I-90 SNOQUALMIE PASS EAST PROJECT

Final Technical Memorandum 1 – Gold Creek Bridges
2007 Geotechnical Analysis and Reporting

June 2008

Washington State Department of Transportation

U. S. Department of Transportation
Federal Highway Administration

Title VI

WSDOT ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person on the basis of race, color, national origin or sex in the provision of benefits and services resulting from its federally assisted programs and activities. For questions regarding WSDOT's Title VI Program, you may contact the Department's Title VI Coordinator at (360) 705-7098.

Americans with Disabilities Act (ADA) Information

If you would like copies of this document in an alternative format – large print, Braille, cassette tape, or on computer disk, please call (360) 705-7097. Persons who are deaf or hard of hearing, please call the Washington State Telecommunications Relay Service, or Tele-Braille at 7-1-1, Voice 1-800-833-6384, and ask to be connected to (360) 705-7097.

June 2008

Washington State Department of Transportation

U. S. Department of Transportation
Federal Highway Administration

Acknowledgements

I-90 Snoqualmie Pass East

Agreement No. 9764
Task Order CA

Final Technical Memorandum No. 1
Gold Creek Bridges
2007 Geotechnical Analysis and Reporting

Submitted to:
WSDOT
I-90 Project Office

Prepared by:
URS Corporation
1501 4th Avenue, Suite 1400
Seattle, Washington 98101

Cecil M. Urlich, PE
Project Manager

Charles L. Vita, PhD, PE
Principal Engineer

David S. Walker, PE
Project Engineer

CECIL M. URLICH
STATE OF WASHINGTON
31611
REGISTERED
PROFESSIONAL ENGINEER

CHARLES L. VITA
STATE OF WASHINGTON
16996
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 5/29/09

EXPIRES 7/3/09

DAVID SCOTT WALKER
STATE OF WASHINGTON
30168
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 9/29/09

TABLE OF CONTENTS

ACRONYMS v
1.0 INTRODUCTION 1
2.0 PROJECT DESCRIPTION 2
2.1 GOLD CREEK BRIDGES 2
2.2 DETOUR BRIDGE 3
3.0 FIELD EXPLORATION AND LABORATORY TESTING RESULTS 3
4.0 SITE CONDITIONS 4
4.1 SITE DESCRIPTION 4
4.2 GEOLOGIC SETTING 4
4.3 SUBSURFACE CONDITIONS 5
4.4 GROUNDWATER 6
4.5 REPRESENTATIVE SUBSURFACE PROFILES 7
4.6 SCOUR 7
5.0 EARTHQUAKE ENGINEERING 9
5.1 BRIDGE MODELING 9
5.2 ABUTMENT AND RETAINING WALL SEISMIC DESIGN 9
5.3 LIQUEFACTION POTENTIAL 10
5.3.1 Liquefaction Analysis 10
5.3.2 Settlement Due to Liquefaction 11
5.3.3 Lateral Spreading 11
5.3.4 Limitations of Liquefaction Analysis 11
5.4 FAULT RUPTURE 11
5.5 DETOUR BRIDGE 12
6.0 GEOTECHNICAL RECOMMENDATIONS 12
6.1 DRILLED SHAFT FOUNDATIONS 12
6.1.1 Bearing and Uplift Resistance 12
6.1.2 Downdrag Loads and Skin Friction Losses 14
6.1.3 Lateral Load Analysis 15
6.2 ABUTMENT RETAINING WALLS 16
6.2.1 Earth Pressures 16
6.2.2 Stability of Approach Fills 17
6.2.3 Liquefaction-Induced Settlement of Approach Fills 19
6.2.4 Ground Improvement 19
6.3 EARTHWORK 21
6.4 DETOUR BRIDGE 23
6.4.1 Bearing Resistance 23
6.4.2 Lateral Loads and Sliding Resistance 23
6.4.3 Foundation Springs 24
6.4.4 Global Stability 24
6.4.5 Earthwork 25
7.0 CONSTRUCTION CONSIDERATIONS 26
8.0 LIMITATIONS 26
9.0 REFERENCES 27

TABLES

Table 1 Summary of Representative Subsurface Profiles
Table 2 Liquefaction Analysis Results
Table 3 Approximate Elevations of Bearing Strata
Table 4 Drilled Shaft Bearing and Uplift Resistance Factors
Table 5 Summary of Downdrag Loads and Skin Friction Losses Due to Liquefaction
Table 6 Design Parameters for Lateral Load Analysis using DFSAP
Table 7 Summary of Global Stability Analysis Results for Approach Fills
Table 8 Summary of Mitigation Measures for Potential Approach Fill Slope Instabilities
Table 9 LRFD Shallow Foundation Resistance Factors
Table 10 Parameters for Determination of Equivalent Spring Constants

FIGURES

Figure 1 Notes and Legend for the Boring Location Plan, Cross Sections, and Subsurface Profiles
Figure 2 Boring Location Plan
Figure 3 Cross Section 1-1' – EB Station 1207+13 – West Abutments for Single-Span Bridges EB and WB
Figure 4 Cross Section 2-2' – EB Station 1208+77 – East Abutments for Single-Span Bridges EB and WB
Figure 5 Cross Section 3-3' – EB Station 1210+82 – Western Multi-Span Bridge Abutments
Figure 6 Cross Section 4-4' – EB Station 1212+39 – Pier 2 for Multi-Span Bridges EB and WB
Figure 7 Cross Section 5-5' – EB Station 1213+91 – Pier 3 for Multi-Span Bridges EB and WB
Figure 8 Cross Section 6-6' – EB Station 1215+47 – Pier 4 for Multi-Span Bridges EB and WB
Figure 9 Cross Section 7-7' – EB Station 1216+82 (DE2 118+95) – Pier 5 for Multi-Span Bridges EB and WB
Figure 10 Cross Section 8-8' – EB Station 1218+53 (DE2 120+62) – Pier 6 for Multi-Span Bridges EB and WB
Figure 11 Cross Section 9-9' – EB Station 1220+13 – Pier 7 for the EB Multi-Span Bridge and Abutment for the WB Multi-Span Bridge
Figure 12 Cross Section 10-10' – EB Station 1221+69 – Abutment for the EB Multi-Span Bridge
Figure 13 EB Subsurface Profile
Figure 14 WB Subsurface Profile
Figure 15 Groundwater Levels, Observation Well H-1-06(OW)
Figure 16 Groundwater Levels, Observation Well H-3-06(OW)
Figure 17 Unfactored Bearing Resistance, Single-Span Bridge Piers, 4-ft Diameter Shaft - Soil
Figure 18 Unfactored Bearing Resistance, Single-Span Bridge Piers, 5-ft Diameter Shaft - Soil
Figure 19 Unfactored Bearing Resistance, Single-Span Bridge Piers, 4-ft Diameter Shaft - Rock

Figure 20 Unfactored Bearing Resistance, Single-Span Bridge Piers, 5-ft Diameter Shaft - Rock
Figure 21 Unfactored Bearing Resistance, Multi-Span Bridge Western Abutments, 4-ft Diameter Shaft - Soil
Figure 22 Unfactored Bearing Resistance, Multi-Span Bridge Western Abutments, 5-ft Diameter Shaft - Soil
Figure 23 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 2 and 3, 7-ft Diameter Shaft - Soil
Figure 24 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 2 and 3, 8-ft Diameter Shaft - Soil
Figure 25 Unfactored Bearing Resistance, Multi-Span Bridge Eastern Abutments, 4-ft Diameter Shaft - Soil
Figure 26 Unfactored Bearing Resistance, Multi-Span Bridge Eastern Abutments, 5-ft Diameter Shaft - Soil
Figure 27 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 4 through 7, 7-ft Diameter Shaft - Soil
Figure 28 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 4 through 7, 8-ft Diameter Shaft - Soil
Figure 29 Unfactored Bearing Resistance, Multi-Span Bridge Abutments, 4-ft Diameter Shaft - Rock
Figure 30 Unfactored Bearing Resistance, Multi-Span Bridge Abutments, 5-ft Diameter Shaft - Rock
Figure 31 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 2 through 7, 7-ft Diameter Shaft - Rock
Figure 32 Unfactored Bearing Resistance, Multi-Span Bridge Interior Piers 2 through 7, 8-ft Diameter Shaft - Rock
Figure 33 Earth Pressure Distribution, Strength Limit State
Figure 34 Earth Pressure Distribution, Extreme Event I Limit State
Figure 35 Unfactored Bearing Resistance vs Effective Footing Width – Detour Bridge
Figure 36 Strength Limit State Earth Pressures – Detour Bridge
Figure 37 Extreme Event I Limit State Earth Pressures – Detour Bridge

APPENDICES

Appendix A Boring Logs
- Table A-1 Summary of Borings for the Gold Creek Bridges
- Appendix A.1 2007 Boring Logs
- Appendix A.2 Previous Boring Logs

Appendix B Laboratory Testing Data
- Table B-1 Summary of Laboratory Testing Results
- Table B-2 Rock Point Load Test Results
- Appendix B.1 2007 Laboratory Testing Data
- Appendix B.2 Previous Laboratory Testing Data

Appendix C Liquefaction Analyses

Appendix D Slope Stability Analyses
- Appendix D.1 Gold Creek Bridges
- Appendix D.2 Detour Bridge

Appendix E Drilled Shaft Rock Socket Resistance Capacity

ACRONYMS

AASHTO	American Society of State Highway and Transportation Officials
amsl	above mean sea level
ASTM	American Society of Testing and Materials
bgs	below ground surface
BP	before present
cfs	cubic feet per second
cm	centimeter
CPT	cone penetrometer test
EB	eastbound
El.	elevation above mean sea level in feet
FHWA	Federal Highway Administration
GDM	WSDOT Geotechnical Design Manual
GSI	geologic strength index
I-90	Interstate-90
km	kilometer
ksi	kilopounds per square inch
LL	liquid limit
LRFD	Load and Resistance Factor Design
MP	milepost
MPa	megaPascal
OW	observation well
PBA	peak bedrock acceleration
pcf	pounds per cubic foot
PGA	peak ground acceleration
PL	plastic limit
psf	pounds per square foot
RMR	rock mass rating
RQD	rock quality designation
SPT	standard penetration test
URS	URS Corporation
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WB	westbound
WBS	Work Breakdown Structure
WSDOT	Washington State Department of Transportation

1.0 INTRODUCTION

WSDOT has identified that the part of I-90 on the east side of Snoqualmie Pass between Hyak and Easton (MP 55.1 to 70.3) needs improvement. WSDOT selected the Hyak to Keechelus Dam segment (MP 55.1 to 59.9) as the first phase of the project.

The objective of the project is to improve the roadway by widening and re-aligning the existing highway and constructing or replacing structural elements that do not meet current federal and WSDOT highway standards. The purpose of the improvements is to eliminate or reduce avalanche closures, increase capacity, stabilize slopes, enhance freight mobility, replace pavement, improve sight distance, and address environmental stewardship.

WSDOT South Central Region contracted URS Corporation as General Engineering Consultant for the project, under WSDOT Agreement No. Y-9764, dated February 14, 2006. URS completed a 2006 conceptual geotechnical investigation for preliminary design that included a compilation and review of previous geotechnical investigations in the project area. URS is now completing a 2007 geotechnical investigation for final design as Task Order BS for the field work and Task Order CA for the analysis and reporting.

The 2006 and 2007 geotechnical investigations consisted of separate scopes for the roadway alignment and rock slopes. The roadway borings consisted mostly of drilling and sampling soil and some coring of bedrock at the bottom of the borings. The rock slope drilling consisted of coring of bedrock. Instrumentation was installed in many of the roadway and rock slope borings. Groundwater levels were measured in all borings.

This technical memorandum presents the URS geotechnical recommendations for the proposed Gold Creek bridges on I-90 near Hyak. The memorandum was prepared under Task Order CA, WBS I90.ENG.21. The memorandum is organized in nine sections.

- Section 1 provides background information;
- Section 2 describes the planned Gold Creek bridges project;
- Section 3 describes the field exploration and laboratory testing results;
- Section 4 describes the site conditions, including the existing bridge; soil, rock, and groundwater conditions; and scour potential;
- Section 5 presents seismological considerations, including ground motion parameters and the potential for liquefaction, lateral spreading and fault rupture;
- Section 6 presents geotechnical design recommendations for drilled shaft foundations, abutment retaining walls, approach fills, and earthwork;
- Section 7 describes construction considerations;
- Section 8 describes the limitations of this memorandum; and
- Section 9 provides the references cited.

2.0 PROJECT DESCRIPTION

The proposed Gold Creek bridges consist of:

- **Single-span bridges**: Two western single-span side-by-side animal crossing bridges with a 118-foot-long bridge in the eastbound (EB) lanes and a 120-foot-long bridge in the westbound (WB) lanes.

- **Multi-span bridges**: Two eastern multi-span creek crossing bridges with a 1,085-foot-long bridge in the EB lanes and a 930-foot-long bridge in the WB lanes. The multi-span bridges consist of seven EB spans and six WB spans.

- **Detour bridge**: One two-lane, 100-foot long single-span temporary bridge.

2.1 GOLD CREEK BRIDGES

Based on preliminary bridge layout drawings provided by WSDOT, the bridges are located between EB Stations 1207+27 and 1221+70. The notes and legend for the boring location map are provided in Figure 1, and the bridge locations are shown in Figure 2.

The abutments and interior columns will be supported by drilled shafts. The piers are numbered as shown below and closely correspond to the subsurface cross section locations shown in Figure 2. The relationship of the pier numbers to the cross section numbers is shown below.

Pier No.	Description	EB Stationing*	WB Stationing	Cross Section No.	Figure No.
Single-span Bridges					
1	West abutments	1207+27	1208+00	1-1’	3
2	East abutments	1208+45.5	1209+20	2-2’	4
Multi-span Bridges					
1	West abutments	1210+85	1211+35	3-3’	5
2	Interior column/shaft row	1212+40	1212+90	4-4’	6
3	Interior column/shaft row	1213+95	1214+45	5-5’	7
4	Interior column/shaft row	1215+50	1216+00	6-6’	8
5	Interior column/shaft row	1217+05	1217+55	7-7’	9
6	Interior column/shaft row	1218+60	1219+10	8-8’	10
7	Interior column/shaft row EB; east abutment WB	1220+15	1220+65	9-9’	11
8	East abutment EB	1221+70	--	10-10’	12

* The EB stationing of the piers differs slightly from the stationing of the cross sections shown in figures 3 through 12 because the cross sections were developed at the boring locations.

The existing embankments within the channel migration zone at the multi-span bridge location would be removed to provide a clearance of at least 18 feet from the ground surface to the bottom of the bridge superstructure, which will allow for channel migration and help restore aquatic, riparian, and terrestrial habitat components. The proposed project would raise the existing roadway surface elevations by about 10 to 15 feet between EB Stations 1207+50 and 1221+50. The approach fill for the EB lane east of the multi-span bridge will be up to approximately 30 feet

thick where the proposed EB lane is shifted to the lake side of the existing EB lane. This fill will be retained by a wall on the lake side. Geotechnical recommendations for this wall will be provided in a subsequent report.

2.2 DETOUR BRIDGE

WSDOT plans call for a detour bridge to be constructed over Gold Creek, upstream of the new Gold Creek bridges, so that the bridges can be constructed without traffic disruptions. Based on preliminary bridge layout drawings provided by WSDOT, the proposed Gold Creek detour bridge consists of a two-lane, 100-foot long single-span bridge between DE2 Stations 119+20 and 120+20.[1] The bridge will be 32 feet wide and will be located immediately south of the existing WB bridge. The roadway surface will be raised approximately two feet above the existing ground level to provide a minimum of 1.4 feet between the normal high pool in the lake and the bottom of the bridge girders. The detour bridge is a temporary bridge with an anticipated service life of approximately three years.

3.0 FIELD EXPLORATION AND LABORATORY TESTING RESULTS

Subsurface conditions in the project area were explored using wet rotary drilling, standard penetration testing, observation well installation and monitoring, and a laboratory testing program. A total of 23 soil borings (GCB-001-07 through GCB-023-007) were drilled within the Gold Creek bridges project area during the 2007 exploration program. The 2007 borings were labeled GCB-0XX-07, where GCB is the abbreviation for Gold Creek Bridges, XX is the boring number from 1 to 23, and 07 denotes the year 2007. Previous borings drilled within the project area include five borings drilled in 2006 and two borings drilled in 1970.

Five of the borings were drilled in the immediate vicinity of the detour bridge. Borings H-1-70A and GCB-017-07 are located near the west abutment, and borings H-2-70A, GCB-020-07, and H-04-06 are located near the east abutment.

Figure 2 shows the locations of the borings. A summary of borings for the Gold Creek bridges is provided in Appendix A, Table A-1. Logs of the borings are provided in Appendix A.

In general, three borings were drilled at each of the abutment and pier locations, as needed to supplement existing boring information. The borings were drilled to a target depth of 100 feet or 15 feet into bedrock. A minimum of 10 feet of competent bearing material was required at the bottom of the boring or it was extended until such material was encountered. Boring GCB-019-07 was advanced to a depth of 130 feet to explore for bedrock beneath the multi-span bridge.

Samples were collected at 2.5-foot intervals to a depth of 20 feet and at 5-foot intervals below the 20 feet depth. Soil samples were collected using a standard penetration test (SPT) split spoon sampler driven with a 140-lb automatic hammer. Rock samples, including cobbles, boulders, and competent bedrock, were collected using HQ and NQ wire-line, triple-tube core barrels attached to a diamond core bit.

[1] DE2 represents the EB detour alignment for the second year. The EB alignment for the first year (DE1) is the same as DE2. The stationing used for the detour bridge was current as of May 30, 2008. The stationing is subject to revision if the detour alignment is changed.

Index properties, including grain-size distribution (ASTM D-422), Atterberg Limits (ASTM D-4318), organic content (ASTM D-2974), and soil resistivity (ASTM G57-06) were determined for selected soil samples. In order to estimate the uniaxial compressive strength of rock at the site, point load testing was performed on rock core samples in accordance with procedures in ASTM D-5731-02. The types and total numbers of laboratory tests are as follows:

- Grain-size distribution: 136 samples, including 6 two-sample composites
- Atterberg Limits: 24 samples
- Organic content: 11 samples
- Soil resistivity: 7 samples
- Point load tests: 8 rock samples

Grain-size distribution testing included 23 hydrometer tests. The laboratory testing results for the Gold Creek bridges soil samples are summarized in Appendix B, Table B-1. The point load test results for rock samples are summarized in Appendix B, Table B-2. Laboratory data sheets are also provided in Appendix B.

4.0 SITE CONDITIONS

4.1 SITE DESCRIPTION

The Gold Creek bridges site is located near the mouth of the Gold Creek valley in the Cascade Mountains. The site is at the northeast end of Keechelus Lake and the northern end of Keechelus Ridge. The Gold Creek valley is approximately 1,800 feet wide at the site.

The existing freeway consists of EB and WB lanes that are separated by a median area. The median area is up to approximately 120 feet wide near the existing single-span Gold Creek bridges. The existing embankment fill thickness varies, but typically ranges from about 10 feet thick beneath the median area to about 20 feet thick beneath the EB lane.

At high lake levels, the EB lake side embankment slope forms the shore of Keechelus Lake. The existing Gold Creek bridges (90/106N and 90/106S) consist of single spans with lengths of 139 feet WB and 126 feet EB between approximately EB Stations 1218+00 and 1219+00. The existing foundations consist of driven concrete piles with the pile tips at El. 2492 feet.

4.2 GEOLOGIC SETTING

The Gold Creek valley is a U-shaped valley of glacial origin. In the vicinity of the site, the valley has been filled in with alluvial deposits to approximately El. 2505 to El. 2510. The maximum thickness of alluvium is at least 130 feet beneath the site. Bedrock outcrops near the western and eastern ends of the site.

Fill was placed at the site to construct the freeway embankments. The WB embankment was constructed in the early 1900s. The EB embankment was constructed in the late 1950s and early 1960s. The water level in Keechelus Lake fluctuates seasonally. The maximum lake level is El. 2517.8 . During high water periods, the EB embankment forms the shoreline of Keechelus Lake. During low water periods, the shoreline is east of Rocky Run Creek.

4.3 SUBSURFACE CONDITIONS

The soils encountered in the borings have been grouped in soil units for geotechnical analyses. The soil units are based primarily on engineering properties and soil classification and, in general, reflect depositional environments as well. Soils were classified using the criteria presented in the WSDOT Geotechnical Design Manual (GDM). Little information was provided in the logs of the 1970 borings. In many cases, samples were recorded as "sand and silt." These samples have been given the classification SP/ML.

Ten cross sections, including one for each of the abutment and pier locations, and two profiles, one each for the WB and EB alignments, have been developed that show the interpreted subsurface conditions. Figure 1 presents the notes and legend for the cross sections and profiles. Figures 3 through 12 present the subsurface cross sections, and Figures 13 and 14 present the subsurface profiles. Cross sections at the detour bridge abutments are shown in Figures 9 and 10. EB stationing is used to define the locations of the subsurface cross sections and the EB profile. WB stationing is used for the WB profile. DE2 stationing is used for the detour bridge.

Six soil units and one rock unit have been identified:

Unit 1 (Gravel with Sand/Cobbles/Boulders [Fill]) consists of medium dense to very dense, poorly- to well-graded gravel with coarse to medium sand or with cobbles and boulders. This material is fill placed for construction of the road embankment. The thickness of this soil unit ranges from approximately 9 to 21 feet. Boulders were encountered in two borings:

- GCB-002-007 at approximately El. 2530, El. 2524, and El. 2518 and
- GCB-008-007 at approximately El. 2518.

Unit 2 (Organic Soil) consists of discontinuous compressible deposits of soft to medium stiff organic silt and silty sand and silt with organic material. This unit corresponds to Stratum 3 in the 2006 Conceptual Geotechnical Report. This unit was encountered in 16 of the 30 borings at the Gold Creek bridges. Where present, it is the uppermost layer of native soil. The thickness of this unit ranges from 1 foot to a maximum of 15 feet in boring GCB-015-007. SPT N-values are typically less than 10. In some samples, only a trace of organic material was present. In these cases, the presence of organics may not affect the engineering properties of the soil.

Unit 3 (Gravel with Sand/Cobbles [Native Soil]) consists of medium dense to very dense gravel and sand with cobbles and localized boulders. This unit corresponds to Stratum 5 in the 2006 Conceptual Geotechnical Report. The thickness of this soil unit ranges from approximately 6 to 24 feet. It is locally absent at boring locations H-03-06(OW) and GCB-021-007. Boulders were encountered in GCB-008-007 and GCB-017-007 at approximately El. 2505.

Unit 4 (Fine Sand and Silt) consists of medium dense silty fine sand, sand, and sandy silt and medium stiff to stiff silt. Locally the density ranges from loose to dense. This unit corresponds to Stratum 4 in the 2006 Conceptual Geotechnical Report. The top of this soil unit was typically encountered between El. 2490 and El. 2500. The soil unit is generally thicker beneath the multi-span bridge location, ranging from 22 to more than 80 feet thick, with the maximum thickness beneath Piers 2 and 3 of the multi-span bridges. It is thinner and locally absent beneath the single-span bridge location.

Unit 5 (Dense Sand and Gravel) consists of medium dense to very dense, well-graded to poorly-graded sand and gravel, with localized areas of silty sand. This unit corresponds to Stratum 5 in the 2006 Conceptual Geotechnical Report. In borings where bedrock was not encountered, Unit 5 is the deepest soil unit explored. This layer is absent in borings beneath the single-span bridge location. Beneath the multi-span bridge location, the thickness of Unit 5 ranges from a few feet at the western abutment location to greater than 55 feet. The top of Unit 5 was generally encountered at higher elevations beneath the eastern end of the multi-span bridge location than beneath the western end.

Unit 6 (Silty Clay) consists of localized deposits of stiff to very stiff silty clay and clay with gravel. This unit occurs between Unit 4 and Unit 5, and was encountered in three borings near Piers 5 and 6 of the proposed EB multi-span bridge. This unit corresponds to Stratum 7 in the 2006 Conceptual Geotechnical Report. The thickness of this unit ranges from 3 to 10 feet.

Unit 7 (Bedrock) consists of andesite and basalt of the Naches formation. Bedrock was encountered at depths of 37 feet to 69 feet bgs below the single-span bridges and at depths of 79 to 102 feet bgs near the western abutments of the multi-span bridges. Bedrock was not encountered below the remainder of the multi-span bridges to the maximum depth explored (129.5 feet). Andesite was encountered in six borings. Rock quality designation (RQD) of the andesite ranged from 15 percent to 95 percent, and typically ranged from 65 to 95 percent. Basalt was encountered in one boring. The RQD of the basalt ranged from 0 to 78 percent. The rock was typically classified in the field as moderately strong (R3) to strong (R4). Based on the average uniaxial compressive strengths measured by point load tests, the rock is classified as follows:

- Very weak (R1) in boring H-01-06, which is located near the west abutment of the single-span bridges;
- Moderately weak (R2) in boring GCB-001-07, which is located near the west abutment of the single-span bridges;
- Moderately strong (R3) in borings GCB-002-07 and GCB-003-07, which are located near the east abutment of the single-span bridges; and
- Strong (R4) in borings H-03-06 and GCB-005-07, which are located near the west abutment of the multi-span bridges.

4.4 GROUNDWATER

Groundwater levels were measured in observation wells completed at boring locations H-1-06(OW) and H-3-06(OW), which are located in the EB lake side shoulder of the existing highway near the western abutment of the proposed single-span bridges and the western abutment of the proposed multi-span bridges, respectively. Groundwater levels were measured during snowfree periods from June 2006 to November 2007. H-1-06(OW) is screened in Units 1, 4, and 5, and H-3-06(OW) is screened in Units 1 and 2. Measured groundwater levels in H-1-06(OW) and H-3-06(OW) are shown in Figures 15 and 16, respectively.

Groundwater levels in H-1-06(OW) ranged from 2506.3 feet in September 2007 to 2518.7 feet in June 2006. Groundwater levels in H-3-06(OW) ranged from 2504.2 feet in September 2007 to

2516.1 feet in June 2006. Groundwater levels in both wells are affected by the lake level during high water periods in Keechelus Lake. The groundwater levels are not affected by the lake level when the lake level is lower than about El. 2500 feet. When the lake level is lower than about El. 2500, it appears the groundwater level at the bridge site is largely controlled by groundwater conditions in the alluvial aquifer of the Gold Creek valley.

4.5 REPRESENTATIVE SUBSURFACE PROFILES

URS interpreted three representative subsurface profiles for analysis of shaft bearing resistance and lateral load response. The representative subsurface profiles were developed for:

- Single-span Bridge Piers 1 and 2
- Multi-span Bridge Piers 1 through 3
- Multi-span Bridge Piers 4 through 8

These profiles represent an idealized, generally conservative interpretation of stratigraphy and soil properties within these areas. A summary of the profiles, including soil types and elevations, is presented in Table 1.

These representative profiles were not used for analysis of liquefaction potential or the stability of the approach fills. Liquefaction potential was evaluated on a sample-by-sample basis for selected borings. The stability of the approach fills was evaluated using subsurface cross sections developed at or near the locations of the fills.

4.6 SCOUR

Scour potential at the proposed multi-span bridges was evaluated by Otak Inc. under subcontract to URS. Design discharges for Gold Creek were estimated to be 5,875 cubic feet per second (cfs) for the 100-year event and 8,568 cfs for the 500-year event. Using these discharges, the U.S. Army Corps of Engineers HEC-RAS computer software was used to compute hydraulic conditions (water-surface elevations, velocities, etc.) for use in the bridge design and scour analysis. Computed maximum water-surface elevations at the proposed multi-span bridges are El. 2518.3 for the 100-year event and El. 2518.6 for the 500-year event. These maximum water surface elevations would coincide with maximum lake levels; however, maximum scour would occur when the lake level is low and stream velocities are higher.

The Gold Creek channel within the project area is being designed as a natural channel without hardened bank protection, which will allow it to migrate freely in the vicinity of the proposed bridge. The degree of lateral migration will be constrained by the U.S. Forest Service (USFS) road that is immediately upstream of the project area. However, the channel could migrate to the locations of the adjacent interior piers and potentially to the east abutment of the WB multi-span bridge. If the USFS road is removed or reconfigured in the future, channel migration over a wider area would be possible. This potential for channel migration was considered in the scour analysis.

Using the results of the hydraulic analysis and considering the potential for lateral channel migration, scour calculations were carried out following the basic procedures outlined in Federal Highway Administration “HEC-18, Evaluating Scour at Bridges.” Preliminary results of the

calculations for the 100-year design event are presented in the following table. The final scour results, including the 500-year event, will be presented in a memorandum prepared by Otak.

Scour Calculation Summary, 100-Year Event

	West Bound Piers	West Bound Abutments	East Bound Piers	East Bound Abutments
Long-term Degradation (feet)	0.0	0.0	0.0	0.0
Contraction Scour (feet)	0.0	0.0	0.0	0.0
Local Scour (feet)	15.8	3.5	17.5	3.5
Total Scour (feet)	15.8	3.5	17.5	3.5
Initial Ground Elevation (feet)*	2500.9	2500.9	2495.9	2495.9
Scour Elevation (feet)	2485.1	2497.4	2478.4	2492.4

*Minimum channel elevation of downstream cross section.

The results show local scour at the piers ranging from about 16 to 18 feet. Considering the potential for channel migration, the potential minimum scour elevations are about El. 2485 for the piers of the WB crossing and El. 2478 for the piers of the EB crossing. The computed local scour at the abutments was 3.5 feet. Considering the potential for the channel to migrate to the toe of the east abutment of the WB bridge, the potential minimum scour elevation is about El. 2497.

Otak also evaluated scour at the detour bridge. Based on the WSDOT preliminary plans dated February 2008, Otak concluded that the detour bridge should be adequately protected from scour. This conclusion is based on the following considerations:

- There are currently existing rock revetments on both the right and left banks at the proposed location of the detour bridge;
- There is no evidence of past bank slope failure at proposed bridge location;
- The detour bridge will be further protected by the existing WB bridge abutment slopes, which are located immediately upstream for the bridge; and
- The life span of the bridge is relatively short (approximately 3 years), which further reduces the risk.

The abutment slopes at the location of the proposed detour bridge and the abutment slopes at the location of the existing WB bridge should not be modified during the life of the detour bridge.

5.0 EARTHQUAKE ENGINEERING

5.1 BRIDGE MODELING

The ground shaking hazard can be defined in general terms using an appropriate acceleration response spectra and site coefficient or by using a site-specific procedure. In the general procedure, the spectral response parameters are determined using the USGS/AASHTO Seismic Hazard Maps produced by the U.S. Geological Survey depicting probabilistic ground motion and spectral response for 7% probability of exceedance in 75 years.

A site-specific procedure is required if any of the following apply:

- Soils at the site can be classified as Class F soils and those soils have the potential to result in a significantly higher response of the bridge. Class F soils consist of peats or highly organic clays that are greater than 10 feet in thickness; very high plasticity clays (PI > 75) greater than 25 feet in thickness; and very thick soft/medium stiff clays greater than 120 feet in thickness.
- The bridge is considered to be critical or essential according to Article 4.2.2 of the AASHTO Guide Specifications for LRFD Seismic Bridge Design.
- The bridge is located within 6 miles of a known active fault and its response could be significantly and adversely influenced by near-fault ground motion characteristics.
- Or, there are different site classes for the various bridge piers.

The above criteria for a site-specific procedure do not apply to the Gold Creek bridges site; therefore, URS recommends that the general procedure be followed. In accordance with AASHTO, the peak horizontal ground acceleration (PGA), 0.2 second spectral acceleration (S_s), and the 1.0 second spectral acceleration (S_1) for Site Class B rock are as follows:

PGA (Site Class B) =	0.28g
S_s =	0.645g
S_1 =	0.210g

Based on average SPT N-values that range from 21 to 32 blows per foot, the site class for the bridge is Site Class D. In this memorandum, the acronym PGA refers to the PGA after the amplification factor for Site Class D is applied, as discussed in the following section. The PGA for Site Class D is equal to 0.35g.

The structural designer will need to determine the site coefficients for the peak ground acceleration (F_{pga}), short-period range (F_a) and the long-period range (F_v) at each structure using the Ground Motion Tool in the AASHTO Seismic Guide Specification.

5.2 ABUTMENT AND RETAINING WALL SEISMIC DESIGN

The PGA for Class B rock recommended above does not include amplification or damping due to the site soils. In order to assess liquefaction potential, seismic earth pressures, and inertial effects on walls and abutments, the PGA for Class B rock needs to adjusted for the site soil conditions. Following the procedures in the AASHTO manual, URS recommends that an acceleration

coefficient of 0.35g be used for the assessing liquefaction potential, seismic earth pressures, and inertial effects on walls and abutments.

5.3 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon whereby saturated soils temporarily lose most of their shear strength and behave as a viscous fluid. This temporary reduction in strength is due to the rapid build-up of pore pressures in response to cyclic loading, such as that occurring during an earthquake. When a soil layer loses part of its shear strength, the result is usually sudden excessive settlements and the generation of large downdrag forces, as well as the loss of lateral support, for deep foundations.

The liquefaction potential of saturated soils is evaluated mainly on soil gradation, density, and the depth of the deposit. The potential for liquefaction is highest for loose, fine- to medium-grained sands and silty sands. Increasing fines content (i.e., silt and clay) reduces the potential for liquefaction. Conversely, clean coarse-grained granular soils are less susceptible to liquefaction because earthquake-induced pore pressures can quickly dissipate by drainage, provided the drainage paths are not blocked by low-permeability soils or rock, or are excessively long. The potential for liquefaction also decreases with increasing density and depth.

5.3.1 Liquefaction Analysis

URS used LiquefyPro software (CivilTech Software 2007) to estimate liquefaction potential and liquefaction-induced settlement. This software employs the empirical procedures based on SPT N-values that are outlined in the industry-accepted standard reference (Youd, et al. 2001). The analysis was limited to a maximum depth of 80 feet and a factor of safety of 1.2 was used, as recommended in the GDM. Fine-grained soils were screened for liquefaction potential using the Bray and Sancio (2006) criteria. Correction factors for fines content were computed using the Stark and Olsen (1995) method. Liquefaction-induced settlement was estimated using the SPT-based method described below.

An earthquake magnitude equal to 6.33 was used in the analysis. The magnitude was determined using the USGS Seismic Hazards Mapping Project (USGS 2007a) for an earthquake having a 7% probability of exceedance during a 75-year period (a nominal return period of 1,000 years). A groundwater elevation of 2517 feet was assumed for the analysis, which is approximately the high groundwater level. Groundwater elevations as low as 2504 feet have been measured at the site. However, the groundwater level fluctuation would have only a slight impact on the results of the analysis because its range is limited.

The results of the liquefaction analysis are presented in Table 2. Graphical results are provided in Appendix C. Unit 4 (fine sand and silt) is the soil unit at the site with the greatest potential for liquefaction and liquefaction-induced settlement. The thickness of this unit ranges from 5 to 93 feet, and generally is greater than 30 feet. The texture is predominantly silty sand, but the texture ranges from clayey silt to clean sand. The soil is saturated and generally medium dense. At 5 of the 12 boring locations evaluated, the analysis indicates potential liquefaction to the maximum depth considered (80 feet).

Isolated zones of loose material in Units 1, 2, 3 were also identified as potentially liquefiable. These zones are present at boring locations H-04-06, H-05--06, GCB-007-07, GCB-009-07, GCB-010-07, and GCB-013-07. The maximum total thickness of potentially liquefiable soil in

these units is 16 feet. Zones of potential liquefaction were also identified in Unit 5; however, these zones were mostly below the maximum depth considered for liquefaction (80 feet).

The analysis results presented in Table 2 are based on existing ground surface elevations. Excavation will reduce the overburden pressure, which will increase the liquefaction potential and estimated liquefaction-induced settlement. Conversely, placement of fill will increase the overburden pressure, and reduce the liquefaction potential and estimated liquefaction-induced settlement.

5.3.2 Settlement Due to Liquefaction

Liquefaction-induced settlement was estimated using the Tokimatsu M-correction procedure. The estimated total settlement ranges from 1.8 inches at multi-span bridge Pier 3 to 10.6 inches at multi-span bridge Pier 6. Because of the magnitude of liquefaction-induced settlement, shallow foundations are not considered suitable for support of the bridge abutments and piers. Should liquefaction occur, the resulting settlement will impose downdrag forces on deep foundations. The estimated total settlements at various boring locations are presented in Table 2.

5.3.3 Lateral Spreading

The potential for significant lateral spread appears to be low in the vicinity of the Gold Creek Bridges because neither a “free face” nor “ground slope” condition, as described in Youd, Hansen, and Bartlett (2002) and Bartlett and Youd (1995), is present at this location. The potentially liquefiable zones appear too deep for significant lateral spreading to occur.

5.3.4 Limitations of Liquefaction Analysis

For the design earthquake loading, the liquefaction analysis indicates the potential for widespread soil liquefaction at the Gold Creek bridges site. The zone of potential liquefaction included all of Unit 4 as well as portions of underlying Unit 5 to the maximum depth considered of 80 feet. In fact, the analysis showed potential liquefaction below a depth of 80 feet for several analyzed boreholes.

These results should be interpreted with an understanding of the limitations in the liquefaction analysis methodology. The methodology is empirically well-supported for analysis of soils less than about 50 deep. Below that depth, limitations in the empirical database reduce the accuracy of the analysis. However, cases of liquefaction are known for soils deeper than 50 feet or 80 feet (e.g., at the San Fernando Dam in 1971).

5.4 FAULT RUPTURE

No active faults have been identified in the vicinity of the project. The nearest Quaternary-age fault is the Straight Creek fault about 15 miles north of the site (USGS 2007b). Thus, the probability of damaging fault rupture is low and does not warrant specific design considerations.

5.5 DETOUR BRIDGE

For the temporary detour bridge, the Proposed AASHTO Guide Specifications for LRFD Seismic Bridge Design (Imbsen 2007) allows the 1,000-year PGA to be reduced by a factor of 2.5 for a temporary structure, and URS understands that WSDOT will design the structure using this reduced PGA. Based on this approach, a PGA equal to 0.14g for Site Class D rock is recommended for the detour bridge.

Given the 3-year service life of the detour bridge, the likelihood of an earthquake occurring that would cause damaging liquefaction beneath the bridge is low. Therefore, liquefaction potential was not evaluated for the detour bridge.

The are no known active faults within six miles of the bridge. As described in Section 5.4, the nearest known Quaternary-age fault is the Straight Creek fault about 15 miles north of the site.

6.0 GEOTECHNICAL RECOMMENDATIONS

The preliminary design includes drilled shafts to support the bridge piers. Drilled shafts are suitable for foundation support because the shafts will transfer the loads to deeper, more competent strata if the upper soils settle due to liquefaction of the sand and silt stratum (Unit 4). Pile foundations could also be used to support the bridge piers; however, the presence of boulders in Units 1 and 2 would likely result in difficult pile driving conditions. In addition, liquefaction induced by pile driving could result in settlement of the existing road and bridges.

Because of the potential for liquefaction of Unit 4, URS recommends that the tips of the shafts be placed into bedrock or the stratum of dense sand and gravel (Soil Unit 5). A minimum rock socket depth of five feet, as measured from the lowest bedrock surface elevation at the rock socket, is recommended. A discussion of the analysis conducted to estimate rock strengths for axial and lateral shaft capacity is presented in Appendix E.

6.1 DRILLED SHAFT FOUNDATIONS

6.1.1 Bearing and Uplift Resistance

URS evaluated the unfactored (nominal) bearing and uplift resistance of 4-foot and 5-foot diameter drilled shafts for the abutments and 7-foot and 8-foot diameter drilled shafts for the interior piers in accordance with the methods presented in the 2008 AASHTO LRFD Bridge Design Specifications. Bearing resistance for the service limit state was calculated assuming an allowable settlement equal to 1.0 inch. Lost skin friction and downdrag loads due to potential liquefaction for the extreme event limit state are discussed in Section 6.1.2.

<u>Single-Span Bridges.</u> The shafts for the single-span bridge should be socketed into bedrock. The depth to bedrock varies widely in this area. The approximate elevations at which the top of bedrock was encountered beneath the single-span bridge are summarized in Table 3. Because of the variability of the bedrock elevation, two sets of charts have been developed to estimate the shaft bearing resistance in this area.

