CONTOUR
ENGINEERING • LLC

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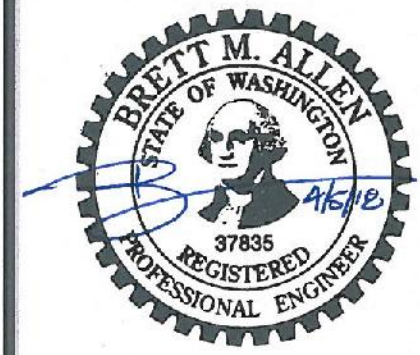
CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

FOR

COTTAGES ON THE RIDGE

KITSAP COUNTY, WASHINGTON

APRIL 2018



Prepared For:
Norpoint Communities
2323 N 31ST ST, SUITE 200
Tacoma, WA 98401

Prepared By:
Kyle Rose, E.I.T., Design Engineer

Approved By:
Brett Allen, P.E., Project Engineer

Project # 17-127

*I hereby state that this Construction Stormwater Pollution Prevention Plan for **Cottages on the Ridge** has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that Kitsap County does not and will not assume liability for the sufficiency, suitability or performance of drainage facilities prepared by me.*

This analysis is based on data and records either supplied to, or obtained by, Contour Engineering, LLC. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry.

Permit Number: 20-01252

TABLE OF CONTENTS

PROJECT DESCRIPTION

Purpose and Scope

This Stormwater Site Plan accompanies the Site Development Activity Permit (SDAP) for the residential development known as Cottages on the Ridge. The project will consist of 103 dwelling units with a mix of single family dwellings and duplexes. The project will gain access through an entrance located within Ridgetop Blvd as well as Timber Shadow Court.

Tax parcels 102501-3-033-2009 and 102501-3-046-2004 are zoned Urban Low Residential with 5-9 dwelling units per acre required.

The subject property is located east of Ridgetop Blvd and north of Timber Shadow court on an unaddressed parcel in a portion of Section 10, Township 25 North, Range 1 East, W.M. See Appendix A for Vicinity Map.

The Kitsap County *2016 Stormwater Management and Site Development Manual* will establish the methodology and design criteria used for this project.

Project Description

The project will construct 103 residential units, a shared community center, internal access ways, driveways and pedestrian pathways, sewer, water, storm and other dry utilities.

The project will result in the following areas:

Total Impervious Area	= 8.97 Ac
Proposed Pond (Includes Access Road)	= 0.87 Ac
Pervious Area (Lawn/Landscape)	= 7.00 Ac
Undisturbed Area (Forested)	= 3.38 Ac
Total Basin Area	= 20.22 Acres

To mitigate the proposed project's stormwater runoff a detention pond has been proposed to meet flow control requirements. Since all stormwater will collected together, all stormwater runoff is considered pollution generating. To meet water quality requirements a wet pond has been proposed. Conveyance systems have been proposed to convey stormwater from the existing nearby ponds and discharge further downstream. See Section 9.0 for detailed analysis and calculations of flow control, water quality, and conveyance capacity.

Existing Site Conditions

Topography

The site has a large amount of elevation change throughout, with the majority of the site having slopes of roughly 50%. The eastern edge of the property generally has less elevation change, with slopes of 5-25%. The entire site has approximately 160 feet of total elevation change.

Ground Cover

Parcel 102501-3-046-2004 has been previously logged, and is mostly covered in small bushes, shrubs, and grass. Logging trails are scattered throughout. Parcel 102501-3-033-2009 has not been logged and is heavily forested. The site is completely undeveloped with no improvements on site.

Native Soils

The NRCS Soil Survey identifies the site as underlain by Alderwood Gravelly Sandy Loam. Alderwood Soils are listed under hydrologic group B, and are considered to be moderately well drained soils.

A geotechnical assessment was completed on site by GeoResources LLC on February 16 and 19th, 2018 and found 0.8 to 1.5 feet of topsoil overlying 1.5 to 2.5 feet of weathered till with glacial till underneath. The majority of test pits found groundwater seepage approximately 3 to 11.5 feet below the ground. Due to the high groundwater table, the high fines content, and density of the glacial till, GeoResources has concluded that infiltration is not feasible for this site.

A copy of the geotechnical report completed by GeoResources is located within Appendix B.

Adjacent Land Uses

The site is bounded as follows:

North:	Thackery Hills Plat, Undeveloped Parcels (Zoned Urban Low Residential)
West:	Ridgetop Blvd ROW
East:	Undeveloped Parcels (Zoned Rural Residential)
South:	Timber Shadow Ct ROW, Timber Glen Plat, Undeveloped Parcels (Zoned Urban Low Residential)

Drainage Patterns

From the topography of the site, it appears all stormwater flows located on site will flow from west to east. No run on from the east will occur due to stormwater improvements located within Ridgetop Blvd ROW. The developed parcels to the north and south have stormwater mitigation in place and will discharge to the nearby detention ponds. These detention ponds currently discharge on to the

project site, but as part of the project improvements will be conveyed further downstream on the east side of the project.

Critical and Sensitive Areas

There are two small unregulated wetlands located on the eastern parcel. These wetlands have appeared due to the detention pond which outfalls into these wetlands. A wetland report has been completed by Soundview Consultants which covers the wetlands in greater detail and can be found in Appendix C.

A geotechnical report has been completed by GeoResources discussing the steep slopes onsite, as well as infiltration feasibility. A copy of the Geotechnical report can be found in Appendix B.

Other Existing Site Information

- Not located in an aquifer recharge area or wellhead protection area
- Does not have specific requirements included in a basin plan for the area
- No historical drainage problems
- No known onsite septic tanks to remain, septic fields, basements, bulkheads, landfills, or underground storage tanks

Erosion Problem Areas

There are no known erosion control problems on the site.

Construction Stormwater Pollution Prevention Elements

The Elements have been addressed and the appropriate BMPs have been incorporated into the Temporary Erosion and Sedimentation Control (TESC) Plan which can be found in Appendix B. Appendix C contains the BMPs used in the sites TESC Plan along with additional BMP's that may be needed if site conditions change as construction progresses. The list of BMPs was taken from the *2016 Kitsap County Stormwater Management and Site Development Manual* and includes:

- BMP C101: Preserving Natural Vegetation
- BMP C103: High Visibility Fence
- BMP C105: Stabilized Construction Entrance
- Bmp C107: Construction Road/Parking Area Stabilization
- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C140: Dust Control

- BMP C150: Materials on Hand
- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage and Containment
- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C207: Check Dams
- BMP C220: Storm Drain Inlet Protection
- BMP C233: Silt Fence
- BMP C235: Straw Wattles
- BMP C241: Temporary Sediment Pond

If necessary, and as site conditions warrant, contractor shall review all available BMPs to provide proper erosion, sediment, and pollutant control on-site.

Element #1: Mark Clearing Limits

Prior to beginning construction activities, all clearing and construction limits shall be delineated. The clearing limits are typically marked with construction fencing, such as a High Visibility Plastic Fence (BMP C103), or with Silt Fencing (BMP C233). The TESC Plan shows the clearing limits for the project.

Element #2: Establish Construction Access

Construction vehicle ingress and egress shall be limited to the Stabilized Construction Entrances (BMP C105) shown on the TESC Plan. The entrance shall be stabilized with quarry spalls to minimize the tracking of sediment onto public roads per the approved plan and BMP C105. It shall be maintained and repaired as needed.

No sediment tracking on the roadway is allowed. In the event that sediment is inadvertently tracked onto the road, the road shall be cleaned thoroughly by the end of that day. Sediment shall be removed from roads by shoveling, sweeping or by another approved means and transported to a controlled sediment disposal area. No street washing of sediments to the storm drain system will be allowed. If deemed necessary, a Wheel Wash (BMP C106) may be needed or an approved mobile wheel wash system may be utilized. It is assumed, if needed, it will be installed at the base of the construction entrance, to one side.

Element #3: Control Flow Rates

Since the project site is over 3 acres, a sediment pond is required. The sediment pond has been sized based on the 10-year peak flow of the site. A temporary riser will be installed to control flow rates leaving the site. Additional Calculations are included within Appendix B. Silt Fencing should be sufficient to control generated runoff along the perimeter of the site. See the plan exhibits in Appendix B. If it is determined that additional measures are needed or instructed by the Inspector, contact the project Erosion Control Lead (CESCL – BMP C160) and the Project Engineer immediately to discuss. Additional BMPs may be employed as needed as field conditions warrant.

Element #4: Install Sediment Controls

As previously stated, Silt Fencing should be adequate for containing sediments on site. Rip Rap should be installed at all pipe outlets per plans, or as needed. Straw Wattles (BMP C235) shall be installed as needed. These could be used in areas of sheet flow to slow down velocities and capture sediments if determined to be needed to prevent erosion. Due to the size of the site, A Temporary Sediment Pond (BMP C241) will need to be constructed. A Temporary sediment pond with surface area of 28,000 SF, 3.5 feet in depth, with 1' of freeboard. See Appendix B for additional details. Areas not needing to be disturbed for the construction operations should be left un-disturbed.

Element #5: Stabilize Soils

Exposed and un-worked soils, such as soil stockpiles, shall be stabilized by application of effective erosion control measures that protect the soil from the erosive forces of raindrops, flowing water, and wind. Such measures include Plastic Covering (BMP C123), Temporary and Permanent Seeding (BMP C120), and Dust Control (BMP 140). Graded slopes of 2:1 or steeper, temporary or permanent, will need to have additional stability measures installed to provide adequate slope protection until stabilized. These additional measures include the use of Mulching (BMP C121), Nets and Blankets (BMP C122), or Sodding (BMP C124).

Staging areas and vehicle parking areas shall be stabilized per BMP C107.

Selected soil stabilization measures shall be appropriate for the time of year, site conditions, estimated duration of use, and the water quality impacts that stabilization agents may have on downstream waters or ground water.

The "Wet Season" is from October 1 to April 30. Within this period, no soils shall remain exposed and un-worked for more than 2 days. The "Dry Season" is from May 1 to September 30. Within this period, no soils shall remain exposed and un-worked for more than 7 days. This stabilization requirement applies to all soils on-site, whether at final grade or not. Soils shall be stabilized at the end of each shift before a holiday or weekend (if needed) based on the weather forecast.

Linear construction activities such as right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirements. Contractors shall install the bedding materials, roadbeds, structures, pipelines, or utilities and re-stabilize the disturbed soils so to adhere to the season timelines outlined in the above paragraph.

Element #6: Protect Slopes

Since a large portion of the project area contains slopes, protection of the slopes will be needed during grading of the site. The primary BMP to protect the slopes is to excavate and grade the site during the dry season, when erosion can be minimized since runoff is minimal. All exposed slopes should be immediately seeded (BMP C120) and further stabilized utilizing Mulching (BMP C121) or Nets and Blankets (BMP C122) as per plans in Appendix B or as needed based on field conditions and direction of City Inspector or Project CESCL. Exposed slopes during the wet season shall also be protected with Plastic Covering (BMP C123), Mulching (BMP C121), or Nets and Blankets (BMP C122). See BMPs in Appendix C.

Element #7: Protect Drain Inlets

It is important to protect storm conveyance systems from any sediment-laden runoff. Both existing and constructed catch basins and other inlets should be protected per the Storm Drainage Inlet Protection BMP (BMP C220). All culvert pipe inlets shall have rip rap protection installed.

Element #8: Stabilize Channels and Outlets

Interceptor Dikes and Swales (BMP C200) shall be constructed throughout the site, due to the steep slopes throughout the site. Rock check dams (BMP C207) shall be installed to provide energy dissipation and some sediment containment. These may be installed as needed per field conditions. The interior channel sides of dikes and swales shall be stabilized using seeded or sodded (BMP C201), rock lined, or nets or blankets (BMP C122) installed if showing signs of any erosion or if field conditions warrant. Interceptor dikes and swales shall be seeded for protection during the "Wet Season". All pipe inlets and outlets will have rip rap placed as needed to ensure proper protection.

Element #9: Control Pollutants

All pollutants, including waste materials and demolition debris, that occur on site during construction shall be handled and disposed of in a manner that does not cause contamination of surface water. Woody debris may be chopped and spread on site. Guidelines for the handling of these materials can be found in (BMP C153) Material Delivery, Storage and Containment.

Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste).

Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into surface water runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

Application of agricultural chemicals including fertilizers and pesticides shall be conducted in a manner and at application rates that will not result in loss of chemical to surface water runoff. Manufacturers' recommendations for application rates and procedures shall be followed.

All applicable BMPs shall be used to prevent or treat contamination of surface water runoff by pH modifying sources. These sources include bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters. Some applicable BMPs include Concrete Handling (BMP C151), Sawcutting and Surfacing Pollution Prevention (BMP C152) and those within Chapter 3 of *Volume IV – Source Control* of the 2016 Gig Harbor Stormwater Management and Site Development Manual.

Element #10: Control Dewatering

It is not anticipated that dewatering will be needed for this project. However, if needed, the following guidance is provided.

Discharge foundation, vault, and trench dewatering water that has similar characteristics to site stormwater runoff into a controlled conveyance system prior to discharge to the sediment pond.

Clean, non-turbid dewatering water, such as well-point groundwater, can be discharged to systems tributary to state surface waters, provided the dewatering flow does not cause erosion or flooding of receiving waters. These clean waters should not be routed through stormwater sediment ponds/tanks.

Handle highly turbid or contaminated dewatering water from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam separately from stormwater at the site.

Other disposal options, depending on site constraints, may include:

- Transport off-site in vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters

- Ecology approved on-site chemical treatment or other suitable treatment technologies
- Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering

Dewatering is not anticipated on this site.

Element #11: Maintain BMPs

Temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with BMPs.

Sediment control BMPs shall be inspected weekly or after a runoff-producing storm event during the "Dry Season" and daily during the "Wet Season". The inspection frequency for stabilized, inactive sites shall be determined by the County based on the level of soil stability and potential for adverse environmental impacts.

Remove temporary erosion and sediment control BMPs within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed and on the approval of the inspector. Trapped sediment shall be removed or stabilized on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

Element #12: Manage the Project

Development projects shall be phased in order to prevent the transport of sediment from the development site during construction, unless the project engineer can demonstrate that construction phasing is infeasible. Re-vegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance and compaction of native soils except as needed for building purposes. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas as may be required by the City, shall be delineated on the site plans and the development site.

Seasonal Work Limitations are from October 1 to April 30 where clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the City that the transport of sediment from the construction site will be prevented. Based on the information provided and local weather conditions, the City may expand or restrict the seasonal limitation on site disturbance. The City may take enforcement action (such

as a notice of violation, administrative order, penalty, or stop-work order) if violations are noticed, required BMPs are not be maintained or the approved plans are not be followed. The following activities are exempt from the seasonal clearing and grading limitations:

1. Routine maintenance and necessary repair of erosion and sediment control BMPs;
2. Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
3. Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Additional BMPs and erosion control measures shall be installed as deemed necessary to protect adjacent properties and right-of-ways. Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, the SWPPP shall be modified, as appropriate, in a timely manner.

Spillage and/or discharge of pollutants shall be reported within 24-hours.

Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into surface water runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

Report spillage or discharge of pollutants within 24-hours to the local jurisdiction.

The Construction SWPPP shall be retained on-site or within reasonable access to the site. The Construction SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance of any BMP. The inspector shall be notified of any changes to the Construction SWPPP. The inspector may require a plan modification to go through the City review process.

Element #13: Protect Low Impact Development BMPs

Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of Construction SWPPP BMPs on portions of the site that drain into Bioretention and/or Rain Garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must

include removal of sediment and any sediment-laden Bioretention/Rain Garden soils, and replacing the removed soils with soils meeting the design specification.

Prevent compacting Bioretention and Rain Garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements, including permeable pavement subgrade, reservoir course, or wearing course.

Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures shown in Volume III of this manual or the manufacturer's procedures.

Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

CONSTRUCTION SEQUENCE

1. Hold a pre-construction meeting with the city and obtain required permits.
2. Field locate and verify all existing services and utilities within the project area. see verification note. field verify horizontal and vertical locations of utilities and utility connections, and provide information to project engineer.
3. Establish clearing and grading limits.
4. Construct perimeter silt fences, tree protection fences, sediment pond, and other erosion control measures as needed.
5. Schedule an erosion control inspection with the city.
6. Demolish and remove existing structures, roads, and utilities.
7. Construct improvements per plans.
8. Stabilize all exposed soils.
9. Contractor shall clean sediment pond as needed during construction.
10. Arrange final inspection with the city.
11. On-site siltation fence to remain until the site is stabilized to the approval of the inspector.
12. Remove TESC measures when allowed by the city inspector.

CONSTRUCTION SCHEDULE

Construction is anticipated to begin as soon as all necessary permits have been issued and be completed within one year.

FINANCIAL/OWNERSHIP RESPONSIBILITIES

Norpoint Communities
2323 N 31ST ST, SUITE 200
Tacoma, WA 98401

EROSION CONTROL SPECIALIST

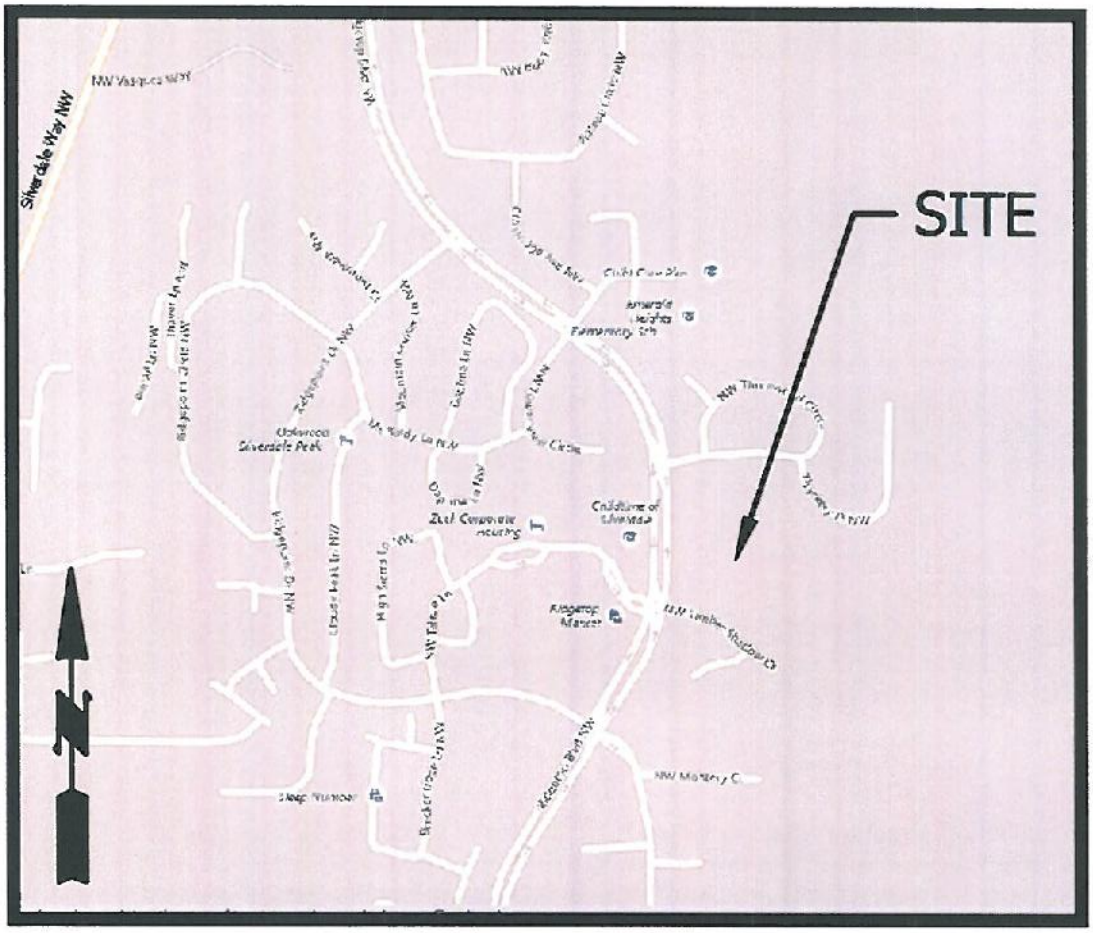
A Certified Professional in Erosion and Sediment Control shall be identified in the Construction SWPPP and shall be on-site or on-call at all times. Certification may be through the WSDOT/AGC of Washington Education Foundation Construction Site Erosion and Sediment Control Certification Program or any equivalent local or national certification and/or training program.

Name: _____

Phone: _____

APPENDIX A

General Exhibits



VICINITY MAP

NOT TO SCALE

BMP C241: Sediment Pond, Volume II, 2005 DOE SMMWW

Dewatering Orifice

$$A_o = \frac{A_s (2h)^{0.5}}{0.6 \cdot 3600 \cdot T g^{0.5}}$$

A_o = Orifice Area (ft^2)
A_s = Pond surface Area (ft^2)
h = Head of water above Orifice (ft)
T = Dewatering time (24 hr)
g = Acc. of gravity (ft/sec^2)

↳ $A_s = \frac{28,000}{3.5}$
$h =$

↳ $A_o = \frac{28000\ (24)^{0.5}}{(0.6)(3600)(24)(32.2)}$

$A_o = 0.252\ ft^2$

Diameter of orifice, D (inches)

↳ $D = 13.54 (\sqrt{A_o})$

↳ $D = 13.54 (\sqrt{\quad})$

$D = 6.80$ in

APPENDIX B

TESC Plan Exhibit

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

GRAPHIC SCALE

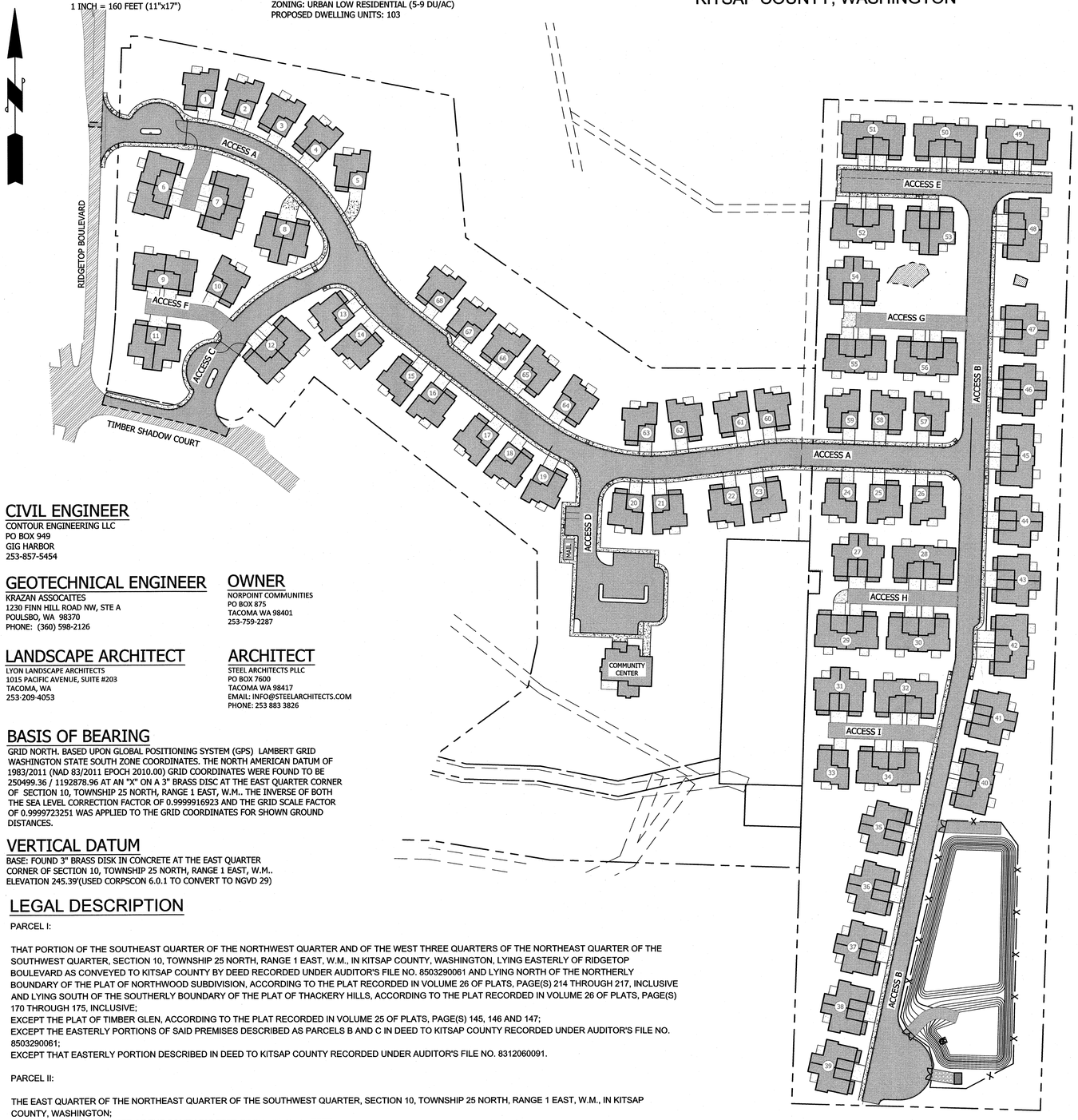
0 80 160

1 INCH = 80 FEET (22"x34")

1 INCH = 160 FEET (11"x17")

SITE INFO

PARCELS:102501-3-046-2004 AND 102501-3-033-2009
PARCEL AREA:21.65 AC
ADDRESS: NO ADDRESS
ZONING: URBAN LOW RESIDENTIAL (5-9 DU/AC)
PROPOSED DWELLING UNITS: 103



CIVIL ENGINEER

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253-857-5454

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PHONE: (360) 598-2126

OWNER

NORPOINT COMMUNITIES
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TACOMA WA 98401
253-759-2287

LANDSCAPE ARCHITECT

LYON LANDSCAPE ARCHITECTS
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TACOMA, WA
253-209-4053

ARCHITECT

STEEL ARCHITECTS PLLC
PO BOX 7600
TACOMA WA 98417
EMAIL: INFO@STEELARCHITECTS.COM
PHONE: 253 883 3826

BASIS OF BEARING

GRID NORTH. BASED UPON GLOBAL POSITIONING SYSTEM (GPS) LAMBERT GRID WASHINGTON STATE SOUTH ZONE COORDINATES. THE NORTH AMERICAN DATUM OF 1983/2011 (NAD 83/2011 EPOCH 2010.00) GRID COORDINATES WERE FOUND TO BE 250499.36 / 1192878.96 AT AN "X" ON A 3" BRASS DISC AT THE EAST QUARTER CORNER OF SECTION 10, TOWNSHIP 25 NORTH, RANGE 1 EAST, W.M.. THE INVERSE OF BOTH THE SEA LEVEL CORRECTION FACTOR OF 0.9999916923 AND THE GRID SCALE FACTOR OF 0.9999723251 WAS APPLIED TO THE GRID COORDINATES FOR SHOWN GROUND DISTANCES.

VERTICAL DATUM

BASE: FOUND 3" BRASS DISK IN CONCRETE AT THE EAST QUARTER CORNER OF SECTION 10, TOWNSHIP 25 NORTH, RANGE 1 EAST, W.M.. ELEVATION 245.39'(USED CORPSCON 6.0.1 TO CONVERT TO NGVD 29)

LEGAL DESCRIPTION

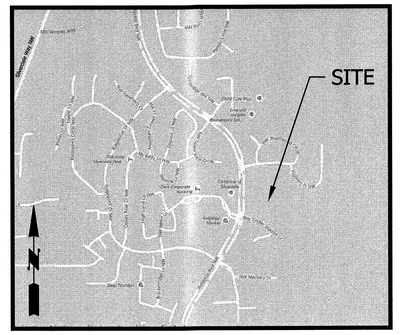
PARCEL I:

THAT PORTION OF THE SOUTHEAST QUARTER OF THE NORTHWEST QUARTER AND OF THE WEST THREE QUARTERS OF THE NORTHEAST QUARTER OF THE SOUTHWEST QUARTER, SECTION 10, TOWNSHIP 25 NORTH, RANGE 1 EAST, W.M., IN KITSAP COUNTY, WASHINGTON, LYING EASTERLY OF RIDGETOP BOULEVARD AS CONVEYED TO KITSAP COUNTY BY DEED RECORDED UNDER AUDITOR'S FILE NO. 8503290061 AND LYING NORTH OF THE NORTHERLY BOUNDARY OF THE PLAT OF NORTHWOOD SUBDIVISION, ACCORDING TO THE PLAT RECORDED IN VOLUME 26 OF PLATS, PAGE(S) 214 THROUGH 217, INCLUSIVE AND LYING SOUTH OF THE SOUTHERLY BOUNDARY OF THE PLAT OF THACKERY HILLS, ACCORDING TO THE PLAT RECORDED IN VOLUME 26 OF PLATS, PAGE(S) 170 THROUGH 175, INCLUSIVE;
EXCEPT THE PLAT OF TIMBER GLEN, ACCORDING TO THE PLAT RECORDED IN VOLUME 25 OF PLATS, PAGE(S) 145, 146 AND 147;
EXCEPT THE EASTERLY PORTIONS OF SAID PREMISES DESCRIBED AS PARCELS B AND C IN DEED TO KITSAP COUNTY RECORDED UNDER AUDITOR'S FILE NO. 8503290061;
EXCEPT THAT EASTERLY PORTION DESCRIBED IN DEED TO KITSAP COUNTY RECORDED UNDER AUDITOR'S FILE NO. 8312060091.

PARCEL II:

THE EAST QUARTER OF THE NORTHEAST QUARTER OF THE SOUTHWEST QUARTER, SECTION 10, TOWNSHIP 25 NORTH, RANGE 1 EAST, W.M., IN KITSAP COUNTY, WASHINGTON;
EXCEPT THE NORTH 30 FEET OF THE SOUTH 707 FEET OF THE WEST 15 FEET.

SHEET INDEX



VICINITY MAP

NOT TO SCALE

LEGEND

SURVEY		PROPOSED
100	CONTOURS	100
	PROPERTY LINE/RIGHT-OF-WAY	
	RIGHT-OF-WAY CENTERLINE	
	EASEMENT	
	BUILDING SETBACK	
-SD-	STORM DRAIN LINE	SD
-S-	SANITARY SEWER LINE	SS
	ROOF DRAIN LINE	RD
	SANITARY SEWER FORCE MAIN LINE	FM
OHP	OVERHEAD POWER LINE	OHP
P	UNDERGROUND POWER LINE	
G	GAS LINE	
	WATER LINE	
	TYPE 2 CATCHBASIN	
	TYPE 1/TYPE 1L CATCHBASIN	
	STORM DRAIN CLEANOUT (SDCO)	
	SANITARY SEWER MANHOLE	
	SANITARY SEWER CLEANOUT (SSCO)	
	HYDRANT	
	WATER VALVE	
	WATER METER	
	SERVICE CABINET	
	JUNCTION BOX (JBOX)	
	GAS MARKING POST	
	GAS METER (GM)	
	GAS VALVE (GV)	
	MONUMENT	
	POWER POLE (PP)	
	GUY WIRE (GW)	
	LIGHT STANDARD/YARD LIGHT (LS/YL)	
TP	TRANSFORMER PAD	
	TELEPHONE JUNCTION BOX	
	SIGNAL BOX (SB)	
	SIGN	
	ASPHALT	
	CONCRETE	
	GRAVEL	
	LANDSCAPE BUFFER	

REVISION	DESCRIPTION	DATE	BY

CONTOUR ENGINEERING • LLC
CIVIL ENGINEERS ~ SURVEYORS ~ LAND PLANNERS
Phone: 253-857-5454 ~ Fax: 253-509-0044 ~ info@contourpllc.com
Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 17005 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: COVER SHEET

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401

CONTACT: TODD STEEL PHONE: 253-759-2287

DESIGNER:	K. ROSE
ENGINEER:	B. ALLEN
DRAWN:	J. JACOBY
S 10 T 25 N R 01E WM	
DATE:	03-07-2018
REVISED:	
PROJECT:	17-127
DWG NAME:	17-127-C

SHEET	REV.
C1	
1 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

0 80 160

1 INCH = 80 FEET (22"x34")

1 INCH = 160 FEET (11"x17")

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

Permit Number: 20-01254

REVISION	DESCRIPTION	DATE	BY

CONTOUR ENGINEERING · LLC

CIVIL ENGINEERS ~ SURVEYORS ~ LAND PLANNERS

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Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 17103 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: HORIZONTAL CONTROL

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401

CONTACT: TODD STEEL PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C2	△
2 OF 68	

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

GRAPHIC SCALE

0 30 30

1 INCH = 30 FEET (22"x34")

1 INCH = 60 FEET (11"x17")

CHECK DAM NOTE

CONTRACTOR TO PLACE CHECK DAMS ALONG INTERCEPTOR DITCH. MAX CHECK DAM SPACING SHALL BE SUCH THAT THE TOE OF THE UPSTREAM DAM IS THE SAME ELEVATION AS THE TOP OF THE DOWNSTREAM DAM. SEE BMP C207 FOR ADDITIONAL DETAILS.

INTERCEPTOR DITCH NOTE

INTERCEPTOR DITCHES SHOWN ARE A SUGGESTION BASED ON GRADES. CONTRACTOR SHALL ADD AND ADJUST DITCHES AS NEEDED AND AS FIELD CONDITIONS WARRANT. INTERCEPTOR DITCH SHALL HAVE A MINIMUM SLOPE OF 2.5%.

INTERCEPTOR DITCH CROSS SECTION

N.T.S.

TESC LEGEND

PP	PRESERVE AND PROTECT AS NOTED	
FF	FILTER FABRIC FENCE	1 C67
IP	INLET PROTECTION	2 C67
CL	CLEARING LIMITS (18.93 ACRES)	
DR	DEMOLISH AND REMOVE	
CE	CONSTRUCTION ENTRANCE	3 C67
SC	SAWCUT LINE FOR GRIND OVERLAY	
ID	INTERCEPTOR DITCH	
CD	CHECK DAM SEE CHECK DAM NOTE	3 C68

INLET PROTECTION NOTE

INLET PROTECTION SHALL BE INSTALLED IN ALL EXISTING INLETS DOWNSTREAM AND WITHIN 500 FEET OF SITE DISTURBED AREAS. ALL NEW INLETS, BOTH ON SITE AND OFF SITE INLETS (IF ANY) SHALL HAVE INLET PROTECTION AS WELL.

CONSTRUCTION SEQUENCE

1. HOLD A PRE-CONSTRUCTION MEETING WITH THE CITY AND OBTAIN REQUIRED PERMITS.
2. FIELD LOCATE AND VERIFY ALL EXISTING SERVICES AND UTILITIES WITHIN THE PROJECT AREA. SEE VERIFICATION NOTE. FIELD VERIFY HORIZONTAL AND VERTICAL LOCATIONS OF UTILITIES AND UTILITY CONNECTIONS, AND PROVIDE INFORMATION TO PROJECT ENGINEER.
3. ESTABLISH CLEARING AND GRADING LIMITS.
4. CONSTRUCT PERIMETER SILT FENCES, TREE PROTECTION FENCES, SEDIMENT POND, AND OTHER EROSION CONTROL MEASURES AS NEEDED.
5. SCHEDULE CLEARING LIMITS, TREE PROTECTION AND EROSION CONTROL INSPECTIONS WITH THE CITY.
6. POTHOLE ALL EXISTING UTILITIES WITHIN CONSTRUCTION AREA. SEE VERIFICATION NOTE, THIS SHEET
7. DEMOLISH AND REMOVE EXISTING STRUCTURES, ROADS, AND UTILITIES.
8. CONSTRUCT IMPROVEMENTS PER PLANS.
9. STABILIZE ALL EXPOSED SOILS.
10. CONTRACTOR SHALL CLEAN SEDIMENT POND AS NEEDED DURING CONSTRUCTION.
11. ARRANGE FINAL INSPECTION WITH THE CITY.
12. ON-SITE SILTATION FENCE TO REMAIN UNTIL THE SITE IS STABILIZED TO THE APPROVAL OF THE INSPECTOR.
13. REMOVE TESC MEASURES WHEN ALLOWED BY THE CITY INSPECTOR.

VERIFICATION NOTE

ALL EXISTING UTILITIES IN THE CONSTRUCTION AREA SHALL BE IDENTIFIED AND VERIFIED FOR DEPTH AND LOCATION PRIOR TO ANY CONSTRUCTION ACTIVITIES SO TO IDENTIFY ANY POTENTIAL CONFLICTS WITH PROPOSED CONSTRUCTION. CONTACT PROJECT ENGINEER IMMEDIATELY IF ANY CONFLICTS ARE IDENTIFIED.

PRIOR TO ANY CONSTRUCTION ACTIVITIES, VERIFY EXISTING TOPOGRAPHY IS CONSISTENT WITH WHAT IS SHOWN ON PLANS AND IF THERE ARE ANY POTENTIAL CONFLICTS WITH PROPOSED CONSTRUCTION ACTIVITIES. CONTACT PROJECT ENGINEER IMMEDIATELY IF ANY CONFLICTS ARE IDENTIFIED.

CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG

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Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 19961 REGISTERED PROFESSIONAL ENGINEER

SHEET TITLE: TESC PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401 — CONTACT: TODD STEEL — PHONE: 253-759-2287

DESIGNER:	K. ROSE
ENGINEER:	B. ALLEN
DRAWN:	J. JACOBY
S 10 T 25 N R 01E WM	
DATE:	03-07-2018
REVISED:	
PROJECT:	17-127
DWG NAME:	17-127-C

SHEET	REV.
C3	△
3 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

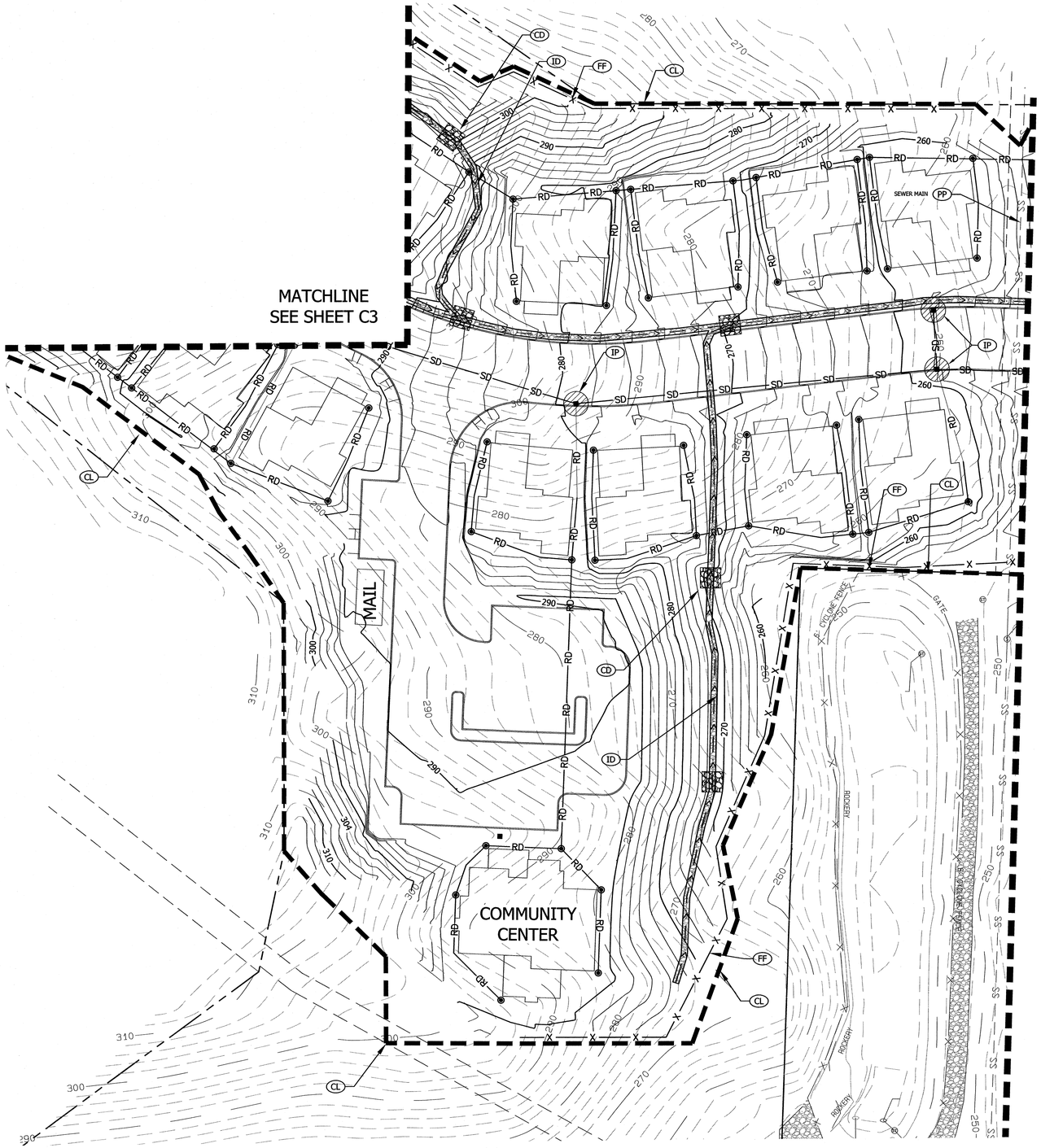
0 30 60

1 INCH = 30 FEET (22"x34")

1 INCH = 60 FEET (11"x17")

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON



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BRETT M. ALLEN — STATE OF WASHINGTON — 17900 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: TESC PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401

CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: J. JACOBY
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C4	△
4 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

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COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

TEMPORARY SEDIMENT POND NOTE

A TEMPORARY SEDIMENT POND IS REQUIRED, WHICH MAY BE BUILT WITHIN THE PERMANENT POND LOCATION. TEMPORARY SEDIMENT POND TO HAVE A MINIMUM 3.5' DEPTH, 1.0' FREEBOARD AND SURFACE AREA AT TOP OF 28,00 SQ FT. SEE SWPPP FOR ADDITIONAL DETAILS.

VERIFICATION NOTE

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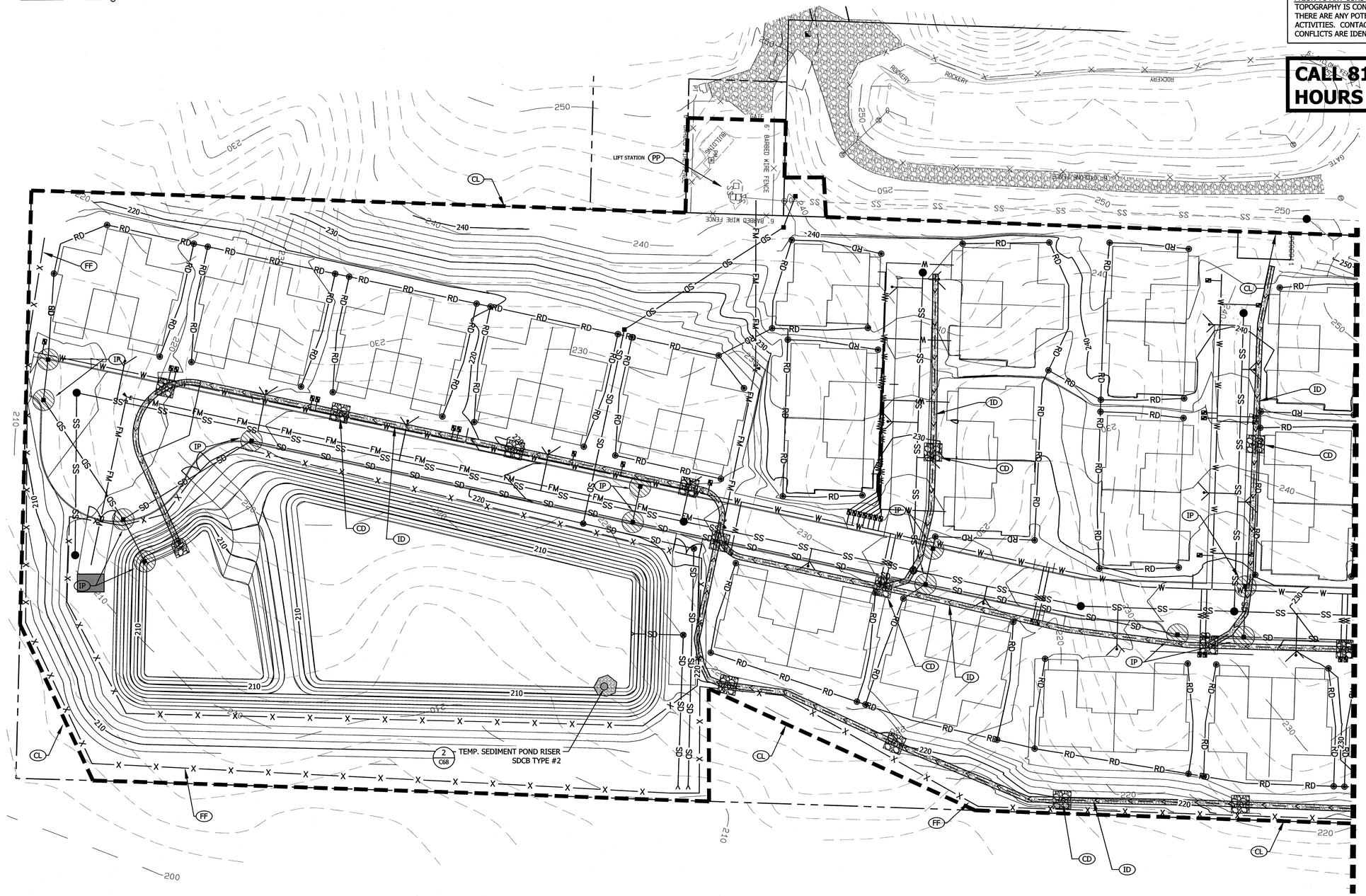

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Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 37600 — REGISTERED PROFESSIONAL ENGINEER — 4/13/18

SHEET TITLE: TESC PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401

CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: J. JACOBY
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C5	△
5 OF 68	

Permit Number: 20-01254

GRAPHIC SCALE

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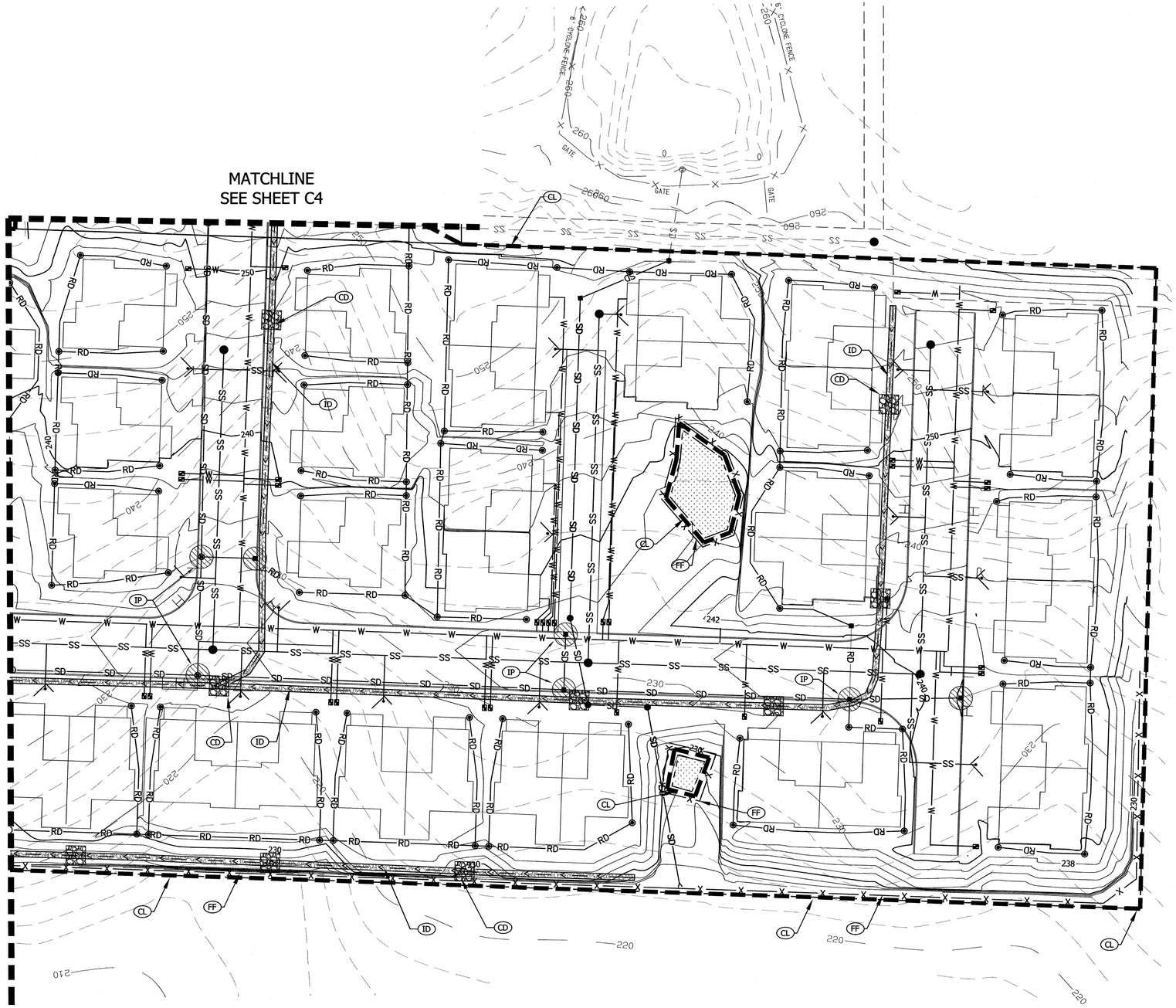
1 INCH = 30 FEET (22"x34")

1 INCH = 60 FEET (11"x17")

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON



VERIFICATION NOTE

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Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 19965 — REGISTERED PROFESSIONAL ENGINEER — 4/30/19

SHEET TITLE: TESC PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401

CONTACT: TODD STEEL PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: J. JACOBY
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C6	△
6 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

0 20 40

1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

AMENDED SOILS NOTE

ALL AREAS SUBJECT TO CLEARING AND GRADING WHICH HAVE NOT BEEN COVERED BY IMPERVIOUS SURFACING, INCORPORATED INTO A DRAINAGE FACILITY, OR ENGINEERED AS STRUCTURAL FILL OR SLOPE SHALL BE AMENDED TO MEET POST-CONSTRUCTION SOIL QUALITY AND DEPTH PER DETAIL 1, SHEET C40.

STRUCTURE FINISH FLOOR NOTE

FINISH FLOOR NOTED ON THE PLANS FOR EACH STRUCTURE IS THE FINISH FLOOR ELEVATION WHERE THE GARAGE MEETS THE DRIVEWAY. MAIN FLOOR OF EACH STRUCTURE WILL BE AN ADDITIONAL 0.25-0.33 FEET HIGHER, SEE ARCHITECTURAL PLANS FOR DETAILS.

GRADING NOTES

1. SPOT ELEVATIONS SHOWN ARE FOR FINISHED GRADE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
2. CONTOUR LINES ARE FOR VISUAL REFERENCE. GRADING SHALL BE PER SPOT ELEVATIONS.
3. TOP OF CURB (TC) WILL BE 0.5' ABOVE BOTTOM OF CURB (BC) UNLESS OTHERWISE SPECIFIED.

GRADING QUANTITIES

CUT =	85,000	CU YD±
FILL =	101,750	CU YD±
NET =	16,750	CU YD± (FILL)

ROAD SECTION=6,050 CU YD (IMPORT)
SIDEWALK SECTION=575 CU YD (IMPORT)
DRIVEWAY SECTION=750 CU YD (IMPORT)
PIPE BED MATERIAL=1,400 CU YD (IMPORT) (SEWER/STORM/WATER MAINS)

TOTAL=7,975 CU YD IMPORT

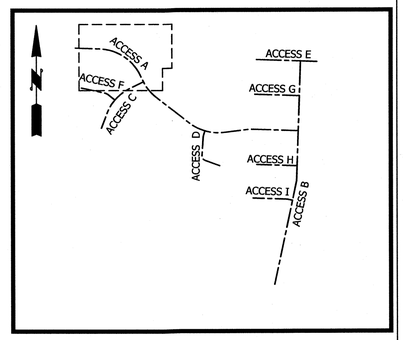
STRIPPINGS/TOP SOIL (ASSUMES 0.5')= 14,000 CU YD ASSUMED REPLACED ON SITE

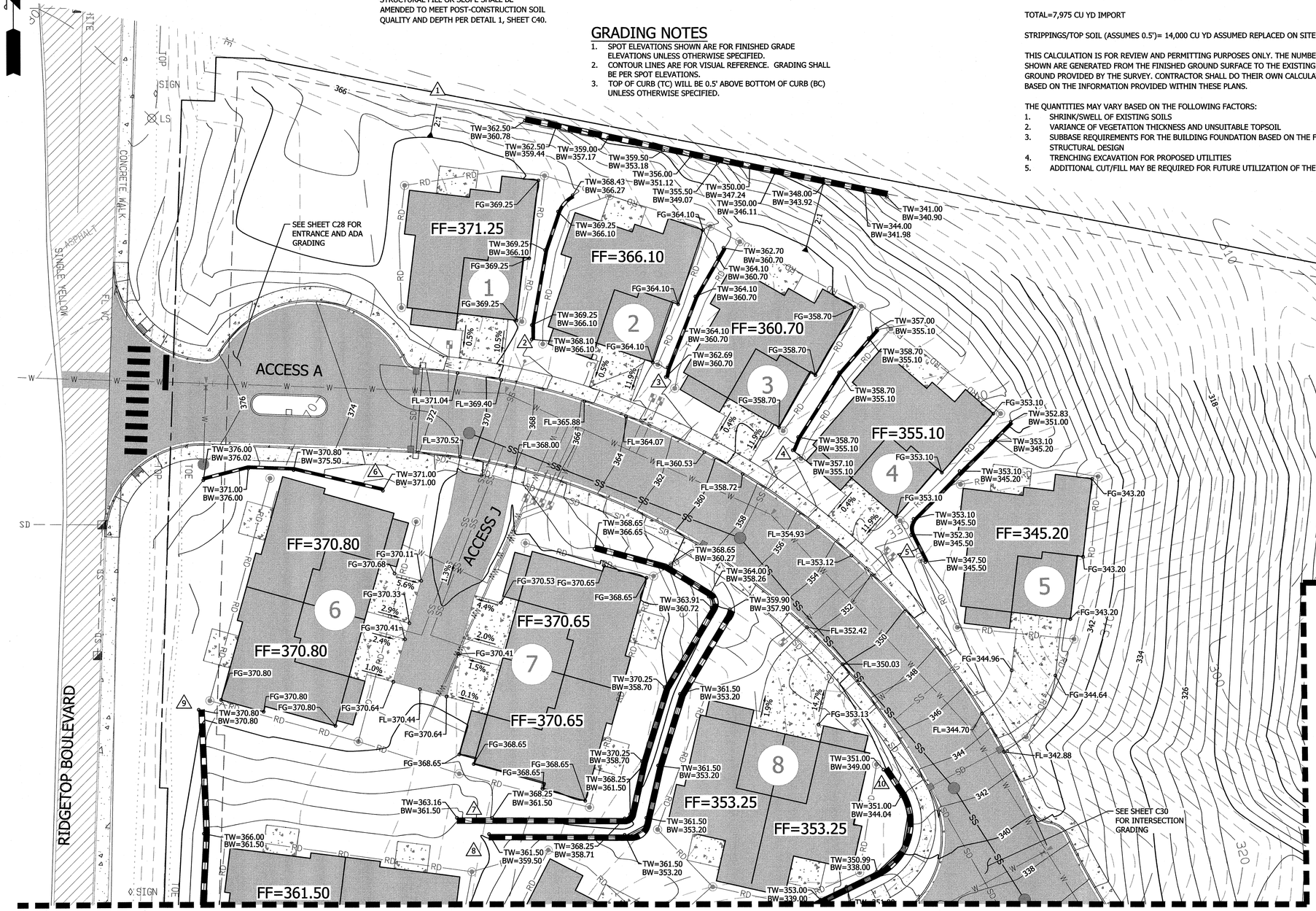
THIS CALCULATION IS FOR REVIEW AND PERMITTING PURPOSES ONLY. THE NUMBERS SHOWN ARE GENERATED FROM THE FINISHED GROUND SURFACE TO THE EXISTING GROUND PROVIDED BY THE SURVEY. CONTRACTOR SHALL DO THEIR OWN CALCULATION BASED ON THE INFORMATION PROVIDED WITHIN THESE PLANS.

THE QUANTITIES MAY VARY BASED ON THE FOLLOWING FACTORS:
1. SHRINK/SWELL OF EXISTING SOILS
2. VARIANCE OF VEGETATION THICKNESS AND UNSUITABLE TOPSOIL
3. SUBBASE REQUIREMENTS FOR THE BUILDING FOUNDATION BASED ON THE FINAL STRUCTURAL DESIGN
4. TRENCHING EXCAVATION FOR PROPOSED UTILITIES
5. ADDITIONAL CUT/FILL MAY BE REQUIRED FOR FUTURE UTILIZATION OF THE SITE

KEY MAP

NTS





GRADING ACRONYMS

BC	= BOTTOM OF CURB
TC	= TOP OF CURB
EG	= EXISTING GRADE
ME	= MATCH EXISTING GRADE
BW	= BOTTOM OF WALL
TW	= TOP OF WALL
LP	= LOW POINT
FF	= FINISH FLOOR
FL	= FLOW LINE
HP	= HIGH POINT
FG	= FINISH GRADE

GRADING SETBACK NOTE

GRADING SHALL BE SETBACK FROM PERIMETER PROPERTY AS FOLLOWS

CUT DEPTH	SETBACK DISTANCE
<10 FEET	2 FEET
10 - 50 FEET	HEIGHT/5
>50 FEET	10 FEET

FILL DEPTH	SETBACK DISTANCE
<4 FEET	2 FEET
4 - 40 FEET	HEIGHT/2
>40 FEET	20 FEET

VERIFICATION NOTE

ALL EXISTING UTILITIES IN THE CONSTRUCTION AREA SHALL BE IDENTIFIED AND VERIFIED FOR DEPTH AND LOCATION PRIOR TO ANY CONSTRUCTION ACTIVITIES SO TO IDENTIFY ANY POTENTIAL CONFLICTS WITH PROPOSED CONSTRUCTION. CONTACT PROJECT ENGINEER IMMEDIATELY IF ANY CONFLICTS ARE IDENTIFIED.

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BRETT M. ALLEN — STATE OF WASHINGTON — 22800 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401 — CONTACT: TODD STEEL — PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C7	△
7 OF 68	

Permit Number: 20-01252

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M., KITSAP COUNTY, WASHINGTON

GRAPHIC SCALE

0 20 40

1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

GRADING ACRONYMS

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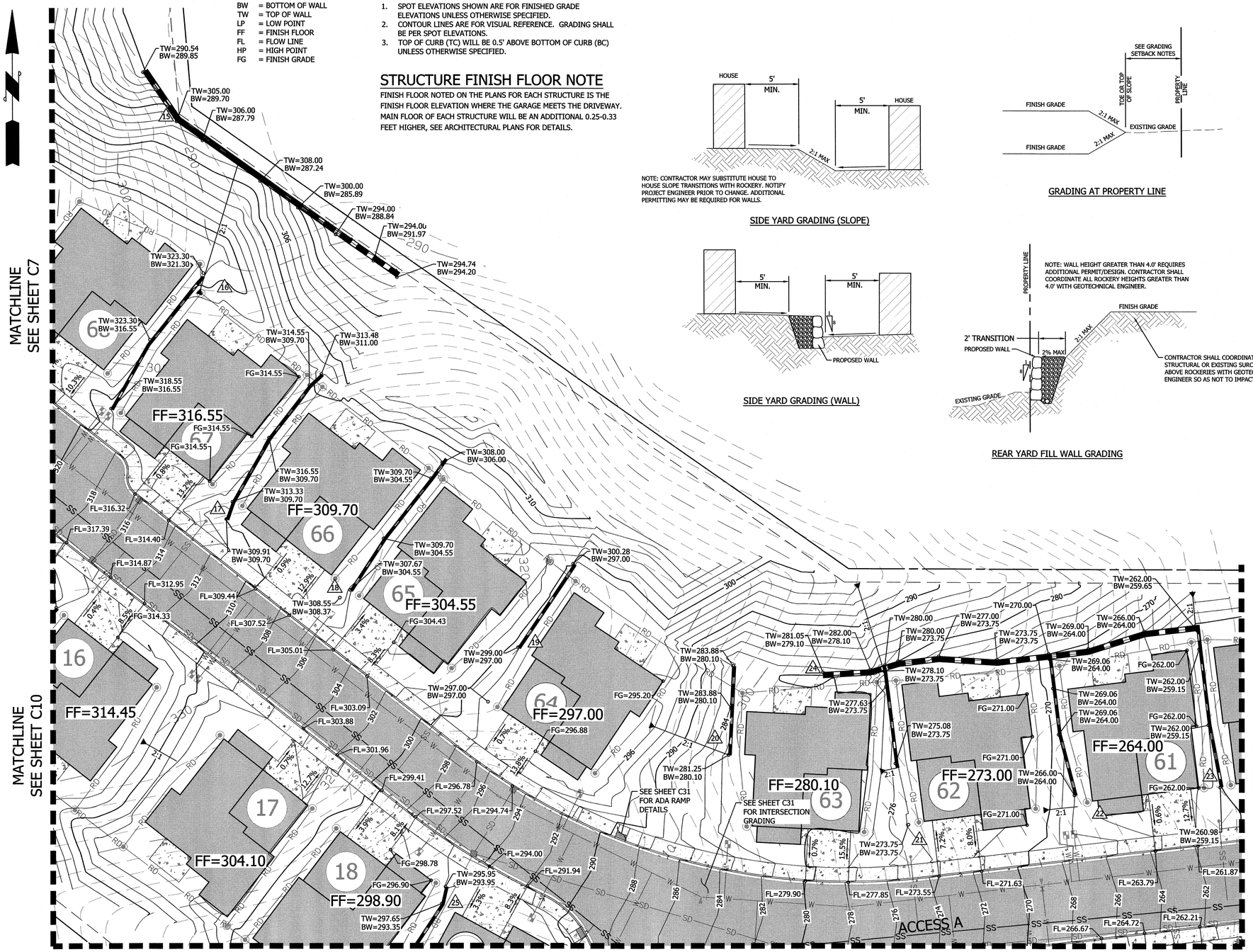
GRADING NOTES

1. SPOT ELEVATIONS SHOWN ARE FOR FINISHED GRADE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
2. CONTOUR LINES ARE FOR VISUAL REFERENCE. GRADING SHALL BE PER SPOT ELEVATIONS.
3. TOP OF CURB (TC) WILL BE 0.5' ABOVE BOTTOM OF CURB (BC) UNLESS OTHERWISE SPECIFIED.

STRUCTURE FINISH FLOOR NOTE

FINISH FLOOR NOTED ON THE PLANS FOR EACH STRUCTURE IS THE FINISH FLOOR ELEVATION WHERE THE GARAGE MEETS THE DRIVEWAY. MAIN FLOOR OF EACH STRUCTURE WILL BE AN ADDITIONAL 0.25-0.33 FEET HIGHER, SEE ARCHITECTURAL PLANS FOR DETAILS.



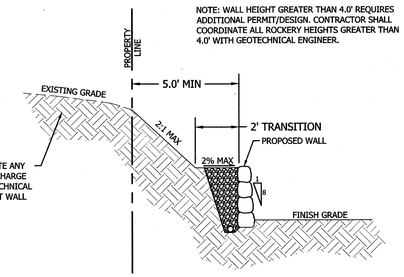
NOTE: CONTRACTOR MAY SUBSTITUTE HOUSE TO HOUSE SLOPE TRANSITIONS WITH ROCKERY. NOTIFY PROJECT ENGINEER PRIOR TO CHANGE. ADDITIONAL PERMITTING MAY BE REQUIRED FOR WALLS.

SIDE YARD GRADING (SLOPE)

SIDE YARD GRADING (WALL)

GRADING AT PROPERTY LINE

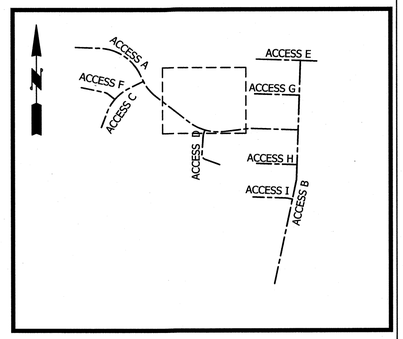
REAR YARD FILL WALL GRADING



REAR YARD CUT WALL GRADING

KEY MAP

NTS



GRADING SETBACK NOTE

GRADING SHALL BE SETBACK FROM PERIMETER PROPERTY AS FOLLOWS

CUT DEPTH	SETBACK DISTANCE
<10 FEET	2 FEET
10 - 50 FEET	HEIGHT/5
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FILL DEPTH	SETBACK DISTANCE
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>40 FEET	20 FEET

VERIFICATION NOTE

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BRETT M. ALLEN STATE OF WASHINGTON 19905 REGISTERED PROFESSIONAL ENGINEER 4/5/18

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401

CONTACT: TODD STEEL PHONE: 253-759-2287

DESIGNER:	K. ROSE
ENGINEER:	B. ALLEN
DRAWN:	B. MORRIS
S 10 T 25 N R 01E WM	
DATE:	03-07-2018
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PROJECT:	17-127
DWG NAME:	17-127-C

SHEET	REV.
C8	△
8 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

0 20 40

1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

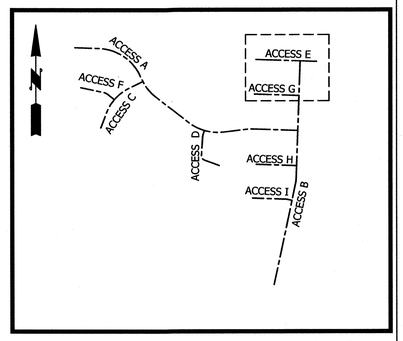
COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON

MATCHLINE
SEE SHEET C12

KEY MAP

NTS



GRADING ACRONYMS

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GRADING NOTES

1. SPOT ELEVATIONS SHOWN ARE FOR FINISHED GRADE ELEVATIONS UNLESS OTHERWISE SPECIFIED.
2. CONTOUR LINES ARE FOR VISUAL REFERENCE. GRADING SHALL BE PER SPOT ELEVATIONS.
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GRADING SETBACK NOTE

GRADING SHALL BE SETBACK FROM PERIMETER PROPERTY AS FOLLOWS

CUT DEPTH	SETBACK DISTANCE
<10 FEET	2 FEET
10 - 50 FEET	HEIGHT/5
>50 FEET	10 FEET

FILL DEPTH	SETBACK DISTANCE
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>40 FEET	20 FEET

VERIFICATION NOTE

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CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG

REVISION	DESCRIPTION	DATE	BY

CONTOUR ENGINEERING, LLC
CIVIL ENGINEERS ~ SURVEYORS ~ LAND PLANNERS
Phone: 253-857-5454 ~ Fax: 253-509-0044 ~ info@contourpllc.com
Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 37935 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401
CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C9	△
9 OF 68	

GRAPHIC SCALE

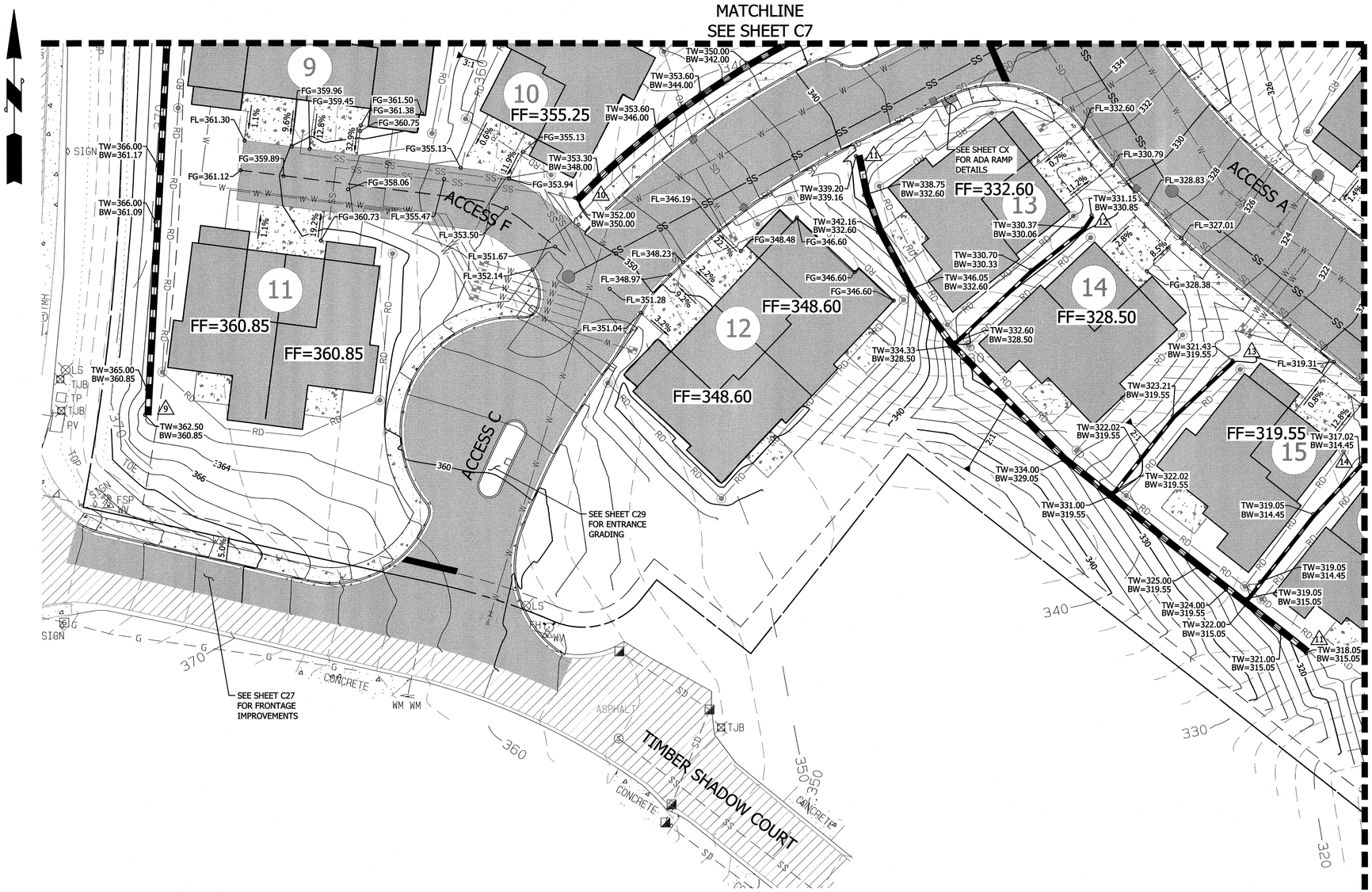
0 20 40

1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

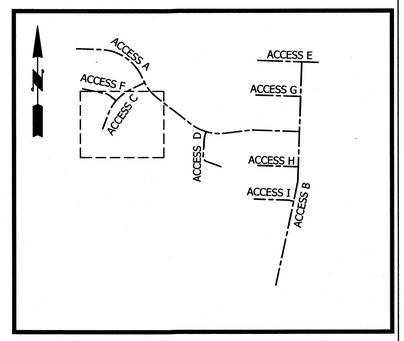
COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON



KEY MAP

NTS



GRADING ACRONYMS

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TC	= TOP OF CURB
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Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 19965 — REGISTERED PROFESSIONAL ENGINEER

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401 — PHONE: 253-759-2287 — CONTACT: TODD STEEL

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C10	△
10 OF 68	

Permit Number: 20-01258

GRAPHIC SCALE

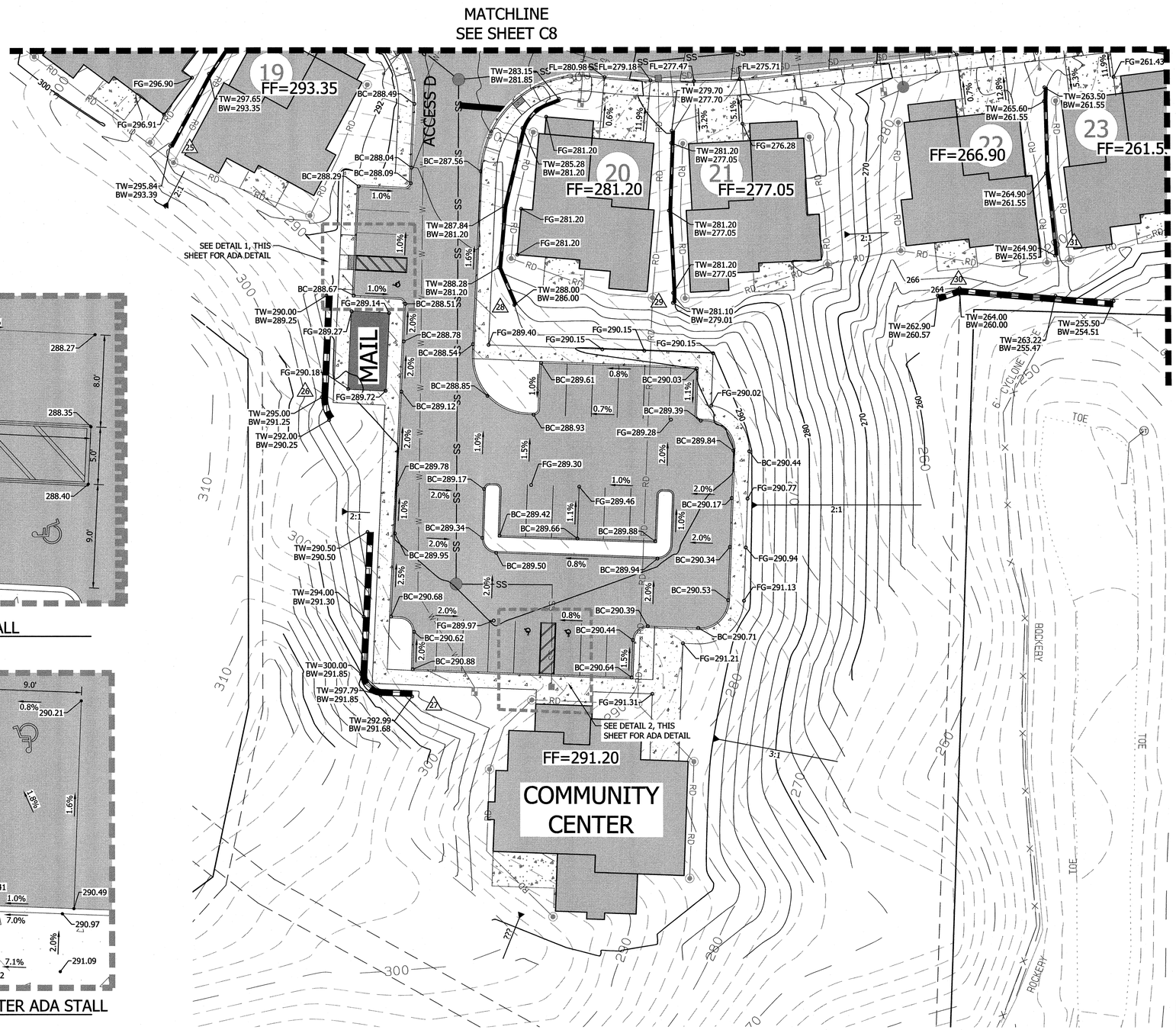
0 20 40

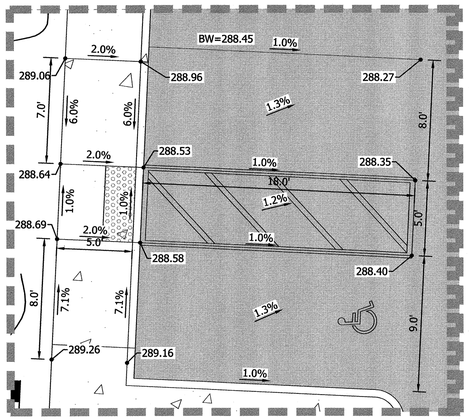
1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

COTTAGES ON THE RIDGE

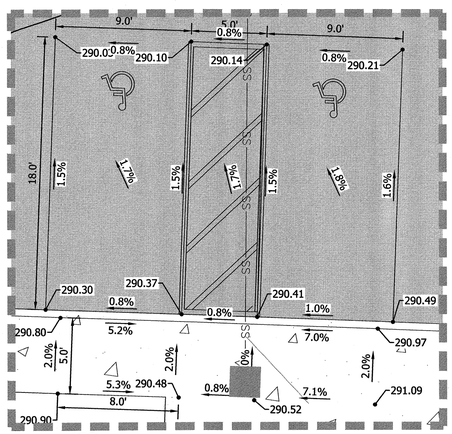
A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON





1 MAILBOX ADA STALL

SCALE: 1"=5'

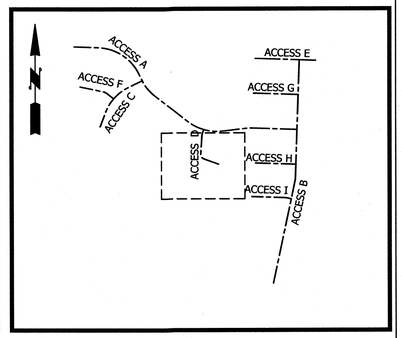


2 COMMUNITY CENTER ADA STALL

SCALE: 1"=5'

KEY MAP

NTS



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CIVIL ENGINEERS ~ SURVEYORS ~ LAND PLANNERS
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Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 21578 — REGISTERED PROFESSIONAL ENGINEER

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES, P.O. BOX 875, TACOMA, WA 98401

CONTACT: TODD STEEL PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C11	△
11 OF 68	

Permit Number: 20-01254

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON

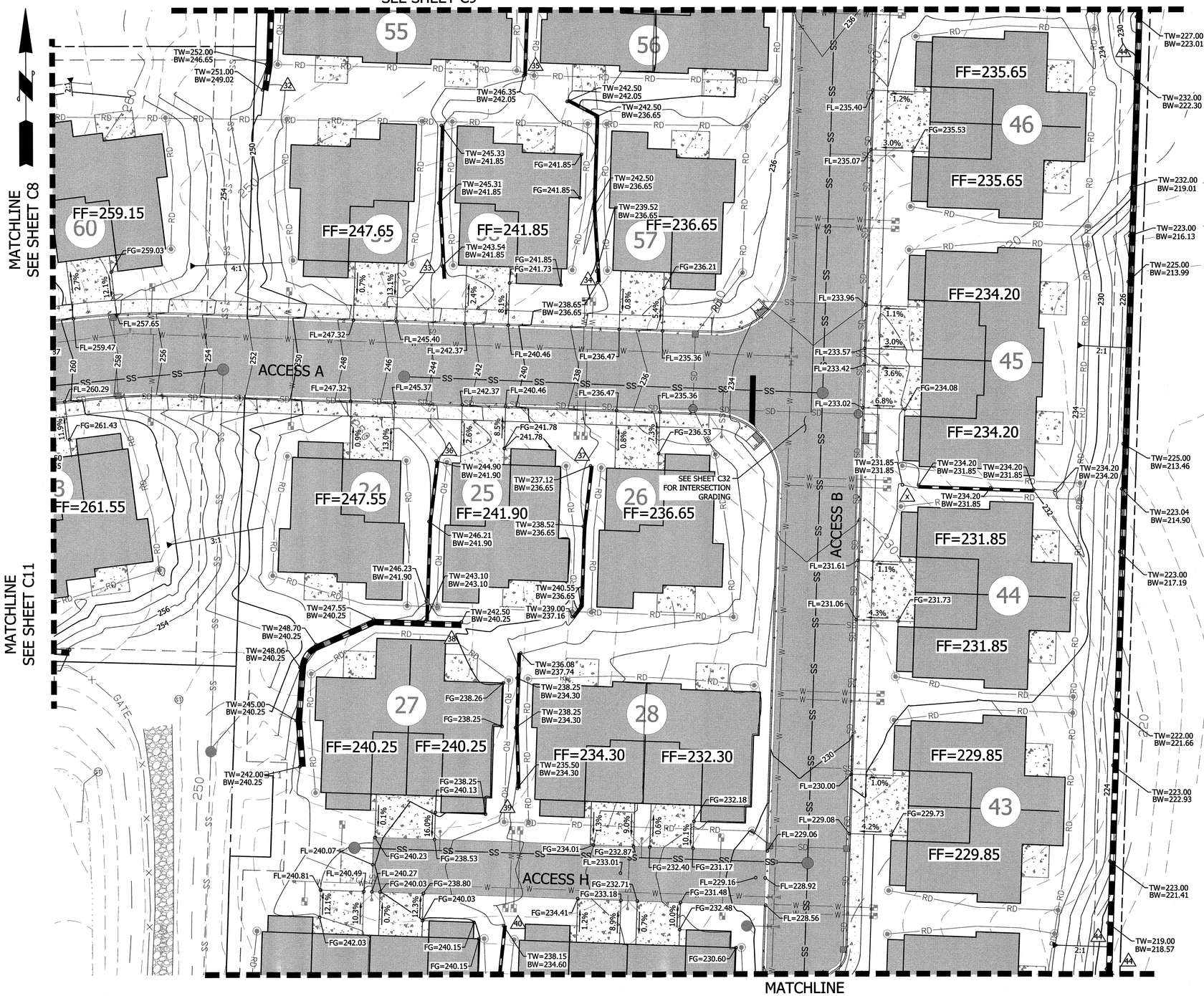
GRAPHIC SCALE
0 20 40
1 INCH = 20 FEET (22"x34")
1 INCH = 40 FEET (11"x17")

MATCHLINE
SEE SHEET C9

MATCHLINE
SEE SHEET C8

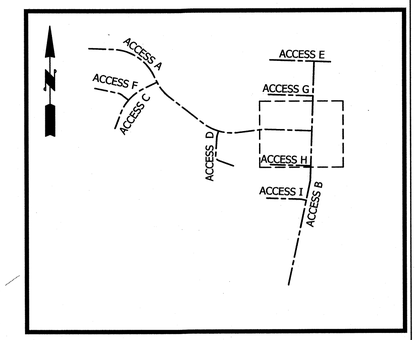
MATCHLINE
SEE SHEET C11

MATCHLINE
SEE SHEET C13



KEY MAP

NTS



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Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 19920 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: PRELIMINARY GRADING PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401
CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER:	K. ROSE
ENGINEER:	B. ALLEN
DRAWN:	B. MORRIS
S 10 T 25 N R 01E WM	
DATE:	03-07-2018
REVISED:	
PROJECT:	17-127
DWG NAME:	17-127-C

SHEET	REV.
C12	△
12 OF 68	

GRAPHIC SCALE

0 20 40

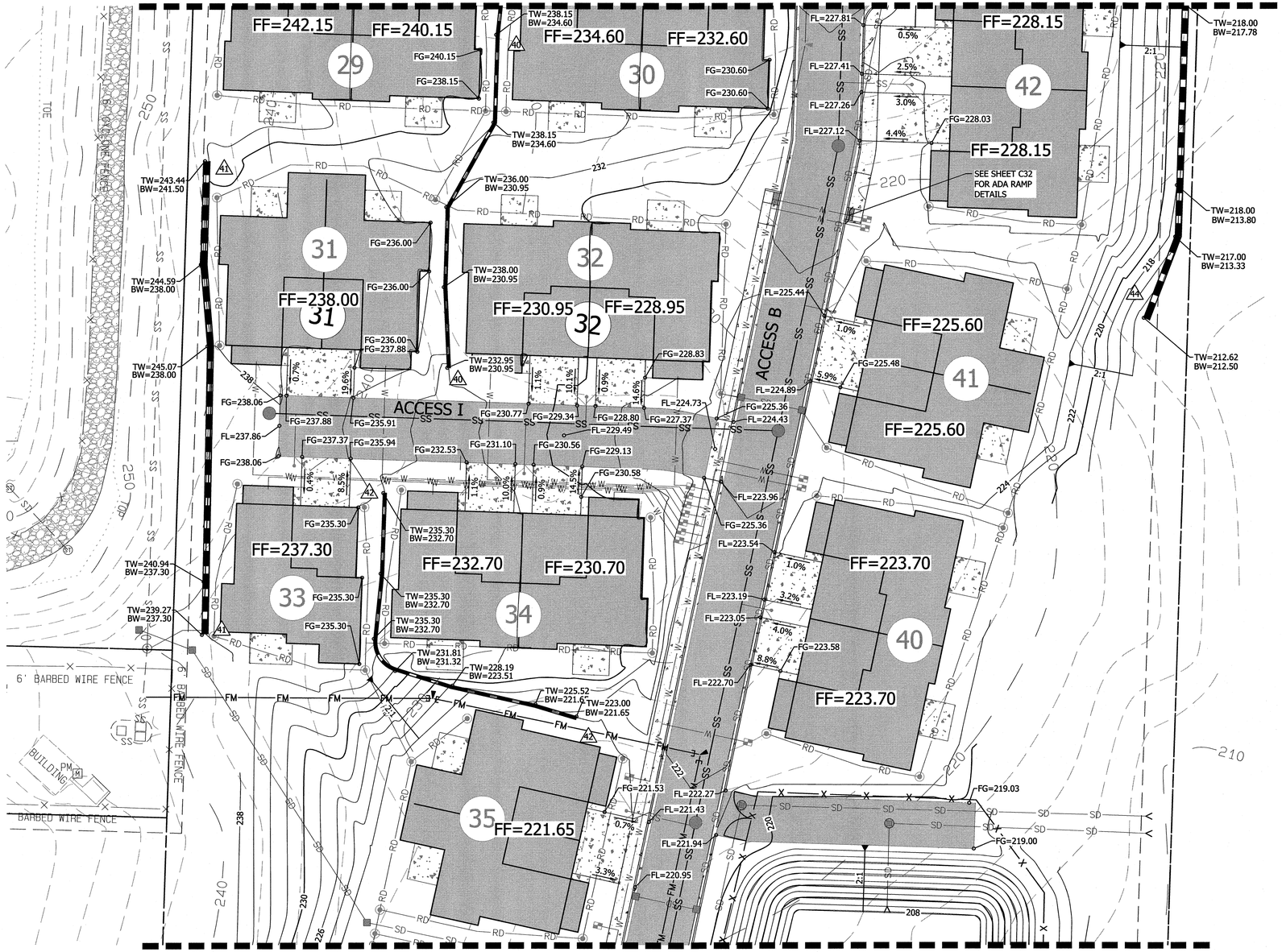
1 INCH = 20 FEET (22"x34")

1 INCH = 40 FEET (11"x17")

COTTAGES ON THE RIDGE

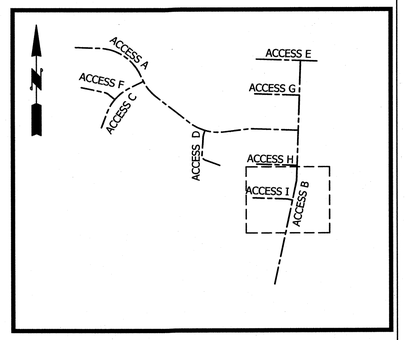
A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON

MATCHLINE
SEE SHEET C12



KEY MAP

NTS



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CONTOUR
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ENGINEERS ~ SURVEYORS ~ LAND PLANNERS
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Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 37828 — REGISTERED PROFESSIONAL ENGINEER

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401
CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C13	△
13 OF 68	

Permit Number: 20-01258

COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON

GRAPHIC SCALE
0 20 40
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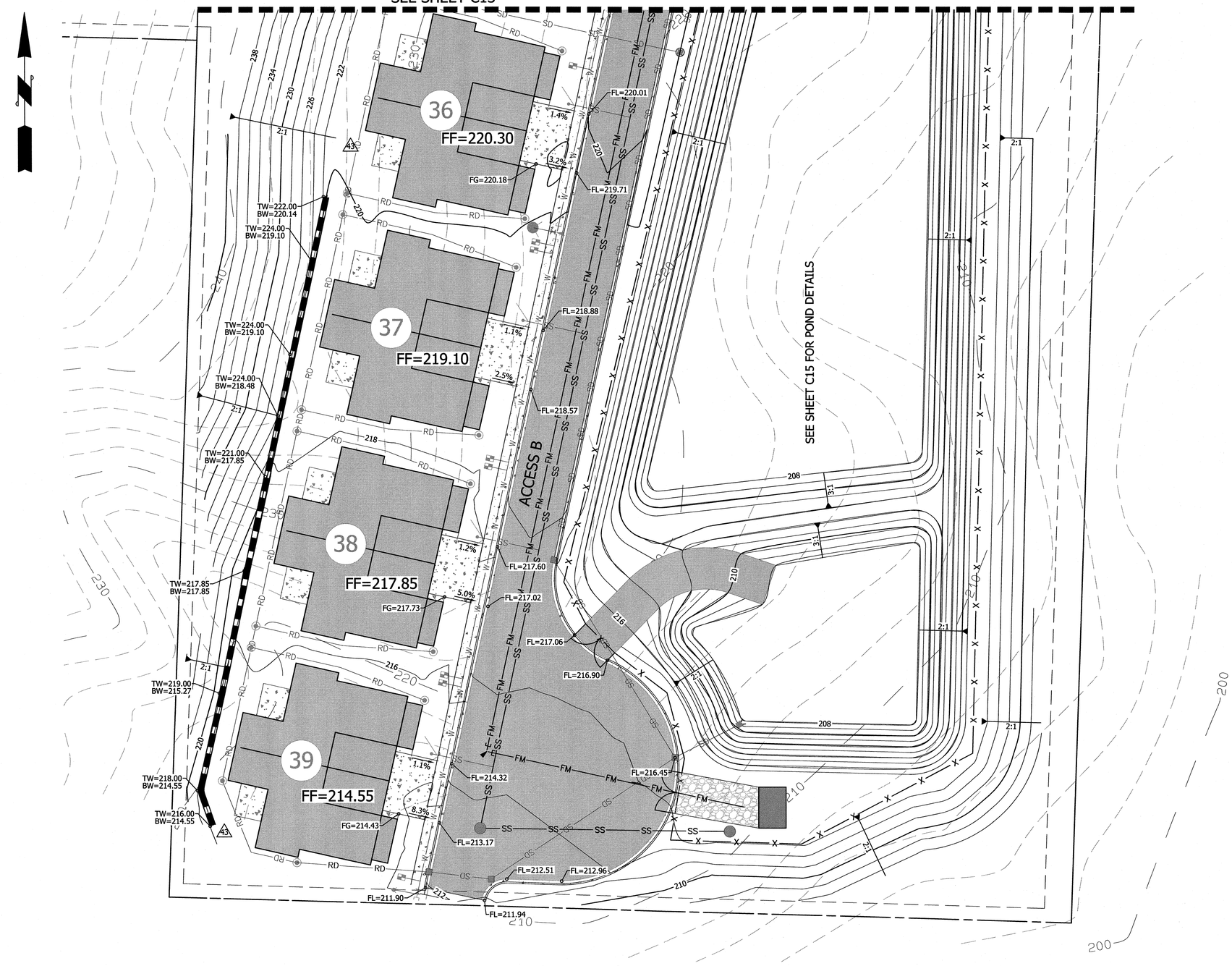
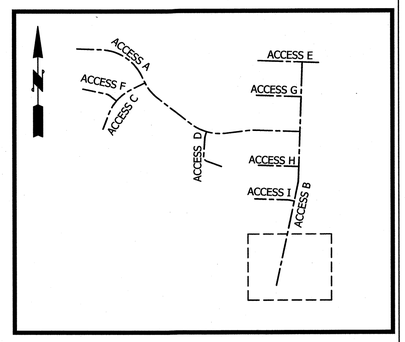


KEY MAP

NTS



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Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 37805 — REGISTERED PROFESSIONAL ENGINEER

SHEET TITLE: GRADING PLAN

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401

CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C14	△
14 OF 68	

Permit Number: 20-01252

GRAPHIC SCALE

0 20 40

1 INCH = 20 FEET (22"x34")

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COTTAGES ON THE RIDGE

A PORTION OF SECTION 10, TOWNSHIP 25N, RANGE 1E, W.M.,
KITSAP COUNTY, WASHINGTON

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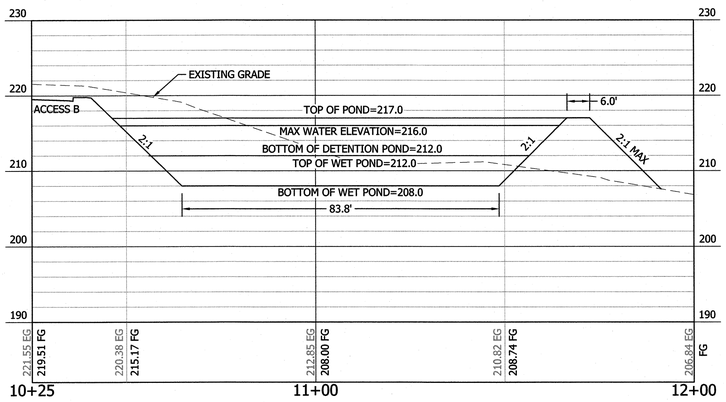
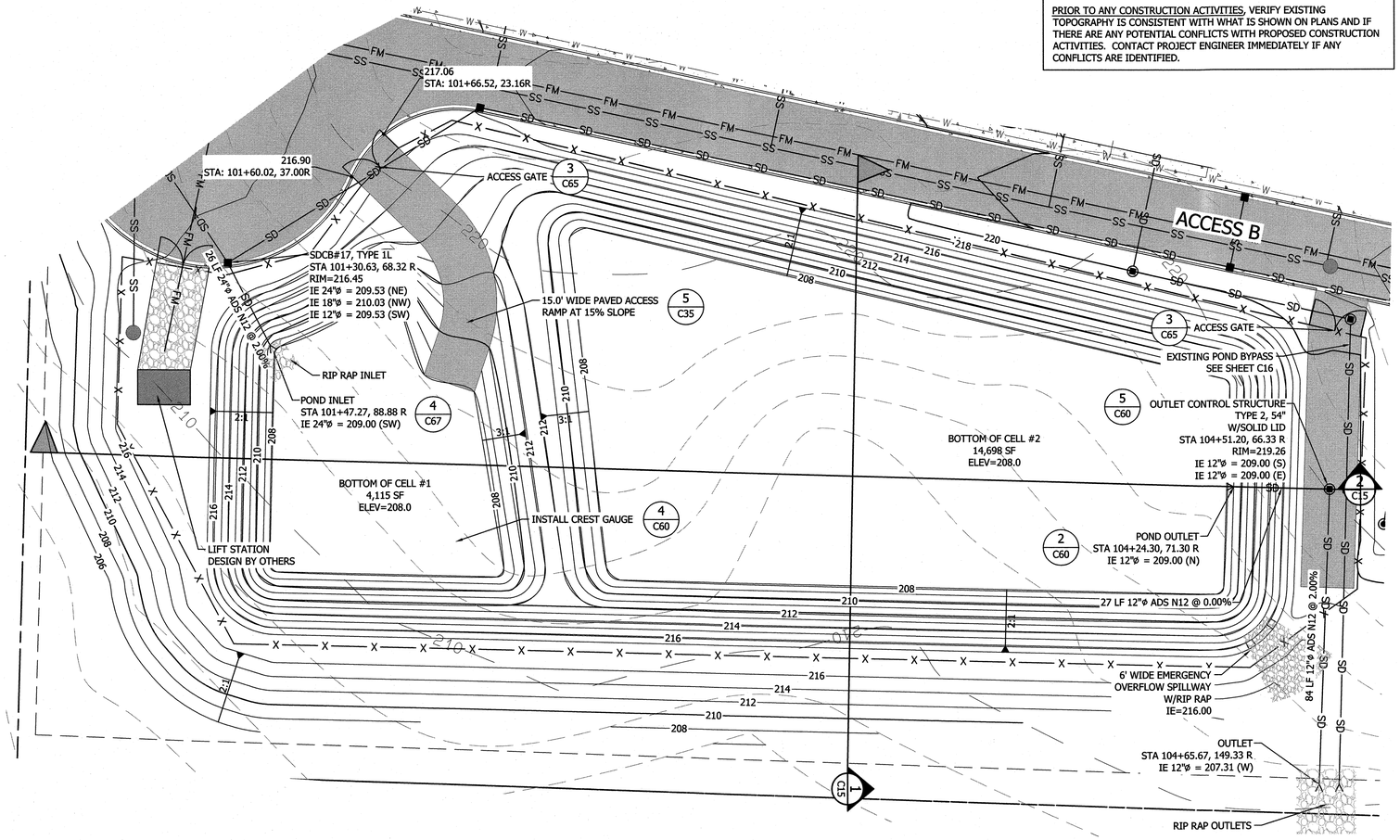
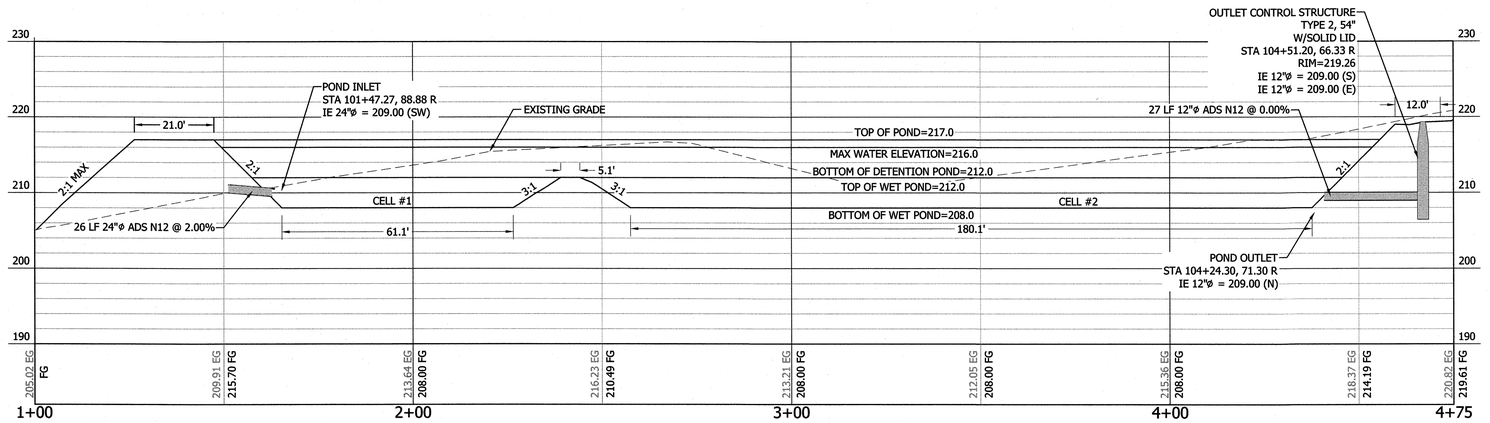


1 POND WEST-EAST SECTION

HORIZONTAL SCALE: 1"=20'
VERTICAL SCALE: 1"=10'





2 POND NORTH-SOUTH SECTION

HORIZONTAL SCALE: 1"=20'
VERTICAL SCALE: 1"=10'

RIP RAP NOTE

RIP RAP TO BE REASONABLY WELL GRADED WITH ROCK GRADATION AS FOLLOWS:

- PASSING 8" SIEVE- 100%
- PASSING 3" SIEVE- 40-60%
- PASSING 0.75" SIEVE 0-10%

MAINTENANCE STANDARDS NOTE

STORMWATER FACILITY IS PRIVATE. IT SHALL BE OPERATED AND MAINTAINED BY THE HOME OWNER'S ASSOCIATION. 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.