The first set of charts, Figures 17 and 18, shows the unfactored skin friction and tip resistance for 4-foot and 5-foot diameter shafts in soil for the strength, service, and extreme event limit states at

the single-span bridge Piers 1 and 2. Tip resistance is provided for a case where bedrock is anomalously deep and shafts may be terminated in soil. Up to 20 percent of the strength limit state skin friction in soil may be used for bearing resistance for shafts socketed into rock. Because of the potential for liquefaction, soil skin friction and tip resistance should be neglected for the extreme event limit state in Unit 4 and overlying soil units wherever Unit 4 occurs above El. 2440. Based on subsurface information from the borings, the base of Unit 4 is at approximately El. 2508 at single-span Pier 1, and between El. 2465 and El. 2492 at Pier 2.

The second set of charts, Figures 19 and 20, shows the unfactored skin friction and tip resistance as a function of depth below top of bedrock for 4-foot and 5-foot diameter shafts in rock for the strength and extreme event limit states. Because the movement needed to mobilize full tip resistance exceeds the movement that will cause yielding in skin friction, the full skin and tip resistances are not additive. Figures 19 and 20 show the unfactored bearing resistance for combined skin friction and tip resistance. For this case, the skin friction is calculated using the residual rock shear strength.

If the factored bearing resistance is greater than the factored loads for the strength limit state, settlement under service conditions should not exceed one inch.

Multi-Span Bridges. The shafts for the multi-span bridge piers should be socketed into rock, if it is encountered above the design shaft tip elevation, or into the dense sand and gravel (Unit 5). The depth to bedrock is known at Pier 1, but is beyond the depth of geotechnical exploration at the other piers. The elevations at which the top of bedrock and the top of Unit 5 were encountered beneath the multi-span bridges are summarized in Table 3.

Two sets of charts have been developed for bearing resistance in soil – one set for Piers 1 through 3, where Unit 4 (fine sand and silt) is relatively thick, and one set for Piers 4 through 8, where Unit 4 is less thick.

The first set of charts, Figures 21 through 24, shows the unfactored skin friction and tip resistance in soil for 4-foot, 5-foot, 7-foot, and 8-foot diameter shafts at Piers 1 through 3 for the strength, service, and extreme event limit states. The second set of charts, Figures 25 through 28, shows the same information for Piers 4 through 8. For shafts terminated in soil, the skin friction and the tip resistance may be added. For shafts socketed into rock, up to 20 percent of the strength limit state skin friction in soil may be used for bearing resistance

For shafts socketed into rock, Figures 29 through 32 show the unfactored skin friction and tip resistance for 4-foot, 5-foot, 7-foot, and 8-foot diameter shafts for the strength, service, and extreme event limit states at the multi-span bridges. The bearing resistance is based on rock conditions encountered at the Pier 1 location. Although bedrock was encountered only at the Pier 1 location, bearing resistance for 7-foot and 8-foot diameter shafts is provided should bedrock be encountered above the design shaft tip elevation at other pier locations.

The full skin and tip resistances are not additive for shafts socketed into rock. Figures 29 through 32 show the unfactored bearing resistance for combined skin friction and tip resistance. If the factored bearing resistance is greater than the factored loads for the strength limit state, settlement under service conditions should not exceed one inch.

Discussion. The unfactored uplift for the strength and service limit states may be taken as equal to the unfactored skin friction. For the extreme event limit state, the unfactored uplift may be taken as equal to the unfactored downdrag load. Downdrag loads are discussed in Section 6.1.2.

Note that the weight of the shaft has not been deducted from the bearing resistance in the figures and is not included in the uplift resistance. Skin friction in the shaft-column splice zone (top 10 feet) was neglected. The computed skin friction and uplift resistances assume there is not a permanent casing below the splice zone.

For the extreme event limit state, all skin friction within and above liquefiable zones should be neglected. Based on subsurface information from the borings, the base of the liquefiable zone is at approximately El. 2508 at single-span Pier 1, and between El. 2465 and El. 2492 at Pier 2. At the multi-span bridge, the liquefiable zones are between El. 2440 and El. 2494 at Piers 1 through 3, and between El. 2440 and El. 2489 feet at Piers 4 through 8. Liquefaction is assumed to be limited to a depth of 80 feet. This lost skin friction, as well as downdrag loads resulting from settlement of the liquefiable zones, is discussed in the following section.

As discussed in Section 4.6, the potential exists for scour at the shaft locations if channel migration occurs. The LRFD Bridge Design Specifications state that the shafts shall be designed so that the nominal (unfactored) resistance remaining after the scour resulting from the check flood provides adequate foundation resistance to support the unfactored strength limit state loads with a resistance factor of 1.0. Because the unfactored skin friction resistance lost due to scour would be small compared to the additional bearing resistance that would be needed to meet the strength limit state criteria using factored loads and resistances, scour will not affect the required shaft penetration for bearing resistance.

Reduction factors for group effects do not need to be applied if the shafts are spaced at least four pile diameters on center. Shaft spacing closer than 4B, where B is the shaft diameter, could potentially result in reduced effective stresses on the shaft sides and at the base as well as overlap of shear zones. These factors reduce the skin friction and tip bearing resistances. The LRFD Bridge Design Specification, Section 10.8.3.6.3, specify a reduction factor of 0.65 for a center-to-center shaft spacing of 2.5B. For center-to-center spacing greater than 4B, the reduction factor is 1.0. Linear interpolation can be used for spacings between 2.5B and 4B.

URS recommends that the resistance factors provided in Table 4 be used when evaluating the different limit states.

URS does not recommend load tests at this time. However, if the shaft sizes and lengths prove to be excessive, load tests could be considered if there is a potential to significantly reduce costs.

6.1.2 Downdrag Loads and Skin Friction Losses

Downdrag loads are created when the soil moves downward relative to the shaft, thus transferring load onto the shaft by skin friction. Excessive downdrag loads can result in either structural failure of the shaft or bearing capacity failure. Downdrag loads are usually generated by post-construction settlement due to placement of fill over a compressible layer and/or settlement induced by liquefaction of one or more soil layers. Liquefaction also results in the loss of the skin friction capacity of the liquefied zone as well as in the soils overlying the liquefied zone.

The possibility exists for settlement at the abutment shaft locations because fill will be placed to raise the roadway elevation. Because of the granular nature of the soils upon which the fills will be placed, we expect that the majority of the settlement will occur during fill placement. It is recommended that construction be staged such that the shafts are constructed after the fill is placed. This staging should result in negligible downdrag loads due to fill placement.

Downdrag resulting from liquefaction-induced settlement was determined as specified in WSDOT GDM Section 8.6.2 and the AASHTO LRFD Bridge Design Specifications. Downdrag could occur as a result of liquefaction of soils in Soil Unit 4. Should liquefaction occur, downdrag forces will be imposed on the shafts by all soil above and including the liquefied zone. For the single-span bridge shafts, downdrag loads could be imposed by all soil layers above approximately El. 2460. For the multi-span bridge shafts, downdrag loads could be imposed by all soil layers above approximately El. 2440. In evaluating downdrag loads and skin friction losses, we assumed liquefaction would be limited to a depth of 80 feet.

Estimated downdrag loads and skin friction losses due to liquefaction-induced settlements are provided in Table 5. Downdrag in the liquefied soil zone was estimated using the residual shear strength of the soil. Downdrag loads should be added directly to the factored bridge loads when evaluating the shaft capacity required for the extreme event limit state.

Skin friction losses should be subtracted from the unfactored side capacity curves for the extreme event limit state (Figures 17 and 18 and 21 through 28). These skin friction losses must also be subtracted from the uplift capacity for the extreme event limit state. For extreme event limit state uplift resistance above the bottom of the liquefied zone, the downdrag load can be considered as uplift resistance, using the resistance factor for uplift.

If it is not possible to obtain adequate bearing resistance below the bottom of the liquefied layer to fully resist the downdrag, the structure should be designed to tolerate the settlement resulting from the downdrag and other applied loads.

6.1.3 Lateral Load Analysis

URS understands that WSDOT will evaluate the soil response under lateral loading using strain wedge theory and the computer program DFSAP. Geotechnical design parameters and soil stratigraphy for use as strain wedge model (DFSAP) input are presented in Table 6. The soil stratigraphy shown in Table 6 is based on representative profiles interpreted for single-span bridge Piers 1 and 2, multi-span bridge Pier 1, multi-span bridge Piers 2 and 3, and multi-span bridge Piers 4 through 8.

DFSAP computes the soil reaction for soils that may be partially or fully liquefied. The potentially liquefiable zones are identified in Table 6. These zones should be analyzed as both potentially liquefiable and non-liquefiable to evaluate soft and stiff foundation responses, respectively. An earthquake magnitude equal to 6.33 and a PGA equal to 0.35g should be used to evaluate liquefaction.

Groundwater elevations generally range from El. 2505 to El. 2517. An analysis using the maximum groundwater elevation will result in the softest foundation response.

For lateral load analysis of the multi-span bridge, the potential effects of scour should be considered. As discussed in Section 4.6, scour at the pier locations could occur if channel

migration occurs. To evaluate the potential effects of scour, it is recommended that soil resistance be neglected above El. 2485 for the WB piers and El. 2478 for the EB piers. Scour should not be considered in combination with earthquake loads or potential liquefaction.

A resistance factor of 1.0 is recommended for lateral load analysis. Group effects for lateral load analysis can be evaluated with DFSAP using the shaft group option for both shaft groups with and without a shaft cap.

Some potential exists for the abutment shafts to be subjected to unbalanced lateral loading caused by lack of overall stability. In general, it is not desirable to resist this loading using the abutment shafts; if possible, the unbalanced forces should be mitigated through stabilization measures. Overall stability and stabilization measures are discussed in Section 6.2.2.

6.2 ABUTMENT RETAINING WALLS AND APPROACH FILLS

6.2.1 Earth Pressures

URS understands that the abutments will include concrete retaining walls that are tied into shaft caps at their bases. Based on the preliminary design, the exposed wall face below the girders is a minimum of 18 feet high at the single-span bridge. The exposed wall face is significantly less, on the order of 4 to 5 feet, at the multi-span abutments because the approach fill slopes down to the finish ground line at the elevation of the floodplain.

It is further understood that the tops of the shaft caps will be a minimum of 2 feet below the finish ground surface. The tops of shaft caps will be at approximately El. 2518 or lower at the single-span bridge, El. 2527 or lower at the west abutment of the multi-span bridge, and El. 2521 or lower at the east abutment of the multi-span bridge.

Lateral earth loads imposed on the abutment walls, wing walls, and curtain walls will depend on whether the wall is free to rotate or translate (i.e., whether the wall is flexible or rigid). Active pressures may be used for flexible walls, and at-rest earth pressures should be used for rigid walls. Earth pressures for abutment walls that are backfilled prior to construction of the superstructure and walls that are able to displace laterally at least 0.001H, where H is the height of the wall, may be calculated using active earth pressures. Wing walls and curtain walls within a distance from the abutment wall that is equal to the abutment wall height should be considered rigid and designed using at-rest earth pressures.

Figures 33 and 34 show the earth pressure distributions for the strength and extreme event I limit states, respectively, for flexible and rigid walls. It is recommended that organic soil, if encountered in the wall excavation, be replaced with compacted granular fill. The water pressure may be neglected if the backfill behind the wall is fully drained.

A traffic live load surcharge has been included as specified by the LRFD Bridge Design Specifications. This traffic surcharge is greater than the 250 psf construction equipment surcharge specified by the GDM. Traffic and construction loads would not occur together; thus, the construction surcharge has not been included in the design earth pressure loads.

For the extreme event I limit state, the seismic earth pressure and static earth pressure have been combined as a single uniform pressure in Figure 34. A PGA equal to 0.35g and horizontal acceleration coefficients equal to 0.5PGA and 1.5PGA for flexible and rigid walls, respectively,

were used to calculate the seismic earth pressure coefficient, K_{ae}. The pressure distribution assumes the backfill behind the wall is drained. It should be noted that additional loads would be imposed on the walls if laterally spreading can occur; however, URS does not expect significant lateral spreading.

For the strength limit state, the LRFD Bridge Design Specifications recommend load factors for lateral earth pressure that range from 0.9 to 1.5 for flexible walls and 0.9 to 1.35 for rigid walls. Load factors for lateral earth loads of 1.5 for flexible walls and 1.35 for rigid walls are recommended. A load factor of 1.0 is recommended for the water pressure component. For the extreme event limit state, a load factor of 1.0 is recommended.

A resistance factor of 0.75 is recommended for passive earth pressure resistance, as specified in the GDM for nongravity cantilever walls.

6.2.2 Stability of Approach Fills

Method of Analysis. URS evaluated the stability of the approach fills within 100 feet of the abutments in the longitudinal and transverse directions for static and seismic conditions. For static conditions, stability was evaluated for failure surfaces that intersect the roadway surface as well as failure surfaces that begin in the embankment slope (i.e., a "localized failure"). For seismic conditions, the evaluation was limited to failure surfaces that intersect the roadway surface. Fill materials and compaction requirements for approach fills are discussed in section 6.3.

For seismic conditions, the nominal 1000-year return interval earthquake was used in the analysis. As described in Section 5, liquefaction of the sand and silt stratum (Unit 4) may occur under the 1000-year event. Two seismic cases were evaluated:

- Stability during the earthquake and
- Stability immediately after the earthquake.

For the case of stability during the earthquake, a pseudostatic analysis was conducted using a horizontal acceleration coefficient, k_h, equal to one-half of the PGA (k_h = 0.185) and static (non-liquefied) soil shear strengths. For the case of stability immediately after the earthquake, static conditions (i.e., k_h = 0) were used in combination with the residual shear strength for Unit 4. The residual shear strength was selected from Figure 6-4 of the GDM.

URS evaluated the effect of the groundwater and lake levels for two cases:

- High groundwater and lake levels (2517 feet) and
- A lower groundwater level (2510 feet) combined with a low lake level.

For live load surcharge, a traffic load surcharge equal to 250 psf and a snow load surcharge equal to 320 psf were considered. It was assumed that these loads would not occur concurrently. For static conditions, the larger snow load surcharge was used. Because of the low probability of the design earthquake occurring concurrently with the maximum snow load, a snow load was not included for seismic conditions. For the traffic load surcharge under seismic conditions, a load factor equal to 0.5 was used, consistent with Section 3.4.1 of the LRFD Bridge Design Specifications, resulting in a surcharge equal to 125 psf.

The east approach fill for the EB lane of the multi-span bridge will be supported by a wall on the lake side. Geotechnical recommendations for this wall will be provided in a subsequent report.

Results. The minimum acceptable factors of safety are 1.5 for static conditions and 1.1 for seismic conditions. For static conditions, factors of safety less than 1.5 were calculated for transverse failure surfaces that intersect the roadway at the east approach fill of the EB single-span bridge (minimum factor of safety = 1.44) and at the west approach fill of the EB multi-span bridge (minimum factor of safety = 1.38). The lowest factors of safety were calculated for high groundwater and lake level conditions.

Static factors of safety of less than 1.5 were also calculated in the longitudinal direction at the single-span bridges; however, the analysis did not include any resistance from the bridge foundations. The presence of the foundation makes it unlikely that a stability failure would develop in the longitudinal direction.

Factors of safety less than 1.5 for static conditions for more surficial failure surfaces that begin in the embankment slope were calculated at four locations. Mitigation was not evaluated for these locations because the likelihood that these potential instabilities would affect the bridge foundations is considered to be low.

For seismic conditions, factors of safety less than 1.1 were calculated at two locations at the single-span bridges and three locations at the multi-span bridges. The calculated factors of safety ranged from 0.79 to 0.96 at these locations. The locations at the single-span bridges included both the east and west approach fills of the EB bridge in the transverse direction. The minimum factor of safety for the east approach fill of the WB bridge in the transverse direction was 1.07, which is taken to meet the minimum acceptable factor of safety.

The locations at the multi-span bridges included:

- Both the east and west approach fills of the EB bridge in the transverse direction and
- The west approach fill of the WB bridge in the transverse direction.

The results of the approach fill stability analyses are summarized in Table 7. Graphical results are provided in Appendix C.

Mitigation of Potential Slope Instabilities. Using SLOPE/W, the following measures have been evaluated for mitigation of potential slope instabilities:

- Single-span bridges, west fill of the EB embankment (transverse). Potential instabilities under seismic loading could be mitigated by reinforcing the top 8 feet of the embankment fill or by constructing a counterberm that is 25 feet wide and up to 8 feet thick.

- Single-span bridges, east fill of the EB embankment (transverse). Potential instabilities under static and seismic loading could be mitigated by constructing a counterberm that is 75 feet wide and up to 14 feet thick.

- Multi-span bridges, west fill of the EB embankment (transverse). Potential instabilities under seismic and static loading could be mitigated by implementing ground

improvement (vibro-replacement method) within a 70-foot wide by 90-foot deep zone. A counterberm was also evaluated; however, the required berm size would be very large. A counterberm is considered to be impractical because of its large size and the likely need for wetlands mitigation.

- Multi-span bridges, east fill of the EB embankment (transverse). Potential instabilities under seismic loading could be mitigated by constructing a counterberm or implementing ground improvement. The dimensions of a counterberm would be 100 feet wide and 16 feet thick. The zone of ground improvement (vibro-replacement method) would be 30 feet wide and 60 feet deep.

- Multi-span bridges, west fill of the WB embankment (transverse). Potential instabilities under seismic loading could be mitigated by constructing a counterberm or implementing ground improvement. The dimensions of a counterberm would be 75 feet wide and 10 feet thick. The zone of ground improvement (vibro-replacement method) would be 25 feet wide and 60 feet deep.

The results are summarized in Table 8. For transverse instabilities, the mitigation measures should be implemented over a section of the approach fill that extends a minimum of 100 feet from the abutments. Mitigation for potential shallow, localized instabilities was not evaluated because it is unlikely such instabilities would affect the bridge foundations.

For ground improvement, it was assumed that the vibro-replacement method would be used. It was assumed the improved soil would be non-liquefiable with a friction angle of 35 degrees. The improved zone was assumed to be placed in the position that would be most effective for increasing stability without necessitating excavation of large amounts of the existing embankment. Further discussion of methods of ground improvement is provided in Section 6.2.4.

Reinforcement of the approach fill using reinforcing strips or high-strength geogrid layers is a measure than has been demonstrated to improve embankment and pavement performance during past earthquakes. Although not quantified, fill reinforcement would also reduce the potential for damage to the bridge that could result from movement of the approach fill during an earthquake. Fill reinforcement would be cost effective compared to ground improvement or counterberms, particularly where implementation of the latter would result in a need for wetlands mitigation.

6.2.3 Liquefaction-Induced Settlement of Approach Fills

An evaluation of liquefaction-induced settlements indicates that relatively large settlements (greater than 8 inches) could occur under the 1000-year earthquake. The GDM (Section 8.6.5.3) notes that a differential settlement between the bridge and the approach fill of 8 inches or more could result in angular distortion of the approach slab that is great enough to become a safety problem for motorists.

6.2.4 Ground Improvement

Ground improvement comprises methods of strengthening the soil and/or reducing its susceptibility to liquefaction. The general approach would be to improve a mass of soil (or “shear key”) that is wide enough in the direction of potential soil movement to achieve the desired factor of safety.

As part of the evaluation, URS consulted with the following five contractors that specialize in ground improvement:

- Hayward Baker Inc. of Tukwila, WA (Mr. Mark Koelling)
- Moore & Taber Geotechnical Constructors of Anaheim, CA (Mr. Jeff Geraci)
- Nicholson Construction Company of Cuddy, PA (Mr. Rick Deschamps)
- Subsurface Constructors, Inc. of St. Louis, MO (Mr. Bill Faherty)
- Layne GeoConstruction of Tacoma, WA (Mr. Steve Story and Mr. Robin Cheng)

Vibro replacement stone columns is a feasible method of achieving ground improvement. This method involves densifying soil with a subsurface vibrating probe. Crushed stone is fed into the hole to replace soil displaced by the probe. The crushed stone is compacted laterally against the surrounding soil. The dense stone then aids in transmitting vibrational energy into the soil, assisting densification. The densified soil is stronger and less susceptible to liquefaction. The stone columns provide reinforcement. The columns also provide drainage to relieve excess pore water pressures generated during an earthquake, further reducing the soil's susceptibility to liquefaction.

Because of the fines content of Unit 4, a relatively close spacing between the columns would be required, which would increase cost. It is estimated the replacement ratio would be on the order of 20 percent (Koelling 2008). Cobbles and/or boulders may be present in the soil overlying the zone to be improved at some locations, which may necessitate predrilling and casing to enable installation and removal of the vibrating probe. The frequency of the cobbles and boulders appears low enough that wet stone columns with high pressure water flushing may be used to install the majority of the columns. Alternatively, if boulders and cobbles are more common, it may be cost effective to excavate the upper soils. The limited extent of the area to be improved would increase the cost-effectiveness of this approach.

Jet grouting is also a feasible method of ground improvement. Jet grouting involves pumping grout at high pressure and velocity through horizontal nozzles on the end of a string of drill rod. The grout mixes with the soil to form "soilcrete" columns that have a consistency similar to low strength concrete, thereby reinforcing the soil and essentially eliminating its liquefaction potential. An advantage of jet grouting is that the smaller diameter rods used to conduct jet grouting can be more readily installed and removed through boulders and cobbles than the larger vibro replacement probe. Nonetheless, at this site jet grouting appears to be significantly more costly than vibro replacement stone columns.

Compaction grouting is considered marginally feasible at this site. Compaction grouting involves pumping grout slowly and at high pressure into the soil being treated, causing the soil to consolidate and densify. Compaction grouting is a relatively slow method, and verification is more difficult to achieve compared to other methods.

Dynamic compaction and vibro compaction are not considered feasible methods of ground improvement at this site. Dynamic compaction is not considered feasible because of the depth

and high fines content of the soil needing improvement and the potential for causing damaging settlements of nearby roads and structures. In addition, this process may be a distraction to motorists on I-90. Vibro compaction is not considered feasible because of the high fines content of the soil needing improvement.

Regardless of the method of ground improvement used, a verification program should be conducted. Verification typically involves conducting SPT or cone penetrometer testing (CPT) before and after ground improvement to assess whether the required degree of improvement has been achieved.

6.3 EARTHWORK

During dry weather, existing granular soils with little organic material can be re-used for general site grading. These soils can be re-used as structural fill beneath pavements and footings and as embankment fill within 100 feet of the abutments if they conform to WSDOT Specification 9-03.14(1) for gravel borrow, or as backfill behind walls if they conform to WSDOT Specification 9-03.12(2) for wall backfill. To conform to these specifications, the soils may require screening to remove large particles. Soils containing significant amounts of organic material should not be used as structural fill. Gravel borrow or wall backfill should be compacted in accordance with the requirements in WSDOT Standard Specification 2-03.3(14)C, Method C.

For general fill that is not within 100 feet of the bridge abutments, fill may be used that meets the requirements of WSDOT Specification 9-03.14(1) for gravel borrow, WSDOT Specification 9-03.14(2) for select borrow, or the following requirements:

- Maximum particle size: 18 inches diameter
- Minimum of 25 percent greater than 4 inches in diameter
- Less than 3 percent by weight passing the U.S. No. 200 sieve
- Los Angeles Abrasion (500 rev): Maximum 50 percent loss
- Washington Degradation Value: Minimum 15
- Weathering Category: I to II
- Jar Slake Index: 5 to 6
- Slake Durability Index: Minimum 85 percent

The material should be compacted in accordance with the requirements in WSDOT Standard Specification 2-03.3(14)A.

Deviation from these recommendations is possible if specifically designed by a geotechnical engineer. A geotechnical engineer should examine and test all materials that are proposed to be imported to the site for use as structural fill. A geotechnical engineer should be on site to monitor the site grading and verify soil compaction.

Boulders were encountered in some of the borings and should not be used as backfill. The contractor should be prepared to remove them for use as riprap or for landscaping.

The exposed subgrade in structure, approach fill, and pavement areas should be evaluated after site grading is complete. Subgrade preparation should be in accordance with Sections 2-06 and 2-09 of the 2006 WSDOT Standard Specifications.

During high lake level periods, typically beginning in May and continuing into July, it should be anticipated that the lake level will rise to El. 2517, which is higher than the finish ground line below the multi-span bridge. The site will become inundated by water from the lake and Gold Creek if final grading is conducted during this period unless water control measures (e.g., levees and dewatering) are employed.

Groundwater elevations range from El. 2505 to El. 2518, as shown in Figures 15 and 16. The soils below the groundwater table elevation are generally highly permeable, and it should be expected that water will rapidly enter any excavation that extends below the groundwater table. Sumps will need to be constructed along the perimeter of any excavations below the groundwater table to capture groundwater. Because of the high permeability of the soils, continuous pumping will likely be needed unless sheet piles are installed to cut off the seepage.

The existing gravel and sand soil is considered a Type C soil under OSHA/WISHA regulations for trenching and shoring. This means that temporary cuts above the groundwater table and no greater than 20 feet deep should be no steeper than 1-1/2 horizontal to 1 vertical (1.5H:1V). A steeper slope may be used if designed by a licensed professional engineer. Surface compaction of the slopes may be needed to control localized sloughing. If groundwater seeps out during the excavation process, the slopes should be flattened to 2H:1V. For open cuts at the site we recommend:

- No traffic, construction equipment, stockpiles, or building supplies be allowed at the top of the cut slopes within a distance of at least 10 feet from the top of the cut.
- Exposed soil along the slope be protected from surface erosion using waterproof tarps, Visqueen, or flashcoating with shotcrete.
- Construction activities be scheduled so that the length of time the temporary cut is left open is reduced to the maximum extent practical.
- Surface water, including storm water or meltwater runoff, be diverted away from the excavation.

The general condition of the slopes be observed and evaluated periodically by a geotechnical engineer to confirm adequate stability, particularly immediately following any storm events.

Permanent cut or fill slopes should not be steeper than 2H:1V. To achieve uniform compaction on fill slopes, we recommend the slope be slightly overbuilt and subsequently cut back to expose properly compacted fill.

6.4 DETOUR BRIDGE

Because of the short service life of the detour bridge, the risk of damaging liquefaction occurring beneath the bridge is low. Therefore, shallow foundations are appropriate for the detour bridge. It is recommended that organic soil that was encountered in a boring near the west abutment between approximately El. 2504 and El. 2507 be overexcavated to a distance of one foot beyond the edge of the footing and replaced with compacted structural fill.

This section presents geotechnical recommendations for the detour bridge, including bearing resistance, resistance to sliding and overturning, values of foundation spring constants, global stability, and earthwork considerations.

Because the approach fill height is less than 8 feet, the detour bridge may be built without an approach slab, provided that the fill meets the gradation and compaction requirements listed in Sections 6.3 and 6.4.5.

6.4.1 Bearing Resistance

Figure 35 presents the unfactored bearing resistance as a function of effective footing width for the strength and extreme event limit states, where the effective footing width (B') is equal to the total footing width (B) minus two times the eccentricity (e), so that B' = B - 2e. Figure 35 shows the unfactored bearing resistance for footings placed at distances measured horizontally from the upper edge of the footing to the slope face (not including riprap) equal to B and 1.5B. The figure presents bearing resistance for footings placed on the existing coarse-grained soils or properly compacted structural fill.

For the service limit state, a bearing resistance equal to 6 kips per square foot (ksf) is recommended. The service limit state bearing resistance is based on an allowable settlement of two inches.

URS recommends the resistance factors presented in Table 9 be used when evaluating the three limit states. The bearing resistance charts presented in Figure 35 do not incorporate the bearing resistance factors.

6.4.2 Lateral Loads and Sliding Resistance

Figures 36 and 37 show the earth pressure distributions for the strength and extreme event I limit states, respectively, for flexible and rigid walls at the detour bridge. It is assumed and required that organic soil, if encountered in the wall excavations, be replaced with compacted granular fill. The water pressure may be neglected if the backfill behind the wall is fully drained.

A traffic live load surcharge has been included as specified by the LRFD Bridge Design Specifications. This traffic surcharge is greater than the 250 psf construction equipment surcharge specified by the GDM. Traffic and construction loads would not occur together; thus, the construction surcharge has not been included in the design earth pressure loads.

For the extreme event I limit state, the seismic earth pressure and static earth pressure have been combined as a single uniform pressure in Figure 37. A PGA equal to 0.14g and horizontal acceleration coefficients equal to 0.5PGA and 1.5PGA for flexible and rigid walls, respectively,

were used to calculate the seismic earth pressure coefficient, K_{ae}. The pressure distribution assumes the backfill behind the wall is drained.

Load factors for lateral earth loads of 1.5 for flexible walls and 1.35 for rigid walls are recommended. A load factor of 1.0 is recommended for the water pressure component. For the extreme event limit state, a load factor of 1.0 is recommended.

Lateral foundation loads may be resisted by friction on the bases of the footings and by passive resistance against the sides of the footings and the abutment walls. For footings cast in place on existing coarse-grained soils or properly compacted, suitable fill, the unfactored frictional resistance may be computed using a coefficient of friction (tan δ) equal to 0.58. The soil weight may be computed using unit weights equal to 135 pounds per cubic foot (pcf) above the water table and 73 pcf below the water table. The computed frictional resistance must be multiplied by the resistance factor for sliding that is provided in Table 9.

Passive resistance to sliding may be calculated using the unfactored passive pressure distributions shown in Figure 36 for the strength limit state and Figure 37 for the extreme event I limit state. Passive resistance was assumed to develop along a vertical soil plane that intersects the outside edge of the footing and not along the wall face. For this reason, it was assumed that no wall friction (Rankine condition) would occur during development of the passive resistance. The computed passive pressure resistance must be multiplied by the resistance factor for passive pressure that is provided in Table 9.

6.4.3 Foundation Springs

Table 9 provides estimates for the shear modulus, G, and Poisson's ratio, , that can be used to calculate the equivalent foundation spring constants for foundations supported on the existing coarse-grained soils or properly compacted, suitable fill. The estimates provided in Table 10 consist of a range of values as the most critical spring will depend on the rigidity of the structure. The range of shear modulus values correspond to soil strain levels of 0.2 and 0.02 percent, which represent relatively soft and stiff site conditions, respectively.

6.4.4 Global Stability

URS evaluated the stability of the approach fills within 100 feet of the detour bridge abutments in the longitudinal direction for static and seismic conditions. Because the embankment side slopes in the direction transverse to the roadway are relatively flat, stability in the transverse direction is not considered to be a concern. However, any cuts into the approach fills of the detour bridge that may be needed for construction of the permanent WB Gold Creek bridge should be evaluated by a geotechnical engineer.

The stability analyses assumed an 8-foot wide footing at El. 2505 and that the organic layer encountered between El. 2504 and El. 2507 in boring GCB-017-07 would be overexcavated and replaced with compacted structural fill. The stability analyses considered both high and low groundwater and creek water levels:

- <u>High groundwater case:</u> the groundwater and creek water levels were both assumed to be at El. 2517.

- Low groundwater case: the groundwater level and creek water levels were both assumed to be at El. 2510.

For the case of stability during the earthquake, a pseudostatic analysis was conducted using a horizontal acceleration coefficient, k_h, equal to 0.0875 and static (non-liquefied) soil shear strengths. Post-earthquake stability was not evaluated because of the low probability of liquefaction occurring during the service life of the bridge.

For live load surcharge, a traffic load surcharge equal to 250 psf and a snow load surcharge equal to 320 psf were included. It was assumed that these loads would not occur concurrently. For static conditions, the larger snow load surcharge was used. Because of the low probability of the design earthquake occurring concurrently with the maximum snow load, a snow load was not included for seismic conditions. For the traffic load surcharge under seismic conditions, a load factor equal to 0.5 was used, consistent with Section 3.4.1 of the LRFD Bridge Design Specifications, resulting in a surcharge equal to 125 psf.

Factors of safety of 1.25 or greater for the static case and 1.0 or greater for the seismic case were considered acceptable for short-term stability consistent with the temporary service life of the bridge. The calculated factors of safety for global stability were found to be acceptable for both the static and seismic cases. For the static case, the calculated factors of safety were 1.44 (low groundwater elevation) and 1.47 (high groundwater elevation). For the seismic case, the calculated factors of safety were 1.28 (low groundwater elevation) and 1.29 (high groundwater elevation). Graphical results of the stability analyses are presented in Appendix D, Figures D106 through D109.

6.4.5 Earthwork

Earthwork for the detour bridge should be completed following the recommendations presented in Section 6.3. The footing excavations will be immediately adjacent to the existing EB bridge, and it is anticipated that shoring will be needed. The contractor will be responsible for design of the shoring system. Soil conditions at the detour bridge foundation locations generally consist of medium dense to very dense gravel with sand and cobbles. The type and method of installation of shoring should be appropriate for these soil conditions.

The maximum lake levels are above the footing elevation for the detour bridge. In a typical year, the lake level drops below the footing elevation by mid-July; however, in a wet year, the lake level may remain above the footing elevation into early August. The limited groundwater level data indicate that the groundwater level is equal to the lake level when the lake level is above approximately El. 2508. The data indicate that the groundwater level remains at approximately El. 2508 after lake level drops below this elevation. Therefore, the potential exists for the groundwater level to be above the bottom of the footing excavation regardless of when the excavation is conducted. If this occurs, it should be anticipated that water will rapidly enter the excavation due to the high permeability of the soil at the site. It is anticipated that groundwater seepage can generally be controlled with sumps and pumps.

7.0 CONSTRUCTION CONSIDERATIONS

WSDOT plans call for a detour bridge to be constructed over Gold Creek, upstream of the new Gold Creek Bridges, so that the bridges can be constructed without traffic disruptions. Therefore, there are no construction considerations with respect to traffic control and work space constraints.

Boulders up to two feet in size and larger were encountered in Unit 1, but were not common. The contractor should have equipment to excavate and to remove or advance casing through boulders.

Shafts should be installed in accordance with WSDOT's Drilled Shaft Special Provisions. The shaft excavations will likely need to be cased through the highly-permeable Units 1 and 3 to prevent excessive loss of slurry into the formation. Casing will be needed in the proximity of Gold Creek to prevent impacts to water and sediment quality that could result from loss of slurry in these upper soil units.

Vibrating the casing has the potential to induce liquefaction and cause settlement of the existing and temporary bridges and embankments. Therefore, it may be prudent to specify casing advancement using a casing-rotating or oscillating method.

Below Unit 3, it is likely that the shaft excavation could be drilled as on open hole with slurry. The potential exists for caving and heaving in the sands of Unit 4, and the slurry will need to be monitored in accordance with the Special Provisions to control potential caving and heaving.

Where shafts will be socketed into rock, the elevation of bedrock surface and the lengths of the shafts can be estimated using the boring logs and the information provided in Table 3. However, it should be anticipated that bedrock surface elevations may vary considerably over relatively short distances, and the contractor should have adequate equipment and materials on site, including steel reinforcement cages, to allow for this variability.

If shafts in rock will be designed achieve the required bearing resistance using tip resistance only or using both side and tip resistance, the bottom of the shaft excavation must be cleaned in accordance with the Special Provisions such that virtually no loose material is present.

Considerations related to water control and dewatering are discussed in Section 6.3 for the permanent bridge and in Section 6.4.5 for the detour bridge.

8.0 LIMITATIONS

This technical memorandum has been prepared by URS to assist WSDOT and URS in the engineering design and construction of the subject project. It should not be used, in part or in whole, for other purposes without contacting the URS geotechnical engineers in the "Acknowledgements" section for a review of the applicability of such reuse. This memorandum should be made available to prospective contractors for their information or factual data only and not as a warranty of ground conditions.

The recommendations contained in this memorandum are based on URS' understanding of the project at the time that the memorandum was written, on site conditions that existed at the time of the field exploration, and on subsurface conditions as interpreted and interpolated from the

geotechnical investigation. If significant changes to the nature, configuration, or scope of the project occur during the design process, URS should be consulted to determine the impact of such changes on the recommendations presented in this report.

The site exploration and testing results characterize subsurface conditions only at the locations of subsurface exploration and at the intervals where samples were collected. These data are interpreted by URS which then renders an opinion regarding the general subsurface conditions. The distribution, continuity, thickness, and characteristics of identified (and unidentified) subsurface materials may vary considerable from that indicated by the subsurface data. Planes of weakness in rock that can strongly affect the strength of the rock mass may not be revealed by the borings.

While this variability cannot be eliminated, URS and WSDOT will need to reduce the impacts of variability on project design, construction, and performance. Periodic observation by geotechnical engineers during construction may be beneficial in this respect.

The recommendations presented in this memorandum assume that surface and subsurface conditions, as observed during field exploration activities, are representative of the site conditions throughout the project area. Actual subsurface conditions can be discovered only during earthwork and construction operations.

9.0 REFERENCES

Bartlett, S. F. and T. L. Youd. 1995. Empirical Prediction of Liquefaction-Induced Lateral Spread. Journal of Geotechnical Engineering, ASCE, Vol. 121, No. 4.

CivilTech Corporation. 2007. LiquefyPro5.2b Liquefaction and Settlement Analysis Software Manual, October 2005.

Imbsen Consulting. 2007. Proposed AASHTO Guide Specifications for LRFD Seismic Bridge Design. Subcommittee for Seismic Effects on Bridges T-3. May 2007.

Stark. T.D. and S.M. Olsen. 1995. Liquefaction Resistance Using CPT and Field Case Histories. Journal of Geotechnical Engineering, ASCE, Vol. 121, No. 12.

URS Corporation. 2007. 2006 Conceptual Geotechnical Report. I-90 Snoqualmie Pass East, Hyak and Keechelus Dam, Washington. Prepared for Washington State Department of Transportation. February 2007.

U.S. Geological Survey (USGS). 2007a. Earthquake Hazards Program, 2002 Interactive Deaggregations at <http://eqint.cr.usgs.gov/deaggint/2002/index.php>

__. 2007b. USGS Quaternary Fault and Fold Database for the United States, Wenatchee 1° by 2° Sheet at <http://earthquake.usgs.gov/regional/qfaults/wa/wen.html>

Youd, L. T., C.M. Hansen, and S.F. Bartlett. 2002. Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement. Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 128, No.12.

TABLES

Table 1
Summary of Representative Subsurface Profiles

Layer	Soil Unit	Soil Description	Elevation, feet		Thickness, feet
			Top	Base	
Single-Span Bridge Piers 1 and 2					
1	1	Gravel with Sand/Cobbles/Boulders (Fill)	Ground surface	2517	Varies
2	2	Organic Soil	2518	2512	5
3	3	Gravel with Sand/Cobbles	2513	2499	13
4	4	Fine Sand and Silt (Note 1)	2500	Varies	Varies
5	7	Bedrock (Note 1)	Varies	Not penetrated (Lowest elevation explored = 2452 ft)	>18
Multi-Span Bridge Piers 1 through 3 (Note 2)					
1	1	Gravel with Sand/Cobbles/Boulders (Fill)	Ground surface	2512	Varies
2	2	Organic Soil	2510	2502	10
3	3	Gravel with Sand/Cobbles	2500	2497	6
4	4	Fine Sand and Silt	2494	2402	96
5	5	Sand and Gravel	2400	Not penetrated (Lowest elevation explored = 2399 ft)	>1
Multi-Span Bridge Piers 4 through 8					
1	1	Gravel with Sand/Cobbles/Boulders (Fill)	Ground surface	2507	Varies
2	3	Gravel with Sand/Cobbles	2507	2490	17
3	4	Fine Sand and Silt	2490	2440	50
4	5	Sand and Gravel	2440	Not penetrated (Lowest elevation explored = 2382 ft)	>58

Notes
1. Bedrock was encountered beneath the single-span bridge at elevations ranging from 2470 to 2497 feet. The base elevation and thickness of Unit 4 and the top elevation of Unit 7 can be determined for each pier using the top of bedrock elevations provided in Table 3.
2. Bedrock was encountered beneath the multi-span bridge Pier 1at elevations ranging from 2416 to 2442 feet.