DETENTION/WET POND PERFORMANCE STANDARD

WETPOND CELL#1= 22,664 CF (25%)
WETPOND CELL #2=69,218 CF (75%)
TOTAL WETPOND VOLUME PROVIDED=2.1093 AC-FT (91,882 CF)
TOTAL WETPOND VOLUME REQUIRED=1.9968 AC-FT (86,981 CF)
APPROXIMATE LENGTH TO WIDTH RATIO=3.6

DETENTION VOLUME REQUIRED =2.020 AC-FT (88, CF)
DETENTION VOLUME PROVIDED=2.8615 AC-FT (124,646 CF)
LIVE STORAGE DEPTH=4.0'
FREEBOARD=1.0'

REVISION	DESCRIPTION	DATE	BY

CONTOUR ENGINEERING • LLC
CIVIL ENGINEERS ~ SURVEYORS ~ LAND PLANNERS
Phone: 253-857-5454 ~ Fax: 253-509-0044 ~ info@contourplic.com
Mailing Address: P.O. Box 949, Gig Harbor, WA 98335
Physical Address: 4706 97th Street NW, Suite 100, Gig Harbor, WA 98332

BRETT M. ALLEN — STATE OF WASHINGTON — 37835 — REGISTERED PROFESSIONAL ENGINEER — 4/5/18

SHEET TITLE: POND DETAILS

CLIENT: NORPOINT COMMUNITIES
P.O. BOX 875
TACOMA, WA 98401

CONTACT: TODD STEEL
PHONE: 253-759-2287

DESIGNER: K. ROSE
ENGINEER: B. ALLEN
DRAWN: B. MORRIS
S 10 T 25 N R 01 E WM
DATE: 03-07-2018
REVISED:

PROJECT: 17-127
DWG NAME: 17-127-C

SHEET	REV.
C15	△
15 OF 68	

Permit Number: 20-01252

APPENDIX C

Applicable 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. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

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

- If tree roots have been exposed or injured, "prune" cleanly with an appropriate pruning saw or loppers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (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 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: Silt Fence (p.367) 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 II-4.1.1 Stabilized Construction Entrance (p.273) 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: High Visibility Fence (p.269)) 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.

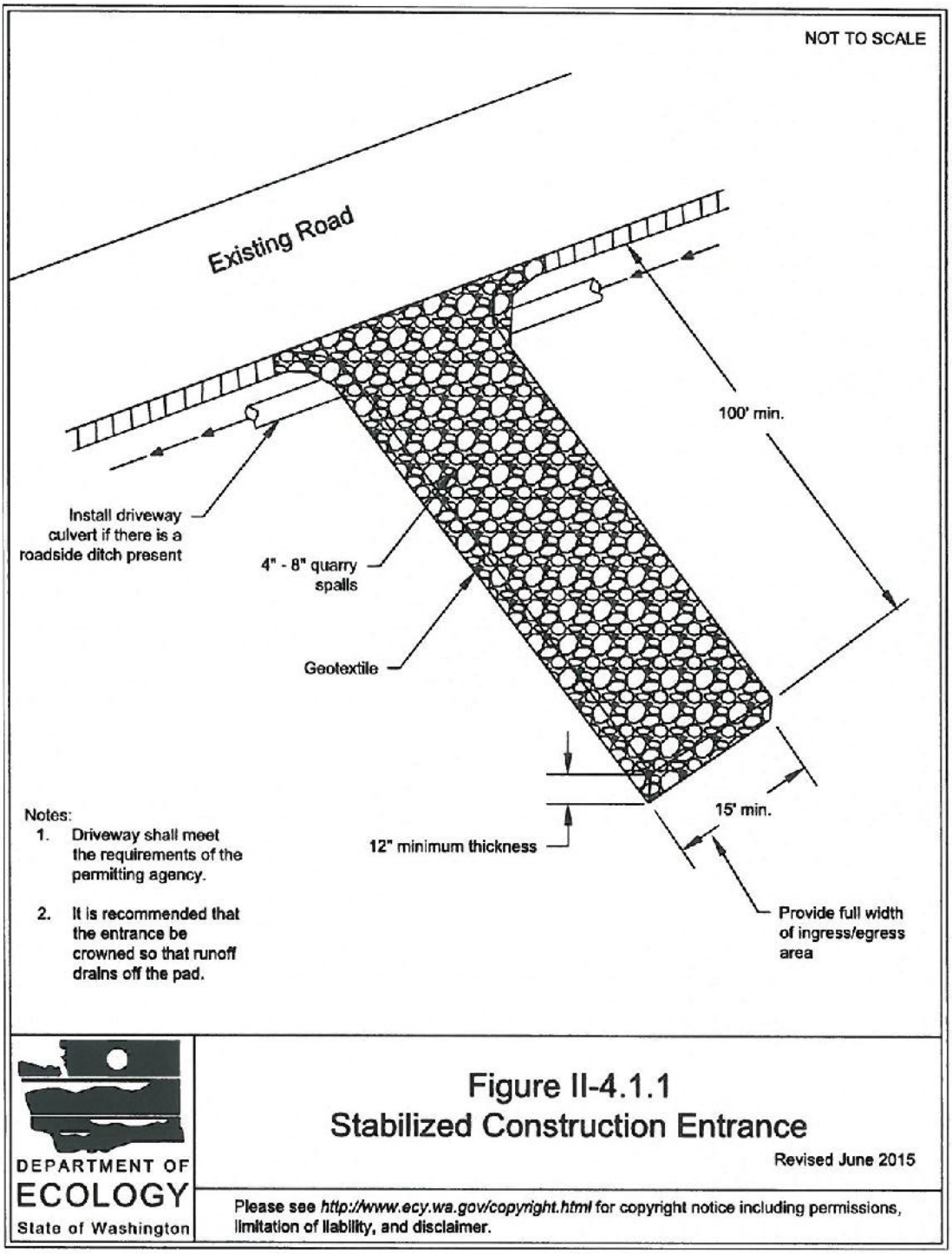
Maintenance Standards

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 II-4.1.1 Stabilized Construction Entrance



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: High Visibility Fence (p.269)) 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 (BMP C252: High pH Neutralization Using CO2 (p.409) and BMP C253: pH Control for High pH Water (p.412)) 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: Storm Drain Inlet Protection (p.357)).

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 (p.284) 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 per-

manent 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 (p.284) 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 II-4.1.2 Temporary Erosion Control Seed Mix (p.280) lists the standard mix for areas requiring a temporary vegetative cover.

Table II-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 II-4.1.3 Landscaping Seed Mix (p.281) lists a recommended mix for landscaping seed.

Table II-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 II-4.1.4 Low-Growing Turf Seed Mix (p.281) lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table II-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 II-4.1.5 Bioswale Seed Mix* (p.281) lists a mix for bioswales and other intermittently wet areas.

Table II-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 II-4.1.6 Wet Area Seed Mix* (p.282) 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 II-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 II-4.1.7 Meadow Seed Mix (p.282) 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.

Table II-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: Temporary and Permanent Seeding. 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 II-4.1.8 Mulch Standards and Guidelines (p.286). 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 II-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 3/4 - 1 inch clog hydromulch equipment. Fibers should be kept to less than 3/4 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%	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: Topsoiling / Composting (p.297) or BMP T5.13: Post-Construction Soil Quality and Depth (p.911). 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.

Table II-4.1.8 Mulch Standards and Guidelines (continued)

Mulch Material	Quality Standards	Application Rates	Remarks
	biosolids.		
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	2" thick min.	Cost-effective protection when applied with adequate thickness. A minimum of 95-percent of the wood strand shall have lengths between 2 and 10-inches, with a width and thickness between 1/16 and 3/8-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))

Table II-4.1.8 Mulch Standards and Guidelines (continued)

Mulch Material	Quality Standards	Application Rates	Remarks
	high length-to-width ratio.		

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 II-4.1.3 Channel Installation (p.292) and Figure II-4.1.4 Slope Installation (p.293) 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: Mulching (p.284)). 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.

Figure II-4.1.3 Channel Installation

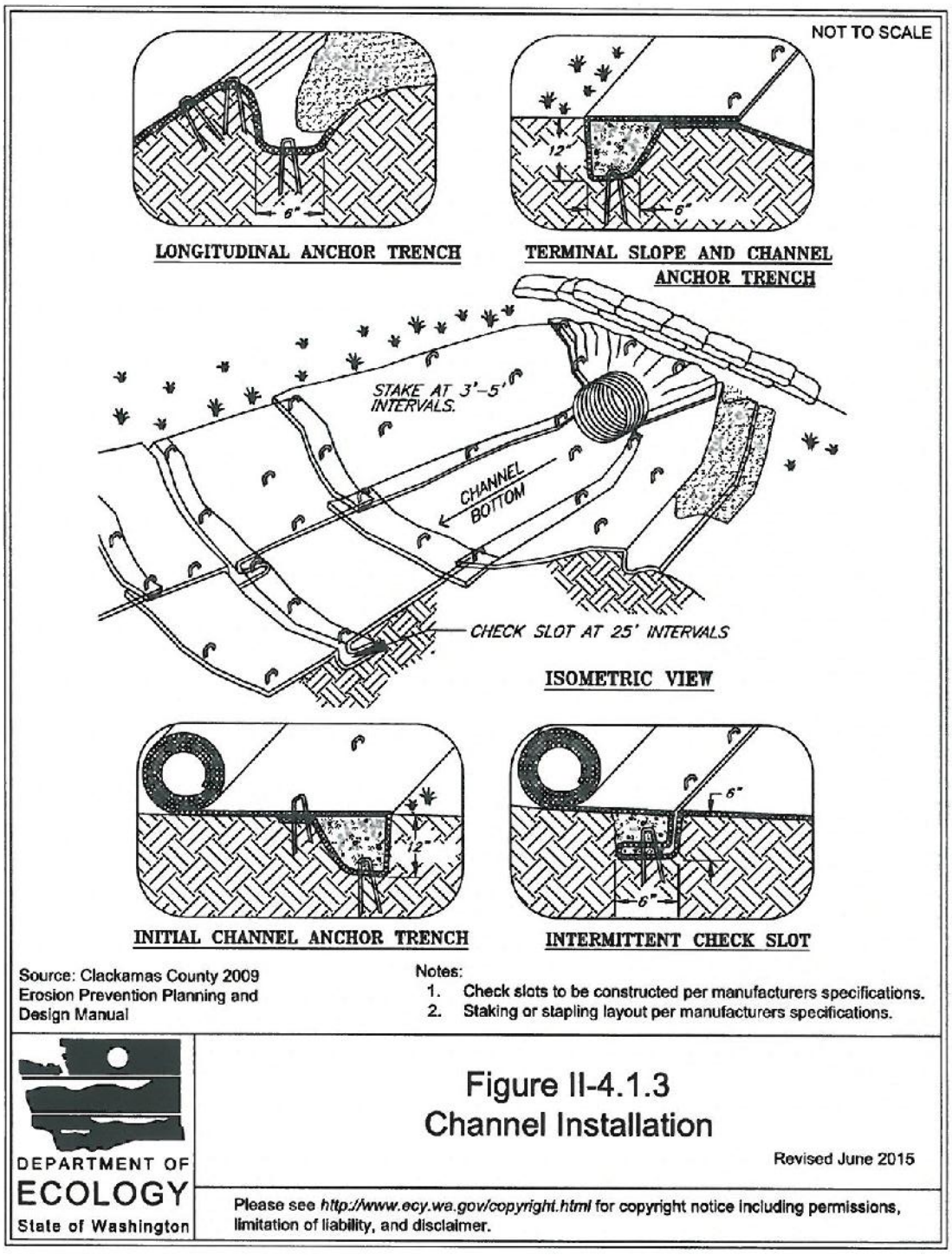
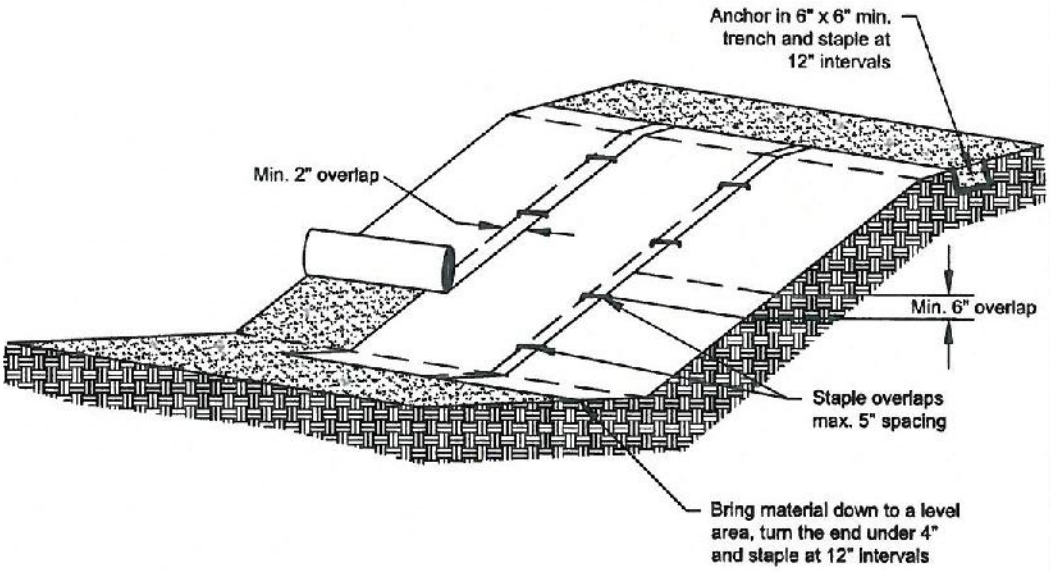


Figure II-4.1.4 Slope Installation



Notes:

1. Slope surface shall be smooth before placement for proper soil contact.
2. Stapling pattern as per manufacturer's recommendations.
3. Do not stretch blankets/mattings tight - allow the rolls to mold to any irregularities.
4. For slopes less than 3H:1V, rolls may be placed in horizontal strips.
5. If there is a berm at the top of the slope, anchor upslope of the berm.
6. Lime, fertilize, and seed before installation. Planting of shrubs, trees, etc. should occur after installation.

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.4
Slope Installation

Revised June 2015

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: Plastic Covering. 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 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: Post-Construction Soil Quality and Depth (p.911) 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.

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 BMP C105: Stabilized Construction Entrance / Exit (p.270).
- 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: Polyacrylamide (PAM) for Soil Erosion Protection (p.300)) 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: Concrete Washout Area (p.317) 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 BMP C252: High pH Neutralization Using CO2 (p.409) and BMP C253: pH Control for High pH Water (p.412) 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:

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: http://www.envirocertintl.org/cpesc/

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.
    - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
    - Any water quality monitoring performed during inspection.
    - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
- Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.

BMP C162: Scheduling

Purpose

Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures

planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Minimize construction during rainy periods.
- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

II-4.2 Runoff Conveyance and Treatment BMPs

This section contains the standards and specifications for Runoff Conveyance and Treatment BMPs. Table II-4.2.1 Runoff Conveyance and Treatment BMPs by SWPPP Element (p.327), below, shows the relationship of the BMPs in II-4.2 Runoff Conveyance and Treatment BMPs to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in II-3.3.3 Step 3 - Construction SWPPP Development and Implementation (p.236).

Table II-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 (p.331)			✓					✓

Table II-4.2.1 Runoff Conveyance and Treatment BMPs by SWPPP Element (continued)

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
for High pH Water (p.412)								

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 (p.284)).
- 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 or flatter.
- Grade: Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
- Stabilization: Seed as per BMP C120: Temporary and Permanent Seeding (p.278), or BMP C202: Channel Lining (p.338), 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 C201: Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. See Figure II-4.2.1 Typical Grass-Lined Channels (p.336) 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 II-4.2.2 Temporary Channel Liners (p.337).
- 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 II-4.2.1 Typical Grass-Lined Channels

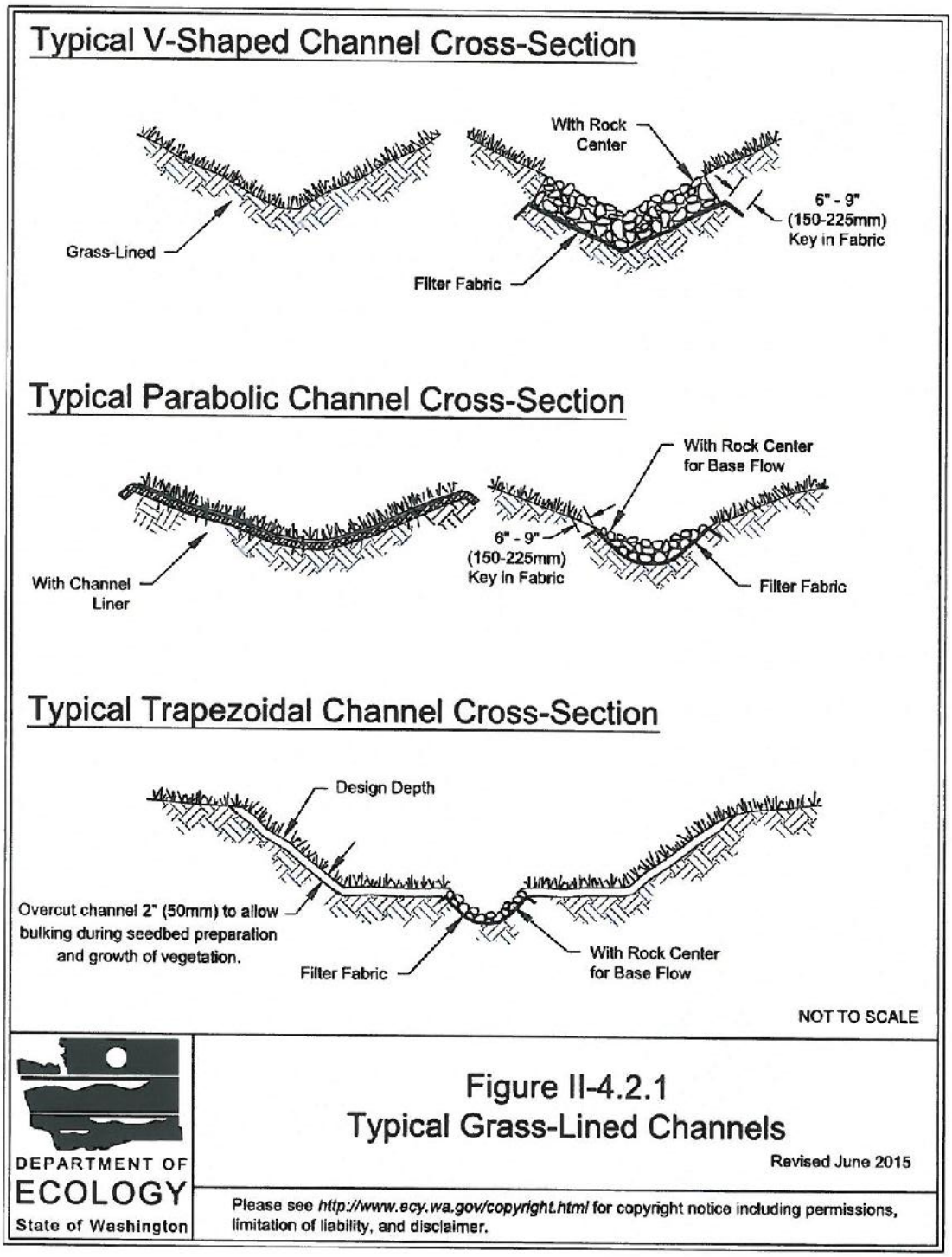
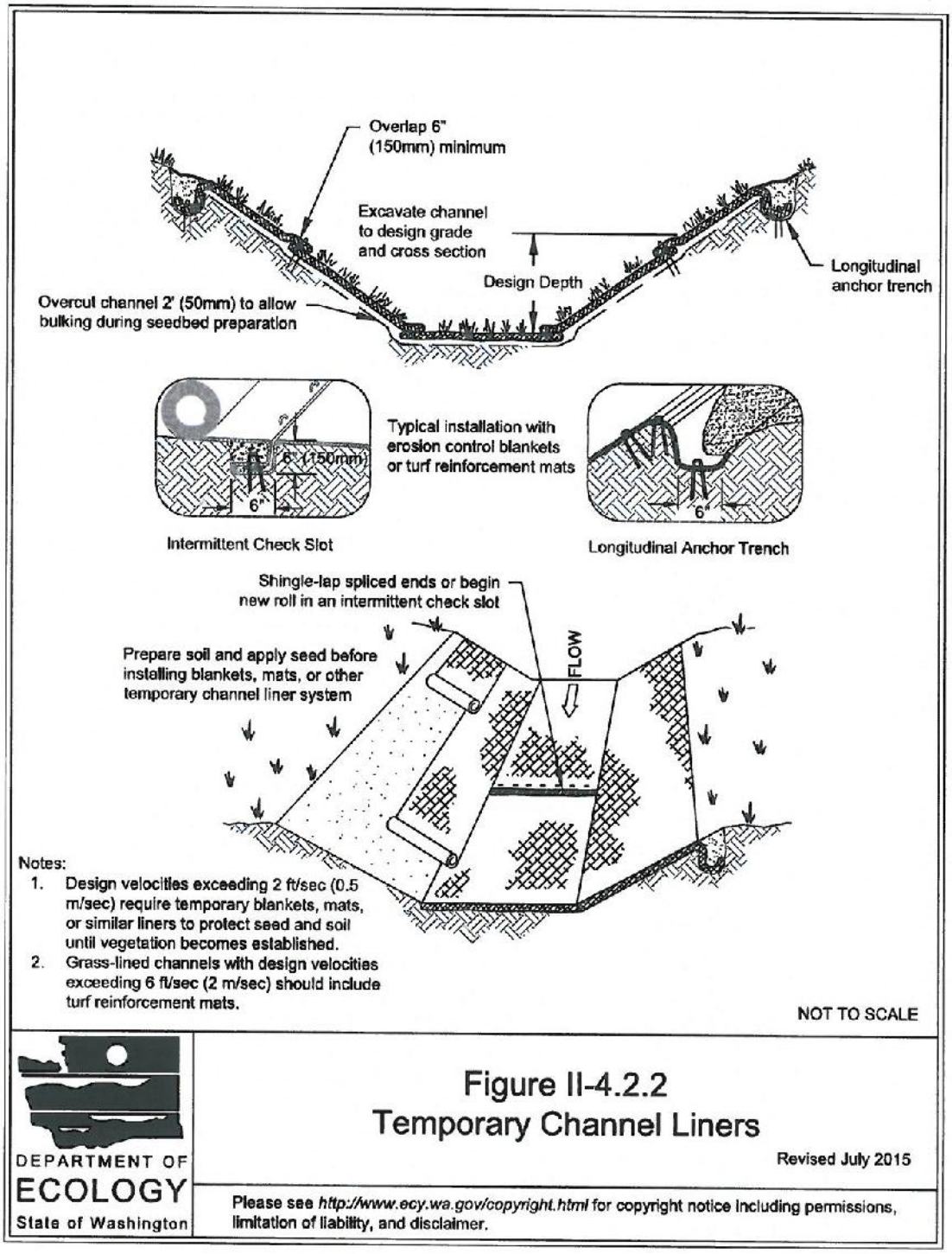


Figure II-4.2.2 Temporary Channel Liners



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 reusable, 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 II-4.2.7 Rock Check Dam (p.354) depicts a typical rock check dam.

Maintenance Standards

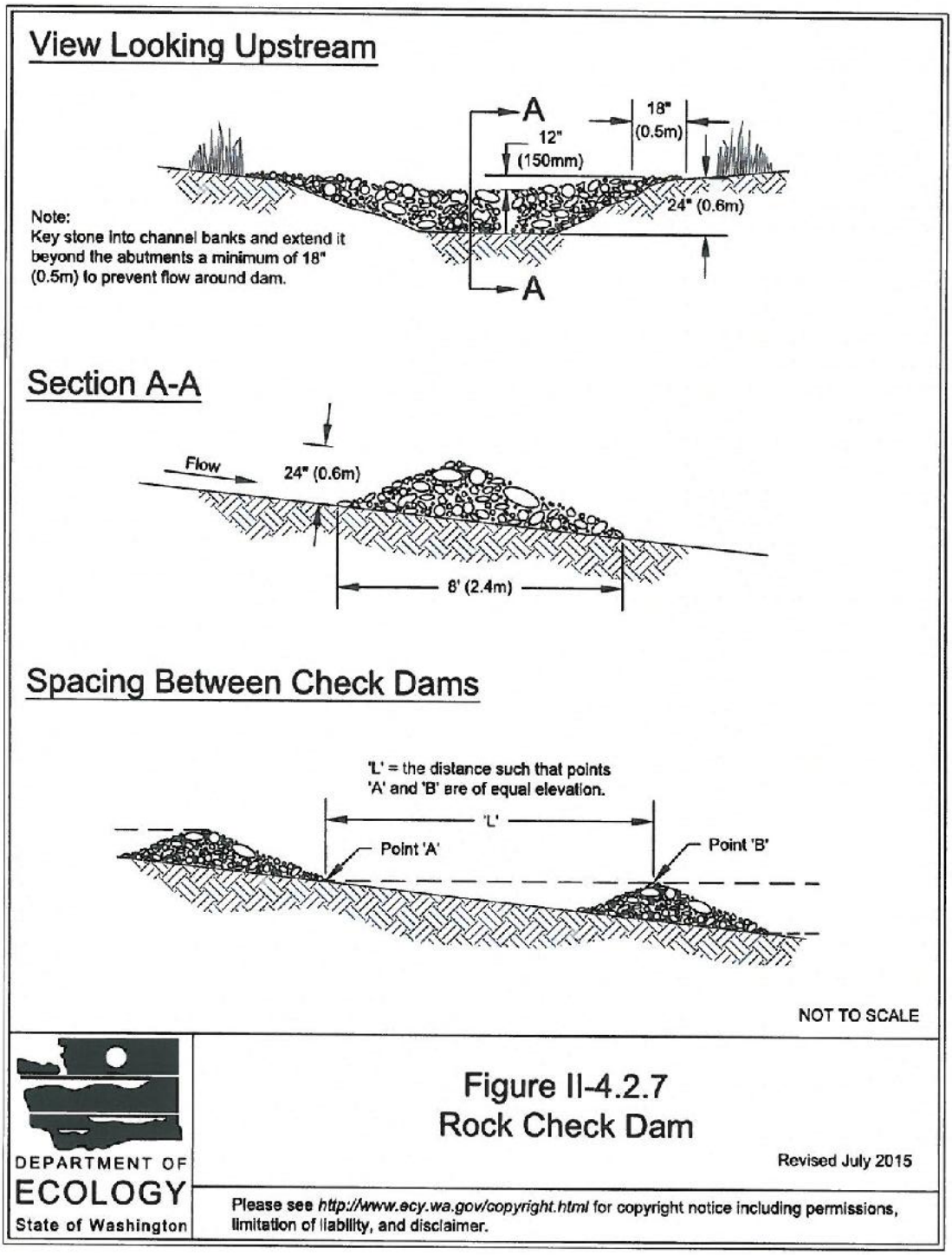
Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- 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: Check Dams. 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 II-4.2.7 Rock Check Dam



- 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 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 (p.765) 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 pre-

vent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table II-4.2.2 Storm Drain Inlet Protection (p.358) 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 II-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'x30'/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 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

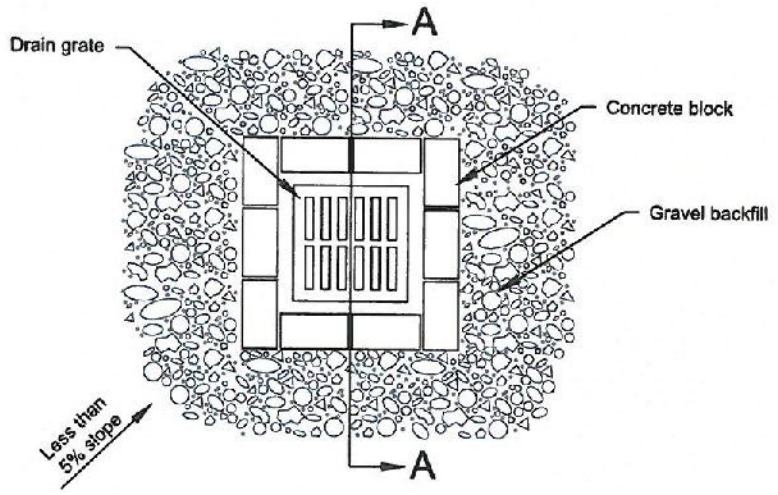
Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- 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.

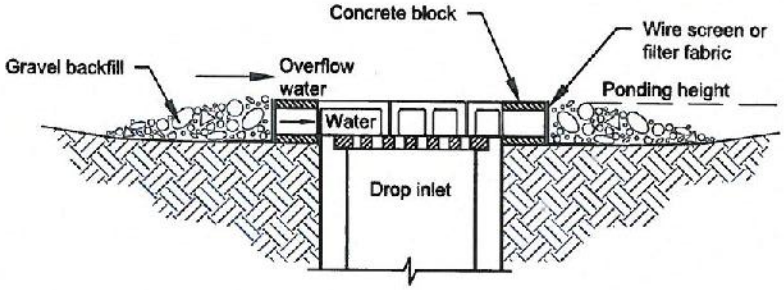
Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure II-4.2.8 Block and Gravel Filter (p.360).

- 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.

Figure II-4.2.8 Block and Gravel Filter



Plan View



Section A-A

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.

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.2.8
Block and Gravel Filter

Revised August 2015

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 II-4.2.9 Block and Gravel Curb Inlet Protection (p.363).

- 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 II-4.2.10 Curb and Gutter Barrier (p.364).

- 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.

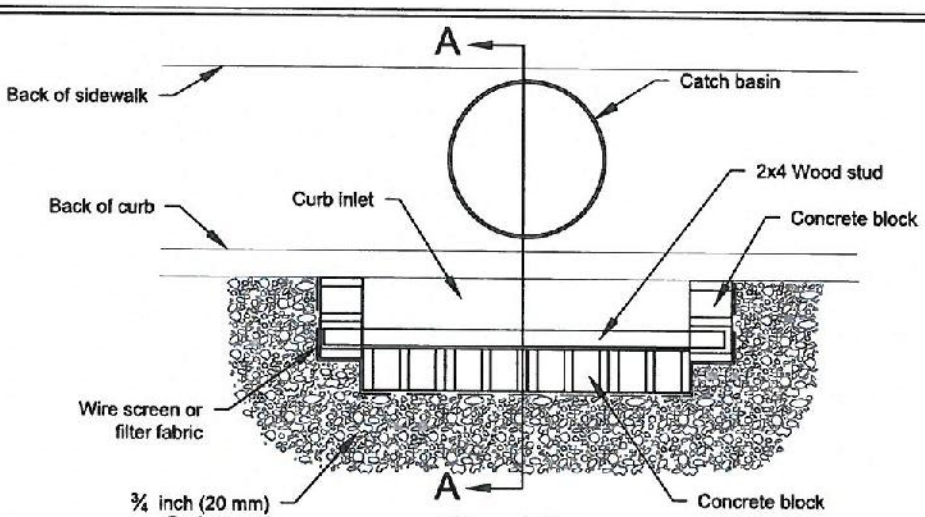
Maintenance Standards

- 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.

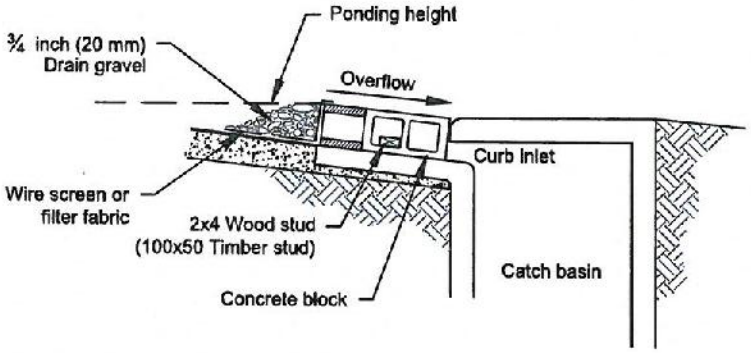
Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C220: Storm Drain Inlet Protection. 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 II-4.2.9 Block and Gravel Curb Inlet Protection



Plan View



Section A-A

Notes:

1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

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Figure II-4.2.9
Block and Gravel Curb Inlet Protection

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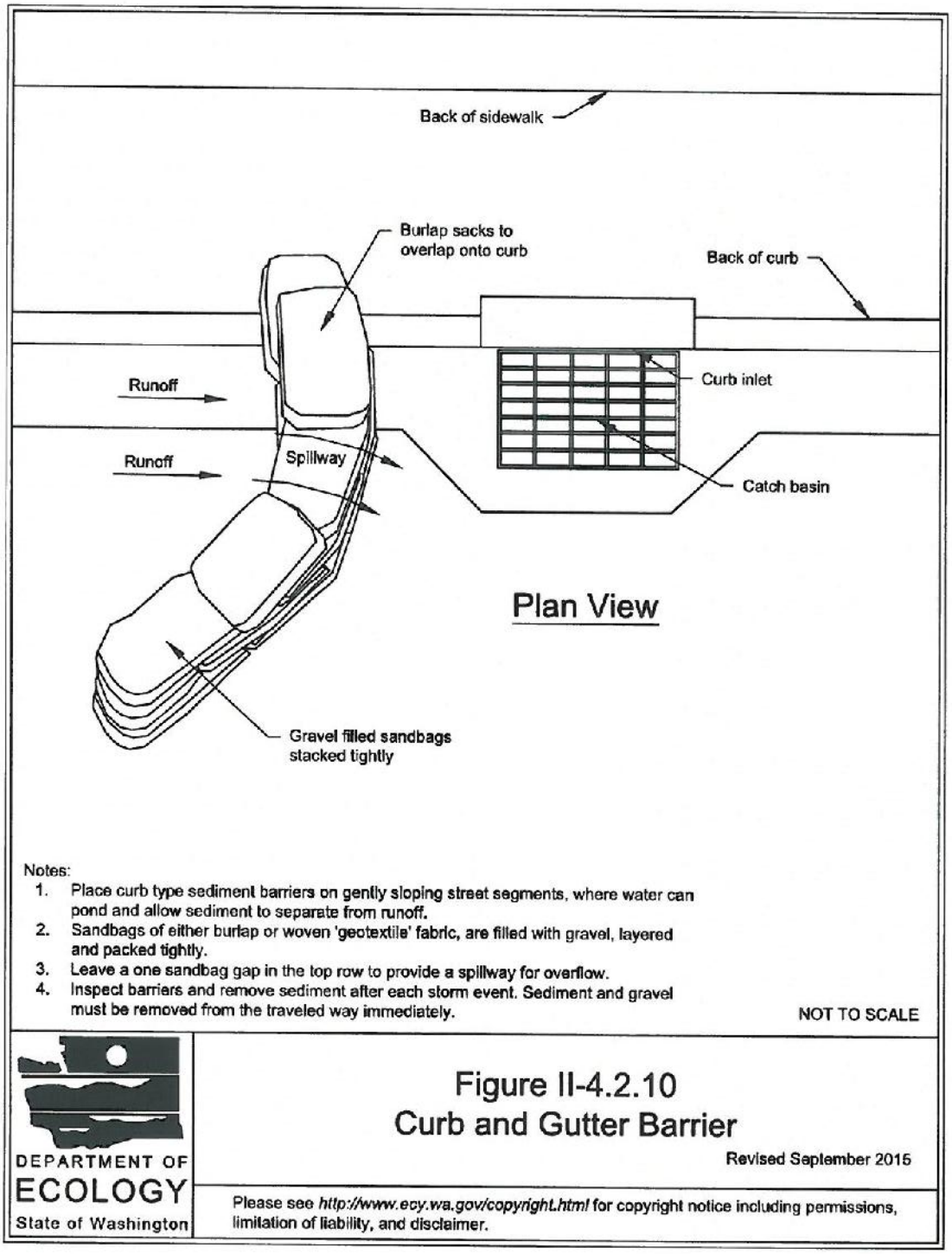
Figure II-4.2.10 Curb and Gutter Barrier



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.

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Figure II-4.2.10
Curb and Gutter Barrier

Revised September 2015

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 C233: Silt Fence

Purpose

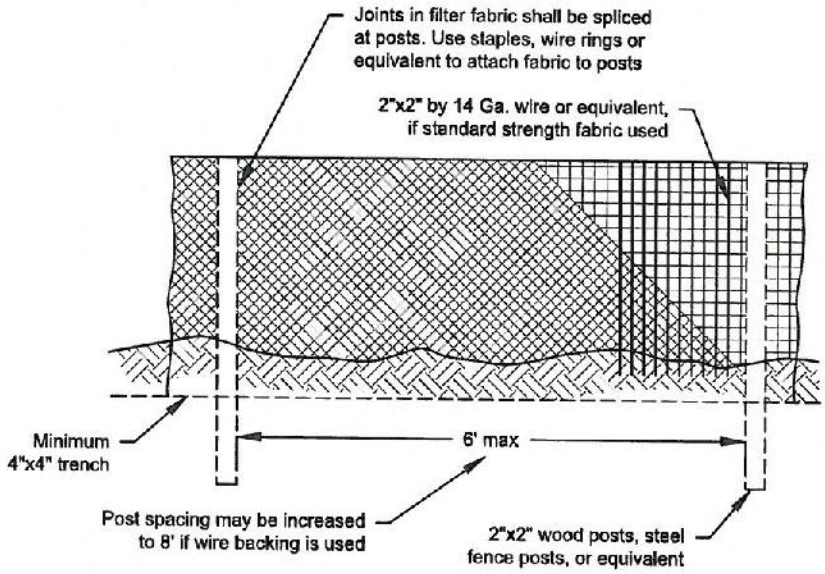
Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure II-4.2.12 Silt Fence (p.369) for details on silt fence construction.

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 II-4.2.12 Silt Fence



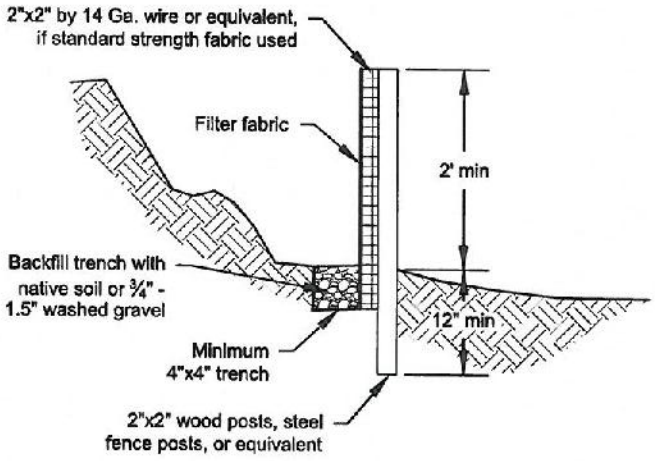


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Figure II-4.2.12
Silt Fence

Revised October 2014

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 II-4.2.3 Geotextile Standards (p.370)):

Table II-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 II-4.2.12 Silt Fence (p.369) for standard silt fence details. Include the following standard Notes for silt fence on construction plans and specifications:

1. The contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
2. Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.
3. The silt fence shall have a 2-feet min. and a 2½-feet max. height above the original ground surface.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.

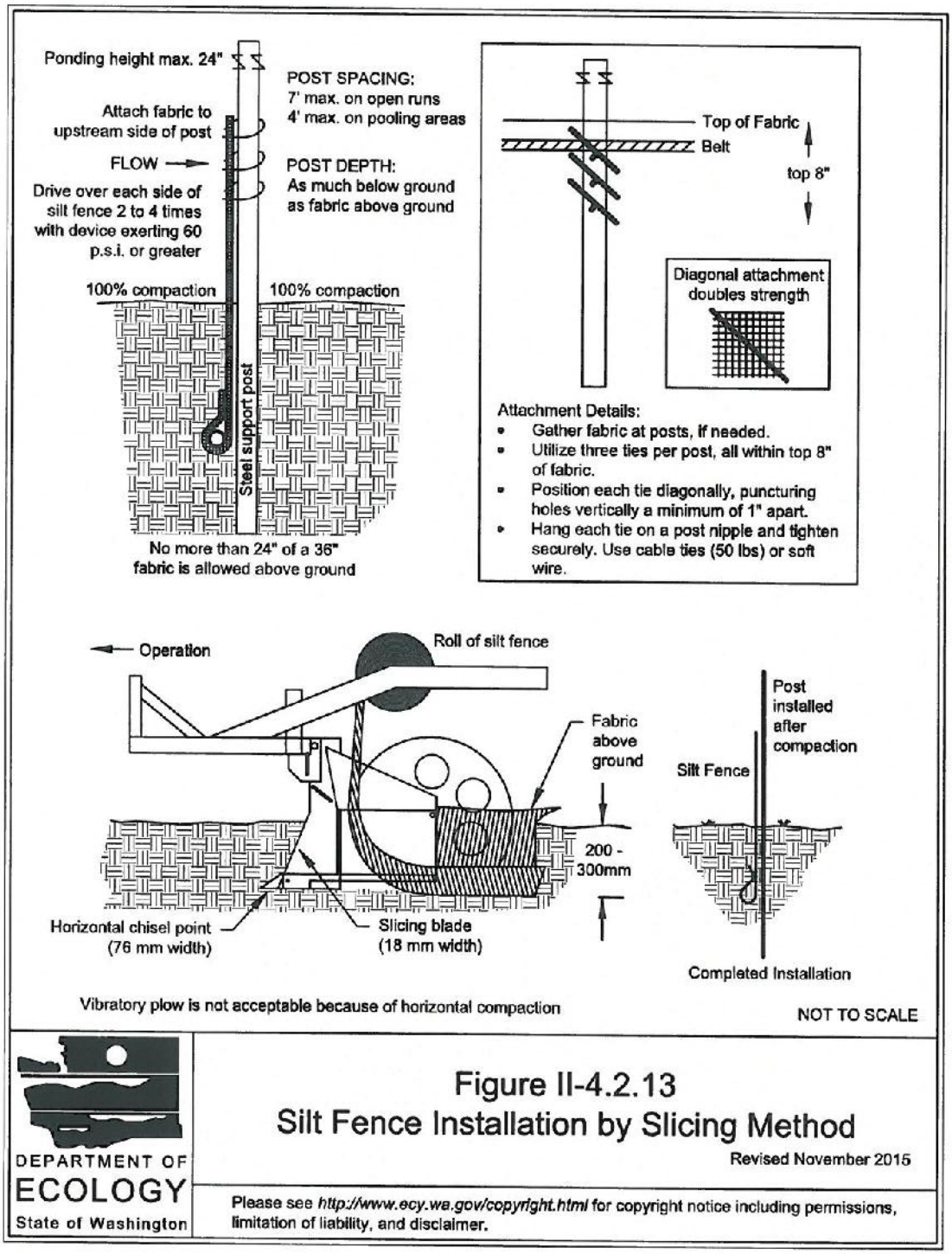
11. Locate silt fences on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.
12. If the fence must cross contours, with the exception of the 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 II-4.2.13 Silt Fence Installation by Slicing Method (p.374) 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.

   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 II-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 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.

Conditions of Use

- 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 II-4.2.4 Contributing Drainage Area for Vegetated Strips (p.375)):

Table II-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 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 II-4.2.14 Wattles (p.378) 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.

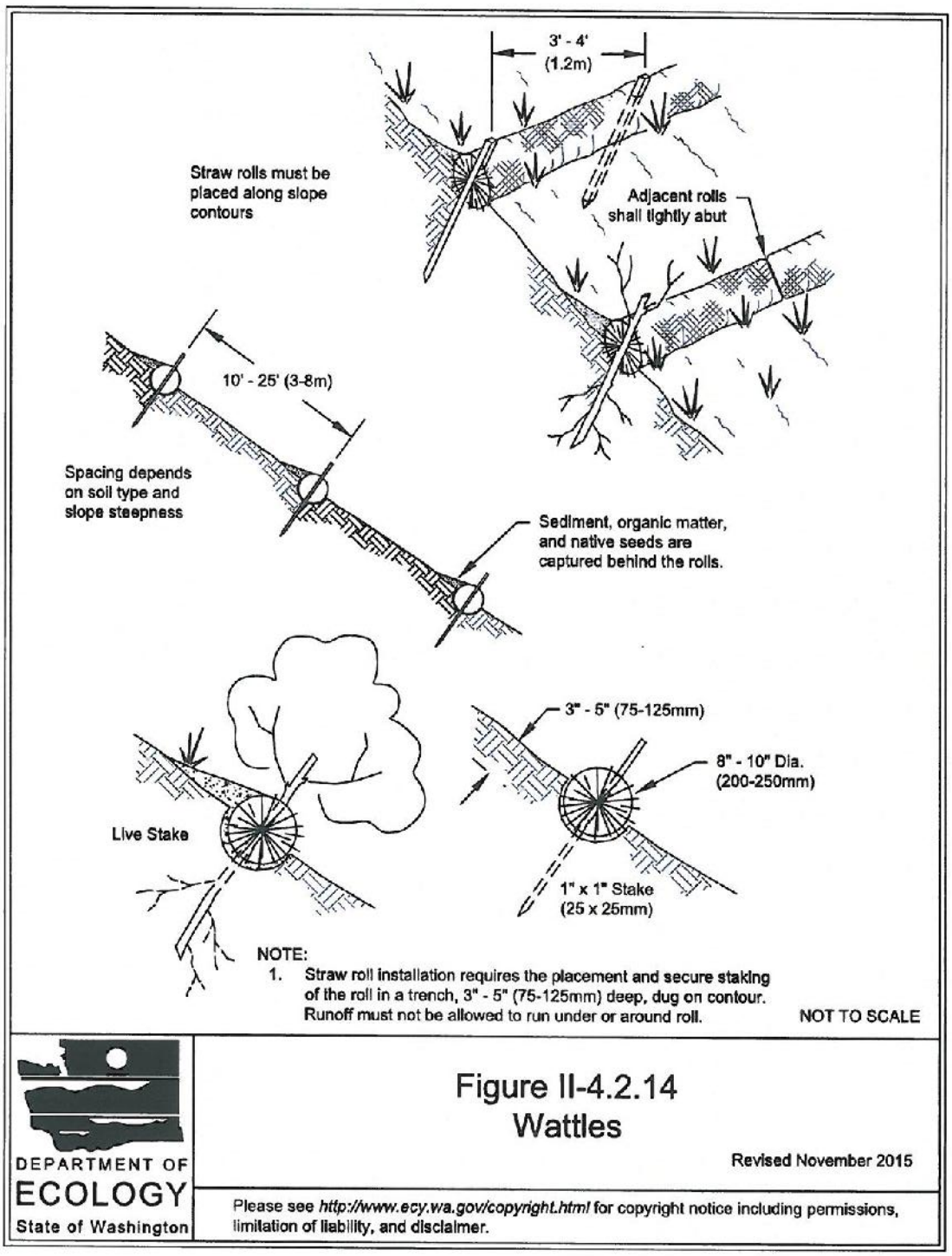
Design Criteria

- 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.

Figure II-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: Wattles. 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 C236: Vegetative Filtration

Purpose

Vegetative Filtration may be used in conjunction with BMP C241: Temporary Sediment Pond (p.388), BMP C206: Level Spreader (p.348) 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

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 Figure II-4.2.18 Sediment Pond Plan View (p.391), Figure II-4.2.19 Sediment Pond Cross Section (p.392), and Figure II-4.2.20 Sediment Pond Riser Detail (p.393) 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: Sediment Trap (p.383) 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:

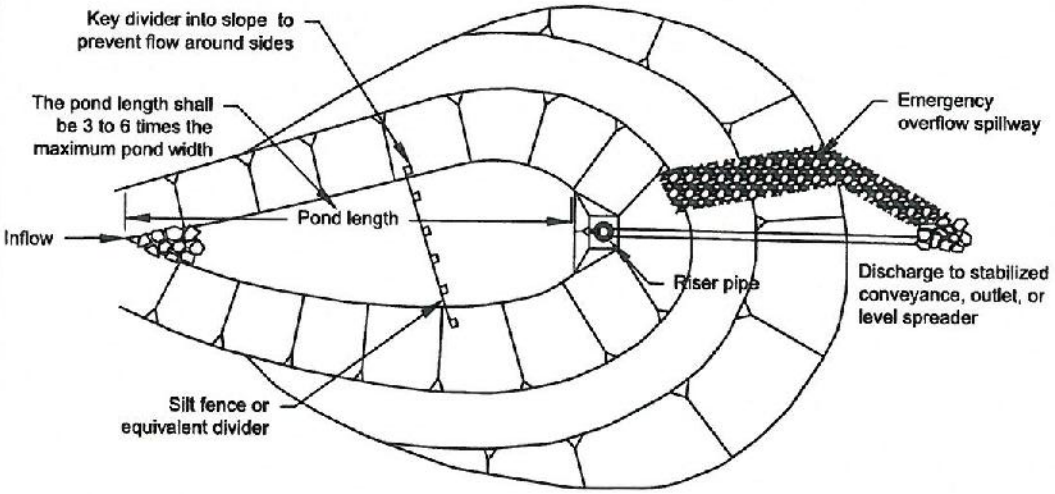
- Required surface area SA (from Step 2 above) at top of riser.
- Minimum 3.5-foot depth from top of riser to bottom of pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum 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 spill-ways. These outlets must pass the peak runoff expected from the contributing drain-age 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 cal-culations 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 I-2.5.7 Minimum Requirement #7: Flow Control (p.64). 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 II-4.2.21 Riser Inflow Curves (p.394) for riser inflow curves.

Figure II-4.2.18 Sediment Pond Plan View



Note: Pond may be formed by berm or by partial or complete excavation

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Figure II-4.2.18
Sediment Pond Plan View

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Figure II-4.2.19 Sediment Pond Cross Section

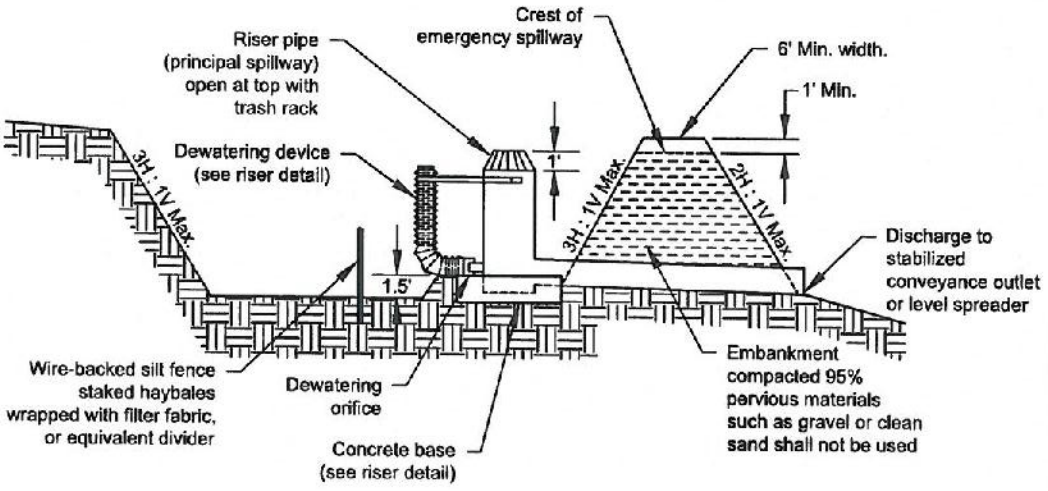

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Figure II-4.2.19
Sediment Pond Cross Section

Revised November 2015

Figure II-4.2.20 Sediment Pond Riser Detail

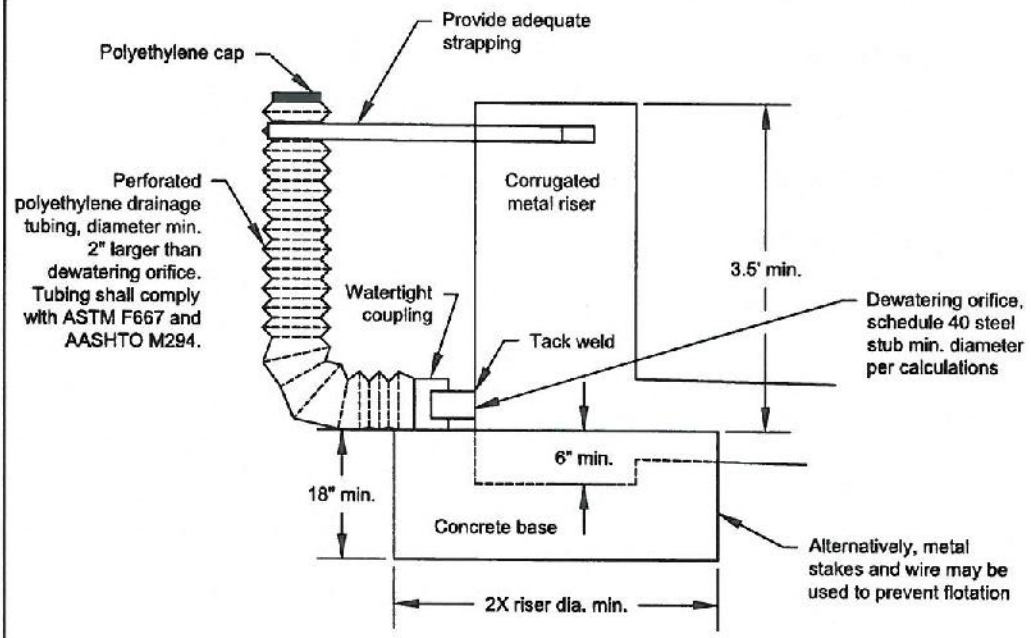

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Figure II-4.2.20
Sediment Pond Riser Detail

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Figure II-4.2.21 Riser Inflow Curves

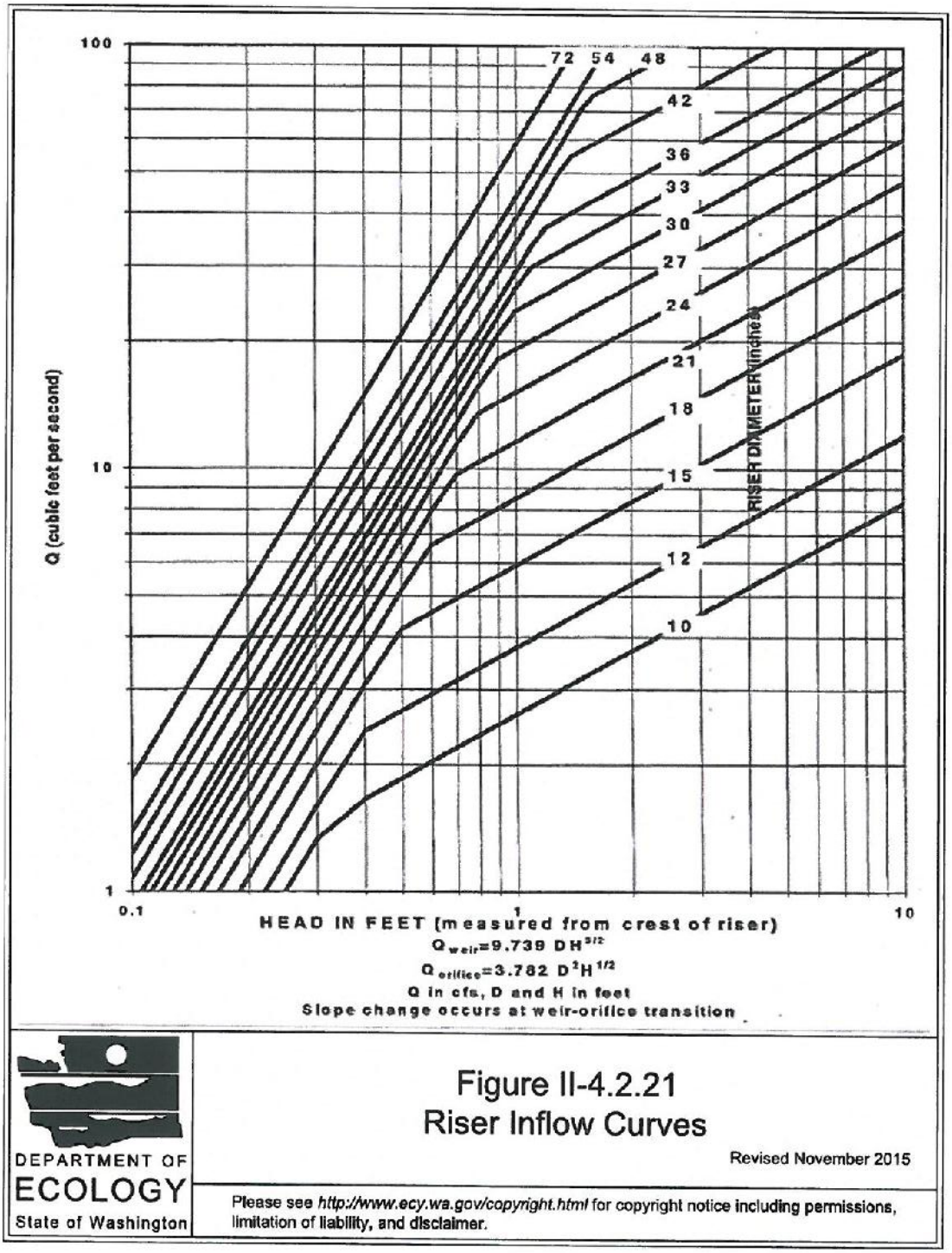

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Figure II-4.2.21
Riser Inflow Curves

Revised November 2015

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 II-4.2.21 Riser Inflow Curves (p.394) 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:

$$A_o = \frac{A_S(2h)^{0.5}}{0.6 \times 3600 T g^{0.5}}$$

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:

$$D = 24 \times \sqrt{\frac{A_o}{\pi}} = 13.54 \times \sqrt{A_o}$$

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 (p.423) 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 dis-

APPENDIX D

Geotechnical Report

GEORESOURCES
earth science & geotechnical engineering
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March 26, 2018

NorPoint Communities
PO Box 875
Tacoma, Washington 98401

Attn: Mr. Todd Steel

Geotechnical Engineering Report
Proposed Multi-Family Development
Xxx Ridgetop Boulevard Northwest
Kitsap County, Washington
PN: 102501-3-046-2004 & -033-2009
Doc ID: NorPoint.OntheRidge.RG

INTRODUCTION

This geotechnical report summarizes our site observations, subsurface explorations, laboratory testing and engineering analyses and provides geotechnical recommendations and design criteria for the proposed multi-family residential development to be constructed at xxx Ridgetop Boulevard Northwest (PN: 102501-3-046-2004 & -033-2009) in Silverdale area of Kitsap County, Washington. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our email and phone correspondences with Mr. Brett Allen of Contour Engineering, LLC, our review of the *Geotechnical Engineering Investigation Report* by Krazan & Associates, Inc. dated June 10, 2003, our review of the preliminary site plan by Contour Engineering, LLC dated January 31, 2018, our February 16 & 19, 2018 site visits, our understanding of the 2016 Kitsap County Stormwater Design Manual (2016 KCSWDM) and development codes, and our experience in the project area.

The site is currently undeveloped. We understand that you propose to develop the site into a senior living community that features 67 residential buildings. We anticipate the new residential buildings will be a mixture of apartment home, duplex and cottage style dwelling, but will be single story, wood-framed structures founded on conventional shallow foundations. We further understand that because of the vertical height and inclinations of slopes on and adjacent to the parcel, Kitsap County is requiring a geotechnical report be completed to satisfy the requirements of the Kitsap County Critical Areas Ordinance Title 19 Section 400.

SCOPE

The purpose of our services is to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed development. Specifically, the scope of services for this project included the following:

1. Reviewing the available geologic, hydrogeologic, and geotechnical data for the site area;
2. Exploring the surface conditions at the site by performing a geotechnical reconnaissance;
3. Exploring subsurface conditions across the site by excavating a series of 11 test pits at select locations at the site;
4. Describing surface and subsurface conditions, including soil type, depth to groundwater, and an estimate of seasonal high groundwater levels;
5. Providing geotechnical conclusions and recommendations regarding seismic site class and design coefficients, seismic hazard analysis, site grading activities including; site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, drainage and erosion control measures;
6. Providing conclusions regarding shallow foundations and floor slab support and design criteria, including bearing capacity and subgrade modulus if appropriate;
7. Providing design criteria regarding subgrade retaining walls, including drainage recommendations;
8. Providing our opinion of the feasibility of infiltration at the site;
9. Providing recommendations for erosion and sediment control during wet weather grading and construction; and,
10. Preparing a written updated *Geotechnical Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

The above scope of work was summarized in our *Proposal for Geotechnical Engineering* Services dated February 6, 2018. We received written authorization to proceed by you on February 12, 2018.

SITE CONDITIONS

Surface Conditions

The project site is located at xxx - Ridgetop Boulevard Northwest (PN: 102501-3-046-2004 & -033-2009) in Silverdale area of Kitsap County, Washington, within an area of existing residential development. The project site consists of two tax parcels, which are irregular in shape, measure approximately 535 to 1,335 feet wide (north to south) by approximately 335 to 1,280 feet deep (east to west) and encompass about 21.65 acres. The site is bounded by existing residential development to the north, east, and south, and by both residential development and Ridgetop Boulevard Northwest to the west. The site and surrounding area is shown on the attached Site Vicinity Map, Figure 2a.

According to topographic information obtained from the Kitsap County GIS data, the site generally slopes down from the west to the east. The western upland portion of the site slopes down towards the central of the site at approximately 15 to 18 percent. The central portion of the site then steepens to approximately 25 to 35 percent. The eastern lower portion of the site then flattens to approximately 8 to 13 percent. There are some local convergent drainage swales sloping down from the western upland portion towards the eastern lower portion of the site at approximately 25 percent. The interior slopes of these drainage swales are approximately 37 to 45 percent with a vertical relief on the order of 35 to 45 feet. From Quail Run Drive Northwest, there is an existing gravel road that provides access to the site. The existing gravel road is approximately 1,050 feet long, that slopes down towards the site at approximately 9 to 15 percent. The slopes in the area of the gravel road are

approximately 50 percent with a vertical relief on the order of 35 to 40 feet. The total topographic relief across the site is on the order of 170 feet. The proposed site development is show on the attached Site and Exploration Plan, Figure 2b.

The steeper upslope portion of the site had been formerly logged, and generally consist a scatted mix of deciduous and coniferous trees along the property boundaries with a very dense understory of native and invasive shrubs and plants. While the western lower portion of the site generally consists of a dense mix of deciduous and coniferous trees with a dense understory of native and invasive shrubs and plants.

Site Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey maps the site as being underlain by Alderwood gravelly sandy loam (1 & 2) soils. The Alderwood soils are typically derived from glacial till, and are included in hydrologic soils group C. The Alderwood (1) soils form on slopes of 0 to 6 percent and are listed as having a "slight" erosion hazard when exposed. The Alderwood (2) soils form on slopes of 6 to 15 percent and are listed as having a "moderate" erosion hazard when exposed. A copy of the NRCS Soil Survey Map is included as Figure 3.

Site Geology

According to the *Geological Map of the Seabeck and Poulsbo 7.5-minute Quadrangle, Kitsap and Jefferson Counties, Washington* by Polenz, Petro, Contreras, Stone, Paulin, and Cakir, the upper, western portion of the site is underlain by glacial till (Qgt); while the lower, eastern portion of the site is mapped as ice-contact deposits (Qgic) and pre-Vashon outwash sand (Qpos). The Vashon glacial till and ice-contact deposits were deposited during the most recent Vashon stade of the Fraser Glaciation, some 12,000 to 15,000 years ago. The glacial till consists of a heterogeneous mixture of clay, silt, sand and gravel that was deposited at the base of the continental ice mass and is typically encountered in a very dense condition. The till was overridden by the ice mass, and as such is considered over-consolidated, in a very dense condition, and exhibits high strength and low compressibility characteristics where undisturbed.

The ice-contact deposits consist of a poorly stratified mixture of sand and gravel that may locally contain silt or clay. The ice-contact deposits were formed on the contacts between the land and the glacial ice mass as it traveled during the Vashon stade of the Fraser Glaciation. The ice-contact deposits are considered normally consolidated and offer moderate strength characteristics.

The pre-Vashon sand are glacial soils that were deposited prior to the Vashon stade of the Fraser Glaciation. The sand consists of a poorly sorted mixture of sand with some silt, clay, and gravel. These pre-Vashon soils are considered over-consolidated, in a very dense condition, and exhibits high strength and low compressibility characteristics where undisturbed. An excerpt of the above referenced geologic map is attached as Figure 4.

Subsurface Explorations

On February 16 & 19, 2018, a field representative from GeoResources, LLC (GeoResources) was on site and monitored the excavation of 11 test pits to depths of 6.0 to 12.0 feet below the existing ground surface, logged the subsurface conditions encountered in each test pit, and obtained representative soil samples. The test pits were excavated by a medium track-mounted excavator operated by a licensed earthwork contractor.

In the spring of 2003, Krazan & Associates, Inc. (Krazan) drilled and monitored a total of three borings as part of the original *Geotechnical Engineering Investigation Report* for the western parcel of the site. Table 1, below, summarizes the approximate functional locations, surface elevations, and termination depths of our test pits and the previous explorations by Krazan.

TABLE 1:
APPROXIMATE LOCATIONS, ELEVATIONS, AND DEPTHS OF EXPLORATIONS

Exploration Number	Functional Location	Surface Elevation (feet)	Termination Depth (feet)	Termination Elevation (feet)
TP-1	Southern portion of the proposed pond	219	12	207
TP-2	Central portion of the proposed pond	218	11	207
TP-3	Northern portion of the proposed pond	218	11	207
TP-4	Northeast of the proposed building 15	324	7	317
TP-5	South of the proposed building 10	364	7	357
TP-6	South of the proposed building 2	364	6	358
TP-7	East of the proposed building 19	290	6.2	283.8
TP-8	South of the proposed building 50	252	7.5	244.5
TP-9	South of the proposed building 59	250	7.5	242.5
TP-10	South of the proposed building 27	241	6.8	234.2
TP-11	South of the proposed building 31	238	6	232
B-1	North of proposed community center	280	41	239
B-2	Southeast of the proposed building 66	327	61	266
B-3	East of the proposed building 4	340	41	299

Notes: Preliminary Site Plan by Contour Engineering, LLC dated January 31, 2018

The specific number, locations, and depths of our explorations were selected based on the configuration of the proposed development and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations and encountered stratigraphy. Representative soil samples obtained from the test pits were placed in sealed plastic bags and then taken to a laboratory for further examination and testing as deemed necessary. The test pits were then backfilled with the excavated soils and bucket tamped, but not otherwise compacted.

The subsurface explorations excavated as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun. Based on our experience in the area and extent of prior explorations in the area, it is our opinion that the soils encountered in the explorations are generally representative of the soils at the site.

The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D: 2488. The USCS is included in Appendix A as Figure A-1. The approximate locations and numbers of our test pits are shown on the attached Site and Exploration Plan, Figure 2b, while the descriptive logs of our test pits are included in Appendix A as Figures A-2 through A-7.

Subsurface Conditions

The subsurface conditions encountered in 2003 borings by Krazan varied slightly across the site, but generally confirmed the mapped stratigraphy. In their report, Krazan described the subsurface conditions encountered in their borings as silty sands and poorly graded sands to the maximum depth explored. The sands were loose in the upper 2 to 4 feet of the borings grading to dense to very dense below 4 feet. Copies of the Krazan boring logs and corresponding laboratory test results are included in Appendix C.

Our test pits TP-1 through TP-12 encountered uniform subsurface conditions that generally confirmed the mapped stratigraphy of glacial till. In general, our test pits except TP-8 encountered approximately 0.8 to 1.5 feet of dark brown topsoil/forest duff mantling approximately 0 to 1.7 feet of brown silty sand with gravel in a loose, moist to damp condition. Test pit TP-8 encountered approximately 1 foot of dark brown topsoil mantling approximately 0.5 feet of brown silty sand with gravel and roots in a loose, moist condition. We interpret these soils to be some undocumented, previously placed fill. Underlying the fill, we encountered approximately 0.5 feet of dark brown relict topsoil/forest duff mantling approximately 1 foot of brown silty sand with gravel in a loose, moist condition. Underlying these surficial soils, we encountered approximately 0.5 to 2.5 feet of brown grey mottled with orange staining silty sand with gravel in a medium dense, moist to damp condition. We interpret these upper soils to be consistent with topsoil over weathered glacial till. Underlying the weathered glacial till soils, we encountered grey silty sand with gravel in a dense to very dense, moist condition to the full depth explored. We interpret these deeper soils to be consistent with glacial till.

TABLE 2:
APPROXIMATE THICKNESS, DEPTHS, AND ELEVATION OF SOIL TYPES ENCOUNTERED IN EXPLORATIONS

Exploration Number	Thickness of Topsoil/Fill (feet)	Thickness of Weathered Till (feet)	Depth to Glacial Till (feet)	Elevation of Top of Glacial Till (feet)
TP-1	1	1½	2½	216½
TP-2	1½	2½	4	214
TP-3	1	2½	3½	214½
TP-4	⅔	1⅓	3	321
TP-5	1	1½	2½	361½
TP-6	1	2½	3½	360½
TP-7	⅔	4⅓	5	285
TP-8	3	½	3½	248½
TP-9	1½	2½	4	246
TP-10	1	2½	4	237
TP-11	1	1	2	236
B-1	4	6½	10½	269½
B-2	0	2½	2½	324½
B-3	3	5	8	332

Notes: Preliminary Site Plan by Contour Engineering, LLC dated January 31, 2018

We interpret the encountered subsurface conditions to be consistent with weathered till over glacial till. Table 2, below, summarizes the approximate thicknesses, depths, and elevations of selected soil layers.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the test pits to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D: 2488, moisture content determinations per ASTM D: 2216, and grain size analyses per ASTM D: 422 standard procedures. The results of the laboratory tests are shown below in Table 3, with graphical output included in Appendix B.

TABLE 3:
LABORATORY TEST RESULTS FOR ON-SITE SOILS

Soil Type	Sample	Lab ID Number	Gravel Content (percent)	Sand Content (percent)	Silt/Clay Content (percent)	D10 Ratio (mm)
Glacial Till	TP-1, S-4, 12'	093800	10.1	58.5	31.4	ND
Glacial Till	TP-5, S-2, 2'	093809	9.6	64.6	25.8	ND
Glacial Till	TP-7, S-2,3'	093814	9.1	60.0	30.9	ND
Glacial Till	TP-8, S-2, 3'	093817	9.9	52.0	38.1	ND
ND = Not determined						

Groundwater Conditions

A layer of mottling was observed at approximately 1 to 5 feet below the existing ground surface in all our test pits. Groundwater seepage was observed at approximately 3 to 11.5 feet below the existing ground surface in test pits TP-1, TP-2, TP-3, TP-9 and TP-10 at the time of digging. Mottling is often indicative of seasonal high perched groundwater.

Perched groundwater typically develops when the vertical infiltration of precipitation through a more permeable soil is slowed at depth by a deeper, less permeable soil type such as glacial till. Perched groundwater also develops seasonally atop the glacially consolidated outwash soils. We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off-site construction activities, and site utilization. Table 4 below summarizes the depths and elevations of groundwater encountered in our test pits and previous borings by Krazan.

TABLE 4:
Approximate Depths and Elevations of Groundwater Encountered in Explorations

Exploration Number	Depth to Groundwater (feet)	Surface Elevation (feet)	Elevation of Groundwater (feet)	Date Observed
TP-1	11.5	219	207.5	February 16, 2018 (ATE)
TP-2	7	218	211	February 16, 2018 (ATE)
TP-3	7	218	211	February 16, 2018 (ATE)
TP-9	3	250	247	February 19, 2018 (ATE)
TP-10	3	241	238	February 19, 2018 (ATE)
B-1	7	280	281	March 22, 2003 (ATD)
B-2	52.5	327	274.5	March 22, 2003 (ATD)

Notes: Preliminary Site Plan by Contour Engineering, LLC dated January 31, 2018
ATD = At time of drilling ATE = At time of excavation NE = Not encountered within depth explored

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations and our experience in the area, it is our opinion that the proposed development is feasible from a geotechnical engineering standpoint, provided the conclusions and geotechnical recommendations regarding the design and construction of the proposed development presented below are included into the project plans.

The use of conventional spread footing is feasible provided the subgrades are prepared as outlined below. The native soils have a high fines content and will be difficult to impossible to reuse as structural fill during periods of extended precipitation. The native soils are not suitable for onsite infiltration,

Erosion Hazard Areas – per Kitsap County Code Chapter 19.400.420

Kitsap County Title 19.400.420 defines erosion hazardous areas based on the following indicators:

A. General. Erosion hazard areas included areas likely to become unstable, such as bluffs, steep slopes, and areas with unconsolidated soils. These include coastal erosion-prone areas and channel migration zones, and may be inclusive of landslide areas.
B. Potential Erosion Hazard Areas. Potential erosion hazard areas are depicted on the Kitsap County erosion hazards map. These potential erosion hazard areas are identified using the following criteria:
    1. Areas of High Erosion Hazard.
        a. Channel migration zones, as mapped by the Washington Department of Ecology;
        b. Coastal erosion with a sediment source rating value of 0.6 to 1.0, per the Prioritization Analysis of Sediment Sources in Kitsap County.

2. Areas of Moderate Erosion Hazard.
    a. Slopes fifteen percent or greater, not classified as I, U, UOS, or URS, with soils classified by the U.S. Department of Agriculture NRCS as "highly erodible" or "potentially highly erodible";
    b. Coastal erosion with a sediment source rating value of 0.3 to 0.6 per the Prioritization Analysis of Sediment Sources in Kitsap County.

C. Erosion Hazard Indicators. The project proponents are responsible for determining actual presence and location of an erosion hazard area. These areas may be indicated by, but not limited to, the following:
    1. Any of the above criteria currently identified in subsection (B) of this section or amended hereafter.
    2. Coastal Erosion Hazards.
        a. Areas with active bluff retreat that exhibit continuing sloughing or calving of bluff sediments, resulting in a vertical or steep bluff face with little or no vegetation;
        b. Lands located directly adjacent to freshwater or marine waters that are identified as regressing, retreating, or potentially unstable as a result of undercutting by wave action or bluff action. The limits of the active shoreline erosion hazard area shall extend landward to include that land area that is calculated, based on the rate of regression, to be subject to erosion processes within the next ten-year time period.
    3. Channel Migration Zones. The lateral extent that a river or stream is expected to migrate over time due to hydrologically and geomorphologically related processes, as indicated by historic record, geologic character, and evidence of past migration over the past one hundred years.

The Kitsap County Code, Chapter 19.400.420 uses the above referenced indicators to define the category of an erosion hazard area. Based on our observations of the site and review of published information, we offer the following comments.

As previously stated, the site is underlain by Alderwood gravelly sandy loam (1 & 2) soils which have "slight" to "moderate" erosion hazard when exposed. No evidence of active or ongoing erosion was observed at the time of our site visits. Based on the Kitsap County erosion hazards map, the subject site or within 200 feet of the site vicinity is not mapped as potential erosion hazard areas. In our opinion, the site does <u>not</u> have an active erosion hazard. Therefore, no prescriptive buffer or development limitation should be imposed by Kitsap County.

Contour Engineering LLC has prepared the site civil drawing that include a temporary erosion and sediment control (TESC) plan. Provided standard Best Management Practices (BMPs) outlined in the Kitsap County stormwater manual are followed, the potential for erosion to impact the project site or adjacent parcel will be minimal.

Landslide Hazard Areas – per Kitsap County Code Chapter 19.400.425

Kitsap County Title 19.400.425 defines landslide hazardous areas based on the following indicators:

A. General. Landslide hazard areas include those areas at risk of mass movement due to a combination of geologic, topographic, and hydrologic factors, such as bedrock, soil, slope (gradient), slope aspect, structure, hydrology, and other factors. Landslide hazards are further classified as either shallow or deep-seated.

B. Potential Landslide Hazard Areas. Potential landslide hazard areas are depicted on the Kitsap County landslide hazards map. These potential landslide hazard areas are identified using the following criteria:
    1. Areas of High Landslide Hazard.
        a. Shallow landslide areas with factor of safety (FS) of 0.5 to 1.5. FS is a method (Harp, 2006) for determining slope stability based on the angle of the slope from LiDAR elevation data and strength parameters.
        b. Areas with slopes greater to or equal to 30 percent in grade and deemed by a qualified geologist or geotechnical engineer to meet the criteria of U, UOS, or URS.
        c. All deep-seated landslide areas.
    2. Areas of Moderate Landslide Hazard.
        a. Shallow landslide areas with FS of 1.5 to 2.5.
        b. Slopes of fifteen percent or greater and not classified as I, U, UOS, or URS, with soils classified by the U.S. Department of Agriculture NRCS as “highly erodible” or “potentially highly erodible”; or slopes of fifteen percent or greater with springs or groundwater seepage.
        c. Slopes in all areas equal to or greater than forty percent.

C. Landslide Hazard Indicators. Project proponents are responsible for determining the actual presence and location of a landslide hazard area. These areas may be indicated by, but not limited to, the following:
    1. Any of the above criteria currently identified in subsection (B) of this section or amended hereafter;
    2. Areas of historic failures, including areas of unstable, old and recent landslides or landslide debris within a head scarp;
    3. Areas within active bluff retreat that exhibit continuing sloughing or calving of bluff sediments, resulting in a vertical or steep bluff face with little or no vegetation;
    4. Hillsides that intersect geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock;
    5. Slopes that are parallel or sub-parallel to planes of weakness, such as bedding planes, joint systems, and fault planes in subsurface materials;
    6. Areas exhibiting geomorphological features indicative of past slope failure, such as hummocky ground, back-rotated benches on slopes, etc.;
    7. Areas with tension cracks or ground fractures along and/or near the edge of the top of a bluff or ravine;
    8. Areas with structures that exhibit structural damage such as settling and cracking of building foundations or separation of steps or porch from a main structure that is located near the edge of a bluff or ravine;
    9. The occurrence of toppling, leaning, bowed, or jackstrawed trees that are caused by disruptions of ground surface by active movement;
    10. Areas with slopes containing soft or liquefiable soils;

11. Areas where gullying and surface erosion have caused dissection of the bluff edge or slope face as a result of drainage or discharge from pipes, culverts, ditches, and natural drainage courses;
12. Areas where seeps, springs or vegetative indicators of a shallow groundwater table are observed on or adjacent to the face of the slope;
13. Areas that include alluvial or colluvial fans located at the base of steep slopes and drainages;
14. Areas within two hundred feet of areas classified as U, UOS, or URS.

The Kitsap County Code, Chapter 19.400.425 uses the above referenced indicators to define the category of a landslide hazardous area. Based on our observations of the site and review of published information, we offer the following comments.

Slopes of 30 percent or greater were observed in the interior slopes of the local drainage swales and existing gravel road; however, no areas of recent or historic failures were observed at the subject site or within 200 feet of the site vicinity. Slopes of 15 percent or greater were observed across the site; however, as previously stated, the site is underlain by Alderwood gravelly sandy loam (1 & 2) soils which have "slight" to "moderate" erosion hazard when exposed. No hummocky ground, back-rotated benches, tension cracks or ground fractures were observed at the time of our site visit. No intersection geologic contacts were, seeps or springs were observed on or adjacent to the face of the slope at the time of our site visit. Evidence of shallow groundwater table on or adjacent to the face of the slope was observed; however, no evidence seeps, springs, active or ongoing erosion were observed at the time of our site visits. No areas of mapped landsdlNo soft or liquefiable soils were observed on the slopes based on our subsurface explorations. Some erosion, and some leaning and bowed trees were also observed along the existing gravel road but site had been logged in the past and the leaning trees appear more indicative of wind-blown trees or deciduous trees that grew at an angle to avoid shading from the taller fir trees. .

Based on the above, it does <u>not</u> appear that there is an active landslide hazard on or within 200 feet of the site vicinity based on our site observations. Therefore, no prescriptive buffer or development limitation should be imposed by Kitsap County. Given the slope inclination and mapped stratigraphy, we do not interpret the site to meet the definition of an area of moderate or high geologic concern.

Seismic Hazard Areas – per Kitsap County Code Chapter 19.400.430

Kitsap County Title 19.400.430 defines seismic hazardous areas based on the following indicators:

A. General. Seismic hazard areas are areas subject to severe risk of damage as a result of earthquake-induced land sliding, seismic ground shaking, dynamic settlement, fault rupture, soil liquefaction, or flooding caused by tsunamis and seiches.
B. Potential Seismic Hazard Areas. Potential seismic hazard areas are depicted on the Kitsap County seismic hazards map. These potential seismic hazard areas are identified using the following criteria:
    1. Areas of high seismic hazard are those areas with faults that have evidence of rupture at the ground surface.
    2. Areas of moderate seismic hazard.

a. Areas susceptible to seismically induced soil liquefaction, such as hydric soils as identified by the NRCS, and areas that have been filled to make a site more suitable for development. This may include former wetlands that have been covered with fill.
b. Areas identified as Seismic Site Class D, E, and F.
c. Faults without recognized evidence of rupture at the ground surface.

C. Seismic Hazard Indicators. Project proponents are responsible for determining actual presence and location of a seismic hazard area. These areas may be indicated by, but not limited to, the following:
1. Any of the above criteria currently identified in subsection (B) of this section or amended hereafter;
2. Areas identified as potential landslide areas, including slopes that can become unstable as a result of strong ground shaking, even though these areas may be stable under nonseismic conditions;
3. Areas identified as high and moderate liquefaction and dynamic settlement hazard areas by the Washington Department of Natural Resources, including areas underlain by unconsolidated sandy or silt soils and a shallow groundwater table (static groundwater depth less than thirty feet) capable of liquefying in response to earthquake shaking. Dynamic settlement hazard areas are those underlain by more than ten feet of loose or soft soil not susceptible to liquefaction, but that could result in vertical settlement of the ground surface in response to earthquake shaking;
4. Tsunami and seiche hazard areas. Generally, these are areas that are adjacent to Puget Sound marine waters and lakes that are designated as "A" or "V" zones as identified by FEMA and depicted on the FEMA maps or other maps adopted by Kitsap County;
5. Fault rupture hazard areas, including areas where displacement (movement up, down, or laterally) of the ground surface has occurred during past earthquake(s) in the Holocene Epoch, and areas adjacent that may be potentially subject to ground surface displacement in a future earthquake.

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. According to the Department of Natural Hazard Map (Geologic Information Portal), the site is located between the east end of the Dabob Bay fault zone and the Seattle Fault Zone, as shown on Figure 5. Given the distance the mapped fault zones and thickness of young, dense glacial sediments underlying the site, we interpret the risk for ground fault surface rupture to be low. No evidence of faulting was observed in our subsurface explorations.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength because of an increase in pore water pressure induced by seismic vibrations. Liquefaction mainly affects geologically recent deposits of loose, fine-grained sands that are below the groundwater tableThe risk for liquefaction is low because of the shallow groundwater table and density of the site soils. In our opinion, the potential for slope instability and lateral spreading is low because of the density of the site soils and lack of groundwater.

Provided the design criteria listed below are followed, the proposed structure will have no greater seismic risk damage than other appropriately designed structures in the Puget Sound area.

Building Setback

While no active landslide hazard buffer should be required by Kitsap County planning, the building department may still require setbacks from slopes steeper than 30 percent in order to satisfy the requirements of the International Building Code (IBC) section 1805. IBC requires a building setback from slopes that are steeper than 3H:1V (Horizontal: Vertical) or 33 percent with greater than 10 feet in vertical height unless evaluated and reduced, and/or a structural setback is provided, by a licensed geotechnical engineer. The IBC setback distance is calculated based on the vertical height of the slope. The typical IBC setback from the top of the slope equals one third the height of the slope while a setback from the toe of the slope equals one half the height of the slope.

The site will be graded resulting in level building pad steeping down the slope from west to east. We have not been provided with a copy of the site grading plan, but anticipate that most steeps will be less than 6 feet in height and will either be retained by a wall or permanent cut or fill slope. Once the final locations of the residences are determined and the setback criteria cannot be met, we can provide alternative foundation recommendations to address the setback criteria.

Seismic Design

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class "D" for the onsite soils in accordance with the 2015 IBC (International Building Code) documents and ASCE 7-10 Chapter 20 Table 20.3-1.

For design of seismic structures using the IBC 2015, mapped short-period and 1-second period spectral accelerations, SS and S1, respectively, are required. SS and S1 are for a maximum considered earthquake, which corresponds to ground motions with a 2 percent probability of exceedance in 50 years or about a 2,500-year return period (with a deterministic maximum cap in some regions). The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. The PSHA ground motion results can be obtained from the USGS website. The results of the updated USGS PSHA were referenced to determine SS and S1 for this site. The results are summarized in the following table with the relevant parameters necessary for IBC 2015 design.

TABLE 5:
2015 IBC PARAMETERS FOR DESIGN OF SEISMIC STRUCTURES

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.371	S_1 = 0.546
Site Coefficients (Site Class D)	F_a = 1.0	F_v = 1.5
Maximum Considered Earthquake SRA	S_{MS} = 1.371	S_{M1} = 0.820
Design SRA	S_{DS} = 0.914	S_{D1} = 0.546

Site Preparation

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials including existing residences, ancillary structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill but may be used for limited depths in non-structural areas. Stripping depths ranging from 12 to 18 inches should be expected to remove these unsuitable soils. Thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

Some previously placed, undocumented fill material was encountered down to approximately 1.5 feet below the existing ground surface in test pit TP-8, located at the northeastern portion of the site. In addition to removal of the topsoil, the undocumented fill material across the site should also be removed. Recommendations regarding the potential reuse of the undocumented fill and native soils are discussed in the "**Suitability of On-Site Materials as Fill**" section.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of any fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the "**Structural Fill**" section of this report.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a ½-inch-diameter steel rod during wet weather conditions.

Soft, loose or otherwise unsuitable areas delineated during proofrolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of over-excavation should be evaluated by our field representative at the time of construction. The areas of previously placed, undocumented fill material should be evaluated during grading operations to determine if they need mitigation; recompaction or removal.

Foundation Support

Based on the encountered subsurface soil conditions encountered across the site and the preliminary building plans, we recommend that the structures be supported by conventional spread and column footings. The footings should be founded on the dense to very dense native glacial till encountered at depth, or on structural fill that extends to suitable native soils. The native soils at the base of the excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed or recompacted, as appropriate. A geotechnical expert or representative of GeoResources LLC should observed the foundation subgrade at the time of excavation.

We recommend a minimum width of 24 inches for isolated footings and at least 18 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Footings founded on the native, unweathered, and undisturbed glacial till may be designed using an allowable soil bearing capacity of 2,500 psf (pounds per square foot) for combined dead and long-term live loads. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying native glacially

consolidated outwash soils. Passive pressure may be determined using an allowable equivalent fluid density of 350 pcf (pounds per cubic foot) for structural fill. Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be less than 1-inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of ½-inch or less across a 50–foot span. Most of the settlements should occur essentially as loads are being applied. However, disturbance of the foundation subgrade during construction could result in larger settlements than predicted.

Subgrade and Below Grade Walls

The lateral pressures acting on subgrade retaining walls (such as vaults foundations or basement walls) will depend upon the nature and density of the soil behind the wall. It is also dependent upon the presence or absence of hydrostatic pressure. If the walls are backfilled with granular well-drained soil, we recommend using an allowable equivalent fluid pressures of 35 pcf for the active condition and 55 pcf for the at rest condition. This design value assumes a level backslope and drained conditions as described below.

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent greater than the US #4 sieve. A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions. A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the MDD. Over-compaction should be avoided as this can lead to excessive lateral pressures.

A minimum 4-inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill, and should be extended over the top of the drainage zone.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 350 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation.

All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements. Based on current Washington State Safety and Health Administration (WSHA) regulations, the fill and weathered glacial till on the site would be classified as Type C soils, and the deeper glacial till would be classified as Type A soils.

According to WSHA, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be sloped at a maximum inclination of 1½H:1V, and the side slopes in lower Type A soils should be sloped at a maximum inclination of 0.75H:1V. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Where retaining structures are greater than 4-feet in height (bottom of footing to top of structure) or have slopes of greater than 15 percent above them, they should be engineered per Washington Administrative Code (WAC 51-16-080 item 5). This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Site Drainage

All ground surfaces, pavements and sidewalks at the site should be sloped away from the structures. Surface water runoff should be controlled by a system of curbs, berms, drainage swales, and or catch basins, and conveyed to an appropriate discharge point.

We recommend that footing drains are installed for the residence in accordance with IBC 1807.4.2, and basement walls (if utilized) have a wall drain as described above. The roof drain should not be connected to the footing drain. Figure 6 shows typical wall drainage and backfilling details. If the basement cut extends below the adjacent municipal stormwater system, a sump and pump system may be required.

Permanent Cut and Fill Slopes

Cut and fill slopes constructed on grades that steeper than 5H:1V should be constructed in accordance with Appendix J of the 2015 IBC and should utilize proper keying and benching methods. An excerpt from the 2015 IBC, Appendix J is included as Figure 7.

All slopes should be protected from erosion. Typical erosion control BMPs as adopted by the Kitsap County stormwater and site design manual, and as indicated in the civil plans prepared by Contour Engineering, should be sufficient for proposed site grading activities. Additionally, permanent slopes should be planted with a mulch, hardy vegetative groundcover or armored with quarry spalls as soon as feasible after grading is completed.

Stormwater Infiltration

Based on the preliminary site plan by Contour Engineering, LLC dated January 31, 2018, the residential development will add more than 10,000 square feet of impervious area, which will trigger

comprehensive subsurface investigation per the 2016 Kitsap County Stormwater Design Manual (2016 KCSWDM), Section 5.3, Table 5.3. Per the 2016 KCSWDM, Appendix G, Section G2.5, a minimum vertical separation of 1-foot between the bottom of the permeable pavement and the high groundwater table is required; while a minimum vertical separation of 3-foot between the bottom of any pond or gallery.

As stated, mottling was observed at approximately 1 to 5 feet below the existing ground surface in all our test pits. Furthermore, given the high fines content and relative density of the glacial till, infiltration is not feasible. Groundwater was also observed at approximately 3 to 11.5 feet below the existing ground surface in test pits TP-1, TP-2, TP-3, TP-9 and TP-10. Mottling is often indicative of seasonal high perched groundwater. Additionally, site grading will result in moderate cuts and fills across the site that will likely remove the upper weathered soils and require the placement of structural. Based on our site observations and subsurface explorations, and our understanding of the site grading plan, it is our opinion that the minimum vertical separation requirement cannot be met per the 2016 KCSWDM, Appendix G, Section G2.5; therefore, onsite infiltration is not feasible for this project.

We recommend that alternative stormwater BMPs be selected in accordance with the 2016 KCSWDM for the proposed development. All minimum setback requirements and infeasibility criteria per the 2016 KCSWDM should be considered prior to the selection of any stormwater facility for the proposed development.

EARTHWORK RECOMMENDATIONS

Structural Fill

All material placed as fill under building areas or retaining structures, should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Structural fill should be compacted to at least 95 percent of MDD (maximum dry density as determined in accordance with ASTM D-1557).

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the 3/4-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash and cobbles greater than 6-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, the non-organic on-site soil may be considered for use as structural fill; provided it meets the criteria described above in the "**Structural Fill"** section and can be compacted as recommended. If the soil material is over-optimum in moisture content when excavated, it will be necessary to aerate or dry the soil prior to placement as structural fill.

The previously placed fill encountered at shallow depths in the northeastern portion of the site consists of a mixture of sand, silt, and gravel with organic material. We do not anticipate that these soils will be suitable for use as structural fill because of the presence of organic material unless they are processed. Screening these granular fill soils with a 3-inch sieve to remove organics would be appropriate. Removal and processing of the undocumented fill soils should include excavating down to native soils, and an appropriate level of processing to meet the specification with WSDOT Common Borrow (9-03.14(3)). GeoResources personnel should provide sufficient laboratory testing and monitoring to ensure the above specification is met and the material is replaced as structural fill.

The shallower native weathered till and glacial till soils encountered across the site generally consisted of silty sand with variable amounts of gravel. These soils are generally comparable to "common borrow" material and will be suitable for use as structural fill provided the moisture content is maintained within 2 percent of the optimum moisture level. Because of the high fines content, these soils are moisture sensitive, and will be difficult to impossible to compact during wet weather conditions, or where seepage occurs. If these soils are excessively moist to saturated, it will be necessary to aerate or dry the soil prior to placement as structural fill.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base, a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend the following:

- No drainage of concentrated surface water or significant sheet flow onto or near the steep slope area.
- No fill should be placed within the buffer or setback zones unless retained by engineered retaining walls or constructed as an engineered fill.
- Grading should be limited to providing surface grades that promote surface flows away from the top of slope to an appropriate discharge location.

Erosion protection measures will need to be in place prior to the start of grading activity on the site. Erosion hazards can be mitigated by applying Best Management Practices (BMP's) outlined in the 2016 Kitsap County Stormwater Design Manual.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, wet weather generally begins about mid-October and continues through about May, although rainy periods could occur at any time of year. Therefore, it is strongly

encouraged that earthwork be scheduled during the dry weather months of June through September. Most of the soil at the site contains sufficient fines to produce an unstable mixture when wet. Such soil is highly susceptible to changes in water content and tends to become unstable and impossible to proof-roll and compact if the moisture content exceeds the optimum.

In addition, during wet weather months, the groundwater levels could increase, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil. However, should wet weather/wet condition earthwork be unavoidable, the following recommendations are provided:

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet-sieving the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above).
- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

We recommend that the above requirements for wet weather/wet condition earthwork be incorporated into the contract specifications.

LIMITATIONS

We have prepared this report for use by the NorPoint Communities, Contour Engineering PLLC, and other members of the design team, for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Our opinions, recommendations, and analyses assume that the conditions encountered in our explorations are representative of the subsurface conditions in general. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

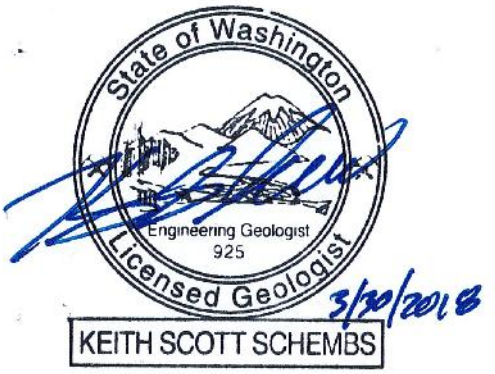
If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.