Table 2
Liquefaction Analysis Results

Parameter	Borehole											
	GCB-003-07	H-03-06(OW)	GCB-004-07	GCB-005-07	GCB-007-07	GCB-009-07	GCB-010-07	GCB-013-07	GCB-019-07	GCB-020-07	H-04-06	H-05-06
Pier location	SS 2	MS 1	MS 1	MS 1	MS 2	MS 3	MS 3	MS 4	MS 6	MS 6	MS 6	MS 8
Top of borehole elevation (feet)	2533.9	2527.4	2522.7	2527.7	2520.0	2525.5	2519.7	2519.1	2519.5	2519.5	2519.3	2524.9
Return period (years)	975	975	975	975	975	975	975	975	975	975	975	975
PGA amplified (g)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Magnitude	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
Total thickness of liquefied zone (ft)	29	37	31	30.5	51	8.5	30.5	47	52	36	40.5	40
Depth of liquefied zone (ft)	24.5-27, 34-38, 44.5-67	33-64, 67-73	43-68, 74-80	30-51.5, 59-61, 67-74	6-8, 12-25, 28-43.5, 47.5-53, 56-69, 78-80	10.5-13, 74-80	10-20, 44-64.5	10-13, 15-18, 27.5-29.5, 35-74	28-80	32-68	15-17, 28-66.5, 75-80	14-20, 40-49, 52-77
Settlement (inch)	5.2	5.5	4.6	5.1	8.4	1.5	6.1	6.0	10.2	6.4	6.8	6.1

The potential for liquefaction was not considered below 80 feet depth
MS Multi-span bridge pier
SS Single-span bridge pier

Table 3
Approximate Elevations of Bearing Strata

Bridges	Pier	Direction	Approximate Elevation, ft	
			Top of Unit 5 (Sand/Gravel)	Top of Unit 7 (Bedrock)
Single-span	1	EB	2510	2497
		WB	2510	2497
	2	EB	Not present	2485
		WB	Not present	2464-2490[1]
Multi-span	1	EB	2440	2435
		WB	2430	2425
	2	EB	2403	<2400
		WB	<2420	<2400
	3	EB	2415	<2400
		WB	2430	<2400
	4	EB	2435	<2400
		WB	2450	<2400
	5	EB	2445	<2400
		WB	2445	<2400
	6	EB	2440	<2400
		WB	2440	<2400
	7	EB	2455	<2400
		WB	2460	<2400
	8	EB	2442	<2420

Notes
[1] If needed, the bedrock elevations at the individual pier locations can be estimated from Figure 4.

Table 4
Drilled Shaft Bearing and Uplift Resistance Factors

Limit State	Resistance Factor, φ		
	Skin Friction	**Bearing Resistance**	**Uplift**
Strength	0.55	0.5	0.45 (soil) 0.4 (rock)
Service	1.0	1.0	1.0
Extreme Event	1.0	1.0	0.8

Table 5
Summary of Downdrag Loads and Skin Friction Losses Due to Liquefaction

Piers	Zone of Downdrag and Skin Friction Losses	Unfactored Downdrag Loads in kips for Various Shaft Diameters				Unfactored Skin Friction Losses in kips for Various Shaft Diameters			
		4 ft	5 ft	7 ft	8 ft	4 ft	5 ft	7 ft	8 ft
Single-Span Piers 1 and 2	Elevation 2460 feet and higher	400	500	NA	NA	880	1,100	NA	NA
Multi-Span Piers 1 and 3	Elevation 2440 feet and higher	660	820	930	1,070	1,230	1,540	1,890	2,140
Multi-Span Piers 4 through 8	Elevation 2440 feet and higher	770	960	1,100	1,260	1,340	1,680	2,030	2,320

Note: The potential for liquefaction and the resulting downdrag loads and skin friction losses are only considered above a depth of 80 feet.
Not applicable; these shaft sizes are not being considered for these piers.

Table 6
Design Parameters for Lateral Load Analysis using DFSAP

Layer	Top of Layer Elevation	Soil Type	Layer Thickness (Note 1)	Effective Unit Weight	Effective Friction Angle	Strain, e_{50}	Cohesion	Rock Unconfined Compressive Strength	Potential Liquefaction	For Potentially Liquefiable Layers		
										Corrected SPT Blow Counts, $(N_1)_{60}$	Effective Fines Content	Grain Shape
Units	feet		feet	pcf	degrees	unitless	psf	psf		blows per foot	percent	
Single-Span Bridges Piers 1 and 2												
1	2520	Sand	2	73	40	0.005	--	--	No	--	--	--
2	2518	C-φ	5	23	25	0.005	50	--	Yes	7	10	Subang.
3	2513	Sand	13	68	38	0.005	--	--	No	--	--	--
4	2500	Sand	Note 4	48	30	0.005	--	--	Yes	10	15 to 35	Subang.
5	Note 4	Rock	5	88	0	0.004	--	3,300	No	--	--	--
6	Note 4	Rock	5	88	0	0.004	--	24,000	No	--	--	--
7	Note 4	Rock	Note 2	88	0	0.004	--	50,000	No	--	--	--
Multi-Span Bridges Pier 1												
1	2515	Sand	5	73	40	0.005	--	--	No	--	--	--
2	2510	C-φ	10	23	25	0.005	50	--	No	7	10	Subang.
3	2500	Sand	6	68	38	0.005	--	--	No	--	--	--
4	2494	Sand	59 (Note 3)	48	30	0.005	--	--	Yes	14	15 to 35	Subang.
5	2435	Sand	Note 5	48	30	0.005	--	--	No (below 80 ft)	--	--	--
8	Note 5	Rock	Note 2	88	0	0.004	--	50,000	No	--	--	--
Multi-Span Bridges Piers 2 and 3												
1	2515	Sand	5	73	40	0.005	--	--	No	--	--	--
2	2510	C-φ	10	23	25	0.005	50	--	No	7	10	Subang.
3	2500	Sand	6	68	38	0.005	--	--	No	--	--	--
4	2494	Sand	59 (Note 3)	48	30	0.005	--	--	Yes	14	15 to 35	Subang.
5	2435	Sand	35	48	30	0.005	--	--	No (below 80 ft)	--	--	--
6	2400	Sand	Note 2	68	38	0.005	--	--	No (below 80 ft)	--	--	--

Table 6 (continued)
Design Parameters for Lateral Load Analysis using DFSAP

Layer	Top of Layer Elevation	Soil Type	Layer Thickness (Note 1)	Effective Unit Weight	Effective Friction Angle	Strain, e_{50}	Cohesion	Rock Unconfined Compressive Strength	Potential Liquefaction	For Potentially Liquefiable Layers		
										Corrected SPT Blow Counts, $(N_1)_{60}$	Effective Fines Content	Grain Shape
Units	feet		feet	pcf	degrees	unitless	psf	psf		blows per foot	percent	
Multi-Span Bridges Piers 4 through 8												
1	2515	Sand	8	73	40	0.005	--	--	No	--	--	--
2	2507	Sand	17	68	38	0.005	--	--	No	--	--	--
3	2490	Sand	50	48	30	0.005	--	--	Yes	11	15 to 35	Subang.
4	2440	Sand	Note 2	68	38	0.005	--	--	No (below 80 ft)	--	--	--

Notes
1. The thickness of Layer 1 is based on a finish ground line elevation of 2520 feet at the single-span bridge and 2515 feet at the multi-span bridge. The thickness should be changed as needed if a different elevation is used.
2. The layer can be assumed to be thick enough to extend below the base of the shaft.
3. The thickness of Layer 4 (potentially liquefiable) is based on a finish ground line elevation of 2515 feet and liquefaction extending to 80 feet below ground surface. The thickness should be changed as needed if a different elevation is used.
4. Bedrock was encountered beneath the single-span bridges at elevations ranging from 2470 to 2497 feet. The thickness of Layer 4 and the top elevations of Layers 5, 6, and 7 can be determined for each pier using the top of bedrock elevations provided in Table 3.
5. Bedrock was encountered beneath the multi-span bridges Pier 1 at elevations ranging from 2425 to 2435 feet. The thickness of Layer 5 and the top elevations of Layers 6, 7, and 8 can be determined for each pier using the top of bedrock elevations provided in Table 3.

Table 7
Summary of Global Stability Analysis Results for Approach Fills

Direction	Location	Calculated Factor of Safety								Results Figure No.
		High Groundwater Level (El. 2517) and High Lake Level (El. 2517)				Design Groundwater Level (El. 2510) and Low Lake Level				
		Static		Seismic		Static		Seismic		
		Roadway	Embankment Slope	Pseudo-static	Residual Strength	Roadway	Embankment Slope	Pseudo-static	Residual Strength	
Single-span Bridges – Proposed Embankment										
Longitudinal	West Fill	1.35		1.19	1.37					D1 to D3
	East Fill	1.29		1.12	1.32					D4 to D6
Transverse, EB Embankment	West Fill, 1207+13 EB	1.71	1.31*	0.93	1.29	1.58	1.51*	1.02	1.28	D7 to D14
	East Fill, 1209+00 EB	1.44	1.14*	0.96	1.11	1.62	1.51	0.99	1.04	D15 to D22
Transverse, WB Embankment	West Fill, 1207+13 EB (1207+48 WB)	2.61		1.68	2.76	2.61		1.68	2.76	D23 to D28
	East Fill, 1210+00 EB (1210+45 WB)	1.70	1.19*	1.14	1.11	1.78	1.33*	1.12	1.07	D29 to D36
Single-span Bridges – With Mitigation										
Transverse, EB Embankment	West Fill, 1207+13 EB Counterberm	1.71		1.18				1.28		D37 to D39
	West Fill, 1207+13 EB Reinforced fill	1.74		1.13						D40 to D41
	East Fill, 1209+00 EB Counterberm	1.70		1.12				1.20	1.21	D42 to D45
Multi-span Bridges – Proposed Embankment										
Longitudinal	West Fill	1.66		1.12	1.18					D46 to D48
	East Fill	1.90		1.29	1.81					D49 to D51

Table 7 (continued)
Summary of Global Stability Analysis Results for Approach Fills

Direction	Location	Calculated Factor of Safety								Results Figure No.
		High Groundwater Level (El. 2517) and High Lake Level (El. 2517)				Design Groundwater Level (El. 2510) and Low Lake Level				
		Static		Seismic		Static		Seismic		
		Roadway	Embankment Slope	Pseudo-static	Residual Strength	Roadway	Embankment Slope	Pseudo-static	Residual Strength	
Transverse, EB Embankment	West Fill, 1210+50 WB (1210+05 EB)	1.38	1.18	0.90	0.89	1.45	1.35*	0.98	0.79	D52 to D59
	East Fill, 1221+69 EB	1.65		1.19	1.09	1.54		1.13	0.91	D60 to D65
Transverse, WB Embankment	West Fill, 1210+50 WB	1.67	1.4*	1.06	1.06	1.73	1.22*	1.07	0.90	D66 to D73
	East Fill, 1220+13 EB (1220+75 WB), Right	1.78		1.19	1.79	1.79		1.20	1.80	D74 to D79
	East Fill, 1220+13 EB (1220+75 WB), Left	1.80		1.24	1.84					D80 to D82
Multi-span Bridges – With Mitigation										
Transverse, EB Embankment	West Fill, 1210+50 WB (1210+05 EB) Counterberm			1.11				1.14	0.87	D83 to D85
	West Fill, 1210+50 WB (1210+05 EB) Ground Improvement	1.72		1.16	1.63	1.89		1.14	1.49	D86 to D91
	East Fill, 1221+69 EB Ground Improvement	1.65		1.21	1.63	1.58		1.14	1.34	D92 to D97
	East Fill, 1221+69 EB Counterberm				1.40				1.09	D98 to D99
Transverse, WB Embankment	West Fill, 1210+50 WB Counterberm								1.15	D100
	West Fill, 1210+50 WB Ground Improvement	1.78		1.10	1.23			1.14	1.15	D101 to D105

* - A lower factor of safety may be calculated if a more localized, surficial failure surface is assumed.
Bold indicates a factor of safety less than 1.5 for static conditions or less than 1.1 for seismic conditions.
For seismic, pseudostatic case, assumed a horizontal acceleration coefficient equal to 0.175.
For seismic, residual strength case, assumed 600 psf cohesion and friction angle = 0 for Soil Unit 4.

Table 8
Summary of Mitigation Measures for Potential Approach Fill Slope Instabilities

Bridge	Direction	Location (Cross section evaluated)	Minimum Calculated Factor of Safety Without Mitigation		Mitigation Measure	Description[1]
			Static	Seismic		
Single-span	Longitudinal	West Fill	1.35	1.19	None	No mitigation needed – foundation would provide any additional lateral resistance needed
		East Fill	1.29	1.12	None	No mitigation needed – foundation would provide any additional lateral resistance needed
	Transverse, EB Embankment	West Fill (1207+13 EB)	1.58	0.93	Reinforced Fill	Reinforcement of top 8 feet of proposed fill
					Counterberm	25-foot wide by maximum 8-foot thick toe berm
		East Fill (1209+00 EB)	1.44	0.96	Counterberm	75-foot wide by maximum 14-foot thick toe berm
	Transverse, WB Embankment	West Fill (1207+48 WB)	2.61	1.68	None	No mitigation needed
		East Fill (1210+45 WB)	1.70	1.07	None	No mitigation needed
Multi-span	Longitudinal	West Fill	1.66	1.12	None	No mitigation needed
		East Fill	1.90	1.29	None	No mitigation needed
	Transverse, EB Embankment	West Fill (1210+05 EB)	1.38	0.79	Counterberm	Impracticably large berm needed for seismic-residual strength case
					Ground Improvement	70-foot wide by 90-foot deep vibro-replacement zone
		East Fill (1221+69 EB)	1.54	0.91	Counterberm	100-foot wide by 16-foot thick toe berm
					Ground Improvement	30-foot wide by 60-foot deep vibro-replacement zone
	Transverse, WB Embankment	West Fill (1210+50 WB)	1.67	0.90	Counterberm	75-foot wide by 10-foot thick toe berm
					Ground Improvement	25-foot wide by 60-foot deep vibro-replacement zone
		East Fill (1220+75 WB)	1.78	1.20	None	No mitigation needed

[1]Mitigation measures for approach fill transverse stability should extend a minimum of 100 feet from the abutment.
Bold indicates a factor of safety less than 1.5 for static conditions or less than 1.1 for seismic conditions.

Table 9
LRFD Shallow Foundation Resistance Factors

Limit State	Resistance Factor, φ		
	Bearing Resistance	Friction Resistance to Sliding	Passive Pressure Resistance to Sliding
Strength[1]	0.45	0.80	0.5
Service	1.0	N/A	N/A
Extreme Event[2]	0.9	0.9	0.9

Notes
[1] Resistance factors for the strength limit state are recommended in the LRFD Bridge Design Specifications, Table 10.5.5.2.2-1.
[2] Resistance factors for the extreme event limit state are recommended in the GDM, Section 8.10.2.

Table 10
Parameters for Determination of Equivalent Spring Constants

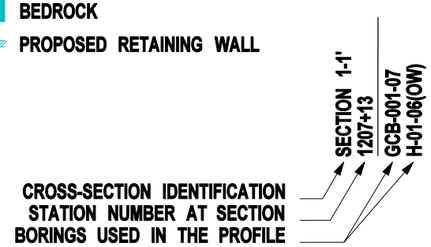
Design Soil Parameters	0.2% Strain	0.02% Strain
Shear Modulus, G (ksf)	580	1,830
Poisson's ratio,	0.35	0.35

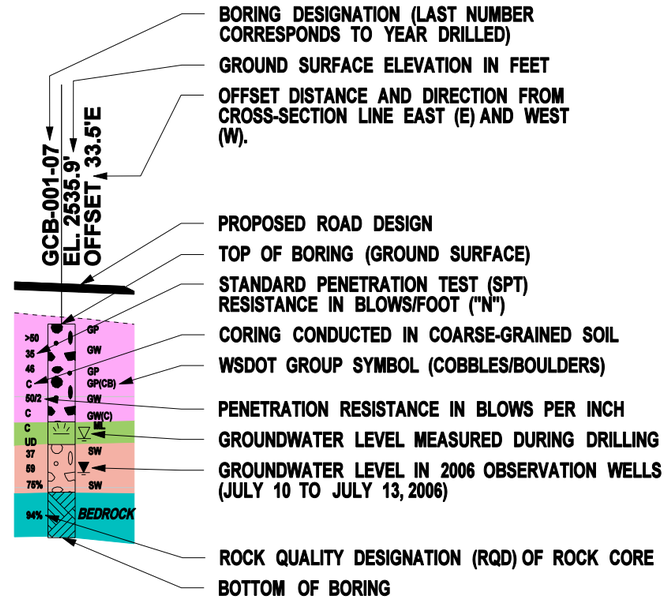
FIGURES

PROFILE AND CROSS-SECTION LEGEND

STRATUM UNIT NUMBER KEY

- *GRAVEL WITH SAND/COBBLES/BOULDERS (PRIMARILY FILL)*
- GRAVEL AND SAND WITH COBBLES/BOULDERS/ ROCK FRAGMENTS (NATIVE SOILS)
- ORGANIC SOIL
- SILT/FINE SAND
- SAND/GRAVEL
- CLAY WITH GRAVEL
- CLAYEY SILT
- BEDROCK
- PROPOSED RETAINING WALL





ABBREVIATIONS

EB - EASTBOUND
WB - WESTBOUND
L - OFFSET LEFT OF THE CENTERLINE
R - OFFSET RIGHT OF THE CENTERLINE

1 GCB 1' — CROSS-SECTION LOCATION (SEE FIGURES 3 THROUGH 12)

⊗ H-1-70A ← BORINGS PERFORMED BY WASHINGTON STATE DEPARTMENT OF HIGHWAYS (NOW WSDOT) IN 1970.

⊗ H-13-06 (OW)

- (OW) OBSERVATION WELL INSTALLED
- LAST NUMBER REFERS TO YEAR DRILLED. REFER TO APPENDIX A FOR BORING LOGS AND TABLE 1 FOR SUMMARY OF BORINGS.
- BORINGS FOR THE I-90 SNOQUALMIE PASS EAST PROJECT PERFORMED BY WSDOT FIELD EXPLORATION UNIT (FEU) FROM JUNE 8 TO JUNE 29, 2006, AND OBSERVED BY URS PERSONNEL.

⊗ GCB-001-07 ← CURRENT BORINGS ADVANCED FOR THE I-90 SNOQUALMIE PASS EAST PROJECT (PROJECT) PERFORMED BY WSDOT FEU AT THE GOLD CREEK BRIDGE (GCB) LOCATION FROM JUNE 26 TO AUGUST 23, 2007, AND OBSERVED BY URS PERSONNEL. LAST NUMBER REFERS TO YEAR DRILLED. REFER TO APPENDIX A FOR BORING LOGS AND TABLE 1 FOR SUMMARY OF BORINGS.

PROFILE AND CROSS-SECTION NOTES

1. A TOTAL OF 23 GEOTECHNICAL BORINGS, GCB-001-07 TO GCB-023-07 WERE COMPLETED BY THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) FIELD EXPLORATION UNIT (FEU) AND OBSERVED BY URS PERSONNEL BETWEEN JUNE 26 AND AUGUST 23, 2007 AT THE PROPOSED GOLD CREED BRIDGE LOCATION. ALL THESE BORINGS WERE COMPLETED ON LAND USING SKID AND TRACK-MOUNTED RIGS.

2. A TOTAL OF FIVE (5) GEOTECHNICAL BORINGS, H-01-06 TO H-05-06, WERE COMPLETED BY WSDOT FEU AND OBSERVED BY URS PERSONNEL BETWEEN JUNE 8 AND JUNE 29, 2006 AT THE PROPOSED GOLD CREEK BRIDGE LOCATION. ALL THESE BORINGS WERE COMPLETED ON LAND USING A SKID-MOUNTED RIG.

3. THE LOCATIONS AND ELEVATIONS OF THE CURRENT GCB BORINGS, EXCEPT FOR GCB-012-07, GCB-015-07, GCB-018-07 AND GCB-021-07 WERE DETERMINED BY WHITE SHIELD INC. USING A SURVEY-GRADE REAL-TIME KINEMATIC (RTK) GPS. THE LOCATIONS AND ELEVATIONS OF BORINGS GCB-012-07, GCB-015-07, GCB-018-07 AND GCB-021-07 WERE DETERMINED BY WSDOT FEU USING MAPPING-GRADE GPS.

4. THE LOCATIONS AND ELEVATIONS OF THE 2006 BORINGS WERE DETERMINED BY WHITE SHIELD INC. USING A SURVEY-GRADE REAL-TIME KINEMATIC (RTK) GPS.

5. THE LOCATIONS OF BORINGS CONDUCTED IN 1970 WERE BASED ON STATIONS AND OFFSETS ON LOGS OF THESE BORINGS OBTAINED FROM WSDOT. THESE STATIONS/OFFSETS REFERENCE DIFFERENT BASELINES THAT HAVE BEEN USED OVER THE YEARS, AND WERE GRAPHICALLY TRANSFERRED TO THE CURRENT PROPOSED BASELINE ON HARDCOPY PLANS AT A SCALE OF 1 INCH=100 FT. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

6. WATER LEVEL READINGS HAVE BEEN MADE IN THE 2006 OBSERVATION WELLS ON THE DATES LISTED IN TABLE 1 OF THE INSTRUMENTATION PLAN. HOWEVER, FLUCTUATIONS IN THE GROUNDWATER LEVEL MAY OCCUR DUE TO VARIATIONS IN RAINFALL, SNOWMELT, TEMPERATURE, AND OTHER FACTORS SINCE THE TIME MEASUREMENTS WERE MADE. OBSERVATION WELL WATER LEVELS SHOWN ON THE PROFILE AND CROSS-SECTIONS REPRESENT READINGS TAKEN BETWEEN JULY 10 AND JULY 12, 2006.

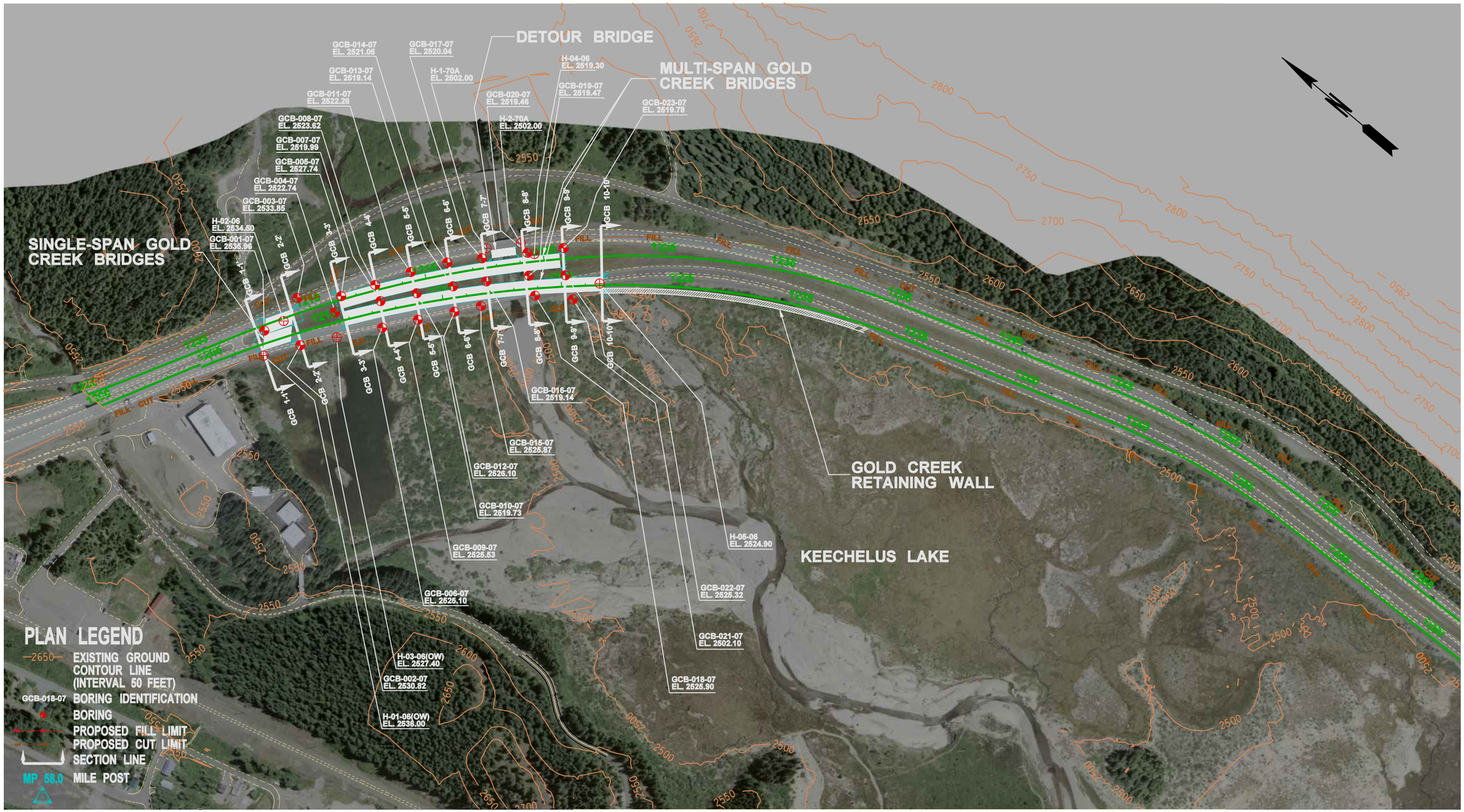
7. WATER LEVEL READINGS NOTED AT THE TIME OF DRILLING ARE ALSO SHOWN ON THE PROFILE.

8. KEECHELUS LAKE HISTORIC MAXIMUM AND MINIMUM, AVERAGE MAXIMUM AND MINIMUM, AND AVERAGE ELEVATIONS WERE PROVIDED BY WSDOT FOR THE 25-YEAR PERIOD BETWEEN 1980 AND 2004.

9. THE STRATIFICATION LINES ARE BASED UPON INTERPRETATIONS BETWEEN WIDELY SPACED BORINGS AND THUS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES. ACTUAL TRANSITIONS MAY VARY FROM THOSE SHOWN.

10. MAGNIFICATION OF VERTICAL SCALE FOR PURPOSES OF PRESENTATION CAUSES TRENDS IN SOIL STRATA TO APPEAR MORE PRONOUNCED THAN THOSE WHICH ACTUALLY EXIST.

11. EASTBOUND (EB) AND WESTBOUND (WB) SUBSURFACE PROFILES WERE INTERPRETED USING SOIL STRATA THAT EXIST AT CROSS-SECTIONS 1-1' TO 10-10' AT CENTERLINES OF THE PROPOSED EB AND WB LANES.



FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
DATE	$$$$DATE$$$						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	Darrell Schlaegel						
CHECKED BY	Suren Balendra				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX DATE

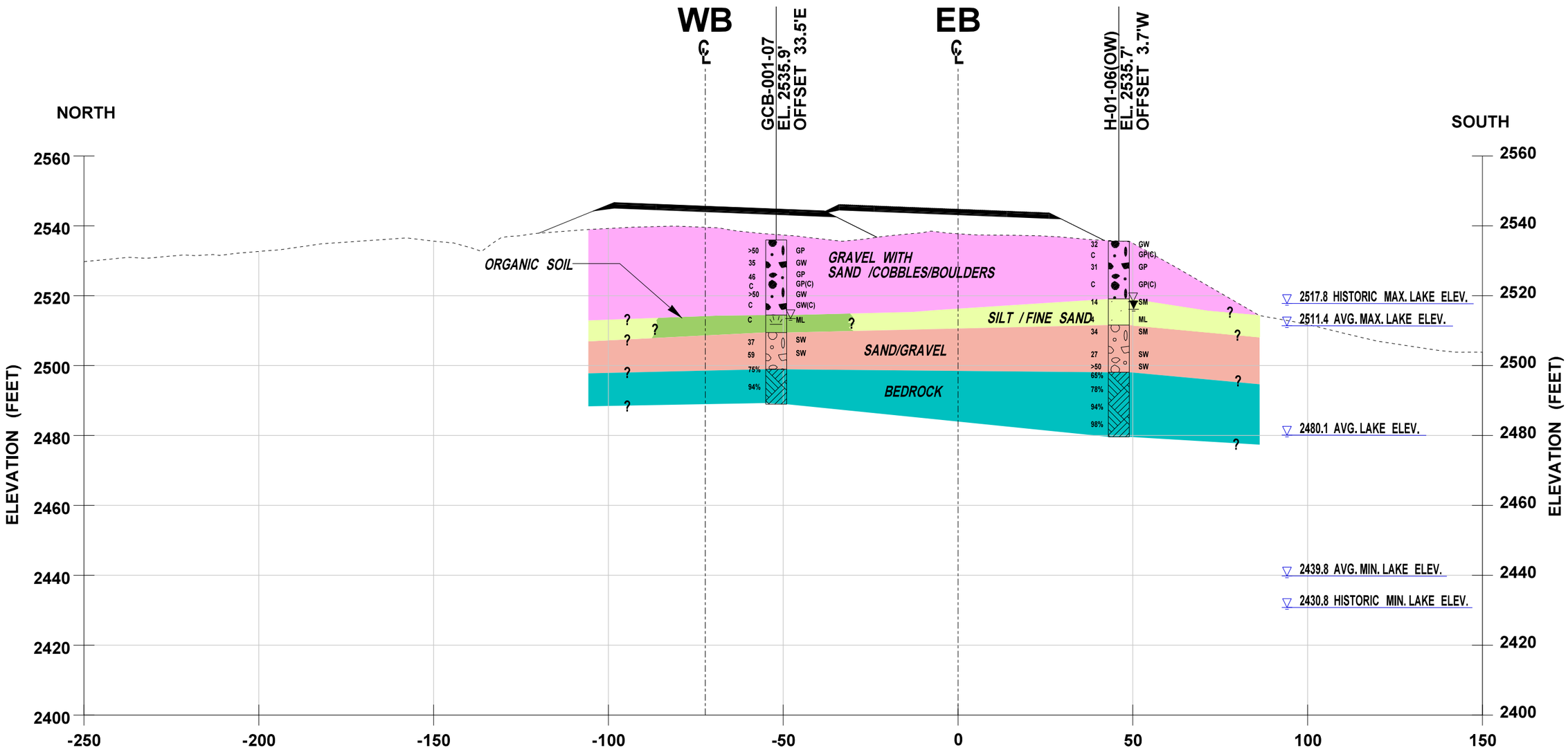
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - BORING LOCATION PLAN

FIGURE 2



EB STATION 1207+13 BRIDGE PIERS
WEST ABUTMENTS FOR SINGLE-SPAN BRIDGES EB AND WB

0 30 60
HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$					
TIME	$TIME$					
DATE	$$$$DATE$$$					
DESIGNED BY	Kranti Maturi					
ENTERED BY	Bob Akers/Ian Sequeira					
CHECKED BY	Suren Balendra					
ASST. PROJ. MNGR.	Brian Hamilton					
PROJ. MNGR.	Cecil Urlich					
		REVISION	DATE	BY		

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX

DATE

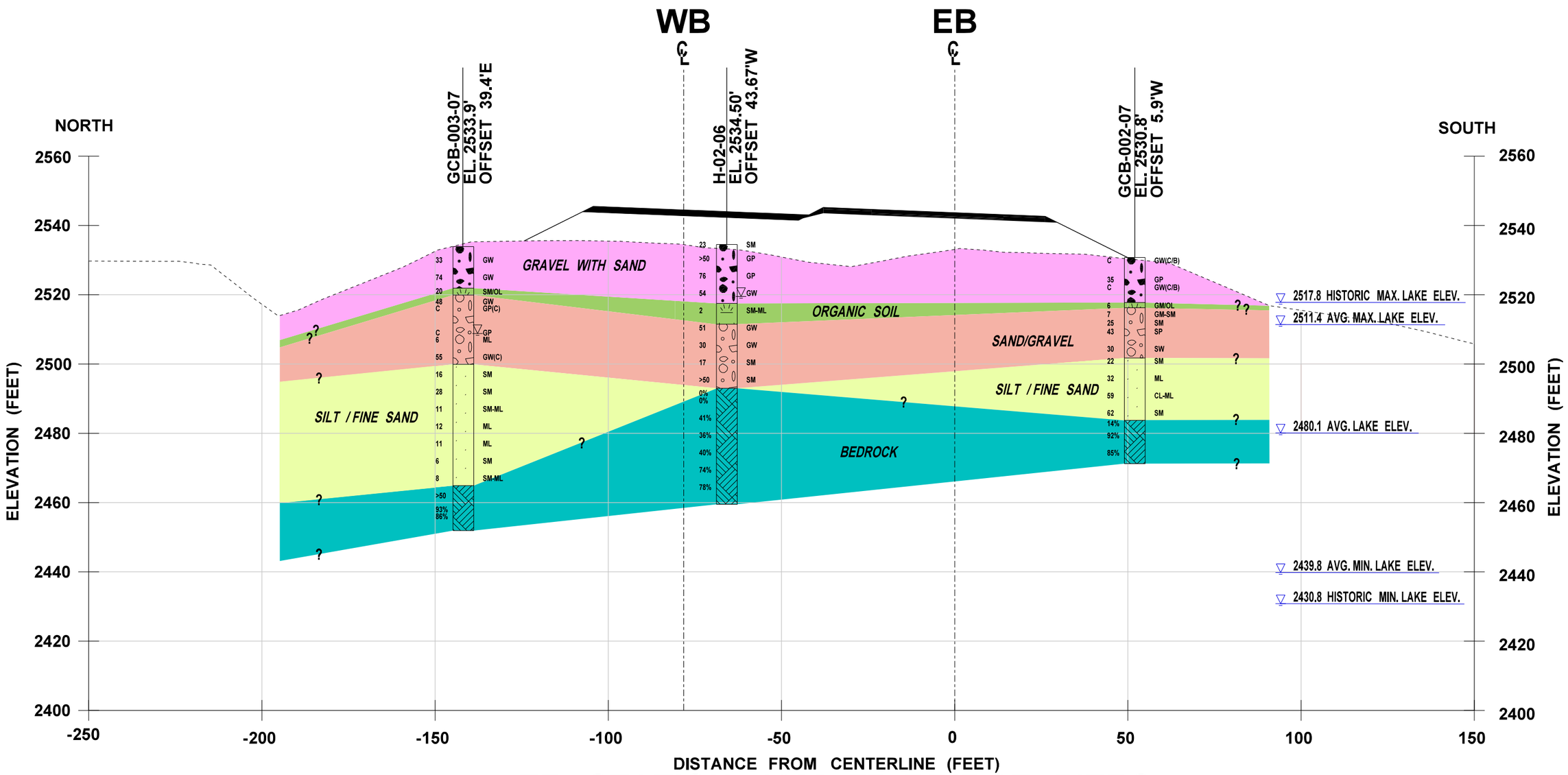
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 1-1'

FIGURE
3



EB STATION 1208+77 BRIDGE PIERS
EAST ABUTMENTS FOR SINGLE-SPAN BRIDGES EB AND WB

0 30 60
HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$				REGION NO.	STATE	FED.AID PROJ.NO.
TIME	$TIME$				10	WASH	
DATE	$$$$DATE$$$				JOB NUMBER		
DESIGNED BY	Kranti Maturi				33758623		
ENTERED BY	Bob Akers/Ian Sequeira				CONTRACT NO.		LOCATION NO.
CHECKED BY	Suren Balendra				Y-9764		
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX
DATE

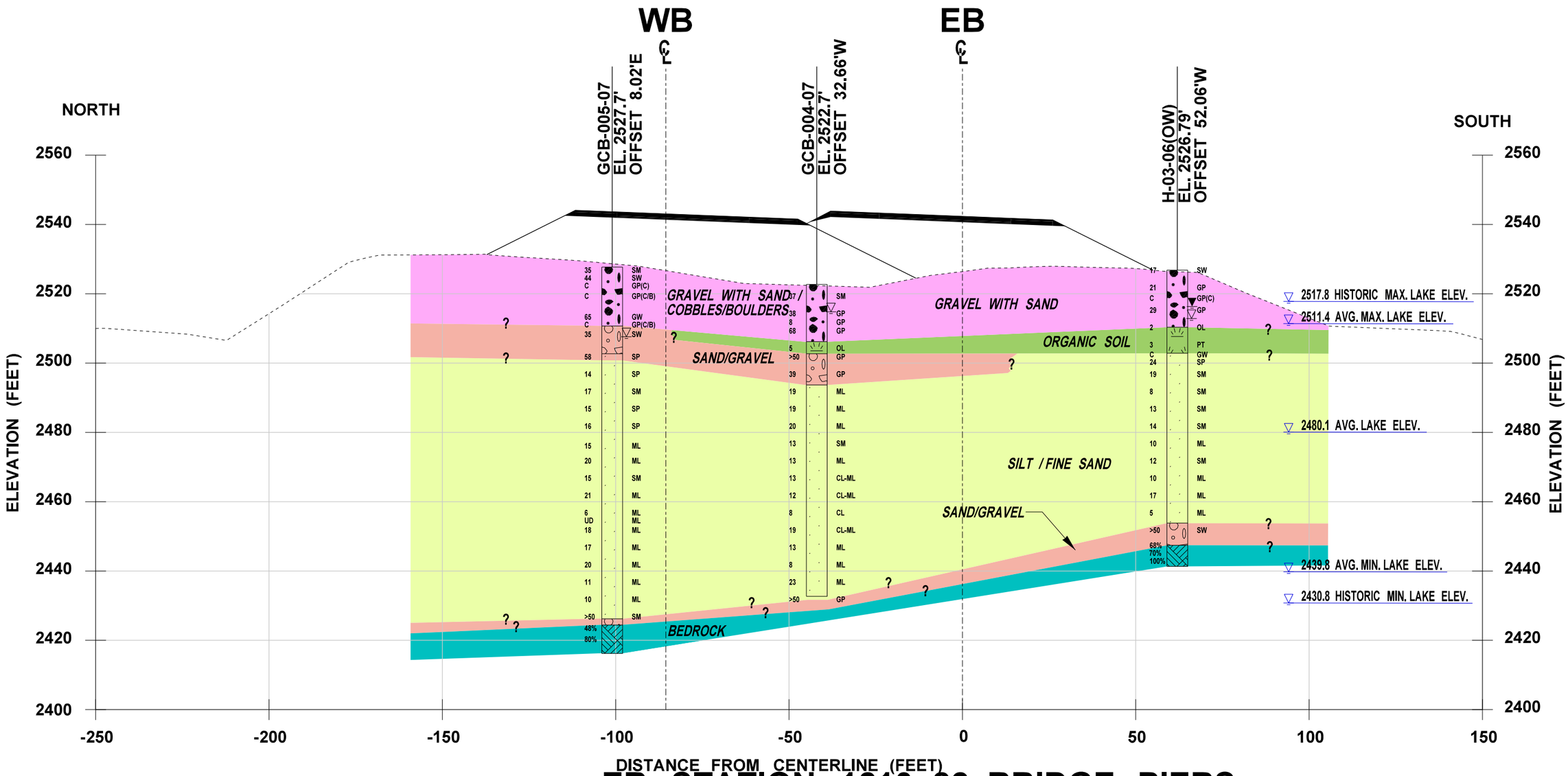
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 2-2'

FIGURE
4



EB STATION 1210+82 BRIDGE PIERS
WESTERN MULTI-SPAN BRIDGE ABUTMENTS

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
DATE	$$$$DATE$$$						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	Bob Akers/Ian Sequeira						
CHECKED BY	Suren Balendra				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX DATE

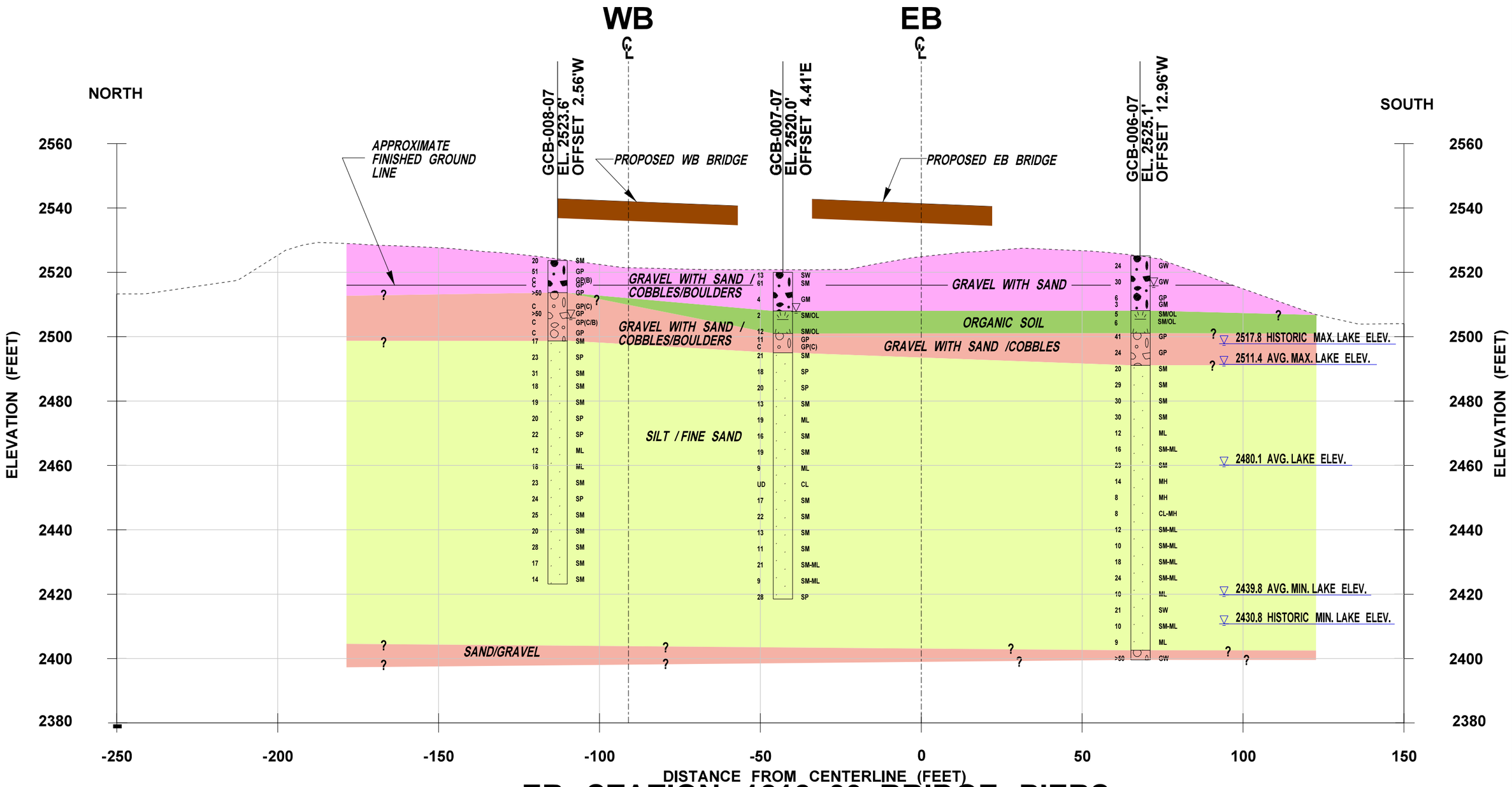
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 3-3'

FIGURE 5



EB STATION 1212+39 BRIDGE PIERS
PIER 2 FOR MULTI-SPAN BRIDGES (EB AND WB)

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$						
DATE	$$$$DATE$$$						
DESIGNED BY	Kranti Maturi						
ENTERED BY	Bob Akers/Ian Sequeira						
CHECKED BY	Suren Balendra						
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX

DATE

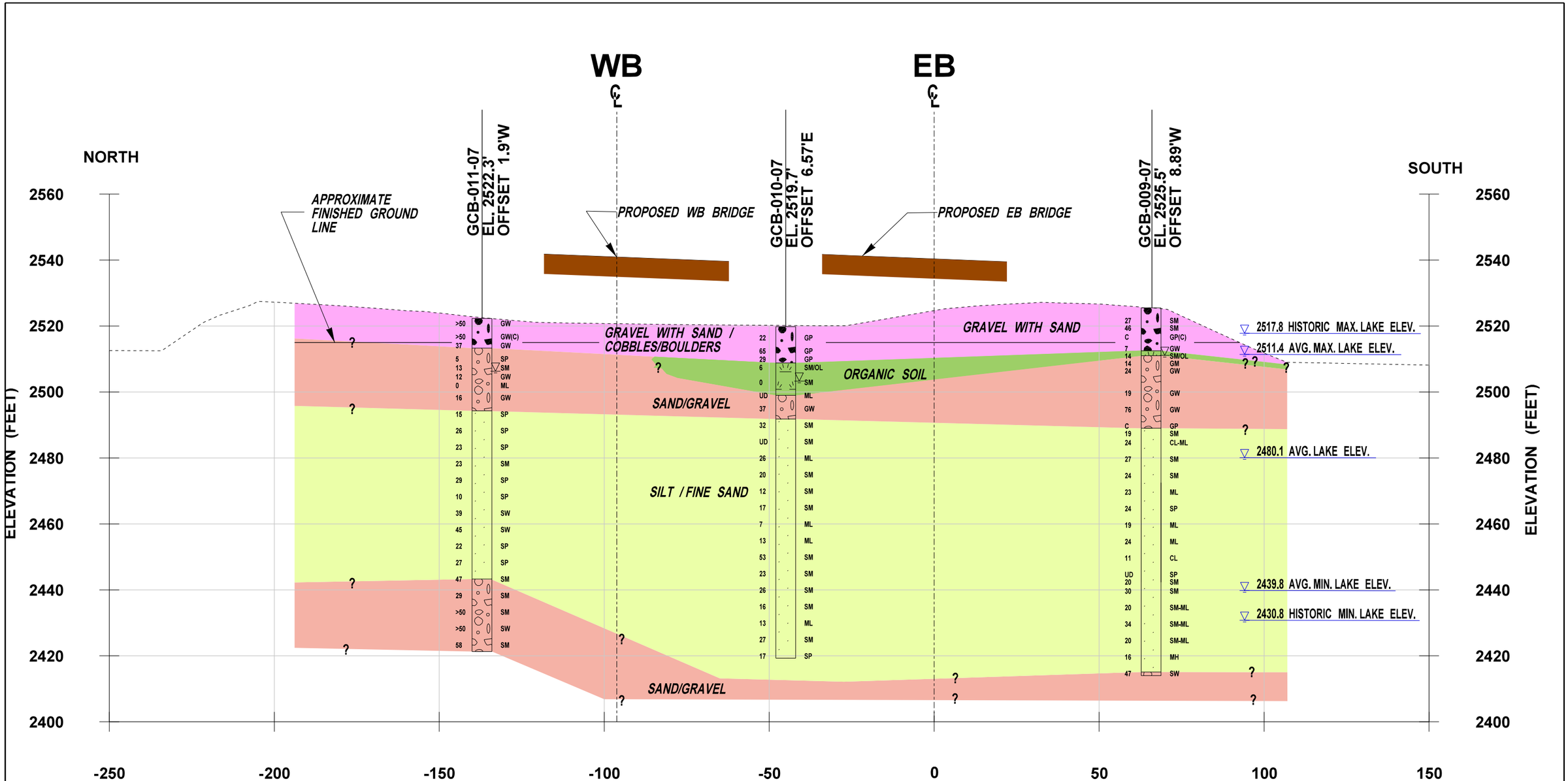
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 4-4'

FIGURE
6



EB STATION 1213+91 BRIDGE PIERS
PIER 3 FOR MULTI-SPAN BRIDGES (EB AND WB)

0 30 60
HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	Kranti Maturi
ENTERED BY	Bob Akers/Ian Sequeira
CHECKED BY	Suren Balendra
ASST. PROJ. MNGR.	Brian Hamilton
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX
DATE

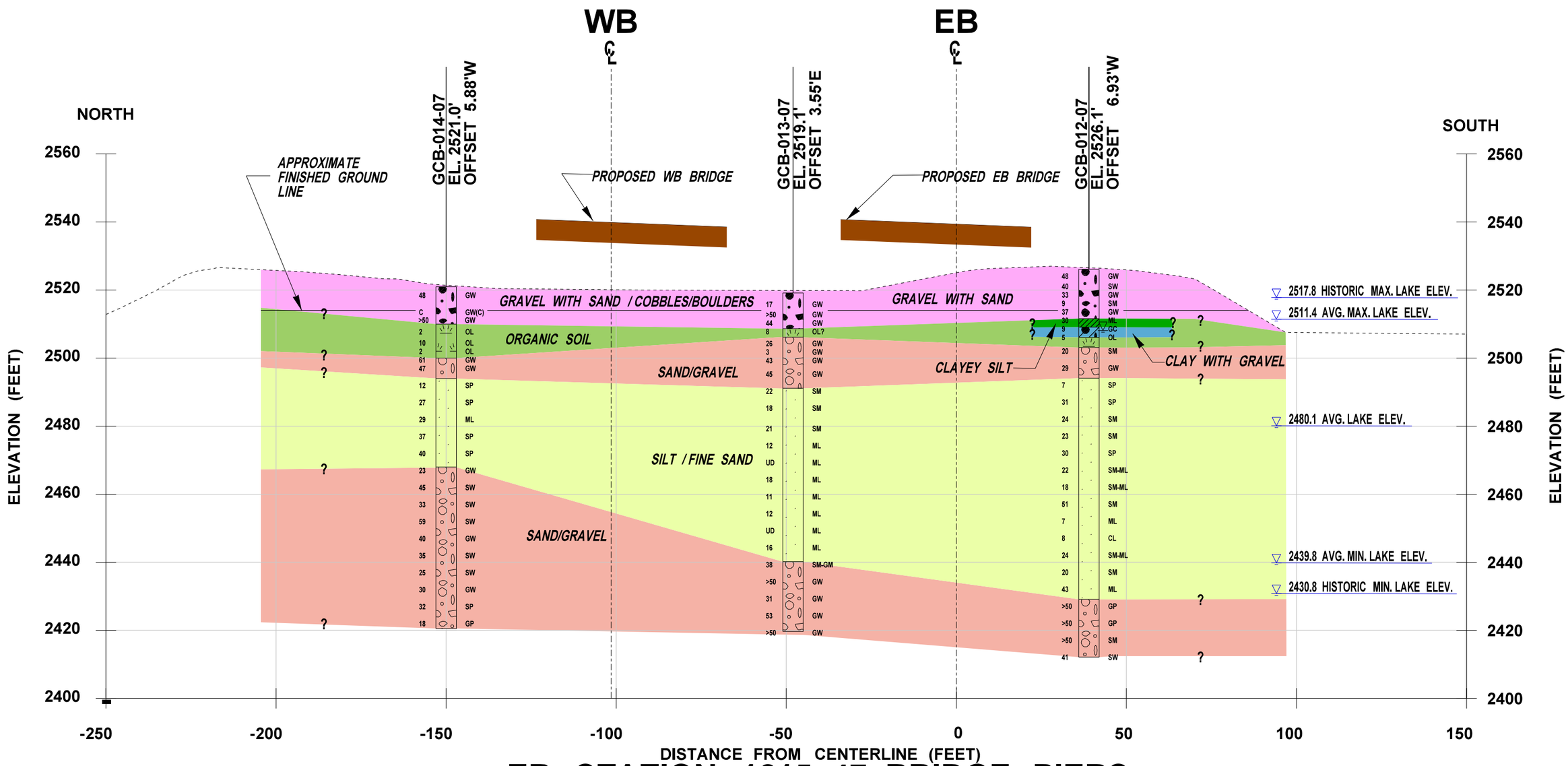
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 5-5'

FIGURE 7



EB STATION 1215+47 BRIDGE PIERS
PIER 4 FOR MULTI-SPAN BRIDGES (EB AND WB)

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$						
DATE	$$$$DATE$$$						
DESIGNED BY	Kranti Maturi						
ENTERED BY	Bob Akers/Ian Sequeira						
CHECKED BY	Suren Balendra						
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX

DATE

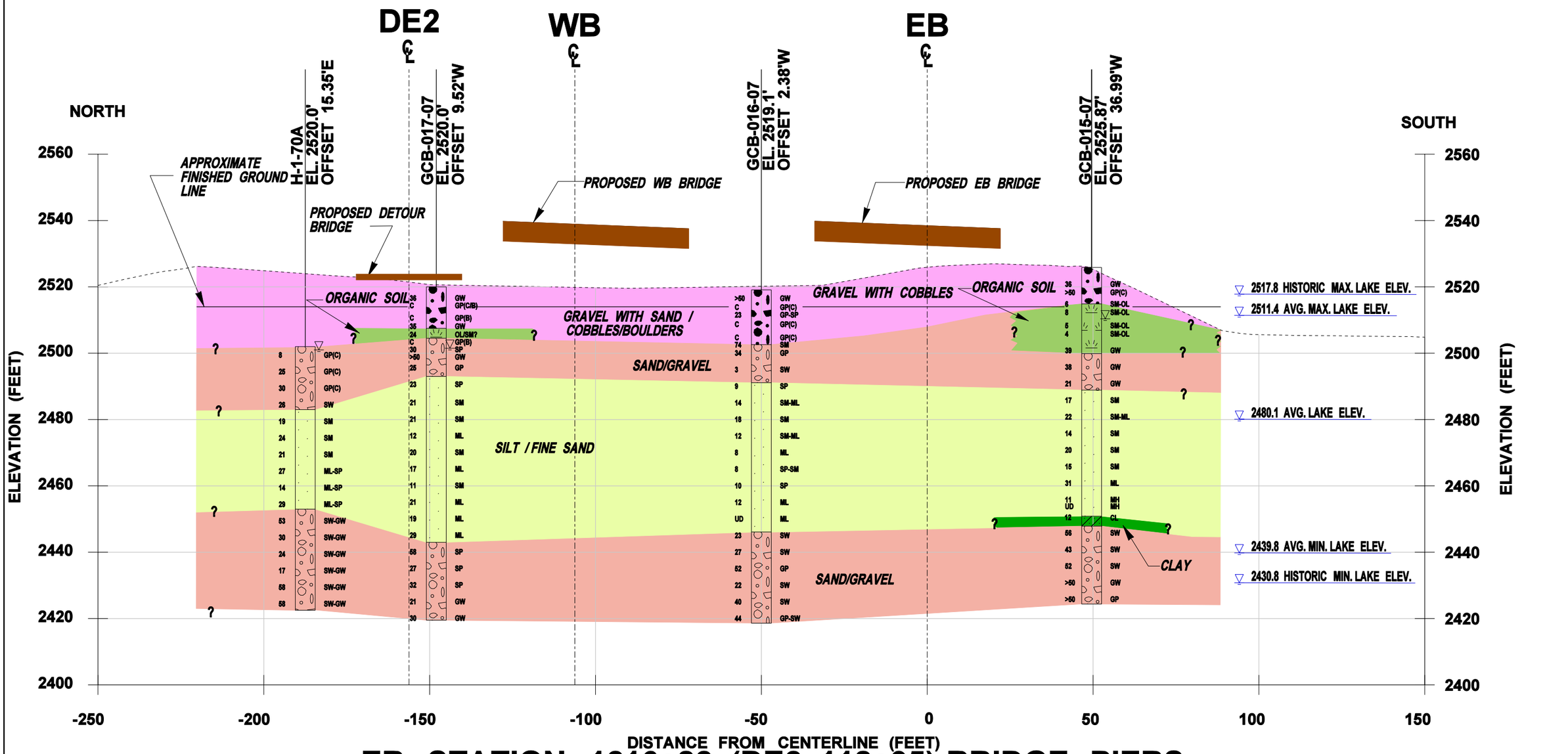
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 6-6'

FIGURE
8



EB STATION 1216+82 (DE2 118+95) BRIDGE PIERS
PIER 5 FOR MULTI-SPAN BRIDGES (EB AND WB)

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$						
DATE	$$$$DATE$$$						
DESIGNED BY	Kranti Maturi						
ENTERED BY	Bob Akers/Ian Sequeira						
CHECKED BY	Suren Balendra						
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX

DATE

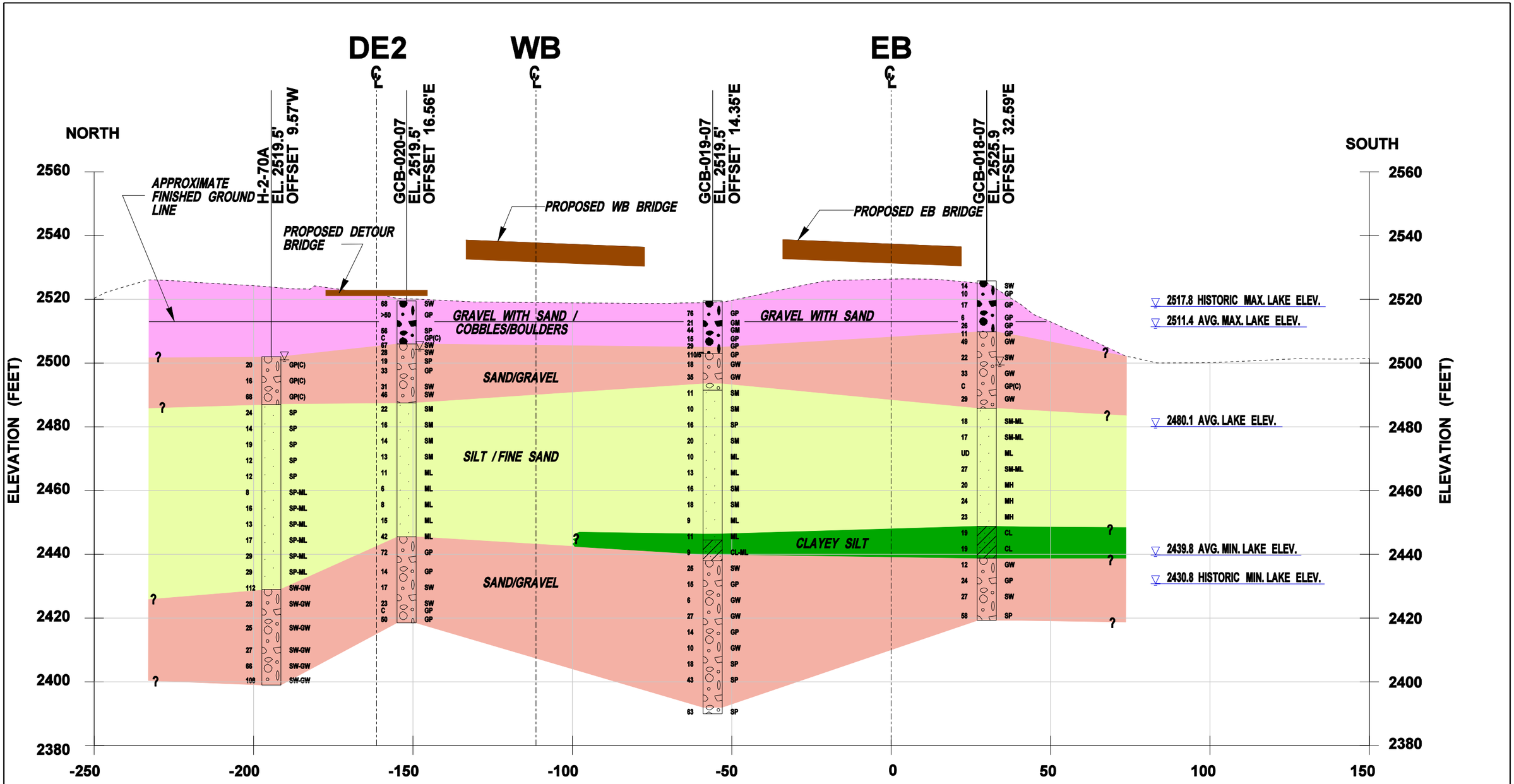
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGE - GCB CROSS-SECTION 7-7'

FIGURE
9



EB STATION 1218+53 (DE2 120+62) BRIDGE PIERS
PIER 6 FOR MULTI-SPAN BRIDGES (EB AND WB)

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	Kranti Maturi
ENTERED BY	Bob Akers/Ian Sequeira
CHECKED BY	Suren Balendra
ASST. PROJ. MNGR.	Brian Hamilton
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX DATE

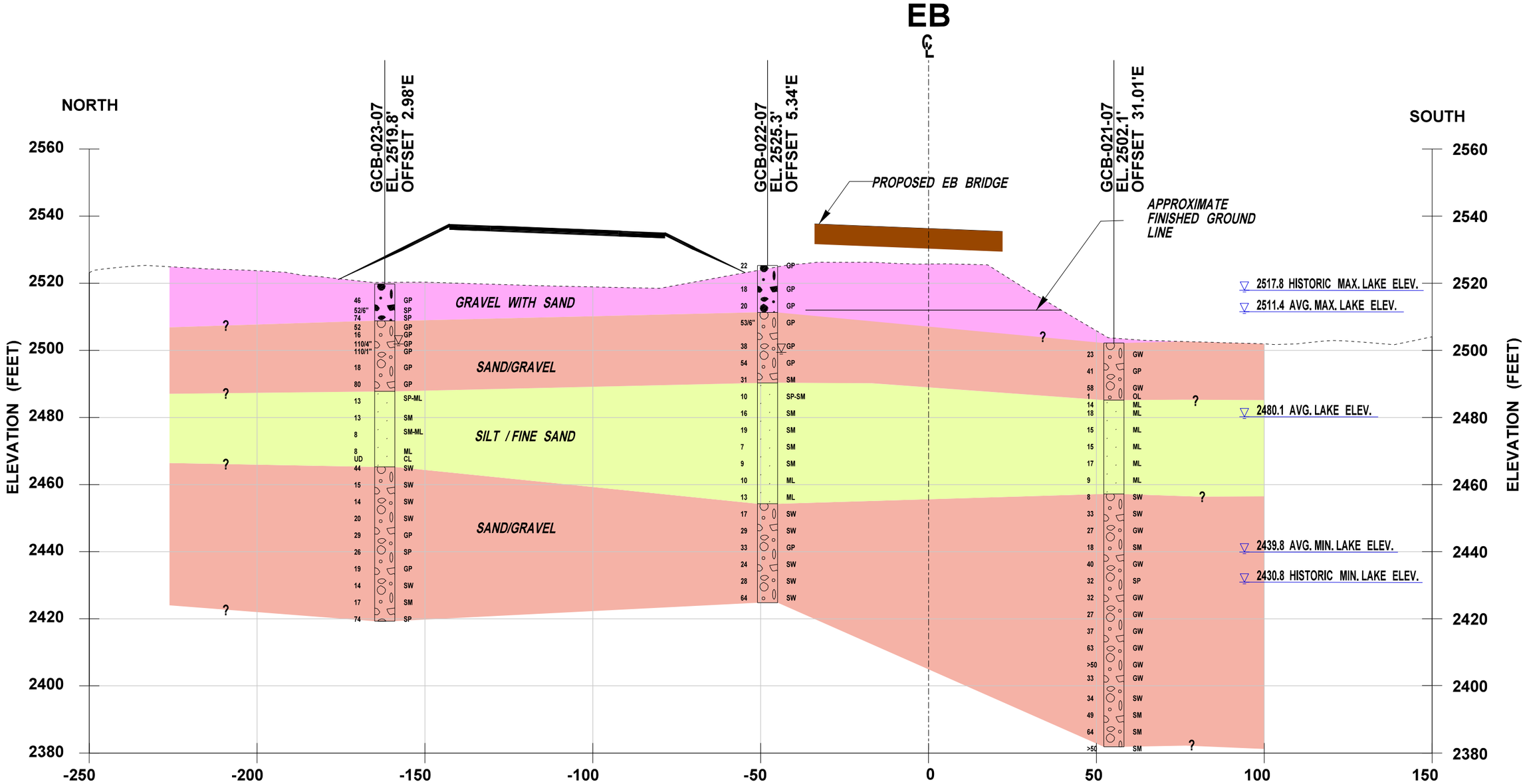
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGE - GCB CROSS-SECTION 8-8'

FIGURE 10



EB STATION 1220+13 BRIDGE PIERS
PIER 7 FOR EB MULTI-SPAN BRIDGE AND ABUTMENT FOR THE WB MULTI-SPAN BRIDGE

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$						
TIME	$TIME$				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
DATE	$$$$DATE$$$				JOB NUMBER 33758623		
DESIGNED BY	Kranti Maturi						
ENTERED BY	Bob Akers/Ian Sequeira						
CHECKED BY	Suren Balendra				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX DATE

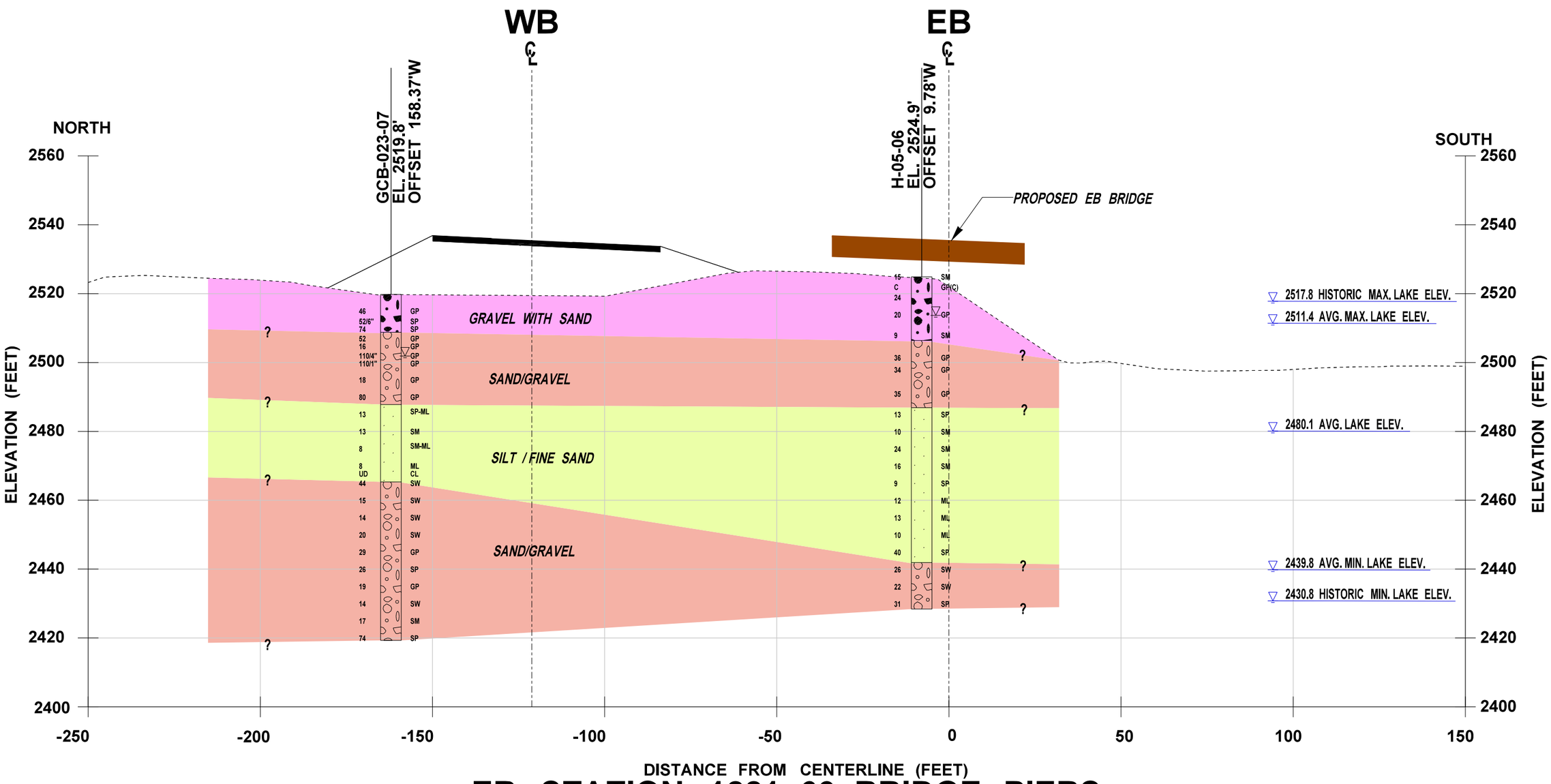
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 9-9'

FIGURE 11



EB STATION 1221+69 BRIDGE PIERS ABUTMENT FOR THE EB MULTI-SPAN BRIDGE

0 30 60

HORIZONTAL SCALE 1"=30'
VERTICAL EXAGGERATION = 1x

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$				REGION NO.	STATE	FED.AID PROJ.NO.
TIME	$TIME$				10	WASH	
DATE	$$$$DATE$$$				JOB NUMBER		
DESIGNED BY	Kranti Maturi				33758623		
ENTERED BY	Bob Akers/Ian Sequeira				CONTRACT NO.		LOCATION NO.
CHECKED BY	Suren Balendra				Y-9764		
ASST. PROJ. MNGR.	Brian Hamilton						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX DATE

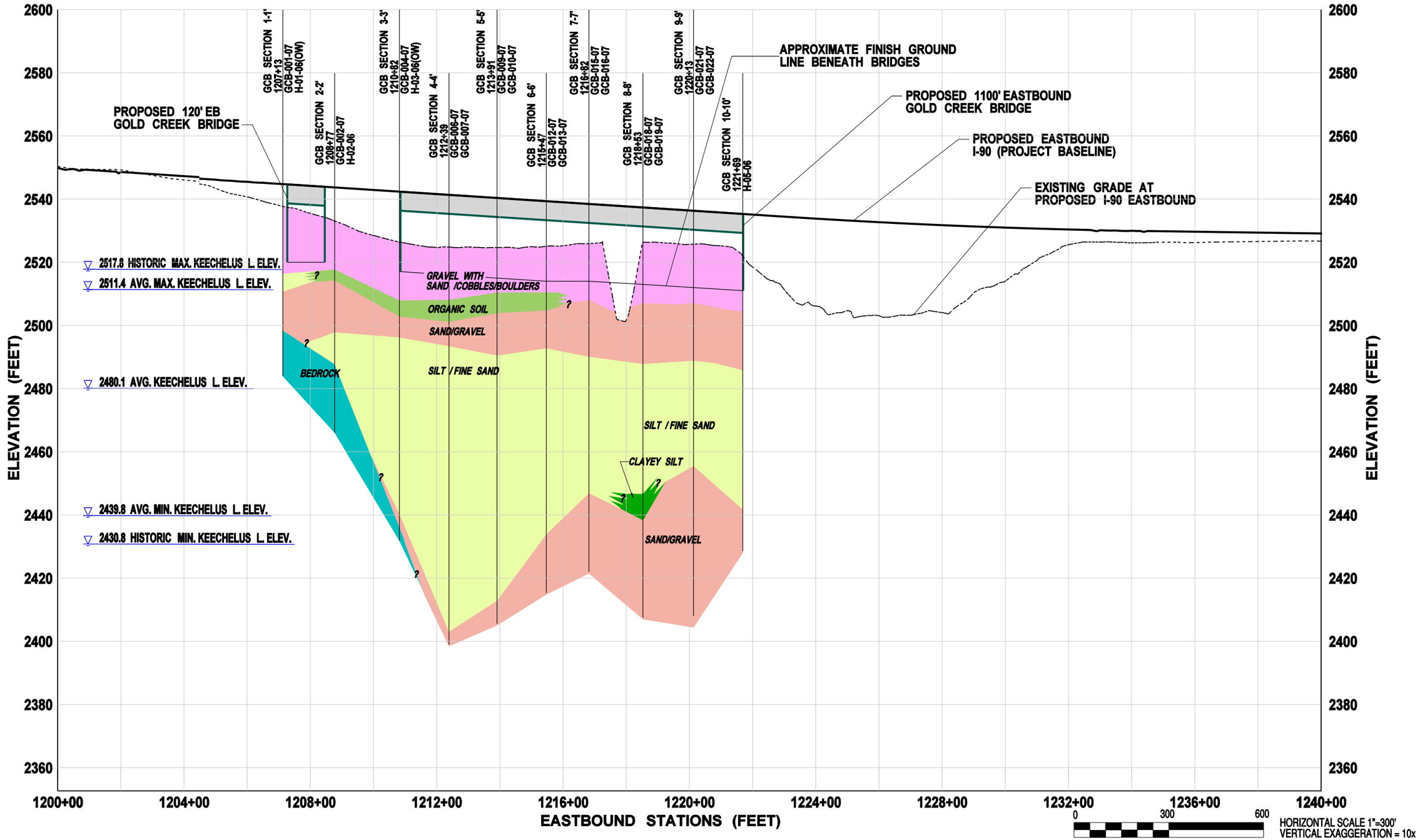
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES (GCB) - CROSS-SECTION 10-10'

FIGURE 12



FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	Kranti Maturi
ENTERED BY	Bob Akers/Ian Sequeira
CHECKED BY	Suren Balendra
ASST. PROJ. MNGR.	Brian Hamilton
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
Y-9764		

P.E. STAMP BOX

DATE

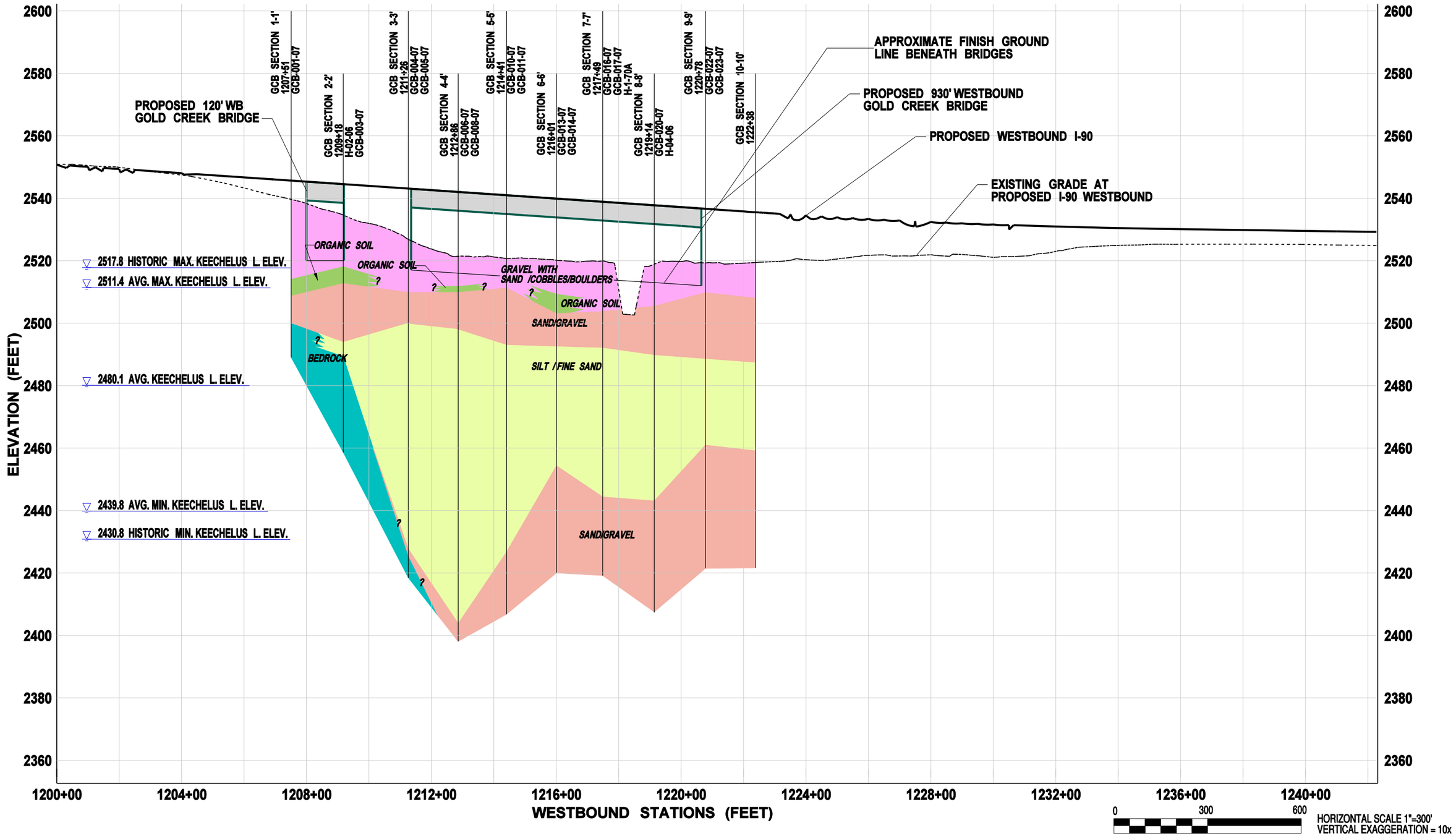
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES - EB SUB-SURFACE PROFILE

FIGURE
13



FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	Kranti Maturi
ENTERED BY	Bob Akers/Ian Sequeira
CHECKED BY	Suren Balendra
ASST. PROJ. MNGR.	Brian Hamilton
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER 33758623		
CONTRACT NO. Y-9764		LOCATION NO.