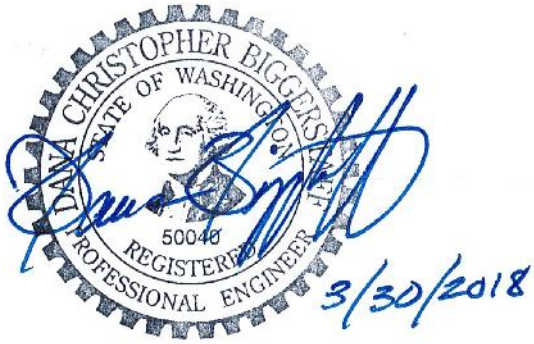
◆ ◆ ◆

We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC

Carson Cheung, EIT
Staff Engineer in Training





Keith S. Schembs, LEG
Principal

Dana C. Biggerstaff, PE
Senior Geotechnical Engineer

CC:KSS:DCB/cc
Doc ID: NorPoint.OntheRidge.RG
Attachments:
Figure 1: Site Location Map
Figure 2a: Site Vicinity Map
Figure 2b: Site & Exploration Map
Figure 3: NRCS Soils Map
Figure 4: Geologic Map
Figure 5: Fault Hazard Map
Figure 6: Typical Wall Drainage and Backfill
Figure 7: IBC Appendix J Detail
Appendix "A" - Subsurface Explorations
Appendix "B" - Laboratory Test results

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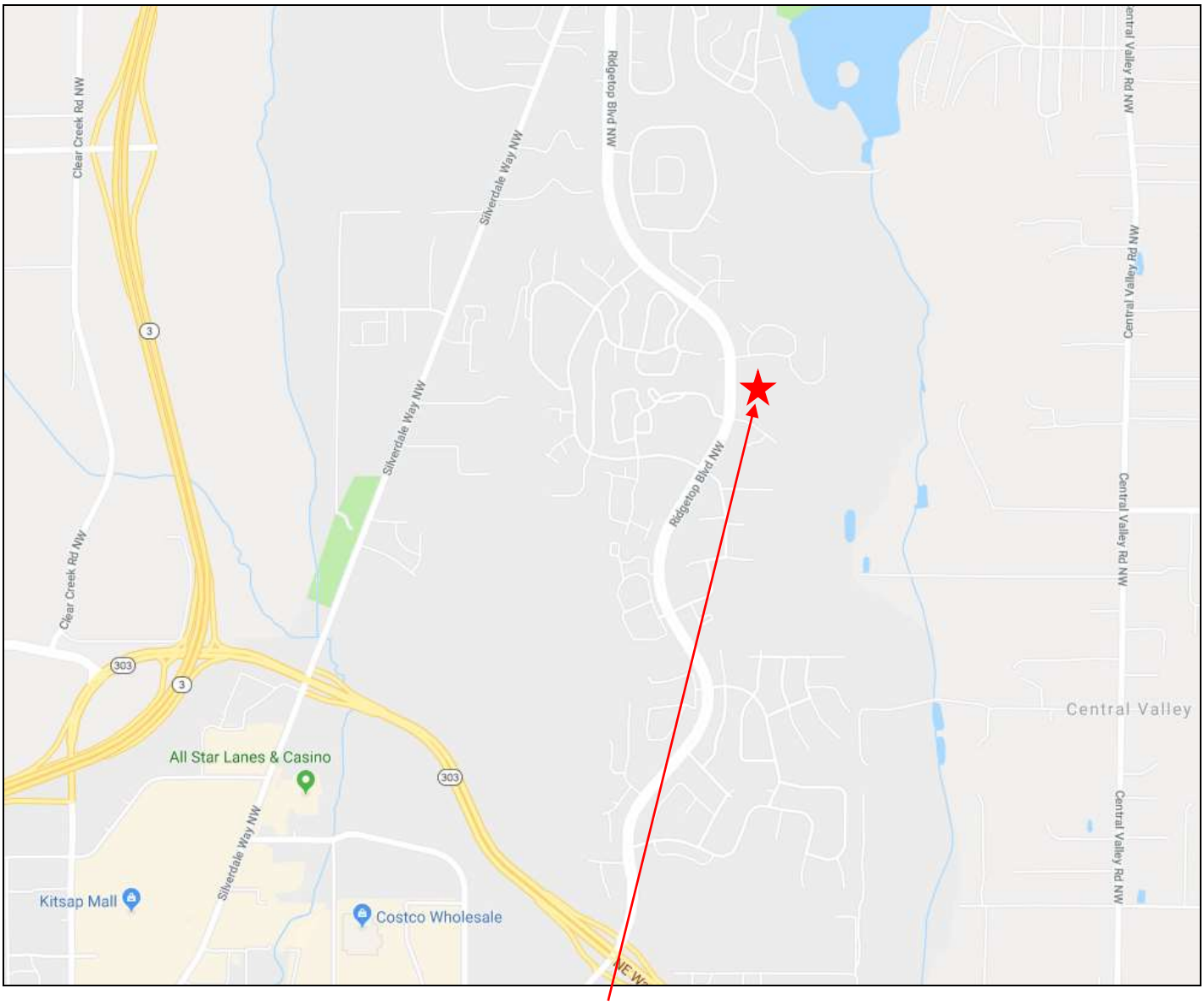

Approximate Site Location

(map created from Google Maps http://maps.google.com/)

Not to Scale

Site Location Map

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

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Permit Number: 20-01252

Approximate Site Location

(map created from Pierce County Parcel Search https://ags.kitsapgov.com/psearch/index.html/)

N W E S

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Site Vicinity Map

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DocID: NorPoint.OntheRidge.F	March 2018	Figure 2a

Permit Number: 20-01252

Approximate Site Location

(map created from *Preliminary Civil Plan* by Contour Engineering, LLC dated January 31, 2018)

Approximate location and number of test pits

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W
E
S

Not to Scale

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Site and Exploration Map

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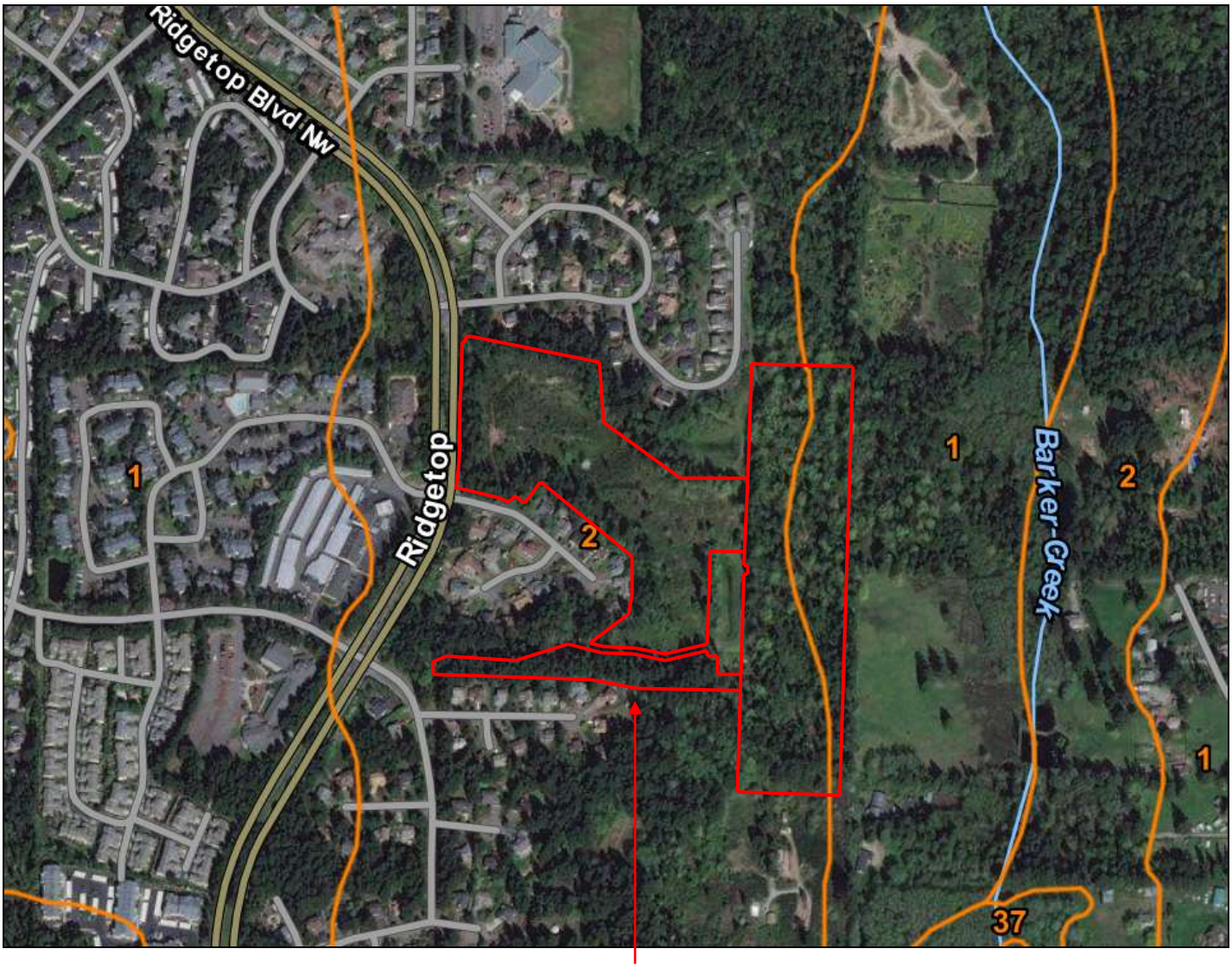
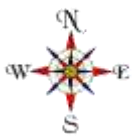


Approximate Site Location

Map created from Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
1	Alderwood gravelly sandy loam	Glacial till	0 to 6	Slight	C
2	Alderwood gravelly sandy loam	Glacial till	6 to 15	Moderate	C
37	Norma fine sandy loam	Glacial alluvium	0 to 3	Slight	B/D



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NRCS Soils Map

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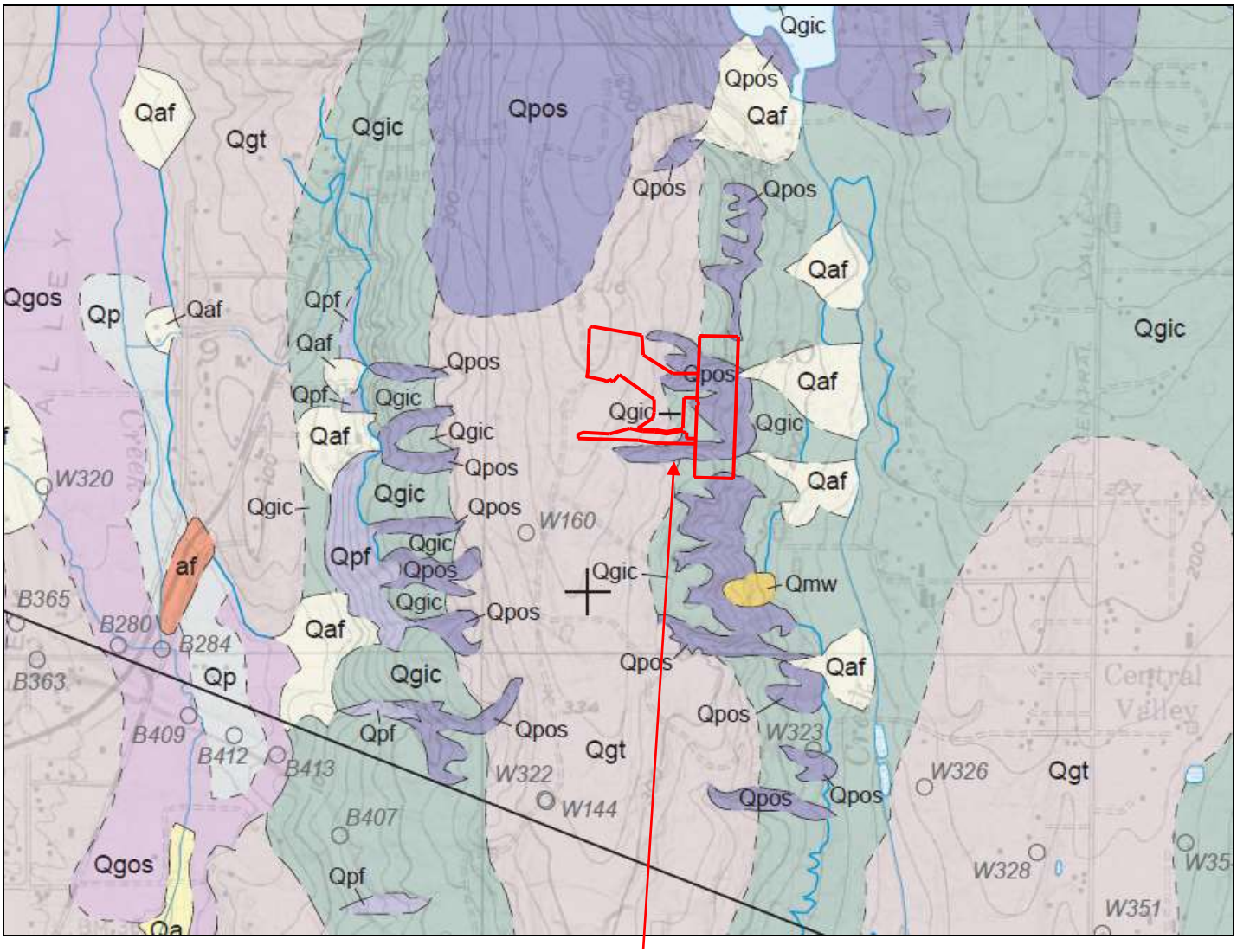

Approximate Site Location

(An excerpt from the *Geologic Map of the Seabeck and Poulsbo 7.5-minute Quadrangle, Kitsap and Jefferson Counties, Washington* by Michael Polenz, Gary T. Petro, Trevor A. Contreras, Kimberly A. Stone, Gabriel Legorreta Paulin, and Recep Cakir)

Qgt	Glacial till
Qgic	Ice-contact deposits
Qpos	Pre-Vashon outwash sand
Qaf	Alluvial fan deposits

Not to Scale

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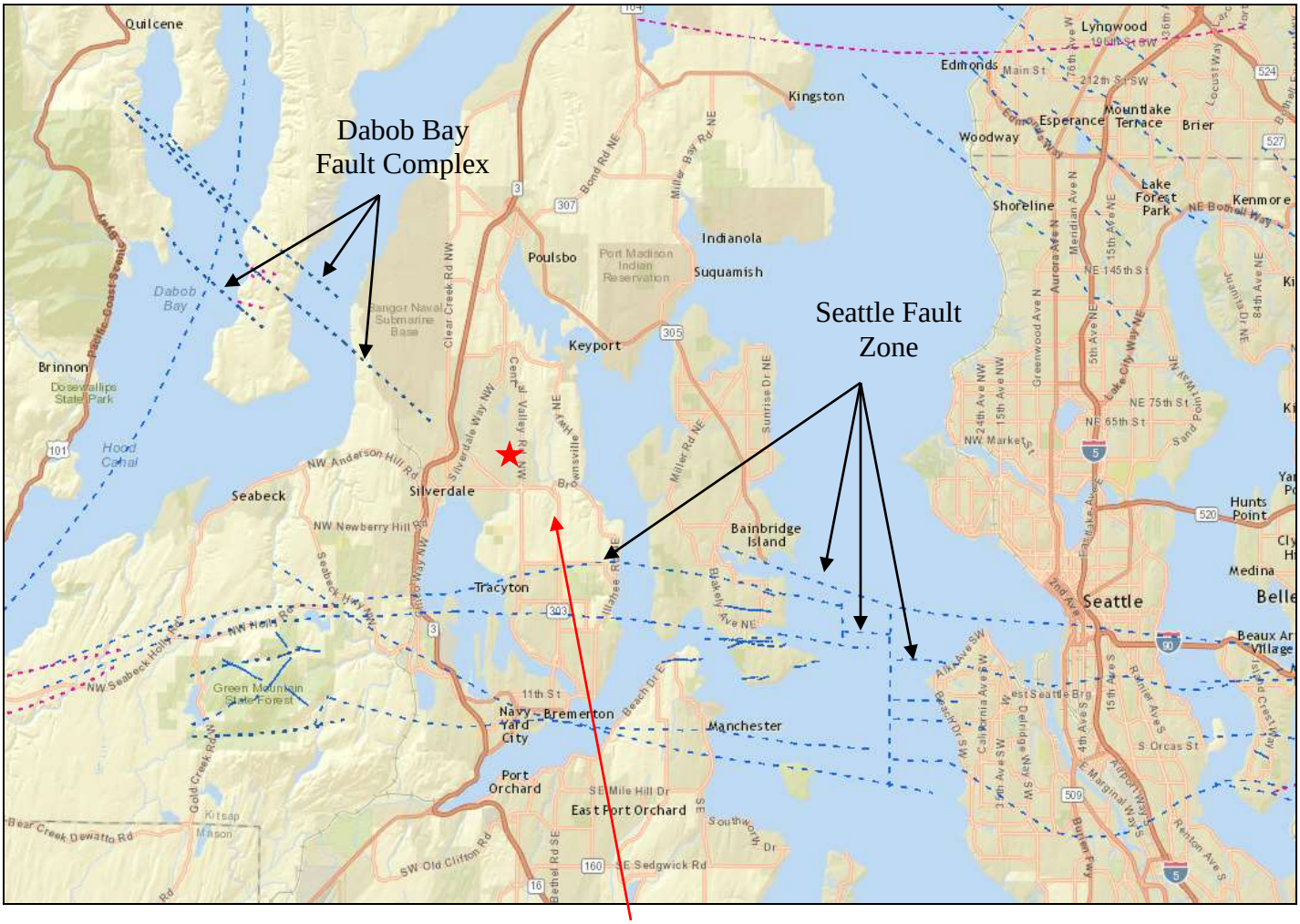
USGS Geologic Map

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

DocID: NorPoint.OntheRidge.F	March 2018	Figure 4

Permit Number: 20-01252



Approximate Site Location

(Map created form Washington DNR Geologic Information Portal http://fortress.wa.gov/dnr/protectiongis/geology/?Theme=wigm)

N W E S

Not to Scale

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Fault Hazard Map

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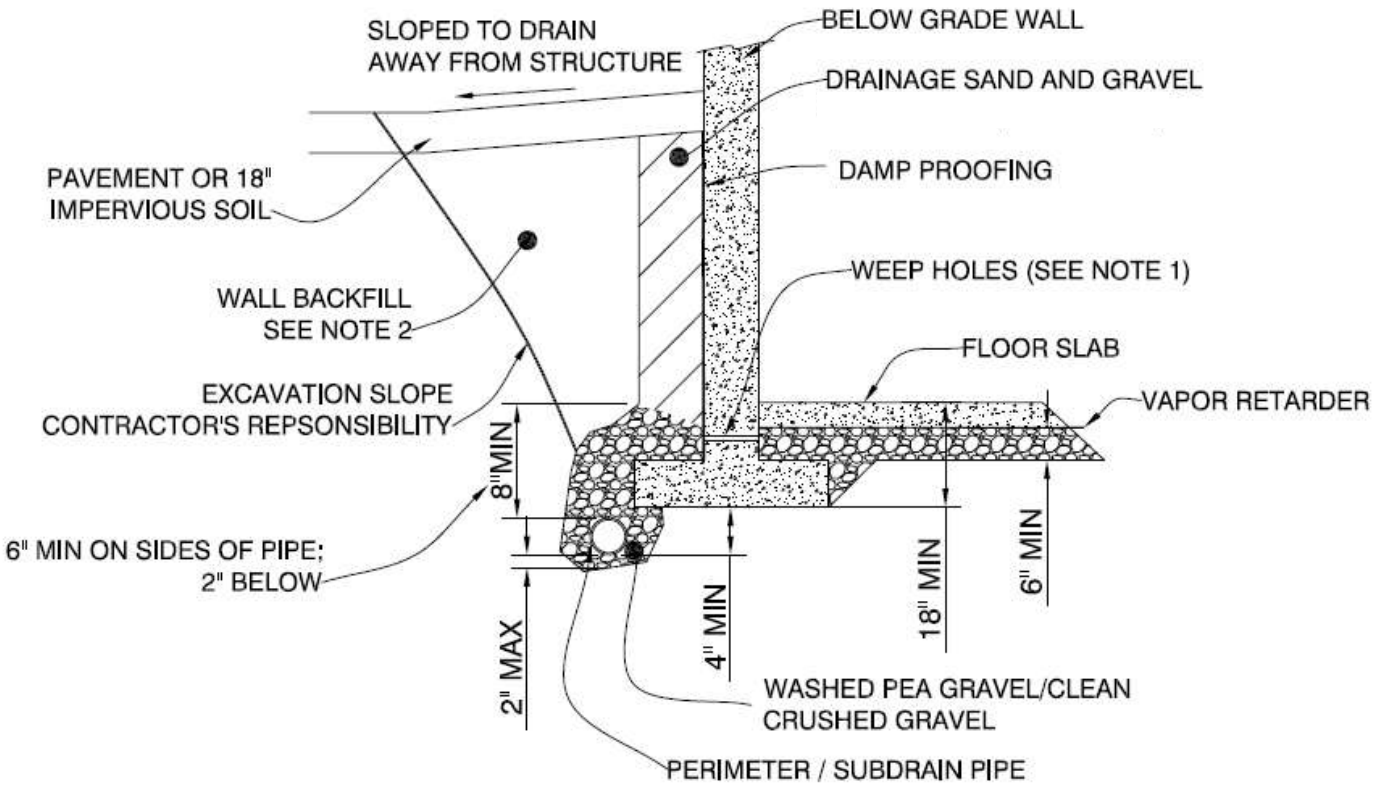
DocID: NorPoint.OntheRidge.F	March 2018	Figure 5

Permit Number: 20-01252



Notes

1. Washed pea gravel/crushed rock beneath floor slab could be hydraulically connected to perimeter/subdrain pipe. Use of 1" diameter weep holes as shown is one applicable method. Crushed gravel should consist of 3/4" minus. Washed pea gravel should consist of 3/8" to No. 8 standard sieve.

2. Wall backfill should meet WSDOT Gravel Backfill for walls Specification 9-03-12(2).

3. Drainage sand and gravel backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall. The table below presents the drainage sand and gravel gradation.

4. All wall back fill should be placed in layers not exceeding 4" loose thickness for light equipment and 8" for heavy equipment and should be densely compacted. Beneath paved or sidewalk areas, compact to at least 95% Modified Proctor maximum density (ASTM: 01557-70 Method C). In landscaping areas, compact to 90% minimum.

5. Drainage sand and gravel may be replaced with a geocomposite core sheet drain placed against the wall and connected to the subdrain pipe. The geocomposite core sheet should have a minimum transmissivity of 3.0 gallons/minute/foot when tested under a gradient of 1.0 according to ASTM 04716.

6. The subdrain should consist of 4" diameter (minimum), slotted or perforated plastic pipe meeting the requirements of AASHTO M 304; 1/8-inch maximum slot width; 3/16- to 3/8-inch perforated pipe holes in the lower half of pipe, with lower third segment unperforated for water flow; tight joints; sloped at a minimum of 6"/100' to drain; cleanouts to be provided at regular intervals.

7. Surround subdrain pipe with 8 inches (minimum) of washed pea gravel (2" below pipe" or 5/8" minus clean crushed gravel. Washed pea gravel to be graded from 3/8-inch to No.8 standard sieve.

8. See text for floor slab subgrade preparation.

Materials				
Drainage Sand and Gravel			¾" Minus Crushed Gravel	
Sieve Size	% Passing by weight		Sieve Size	% Passing by weight
¾"	100		¾"	100
No. 4	28-56		½"	75-100
No. 8	20-50		¼"	0-25
No. 50	3-11		No. 100	0-2
No. 100	0-2		(wet sieving)	(non-plastic)

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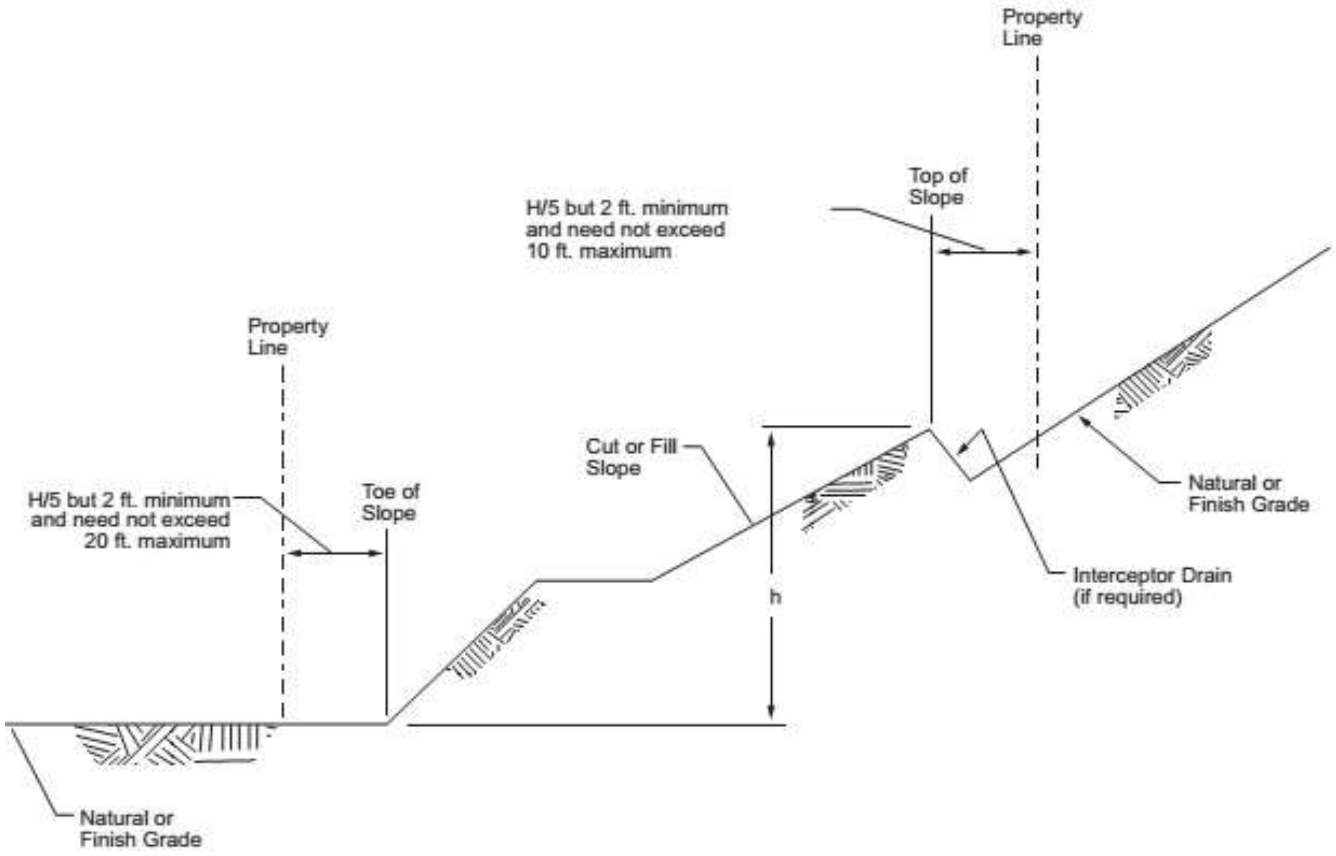
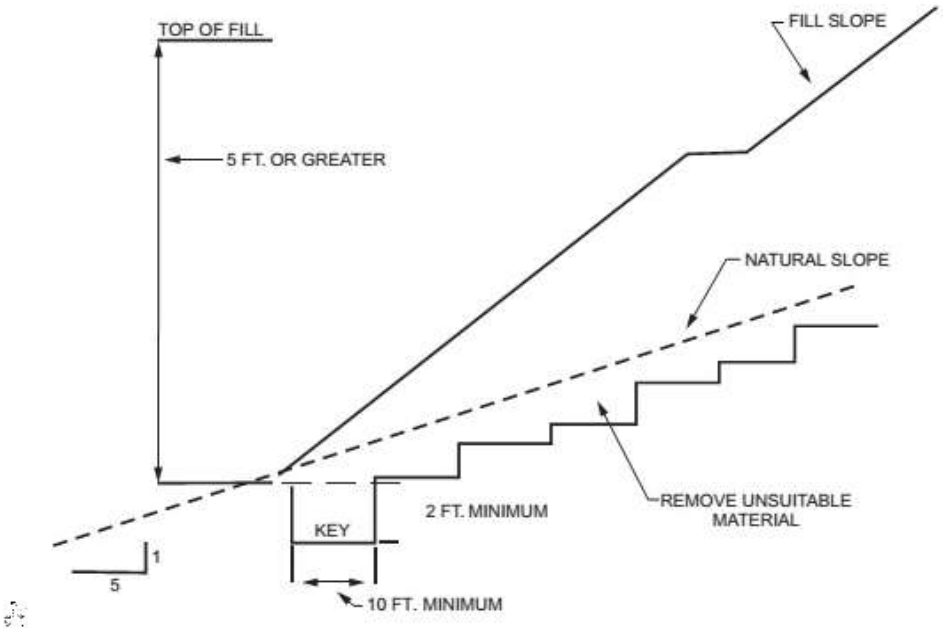
Typical Drainage and Backfill Detail

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009





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Typical Drainage and Backfill Detail

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Doc ID: NorPoint.OntheRidge.F	March 2018	Figure 7

Permit Number: 20-01252

Appendix A

Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or more	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

Dry- Absence of moisture, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

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Unified Soils Classification System

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Test Pit TP-1

Location: Southern portion of the proposed pond
Approximate Elevation: 219'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.0	-	2.0	SM	Brown silty SAND with gravel (loose, moist)
2.0	-	2.5	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
2.5	-	12.0	SM	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (becomes less silty and coarser with depths)(Glacial Till)

Terminated at 12.0 feet below existing ground surface.
No caving observed.
Minor mottling/orange staining observed at 1.5 feet below existing ground surface.
Groundwater seepage observed at 11.5 feet below existing ground surface.

Test Pit TP-2

Location: Central portion of the proposed pond
Approximate Elevation: 218'

Depth (ft)			Soil Type	Soil Description
0	-	1.5	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.5	-	2.5	SM	Brown silty SAND with gravel (loose, moist)
2.5	-	4.0	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
4.0	-	11.0	SM	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (Glacial Till)

Terminated at 11.0 feet below ground surface.
Caving observed at 7.0 feet below existing ground surface.
Mottling/orange staining observed at 2.5 feet below existing ground surface.
Groundwater seepage observed at 7.0 feet below existing ground surface.

Logged by: CC **Excavated on: February 16 & 19, 2018**

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Test Pit Logs

Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Test Pit TP-3

Location: Northern portion of the proposed pond
Approximate Elevation: 218'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.0	-	2.0	SM	Brown silty SAND with gravel (loose, moist)
2.0	-	3.5	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
3.5	-	11.0	SM	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (Glacial Till)

Terminated at 11.0 feet below existing ground surface.
Caving observed at 7.0 feet below existing ground surface.
Mottling/orange staining observed at 2.5 feet below existing ground surface.
Groundwater seepage observed at 7.0 feet below existing ground surface.

Test Pit TP-4

Location: Northeast to the proposed building 15
Approximate Elevation: 324'

Depth (ft)			Soil Type	Soil Description
0	-	0.8	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
0.8	-	1.5	SM	Brown silty SAND with gravel (loose, moist)
1.5	-	3.0	SW	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
3.0	-	7.0	SW	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (similar to TP-1, finer sand) (Glacial Till)

Terminated at 7.0 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 1.5 feet below existing ground surface.
No groundwater seepage observed.

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Test Pit Logs
Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Test Pit TP-5

Location: South to the proposed building 10
Approximate Elevation: 364'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots, organics and occasional wood debris (loose, moist) (topsoil)
1.0	-	1.8	SM	Brown silty SAND with gravel (loose, moist)
1.8	-	2.5	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, dry to moist)
2.5	-	6.0	SM	Grey silty SAND with gravel (dense to very dense, dry to moist) (cemented) (Glacial Till)

Terminated at 7.0 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 1.8 feet below existing ground surface.
No groundwater seepage observed.

Test Pit TP-6

Location: South to the proposed building 2
Approximate Elevation: 364'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots, organics and occasional wood debris (loose, moist) (topsoil)
1.0	-	3.5	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, dry to moist)
3.5	-	6.0	SM	Grey silty SAND with gravel (dense to very dense, dry to moist) (cemented) (Glacial Till)

Terminated at 6.0 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 2.0 feet below existing ground surface.
No groundwater seepage observed.

Logged by: CC **Excavated on: February 16 & 19, 2018**

Test Pit TP-7

Location: East to the proposed building 19
Approximate Elevation: 290'

Depth (ft)			Soil Type	Soil Description
0	-	0.8	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
0.8	-	2.5	SM	Brown silty SAND with gravel (loose, moist)
2.5	-	5.0	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
5.0	-	6.2	SM	Grey silty SAND with gravel (dense to very dense, dry to moist) (slightly cemented) (Glacial Till)

Terminated at 6.2 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 2.5 feet below existing ground surface.
No groundwater seepage observed.

Test Pit TP-8

Location: South to the proposed building 50
Approximate Elevation: 252'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.0	-	1.5	SM	Brown silty SAND with gravel and roots (loose, moist) (fill)
1.5	-	2.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (relict topsoil)
2.0	-	3.0	SM	Brown silty SAND with gravel (loose, moist)
3.0	-	3.5	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, moist)
3.5	-	7.5	SM	Grey silty SAND with gravel (dense to very dense, dry to moist) (Glacial Till)

Terminated at 7.5 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 3.0 feet below existing ground surface.
No groundwater seepage observed.

Logged by: CC **Excavated on: February 16 & 19, 2018**

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Test Pit Logs
Proposed Multi-Family Development
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Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Test Pit TP-9

Location: South to proposed building 59
Approximate Elevation: 250'

Depth (ft)			Soil Type	Soil Description
0	-	1.5	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.5	-	2.7	SM	Brown silty SAND with gravel (loose, moist to damp)
2.7	-	4.0	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, damp)
4.0	-	7.5	SM	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (Glacial Till)

Terminated at 7.5 feet below ground surface.
Caving observed at 2.0 feet below existing ground surface.
Mottling/orange staining observed at 2.5 feet below existing ground surface.
Groundwater seepage observed at 3.0 feet below existing ground surface.

Test Pit TP-10

Location: South to the proposed building 27
Approximate Elevation: 241'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.0	-	2.5	SM	Brown silty SAND with gravel (loose, moist to damp)
2.5	-	4.0	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, damp)
4.0	-	6.8	SM	Grey silty SAND with gravel (dense to very dense, moist) (cemented) (Glacial Till)

Terminated at 6.8 feet below ground surface.
Caving observed at 3.5 feet below existing ground surface.
Mottling/orange staining observed at 3.0 feet below existing ground surface.
Groundwater seepage observed at 3.0 feet below existing ground surface.

Logged by: CC **Excavated on: February 16 & 19, 2018**

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Test Pit Logs
Proposed Multi-Family Development
xxx – Ridgetop Boulevard Northwest
Silverdale, Washington
PN: 102501-3-046-2004 & -033-2009

Test Pit TP-11

Location: South to the proposed building 31
Approximate Elevation: 238'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Dark brown topsoil/forest duff with roots and organics (loose, moist) (topsoil)
1.0	-	2.0	SM	Brown grey mottled/orange staining silty SAND with gravel (medium dense, damp)
2.0	-	6.0	SM	Grey silty SAND with gravel (very dense, moist) (cemented) (Glacial Till)

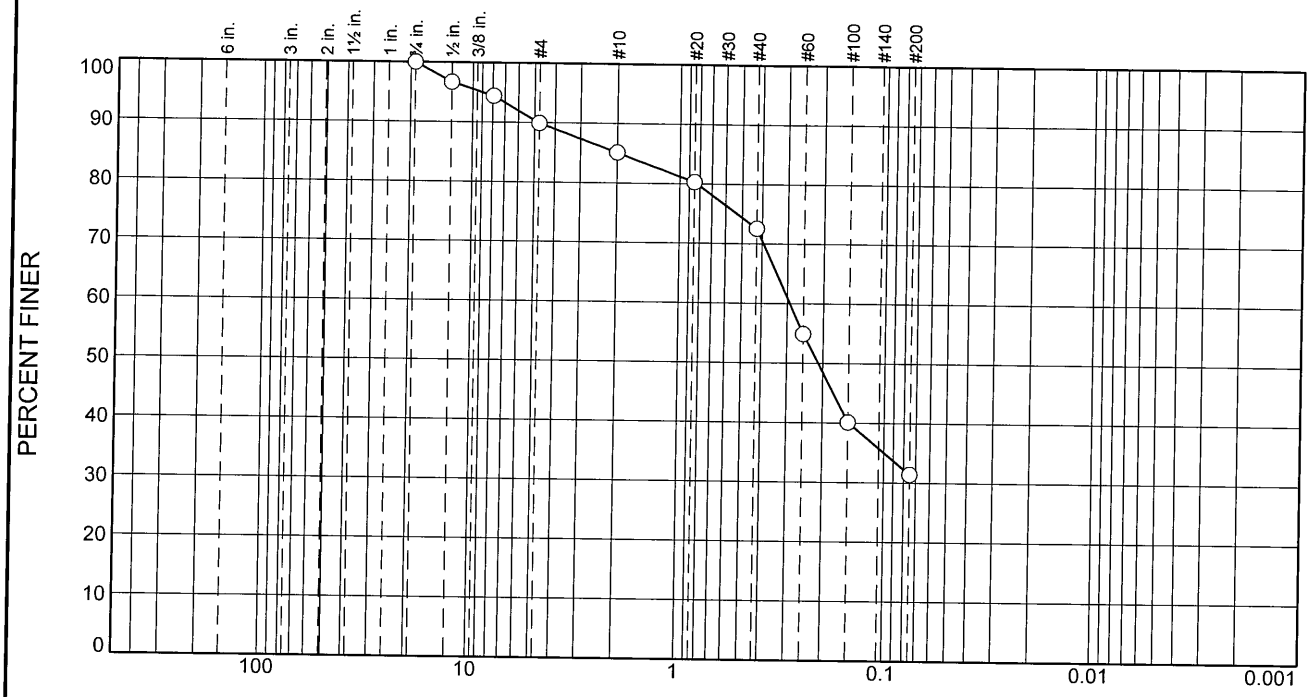
Terminated at 6.0 feet below ground surface.
No caving observed.
Mottling/orange staining observed at 1.0 feet below existing ground surface.
No groundwater seepage observed.

Logged by: CC **Excavated on: February 16 & 19, 2018**

Appendix B

Laboratory Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.1	4.8	12.5	41.2	31.4	

Test Results (ASTM D 422 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	96.7		
.3125	94.4		
#4	89.9		
#10	85.1		
#20	80.3		
#40	72.6		
#60	54.9		
#100	40.1		
#200	31.4		

* (no specification provided)

Material Description

Grey poorly-graded silty SAND with gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D_{90}= 4.8155 D_{85}= 1.9779 D_{60}= 0.2915
D_{50}= 0.2111 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: _____ Date Tested: 2/21/2018

Tested By: CC

Checked By: KSS

Title: PM

Location: TP-1 S-4 D@12' **Depth:** 12' **Date Sampled:** 2/16/2018

Sample Number: 093800

GeoResources, LLC

Fife, WA

Client: NorPoint Communities

Project: NorPoint.OntheRidge

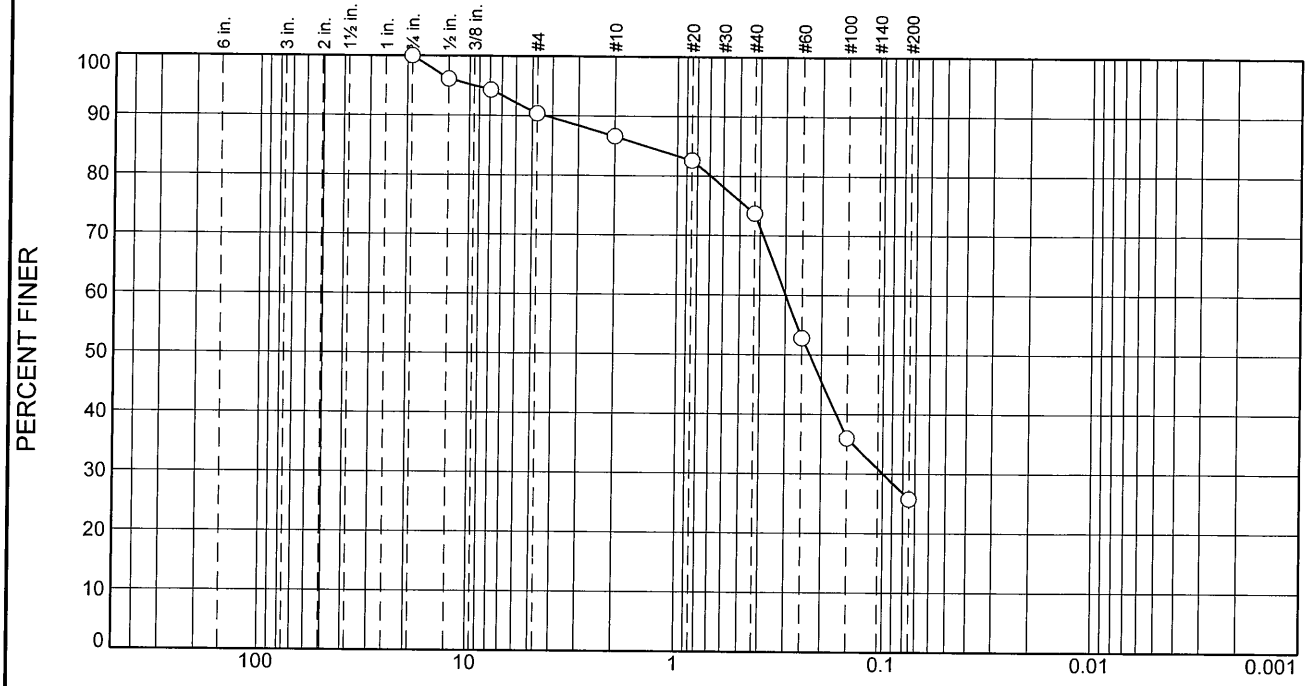
Project No: NorPoint.OntheRidge **Figure** B-1

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Permit Number: 20-01252

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.6	3.8	12.9	47.9	25.8	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	96.1		
.3125	94.3		
#4	90.4		
#10	86.6		
#20	82.6		
#40	73.7		
#60	52.8		
#100	36.0		
#200	25.8		

* (no specification provided)

Material Description

Brown grey silty SAND with gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D_{90}= 4.3687 D_{85}= 1.4249 D_{60}= 0.3000
D_{50}= 0.2295 D_{30}= 0.0999 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: _____ Date Tested: _____

Tested By: _____

Checked By: _____

Title: _____

Location: TP-5 S-2 D@2'
Sample Number: 093809

Date Sampled:

GeoResources, LLC

Fife, WA

Client: NorPoint Communities
Project: NorPoint.OntheRidge

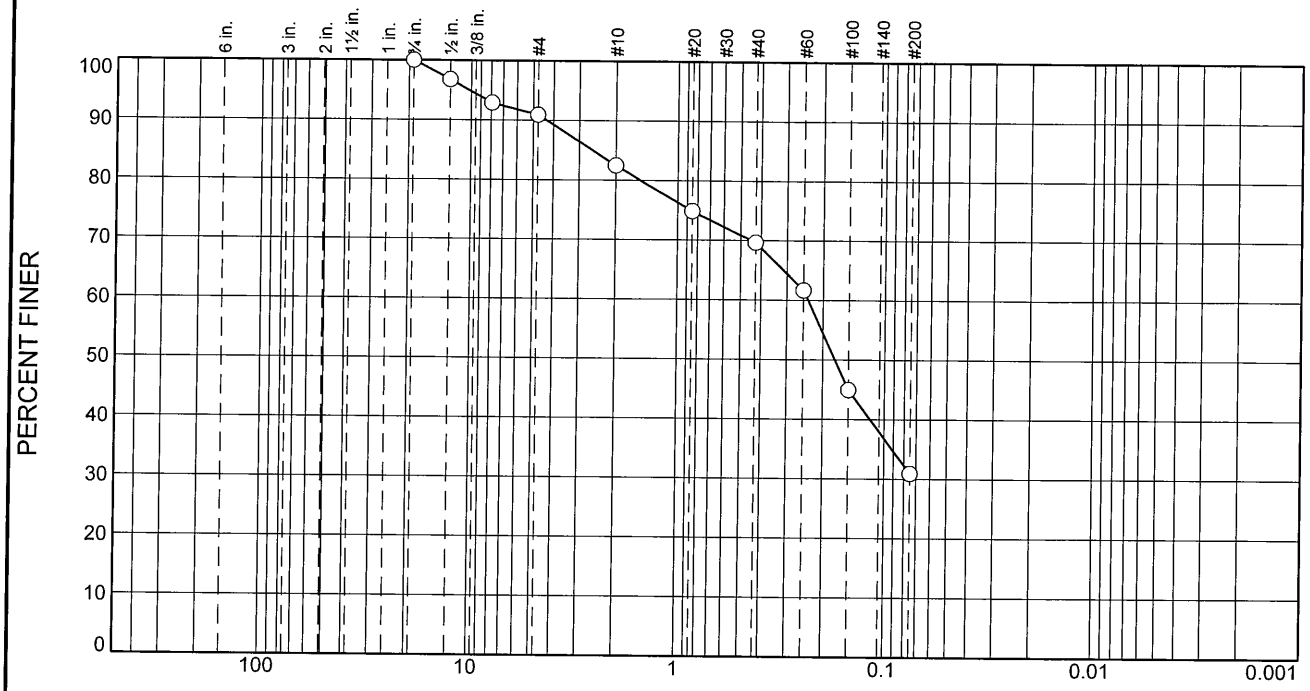
Project No: NorPoint.OntheRidge **Figure** B-2

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Permit Number: 20-012521

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.1	8.5	12.8	38.7	30.9	

Test Results (ASTM D 422 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	96.8		
.3125	92.9		
#4	90.9		
#10	82.4		
#20	74.8		
#40	69.6		
#60	61.7		
#100	45.0		
#200	30.9		

* (no specification provided)

Material Description

Brown grey silty SAND with gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 4.3295 D_{85}= 2.5993 D_{60}= 0.2376
D_{50}= 0.1749 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: _____ **Date Tested:** 2/21/2018

Tested By: CC

Checked By: KSS

Title: PM

Location: TP-7 S-2 D@3'
Sample Number: 093814

Date Sampled: 2/19/2018

GeoResources, LLC

Fife, WA

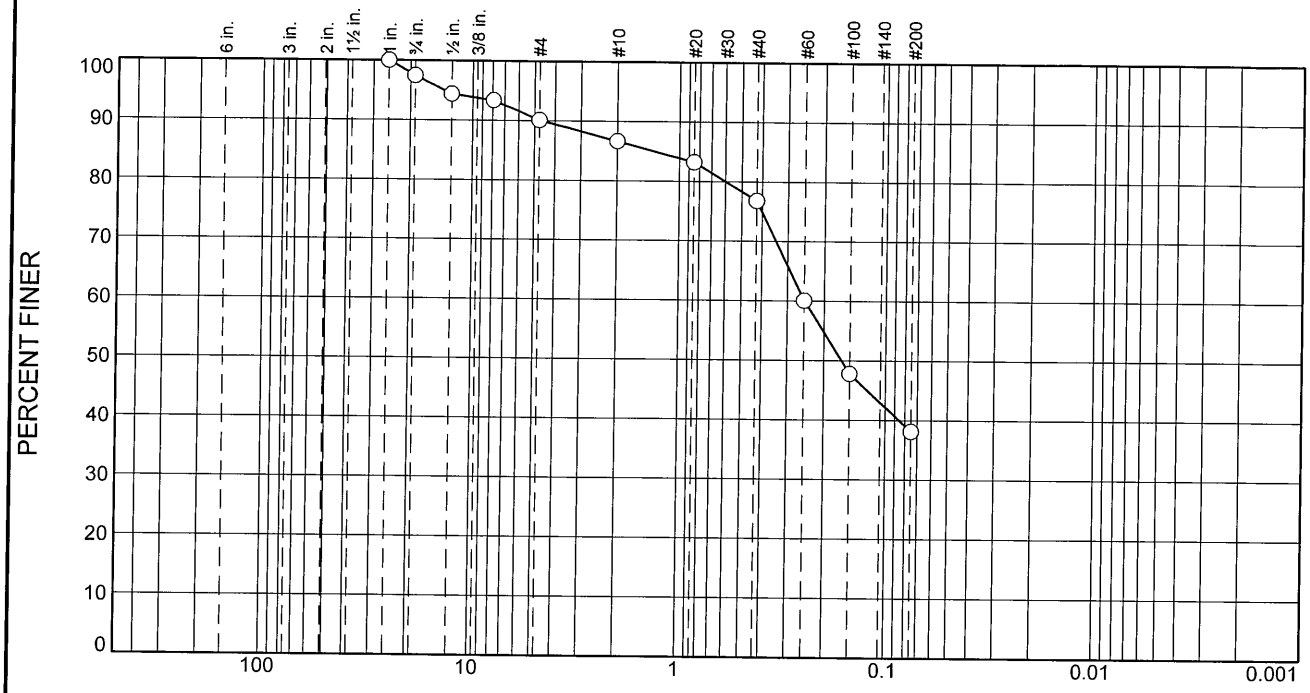
Client: NorPoint Communities
Project: NorPoint.OntheRidge
Project No: NorPoint.OntheRidge **Figure** B-3

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Permit Number: 20-012521

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.6	7.3	3.5	9.8	38.7	38.1	

Test Results (ASTM D 422 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	97.4		
.5	94.4		
.3125	93.4		
#4	90.1		
#10	86.6		
#20	83.2		
#40	76.8		
#60	60.1		
#100	47.8		
#200	38.1		

* (no specification provided)

Material Description

Brown grey silty SAND with gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients

D_{90}= 4.6518 D_{85}= 1.3341 D_{60}= 0.2494
D_{50}= 0.1643 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: _____ Date Tested: 2/21/2018

Tested By: CC

Checked By: KSS

Title: PM

Location: TP-8 S-2 D@3'
Sample Number: 093817

Date Sampled: 2/19/2018

GeoResources, LLC

Fife, WA

Client: NorPoint Communities
Project: NorPoint.OntheRidge
Project No: NorPoint.OntheRidge **Figure** B-4

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

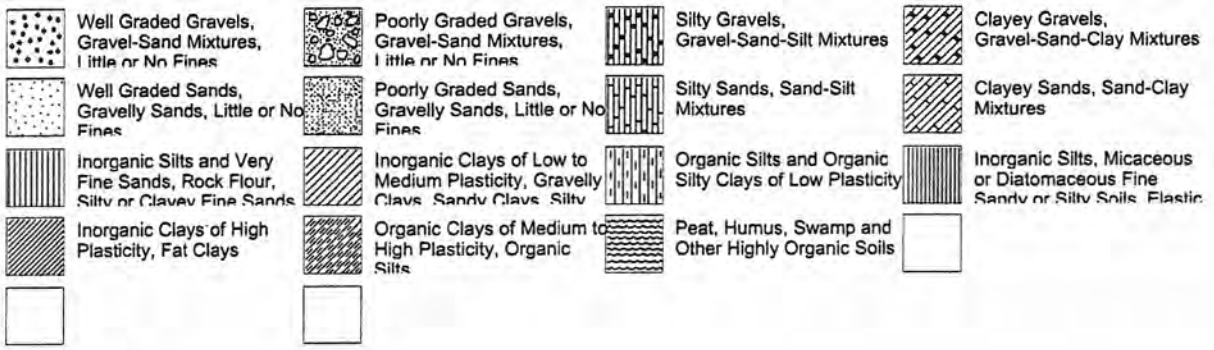
Permit Number: 20-01252

Appendix C

Boring Logs and Laboratory Results by Others
(Krazan, 2003)

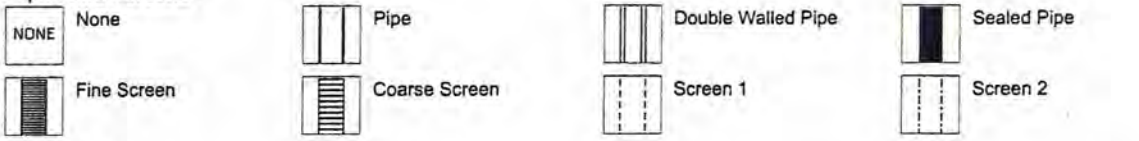
WinLoG Symbol Legend

USCS

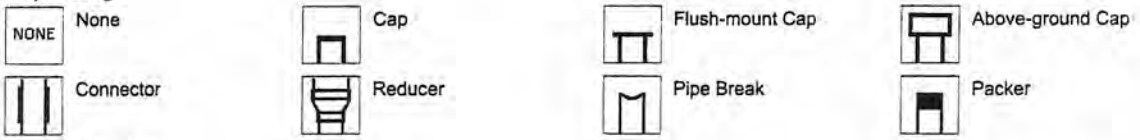


Well Symbols

Pipes and Screens

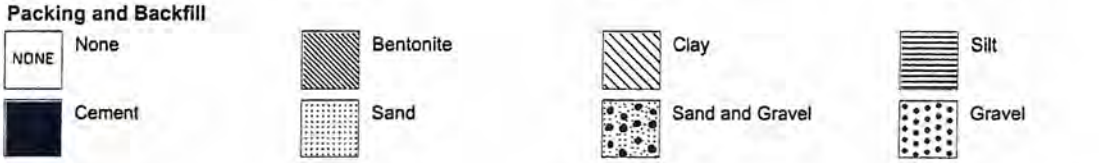


Top Fittings



Bottom Fittings

Packing and Backfill



Sample Symbols

Log of Boring B-1

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~15.5' during drilling, ~7' on removal