P.E. STAMP BOX DATE

URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

GOLD CREEK BRIDGES - WB SUB-SURFACE PROFILE

FIGURE 14

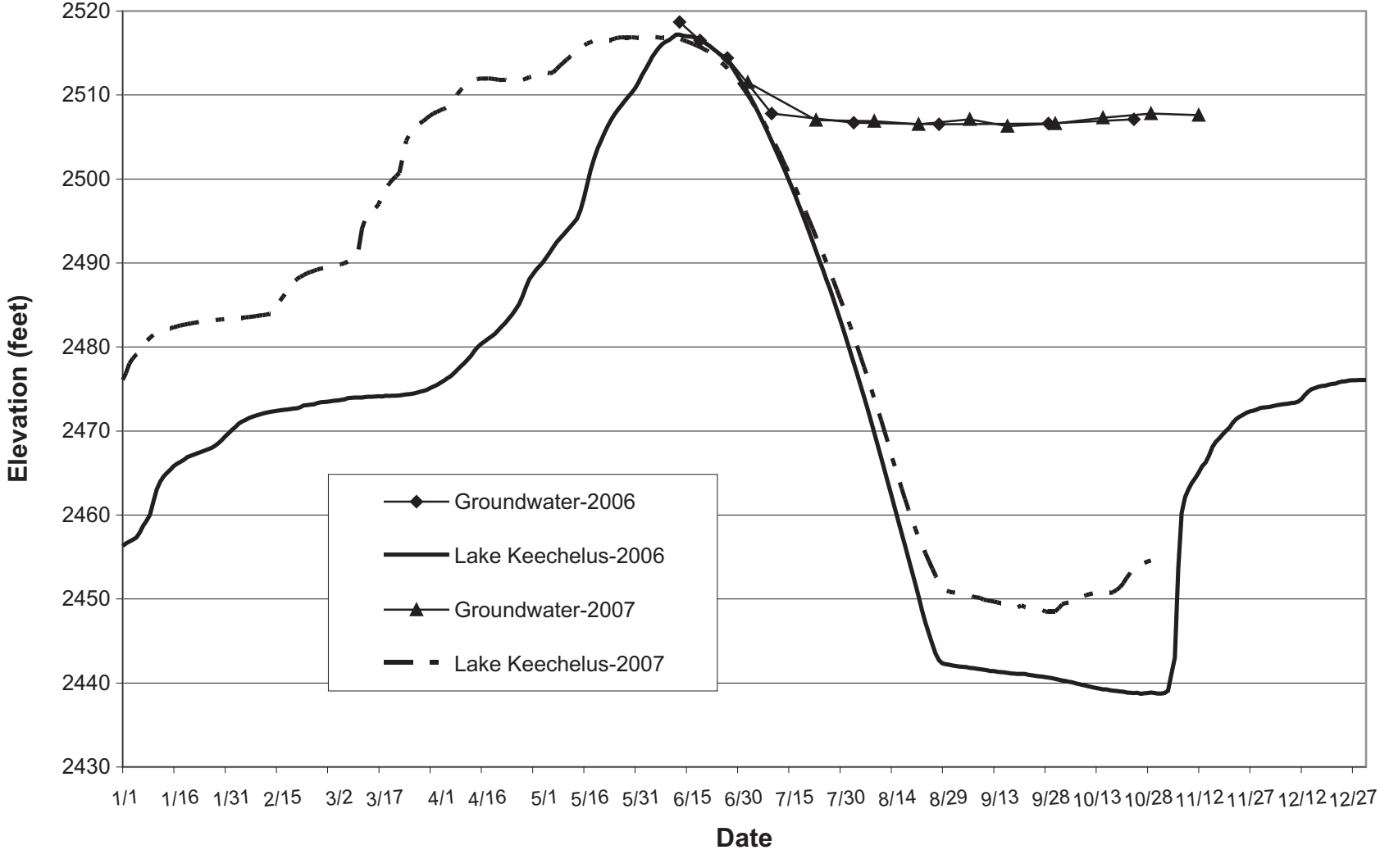


Figure 15

Groundwater Levels, Monitoring Well H-01-06 (OW)

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

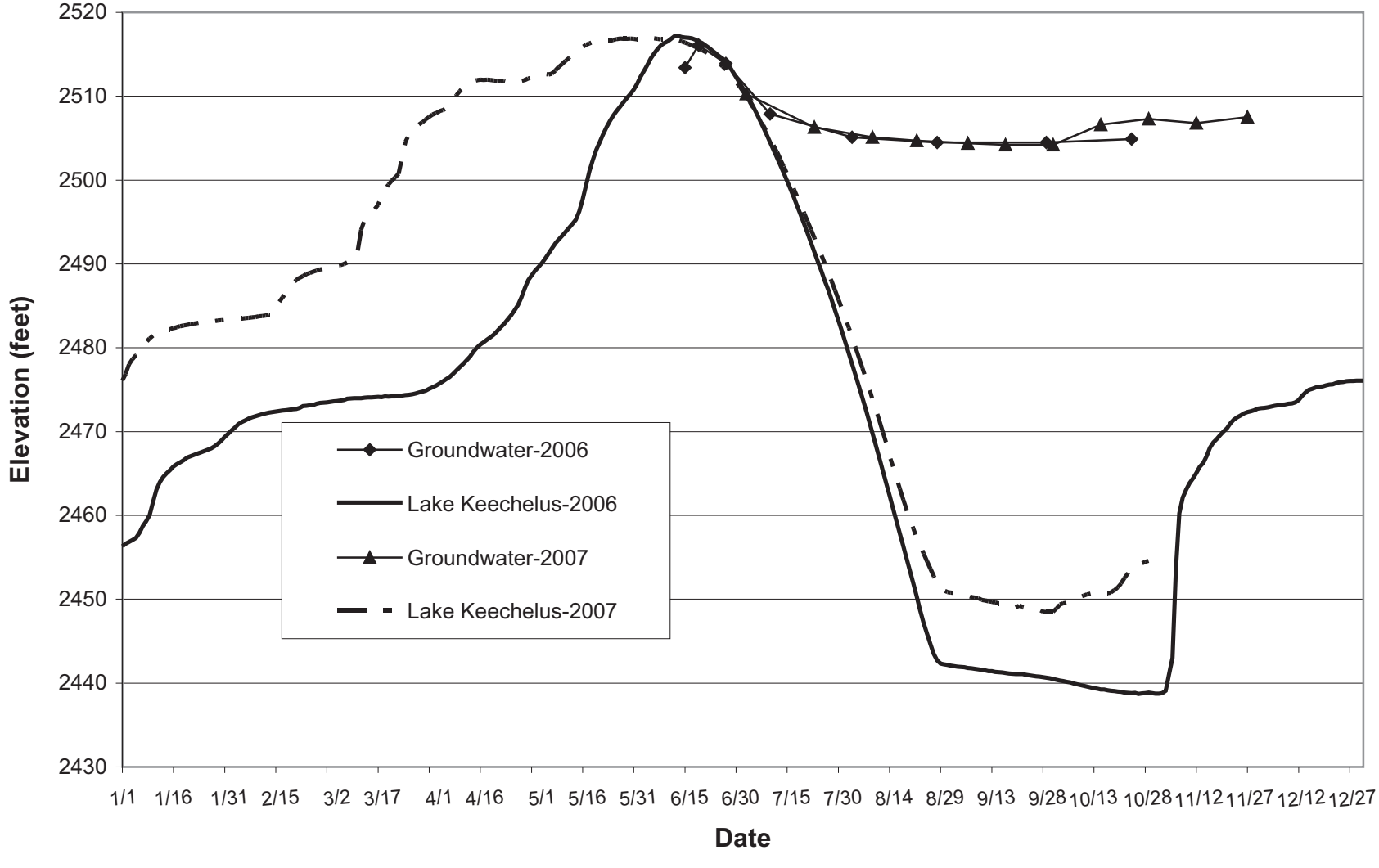


Figure 16

Groundwater Levels, Monitoring Well H-03-06 (OW)

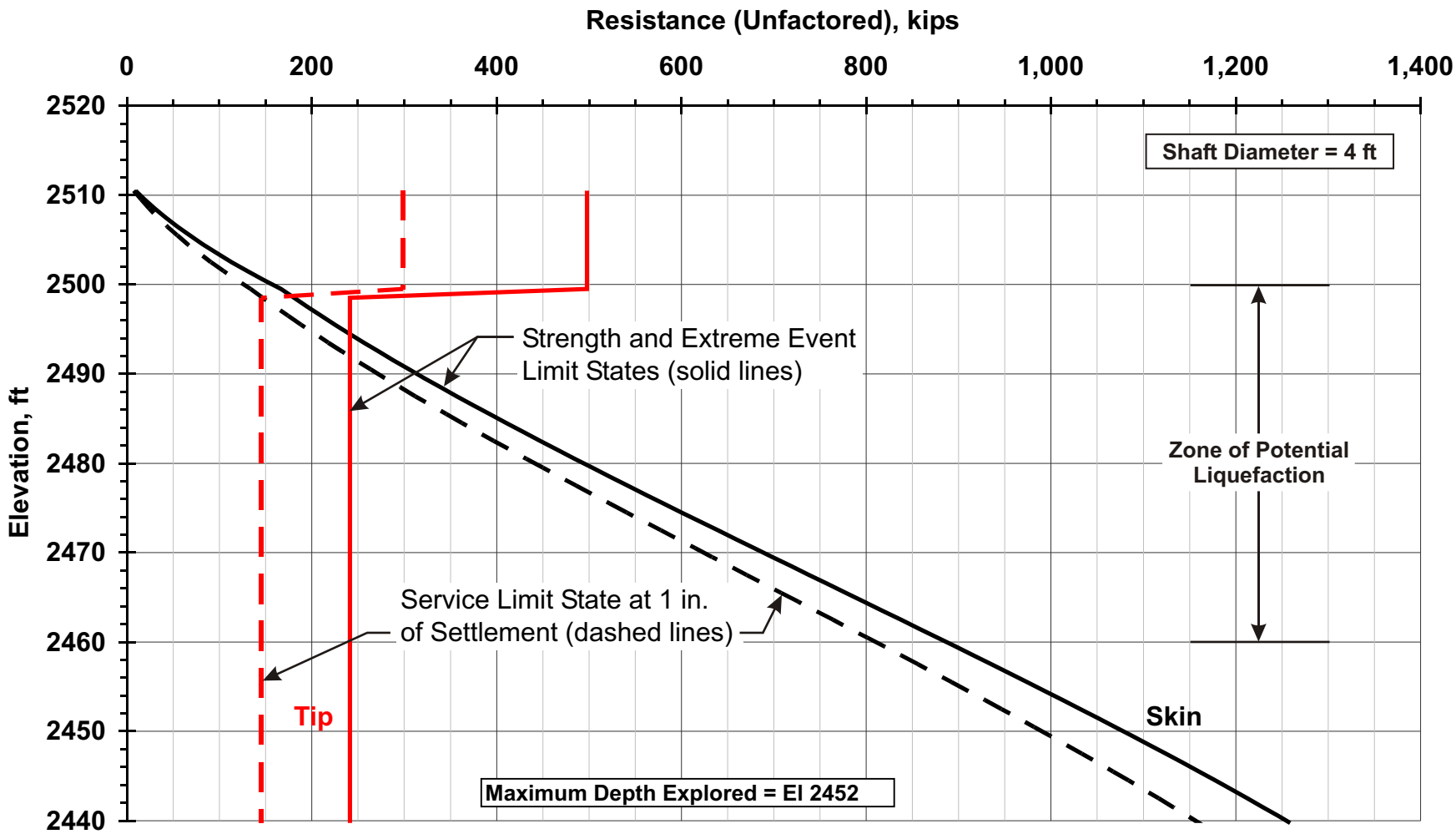


Figure 17

Unfactored Bearing Resistance
Single Span Bridge Piers, 4-ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

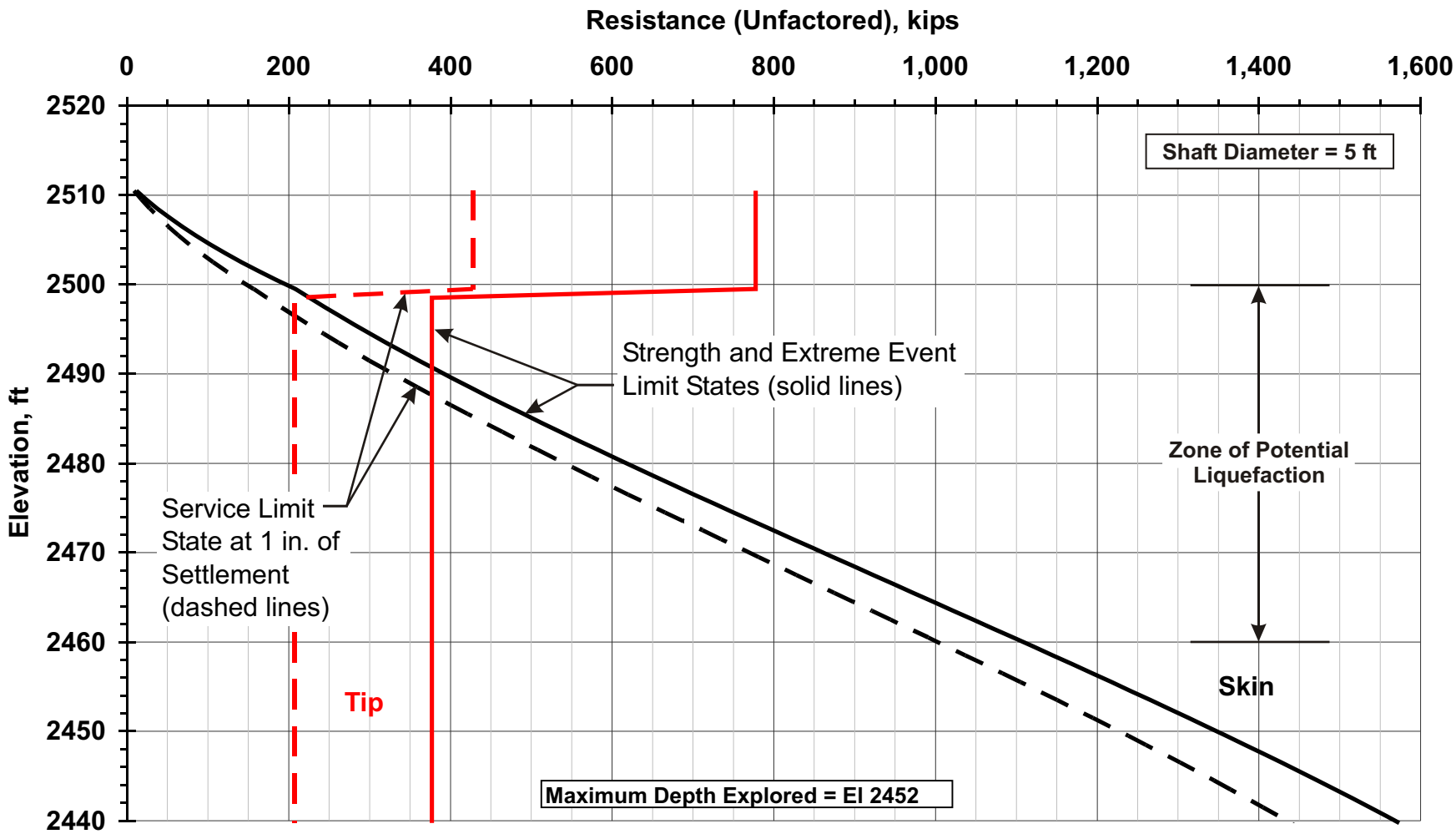


Figure 18

Unfactored Bearing Resistance
Single Span Bridge Piers, 5-ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

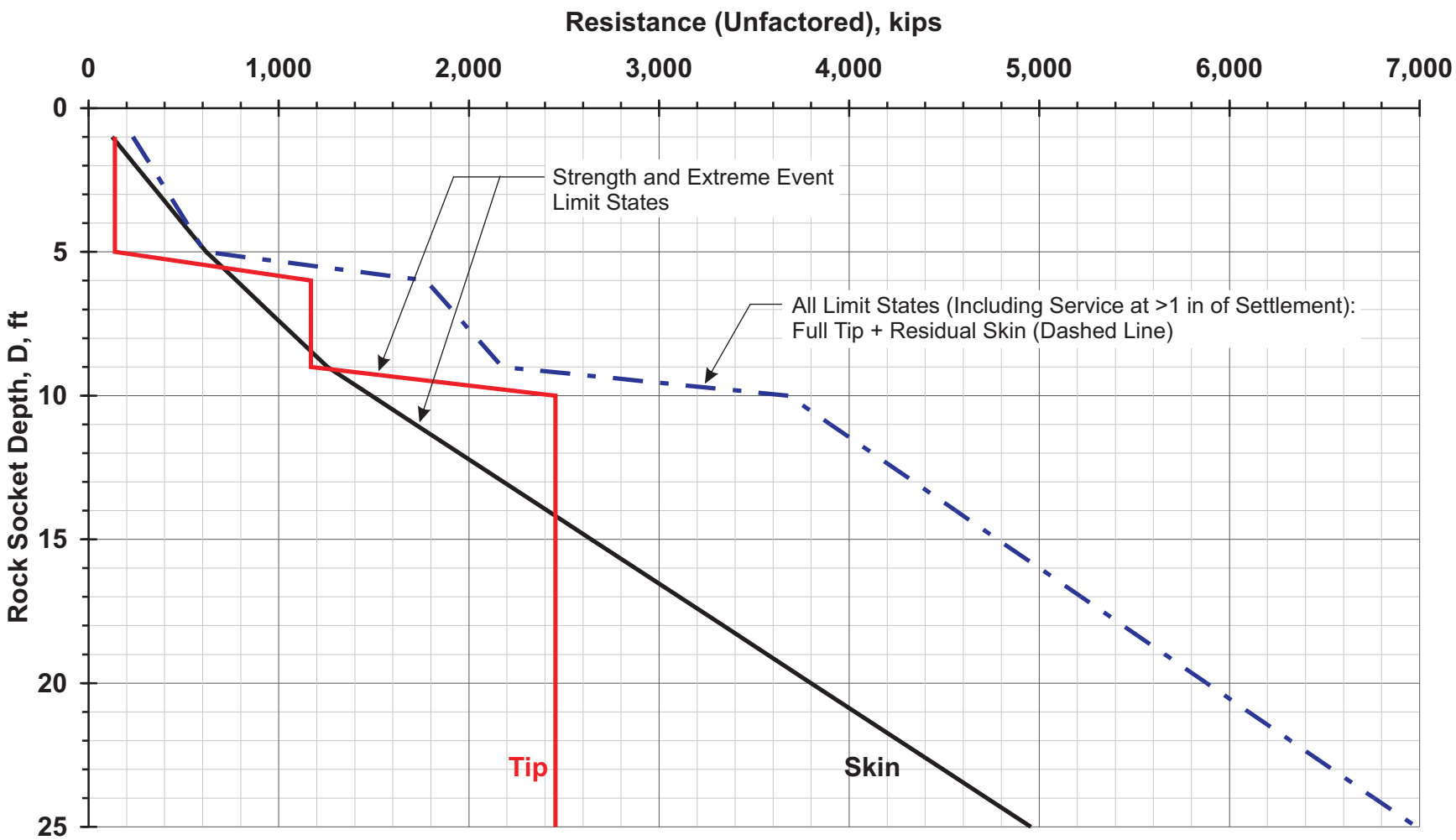


Figure 19

Unfactored Bearing Resistance
Single-Span Bridge Piers, 4-ft Diameter Shaft – Rock

Job No. 33758623.50103

URS

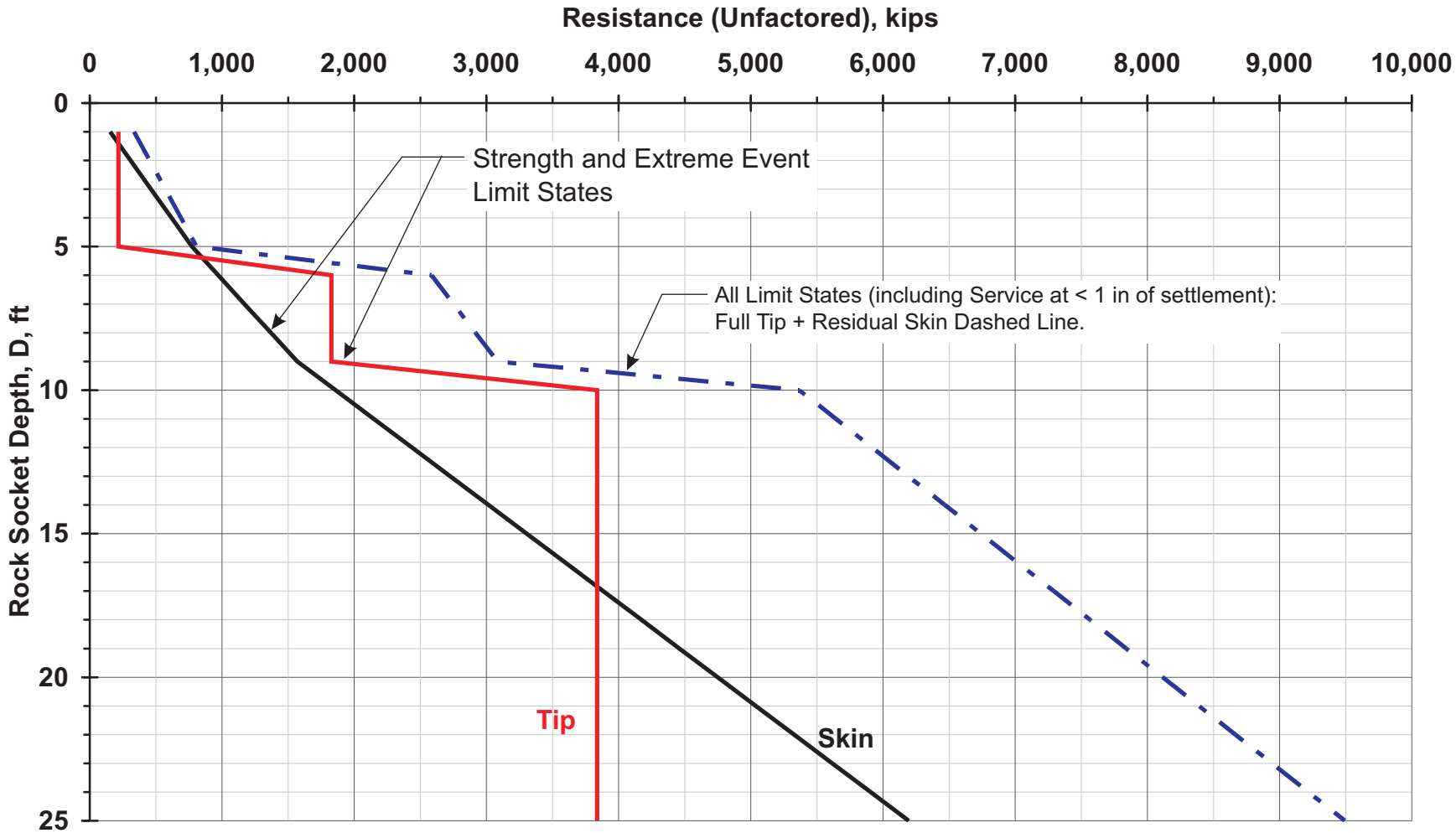


Figure 20

Unfactored Bearing Resistance
Single-Span Bridge Piers, 5-ft Diameter Shaft – Rock

Job No. 33758623.50103

URS

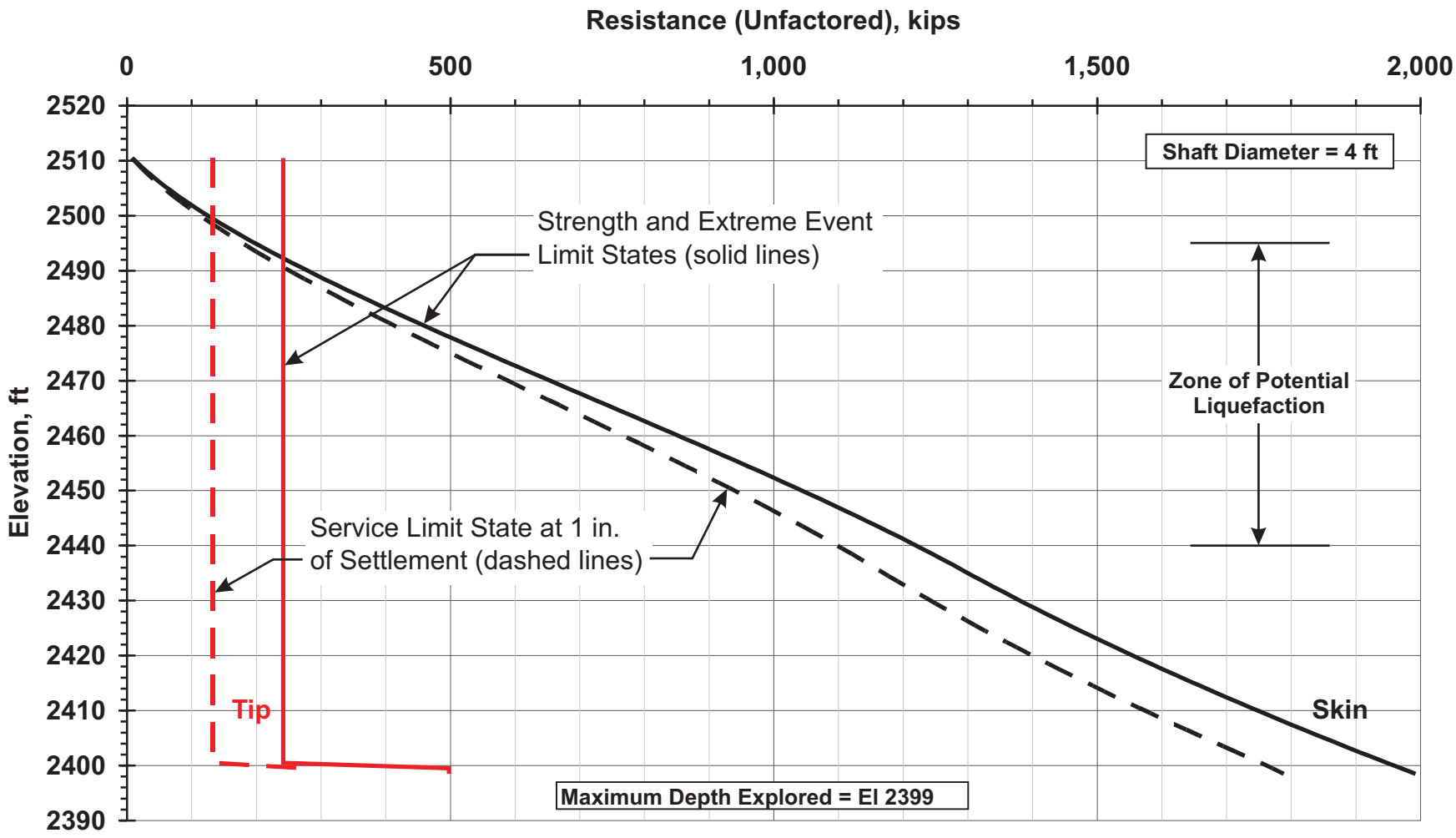


Figure 21

Unfactored Bearing Resistance

Multi-Span Bridge Western Abutments, 4 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

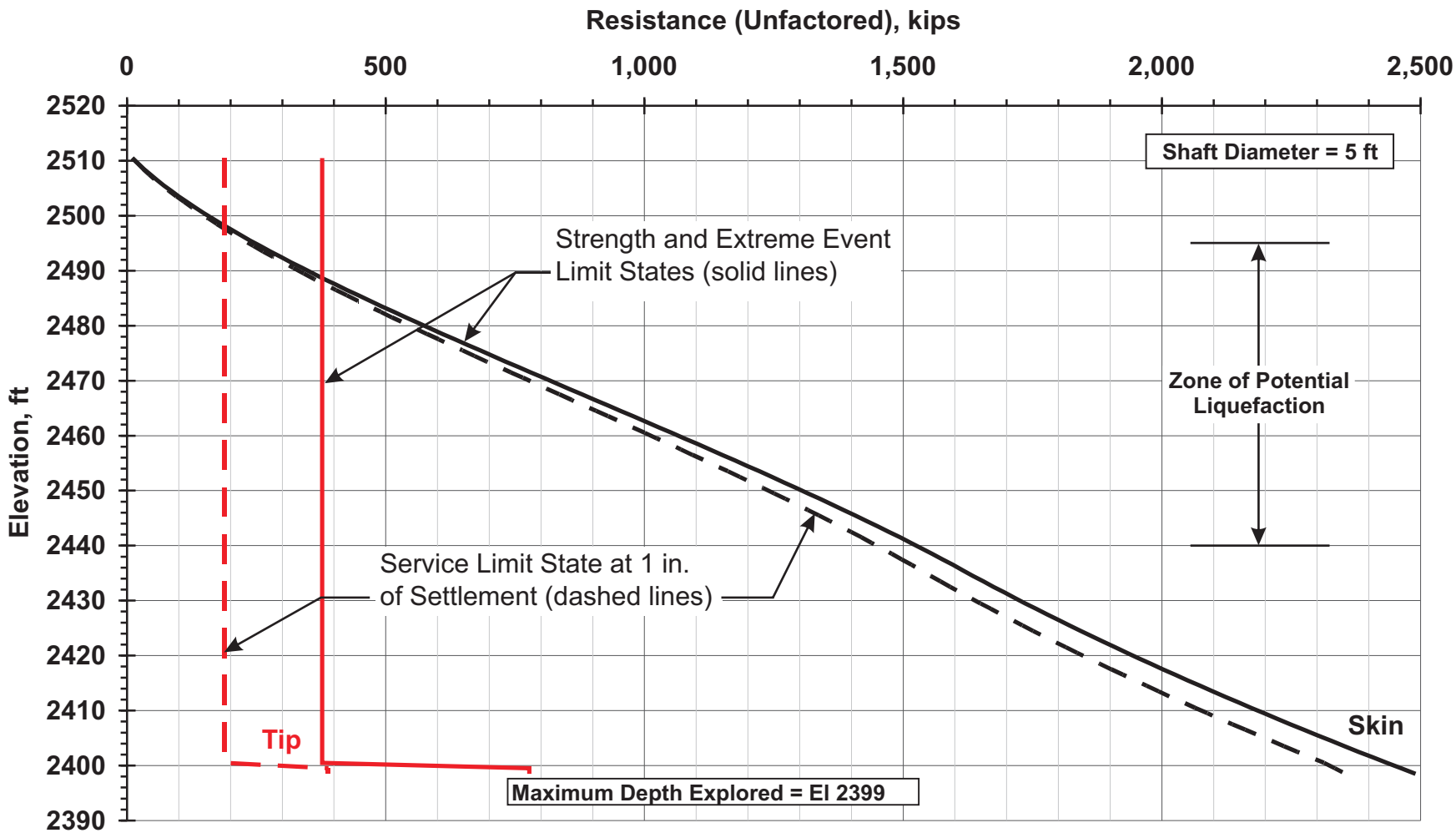


Figure 22

Unfactored Bearing Resistance

Multi-Span Bridge Western Abutments, 5 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

Figure 23

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers 2 and 3, 7 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

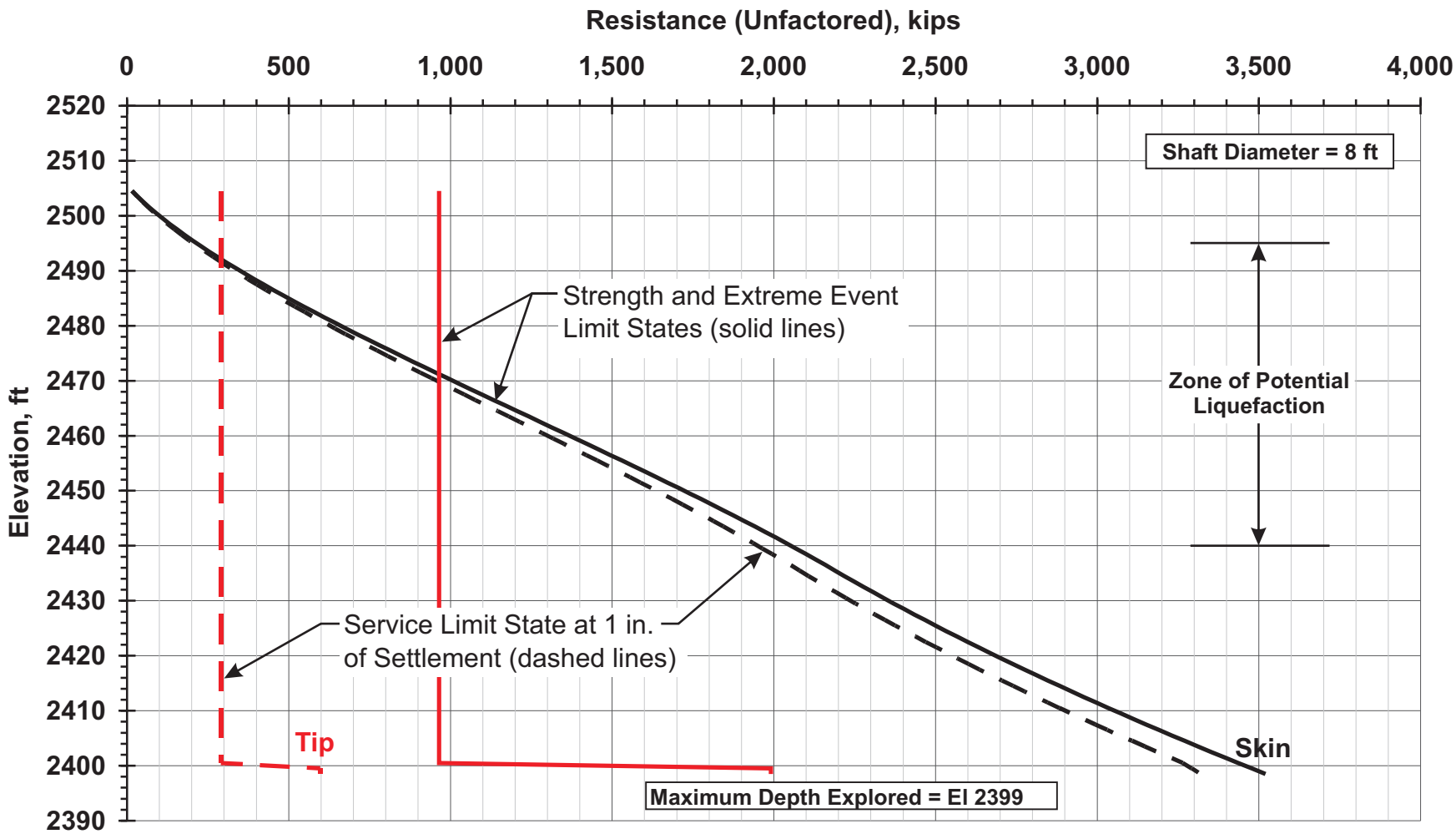


Figure 24

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers 2 and 3, 8 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

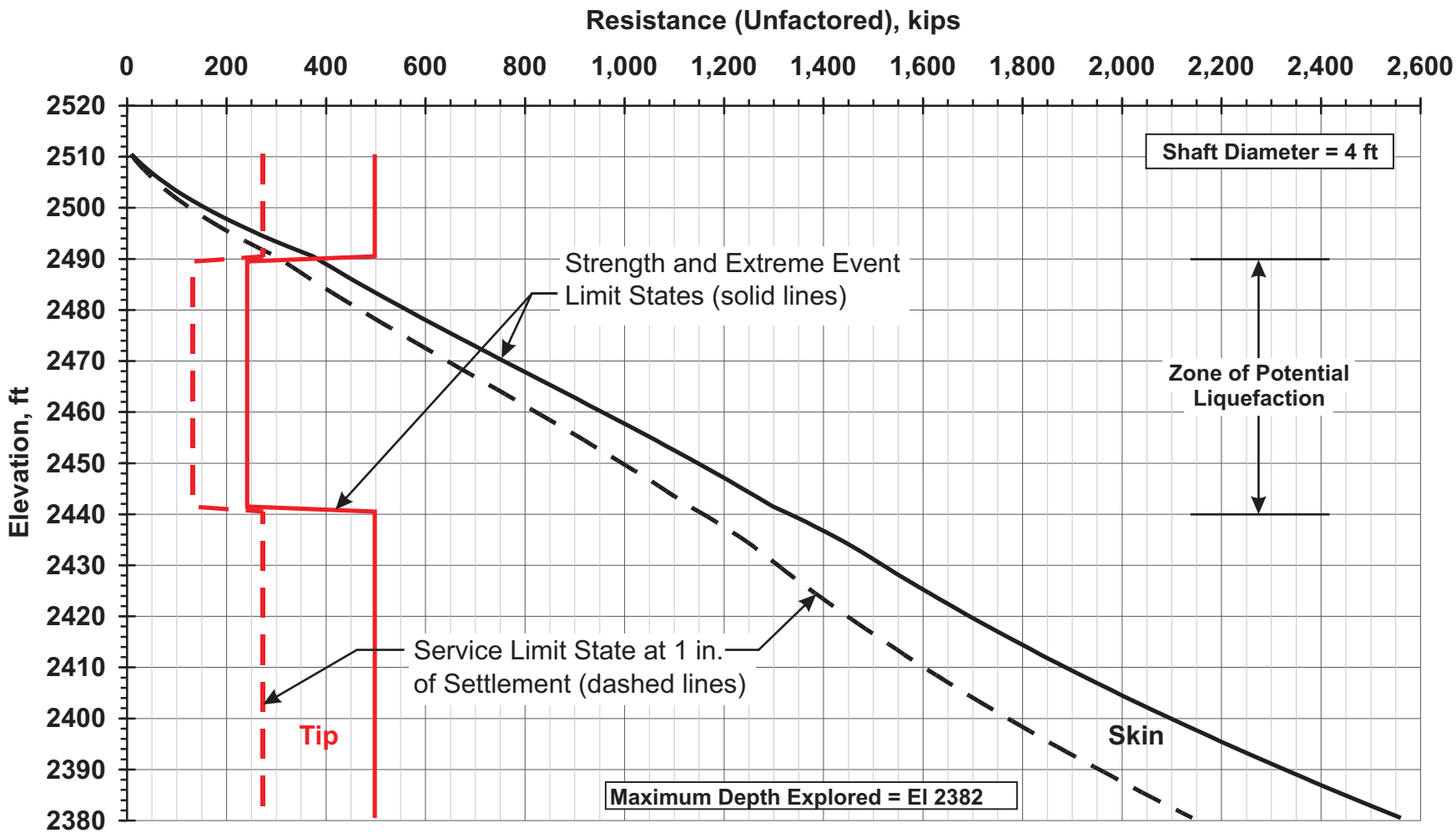


Figure 25

Unfactored Bearing Resistance

Multi-Span Bridge Eastern Abutments, 4 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

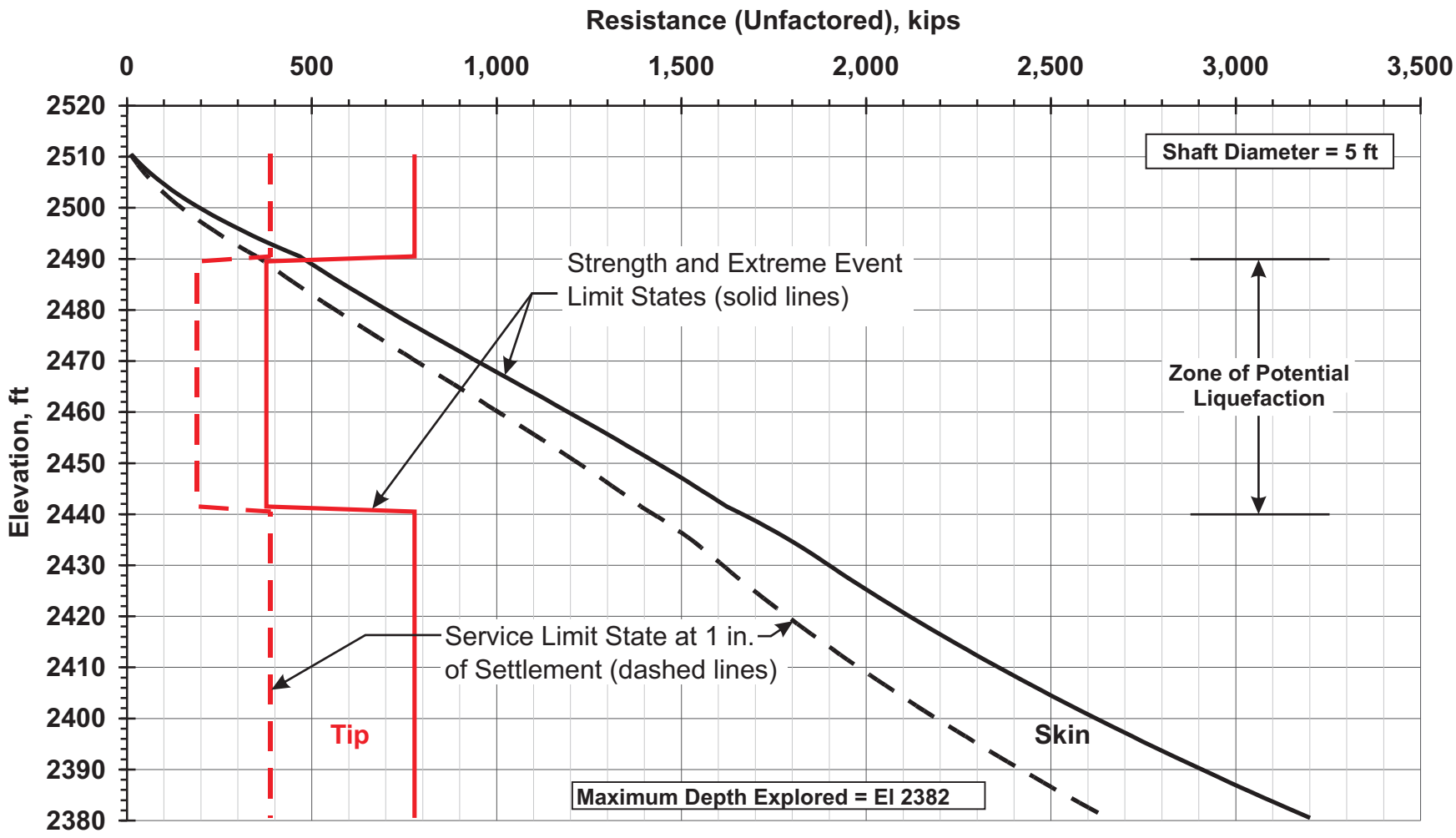


Figure 26

Unfactored Bearing Resistance

Multi-Span Bridge Eastern Abutments, 5 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

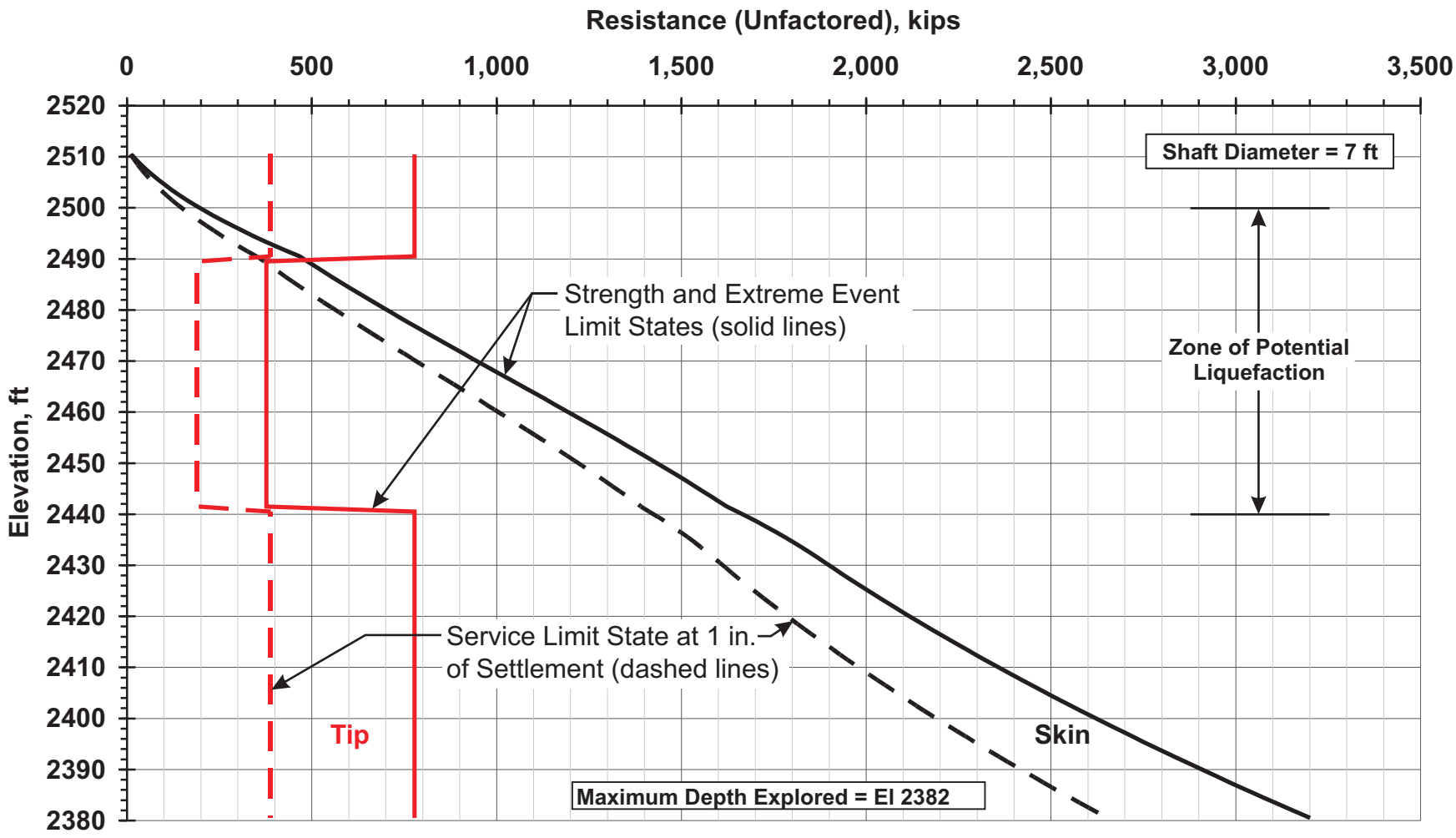


Figure 27

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers 4 through 7, 7 ft Diameter Shaft – Soil

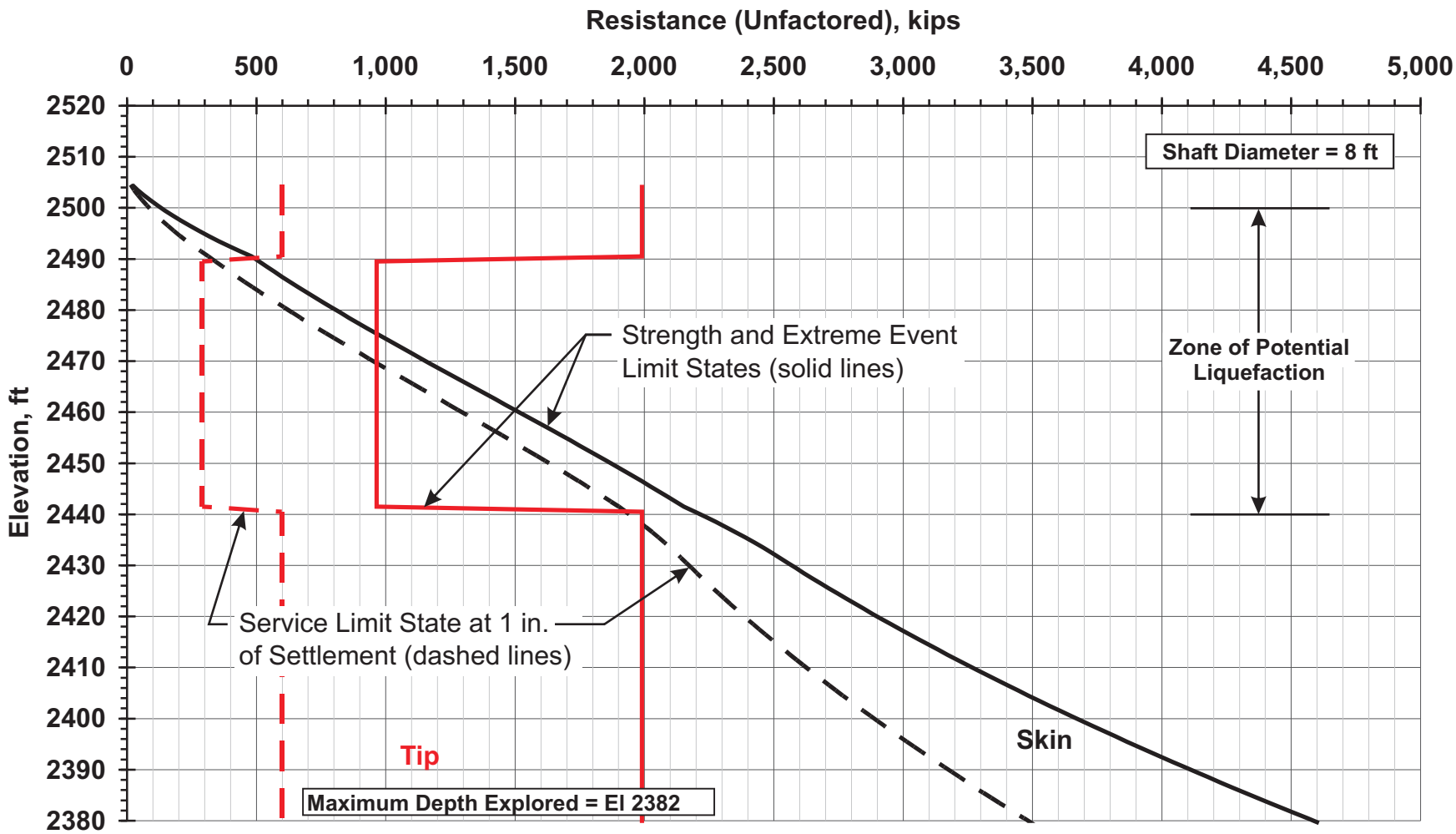


Figure 28

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers 4 through 7, 8 ft Diameter Shaft – Soil

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

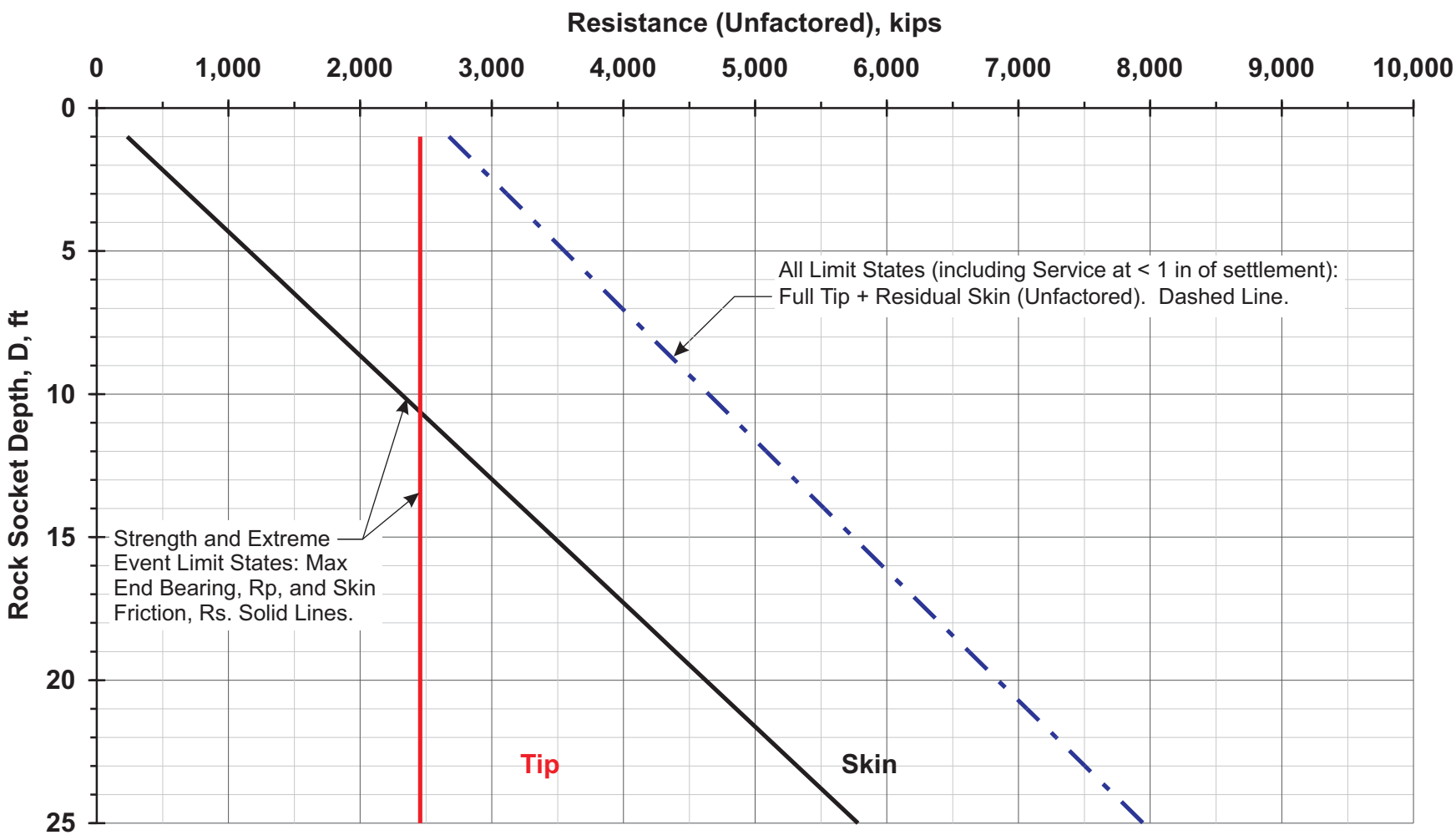


Figure 29

Unfactored Bearing Resistance
Multi-Span Bridge Abutments, 4-ft Diameter Shaft – Rock

Job No. 33758623.50103

URS

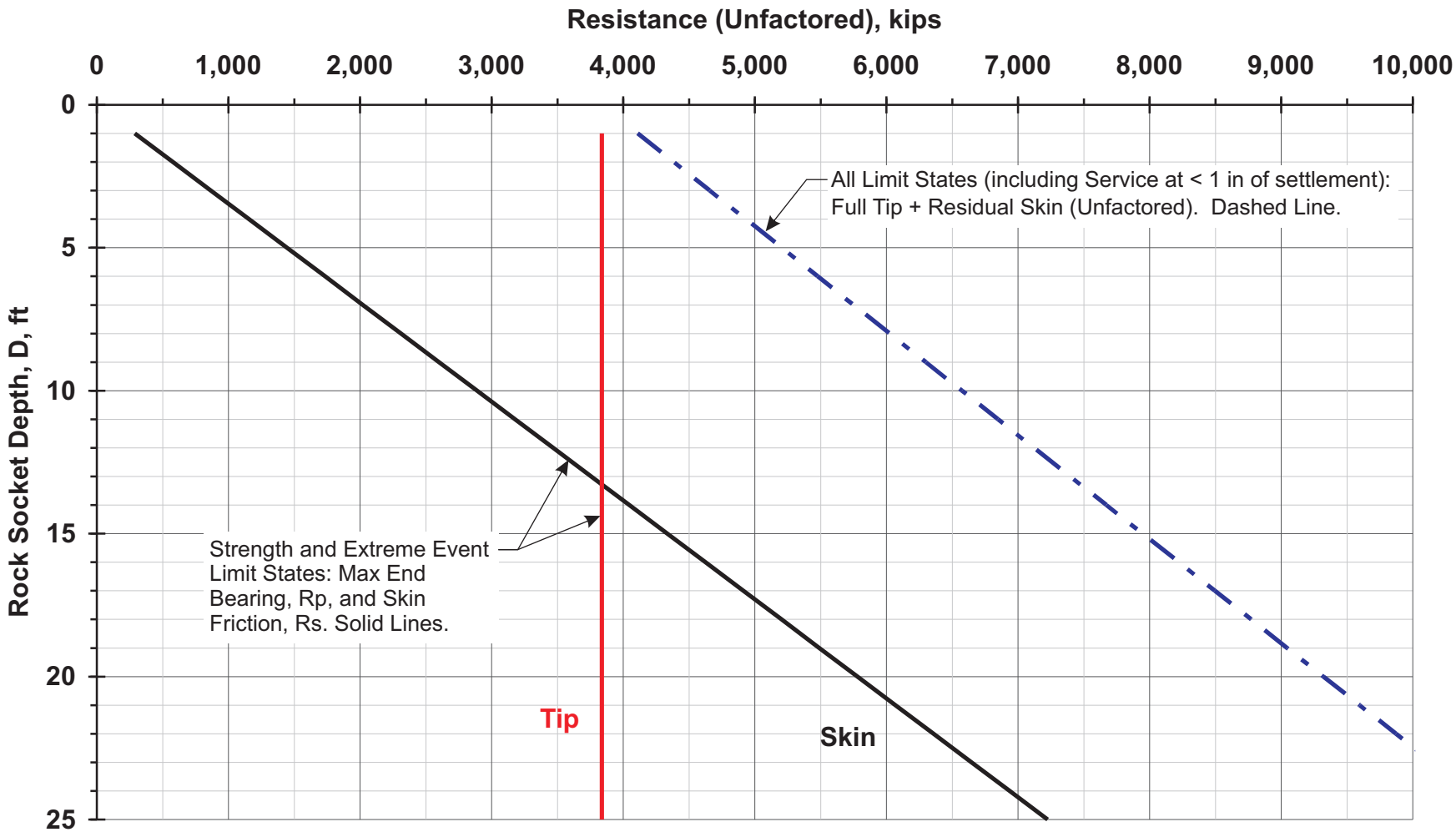


Figure 30

Unfactored Bearing Resistance
Multi-Span Bridge Abutments, 5-ft Diameter Shaft – Rock

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

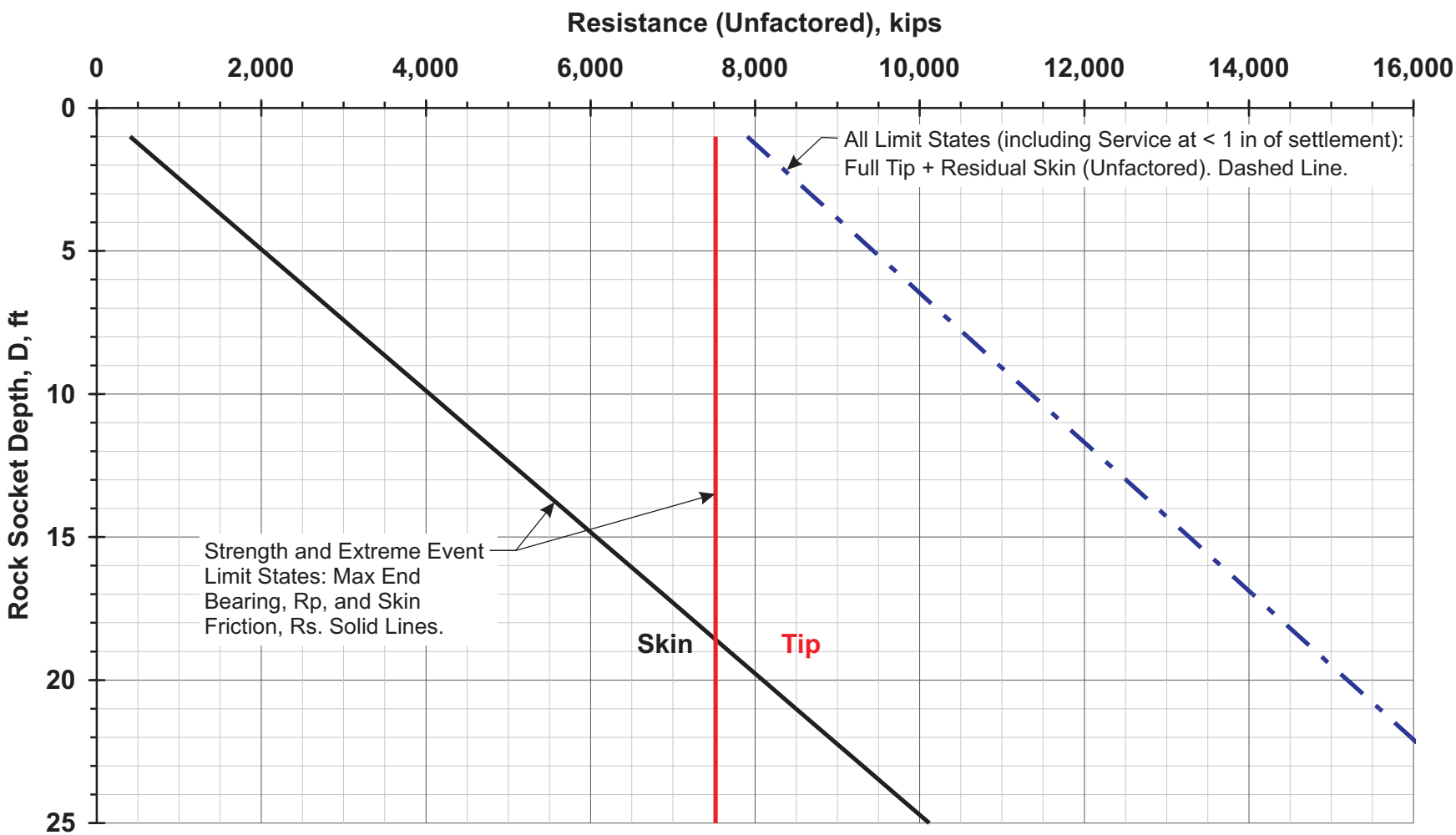


Figure 31

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers, 2 through 7, 7-ft Diameter Shaft – Rock

Job No. 33758623.50103

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

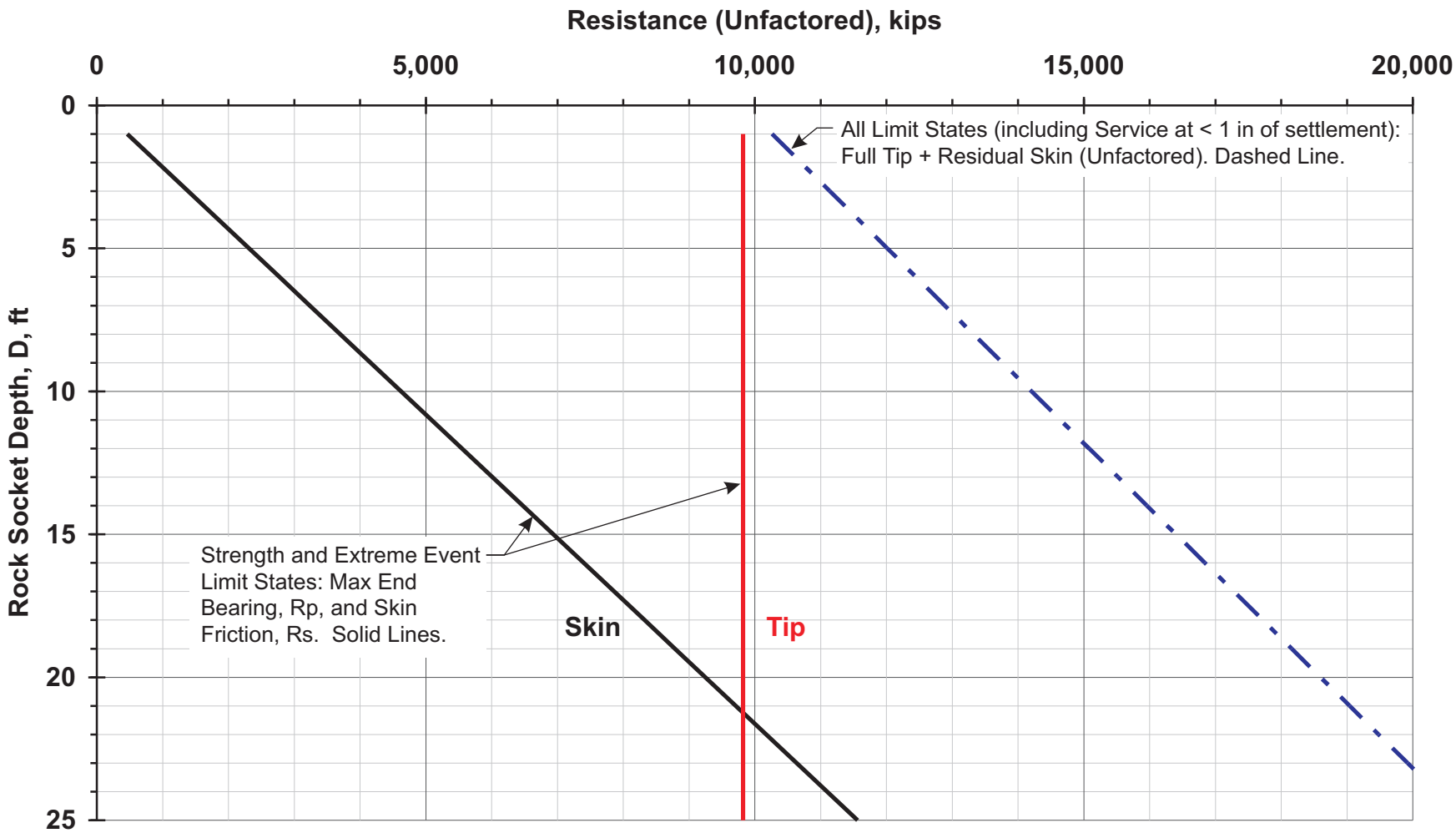


Figure 32

Unfactored Bearing Resistance

Multi-Span Bridge Interior Piers, 2 through 7, 8-ft Diameter Shaft – Rock

33758623.50103_03.CDR

Notes

1. A stub-type abutment is shown. For this type of abutment, earth pressures over the height of the superstructure (indicated by dashed lines) do not act on the abutment wall. For an L-type abutment, earth pressures over the height of the superstructure must be included in the pressures that act on the abutment wall.

2. Earth pressures in psf for abutment walls that can deflect (active pressure conditions) may be calculated using the equations and values below.

$P_1 = K_a\gamma H_1$
$P_2 = K_a\gamma H_1 + K_a\gamma'(H_2 + H_3)$
$P_3 = K_a\gamma h_{eq}$
$P_4 = 62.4H_2$
$P_5 = K_p\gamma' H_3$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing and curtain walls within a distance H of the abutment wall, may be calculated using the equations and values below.

$P_1 = K_0\gamma H_1$
$P_2 = K_0\gamma H_1 + K_0\gamma'(H_2 + H_3)$
$P_3 = K_0\gamma h_{eq}$
$P_4 = 62.4H_2$
$P_5 = K_p\gamma' H_3$

The values of H_1 and H_2 may be calculated assuming a water table elevation = 2517 feet, which corresponds to high lake level conditions.

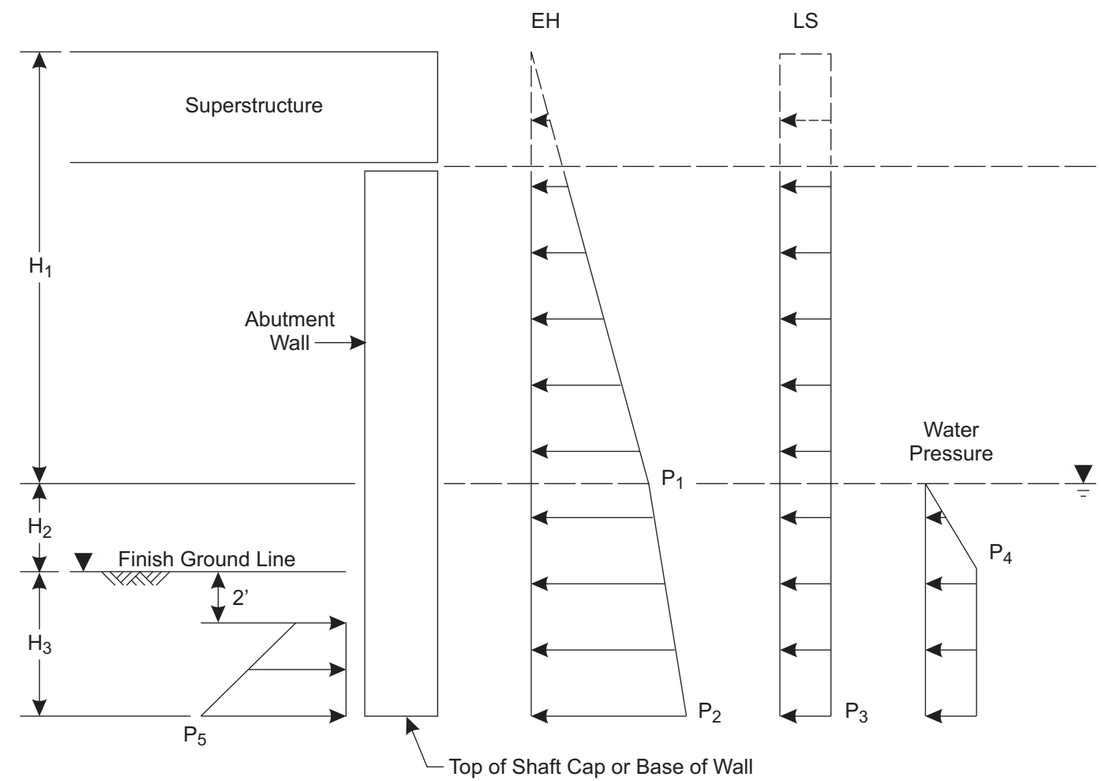
Design Parameters for Calculating Lateral Earth Pressures for Strength Limit State

Parameter	Units	Value
Soil Unit Weight, γ	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, γ'	pcf	73
Soil Friction Angle, φ	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.20
At-Rest Earth Pressure Coefficient, K_0	unitless	0.36
Equivalent Height of Soil for Vehicular Loading on Walls Perpendicular to Traffic, h_{eq}	feet	5<H<10: 4.0 10<H<20: 3.0 H≥20: 2.0
Equivalent Height of Soil for Vehicular Loading on Walls Parallel to Traffic, h_{eq}[1]	feet	2.0
Passive Earth Pressure Coefficient, K_p, for level finish ground line	unitless	10
Passive Earth Pressure Coefficient, K_p, for finish ground line sloped at 2H:1V	unitless	2.3

H = Height of top of approach fill above finish ground line elevation, feet
[1] Minimum distance from wall backface to edge of traffic = 1.0 foot

3. The water pressure may be neglected if the backfill behind the wall is fully drained.

4. Any fine-grained or organic soil encountered in the wall excavation must be removed and replaced with compacted select fill.



Job No. 33758623.50103

Figure 33
Strength Limit State Earth Pressures

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

33758623.50103_04.CDR

Notes

1. A stub-type abutment is shown. For this type of abutment, earth pressures over the height of the superstructure (indicated by dashed lines) do not act on the abutment wall. For an L-type abutment, earth pressures over the height of the superstructure must be included in the pressures that act on the abutment wall.

2. Earth pressures in psf for abutment walls that can deflect (active pressure conditions) may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(f)}\gamma(H_1 + H_2)$
$P_2 = K_a\gamma H_1 + K_a\gamma' H_2$
$P_3 = K_a\gamma H_1 + K_a\gamma'(H_2 + H_3)$
$P_4 = K_a\gamma h_{eq}$
$P_5 = 62.4H_2$
$P_6 = K_{pe}\gamma'(H_3 - 2)$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing and curtain walls within a distance H of the abutment wall, may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(r)}\gamma(H_1 + H_2)$
$P_2 = K_0\gamma H_1 + K_o\gamma' H_2$
$P_3 = K_0\gamma H_1 + K_o\gamma'(H_2 + H_3)$
$P_4 = K_0\gamma h_{eq}$
$P_5 = 62.4H_2$
$P_6 = K_o\gamma'(H_3 - 2)$

The values of H_1 and H_2 may be calculated assuming a water table elevation = 2517 feet, which corresponds to high lake level conditions.

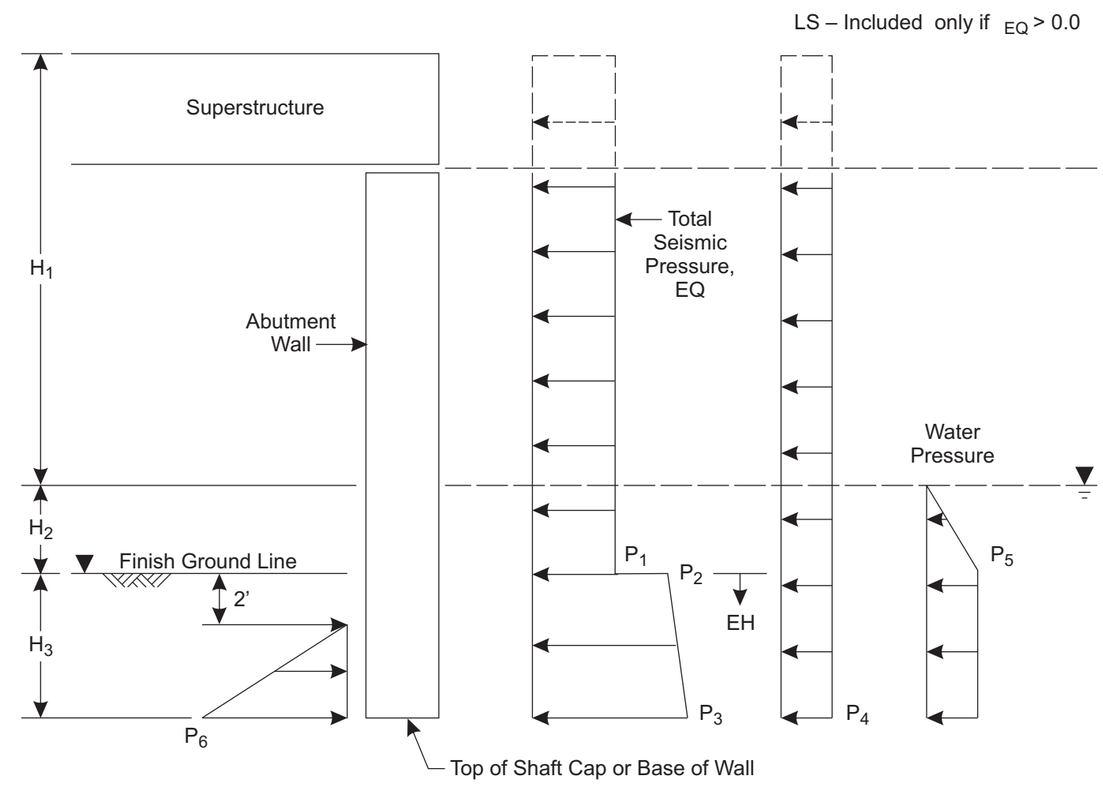
Design Parameters for Calculating Lateral Earth Pressures for Extreme Event Limit State

Parameter	Units	Value
Soil Unit Weight, γ	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, γ'	pcf	73
Soil Friction Angle, φ	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.20
At-Rest Earth Pressure Coefficient, K_0	unitless	0.36
Equivalent Height of Soil for Vehicular Loading on Walls Perpendicular to Traffic, h_{eq}	feet	5<H<10: 4.0 10<H<20: 3.0 H≥20: 2.0
Equivalent Height of Soil for Vehicular Loading on Walls Parallel to Traffic, h_{eq}[1]	feet	2.0
Seismic Earth Pressure Coefficient for Flexible Retaining Walls, $K_{ae(f)}$	unitless	0.31
Seismic Earth Pressure Coefficient for Shafts and Rigid Retaining Walls, $K_{ae(r)}$	unitless	0.78
Seismic Passive Earth Pressure Coefficient for Flexible Walls, K_{pe}	unitless	4.2

H = Height of top of approach fill above finish ground line elevation, feet
[1] Minimum distance from wall backface to edge of traffic = 1.0 foot

3. The water pressure may be neglected if the backfill behind the wall is fully drained.

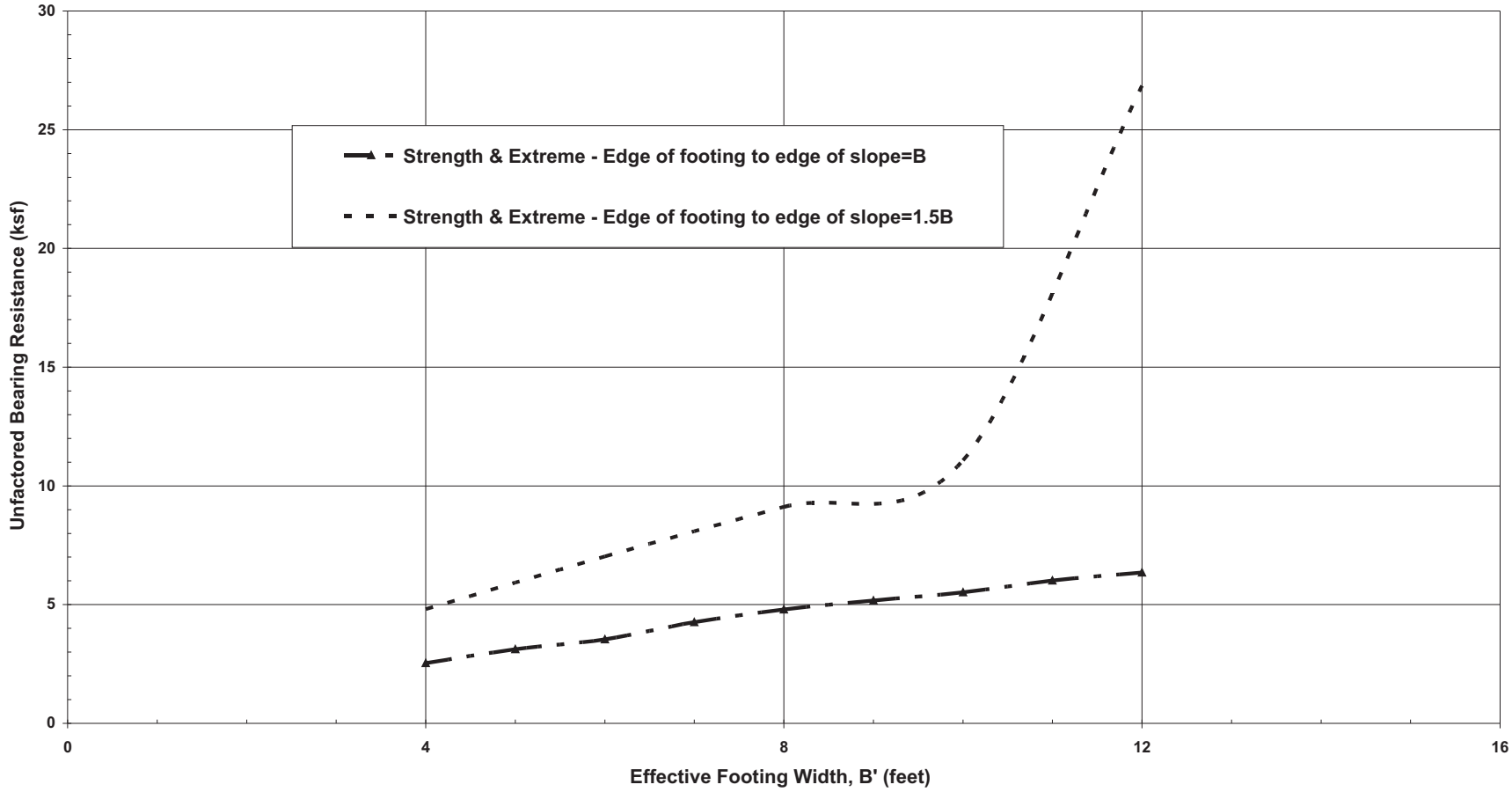
4. Any fine-grained or organic soil encountered in the wall excavation must be removed and replaced with compacted select fill.



Job No. 33758623.50103

Figure 34
Extreme Event I Limit State Earth Pressures

URS



Notes:

1. Effective footing length (L') = 32 feet
2. Groundwater assumed to be at El. 2517
3. B=Total footing width, feet
4. Edge of footing to edge of slope should be measured to earth slope line without any slope armoring

Figure 35

Job No. 33758623.50103

Unfactored Bearing Resistance vs Effective Footing Width - Detour Bridge

URS

33758623.50103_19.CDR

Notes

1. An L-type abutment is shown. For this type of abutment, earth pressures over the height of the superstructure act on the abutment wall. For a stub-type abutment, earth pressures over the height of the superstructure do not need to be included in the pressures that act on the abutment wall.

2. Earth pressures in psf for abutment walls that can deflect (active pressure conditions) may be calculated using the equations and values below.

$P_1 = K_a\gamma(H_1 + H_2)$
$P_2 = K_a\gamma(H_1 + H_2) + K_a\gamma' H_3$
$P_3 = K_a\gamma h_{eq}$
$P_4 = K_p\gamma(H_2 - 2)$
$P_5 = K_p\gamma(H_2 - 2) + K_p\gamma' H_3$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing walls within a distance H of the abutment wall, may be calculated using the equations and values below.

$P_1 = K_0\gamma(H_1 + H_2)$
$P_2 = K_0\gamma(H_1 + H_2) + K_0\gamma'(H_3)$
$P_3 = K_0\gamma h_{eq}$
$P_4 = K_0\gamma(H_2 - 2)$
$P_5 = K_0\gamma(H_2 - 2) + K_0\gamma' H_3$

The values of H_2 and H_3 may be calculated assuming a water table elevation = 2517 feet, which corresponds to high lake level conditions.

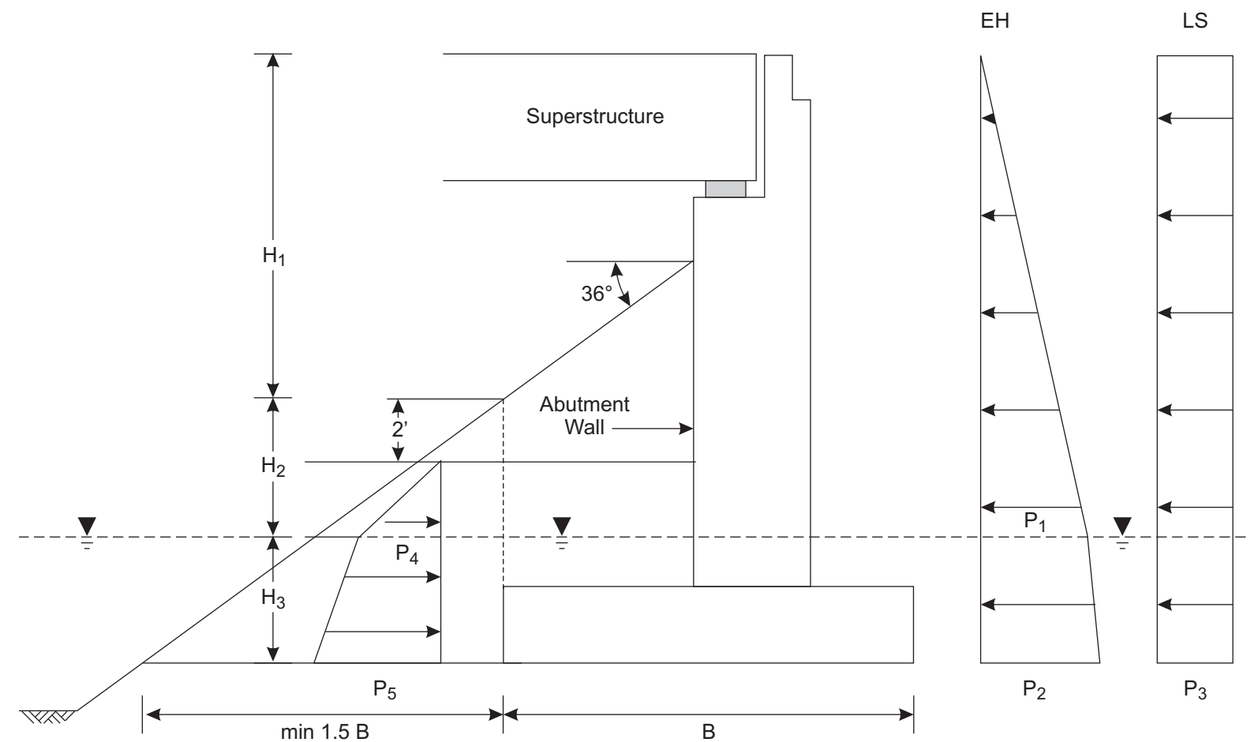
Design Parameters for Calculating Lateral Earth Pressures for Strength Limit State

Parameter	Units	Value
Soil Unit Weight, γ	pounds per cubic foot (pcf)	130
Soil Effective Unit Weight, γ'	pcf	68
Soil Friction Angle, φ	degrees	38
Active Earth Pressure Coefficient, K_a	unitless	0.24
At-Rest Earth Pressure Coefficient, K_0	unitless	0.38
Equivalent Height of Soil for Vehicular Loading on Walls Perpendicular to Traffic, h_{eq}	feet	5<H<10: 4.0 10<H<20: 3.0 H≥20: 2.0
Equivalent Height of Soil for Vehicular Loading on Walls Parallel to Traffic, h_{eq}[1]	feet	2.0
Passive Earth Pressure Coefficient, K_p, for level finish ground line	unitless	4.2
Passive Earth Pressure Coefficient, K_p, for finish ground line sloped at 1.4H:1V	unitless	0.5

H = Height of top of approach fill above finish ground line elevation, feet
[1] Minimum distance from wall backface to edge of traffic = 1.0 foot

3. Any fine-grained or organic soil encountered in the wall excavation must be removed and replaced with compacted select fill.