Project No: 102-03046
Figure No.: A-1
Logged By: D.H.
Elevation: ~280 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
0		Ground Surface						
		POORLY GRADED SAND WITH SILT (SP-SM) Loose, reddish brown, moist. (TOPSOIL/DISTURBED AREA FOR DRILLING PAD)						
5		***POORLY GRADED SAND WITH SILT (SP-SM)*** Medium dense, tan to gray, very moist to wet.	S-1			SS	16	14.5
10		***SILTY SAND (SM)*** Dense, fine grained sand, gray, moist to wet.	S-2		39	SS	35	22
15		***POORLY GRADED SAND WITH SILT*** AND GRAVEL (SP-SM) Dense, gray, wet. Contains silt lenses.	S-3A S-3B			SS SS	46 46	29.1 22.3
20		Becomes very dense at 20 feet.	S-4			SS	52	18.5
25			S-5A S-5B		6 45	SS SS	19\50:5.5" 19\50:5.5"	17.4 20.5
30			S-6		6	SS	17\50:4"	15.8
35								

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/22/03
Sample Method: SPT, California
Sheet: 1 of 2

Permit Number: 20-01252

Log of Boring B-1

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~15.5' during drilling, ~7' on removal

Project No: 102-03046
Figure No.: A-1
Logged By: D.H.
Elevation: ~280 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
40			S-7A			SS	23\50:4"	20.2
			S-7B		95	SS	23\50:4"	23.3
			S-8		7	SS	39\50:3"	13.4
45		End of Boring Boring collapsed at 14 feet on removal of auger.						
50								
55								
60								
65								
70								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/22/03
Sample Method: SPT, California
Sheet: 2 of 2

Permit Number: 20-01252

Log of Boring B-2

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~52.5' durring drilling

Project No: 102-03046
Figure No.: A-2
Logged By: D.H.
Elevation: ~327 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
0		Ground Surface						
		POORLY GRADED SAND WITH SILT (SP-SM) Loose, reddish brown, moist. (TOPSOIL/DISTURBED AREA FOR DRILLING PAD)	S-0			Grab		14.7
5		***SILTY SAND (SM)*** Very dense, fine grained sand, gray, moist. Contains gravel.	S-1			SS	60	10
10			S-2		30	SS	57	8.5
15			S-3			SS	75	9
20			S-4			SS	76	6
25		***POORLY GRADED SAND WITH SILT (SP-SM)*** Very dense, fine grained sand, brown, moist to very moist.	S-5			SS	51	11.8
30			S-6		6	SS	36\50:5"	7.3
35								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/22/03 - 3/23/03
Sample Method: SPT, California
Sheet: 1 of 2

Permit Number: 20-01252

Log of Boring B-2

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~52.5' durring drilling

Project No: 102-03046
Figure No.: A-2
Logged By: D.H.
Elevation: ~327 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
40			S-7			Calif.	74\110:5"	9.9
			S-8			SS	69	8.8
			S-9			SS	82	8.1
45		*SILTY SAND (SM)* Very dense, brown, wet.	S-10		20	SS	81	14.6
50			S-11			SS	85	16.7
55			S-12			SS	38\50:5"	24
60			S-13		56	SS	67	25.8
65		End of Boring Boring collapsed at 35 feet on removal of auger.						
70								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

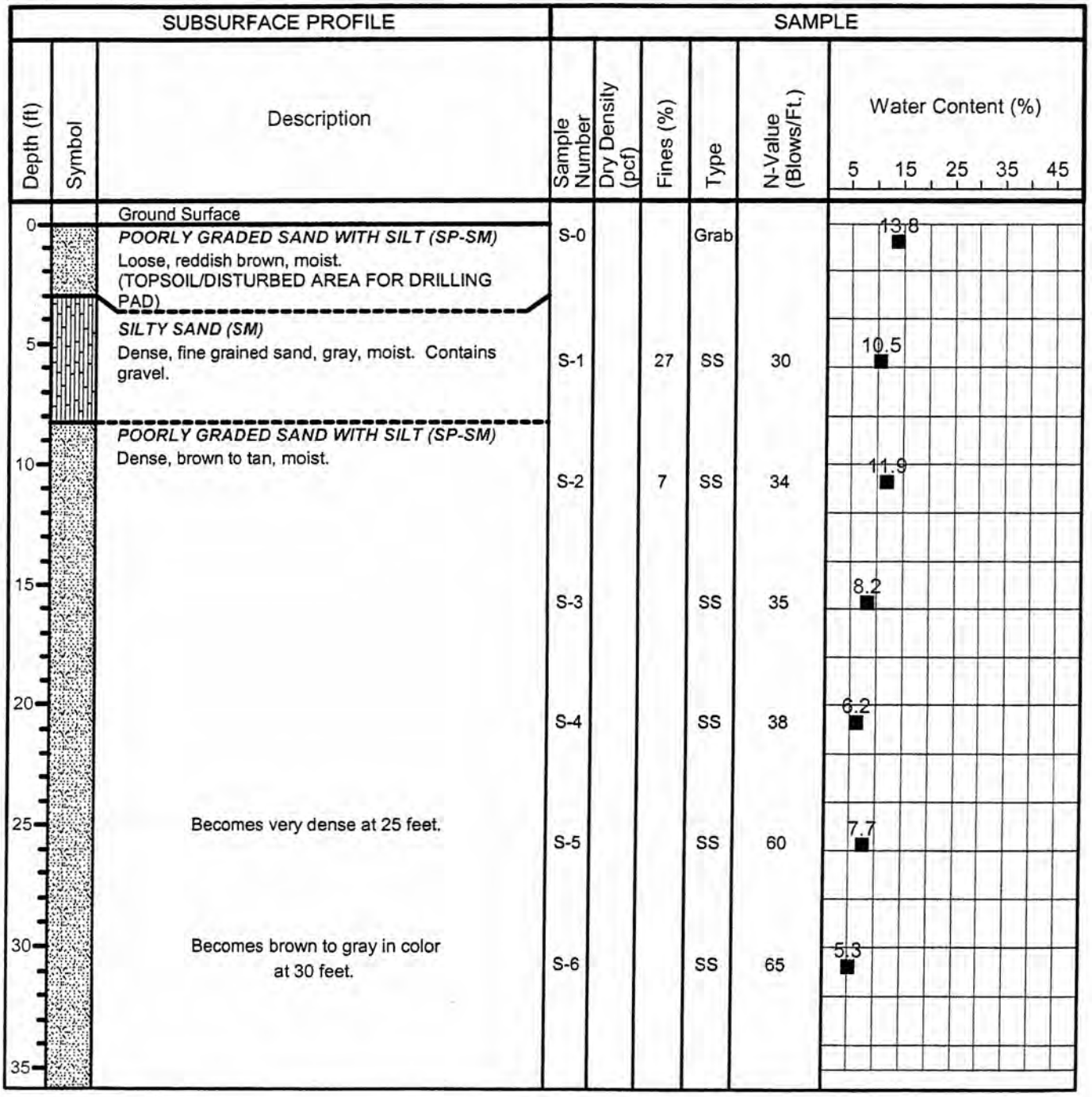
Drill Date: 3/22/03 - 3/23/03
Sample Method: SPT, California
Sheet: 2 of 2

Permit Number: 20-01252

Log of Boring B-3

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: Not encountered

Project No: 102-03046
Figure No.: A-3
Logged By: D.H.
Elevation: ~340 Feet.



Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/23/03
Sample Method: SPT
Sheet: 1 of 2

Permit Number: 20-01254

Log of Boring B-3

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: Not encountered

Project No: 102-03046
Figure No.: A-3
Logged By: D.H.
Elevation: ~340 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%) 5 15 25 35 45
40			S-7			SS	53	6.6
			S-8			SS	69	5.9
		End of Boring						
45								
50								
55								
60								
65								
70								

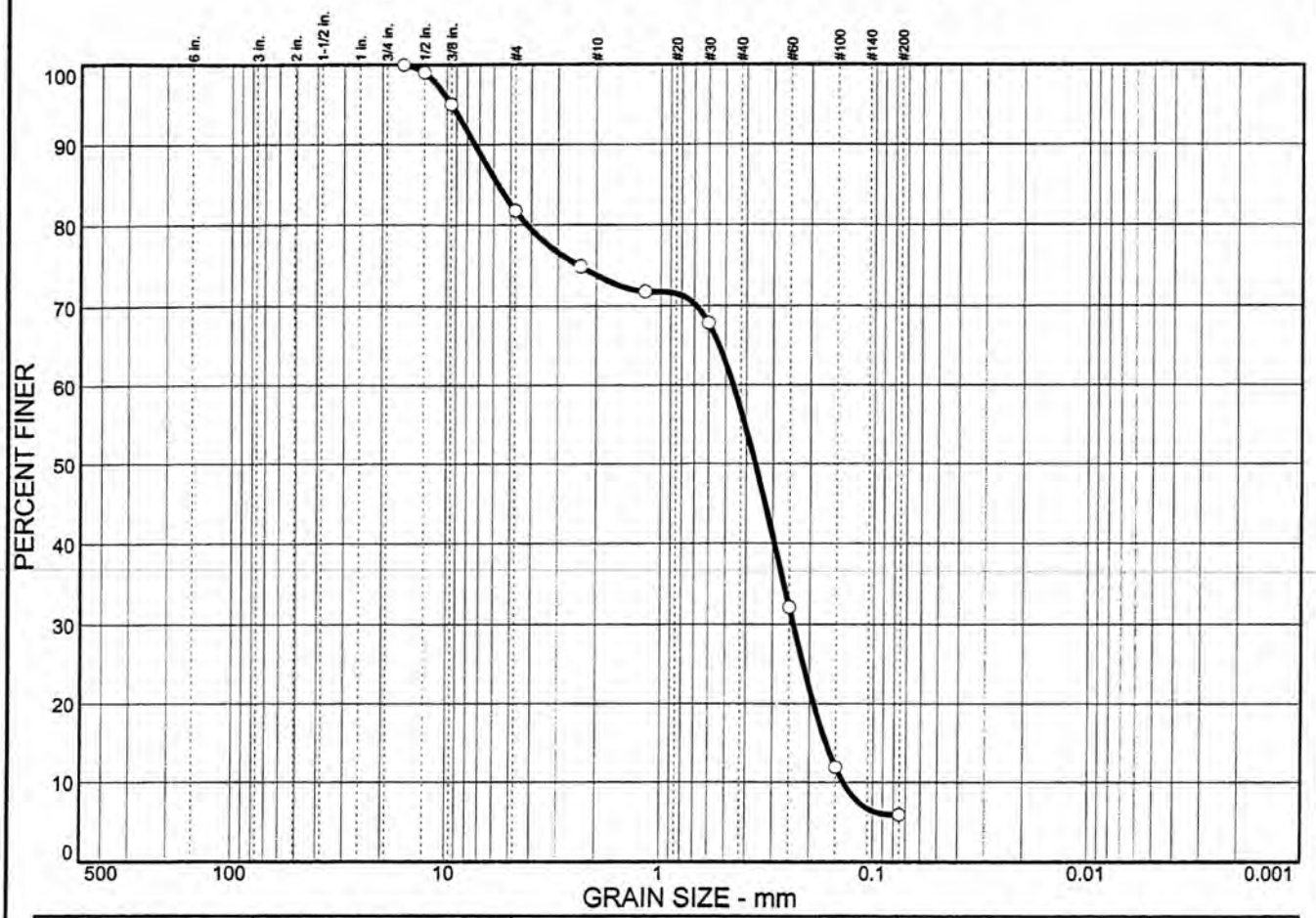
Method: Track HSA
Driller: Davies
Operator: Jeff Davies

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/23/03
Sample Method: SPT
Sheet: 2 of 2

Permit Number: 20-01252

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	18.2	75.9	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.625 in.	100.0		
0.5 in.	99.0		
0.375 in.	95.0		
#4	81.8		
#8	74.9		
#16	71.8		
#30	67.8		
#60	32.1		
#100	11.9		
#200	5.9		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.71 D_{60}= 0.461 D_{50}= 0.363
D_{30}= 0.239 D_{15}= 0.167 D_{10}= 0.138
C_u= 3.34 C_c= 0.90

Classification

USCS= SP-SM AASHTO=

Remarks

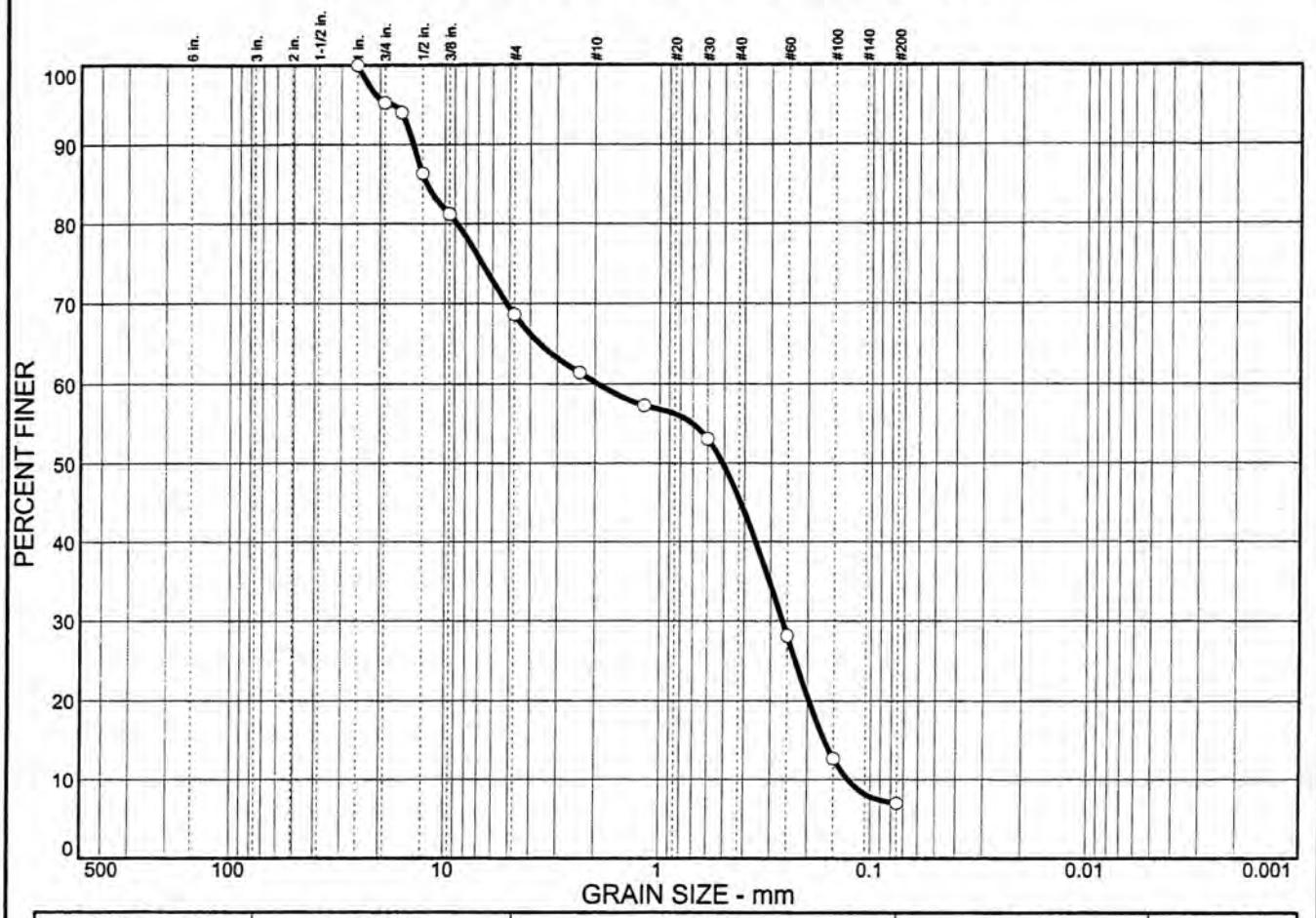
SAMPLE #; P4832
REPORT #: 10072
DATE: 5/27/2003

Sample No.: P4832 **Source of Sample:** BORING 1 **Date:** 5/27/2003
Location: B-1,S-6 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-4

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	31.4	61.6	7.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0 in.	100.0		
0.75 in.	95.2		
0.625 in.	94.0		
0.5 in.	86.4		
0.375 in.	81.2		
#4	68.6		
#8	61.4		
#16	57.3		
#30	53.1		
#60	28.2		
#100	12.7		
#200	7.0		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 12.1 D_{60}= 1.94 D_{50}= 0.509
D_{30}= 0.263 D_{15}= 0.165 D_{10}= 0.128
C_u= 15.16 C_c= 0.28

Classification

USCS= SP-SM AASHTO=

Remarks

SAMPLE #: P4832
REPORT #: 10072
DATE: 5/27/2003

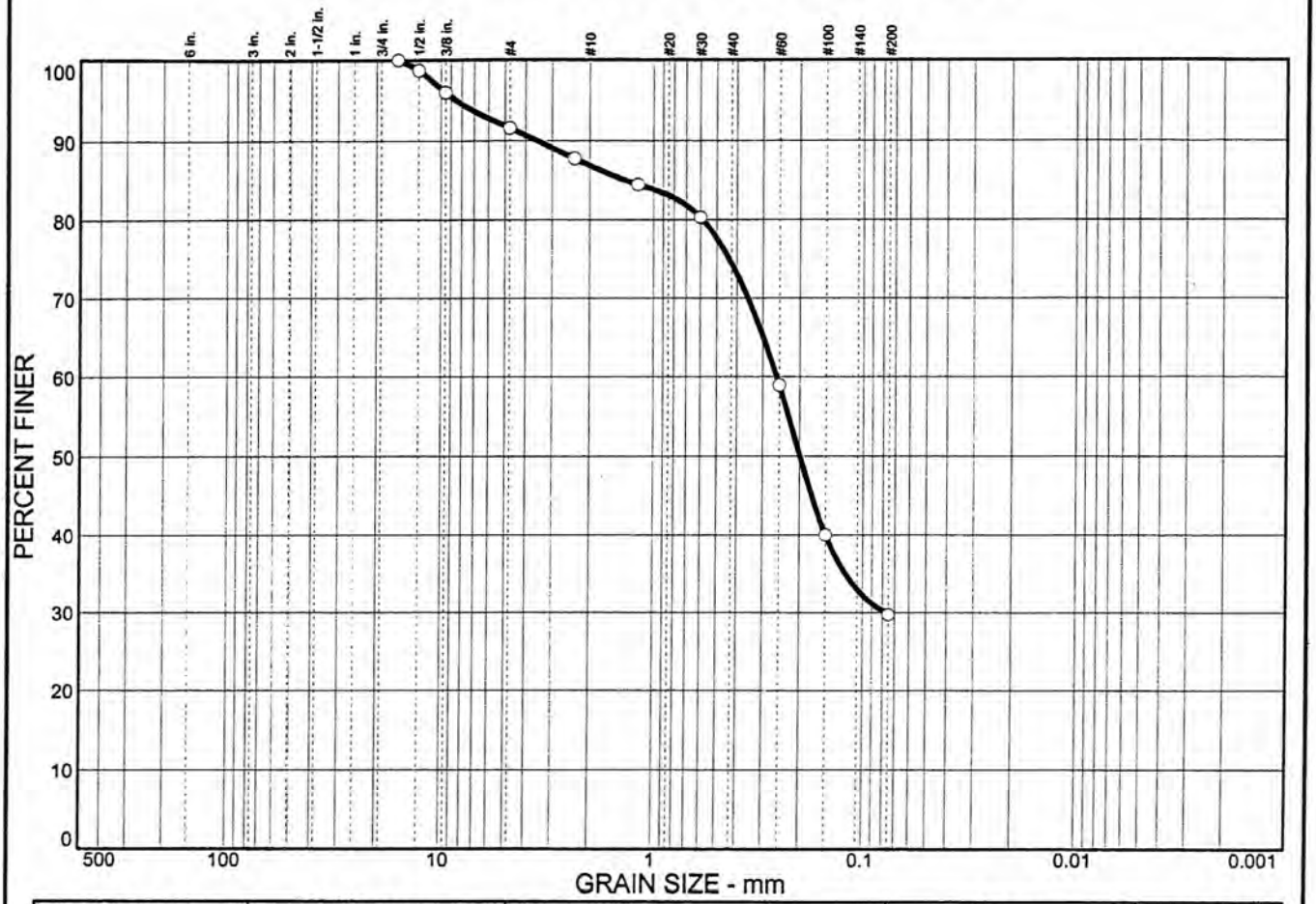
Sample No.: P4832, B-1 **Source of Sample:** BORING 1 **Date:** 5/27/2003
Location: B-1,S-8 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-5

Permit Number: 20-01252

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	8.4	61.9	29.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.625 in.	100.0		
0.5 in.	98.7		
0.375 in.	96.0		
#4	91.6		
#8	87.8		
#16	84.5		
#30	80.3		
#60	58.9		
#100	40.0		
#200	29.7		

* (no specification provided)

Soil Description

USCS: SILTY SAND (SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.33 D_{60}= 0.258 D_{50}= 0.199
D_{30}= 0.0779 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

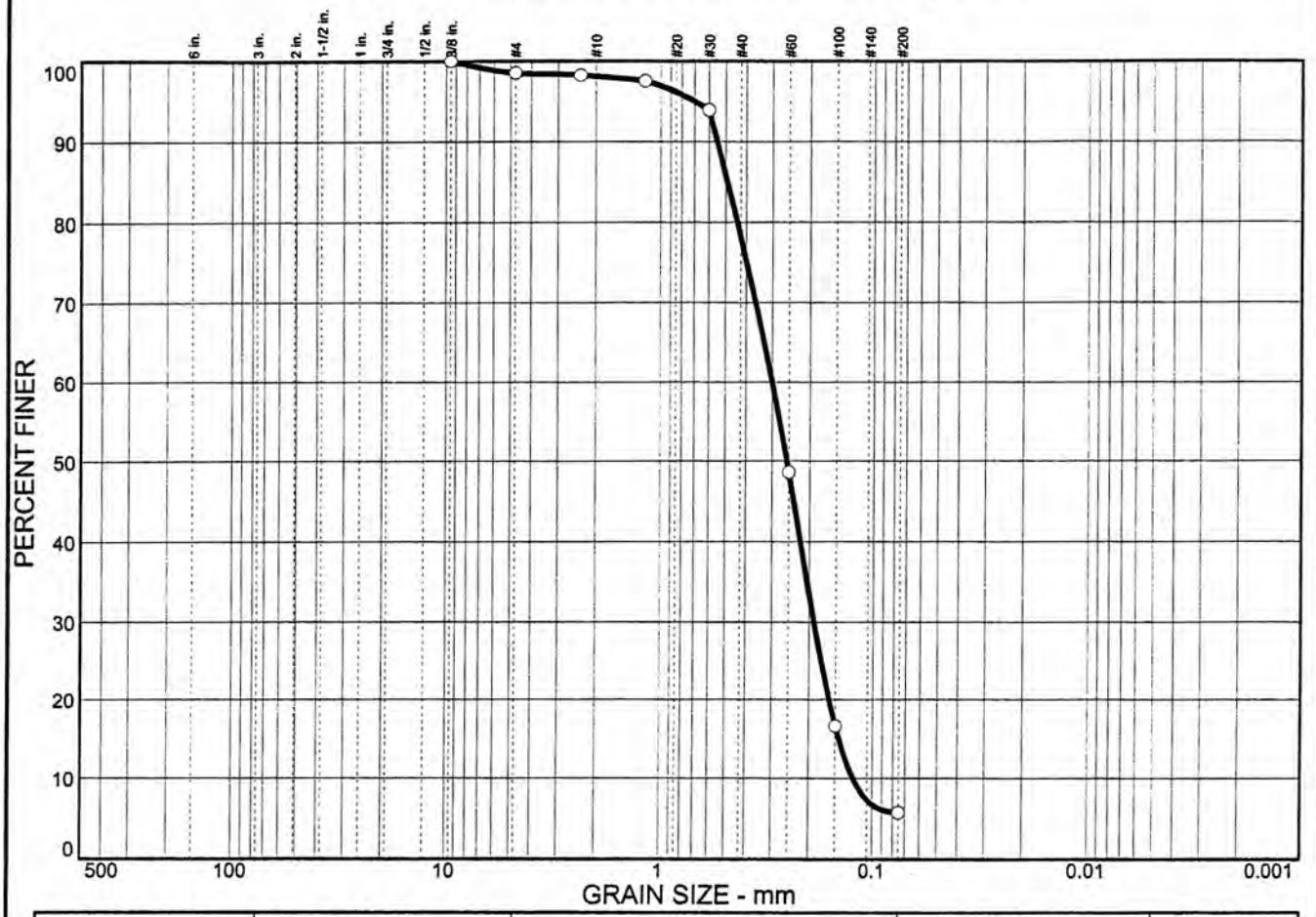
SAMPLE #; P4833
REPORT #; 10072
DATE: 5/27/2003

Sample No.: P4833 **Source of Sample:** BORING 2 **Date:** 5/27/2003
Location: B-2,S-2 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-6

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.5	92.7	5.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	98.5		
#8	98.2		
#16	97.5		
#30	93.9		
#60	48.6		
#100	16.6		
#200	5.8		

* (no specification provided)

Soil Description

USCS:POORLY GRADED SAND WITH SILT (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.491 D_{60}= 0.301 D_{50}= 0.255
D_{30}= 0.190 D_{15}= 0.144 D_{10}= 0.123
C_u= 2.44 C_c= 0.97

Classification

USCS= SP-SM AASHTO=

Remarks

SAMPLE #; P4833
REPORT #; 10072
DATE: 5/27/2003

Sample No.: P4833,B-2 **Source of Sample:** BORING 2 **Date:** 5/27/2003
Location: B-2,S-6 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-7

Permit Number: 20-01252

Direct Shear of Consolidated, Drained Soils
ASTM D - 3080 / AASHTO T - 236

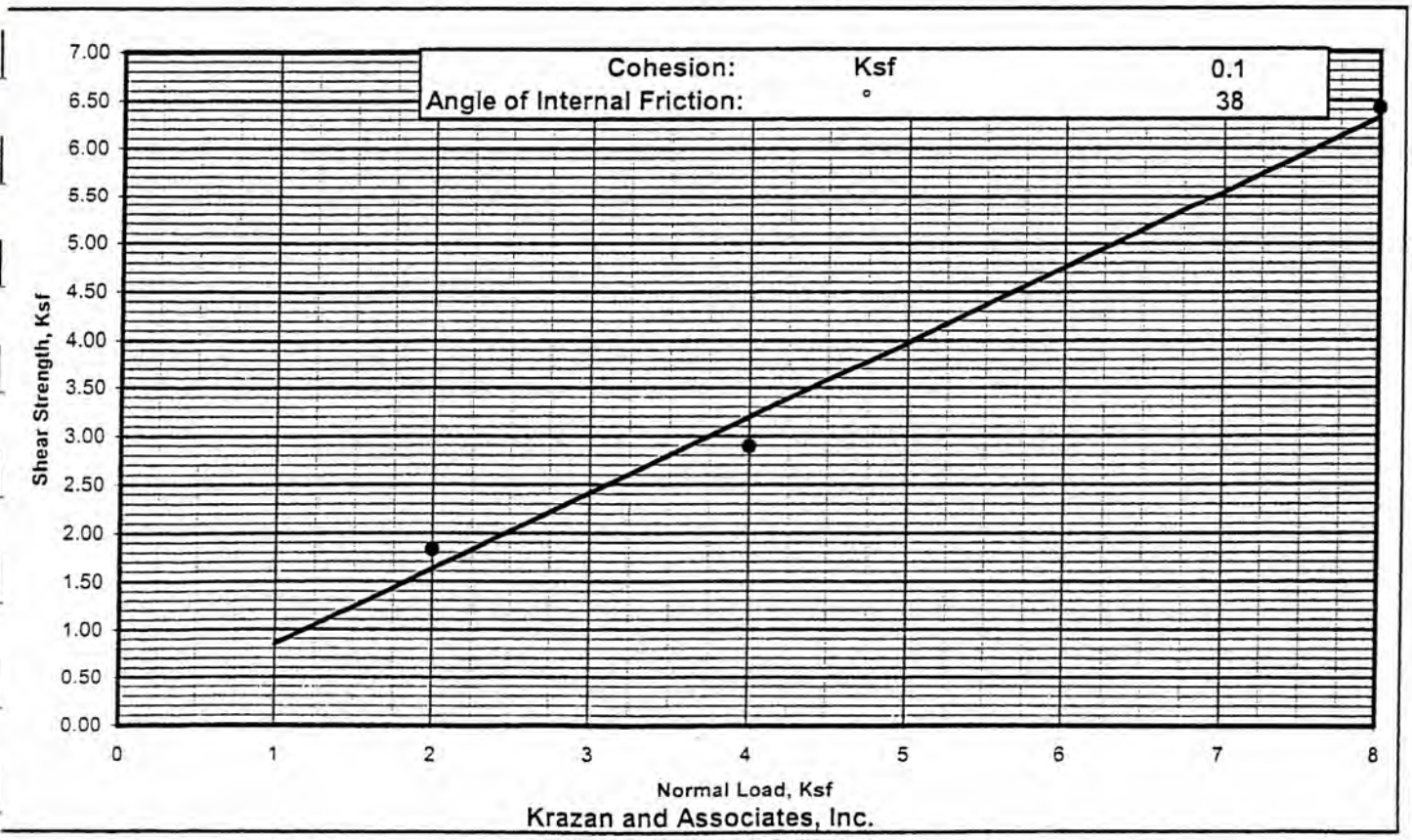
Project Number	: 10203046
Project Name	: Copper Canyon
Date	: 5/23/03
Sample Location	: B-2/S-7
Soil Classification	: SP
Sample Surface Area	: 0.03168

STRESS DISPLACEMENT DATA

Lat. Disp. (in.)	Normal Load		
	2000	4000	8000
0	0	0	0
0.030	100	184	338
0.060	152	228	430
0.090	180	261	464
0.120		284	479
0.150		289	482
0.180			
0.210			
0.240			
0.270			
0.300			
0.330			
0.360			

Normal Load psf	Shear force lbs	Shear Stress psf
2	58.0	1831
4	91.7	2894
8	203.5	6425

Specimen Information		
	Initial	Final
Diameter (in):	2.5	2.5
Thickness (in):	1	1
Moisture Content	9.88%	26.00%
Wet Density (pcf):	133.85	133.85
Dry Density (pcf):	106.23	121.82



Krazan and Associates, Inc.
19501 144th Ave. NE #F-300
Woodinville, Washington
98072

Figure A-8

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT COPPER CANYON DEVELOPMENT RIDGETOP BOULEVARD NW SILVERDALE, WASHINGTON

JOB NUMBER 102-03046
JUNE 10, 2003

Prepared for:

Crescent Investments, LLC
P. O. Box 5
Tracyton, WA 98393

Prepared by:

KRAZAN & ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING DIVISION
20714 State Highway 305 NE, Suite 3C
Poulsbo, Washington 98370
(360) 598-2126

Krazan & ASSOCIATES, INC.
SITE DEVELOPMENT ENGINEERS

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

June 10, 2003

KA Project No. 102-03046

Mr. Hal Fergusson
Crescent Investments, LLC
P. O. Box 5
Tracyton, WA 98393

RE: GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
COPPER CANYON DEVELOPMENT
RIDGETOP BOULEVARD NW
SILVERDALE, WASHINGTON

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced project. The results of our investigation are presented in the attached report. This report presents the results of our field exploration, laboratory tests, and engineering analyses including design recommendations for 1H:1V Mechanically Stabilized Earth slope.

If you have any questions or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,

KRAZAN AND ASSOCIATES, INC.

Todd S. Parkington

Todd S. Parkington, P.E.
Senior Geotechnical Engineer

TSP

TABLE OF CONTENTS

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

June 10, 2003

KA Project No. 102-03046

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
COPPER CANYON DEVELOPMENT
RIDGETOP BOULEVARD NW
SILVERDALE, WASHINGTON

INTRODUCTION

This report contains the results of a site investigation performed by Krazan & Associates for the above referenced project.

SITE LOCATION

The proposed Copper Canyon Development is located east of Ridgetop Boulevard NW between NW Timber Shadow Court and NW Thornwood Circle in Silverdale, Washington. According to the United States Geological Survey (USGS), 7.5 minute Poulsbo, Washington topographic quadrangle map, the site is located in the southeast quarter of the northwest quarter of Section 10, Township 25 North, Range 1 East, W.M. and at approximately Latitude 47.675 degrees, Longitude 122.663 degree. The site location is shown on the Site Vicinity Map, Figure 1.

PROPOSED CONSTRUCTION

We understand that the development will consist of 147 residential lots with associated streets, utilities and common areas. The subject property consists of two parcels, hereinafter referred to as the western parcel and the eastern parcel. The eastern parcel will have 82 lots located in a relatively flat area at the base of a hill. The remaining 65 lots will be adjacent to the access road, which will descend the hill from Ridgetop Boulevard.

We assume that the residences will be one to two stories in height and of relatively light wood frame construction. We further assume that traffic on the access road and other streets within the development will consist primarily of passenger vehicles with occasional service vehicles.

We understand the plan is to mass grade the site with an essentially balanced cut & fill operation. Based on the preliminary site plan provided to us, we estimate cuts of up to 30 feet and fills of up to 50 feet. Due to space constraints, 1H:1V (horizontal:vertical) fill slopes are planned for two areas. The westernmost of the two fill slopes will be approximately 450 feet long with a maximum height of about 50 feet. The

easternmost of the two fill slopes will be approximately 350 feet long with a maximum height of about 25 feet. The location of these fill slopes are indicated on the Site Plan, Figure 2.

Note that the Site Plan does not include the 82 lots on the eastern parcel, as we did not perform any fieldwork on the eastern parcel.

In the event the proposed construction information detailed in this report is inconsistent with the final design, we should be notified so that we may update this writing as applicable.

PURPOSE & SCOPE

The purpose of this project is to provide geotechnical engineering recommendations for construction of the referenced development. Our scope of work includes the following items:

- Investigation of the soil and groundwater conditions in the project area by drilling 3 borings. The borings ranged in depth from 41 to 61 feet below the ground surface (bgs). Groundwater measurements were taken during drilling.
- Laboratory testing appropriate to the soil conditions encountered and the planned construction was conducted. Tests for moisture content, grain size distribution and direct shear strength were performed.
- Slope stability analyses of the proposed 1H:1V fill slopes and the native slope in the ravine on the north side of the property were performed.
- Preparation of this report detailing our findings and conclusions including recommendations for setbacks from the native slopes in the ravine to the north, reinforcement for the 1H:1V fill slopes, structural fill requirements, drainage, pavement design, soil compaction criteria, and the suitability of the on-site soil for reuse as fill.

SITE INVESTIGATION

SITE DESCRIPTION

The site is bordered to the north and south by residential developments, to the west by Ridgetop Boulevard NW and to the east by undeveloped land.

The western parcel slopes down to the east with gradients ranging from about 15 to 50 percent and a total elevation change from the west to the east of about 140 feet. There is a steep sided (50 percent slopes) ravine along the north property edge of this parcel, with two short ravines leading into the property off of the main ravine. The proposed grading plan for the project includes filling of the two short ravines. Please see the Site Plan, Figure 2, for more information on the topography of the site.

The eastern parcel also slopes to the east with gradients ranging from 10 to 15 percent and a total elevation change of about 30 feet. Note that the site investigation focused on the western parcel, as the slopes on the eastern parcel are too gentle to constitute a slope hazard.

At the time of our investigation, the site was forested with second growth timber and moderately heavy underbrush.

GEOLOGIC SETTING

The subject site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved with a depositional and erosional history including at least four separate glacial advance/retreats. The Puget Lowland is bounded on the west by the Olympic Mountains and on the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments consisting of interbedded gravel, sand, silt, till, and peat lenses.

The Geologic Map of Washington – Northwest Quadrant published by the Washington State Division of Geology and Earth Resources, 2002, indicates the site is underlain by glacial till. Till consists of an unsorted, unstratified, highly-compacted mixture of clay, silt, sand, gravel, and boulders deposited by glacial ice. Till may contain interbedded stratified sand, silt, and gravel. The till generally overlies advanced outwash deposits.

SUBSURFACE EXPLORATION

The field investigation consisted of drilling three borings to depths ranging from 41 to 61 feet below the ground surface. Groundwater measurements were taken during drilling. The boring locations are indicated on the Site Plan, Figure 2.

Soil

The soils encountered in the borings consisted of silty sands and poorly graded sands to the maximum depth explored. The sands were loose in the upper 2 to 4 feet of the borings grading to dense to very dense below 4 feet. Please refer to the boring logs in Appendix A for more information.

Groundwater

Groundwater was encountered at approximately elevation 274 in borings B-1 and B-2. Groundwater was not encountered in boring B-3. Note that the lowest elevation reached by boring B-3 was approximately elevation 299. Water table elevations fluctuate with time, being dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. Therefore, water level observations at the time of the field investigation may vary from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

Laboratory Testing

Soil samples were obtained from the borings for visual classification and laboratory testing for engineering properties. Tests were performed for moisture content, fines content, grain size distribution and direct shear strength. Please see Appendix A for more information.

SEISMIC ZONE

According to the *Seismic Zone Map of the United States* contained in the 1997 *Uniform Building Code,* the project site lies within Seismic Risk Zone 3. The overall soil profile generally corresponds to seismic soil profiles S_C as defined by Table 16-J of the 1997 *Uniform Building Code (UBC)*. Soil profile S_C applies to a profile consisting primarily of very dense soils within the upper 100 feet of the profile. The United States Geologic Survey, Earthquake Hazards Program, National Seismic Hazard Mapping Project website indicates that the peak ground acceleration for the site with a probability of exceedence of 10 percent in 50 years is 0.32 g.

Due to the relatively dense nature of the soils encountered during our field exploration, it is our opinion that the risk for liquefaction of the soils at the site is minimal.

SITE RECONNAISSANCE

The slopes and adjacent properties were examined for indications of slope failures or instability. Indications of slope failure and/or instability include head scarps, hummocky terrain, inconsistent patterns of vegetation, tension cracks, seepage zones and course grain material overlaying silt and clay soils. We did not observe any indication of previous slope failures or instability.

CONCLUSIONS AND RECOMMENDATIONS

The results of our analysis indicate that the proposed grading for the site, including the proposed 1H:1V fill slopes, is feasible. The 1H:1V fill slopes will require geogrid reinforcement commonly referred to as mechanically stabilized earth slopes or MSE slopes. Setbacks for buildings will be 12 feet from the top of 1H:1V reinforced fill slopes and 8 feet from 2H:1V native slopes. Please refer to the sections below for additional details.

MECHANICALLY STABILIZED EARTH SLOPE (MSE SLOPE)

As described above, 1H:1V fill slopes are proposed for the project in two areas. In this section we provide recommendations for constructing a mechanically stabilized earth fill slope at 1H:1V. Two types of reinforcement will be used; primary and secondary.

Slope Preparation

The area beneath the reinforced section of the MSE slopes will need to be prepared to ensure that adequately dense soil underlies it. Up to 4 feet of loose sand was encountered in our borings. The loose sand must be removed and recompacted from beneath the reinforced section of the MSE slope (i.e. there should be no loose sand beneath the bottom layer of reinforcement). Any of the loose sand relatively free of organics and otherwise conforming to the recommendations given below under Structural Fill may be reused as such. In areas where the primary reinforcement would extend into the existing slope, a bench will need to be cut into the existing slope. The back wall of the bench should slope up at 1H:1V.

Construction of the taller of the two MSE slopes will involve filling two ravines. After the loose sand has been removed as described above, we recommend that a layer of washed rock be placed in the base of each of the ravines. The washed rock should be at least 2 feet thick and 4 feet wide and wrapped in filter fabric. The washed rock should consist of washed gravel with no sand or fines. The upper end of the rock drain should end at about 4 feet below the top of the fill. The exit from the rock drain at the face of the MSE slope should be wrapped in filter fabric and covered with a 1-foot thick layer of 2 to 4 inch quarry spalls.

In addition, a drain should be placed at the back edge of the deepest reinforcement on both MSE slopes. These drains should consist of a round section of washed gravel wrapped in filter fabric with a diameter of at least 18 inches. These drains should connect to the ravine drains on the taller MSE slope and should connect to 2 evenly spaced drains constructed in a similar manner to the ravine drains on the smaller MSE slope.

Primary Reinforcement

The primary reinforcement will consist of Tensar Earth Technologies, Inc. Structural Geogrid UX1400HS or an equivalent geogrid with a long-term allowable load of at least 2,000 lb/ft. Any proposed substitute geogrid should be submitted to us for approval. In general, the vertical spacing of the primary reinforcement within the MSE slope will be 4 feet to a depth of 42 feet below the top of the slope and 2 feet below a depth of 42 feet. In the tables below we provide the depth and length of each layer of primary reinforcement. The first table is for the portion of the slopes that are less than 34 feet high. The second table is for the portion of the slopes that are more than 34 high up to a maximum height of 54 feet. In reading the tables below, please note that any layers that would be deeper than the toe of the MSE slope may be omitted (i.e. at a section of MSE slope that is 20 feet high, layers 5, 6 & 7 from Table 1 may be omitted).

Uniaxial grids (UX) are always unrolled perpendicular to the slope (i.e. start unrolling at the slope face and roll into the fill. Follow the manufacturers recommendations for connecting geogrid rolls together.

Table 1

Primary Reinforcement for MSE Slopes less than 34 feet high

Layer #	Depth below top of slope (ft)	Length (ft)
1	6	10
2	10	12
3	14	22
4	18	24
5	22	26
6	26	28
7	30	28

Table 2

Primary Reinforcement for MSE Slopes more than 34 feet up to 54 feet high

Layer #	Depth below top of slope (ft)	Length (ft)
1	6	24
2	10	28
3	14	32
4	18	34
5	22	34
6	26	36
7	30	38
8	34	38
9	38	40
10	42	40
11	44	40
12	46	42
13	48	42
14	50	42
15	52	42

Tension must be maintained in the reinforcement as fill is placed over it. Tracked vehicles should never be allowed to drive directly on the reinforcement.

The design life of geogrid reinforcement is estimated to be 75 years, which is similar to the intended design life of most structures. As geogrid is a relatively new product, the design life can only be estimated.

Secondary Reinforcement

The secondary reinforcement will consist of Tensar Earth Technologies, Inc. Structural Geogrid BX1400 or an equivalent geogrid with a true tensile strength at 5 percent strain of 900 lb/ft in the direction perpendicular to the slope. Any proposed substitute geogrid should be submitted to us for approval. The secondary

reinforcement will be placed at 1 foot vertical intervals between the primary reinforcement, beginning at 1 foot below the ground surface. The secondary reinforcement should extend at least 5 feet into the slope. Biaxial geogrids can be unrolled either perpendicular or parallel to the slope. We have assumed for our design that the BX1400 will be unrolled parallel to the slope.

Fill

The fill used for construction should conform to the recommendations given under Structural Fill below. Fill placed along the slope face should be overbuilt by at least 6 inches. The slope face should be compacted every 2 to 3 feet using a hoe pack in addition to the standard rolling of the top of the lift.

SLOPE STABILITY

Slope stability analyses were performed on three cross-sections; two within the taller MSE slope and one on a ravine slope that will not be re-graded. The locations of the cross-sections are indicated on the Site Plan, Figure 2. Topography used in the analysis was based on the Copper Canyon Site Plan, dated March 31, 2003 prepared by Team 4 Engineering. The slope stability computer program Slope/W by GeoSlope International was used to evaluate the stability of the existing slopes and proposed MSE slopes under static and seismic conditions. Soil strength parameters used in our analysis were based on in-situ penetration tests, laboratory shear strength tests and published values. The engineering properties of the soil used in our analysis are presented on Figure 3, Cross Sections A-A', Figure 4, Cross Section B-B', and Figure 5 Cross Section C-C'. Cross Section A-A' represents the maximum height of MSE slope on the site, Cross Section B-B' represents the closest approach of the access road to the MSE slope, and Cross Section C-C' represents a relatively steep section of native slope. Water levels used in the stability analyses were conservatively assumed to be higher than the water level encountered in our borings.

The psuedostatic method was used for our slope stability analyses to estimate the factor of safety under seismic conditions. The United States Geologic Survey, Earthquake Hazards Program – National Seismic Hazard Mapping Project, indicates that a peak ground acceleration (PGA) of 0.32 g has a 10 percent probability of exceedence in 50 years (500 year return period). The seismic coefficient is typically taken to be ½ of the PGA. A seismic coefficient of 0.16 was used in our analyses.

The results of slope stability analyses are expressed as factors-of-safety against rotational failure. The factor-of-safety is the ratio of driving forces to resisting forces. A factor-of-safety of 1.0 is equilibrium; a factor-of-safety of less than 1.0 indicates failure. Typically, a factor-of-safety of 1.5 for static conditions and 1.1 for seismic conditions is considered adequate. Factors of safety greater than 1 but less than 1.5 (or 1.1) are not adequate due to the uncertainties inherent in the modeling process. A lower safety factor for seismic conditions is considered adequate, as the probability of occurrence of the seismic conditions analyzed is relatively low. The slope stability analyses used on cross sections A-A' and B-B' were used to design the lengths and geogrid spacing for the MSE slopes. The slope stability analyses performed on cross section C-C' indicate a static factor of safety of 1.70 and a seismic factor of safety of 1.21. The results of our slope stability analyses are also presented graphically in Appendix B.

In our opinion the existing steep slopes and the proposed MSE slopes will have an adequate factor of safety against slope failure. For more information concerning the slope stability results see Appendix B.

Based on our slope reconnaissance, and slope stability analysis the slopes are relatively stable in their present condition. In order to enhance the long-term stability of the slopes, surface runoff from the development will need to be collected and directed away from slopes. Do not allow additional surcharge loads, soil stockpiles, standing water or loosened soil conditions to occur between the residences and the top of slopes. Irrigation utilized in landscaping should be monitored closely to insure that it is functioning correctly. Malfunctioning irrigation systems or ruptured irrigation lines may flood slope areas causing slope failures.

Setbacks

In order to protect structures from slope migration and future instability, structures should be setback at least 12 feet from the top edge of the proposed MSE slopes. Note that the primary reinforcement will likely extend beneath structures on Lot Numbers 20, 21 and 22. Setbacks from native slopes steeper than 3H:1V should conform to UBC requirements except that setbacks need not exceed 8 feet. Setbacks are to be measured from the furthest projection of the footing element. The setback distance assumes a standard footing embedment depth of 1.5 feet, re-vegetation of graded slope areas and that site grades are roughly the same as analyzed in our two cross sections.

Note that the setback described above is intended for buildings constructed on the lots as presented on the Plan presented to us and is **not** intended to apply to the roads as laid out on the Site Plan, Figure 2. If the road alignments are altered with respect to the top of slopes we should be notified so that we may review the stability of slopes with respect to road locations.

Note that the UBC requirements provide for measuring the setback from the base of the footing to the slope at the elevation of the footing. This effectively allows a setback to be met by increasing the depth of the footing. This method is acceptable at this site for setbacks from native slopes but does **not** apply to setbacks from the MSE slopes. The setback from the MSE slope is to be measured from the top of the slope to the furthest projection of the footing element regardless of footing depth.

EARTHWORK CONSIDERATIONS

During wet weather conditions, typically October through April, subgrade stability problems and grading difficulties may develop due to high moisture content in the soil, disturbance of sensitive soils and/or the presence of perched groundwater. Therefore, we recommend that grading activities be limited to the dry season (May through September). Note that this is a recommendation to avoid additional costs associated with earthwork activities performed during wet weather. Earthwork activities may occur during the wet season provided the owner and contractor are prepared to accept additional costs associated with wet weather earthwork construction.

Note when installing utilities on the site, care must be taken not to damage the geogrid reinforcement.

Site Preparation

General site clearing should include removal of vegetation, trees and associated root systems, wood, pavement, retaining walls, rubble, and rubbish. Site stripping must extend to a minimum depth of 4 inches, or until all organics in excess of 3 percent by volume are removed. Deeper stripping may be required in localized areas. These materials will not be suitable for use as fill for parking or building areas. However, stripped topsoil may be stockpiled and reused in landscape or non-structural areas.

Any buried structures encountered during construction will likely need to be removed. Specific recommendations should be obtained from the geotechnical engineer regarding any buried structures encountered. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be entirely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as recommended by the Geotechnical engineer. Excavations, depressions, or soft and pliant areas extending below planned finish subgrade level should be cleaned to firm undisturbed soil, and backfilled with general fill.

Groundwater Concerns

Groundwater was encountered in 2 of our 3 borings at approximately elevation 276. As we did not observe any evidence of groundwater seepage on the slopes at or above the existing storm water ponds, we do not anticipate construction on the western parcel to be significantly impacted by groundwater. We did not perform a reconnaissance on the eastern parcel and the eastern parcel is relatively close to the outlet stream for Island Lake. It is possible that shallow groundwater may impact construction on the eastern parcel. However, a more detailed analysis of the effect of groundwater on construction on the eastern parcel is outside the scope of this report.