4. Wall must be fully drained.



Job No. 33758623.50103

Figure 36
Strength Limit State Earth Pressures - Detour Bridge

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

33758623.50103_20.CDR

Notes

1. An L-type abutment is shown. For this type of abutment, earth pressures over the height of the superstructure act on the abutment wall. For a stub-type abutment, earth pressures over the height of the superstructure do not need to be included in the pressures that act on the abutment wall.

2. Earth pressures in psf for abutment walls that can deflect (active pressure conditions) may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(f)}\gamma(H_1 + H_2 + H_3)$
$P_2 = K_{ae(f)}\gamma_{EQ}(\gamma h_{eq})$
$P_3 = K_{pe(f)}\gamma(H_2 - 2)$
$P_4 = K_{pe(f)}\gamma(H_2 - 2) + K_{pe(f)}\gamma' H_3$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing wall within a distance H of the abutment wall, may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(r)}\gamma(H_1 + H_2 + H_3)$
$P_2 = K_{ae(r)}\gamma_{EQ}(\gamma h_{eq})$
$P_3 = K_{pe(r)}\gamma(H_2 - 2)$
$P_4 = K_{pe(r)}\gamma(H_2 - 2) + K_{pe(r)}\gamma' H_3$

The values of H_2 and H_3 may be calculated assuming a water table elevation = 2517 feet, which corresponds to high lake level conditions.

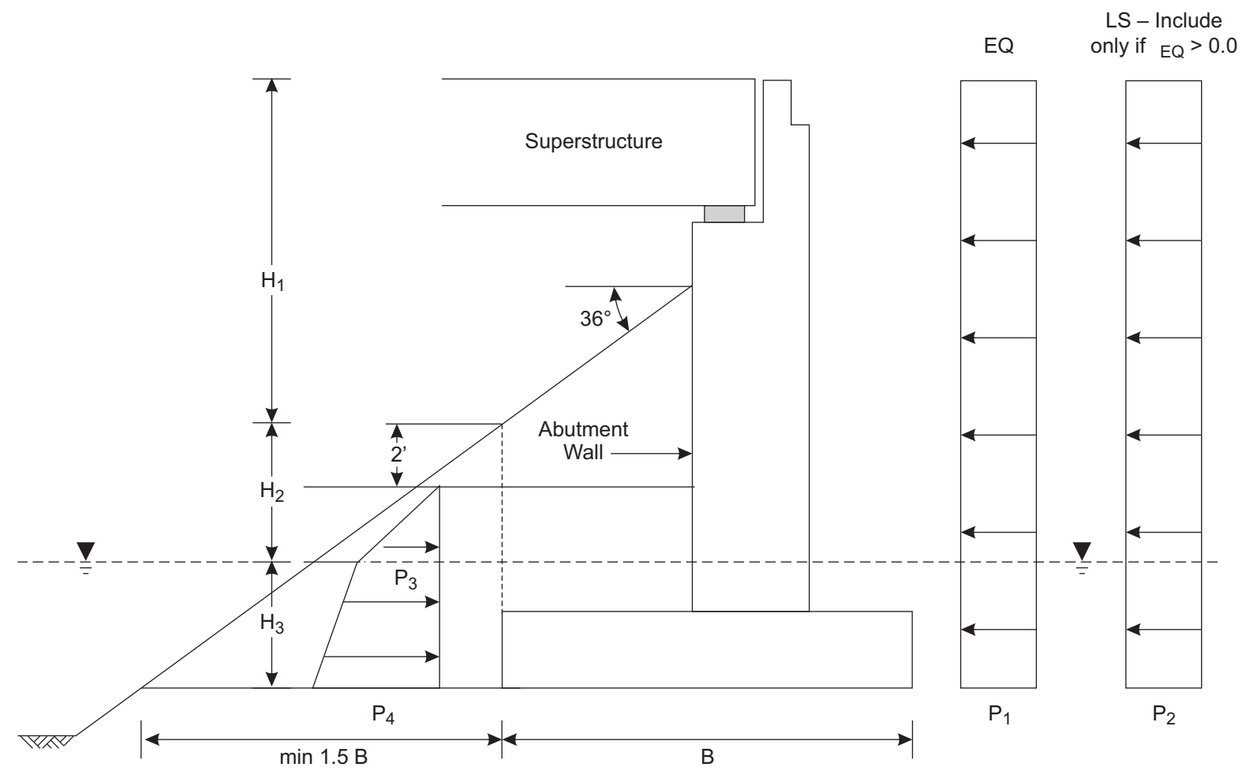
Design Parameters for Calculating Lateral Earth Pressures for Extreme Event Limit State

Parameter	Units	Value
Soil Unit Weight, γ	pounds per cubic foot (pcf)	130
Soil Effective Unit Weight, γ'	pcf	68
Soil Friction Angle, φ	degrees	38
Active Earth Pressure Coefficient, K_a	unitless	0.24
At-Rest Earth Pressure Coefficient, K_0	unitless	0.38
Equivalent Height of Soil for Vehicular Loading on Walls Perpendicular to Traffic, h_{eq}	feet	5<H<10: 4.0 10<H<20: 3.0 H≥20: 2.0
Equivalent Height of Soil for Vehicular Loading on Walls Parallel to Traffic, h_{eq} [1]	feet	2.0
Seismic Passive Earth Pressure Coefficient, $K_{pe(f)}$, for Level Finish Ground Line and Flexible Wall	unitless	4.0
Seismic Passive Earth Pressure Coefficient, $K_{pe(f)}$, for Finish Ground Line Sloped at 1.4H:1V and Flexible Wall	unitless	0.40
Seismic Active Earth Pressure Coefficient for Flexible Retaining Walls, $K_{ae(f)}$	unitless	0.27
Seismic Active Earth Pressure Coefficient for Rigid Retaining Walls, $K_{ae(r)}$	unitless	0.36
Seismic Passive Earth Pressure Coefficient for Level Finish Ground and Rigid Walls, $K_{pe(r)}$	unitless	use K_0
Seismic Passive Earth Pressure Coefficient for Finish Ground Line Sloped at 1.4H:1V and Rigid Wall, $K_{pe(r)}$	unitless	use K_0
Load Factor for Surcharge Load LS, $_{EQ}$	unitless	0.5

H = Height of top of approach fill above finish ground line elevation, feet
[1] Minimum distance from wall backface to edge of traffic = 1.0 foot

3. Any fine-grained or organic soil encountered in the wall excavation must be removed and replaced with compacted select fill.

4. Wall must be fully drained.



Job No. 33758623.50103

Figure 37
Extreme Event I Limit State Earth Pressures - Detour Bridge

URS

WSDOT I-90 Snoqualmie Pass East
Technical Memorandum No. 1 – Gold Creek Bridges

APPENDIX A
BORING LOGS

Table A-1
Summary of Borings for the Gold Creek Bridges

Boring ID	Date Drilled		Elevation (ft)	Project Datum		Total Depth (ft)
	Started	Completed		Northing (ft)	Easting (ft)	
2007 Borings						
GCB-001-07	7/19/2007	7/26/2007	2535.9	1,080,193	1,749,091	47.0
GCB-002-07	8/1/2007	8/1/2007	2530.8	1,080,038	1,749,141	59.5
GCB-003-07	7/31/2007	8/1/2007	2533.9	1,080,174	1,749,284	82.0
GCB-004-07	6/19/2007	6/20/2007	2522.7	1,080,015	1,749,341	90.0
GCB-005-07	7/14/2007	7/18/2007	2527.7	1,080,039	1,749,409	111.5
GCB-006-07	8/14/2007	8/15/2007	2525.1	1,079,823	1,749,417	125.5
GCB-007-07	7/10/2007	7/11/2007	2520.0	1,079,900	1,749,499	101.5
GCB-008-07	7/12/2007	7/14/2007	2523.6	1,079,960	1,749,536	100.5
GCB-009-07	8/16/2007	8/22/2007	2525.5	1,079,729	1,749,539	111.5
GCB-010-07	7/11/2007	7/12/2007	2519.7	1,079,804	1,749,622	100.5
GCB-011-07	7/10/2007	7/11/2007	2522.3	1,079,881	1,749,674	101.5
GCB-012-07	8/15/2007	8/21/2007	2526.1	1,079,634	1,749,664	115.5
GCB-013-07	7/13/2007	7/14/2007	2519.1	1,079,706	1,749,742	99.5
GCB-014-07	7/24/2007	7/25/2007	2521.0	1,079,789	1,749,802	100.5
GCB-015-07	8/21/2007	8/23/2007	2525.9	1,079,564	1,749,753	100.3
GCB-016-07	7/15/2007	7/18/2007	2519.1	1,079,613	1,749,847	100.5
GCB-017-07	7/19/2007	7/24/2007	2520.0	1,079,690	1,749,909	100.5
GCB-018-07	8/8/2007	8/14/2007	2525.9	1,079,418	1,749,932	106.5
GCB-019-07	7/15/2007	7/18/2007	2519.5	1,079,492	1,749,980	129.5
GCB-020-07	6/26/2007	6/27/2007	2519.5	1,079,558	1,750,049	101.0
GCB-021-07	8/3/2007	8/8/2007	2502.1	1,079,287	1,750,022	120.0
GCB-022-07	7/24/2007	7/26/2007	2525.3	1,079,376	1,750,080	100.5
GCB-023-07	7/19/2007	7/24/2007	2519.8	1,079,455	1,750,162	100.5

Table A-1
Summary of Borings for the Gold Creek Bridges (continued)

Boring ID	Date Drilled		Elevation (ft)	Project Datum		Total Depth (ft)
	Started	Completed		Northing (ft)	Easting (ft)	
Previous Borings						
H-1-70A	4/20/1970	4/21/1970	2502.0	1,079,701	1,749,954	79.5
H-2-70A	4/21/1970	4/23/1970	2502.0	1,079,606	1,750,062	103.0
H-01-06 (OW)	6/8/2006	6/13/2006	2536.0	1,080,128	1,749,009	56.0
H-02-06	6/15/2006	6/15/2006	2534.5	1,080,157	1,749,174	75.0
H-03-06 (OW)	6/13/2006	6/15/2006	2527.4	1,079,942	1,749,265	85.5
H-04-06	6/15/2006	6/21/2006	2519.3	1,079,533	1,750,064	96.5
H-05-06	6/27/2006	6/29/2006	2524.9	1,079,244	1,750,145	96.5

OW - indicates groundwater observation well installed
Vertical datum is the North American Vertical Datum (NAVD) 1988
Horizontal datum is based on the Washington Coordinate System, South Zone, and North American Datum (NAD) 1983/91
Northing and easting for previous borings have been updated from State Plane datum to the Project datum.

APPENDIX A.1
2007 BORINGS

Washington State Department of Transportation

Test Boring Legend

URS

Sampler Symbols

	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Bottom Seal
	Inclinometer Casing in Concrete Bentonite Grout

Graphic Legend for Soil Strata

	Gravel with sand/cobbles/ boulders (primarily fill)
	Gravel/cobbles/boulders/sand/ silt (primarily colluvium)
	Organic soil
	Silt/fine sand
	Sand/gravel
	Clay with gravel
	Clayey silt
	Bedrock

33758606_01.cdr

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 0.25 inch thick, note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 0.25 inch thick, note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, somtimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCL Reaction

No HCL Reaction	No visible reaction.
Weak HCL Reaction	Some reaction with bubbles forming slowly.
Strong HCL Reaction	Violent reaction with bubbles forming imediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

Note: This page was modified by URS to include graphic legend for soil strata and to show US standard units.

Washington State Department of Transportation

Test Boring Legend

URS

Grain Size

Fine Grained	<0.04 in	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	0.04 in to 0.2 in	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	>0.2 in	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Description	Unconfined Compressive Strength (Approximate)
R0	Extremely Weak Rock	Indented by thumbnail	0.04 to 0.15 ksi
R1	Very Weak Rock	Specimen crumbles under sharp blow with point of geological hammer, can be peeled by a pocket knife	0.15 to 3.6 ksi
R2	Moderately Weak Rock	Shallow cuts or scrapes can be made in a specimen with a pocket knife, geological hammer point indents deeply with a firm blow	3.6 to 7.3 ksi
R3	Moderately Strong Rock	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer point	7.3 to 15 ksi
R4	Strong Rock	Specimen requires more than one blow of geological hammer to fracture it	15 to 29 ksi
R5	Very Strong Rock	Specimen requires many blows of geological hammer to fracture it	>29 ksi

Discontinuities

Spacing

Very Widely	Greater than 10 feet
Widely	3 feet to 10 feet
Moderately	1 foot to 3 feet
Closely	2 inches to 12 inches
Very Closely	Less than 2 inches

RQD (%)

$$\frac{100(\text{length of core in pieces} > 4 \text{ inches})}{\text{Length of core run}}$$

Condition

Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 0.05 inches, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 0.05 inches, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 0.2 inches thick, or open discontinuities 0.05 to 0.2 inches.
Very Poor	Soft gouge greater than 0.2 inches thick, or open discontinuities greater than 0.2 inches.

Fracture Frequency (FF) is the average number of fractures per unit length of core recovered.
Does not include mechanical breaks caused by drilling or handling.

Note: This page was modified by URS to include graphic legend for soil strata and to show US standard units.

33758606_01.cdr

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-001-07

Sheet 1 of 3

Job No. 33758613.04000 SR 90 Elevation 2536.0 ft (773.0 m)

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Suren Balendra / Ken Yang

Start July 19, 2007 Completion July 26, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1207+46 Offset 52'L Casing HW, HQ, NQ

Method Wet Rotary

Northing 1080192.8 Easting 1749090.983 Latitude 47°23'31.455"N

Longitude 121°23'11.334"W

County Kittitas Subsection NW 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 21.5 feet: Poorly to well graded GRAVEL with sand and occasional cobbles and boulders, subangular, dense to very dense, gray, wet, homogenous, HCl not tested.		
									0 feet: Very dense poorly graded GRAVEL with sand.		
	1			40			D-1 / GP	50 for 5" (>50)			
				40			C-2 / GP(C)		grades to GRAVEL with cobbles. Maximum length of the cobbles encountered is 6 inches.		
5											
	2			43			D-3 / GW	9 17 18 (35)	grades to dense well graded GRAVEL with sand.		
				50			D-4 / GW	18 20 23 (43)			
10	3										
				30			D-5 / GP	13 21 25 (46)	grades to poorly graded.		
				50			C-6 / GP(C)		grades to GRAVEL with cobbles. Maximum length of the cobbles encountered is 6 inches.		
	4										
15											
				20			D-7 / GW	6 11 50 for 3" (>50)	grades to very dense well graded GRAVEL with sand.		
	5			100			C-8 / GW(C/B)		grades to GRAVEL with cobbles and boulders. Maximum length of cobbles encountered is 12 inches.		
				100			C-9 / GW(C)		grades to GRAVEL with cobbles.		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-001-07

Job No. 33758613.04000 SR 90 Elevation 2536.0 ft (773.0 m)

Sheet 2 of 3

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100 / 44			C-10 ML C-11 ML		21.5 to 26.5 feet: ORGANIC SOIL (silt with trace of organics), soft, dark brown to brown, wet, homogenous, HCl not tested. (PP = 0.25 tsf).	▽	
25	7										
	8			80			D-11A SW	5 14 23 (37)	26.5 to 37 feet: Well graded SAND with gravel, subrounded to subangular, dense to very dense, brown to gray, wet, homogenous, HCl not tested.		
30	9										
				67			D-12 SW	16 20 39 (59)			
	10										
35	11										
				64 / 1.9			C-13		37 to 47 feet: Andesite, grayish blue, medium grained, slighty weathered, moderately strong (R3). No HCl reaction. Discontinuities are closely to medium spaced and in fair to good condition. CR = 64-100%, RQD = 75-94%, FF = 0.8 to 1.9.		
40	12								37 feet: slightly weathered rock. Discontinuities are closely spaced and in fair condition.		
	13			100 / 0.8			C-14		grades to fresh rock. Discontinuities are medium spaced and are in good condition.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-001-07

Job No. 33758613.04000 SR 90 Elevation 2536.0 ft (773.0 m)

Sheet 3 of 3

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14										
									Bottom of boring at 47 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/26/07 at 08:00 - 22.5 feet.		
	15										
50											
	16										
55											
	17										
	18										
60											
	19										
65											
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-002-07

Sheet 1 of 3

Job No. 33758613.04000 SR 90 Elevation 2530.8 ft (771.4 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start August 1, 2007 Completion August 1, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1208+71 Offset 52'R Casing HW, HQ Method Wet Rotary

Northing 1080037.889 Easting 1749140.897 Latitude 47°23'29.932"N Longitude 121°23'10.583"W

County Kittitas Subsection NW 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			C-1 GW(C/B)		0 to 13 feet: Well graded to poorly graded GRAVEL with sand or with cobbles and boulders, subrounded to angular, medium dense to dense, light to dark gray, moist to wet, homogenous, HCl not tested.		
									0 feet: Well graded GRAVEL with sand.		
	1								grades to GRAVEL with cobbles and boulders.		
5				17			D-2 GP	16 25 10 (35)	grades to dense poorly graded GRAVEL with sand.		
	2			100			C-3 GW(C/B)		grades to well graded GRAVEL with cobbles and boulders.		
				63			C-4 GW(C/B)				
10	3			22			D-5 GW	1 13 10 (23)	grades to GRAVEL with sand.		
							C-6 GW(C/B)		grades to GRAVEL with cobbles and boulders.		
	4			56			D-7 GM/OL	3 2 4 (6)	13 to 14.5 feet: ORGANIC SOIL (Silty GRAVEL with sand and organics), loose, brown, wet, stratified, HCl not tested.		
15							C-8 GM-SM		14.5 to 29 feet: Well graded silty GRAVEL with sand or silty SAND with fine gravel and occasional layers of gravel/sand/silty sand/sandy silt, subrounded to subangular, medium dense to dense, moist to wet, homogenous, HCl not tested.		
				0			D-9 GM-SM	4 2 5 (7)			
	5						C-10 GM		14.5 feet: Loose silty SAND with gravel or silty GRAVEL with sand. grades to silty GRAVEL with sand.		
							D-11 SM	1 4 21 (25)	grades to dense silty SAND with occasional sandy SILT layers.		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-002-07

Job No. 33758613.04000 SR 90 Elevation 2530.8 ft (771.4 m)

Sheet 2 of 3

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			D-12 SP	13 17 26 (43)	grades to poorly graded SAND with gravel.		
	7										
25				56			D-13 SW	8 14 16 (30)	grades to well graded SAND with gravel.		
	8										
	9			56			D-14 SM	7 9 13 (22)	29 to 47 feet: Silty SAND/SILT with occasional layers of hard clayey SILT/silty CLAY, medium dense to very dense, light to dark brown, moist, homogenous with occasionally stratified or laminated layers, HCl not tested.		
30									29 feet: medium dense silty SAND with gravel.		
	10										
				44			D-15 ML	7 15 17 (32)	grades to dense sandy SILT. Medium dilitancy.		
35											
	11										
	12			100			D-16 CL-ML	16 29 30 (59)	grades to hard clayey SILT/silty CLAY.		
40											
	13										
				89			D-17 SM	8 30 32			
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-002-07

Job No. 33758613.04000 SR 90 Elevation 2530.8 ft (771.4 m)

Sheet 3 of 3

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(62)	grades to very dense silty SAND with gravel.		
	14										
				43			C-18		47 to 59.5 feet: Andesite, bluish gray, medium grained, fresh to highly weathered, strong to very strong (R4 to R5). None to very slight HCl reaction, Discontinuities are closely spaced and are in poor condition. CR = 40% - 100%, RQD = 14% - 85%.		
	15								47 feet: fresh rock.		
50				95			C-19		grades to highly weathered rock, very slight HCl reaction.		
	16										
55											
	17			100			C-20				
	18										
60									Bottom of boring at 59.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
	19										
65											
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-003-07

Sheet 1 of 4

Job No. 33758613.04000 SR 90 Elevation 2533.9 ft (772.3 m)

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang

Start July 31, 2007 Completion August 1, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1209+16 Offset 142'L Casing HW 13', HQ 80'

Method Wet Rotary

Northing 1080174.166 Easting 1749284.448 Latitude 47°23'31.292"N

Longitude 121°23'08.520"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									Top 2 feet - Topsoil.		
									2 to 12 feet: Well graded GRAVEL with sand, subangular to angular, dense to very dense, gray, moist to wet, homogenous, HCl not tested.		
	1			60			D-1 / GW	10 16 17 (33)			
5				53			D-2 / GW	13 29 43 (72)			
	2										
				80			D-3 / GW	17 42 32 (74)			
10	3			73			D-4 / GW	26 37 35 (72)			
									12 to 15 feet: Organic SOIL (silty SAND with gravel and small wood pieces), medium dense, dark brown, wet, stratified, HCl not tested.		
	4			67			D-5 / SM/OL	13 10 10 (20)			
15				53			D-6 / GW	15 24 24 (48)	15 to 34 feet: Poorly to well graded GRAVEL with sand and occasional cobbles and occasional layers of loose ORGANIC SOIL/sandy SILT, angular, dense to very dense, gray, wet, homogenous, HCl not tested.		
	5			83			C-7 / GP(C)		15 feet: Dense well graded GRAVEL with sand. grades to poorly graded GRAVEL with cobbles. Maximum length of the cobbles encountered is 10 inches.		
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-003-07

Job No. 33758613.04000 SR 90 Elevation 2533.9 ft (772.3 m)

Sheet 2 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			C-8 / GP(C)		Maximum length of the cobbles encountered is 3 inches.		
	7										
				95			C-9 / GP				
25										▽	
	8			73			D-10 / ML	2 3 3 (6)	grades to ORGANIC SOIL (silt with wood pieces), loose, black, wet, homogenous, HCl not tested. grades to sandy SILT, loose, dark gray, moist, stratified, HCl not tested.		
	9										
30											
				60			D-11 / GW(C)	24 27 28 (55)	grades to very dense well graded GRAVEL with cobbles.		
	10										
									34 to 69 feet: Silty SAND/sandy SILT, loose to medium dense, gray, wet, homogenous, HCl not tested. 34 feet: medium dense silty SAND.		
35											
	11			53			D-12 / SM	1 6 10 (16)			
	12										
40											
				87			D-13 / SM	18 14 14 (28)	grades to dense.		
	13										
45											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-003-07

Job No. 33758613.04000 SR 90 Elevation 2533.9 ft (772.3 m)

Sheet 3 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			80			D-14 SM-ML	4 5 6 (11)	grades to medium dense silty SAND/ sandy SILT.		
	15										
50											
				80			D-15 ML	4 5 7 (12)	grades to sandy SILT, rapid dilitancy.		
	16			100			UD-16 ML				
55											
	17			60			D-17 ML	5 5 6 (11)			
	18										
60											
				93			D-18 SM	2 3 3 (6)	grades to loose silty SAND.		
	19										
65											
	20			93			D-19 SM-ML	3 4 4 (8)	grades to silty SAND/sandy SILT.		
	21								69 to 82 feet: Andesite, grayish blue, fine grained, fresh, moderately strong rock (R3). None to weak HCl reaction.		
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-003-07

Job No. 33758613.04000 SR 90 Elevation 2533.9 ft (772.3 m)

Sheet 4 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				0			D-19A C-19B	10 for 0"	Discontinuities are closely spaced and in fair to poor condition. CR = 75 - 100%, RQD = 86 - 93%, FF = 1 - 1.3. 69 feet: Discontinuities are closely spaced and in fair condition.		
75	22 23			75 / 1.3			C-20				
				100 / 1			C-21		Discontinuities are closely spaced and in fair to poor condition.		
80	24										
	25								Bottom of boring at 82 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 8/1/07 at 08:00: 25.1 feet.		
85	26										
	27										
90	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-004-07

Sheet 1 of 4

Job No. 33758613.04000 SR 90 Elevation 2522.7 ft (768.9 m)

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang, Dave Nelson

Start June 19, 2007 Completion June 20, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1210+49 Offset 42'L Casing HW 20' 4.5" Method Wet Rotary

Northing 1080014.842 Easting 1749340.926 Latitude 47°23'29.726"N Longitude 121°23'07.673"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
							SM		Top 2 feet: Silty SAND, dark gray, moist, with roots (Topsoil)		
	1			50			D-1 / SM	16 12 25 (37)	2 to 16.5 feet: Alternating layers of poorly graded GRAVEL with sand and silty SAND with gravel, subangular to angular, generally dense to very dense, brown to gray, moist to wet, homogenous, HCl not tested.		
5									2 feet: Dense silty SAND with gravel.		
	2			60			D-2 / SM	13 11 26 (37)			
				60			D-3 / GP	4 15 23 (38)	grades to poorly graded GRAVEL with sand.	▽	
10	3			0			D-4 / GP	9 5 3 (8)	grades to loose.		
	4			40			D-6 / GP	5 30 38 (68)	grades to very dense.		
15				13			D-7 / GP	39 26 33 (59)			
	5						C-8		16.5 to 20 feet: ORGANIC SOIL (silt), loose, gray-green, wet, homogenous, HCl not tested. PP=0.5 tsf. Note: A 3.5-inch long wood piece was encountered at 16.5 feet.		
				67			D-9 / OL	1 1 4 (5)			
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-004-07

Job No. 33758613.04000 SR 90 Elevation 2522.7 ft (768.9 m)

Sheet 2 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				33			D-10 / GP	15 21 50 for 3" (>50)	20 to 29 feet: Poorly graded GRAVEL with sand, angular, dense to very dense, gray, wet, homogenous, HCl not tested. 20 feet: very dense.		
	7										
25				20			D-11 / GP	22 18 21 (39)	grades to dense.		
	8										
	9								29 to 90.01 feet: Silty SAND (fine)/sandy SILT/SILT/silty CLAY, generally medium dense, gray, wet, homogenous, HCl not tested. 29 feet: Medium dense sandy SILT.		
30				100			D-12 / ML	2 7 12 (19)			
	10										
35				100			D-13 / ML	8 10 9 (19)			
	11										
	12										
40				73			D-14 / ML	8 10 10 (20)			
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-004-07

Job No. 33758613.04000 SR 90 Elevation 2522.7 ft (768.9 m)

Sheet 3 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			D-15 SM	5 5 8 (13)	grades to silty SAND.		
	14										
	15										
50				100			D-16 ML	5 6 7 (13)	grades to sandy SILT.		
	16										
55				80			D-17 CL-ML	6 6 7 (13)	grades to stiff clayey SILT/silty CLAY.		
	17										
	18										
60				80			D-18 CL-ML	5 5 7 (12)			
	19										
									grades to medium stiff silty CLAY.		
65				100			D-19 CL	3 4 4 (8)			
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-004-07

Job No. 33758613.04000 SR 90 Elevation 2522.7 ft (768.9 m)

Sheet 4 of 4

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				60			D-20 CL-ML	4 7 12 (19)	grades to very stiff silty CLAY/clayey SILT, stratified.		
	22										
75	23			60			D-21 ML	5 7 6 (13)	grades to medium dense sandy SILT.		
	24										
80				47			D-22 ML	5 4 4 (8)	grades to loose.		
	25										
85	26			100			D-23 ML	3 3 20 (23)	grades to medium dense.		
	27										
90				0			D-24 GP	50 for 0"	Bottom of boring at 90.01 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 6/20/07 at 07:15: 7.9 feet.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-005-07

Job No. 33758613.04000 SR 90 Elevation 2527.7 ft (770.5 m)

Sheet 1 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Drilling Contractor WSDOT Field Exploration Unit

Inspector Suren Balendra

Start July 14, 2007 Completion July 18, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1210+90 Offset 101'L Casing HW, HQ, NQ

Method Wet Rotary

Northing 1080039.302 Easting 1749408.577 Latitude 47°23'29.975"N

Longitude 121°23'06.694"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				60			D-1 SM	9 16 19 (35)	Top 3.5 feet: Dense silty SAND/ well graded SAND with gravel.		
				63			D-2 SW	6 18 26 (44)			
	1			50			C-3 GP(C)		3.5 to 17 feet depth: Poorly to well graded GRAVEL with sand or well graded SAND with gravel, occasional cobbles and boulders, subrounded, very dense, gray, wet, homogenous, HCl not tested.		
5											
				60			D-4 SW	17 21 30 (51)	3.5 feet: Dense poorly graded GRAVEL with cobbles. Maximum length of the cobbles encountered is 3.5 inches. grades to very dense well graded SAND with gravel.		
	2			100			C-5 GP(C/B)		grades to GRAVEL with cobbles and boulders. Maximum length of the cobbles encountered is 8 inches.		
				100			C-6 GP(C/B)				
10	3										
				100			D-7 SW	17 50 for 4"	grades to very dense well graded GRAVEL with sand or SAND with gravel.		
				75			C-8 GP(C/B)		grades to poorly graded GRAVEL with cobbles and boulders.		
	4			50			D-9 GW	13 29 36 (65)	grades to very dense well graded GRAVEL with sand.		
15				150			C-10 GP(C/B)		grades to poorly graded GRAVEL with cobbles and boulders.		
	5			32			C-11 GP(C/B)				
									17 to 27 feet depth: Well to poorly graded SAND with gravel, subrounded, dense to very dense, olive brown to gray, wet, homogenous, HCl not tested.		
				30			D-12 SW	29 16 19 (35)	17 feet: dense.		
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-005-07

Job No. 33758613.04000 SR 90 Elevation 2527.7 ft (770.5 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	7										
25				43			D-13 / SP	3 35 23 (58)	grades to very dense.		
	8										
									27 to 101.5 feet depth: Poorly graded SAND, silty fine SAND, sandy SILT and SILT, medium dense, brown to gray, wet, homogenous, HCl not tested. 27 feet: Poorly graded SAND.		
	9										
30				80			D-14 / SP	5 7 7 (14)			
	10										
35				80			D-15 / SM	6 8 9 (17)	grades to silty SAND.		
	11										
	12										
40				80			D-16 / SP	4 7 8 (15)	grades to poorly graded SAND.		
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-005-07

Job No. 33758613.04000 SR 90 Elevation 2527.7 ft (770.5 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				73			D-17 SP	4 7 9 (16)			
	14										
	15										
50				100			UD-18 ML		grades to medium dense SILT, rapid dilitancy.		
				67			D-19 ML	5 7 8 (15)			
	16										
55				77			D-20 ML	6 9 11 (20)			
	17										
	18										
60				53			D-21 SM	3 4 11 (15)	grades to medium dense silty SAND.		
	19										
65				43			D-22 ML	6 9 12 (21)	grades to medium dense SILT with sand.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-005-07

Job No. 33758613.04000 SR 90 Elevation 2527.7 ft (770.5 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-23 / ML	2 3 3 (6)	grades to loose SILT.		
	22			100			UD-24 / ML				
75	23			33			D-25 / ML	5 9 9 (18)	grades to medium dense sandy SILT.		
	24										
80				60			D-26 / ML	5 8 9 (17)			
	25										
85	26			47			D-27 / ML	5 10 10 (20)			
	27										
90				37			D-28 / ML	6 6 5 (11)			
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-005-07

Job No. 33758613.04000 SR 90 Elevation 2527.7 ft (770.5 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			47			D-29 / ML	4 4 6 (10)	grades to loose.		
	30										
100				47			D-30 / SM	13 7 50 for 4.5"	grades to very dense silty SAND with gravel.		
	31			19			D-31A		101.5 to 103.3 feet: Poorly graded GRAVEL with sand or well graded SAND with gravel, subrounded to subangular, very dense, gray, wet, homogenous, HCl not tested.		
				100 / 6			C-31		101.5 feet: Silty SAND with gravel. grades to poorly graded GRAVEL.		
105	32								103.3 to 111.5 feet: Andesite, light green, fine grained, fresh to slightly weathered, moderately strong rock. No HCl reaction. Discontinuities are closely spaced and in very poor to good condition. CR = 77-100%, RQD = 34 - 80%, FF = 2.5 to 6.		
				100 / 2.5			C-32		103.3 feet: slightly weathered rock. Discontinuities are in very poor condition. Sheared zone at 105.5 feet. grades to fresh rock. Discontinuities are in good condition.		
	33										
110											
	34								Bottom of boring at 111.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
									Water level measurements (below existing ground surface): - 7/17/07 at 11:00: 20.1 feet.		
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Sheet 1 of 6

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang, Dave Nelson

Start August 14, 2007 Completion August 15, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1212+26 Offset 68'R Casing HW, HQ 125'

Method Wet Rotary

Northing 1079822.536 Easting 1749417.353 Latitude 47°23'27.837"N

Longitude 121°23'06.531"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 17 feet depth: Well graded to poorly graded GRAVEL with sand or silty gravel with sand, subrounded to angular, very loose to dense, light brown to light gray, moist to wet, homogenous, HCl not tested.		
									0 feet : medium dense well graded GRAVEL with sand.		
	1			67			D-1 / GW	5 13 11 (24)			
5				53			D-2 / GW	14 16 23 (39)	grades to dense.		
	2										
				0			D-3 / GW	13 8 22 (30)		▽	
10	3			20			D-4 / GW	5 11 7 (18)	grades to medium dense.		
	4			20			D-5 / GP	4 4 2 (6)	grades to loose.		
15				33			D-6 / GM	1 2 1 (3)	grades to very loose silty GRAVEL with sand.		
	5										
									17 to 24 feet: ORGANIC SOIL (Silty fine SAND with trace organics/wood and gravel), subrounded, loose, dark brown to dark gray, moist, homogenous and occasionally stratified, HCl not tested.		
				50			D-7 / SM/OL	2 2 3 (5)			
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Sheet 2 of 6

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-8 SM/OL	1 2 4 (6)			
	7										
25				50			D-9 GP	12 22 19 (41)	24 to 34 feet: Poorly graded GRAVEL with sand, subangular to angular, medium dense to dense, bluish-gray to light brown, wet, homogenous, HCl not tested. 24 feet: dense.		
	8										
	9										
30				0			D-10 GP	11 15 9 (24)	grades to medium dense.		
	10										
35				100			D-11 SM	4 8 12 (20)	34 to 122.5 feet: Silty fine SAND, medium dense, light brown, wet, homogenous, HCl not tested and sandy SILT/elastic SILT/silty CLAY, medium dense/ medium stiff to stiff, light brown to gray, wet, homogenous, occasionally laminated or stratified, HCl not tested. 34 feet: silty fine SAND.		
	11										
	12										
40				20			D-12 SM	9 14 15 (29)			
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Sheet 3 of 6

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-13 SM	10 15 15 (30)			
	14										
	15										
50				80			D-14 SM	8 14 16 (30)			
	16								grades to medium dense sandy SILT, rapid dilitancy.		
55				60			D-15 ML	3 6 6 (12)			
	17										
	18										
60				100			D-16 SM-ML	4 8 8 (16)	grades to silty SAND/sandy SILT.		
	19										
65				7			D-17 SM	6 12 11 (23)	grades to silty fine SAND.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Sheet 4 of 6

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				50			D-18 MH	4 6 8 (14)	grades to stiff elastic SILT.		
	22										
75	23			80			D-19 MH	2 4 4 (8)	grades to medium stiff. PP = 0.5 tsf.		
	24										
80				100			D-20 CL-MH	2 4 4 (8)	grades to silty CLAY/elastic SILT. PP=1.25 tsf.		
	25						UD-21 CL-MH		82.2 to 122.5 feet: Silty SAND/sandy SILT, loose to medium dense. bluish gray, wet, homogenous, HCl not tested, with occasional layers of loose SILT and medium dense well graded SAND. 82.2 feet: medium dense silty SAND/sandy SILT.		
85	26			67			D-22 SM-ML	3 5 7 (12)			
	27										
90				67			D-23 SM-ML	3 6 4 (10)	grades to loose.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Sheet 5 of 6

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			60			D-24 SM-ML	6 9 9 (18)	grades to medium dense.		
	30										
100				67			D-25 SM-ML	6 12 12 (24)			
	31										
105	32			67			D-26 ML	3 3 7 (10)	grades to loose sandy SILT.		
	33										
110				53			D-27 SW	7 12 9 (21)	grades to medium dense well graded SAND with gravel.		
	34										
115	35			80			D-28 SM-ML	3 4 6 (10)	grades to loose silty SAND/sandy SILT.		
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-006-07

Job No. 33758613.04000 SR 90 Elevation 2525.1 ft (769.7 m)

Sheet 6 of 6

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				60			D-29 / ML	3 4 5 (9)	grades to sandy SILT.		
	37										
									122.5 to 125.5 feet: Well graded GRAVEL with sand, subangular, very dense, bluish-gray, wet, homogenous, no HCl reaction.		
	38										
125				60			D-30 / GW	50 for 6" (50)			
									Bottom of boring at 125.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 8/15/07 at 07:15: 9.3 feet.		
	39										
130											
	40										
	41										
135											
	42										
140											
	43										
	44										
145											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-007-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Drilling Contractor WSDOT Field Exploration Unit

Inspector Suren Balendra

Start July 10, 2007 Completion July 11, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1212+43 Offset 43'L Casing HW, HQ

Method Wet Rotary

Northing 1079899.668 Easting 1749498.686 Latitude 47°23'28.607"N

Longitude 121°23'05.362"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				93			D-1 / SW	2 5 8 (13)	Top 2 feet: Medium dense well graded SAND with grass (topsoil).		
	1			76			D-2 / SM	23 33 28 (61)	2 to 12 feet: Silty SAND with gravel/silty GRAVEL with sand, subrounded to subangular, generally medium dense to very dense, brown to gray, moist to wet, homogenous, HCl not tested. 2 feet: very dense silty SAND with gravel.		
5	2			57			D-3 / GM	6 10 12 (22)	grades to medium dense silty GRAVEL with sand.		
				0			D-4 / GM	5 2 2 (4)	grades to very loose.		
10	3			50			D-5 / GM	22 16 27 (53)	grades to very dense.		
	4			40			D-6 / SM/OL	1 1 1 (2)	12 to 19 feet: ORGANIC SOIL (silty SAND), very loose to medium dense, brown to black, wet, homogenous, HCl not tested. 12 feet: very loose.	▽	
15	5						UD-7 / SM/OL		grades to medium dense.		
				67			D-8 / SM/OL	4 8 4 (12)			
20	6								19 to 25 feet: Poorly graded GRAVEL, occasional cobbles, subrounded to angular, medium dense, olive		

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-007-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				20			D-9 / GP	6 4 7 (11)	gray or grayish green, wet, homogenous, HCl not tested. 19 feet: medium dense poorly graded GRAVEL.		
	7			60			C-10 / GP(C)		grades to GRAVEL with cobbles.		
25	8			67			D-11 / SM	8 9 12 (21)	25 to 101.5 feet: Silty SAND/sandy SILT with occasional layers of clay and medium dense poorly graded SAND, loose to medium dense, gray, wet, homogenous, HCl not tested. 25 feet: medium dense silty SAND.		
30	9			83			D-12 / SP	3 9 9 (18)	grades to poorly graded fine SAND.		
35	10			93			D-13 / SP	6 10 10 (20)			
40	11			83			D-14 / SM	4 6 7 (13)	grades to silty SAND.		
45	12										
	13										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-007-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-15 / ML	6 7 12 (19)	grades to sandy SILT, rapid dilitancy.		
	14										
	15										
50				73			D-16 / SM	6 7 9 (16)	grades to silty SAND.		
	16										
55							D-17 / SM	6 8 11 (19)			
	17										
	18										
60				87			D-18 / ML	7 5 4 (9)	grades to medium stiff SILT, rapid dilitancy. PP= 0.5 tsf.		
	19										
65				100			UD-19 / CL		grades to CLAY.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-007-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				40			D-20 SM	7 8 9 (17)	grades to medium dense silty SAND.		
	22										
75	23			80			D-21 SM	9 11 11 (22)			
	24										
80				73			D-22 SM	3 6 7 (13)			
	25										
85	26			73			D-23 SM	3 4 7 (11)			
	27										
90				73			D-24 SM-ML	8 9 12 (21)	grades to sandy SILT/silty SAND.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-007-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			80			D-25 SM-ML	4 3 6 (9)			
	30										
100				80			D-26 SP	6 13 15 (28)	grades to dense poorly graded medium SAND.		
	31								Bottom of boring at 101.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/10/07 at 07:30: 12.2 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-008-07