Excavations

In our opinion the soils encountered in our subsurface investigation are a Type B material as defined by the Washington Industrial Safety and Health Act's (WISHA) regulations on excavation, trenching and shoring. Temporary slopes excavated in Type B material should be inclined no steeper than 1H:1V. Permanent cut and fill slopes (non-reinforced) should be inclined no steeper than 2H:1V. Please see the MSE Slopes section above for more information on permanent slopes steeper than 2H:1V. A representative of our firm should evaluate temporary and permanent slopes to insure that they are appropriate for the soils encountered during construction.

Temporary slope areas should be covered with plastic visqueen to help minimize erosion and raveling and reduce sediment loading in surface runoff. During construction, any signs of instability along temporary slopes should be brought to our attention. All permanent slopes should be replanted with fast-growing, deep-rooted grass, shrubs and other ground cover as soon after final grading as practical. If the vegetation is not fully established prior to the on set of wet weather, the slopes should be covered with clear visqueen to aid in preventing excessive erosion and water infiltration.

In areas where it is not possible to maintain the recommended slopes due to space constraints, temporary shoring will be required. Please contact us for more information if temporary shoring will be required.

Structural Fill

The on site soils may be used as structural fill. Structural fill should be placed in loose lifts no more than 12-inches thick, moisture-conditioned as necessary, (moisture content of soil should be within ±2 percent of optimum moisture) and compacted to 95 percent of the maximum density based on ASTM Test Method D-1557. Additional lifts should not be placed if the previous lift did not meet the required dry density or if soil conditions are not stable. Note that, although density testing of fill is frequently used as the primary criteria for acceptance of fill, it should not be the only criteria. If, in the judgment of the geotechnical engineer or his representative, placed fill is not suitable it should be rejected regardless of density test results. As an example, fill that is compacted wet of the optimum moisture content may exhibit "pumpy" behavior even if density test results indicate better than 95 percent compaction has been achieved. In such a situation, the fill should be removed and replaced with drier material.

Imported structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 1½ inches and less than 5 percent fines. All imported structural fill material should be submitted for approval to the Geotechnical Engineer at least 48 hours prior to delivery to the site.

Note that the on site soils typically have a high silt content and will therefore be difficult or impossible to compact if they are well over the optimum moisture content.

Utility Trench Backfill

Utility trenches should be excavated according to accepted engineering practice following WISHA standards by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized. Cyclic wetting and drying of excavation side slopes should also be avoided.

Utility trench backfill should be structural fill. Pipe bedding should be in accordance with pipe manufacturer's recommendations. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction.

DRAINAGE

The ground surface should slope away from building pad and pavement areas toward appropriate drop inlets or other surface drainage devices. We recommend that adjacent exterior grades be sloped a minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations. Subgrade soils in pavement areas should be sloped a minimum of 1 percent and drainage gradients maintained to carry all surface water to collection facilities. These grades should be maintained for the life of the project. Footing drains should be placed around the perimeter of the building.

EROSION CONTROL

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. As the site is not directly adjacent to surface waters, we anticipate that standard erosion and sediment control measures (such as silt fences at the perimeter of the construction area, and protection for any existing storm sewer inlets that may be affected by the construction) for this site will be sufficient. Note that water should not be allowed to flow over the top of the steep slope.

PAVEMENT DESIGN

The soils underlying the topsoil consist of silty sand and poorly graded sand with silt. We rate this soil as fair subgrade material. We estimate that this subgrade will have a California Bearing Ratio (CBR) value of 10 to 20, provided the subgrade is prepared in general accordance with our recommendations.

We recommend that all topsoil be removed and a minimum 12 inches of the existing subgrade material be moisture conditioned (as necessary) and re-compacted to prepare for the construction of pavement sections. The parking and pavement subgrade areas should be proof-rolled with a fully loaded dump truck. The proof rolling will identify loose and pliant areas. Such areas should either be compacted or over-excavated and backfilled.

Traffic loads were not provided. However, based on our knowledge of the proposed development, we expect the majority of the traffic loads to be for light traffic and occasional service vehicles. Provided below are recommendations for light and heavy-duty pavement areas. Heavy-duty pavement areas are intended primarily for the unloading of large delivery trucks and/or the movement of garbage trucks and as such are required for all streets within the development. Light duty pavement areas are intended for any areas that are likely to see only automobile traffic, such as parking areas. The following tables show the recommended pavement sections for light duty and heavy-duty areas.

ASPHALTIC CONCRETE PAVEMENT
LIGHT DUTY

Traffic Level	Asphaltic Concrete	Aggregate Base*
Low	2.0 inches	8.0 inches

ASPHALTIC CONCRETE PAVEMENT
HEAVY DUTY

Traffic Level	Asphaltic Concrete	Aggregate Base*
Low	4.0 inches	8.0 inches

** Aggregate base should conform to the specifications for Crushed Surfacing – Base Course provided in Section 9-03.9(3) of the Washington State Department of Transportation Standard Specifications Manual dated 2000. Aggregate base and subgrade should be compacted to 95% based on ASTM Test Method D1557.*

The provided heavy and light duty pavement sections are based on flexible pavement design procedures for low volume roads presented in the AASHTO Guide for Design of Pavement Structures. Based on the subsurface exploration for the pavement design, we assumed a fair subgrade with inherent reliability of 50 percent. The structural number used in the pavement design was based on the climatic region II and assumed traffic volume. Pavement design recommendations assume proper drainage and construction observation and are based on AASHTO design parameters for a 15 to 25 year design period. However, pavement maintenance after about 8 to 10 years should be expected to obtain the desired service life.

FOUNDATIONS & SUBSURFACE WALLS

Recommendations for design of individual residence foundations and retaining walls were not part of our scope of work. Recommendations for these elements can be provided upon request for an additional fee.

TESTING AND INSPECTION

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services. Specifically, Krazan and Associates should be present to observe placement of structural fill (to verify soil type and minimum compaction requirements were met) and placement of geogrid reinforcement within the MSE slopes. Note that monitoring of fill and geogrid placement within the MSE slopes must be done on a full-time basis (i.e. the representative of the geotechnical engineer is on-site whenever the contractor is placing fill or geogrid in the MSE slope area). We should also observe cut and fill slopes to ensure that the soils encountered during construction match the soils encountered during the exploration.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of Geotechnical engineering, physical changes in the site either due to excavation or fill placement, new agency regulations or possible changes in the proposed project after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the Owner should be aware that there is a practical limit to the usefulness of this report without critical review.

Earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original field investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. If any variations or undesirable conditions

are encountered during construction, the Geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The Geotechnical engineer should be notified of any changes so the recommendations can be reviewed and reevaluated.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements, or absence of statements, in this report or on any logs regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous materials.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not be used for any other site.

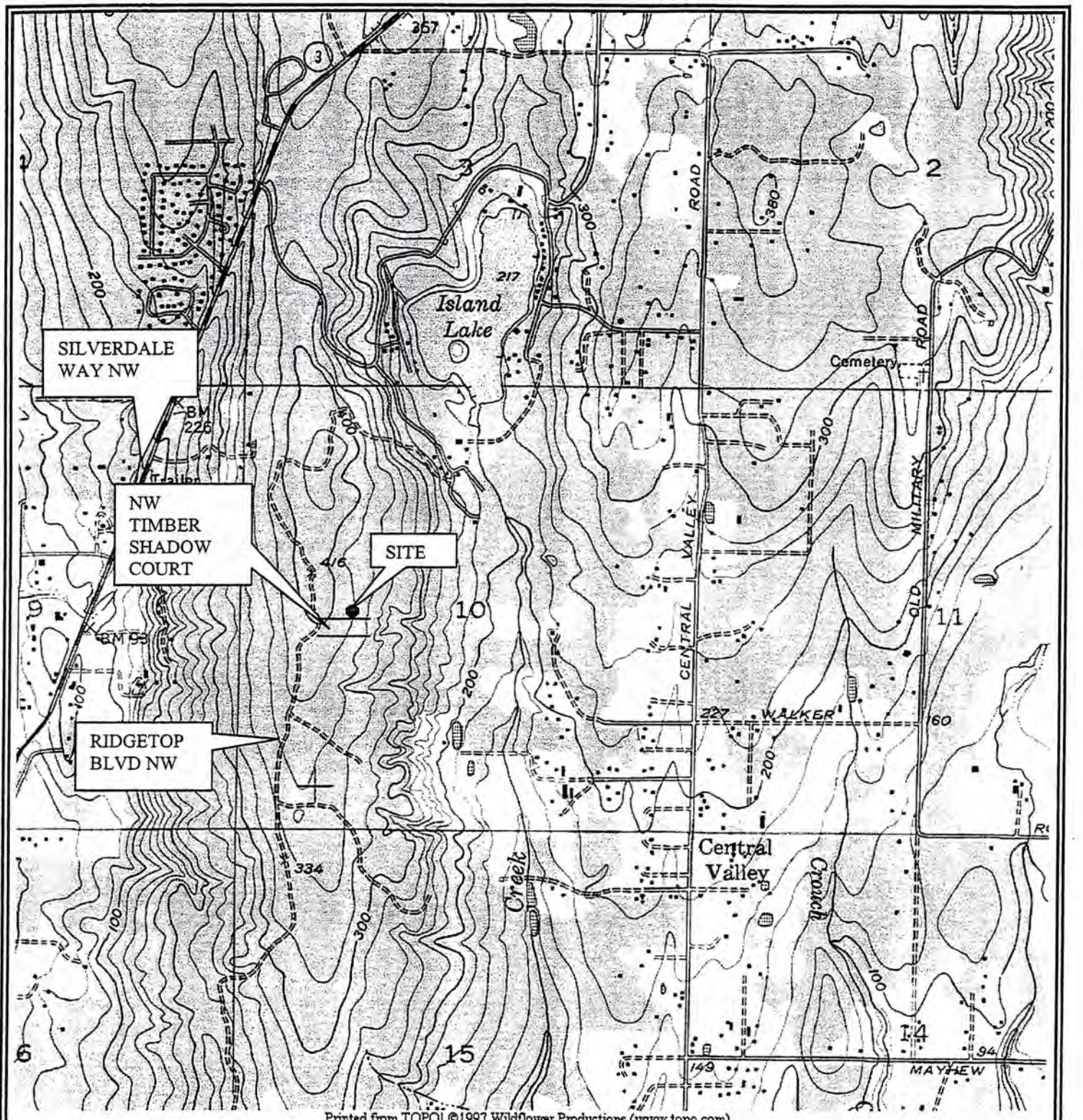
Respectfully submitted,

KRAZAN & ASSOCIATES, INC.

Todd S. Parkington

Todd S. Parkington, P.E.
Senior Geotechnical Engineer

TSP:wrj/sew



Note: Map adapted from TOPO! © 1997, Wildflower Productions.

KRAZAN & ASSOCIATES, INC.
20714 State Route 305-Suite 3C
Poulsbo, WA 98370
360-598-2126

FIGURE 1 – SITE VICINITY MAP

Job name: Copper Canyon
Location: Kitsap County, Washington
Job No. : 102-03046
Client: Crescent Investments, LLC
Date: 5/27/03

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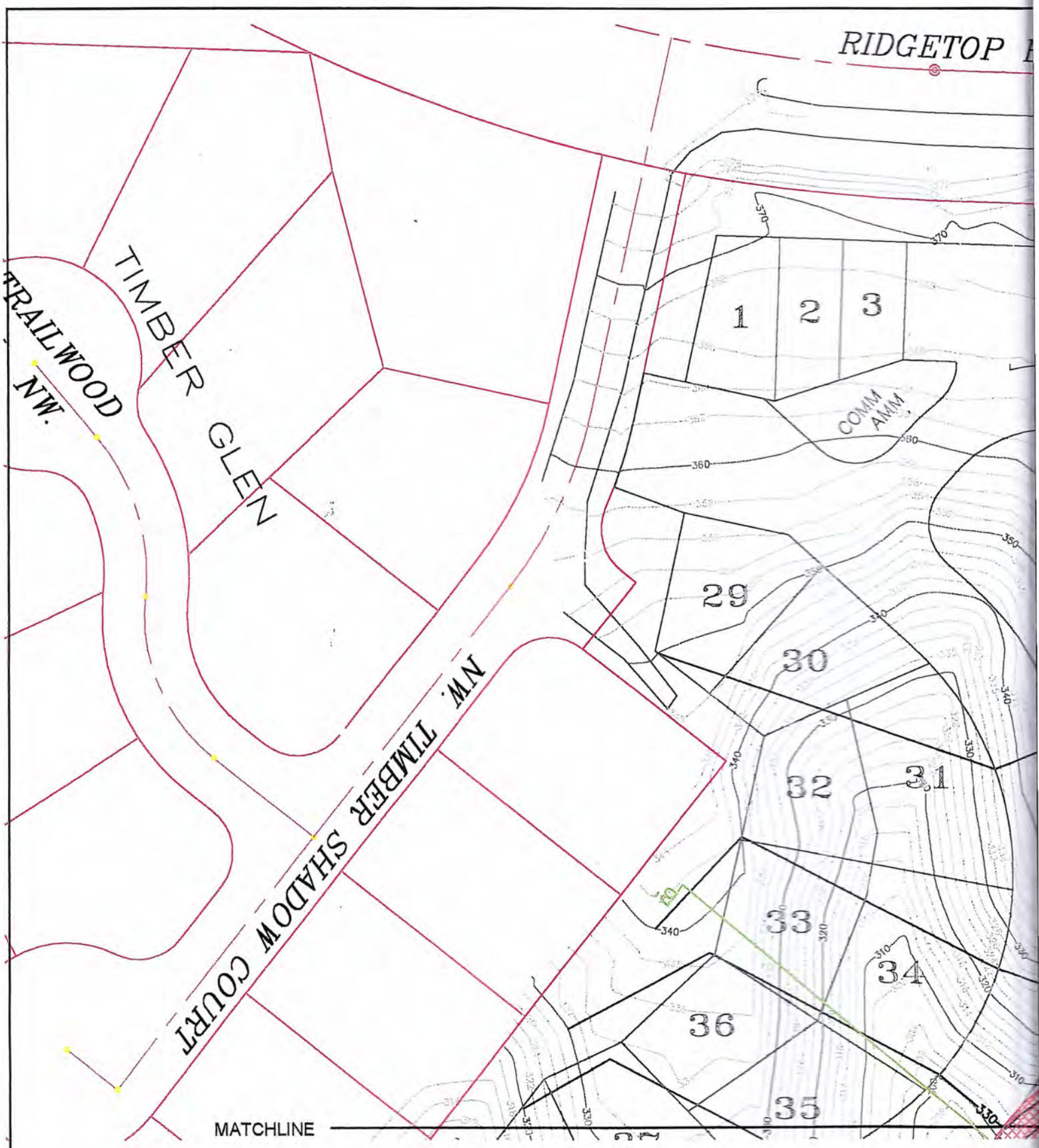
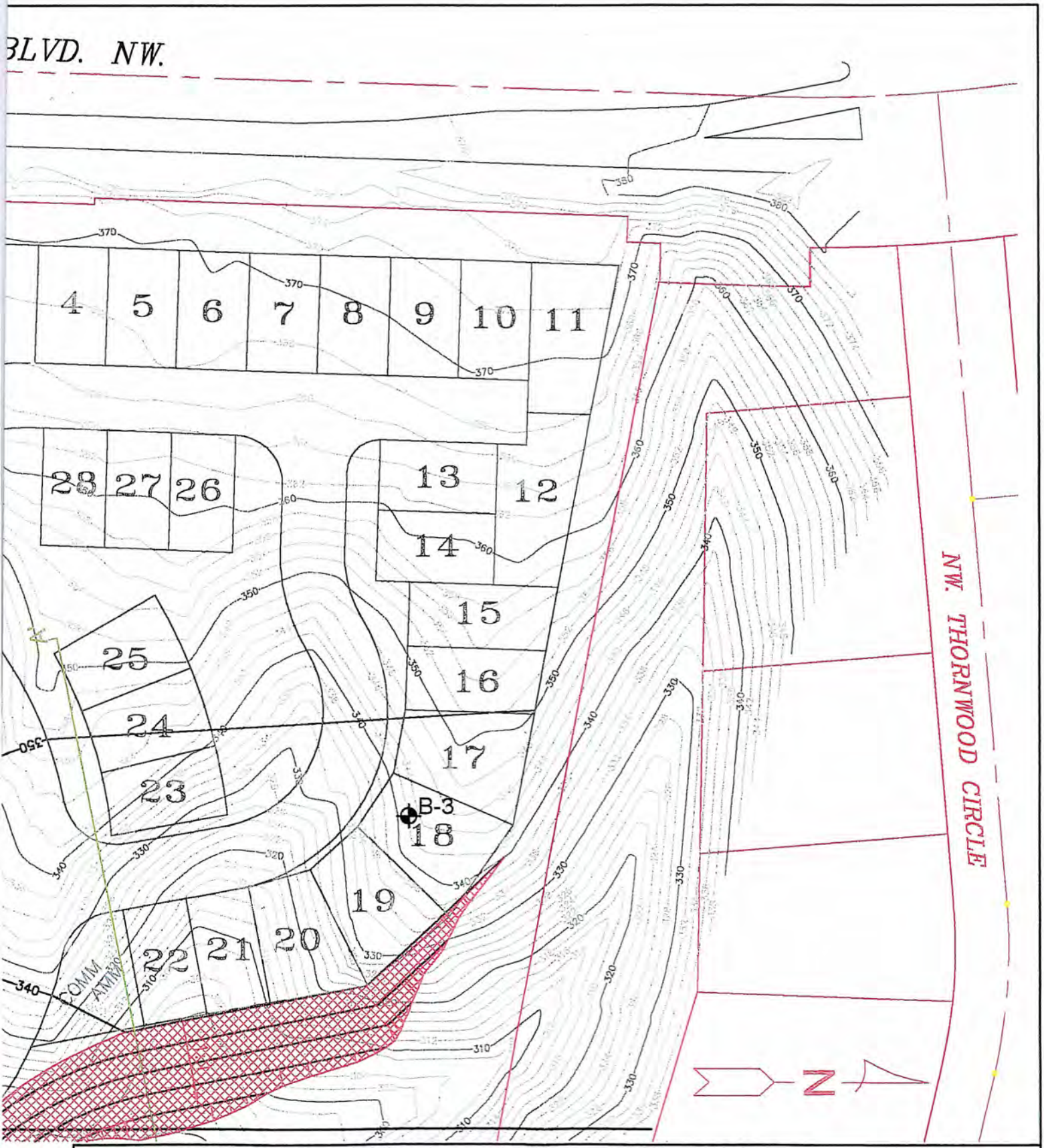


Note Legend information on Figure 2B

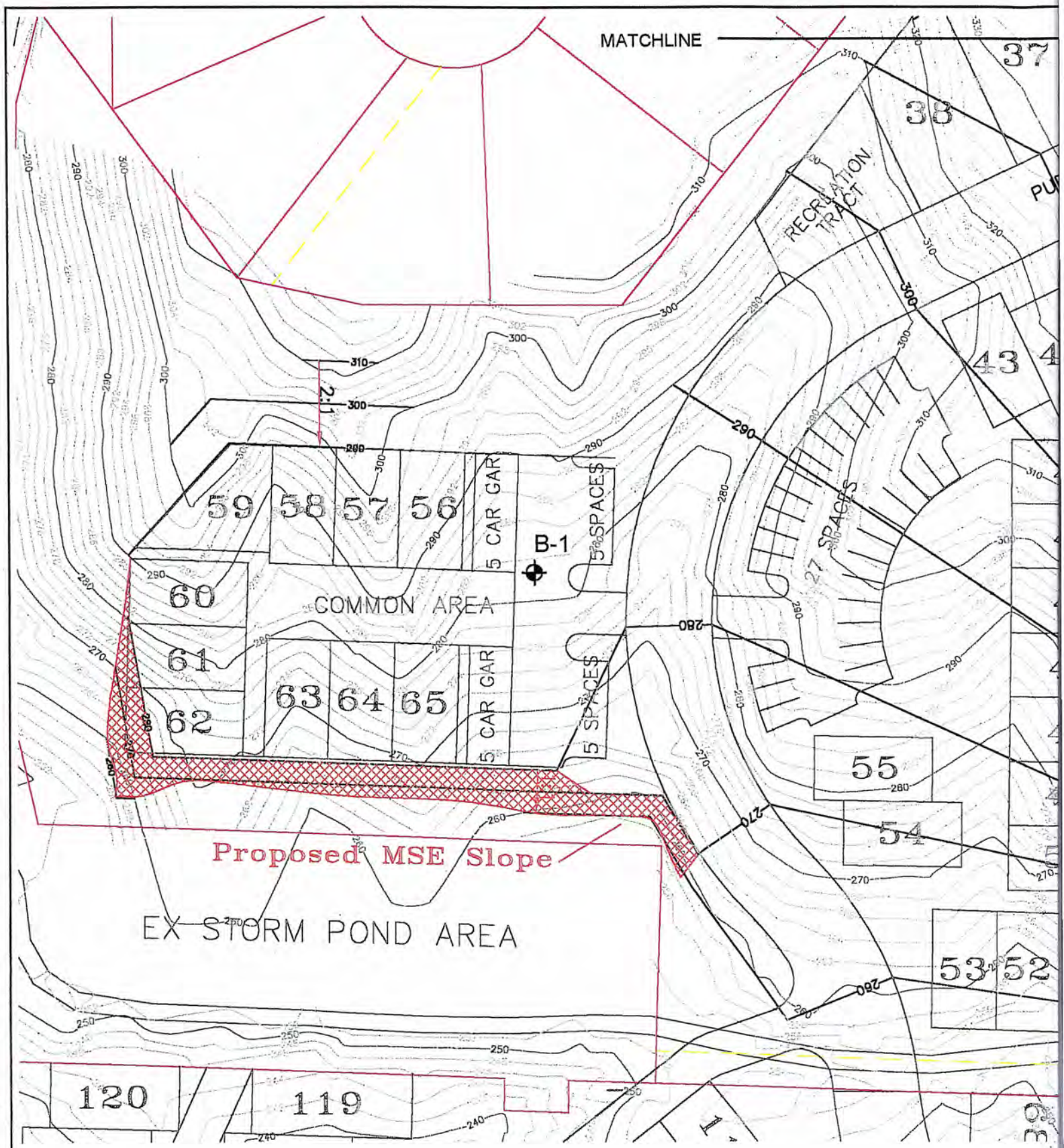
Site Plan developed from plans provided by Team 4 Engineering, Copper Canyon Site Plan, Dated 3/31/03



Site Plan - West Section

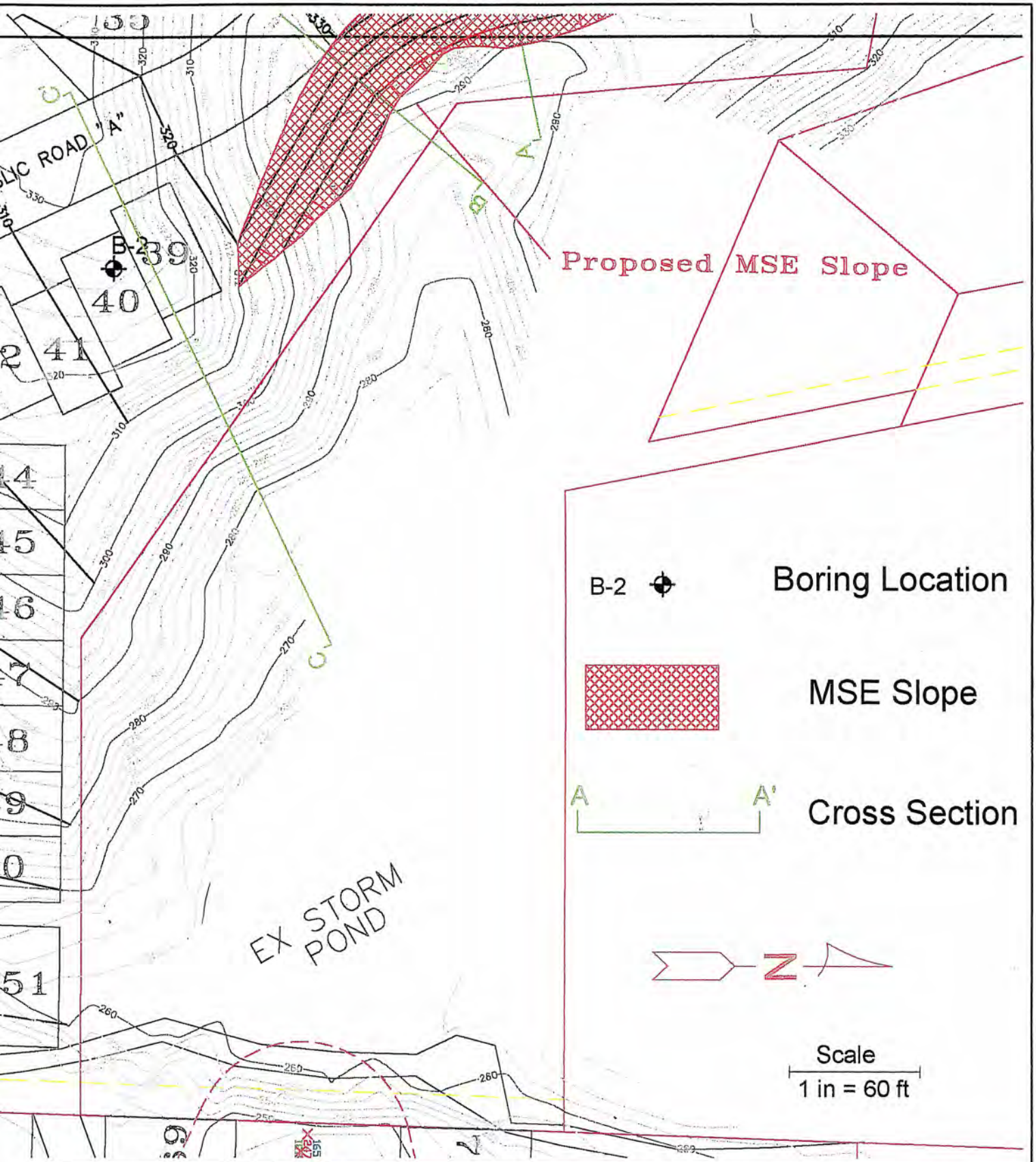
Copper Canyon		Figure 2a
Scale: 1 in = 60 ft	Job Number: 102-03046	Drawn By: JLM Revised By:
Date: June 9, 2003	Krazan & Associates, Inc.	Drawing Number: 1 Drawing Type: Site Map

Permit Number: 20-01252



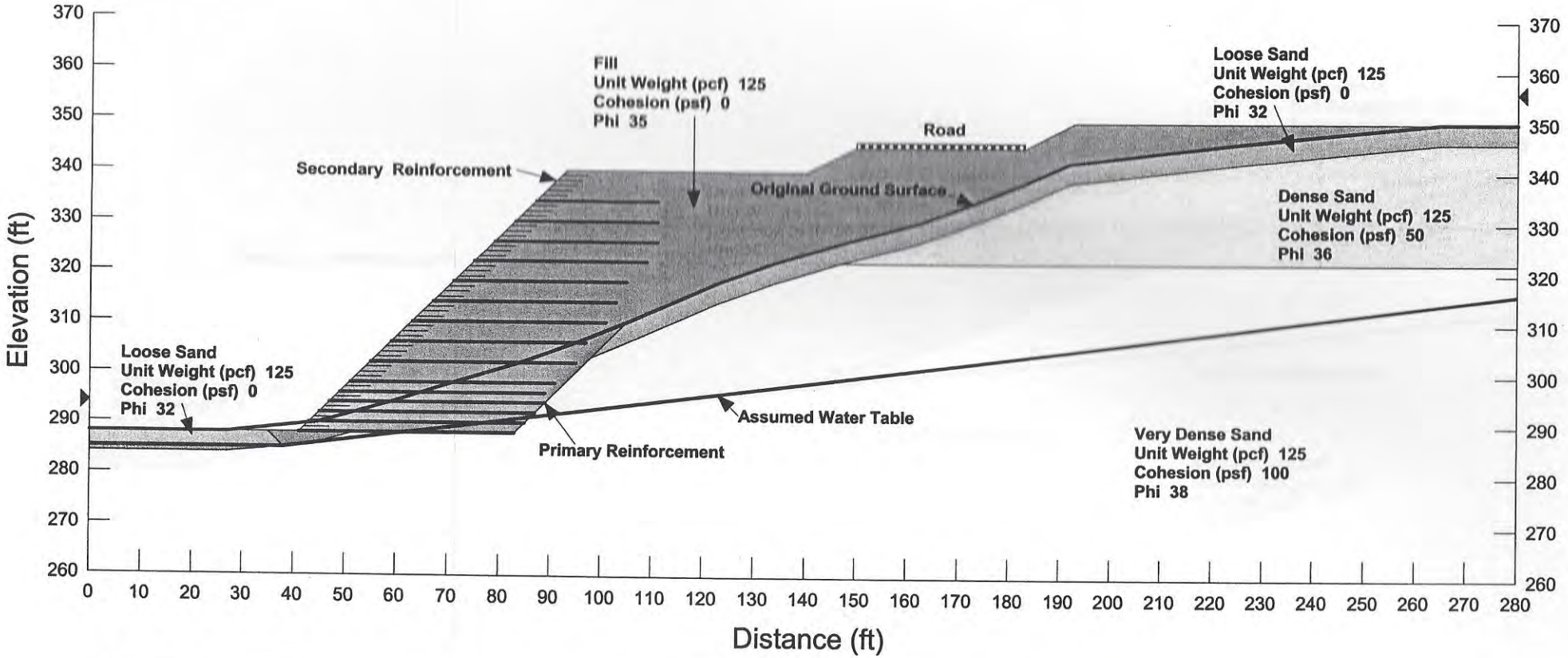
Site Plan developed from plans provided by Team 4 Engineering, Copper Canyon Site Plan, Dated 3/31/03

Permit Number: 20-01254



Site Plan - East Section

Copper Canyon		Figure 2b
Scale: 1 in = 60 ft	Job Number: 102-03046	Drawn By: JLM
		Revised By:
Date: June 9, 2003	Krazan & Associates, Inc.	Drawing Number: 1
		Drawing Type: Site Map



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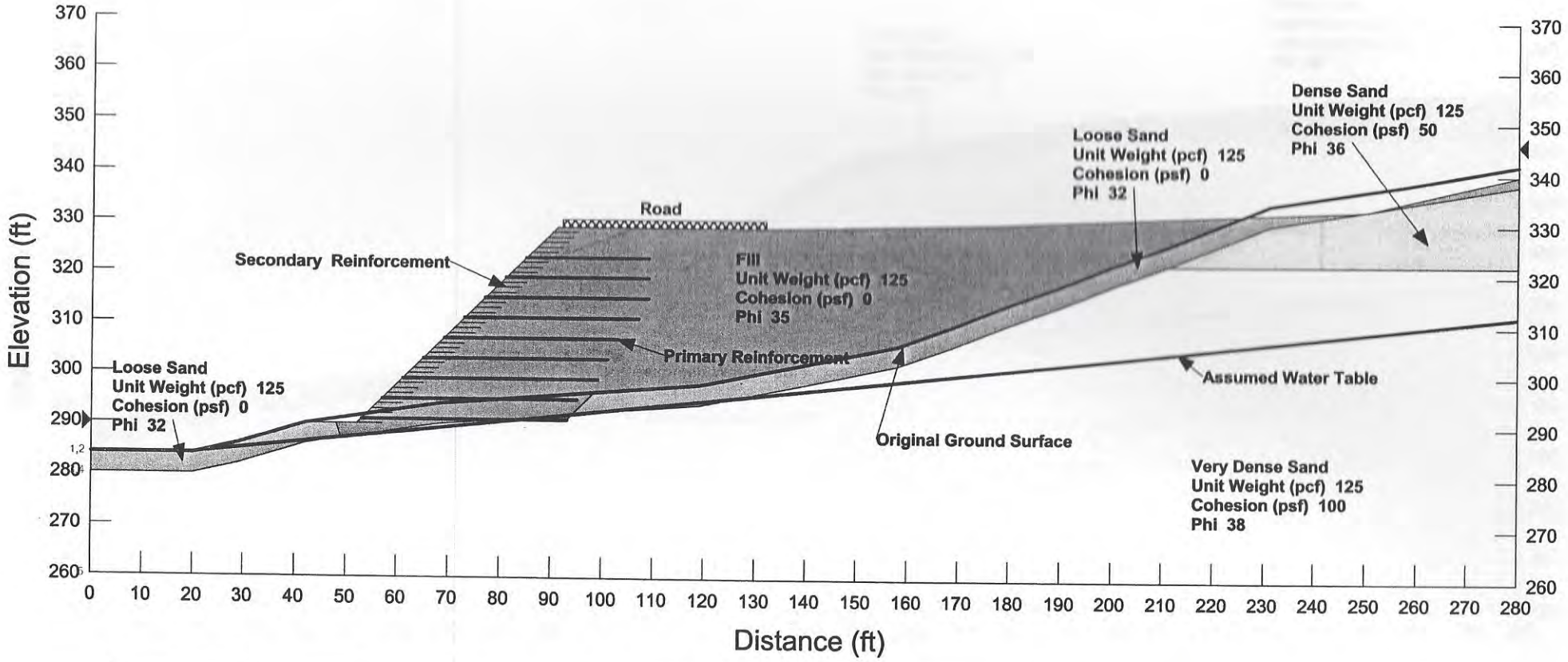
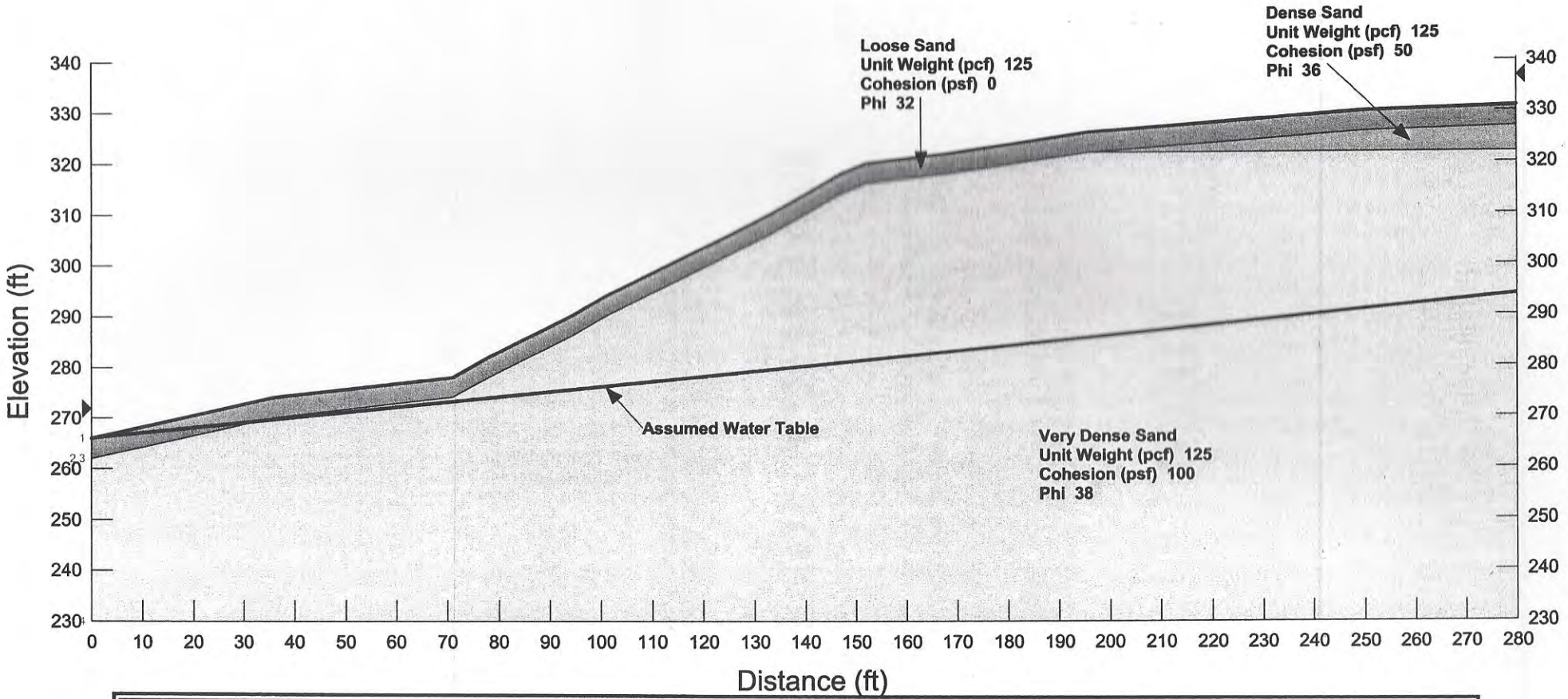
360-598-2126

FIGURE 3 – CROSS SECTION A-A'

Job name:	Copper Canyon
Location:	Silverdale, Washington
Job No. :	102-03046
Client:	Crescent Investments, LLC
Date:	June 12, 2003



KRAZAN & ASSOCIATES, INC. **20714 State Highway 305 NE, Suite 3C** **POULSBO, WA 98370** **360-598-2126**	**FIGURE 4 – CROSS SECTION B-B'** **Job name:** Copper Canyon **Location:** Silverdale, Washington **Job No. :** 102-03046 **Client:** Crescent Investments, LLC **Date:** June 12, 2003



KRAZAN & ASSOCIATES, INC. 20714 State Highway 305 NE, Suite 3C POULSBO, WA 98370 360-598-2126	**FIGURE 5 – CROSS SECTION C-C'** Job name: Copper Canyon Location: Silverdale, Washington Job No. : 102-03046 Client: Crescent Investments, LLC Date: June 12, 2003

Permit Number: 20-01252

FIELD

AND

LABORATORY

INVESTIGATIONS

Appendix A

APPENDIX A

FIELD AND LABORATORY INVESTIGATIONS

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploratory program with three borings. The boring locations are shown on the Site Plan, Figure 2. The depths shown on our boring logs are established from the existing ground surface at the time of the subsurface exploration.

The borings were advanced using a limited access track-mounted drill rig. Disturbed soil samples were obtained by using the Standard Penetration Test (SPT) as described in ASTM: D-1586 and relatively undisturbed soil samples were obtained using a California ring-lined sampler as described in ASTM: D-3550. The Standard Penetration Test and sampling method consists of driving a standard 2-inch outside-diameter, split barrel sampler into the subsoil with a 140-pound hammer free falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the Standard Penetration Resistance, or N-value. The resistance, or "N" value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils. The California sampling method consists of the same driving methods as the Standard Penetration Test, and is used to obtain relatively undisturbed samples. The blow counts obtained from a California sampler are multiplied by 0.63 to obtain an N-value that is nominally equivalent to the N-value obtained from the Standard Penetration Test. Note that the value presented on the log for California samples is the uncorrected blow count.

The soils encountered were logged in the field during the exploration and, with supplementary laboratory test data, are described in accordance with the Unified Soil Classification System.

All samples were returned to our Poulsbo laboratory for evaluation.

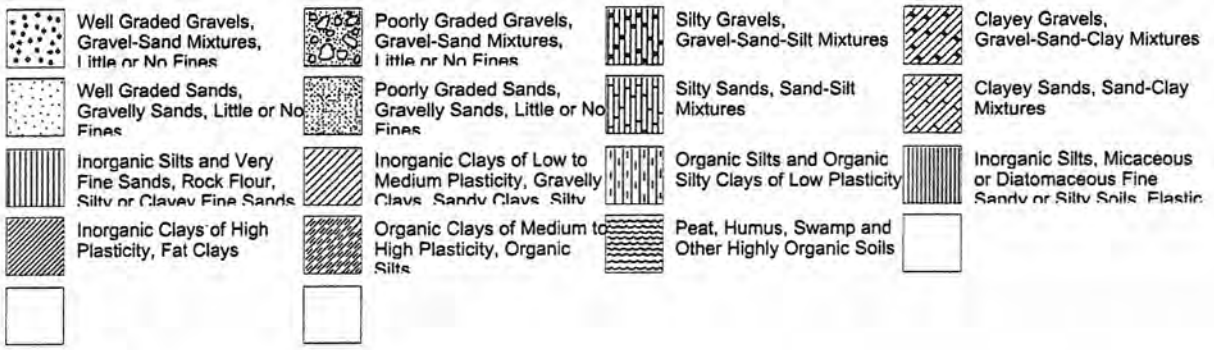
Laboratory Investigation

The laboratory investigation was used to estimate the physical and mechanical properties of the foundation soil underlying the site. In-situ moisture content, fines content, grain size distribution, and direct shear strength tests were performed for samples representative of the subsurface material. These tests, supplemented by visual observation, comprised the basis for our evaluation of the site soil.

The results of the moisture content and the fines content tests are presented on the boring logs. The results of the grain size distribution and direct shear strength tests are presented on individual sheets following the logs.

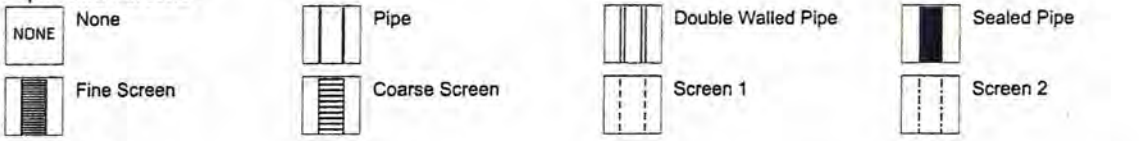
WinLoG Symbol Legend

USCS

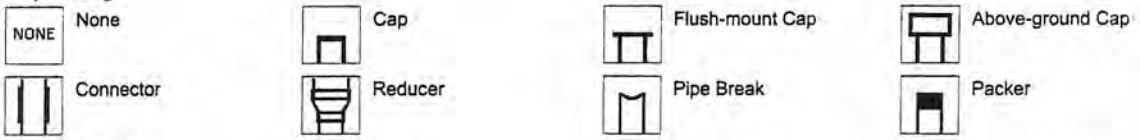


Well Symbols

Pipes and Screens

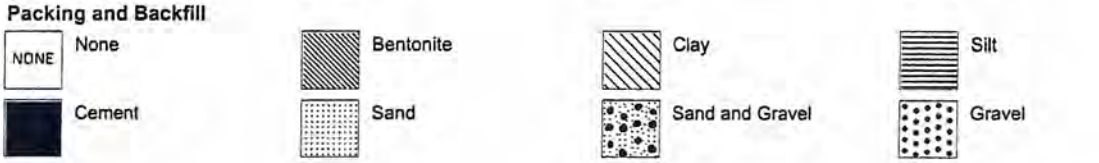


Top Fittings



Bottom Fittings

Packing and Backfill



Sample Symbols

Log of Boring B-1

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~15.5' during drilling, ~7' on removal

Project No: 102-03046
Figure No.: A-1
Logged By: D.H.
Elevation: ~280 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
0		Ground Surface						
		POORLY GRADED SAND WITH SILT (SP-SM) Loose, reddish brown, moist. (TOPSOIL/DISTURBED AREA FOR DRILLING PAD)						
5		***POORLY GRADED SAND WITH SILT (SP-SM)*** Medium dense, tan to gray, very moist to wet.	S-1			SS	16	14.5
10		***SILTY SAND (SM)*** Dense, fine grained sand, gray, moist to wet.	S-2		39	SS	35	22
15		***POORLY GRADED SAND WITH SILT*** AND GRAVEL (SP-SM) Dense, gray, wet. Contains silt lenses.	S-3A S-3B			SS SS	46 46	29.1 22.3
20		Becomes very dense at 20 feet.	S-4			SS	52	18.5
25			S-5A S-5B		6 45	SS SS	19\50:5.5" 19\50:5.5"	17.4 20.5
30			S-6		6	SS	17\50:4"	15.8
35								

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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Suite 3C
Poulsbo, Washington 98370

Drill Date: 3/22/03
Sample Method: SPT, California
Sheet: 1 of 2

Permit Number: 20-01252

Log of Boring B-1

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~15.5' during drilling, ~7' on removal

Project No: 102-03046
Figure No.: A-1
Logged By: D.H.
Elevation: ~280 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
40			S-7A			SS	23\50:4"	20.2
			S-7B		95	SS	23\50:4"	23.3
			S-8		7	SS	39\50:3"	13.4
45		End of Boring Boring collapsed at 14 feet on removal of auger.						
50								
55								
60								
65								
70								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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Poulsbo, Washington 98370

Drill Date: 3/22/03
Sample Method: SPT, California
Sheet: 2 of 2

Permit Number: 20-01252

Log of Boring B-2

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~52.5' durring drilling

Project No: 102-03046
Figure No.: A-2
Logged By: D.H.
Elevation: ~327 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
0		Ground Surface						
		POORLY GRADED SAND WITH SILT (SP-SM) Loose, reddish brown, moist. (TOPSOIL/DISTURBED AREA FOR DRILLING PAD)	S-0			Grab		14.7
5		***SILTY SAND (SM)*** Very dense, fine grained sand, gray, moist. Contains gravel.	S-1			SS	60	10
10			S-2		30	SS	57	8.5
15			S-3			SS	75	9
20			S-4			SS	76	6
25		***POORLY GRADED SAND WITH SILT (SP-SM)*** Very dense, fine grained sand, brown, moist to very moist.	S-5			SS	51	11.8
30			S-6		6	SS	36\50:5"	7.3
35								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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Poulsbo, Washington 98370

Drill Date: 3/22/03 - 3/23/03
Sample Method: SPT, California
Sheet: 1 of 2

Permit Number: 20-01252

Log of Boring B-2

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: ~52.5' durring drilling

Project No: 102-03046
Figure No.: A-2
Logged By: D.H.
Elevation: ~327 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%)
40			S-7			Calif.	74\110:5"	9.9
			S-8			SS	69	8.8
			S-9			SS	82	8.1
45		*SILTY SAND (SM)* Very dense, brown, wet.	S-10		20	SS	81	14.6
50			S-11			SS	85	16.7
55			S-12			SS	38\50:5"	24
60			S-13		56	SS	67	25.8
65		End of Boring Boring collapsed at 35 feet on removal of auger.						
70								

Water Content (%): 5 15 25 35 45

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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Poulsbo, Washington 98370

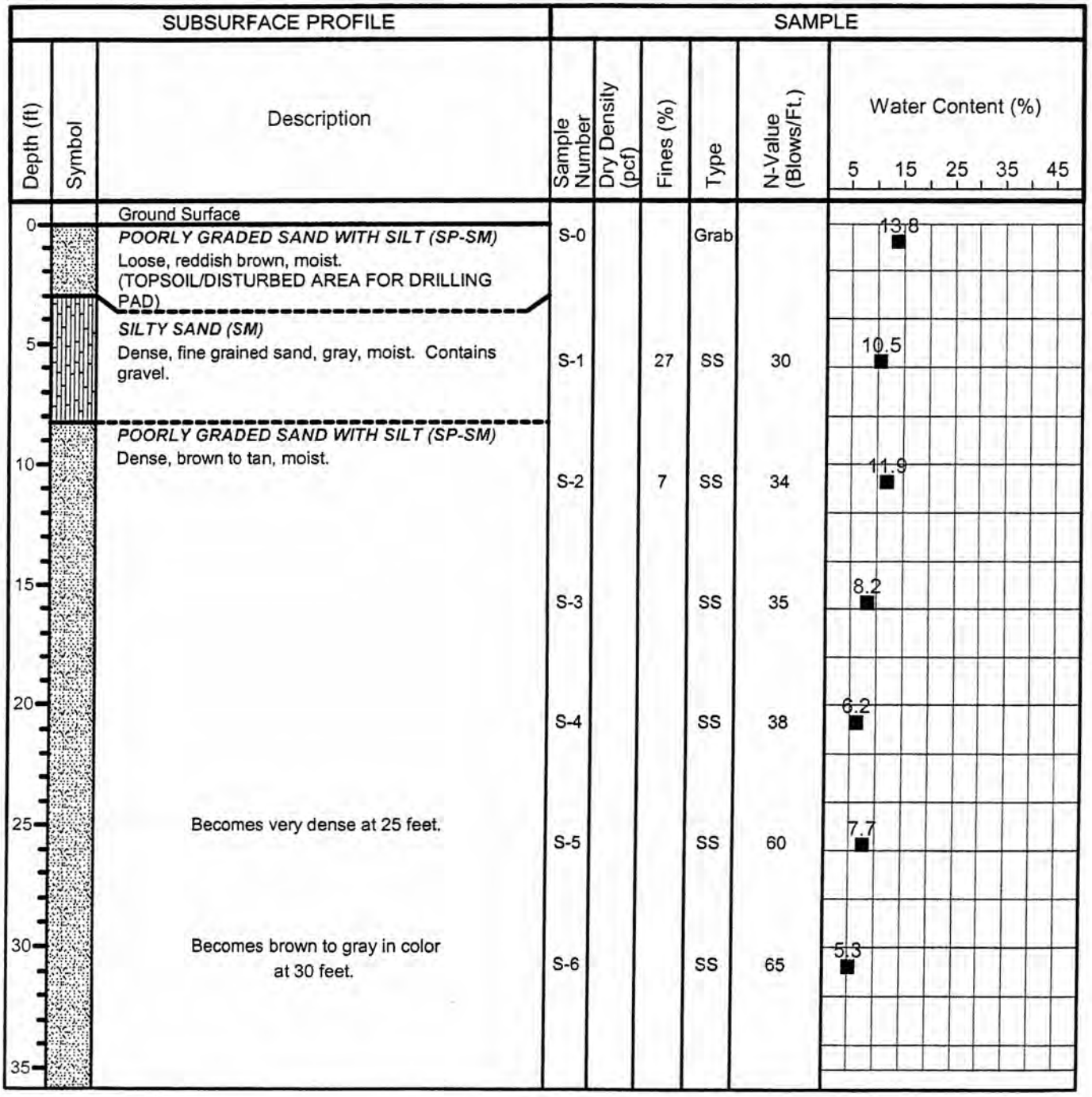
Drill Date: 3/22/03 - 3/23/03
Sample Method: SPT, California
Sheet: 2 of 2

Permit Number: 20-01252

Log of Boring B-3

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: Not encountered

Project No: 102-03046
Figure No.: A-3
Logged By: D.H.
Elevation: ~340 Feet.



Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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Drill Date: 3/23/03
Sample Method: SPT
Sheet: 1 of 2

Permit Number: 20-01254

Log of Boring B-3

Project: Copper Canyon
Client: Crescent Investments LLC
Location: Kitsap County, WA
Depth to Water: Not encountered

Project No: 102-03046
Figure No.: A-3
Logged By: D.H.
Elevation: ~340 Feet.

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Number	Dry Density (pcf)	Fines (%)	Type	N-Value (Blows/Ft.)	Water Content (%) 5 15 25 35 45
40			S-7			SS	53	6.6
			S-8			SS	69	5.9
		End of Boring						
45								
50								
55								
60								
65								
70								

Method: Track HSA
Driller: Davies
Operator: Jeff Davies

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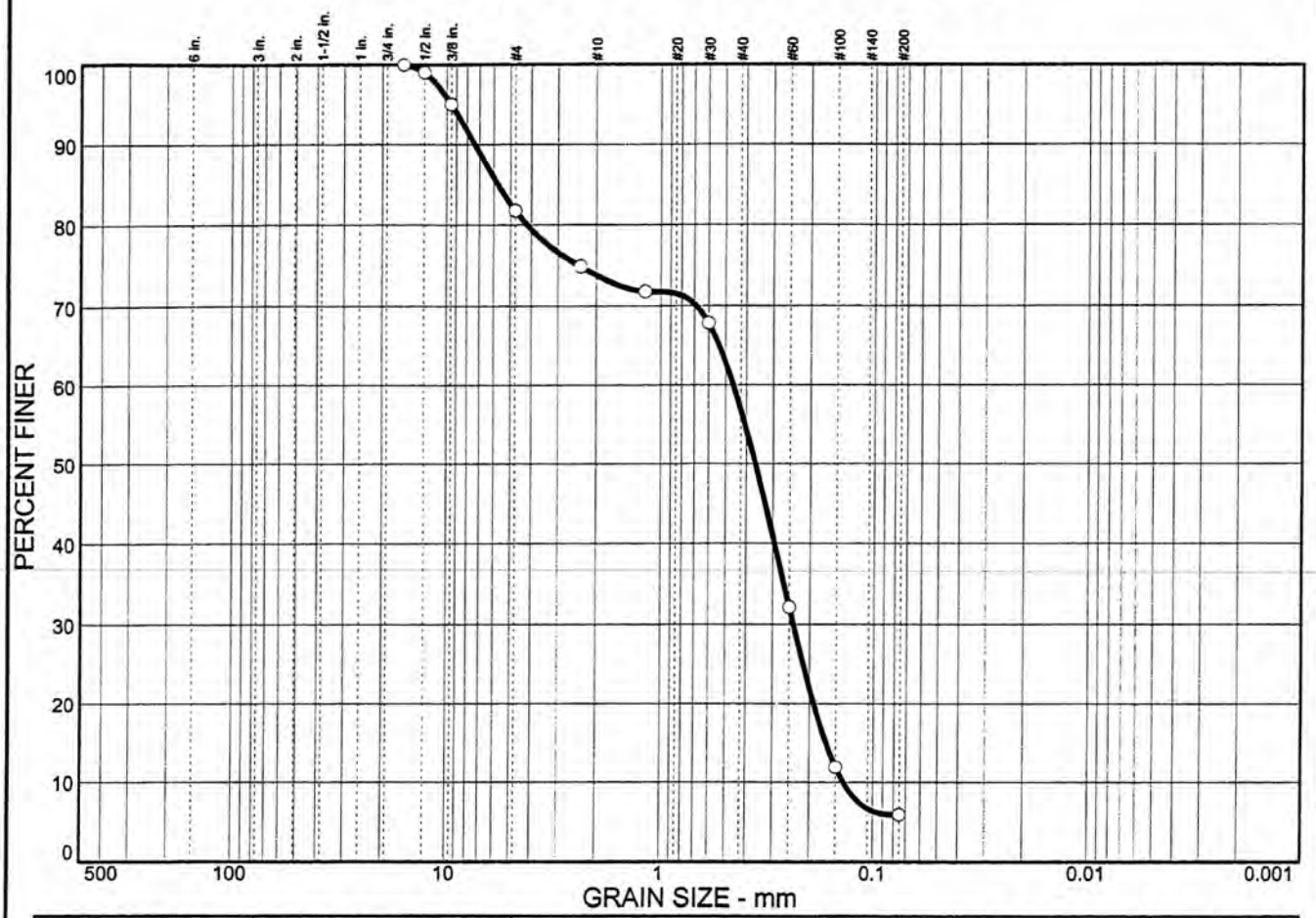
Poulsbo, Washington 98370

Drill Date: 3/23/03
Sample Method: SPT
Sheet: 2 of 2

Permit Number: 20-01252

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	18.2	75.9	5.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.625 in.	100.0		
0.5 in.	99.0		
0.375 in.	95.0		
#4	81.8		
#8	74.9		
#16	71.8		
#30	67.8		
#60	32.1		
#100	11.9		
#200	5.9		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.71 D_{60}= 0.461 D_{50}= 0.363
D_{30}= 0.239 D_{15}= 0.167 D_{10}= 0.138
C_u= 3.34 C_c= 0.90

Classification

USCS= SP-SM AASHTO=

Remarks

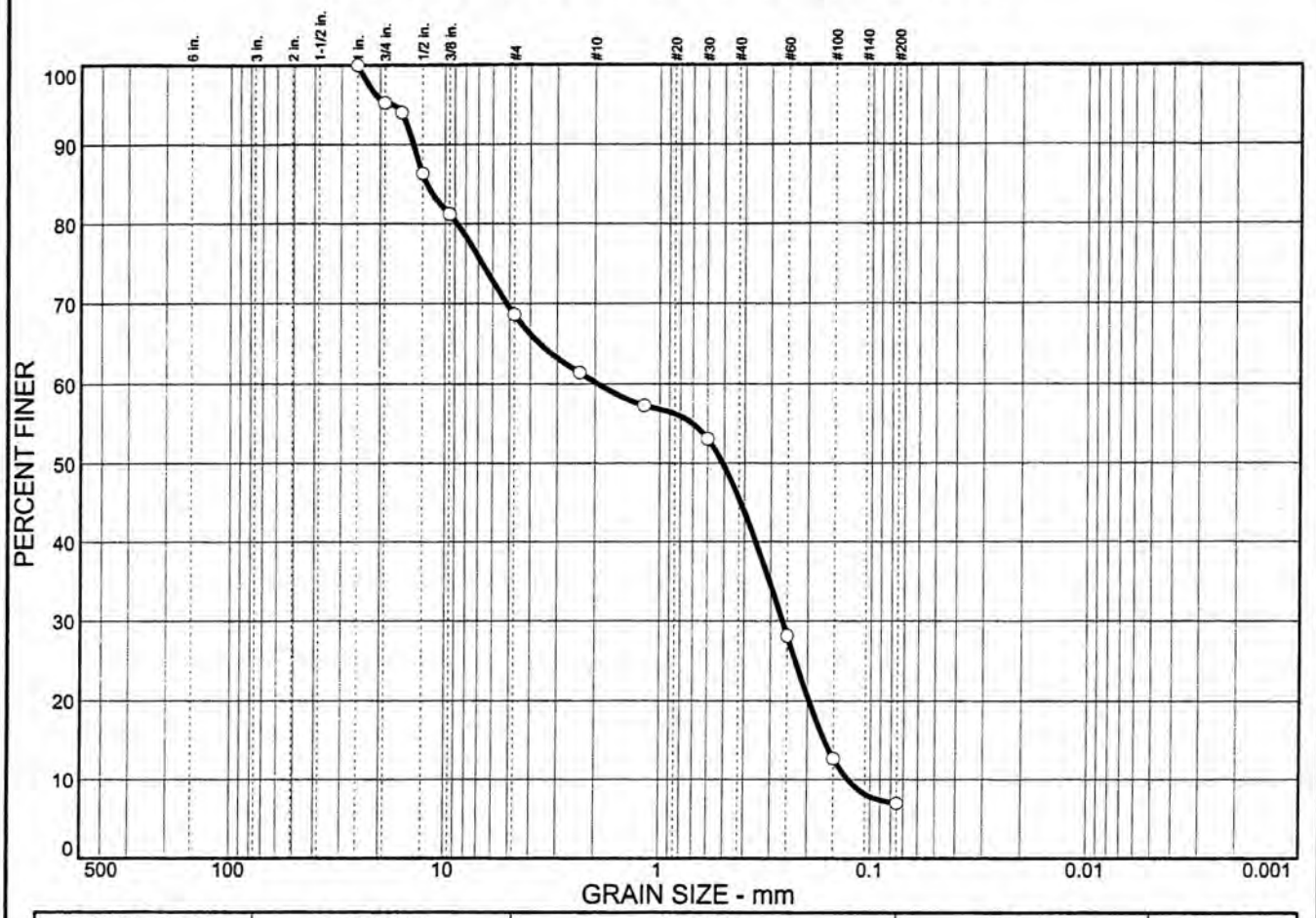
SAMPLE #; P4832
REPORT #: 10072
DATE: 5/27/2003

Sample No.: P4832 **Source of Sample:** BORING 1 **Date:** 5/27/2003
Location: B-1,S-6 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-4

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	31.4	61.6	7.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0 in.	100.0		
0.75 in.	95.2		
0.625 in.	94.0		
0.5 in.	86.4		
0.375 in.	81.2		
#4	68.6		
#8	61.4		
#16	57.3		
#30	53.1		
#60	28.2		
#100	12.7		
#200	7.0		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 12.1 D_{60}= 1.94 D_{50}= 0.509
D_{30}= 0.263 D_{15}= 0.165 D_{10}= 0.128
C_u= 15.16 C_c= 0.28

Classification

USCS= SP-SM AASHTO=

Remarks

SAMPLE #: P4832
REPORT #: 10072
DATE: 5/27/2003

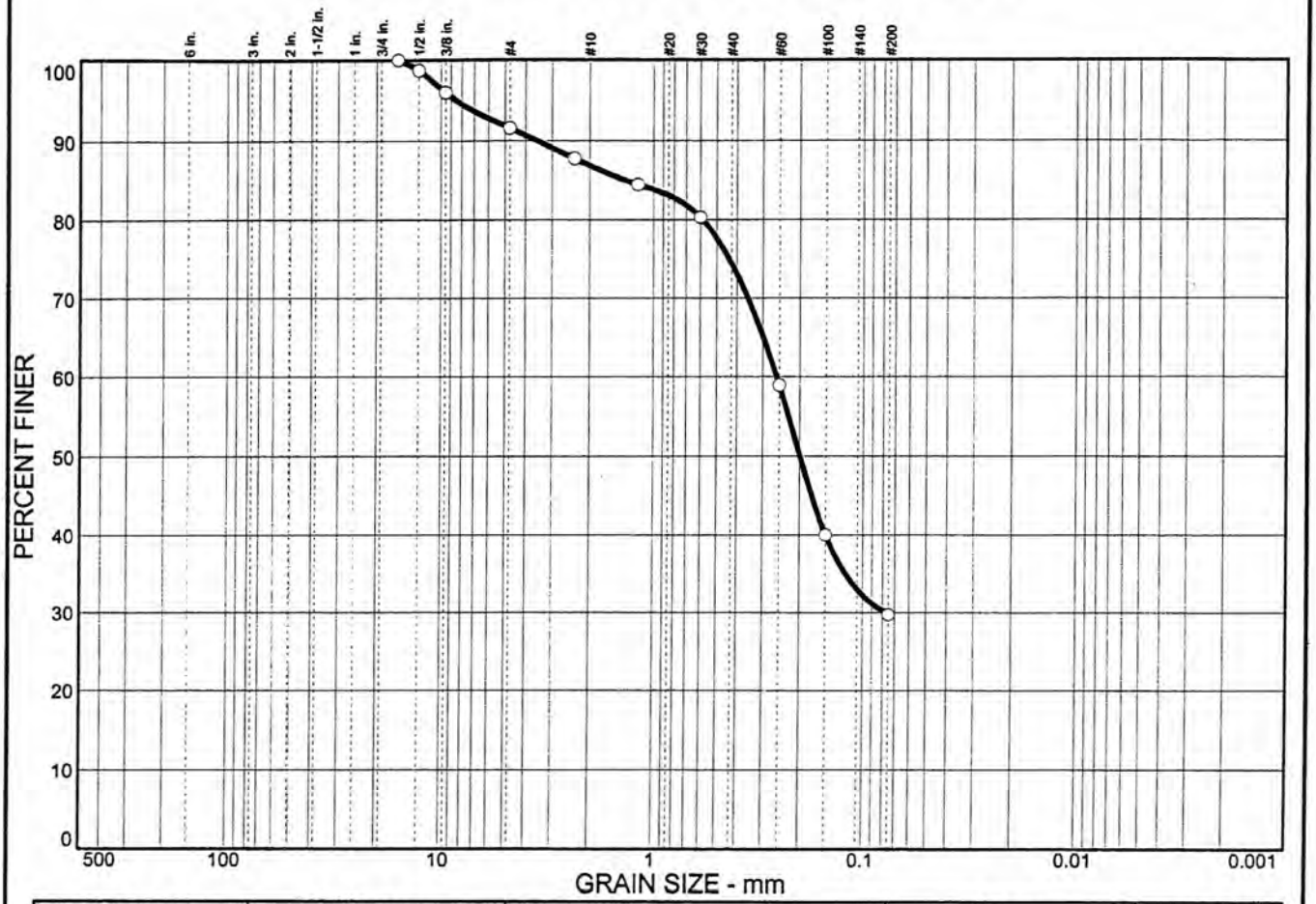
Sample No.: P4832, B-1 **Source of Sample:** BORING 1 **Date:** 5/27/2003
Location: B-1,S-8 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-5

Permit Number: 20-01252

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	8.4	61.9	29.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.625 in.	100.0		
0.5 in.	98.7		
0.375 in.	96.0		
#4	91.6		
#8	87.8		
#16	84.5		
#30	80.3		
#60	58.9		
#100	40.0		
#200	29.7		

* (no specification provided)

Soil Description

USCS: SILTY SAND (SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.33 D_{60}= 0.258 D_{50}= 0.199
D_{30}= 0.0779 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

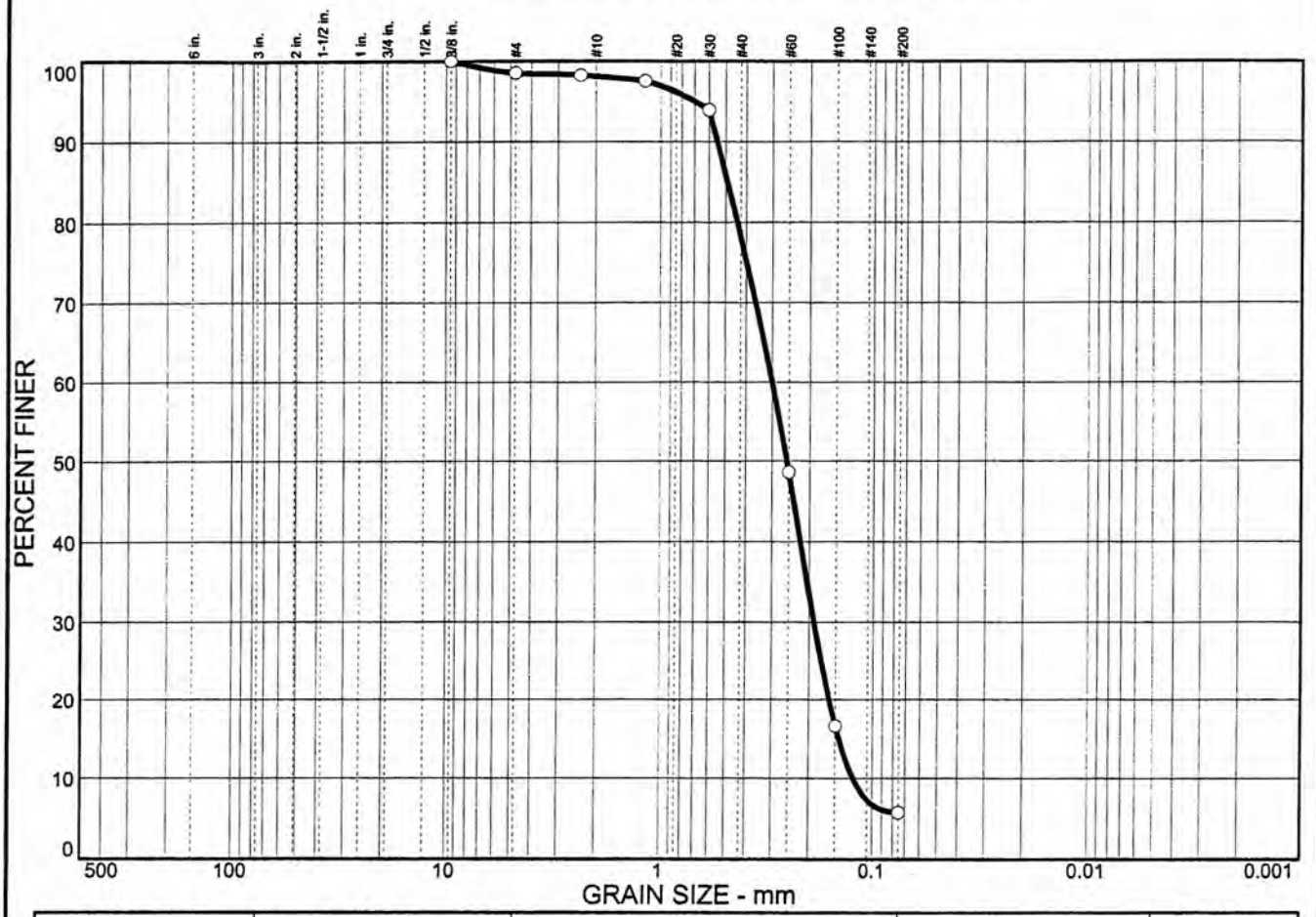
SAMPLE #; P4833
REPORT #; 10072
DATE: 5/27/2003

Sample No.: P4833 **Source of Sample:** BORING 2 **Date:** 5/27/2003
Location: B-2,S-2 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-6

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.5	92.7	5.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	98.5		
#8	98.2		
#16	97.5		
#30	93.9		
#60	48.6		
#100	16.6		
#200	5.8		

* (no specification provided)

Soil Description

USCS:POORLY GRADED SAND WITH SILT (SP-SM)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.491 D_{60}= 0.301 D_{50}= 0.255
D_{30}= 0.190 D_{15}= 0.144 D_{10}= 0.123
C_u= 2.44 C_c= 0.97

Classification

USCS= SP-SM AASHTO=

Remarks

SAMPLE #; P4833
REPORT #; 10072
DATE: 5/27/2003

Sample No.: P4833,B-2 **Source of Sample:** BORING 2 **Date:** 5/27/2003
Location: B-2,S-6 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: CRESCENT INVESTMENTS, LLC
Project: COPPER CANYON
Project No: 102-03046 **FIGURE** A-7

Permit Number: 20-01252

Direct Shear of Consolidated, Drained Soils
ASTM D - 3080 / AASHTO T - 236

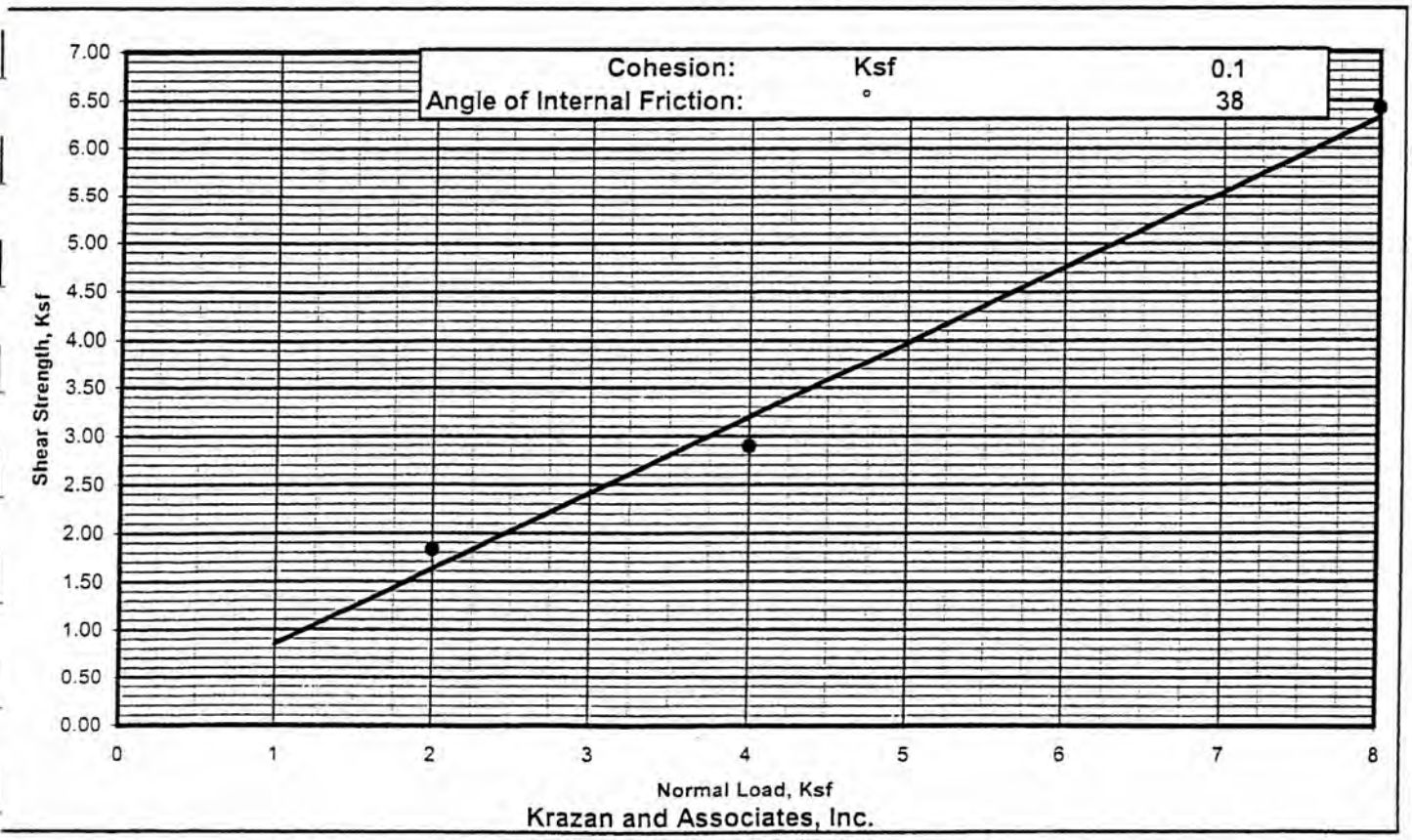
Project Number	: 10203046
Project Name	: Copper Canyon
Date	: 5/23/03
Sample Location	: B-2/S-7
Soil Classification	: SP
Sample Surface Area	: 0.03168

STRESS DISPLACEMENT DATA

Lat. Disp. (in.)	Normal Load		
	2000	4000	8000
0	0	0	0
0.030	100	184	338
0.060	152	228	430
0.090	180	261	464
0.120		284	479
0.150		289	482
0.180			
0.210			
0.240			
0.270			
0.300			
0.330			
0.360			

Normal Load psf	Shear force lbs	Shear Stress psf
2	58.0	1831
4	91.7	2894
8	203.5	6425

Specimen Information		
	Initial	Final
Diameter (in):	2.5	2.5
Thickness (in):	1	1
Moisture Content	9.88%	26.00%
Wet Density (pcf):	133.85	133.85
Dry Density (pcf):	106.23	121.82



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Woodinville, Washington
98072

Figure A-8

SLOPE

STABILITY

ANALYSES

Appendix B

APPENDIX B

SLOPE STABILITY ANALYSES

Slope stability analyses were performed on three cross-sections; two within the taller MSE slope and one on a ravine slope that will not be re-graded. The locations of the cross-sections are indicated on the Site Plan, Figure 2. Topography used in the analysis was based on the Copper Canyon Site Plan, dated March 31, 2003 prepared by Team 4 Engineering. The slope stability computer program Slope/W by GeoSlope International was used to evaluate the stability of the existing slopes and proposed MSE slopes under static and seismic conditions. Soil strength parameters used in our analysis were based on in-situ penetration tests, laboratory shear strength tests and published values. The engineering properties of the soil used in our analysis are presented on Figure 3, Cross Sections A-A', Figure 4, Cross Section B-B', and Figure 5 Cross Section C-C'. Cross Section A-A' represents the maximum height of MSE slope on the site, Cross Section B-B' represents the closest approach of the access road to the MSE slope, and Cross Section C-C' represents a relatively steep section of native slope. Water levels used in the stability analyses were conservatively assumed to be higher than the water level encountered in our borings.

The psuedostatic method was used for our slope stability analyses to estimate the factor of safety under seismic conditions. The United States Geologic Survey, Earthquake Hazards Program – National Seismic Hazard Mapping Project, indicates that a peak ground acceleration (PGA) of 0.32 g has a 10 percent probability of exceedence in 50 years (500 year return period). The seismic coefficient is typically taken to be ½ of the PGA. A seismic coefficient of 0.16 was used in our analyses.

The results of slope stability analyses are expressed as factors-of-safety against rotational failure. The factor-of-safety is the ratio of driving forces to resisting forces. A factor-of-safety of 1.0 is equilibrium; a factor-of-safety of less than 1.0 indicates failure. Typically, a factor-of-safety of 1.5 for static conditions and 1.1 for seismic conditions is considered adequate. Factors of safety greater than 1 but less than 1.5 (or 1.1) are not adequate due to the uncertainties inherent in the modeling process. A lower safety factor for seismic conditions is considered adequate as the probability of occurrence of the seismic conditions analyzed is relatively low. The calculated minimum factor of safety for each slope is presented on the figures in this appendix.

Two figures are provided for each cross section; one for static conditions and one for seismic conditions.

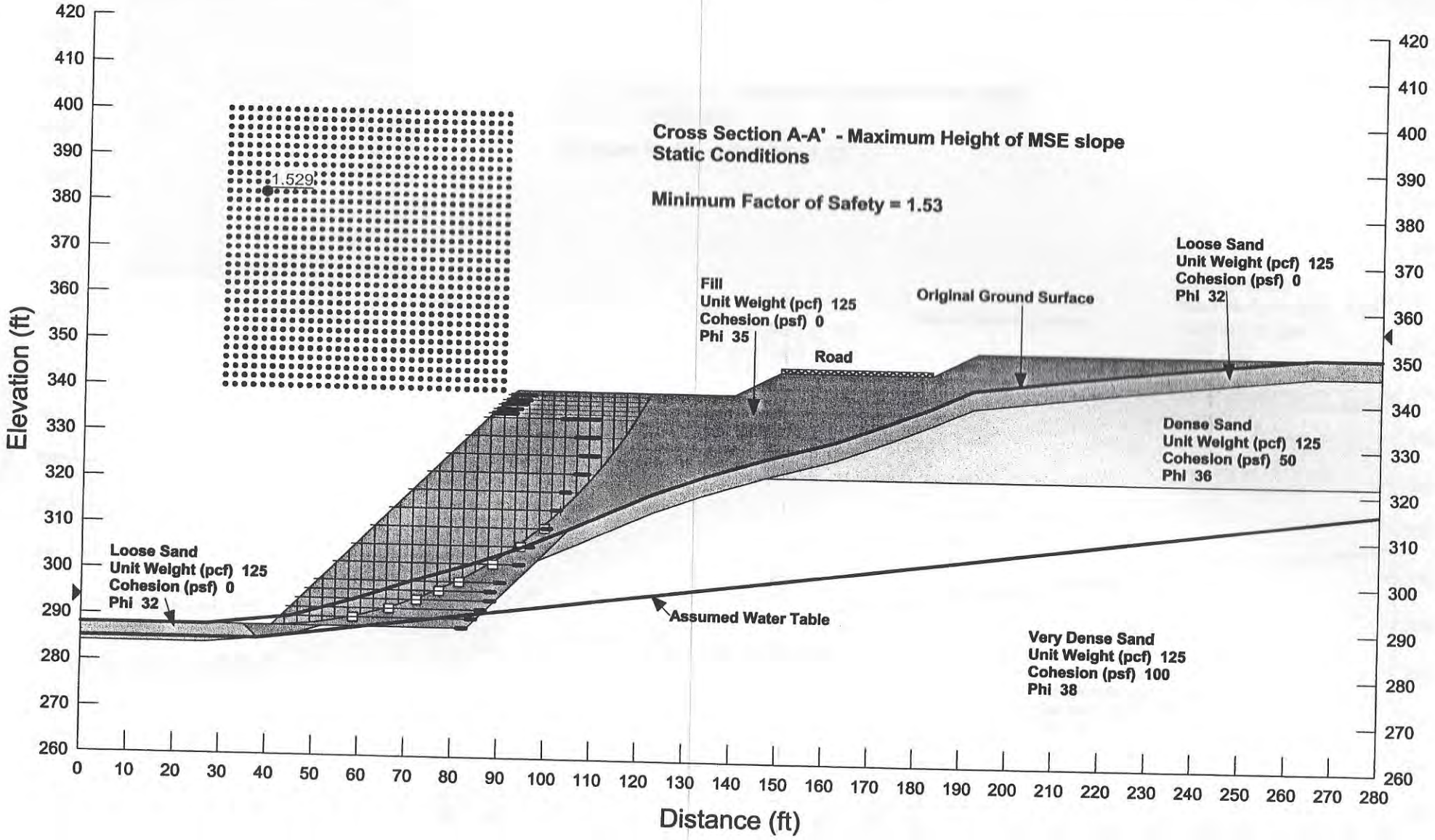


Figure B-1

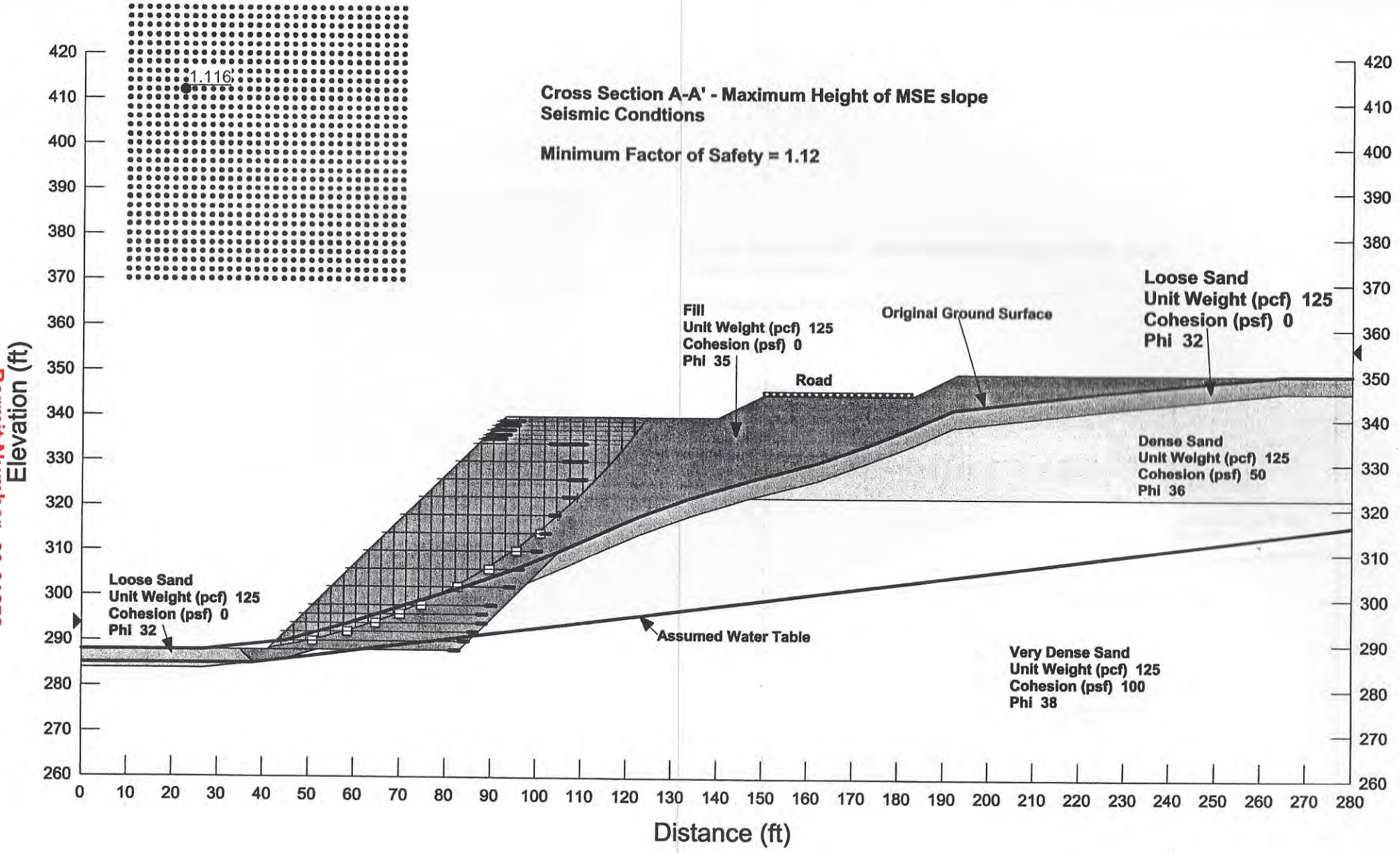


Figure B-2

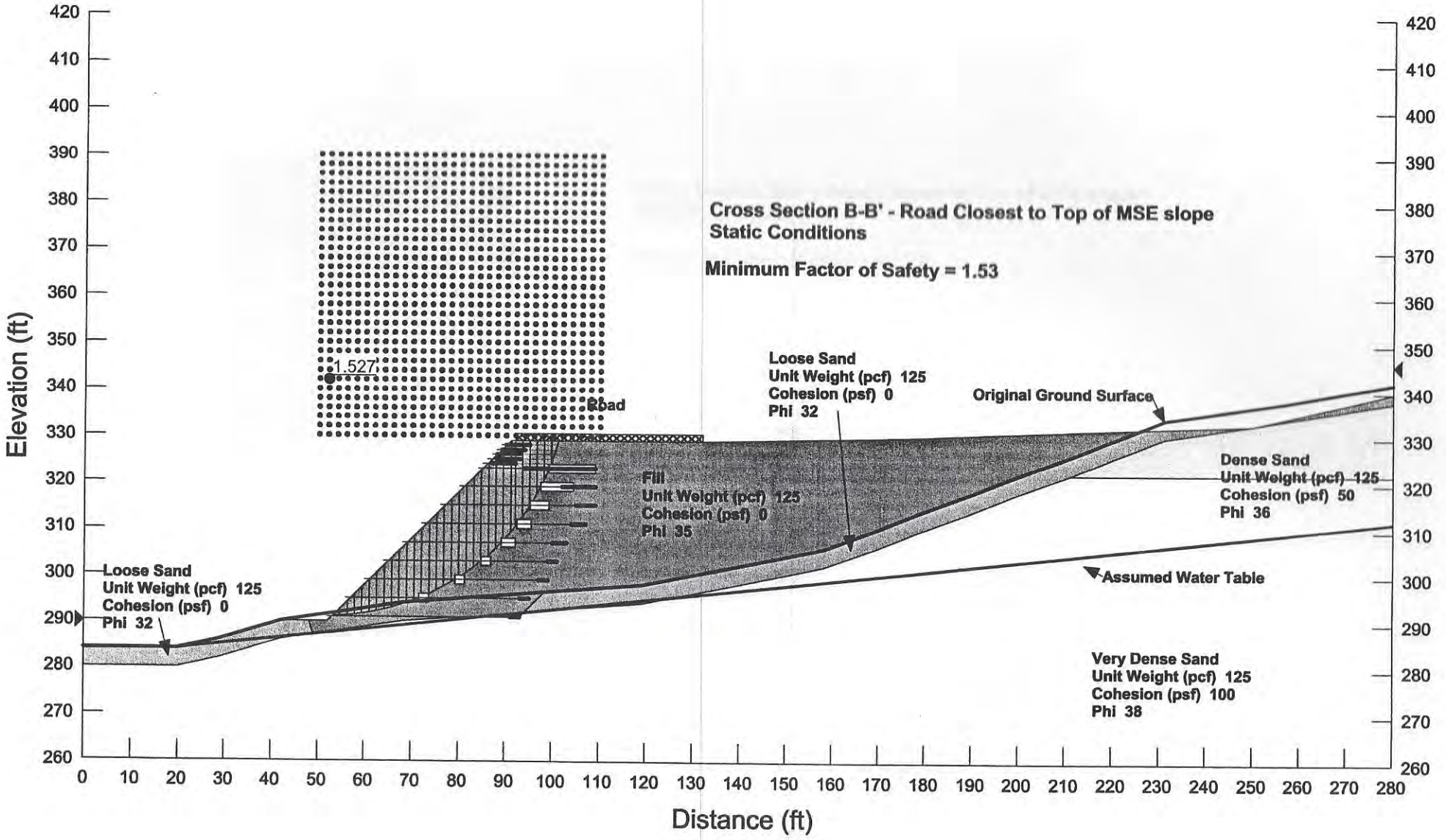


Figure B-3

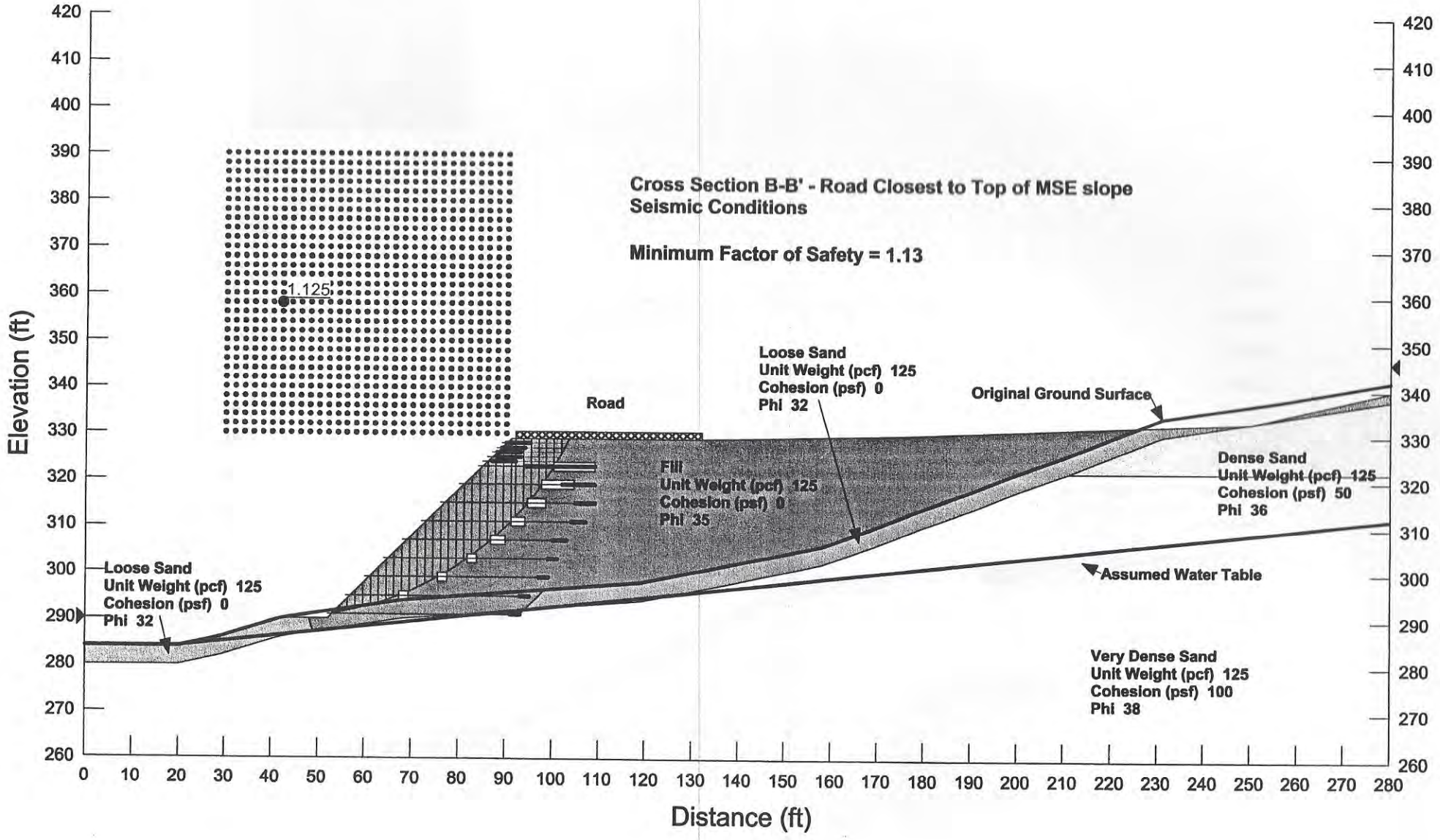


Figure B-4

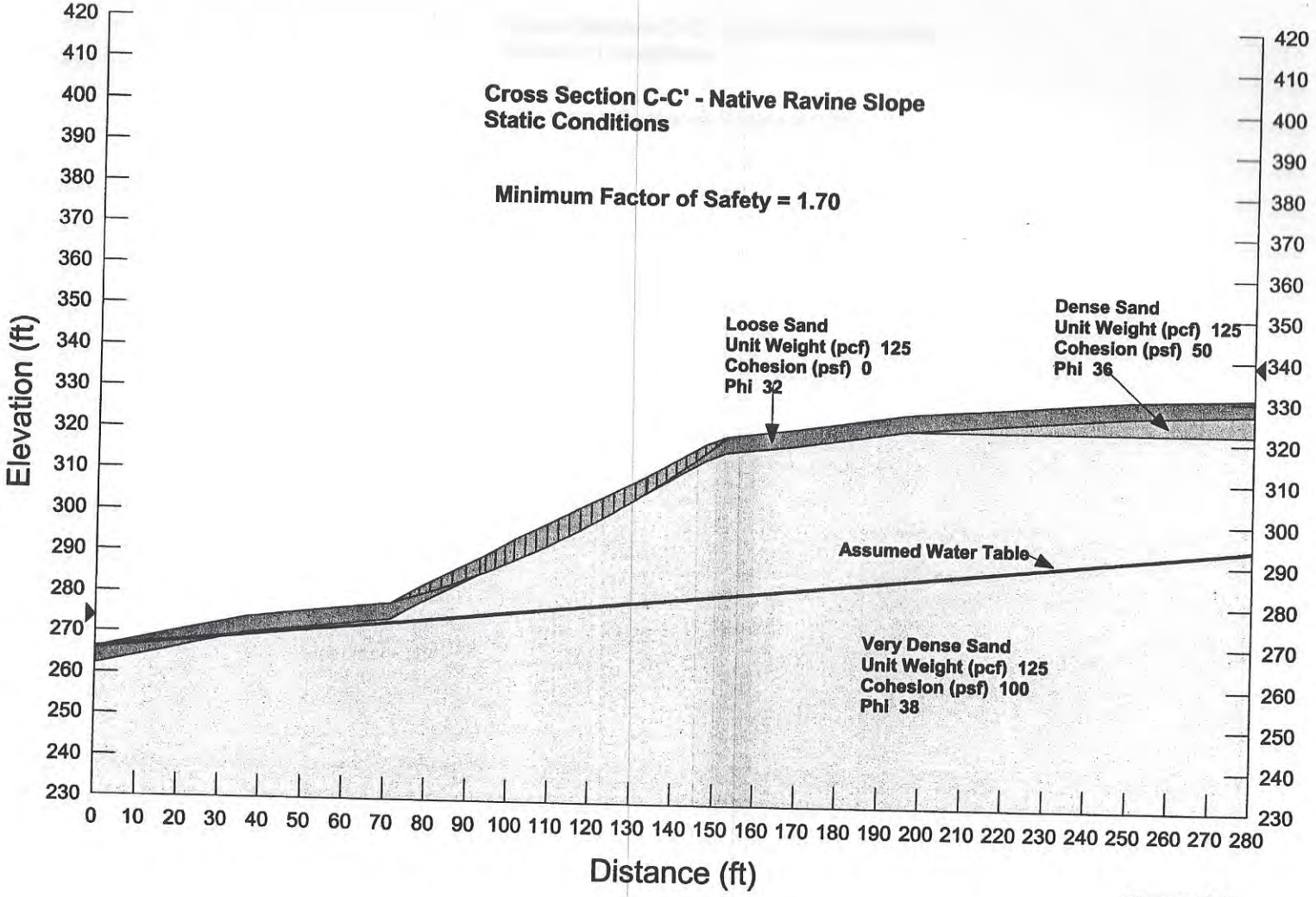
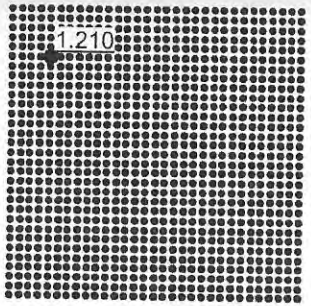


Figure B-5



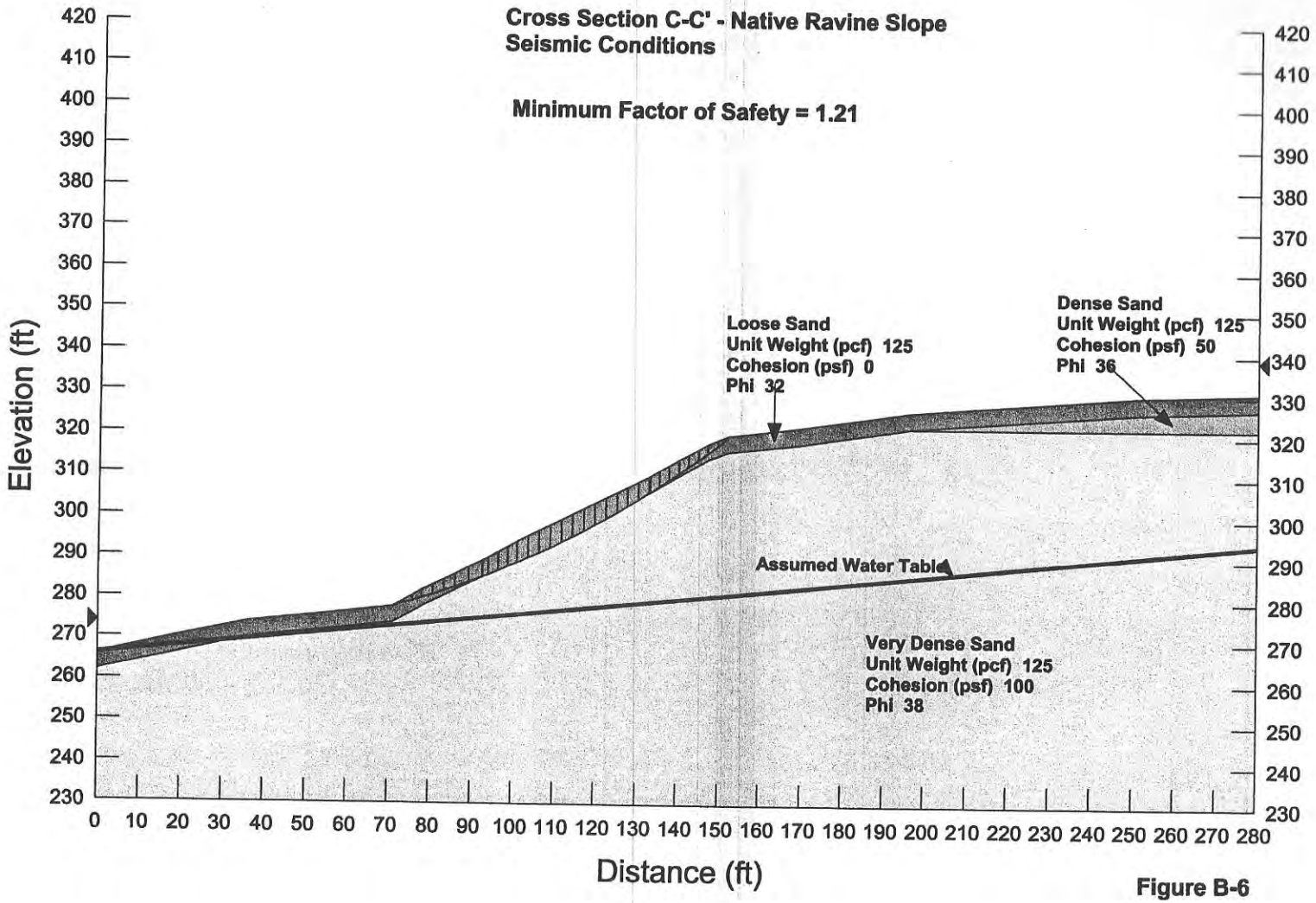


Figure B-6