Job No. 33758613.04000 SR 90 Elevation 2523.6 ft (769.2 m)

Sheet 1 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Drilling Contractor WSDOT Field Exploration Unit

Inspector Suren Balendra

Start July 12, 2007 Completion July 14, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1212+37 Offset 113'L Casing HW, HQ Method Wet Rotary

Northing 1079959.816 Easting 1749536.218 Latitude 47°23'29.205"N Longitude 121°23'04.826"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				80			D-1 SM	5 7 13 (20)	Top 2 feet: Medium dense silty SAND with grass roots (topsoil).		
				10			C-2 GP		2 to 10 feet: Poorly graded GRAVEL with sand, with occasional cobbles and boulders, subrounded to angular, very dense, brown to gray, moist to wet, homogeneous, HCl not tested.		
	1			47			D-3 GP	28 26 25 (51)	2 feet: GRAVEL with sand.		
5				140			C-4 GP(C)		grades to GRAVEL with cobbles. Maximum length of the cobbles encountered is 10 inches.		
				100			C-5 GP(B)		grades to GRAVEL with cobbles and boulders.		
	2			72			C-6 GP		grades to GRAVEL with sand.		
10	3			43			D-7 GP	18 15 50 for 6" (>50)	10 to 25 feet: Poorly graded GRAVEL with sand and occasional cobbles and boulders, subrounded to subangular, very dense, brown to gray, wet, homogenous, HCl not tested.		
				100			C-8 GP		10 feet: GRAVEL with sand.		
	4			67			D-9 GP	22 50 for 5" (>50)			
				41			C-10 GP(C)		grades to GRAVEL with cobbles.		
15				20			D-11 GP	50 for 5"	grades to GRAVEL with cobbles and boulders.		
				100			C-12 GP(C/B)				
	5			100			C-13 GP(C/B)			▽	
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-008-07

Job No. 33758613.04000 SR 90 Elevation 2523.6 ft (769.2 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				60			C-14 GP		grades to GRAVEL.		
	7										
25				50			D-15 SM	5 6 1 (17)	25 to 100.5 feet: Poorly graded silty SAND or fine SAND with occasional layers of medium dense sandy silt, medium dense to dense, light brown to gray, wet, homogenous, HCl not tested.		
	8								25 feet: medium dense silty SAND.		
	9										
30				63			D-16 SP	9 10 13 (23)	grades to poorly graded SAND.		
	10										
35				77			D-17 SM	7 12 19 (31)	grades to dense silty SAND.		
	11										
	12			53			D-18 SM	5 9 9 (18)	graded to medium dense.		
40											
	13										
				77			D-19 SM	6 9 10			
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-008-07

Job No. 33758613.04000 SR 90 Elevation 2523.6 ft (769.2 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(19)			
	14										
	15			67			D-20 SP	6 9 11 (20)	grades to poorly graded SAND.		
50											
	16										
				77			D-21 SP	5 8 14 (22)			
55											
	17										
	18			50			D-22 ML	6 6 6 (12)	grades to sandy SILT, low dilitancy.		
60											
	19										
				90			D-23 ML	3 5 13 (18)	grades to silty SAND.		
65											
	20										
	21			73			D-24 SM	6 10 13			
70											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-008-07

Job No. 33758613.04000 SR 90 Elevation 2523.6 ft (769.2 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(23)			
	22										
				73			D-25 SP	5 11 13 (24)	grades to poorly graded SAND.		
75	23										
	24			80			D-26 SM	9 12 13 (25)	grades to dense silty SAND.		
80											
	25										
				87			D-27 SM	6 9 11 (20)	grades to medium dense.		
85	26										
	27			67			D-28 SM	9 13 15 (28)	grades to dense.		
90											
	28										
				67			D-29 SM	7 7 10			
95											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-008-07

Job No. 33758613.04000 SR 90 Elevation 2523.6 ft (769.2 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Joe Judd Lic# 3454

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(17)	grades to medium dense.		
	30										
100				80			D-30 / SM	4 5 9 (14)			
									Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/14/07 at 10:30: 17.9 feet.		
	31										
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-009-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2525.5 ft (769.8 m)

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang / Dave Nelson

Start August 16, 2007 Completion August 22, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1213+19 Offset 66'R Casing HW 15', HQ 110'

Method Wet Rotary

Northing 1079728.939 Easting 1749539.436 Latitude 47°23'26.927"N

Longitude 121°23'04.742"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 13 feet: Silty SAND with gravel or poorly to well graded GRAVEL with sand and occasional cobbles, subangular, dense, gray, wet, homogenous, HCl not tested.		
									0 feet: Silty SAND with gravel.		
	1			40			D-1 / SM	15 18 9 (27)			
5				50			D-2 / SM	6 22 24 (46)			
	2										
				75			C-3 / GP(C)		grades to GRAVEL with cobbles. Maximum size of the cobbles encountered is 5 inches.		
				26			C-4 / GP(C)		Maximum size of the cobbles encountered is 8 inches.		
10	3										
				0			D-5 / GW	1 3 4 (7)	grades to well graded GRAVEL with sand.		
	4			80			D-6 / SM/OL	7 8 6 (14)	13 to 14.5 feet: Silty SAND with gravel and trace organics?, subangular, medium dense, dark brown, moist, homogenous, HCl not tested.	▽	
15				67			D-7 / GM	4 7 7 (14)	14.5 to 36.5 feet: Well graded to poorly graded GRAVEL with sand, subangular to angular, medium dense to very dense, reddish yellow to brown to bluish gray, wet, homogenous, HCl not tested.		
	5								14.5 feet: Medium dense silty GRAVEL with sand.		
				50			D-8 / GW	5 12 12 (24)	grades to medium dense well graded GRAVEL with sand.		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-009-07

Job No. 33758613.04000 SR 90 Elevation 2525.5 ft (769.8 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				40			D-9 / GW	10 15 15 (30)	grades to dense.		
	7										
25				40			D-10 / GW	3 3 16 (19)	grades to medium dense.		
	8										
	9										
30				40			D-11 / GW	23 44 32 (76)	grades to very dense.		
	10										
35				50			C-12 / GP		grades to poorly graded.		
	11										
				73			D-13 / SM	6 9 10 (19)	36.5 to 53 feet: Silty SAND with occasional layers of clayey silt/silty clay, medium dense to dense, light brown to brown, wet, homogenous, HCl not tested. 36.5 feet: Medium dense silty SAND.		
	12										
40				73			D-14 / CL-ML	6 11 13 (24)	grades to very stiff clayey SILT/silty CLAY.		
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-009-07

Job No. 33758613.04000 SR 90 Elevation 2525.5 ft (769.8 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				87			D-15 / SM	14 14 13 (27)	grades to dense silty SAND.		
	14										
	15										
50				100			D-16 / SM	6 11 13 (24)	grades to medium dense.		
	16										
									53 to 83.2 feet: Layers of SILT, SAND and silty CLAY, medium dense, gray to brown, wet, homogenous, HCl not tested.		
									53 feet: SILT with sand.		
55				100			D-17 / ML	7 10 13 (23)			
	17										
	18										
60				80			D-18 / SP	7 11 13 (24)	grades to poorly graded fine SAND.		
	19										
65				80			D-19 / ML	7 8 11 (19)	grades to sandy SILT.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-009-07

Job No. 33758613.04000 SR 90 Elevation 2525.5 ft (769.8 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				73			D-20 ML	9 12 12 (24)			
	22										
75	23			80			D-21 CL	4 6 5 (11)	grades to stiff silty CLAY.		
	24										
80				100			UD-22 SP		grades to poorly graded fine SAND.		
	25			100			D-23 SM	4 5 15 (20)	grades to medium dense silty SAND.		
									83.2 to 110.4 feet: silty SAND/sandy SILT with occasional layers of very stiff elastic SILT, medium dense to dense, gray, wet, homogenous, HCl not tested.		
85	26			90			D-24 SM	10 14 16 (30)	83.2 feet: Dense silty SAND.		
	27										
90				50			D-25 SM-ML	8 9 11 (20)	grades to medium dense silty SAND/sandy SILT.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-009-07

Job No. 33758613.04000 SR 90 Elevation 2525.5 ft (769.8 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			17			D-26 SM-ML	9 15 19 (34)	grades to dense.		
	30										
100				50			D-27 SM-ML	6 9 11 (20)	grades to medium dense.		
	31										
105	32			87			D-28 MH	5 8 8 (16)	grades to very stiff elastic SILT.		
	33										
110				60			D-29 SW	12 32 15 (47)	110.4 to 111.5 feet: Well graded SAND with trace of gravel, rounded, dense, bluish-gray, wet, stratified, HCl not tested.		
	34								Bottom of boring at 111.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 8/22/07 at 07:30: 14.4 feet.		
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-010-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2519.7 ft (768.0 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 11, 2007 Completion July 12, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1213+97 Offset 45'L Casing HW, HQ

Method Wet Rotary

Northing 1079804.192 Easting 1749621.536 Latitude 47°23'27.679"N

Longitude 121°23'03.561"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 11 feet: Poorly graded GRAVEL with sand, subrounded to angular, medium dense to very dense, brown to gray, wet, homogenous, HCl not tested.		
									0 feet: medium dense.		
				83			D-1 GP	21 12 10 (22)			
	1										
				83			D-2 GP	3 9 12 (21)			
5											
	2			44			D-3 GP	4 15 50 for 6"	grades to very dense.		
				0			D-4 GP	16 16 13 (29)	grades to dense.		
10	3										
									11 to 20.8 feet: Silty SAND or silty GRAVEL or sandy SILT with trace of organics, very loose to loose, brown to black, wet, homogenous, HCl not tested.		
				39			D-5 SM/OL	1 1 5 (6)	11 feet: Loose silty SAND.		
	4										
				22			D-6 GM	3 1 2 (3)	grades to very loose silty GRAVEL.		
15											
				100			D-7 SM	1 0 0 (0)	grades to silty SAND.	▽	
	5										
	6										
20											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-010-07

Job No. 33758613.04000 SR 90 Elevation 2519.7 ft (768.0 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
							UD-8 / ML		grades to sandy SILT.		
									20.8 to 28 feet: Well graded GRAVEL with sand, subrounded, dense, reddish brown, wet, homogenous, HCl not tested.		
	7										
				44			D-9 / GW	12 12 25 (37)			
25											
	8										
									28 to 100.5 feet: Silty SAND or poorly graded SAND with layers of loose to medium dense sandy SILT, medium dense to very dense, brown to gray, wet, homogenous, HCl not tested.		
				67			D-10 / SM	8 10 22 (32)	28 feet: Dense silty SAND.		
	9										
30											
	10										
							UD-11 / SM				
35											
	11										
	12			89			D-12 / ML	10 11 15 (26)	grades to dense sandy SILT.		
40											
	13										
				100			D-13 / SM	6 9 11	grades to medium dense silty SAND.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-010-07

Job No. 33758613.04000 SR 90 Elevation 2519.7 ft (768.0 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(20)			
	14										
	15			83			D-14 SM	6 5 7 (12)			
50											
	16										
				83			D-15 SM	6 8 9 (17)			
55											
	17										
									grades to loose sandy SILT.		
	18			100			D-16 ML	3 3 4 (7)			
60											
	19										
				100			D-17 ML	3 4 9 (13)	grades to medium dense.		
65											
	20										
									grades to very dense silty SAND.		
	21			39			D-18 SM	24 23 30			
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-010-07

Job No. 33758613.04000 SR 90 Elevation 2519.7 ft (768.0 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(53)			
	22										
				83			D -19 / SM	7 10 13 (23)	grades to medium dense.		
75	23										
	24			100			D-20 / SM	7 12 14 (26)	grades to dense.		
80											
	25										
				100			D-21 / SM	7 6 10 (16)	grades to medium dense.		
85	26										
	27			83			D-22 / ML	5 6 7 (13)	grades to medium dense sandy SILT.		
90											
	28										
				67			D-23 / SM	6 8 19	grades to dense silty SAND.		
95											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-010-07

Job No. 33758613.04000 SR 90 Elevation 2519.7 ft (768.0 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(27)			
	30										
100				67			D-24 / SP	8 8 9 (17)	grades to medium dense poorly graded SAND.		
	31								Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/12/07: 16.5 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-011-07

Job No. 33758613.04000 SR 90 Elevation 2522.3 ft (768.8 m)

Sheet 1 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 10, 2007 Completion July 11, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1213+89 Offset 137'L Casing HW, HQ

Method Wet Rotary

Northing 1079880.63 Easting 1749673.519 Latitude 47°23'28.439"N

Longitude 121°23'02.818"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 9 feet: Well graded GRAVEL with sand, occasional cobbles and boulders, angular, dense to very dense, gray, moist, homogenous, HCl not tested.		
				100			D-1 GW	50 for 0"	0 feet: Very dense GRAVEL with sand.		
							C-3 GW(C/B)		grades to GRAVEL with cobbles and boulders.		
	1										
5				50			D-2 GW(C/B)	50 for 0"	grades to GRAVEL with cobbles.		
							C-5 GW				
	2										
				33			D-4 GW	21 21 16 (37)	grades to dense GRAVEL with sand.		
				33			D-7 SM	6 4 4 (8)	9 to 28 feet: Poorly graded SAND with gravel or silty SAND, loose to medium dense, dark brown, wet, homogenous, HCl not tested and Well graded GRAVEL with sand, subrounded to subangular, medium dense, brown to gray, wet, homogenous, HCl not tested with occasional layers of very loose SILT.		
10	3						C-8 SM				
				1			D-9 SP	3 3 2 (5)	9 feet: Loose SAND with gravel. 12 feet: grades to poorly graded SAND.		
	4			1			C-10 SP				
				17			D-11 SM	1 3 10 (13)	grades to medium dense silty SAND.		
15							C-12 SM			▽	
	5			11			D-13 GW	7 6 6 (12)	grades to well graded GRAVEL with sand.		
				100			D-14 ML	1 0 0	grades to very loose SILT.		
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-011-07

Job No. 33758613.04000 SR 90 Elevation 2522.3 ft (768.8 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				130			UD-15 / ML	(0)			
	7										
25				33			D-16 / GW	10 11 5 (16)	grades to medium dense well graded GRAVEL with sand.		
	8										
									28 to 79 feet: Poorly graded fine SAND and silty SAND, medium dense to dense, brown, moist to wet, homogenous, HCl not tested with occasional layers of dense well graded SAND. 28 feet: Medium dense fine SAND.		
30	9			67			D-17 / SP	4 7 8 (15)			
	10										
35				67			D-18 / SP	10 11 15 (26)	grades to dense.		
	11										
40	12			67			D-19 / SP	7 11 12 (23)	grades to medium dense.		
	13										
45				67			D-20 / SM	8 10 13	grades to silty SAND.		

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-011-07

Job No. 33758613.04000 SR 90 Elevation 2522.3 ft (768.8 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(23)			
	14										
	15			67			D-21 / SP	7 13 16 (29)	grades to dense fine SAND.		
50											
	16										
				100			D-22 / SP	6 4 6 (10)	grades to loose.		
55											
	17										
	18			67			D-23 / SW	19 20 19 (39)	grades to dense well graded SAND.		
60											
	19										
				72			D-24 / SW	12 21 24 (45)			
65											
	20										
	21			100			D-25 / SP	6 10 12	grades to medium dense fine SAND.		
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-011-07

Job No. 33758613.04000 SR 90 Elevation 2522.3 ft (768.8 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(22)			
	22										
				83			D-26 / SP	10 11 16 (27)	grades to dense.		
75	23										
	24										
				83			D-27 / SM	17 25 22 (47)	79 to 101.5 feet: Poorly graded silty SAND and well graded SAND with gravel, subrounded, dense to very dense, gray, wet, homogenous,HCl not tested. 79 feet: Dense silty SAND.		
80											
	25										
				100			D-28 / SM	10 14 15 (29)			
85	26										
	27										
				80			D-29 / SM	19 45 50 for 3"	grades to very dense.		
90											
	28										
				100			D-30 / SW	38 50 for 6"	grades to very dense well graded SAND with gravel.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-011-07

Job No. 33758613.04000 SR 90 Elevation 2522.3 ft (768.8 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller James Fetterly Lic# 2507

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29										
	30			83			D-31 / SM	11 27 31 (58)	grades to very dense silty SAND.		
100											
	31								Bottom of boring at 101.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/11/07: 16.0 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-012-07

Job No. 33758613.04000 SR 90 Elevation 2526.1 ft (770.0 m)

Sheet 1 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start August 15, 2007 Completion August 21, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1215+47 Offset 43'R Casing HW, HQ

Method Wet Rotary

Northing 1079633.5 Easting 1749663.6 Latitude 47° 23' 25.9974"N

Longitude 121° 23' 2.9184"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 14.5 feet: Well graded graded GRAVEL with sand, subangular to subrounded, dense, grayish brown to brown, moist, homogenous, HCl not tested with occasional lenses of dense well graded SAND with gravel and loose silty SAND with gravel.		
				100			D-1 / GW	13 25 23 (48)	0 feet: Dense well graded GRAVEL with sand.		
	1										
5				67			D-2 / SW	15 18 22 (40)	grades to well graded SAND with gravel.		
	2										
				44			D-3 / GW	18 22 11 (33)	grades to well graded GRAVEL with sand.		
10	3			44			D-4 / SM	3 5 4 (9)	grades to loose silty SAND with gravel.		
				44			D-5 / GW	8 20 17 (37)	grades to dense well graded GRAVEL with sand.		
	4										
15				67			D-6 / ML	4 10 20 (30)	14.5 to 17 feet: Clayey SILT, very stiff, dark brown to light yellowish brown, moist, homogenous, HCl not tested.		
	5										
				67			D-7 / GC	7 5 4 (9)	17 to 20 feet: Poorly graded clayey GRAVEL with sand, subrounded, dense, brown, moist, homogenous, HCl not tested.	▽	
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-012-07

Job No. 33758613.04000 SR 90 Elevation 2526.1 ft (770.0 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				39			D-8 / OL	3 2 3 (5)	20 to 23 feet: ORGANIC SOIL (sandy silt), medium stiff, brown, moist, homogenous, HCl not tested.		
	7								23 to 32 feet: Poorly graded silty SAND with gravel, subangular, medium dense, dark brown, homogenous, HCl not tested and well graded GRAVEL with sand, subangular to subrounded, dense, gray to brown, moist, homogenous, HCL not tested. 23 feet: Loose silty SAND with gravel.		
25				67			D-9 / SM	1 7 13 (20)			
	8										
	9			33			D-10 / GW	11 14 15 (29)	grades to medium dense well graded GRAVEL with sand.		
30											
	10								32 to 97 feet: Poorly graded SAND or silty SAND, medium dense to dense, brown to gray, moist to wet, homogenous, HCl not tested, with occasional layers of medium stiff to hard clayey SILT/silty CLAY and medium dense to dense sandy SILT. 32 feet: Loose poorly graded SAND.		
35				100			D-11 / SP	5 4 3 (7)			
	11										
	12			83			D-12 / SP	11 16 15 (31)	grades to dense.		
40											
	13										
				83			D-13 / SM	7 11 13	grades to medium dense silty SAND.		
45											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-012-07

Job No. 33758613.04000 SR 90 Elevation 2526.1 ft (770.0 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(24)			
	14										
	15			83			D-14 SM	10 11 12 (23)			
50											
	16										
				67			D-15 SP	14 15 15 (30)	grades to dense poorly graded SAND.		
55											
	17										
	18			67			D-16 SM-ML	8 11 11 (22)	grades to medium dense silty SAND/sandy SILT.		
60											
	19										
				50			D-17 SM-ML	6 8 10 (18)			
65											
	20										
	21			83			D-18 SM	21 20 25	grades to very dense silty SAND.		
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-012-07

Job No. 33758613.04000 SR 90 Elevation 2526.1 ft (770.0 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(51)			
	22										
				83			D-19 ML	4 3 4 (7)	grades to medium stiff clayey SILT.		
75	23										
				100			UD-20 ML				
	24										
				83			D-21 CL	4 3 5 (8)	grades to silty CLAY.		
80											
	25										
				72			D-22 SM-ML	8 9 15 (24)	grades to medium dense silty SAND/sandy SILT.		
85	26										
	27										
				67			D-23 SM	7 10 10 (20)	grades to silty SAND.		
90											
	28										
				67			D-24 ML	7 10 33	grades to dense sandy SILT.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-012-07

Job No. 33758613.04000 SR 90 Elevation 2526.1 ft (770.0 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(43)			
									97 to 109 feet: Poorly graded GRAVEL with sand, subangular, very dense, gray, moist, homogenous, HCl not tested.		
	30			40			D-25 / GP	34 50 for 4" (50)			
100											
	31										
				50			D-26 / GP	46 50 for 4" (50)			
105	32										
	33										
				64			D-27 / SM	10 50 for 5" (50)	109 to 115.5 feet: Poorly graded silty SAND with gravel, subangular, very dense, grayish brown, moist, homogenous, HCl not tested, and well graded SAND with gravel, subangular to subrounded, dense, grayish brown, moist, homogenous, HCl not tested. 109 feet: Very dense silty SAND with gravel.		
110											
	34										
				56			D-28 / SW	24 29 12 (41)	grades to dense well graded SAND with gravel.		
115	35										
									Bottom of boring at 115.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
									Water level measurements (below existing ground surface): - 8/21/07: 18.0 feet.		
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-013-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 13, 2007 Completion July 14, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1215+51 Offset 48'L Casing HW, HQ

Method Wet Rotary

Northing 1079706.324 Easting 1749741.722 Latitude 47°23'26.727"N

Longitude 121°23'01.799"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 10.5 feet: Well graded GRAVEL with sand, subrounded to subangular, medium dense to very dense, gray to brown, moist to wet, homogenous, HCl not tested.		
									0 feet: Medium dense.		
				50			D-1 GW	14 8 9 (17)			
	1			0			C-2 GW				
5				22			D-3 GW	5 50 for 3"	grades to very dense.		
	2			0			C-4 GW				
				72			D-5 GW	23 25 19 (44)	grades to dense.		
10	3			0			C-6 GW				
				0			D-7 OL?	3 4 4 (8)	10. 5 to 13 feet: No recovery. Material probably is ORGANIC SOIL.		
	4								13 to 28 feet: Well graded to poorly graded GRAVEL with sand, subrounded to subangular, very loose to dense, gray to brown, moist to wet, homogenous, HCl not tested.		
				39			D-8 GW	14 16 10 (26)			
15									13 feet: Dense.		
	5			11			D-9 GW	3 2 1 (3)	grades to very loose.		
				67			D-10 GW	18 20 23	grades to dense.		
	6										
20											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-013-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(43)			
	7			33			D-11 / GW	10 21 24 (45)			
25											
	8			0			C-12 / GP				
				0			D-13 / SM	1 9 13 (22)	28 to 79 feet: Silty SAND, medium dense, light brown to gray, wet, homogenous, HCl not tested and sandy SILT or SILT with sand, medium dense, gray, wet, slow dilitancy, homogenous, occasionally laminated, HCl not tested. 28 feet: Medium dense silty SAND.		
	9										
30											
	10			89			D-14 / SM	4 5 13 (18)			
35											
	11										
	12			67			D-15 / SM	6 9 12 (21)			
40											
	13										
				100			D-16 / ML	5 6 6	grades to medium dense sandy SILT.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-013-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(12)			
	14										
	15						UD-17 ML				
50											
	16										
				78			D-18 ML	5 7 11 (18)	grades to SILT with sand.		
55											
	17										
	18			89			D-19 ML	4 4 7 (11)	grades to loose sandy SILT.		
60											
	19										
				83			D-20 ML	5 5 7 (12)	grades to medium dense SILT.		
65											
	20										
	21			92			UD-21 ML				
70											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-013-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	22										
75	23			100			D-22 / ML	10 8 8 (16)			
	24										
80				67			D-23 / SM-GM	10 18 20 (38)	79 to 99.5 feet: Well graded GRAVEL with sand with occasional layers of silty SAND or silty GRAVEL, subrounded to subangular, dense to very dense, brown to gray, homogenous, HCl not tested. 79 feet: Dense silty SAND or silty GRAVEL.		
	25										
85	26			80			D-24 / GW	36 42 50 for 3"	grades to very dense well graded GRAVEL with sand.		
	27										
90				44			D-25 / GW	16 15 16 (31)	grades to dense.		
	28										
95				11			D-26 / GW	35 26 27	grades to very dense.		

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-013-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(53)			
	30			0			D-27 / GW	50 for 5"			
100									Bottom of boring at 99.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
	31										
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-014-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2521.0 ft (768.4 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 24, 2007 Completion July 25, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1215+41 Offset 150'L Casing HW, HQ Method Wet Rotary

Northing 1079789.011 Easting 1749801.994 Latitude 47°23'27.549"N Longitude 121°23'00.936"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 11 feet: Well graded GRAVEL with sand and occasional cobbles and boulders, subrounded to subangular, dense to very dense, brown to gray, moist, homogeneous, HCl not tested.		
									0 feet: Dense well graded GRAVEL with sand.		
				44			D-1 GW	10 23 25 (48)			
	1										
				100			C-2 GW(C)		grades to GRAVEL with cobbles.		
5											
				33			D-3 GW	16 20 28 (48)	grades to GRAVEL with sand.		
	2										
				100			C-4 GW(C)		grades to GRAVEL with cobbles.		
				0			D-5 GW	30 50 for 4" (50)	grades to very dense GRAVEL with sand.		
				100			C-6 GP(C/B)		grades to GRAVEL with cobbles and boulders.		
10	3										
				0			D-7 OL	3 1 1 (2)	11 to 21 feet: ORGANIC SOIL with sand, very soft to stiff, brown and black, wet, disrupted, HCl not tested.		
									11 feet: Soft.		
				100			C-8 OL				
	4			39			D-9 OL	1 0 1 (1)	grades to very soft.		
15											
	5			33			D-10 OL	2 7 3 (10)	grades to stiff.		
				0			D-11 OL	3 1 1	grades to soft.		
20	6										

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-014-07

Job No. 33758613.04000 SR 90 Elevation 2521.0 ft (768.4 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(2)			
				22			D-12 / GW	8 45 16 (61)	21 to 27 feet: Well graded GRAVEL with sand, subangular, dense to very dense, brown to gray, wet, homogenous, HCl not tested. 21 feet: Very dense.		
	7										
25				33			D-13 / GW	38 31 16 (47)	grades to dense.		
	8										
									27 to 53 feet: Poorly graded SAND, medium dense to dense, brown to gray, wet, homogeneous, HCl not tested with occasional layers of dense sandy SILT, dense, moist, homogenous, HCl not tested.		
	9			67			D-14 / SP	6 6 6 (12)	27 feet: Medium dense poorly graded SAND.		
30											
	10										
35				89			D-15 / SP	12 13 14 (27)	grades to dense.		
	11										
	12			89			D-16 / ML	4 12 17 (29)	grades to sandy SILT.		
40											
	13										
45				44			D-17 / SP	10 16 21	grades to poorly graded SAND.		

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-014-07

Job No. 33758613.04000 SR 90 Elevation 2521.0 ft (768.4 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(37)			
	14										
	15			67			D-18 / SP	8 13 27 (40)			
50											
	16										
									53 to 100.5 feet: Alternating layers of well graded to poorly graded GRAVEL with sand and well graded to poorly graded SAND with gravel, subangular, medium dense to dense, brown to gray, moist to wet, homogenous, HCl not tested.		
				67			D-19 / GW	21 16 7 (23)			
55									53 feet: Medium dense well graded GRAVEL with sand.		
	17										
	18			67			D-20 / SW	15 25 20 (45)	grades to dense well graded SAND with gravel.		
60											
	19										
				44			D-21 / SW	12 15 18 (33)			
65											
	20										
	21			56			D-22 / SW	22 28 31	grades to very dense.		
70											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-014-07

Job No. 33758613.04000 SR 90 Elevation 2521.0 ft (768.4 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(59)			
	22										
				33			D-23 GW	16 22 18 (40)	grades to dense well graded GRAVEL with sand.		
75	23										
	24			56			D-24 SW	10 17 18 (35)	grades to well graded SAND with gravel.		
80											
	25										
				56			D-25 SW	9 10 15 (25)			
85	26										
	27			44			D-26 GW	10 15 15 (30)	grades to well graded GRAVEL with sand.		
90											
	28										
				56			D-27 SP	12 14 18	grades to poorly graded SAND with gravel.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-014-07

Job No. 33758613.04000 SR 90 Elevation 2521.0 ft (768.4 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(32)			
	30										
100				33			D-28 / GP	6 8 10 (18)	grades to medium dense poorly graded GRAVEL with sand.		
	31								Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-015-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Project I-90 Snoqualmie Pass East

Driller Robert Walker Lic# 2864T

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start August 21, 2007 Completion August 23, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1216+92 Offset 44'R Casing HW, HQ Method Wet Rotary

Northing 1079563.936 Easting 1749753.417 Latitude 47°23'25.323"N Longitude 121°23'01.606"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 11 feet: Well graded to poorly graded GRAVEL with sand and occasional cobbles, subangular to subrounded, dense to very dense, bluish-gray, wet, homogenous, HCl not tested.		
									0 feet: Dense GRAVEL with sand.		
	1										
5				50			D-1 / GW	15 16 20 (36)			
	2										
				75			D-2 / GP(C)	10 50 for 2" (50)	grades to very dense GRAVEL with cobbles.		
				100			C-3 / GW(C)				
10	3										
				0			D-4 / SM-OL	2 2 4 (6)	11 to 25 feet: Very loose to loose Silty SAND with gravel and trace organics, loose, moist, homogenous, HCl not tested. 11 feet: Loose		
	4										
				50			D-5 / SM-OL	2 3 5 (8)			
15										▽	
	5										
				56			D-6 / SM-OL	2 2 3 (5)			
	6										
20											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-015-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Robert Walker Lic# 2864T

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				83			D-7 / SM-OL	2 2 2 (4)	grades to very loose.		
	7										
25				56			D-7A / GW	9 24 15 (39)	25 to 37 feet: Well graded GRAVEL with sand, subrounded to subangular, medium dense to dense, brown to gray, moist to wet, homogenous, HCl not tested. 25 feet: Dense		
	8										
	9										
30				33			D-8 / GW	20 20 18 (38)			
	10										
35				39			D-9 / GW	11 12 9 (21)	grades to medium dense.		
	11										
									37 to 63 feet: Silty SAND or sandy SILT, medium dense, light brown to gray, wet, homogenous, HCl not tested. 37 feet: Silty SAND.		
	12										
40				28			D-10 / SM	3 7 10 (17)			
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-015-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Robert Walker Lic# 2864T

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				83			D-11 SM-ML	11 11 11 (22)	grades to silty SAND/sandy SILT.		
	14										
	15										
50				83			D-12 SM	7 7 7 (14)	grades to silty SAND.		
	16										
55				67			D-13 SM	7 9 11 (20)			
	17										
	18										
60				28			D-14 SM	6 8 7 (15)			
	19								63 to 75 feet: SILT to elastic SILT, stiff to hard, gray, moist, homogenous, HCl not tested.		
									63 feet: hard SILT.		
65				100			D-15 ML	10 15 16 (31)			
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-015-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Robert Walker Lic# 2864T

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			D-16 / MH	5 6 5 (11)	70 feet: grades to stiff elastic SILT. PP=2.25 tsf.		
	22			50			UD-17 / MH				
75	23			100			D-18 / CL	3 6 6 (12)	75 to 78 feet: CLAY, stiff, brown, moist, homogenous, HCl not tested.		
	24								78 to 100.25 feet: Well graded SAND with gravel or well graded to poorly graded GRAVEL with sand, subrounded to subangular, dense to very dense, light brown to light gray, moist, homogenous, HCl not tested.		
80				67			D-19 / SW	25 30 26 (56)	78 feet: Very dense well graded SAND with gravel.		
	25										
85	26			67			D-20 / SW	11 22 21 (43)	grades to dense.		
	27										
90				50			D-21 / SW	26 26 26 (52)	grades to very dense.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-015-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Robert Walker Lic# 2864T

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			67			D-22 GW	50 for 6" (50)	grades to well graded GRAVEL with sand.		
	30										
100				33			D-23 GP	50 for 3" (50)	grades to poorly graded.		
	31								Bottom of boring at 100.25 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 8/23/07: 15.5 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-016-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 15, 2007 Completion July 18, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1216+90 Offset 50'L Casing HW, HQ

Method Wet Rotary

Northing 1079612.87 Easting 1749846.73 Latitude 47°23'25.816"N

Longitude 121°23'00.258"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 16.5 feet: Well to poorly graded GRAVEL with sand and occasional SAND with gravel, occasional cobbles, subrounded to angular, medium dense to very dense, brown to gray, moist, homogeneous, HCl not tested.		
									0 feet: Very dense well graded GRAVEL with sand.		
				80			D-1 GW	17 25 50 for 3"			
	1										
				100			C-2 GP(C)		grades to poorly graded GRAVEL with cobbles.		
5				100			C-4 GP(C)				
	2										
				94			D-5 GP-SP	11 11 12 (23)	grades to medium dense GRAVEL with sand or SAND with gravel.		
				100			C-6 GP		grades to GRAVEL with sand.		
10	3			100			C-8 GP(C)		grades to GRAVEL with cobbles.		
				100			C-9				
	4			100			C-10 to C-13 GP(C)				
							GP(C)				
15											
	5			22			D-14 SM	17 34 40 (74)	16.5 to 28 feet: Well graded SAND or silty SAND with trace of gravel and silt, very loose to very dense, brown, wet, homogenous, HCl not tested, and poorly graded GRAVEL with sand, rounded to subangular, dense, gray, moist, homogenous, HCl not tested.		
				33			D-15 GP	6 12 22(34)	16.5 feet: Very dense poorly graded SAND with trace of gravel and silt. grades to dense poorly graded GRAVEL with sand.		
	6										
20											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-016-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	7								grades to very loose well graded SAND with gravel.		
25				67			D-16 SW	8 2 1 (3)			
	8										
									28 to 73 feet: Silty SAND or sandy SILT, loose to medium dense, brown, moist to wet, homogenous, HCl not tested with occasional layers of loose poorly graded loose fine SAND.		
	9			83			D-17 SP	3 4 5 (9)	28 feet: Loose poorly graded fine SAND.		
30											
	10										
				89			D-18 SM-ML	7 7 7 (14)	grades to medium dense silty SAND/sandy SILT.		
35											
	11										
	12			83			D-19 SM	7 8 10 (18)	grades to medium dense silty SAND.		
40											
	13										
				89			D-20 SM-ML	6 5 7	grades to medium dense silty SAND/sandy SILT.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-016-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(12)			
	14										
	15			61			D-21 / ML	4 3 5 (8)	grades to loose sandy SILT.		
50											
	16										
				94			D-22 / SP-SM	4 4 4 (8)	grades to loose poorly graded SAND/silty SAND.		
55	17										
	18			67			D-23 / SP	2 4 6 (10)	grades to loose poorly graded fine SAND.		
60											
	19										
				94			D-24 / ML	6 5 7 (12)	grades to medium dense sandy SILT.		
65	20										
	21						UD-25 / ML				
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-016-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	22										
									73 to 100.5 feet: Alternating layers of well graded SAND with gravel and poorly graded GRAVEL with sand, subrounded to subangular, medium dense to very dense, gray, moist, homogeneous, HCl not tested.		
				83			D-26 / SW	14 14 9 (23)	73 feet: Medium dense well graded SAND with gravel.		
75	23										
	24			67			D-27 / SW	9 11 16 (27)			
80											
	25										
				22			D-28 / GP	6 7 45 (52)	grades to very dense poorly graded GRAVEL.		
85	26										
	27			89			D-29 / SW	15 12 10 (22)	grades to medium dense well graded SAND with gravel.		
90											
	28										
				83			D-30 / SW	10 15 25	grades to dense well graded SAND with gravel.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-016-07

Job No. 33758613.04000 SR 90 Elevation 2519.1 ft (767.8 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(40)			
	30			67			D-31 GP-SW	33 21 23 (44)	grades to poorly graded GRAVEL with sand/well graded SAND with gravel.		
100									Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
	31										
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-017-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start July 19, 2007 Completion July 24, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1216+83 Offset 148'L Casing HW, HQ

Method Wet Rotary

Northing 1079689.55 Easting 1749908.829 Latitude 47°23'26.579"N

Longitude 121°22'59.368"W

County Kittitas Subsection NE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 13.5 feet: Poorly graded to well graded GRAVEL with sand and occasional boulders or cobbles , subrounded to subangular, dense to very dense, brown to gray, moist to wet, homogenous, HCl not tested.		
									0 feet: Dense well graded GRAVEL with sand.		
				44			D-1 / GW	15 15 21 (36)			
	1										
				75			C-2 / GP(B/C)		grades to well graded GRAVEL with cobbles/boulders.		
5				29			D-3 / GW	16 21 50 for 2" (50)	grades to very dense well graded GRAVEL with sand.		
	2			67			C-4 / GW(B/C)		grades to well graded GRAVEL with cobbles/boulders.		
				80			D-5 / GW	50 for 5" (50)	grades to well graded GRAVEL with sand.		
				78			C-6 / GP(B)		grades to well graded GRAVEL with boulders.		
10	3										
				56			D-7 / GW	31 21 14 (35)	grades to dense well graded GRAVEL with sand.		
				20			C-8 / GW				
	4			0			D-9 / OL/SM?	6 6 18(24)	No recovery. Material probably is a medium dense organic material or silty sand.		
15				67			C-10 / GP(B)				
	5			33			D-11 / SP	10 13 17 (30)	15.5 to 27 feet: Poorly graded SAND with gravel or GRAVEL with sand, subrounded to subangular, dense to very dense, gray, moist to wet, homogenous, HCl not tested.		
									15.5 feet: Dense Poorly graded SAND with gravel.	▽	
				60			D-12 / GW	5 11 50 for 2" (50)	grades to very dense well graded GRAVEL.		
	6										
20											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-017-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	7			56			D-13 / GP	23 15 10 (25)	grades to medium dense poorly graded GRAVEL with sand.		
25	8										
									27 to 77 feet: Silty SAND/sandy SILT/fine SAND, with lenses of SILT, medium dense, brown to gray, moist to wet, homogenous, HCl not tested.		
	9			33			D-14 / SP	20 11 12 (23)	27 feet: Poorly graded fine SAND.		
30											
	10										
				100			D-15 / SM	8 11 10 (21)	grades to silty SAND.		
35	11										
	12			100			D-16 / SM	7 11 10 (21)			
40											
	13										
				100			D-17 / ML	5 6 6	grades to sandy SILT.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-017-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(12)			
	14										
	15			100			D-18 / SM	6 9 11 (20)	grades to silty SAND.		
50											
	16										
				100			D-19 / ML	7 8 9 (17)	grades to sandy SILT.		
55											
	17										
	18			83			D-20 / SM	4 5 6 (11)	grades to silty SAND.		
60											
	19										
				67			D-21 / ML	5 10 11 (21)	grades to SILT with fine sand.		
65											
	20										
	21			83			D-22 / ML	6 7 12	grades to SILT.		
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-017-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(19)			
	22										
				72			D-23 / ML	7 12 17 (29)			
75	23										
									Poorly graded SAND with or without gravel, dense to very dense, brown, moist, homogenous, HCl not tested and well graded GRAVEL with sand, subangular, medium dense to dense, light brown to gray, moist to wet, homogenous, HCl not tested.		
	24			100			D-24 / SP	8 20 38 (58)	77 feet: Very dense poorly graded SAND.		
80											
	25										
				67			D-25 / SP	13 13 14 (27)	grades to dense poorly graded SAND with gravel.		
85	26										
	27			33			D-26 / SP	10 11 21 (32)			
90											
	28										
				22			D-27 / GW	5 3 18	grades to medium dense well graded GRAVEL with sand.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-017-07

Job No. 33758613.04000 SR 90 Elevation 2520.0 ft (768.1 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(21)			
	30			22			D-28 / GW	28 18 12 (30)	grades to dense.		
100											
	31								Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/24/07: 18.5 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-018-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start August 8, 2007 Completion August 14, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1218+61 Offset 38'R Casing HW, HQ

Method Wet Rotary

Northing 1079418.2 Easting 1749931.9 Latitude 47° 23' 23.9022"N

Longitude 121° 22' 58.9872"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									Top 3 feet: Well graded SAND, subangular, medium dense, brown and gray, wet, homogenous, HCl not tested (topsoil).		
				33			D-1 / SW	7 8 6 (14)			
	1								3 to 16 feet: Poorly graded GRAVEL with sand, subangular to angular, loose to dense, light brown to gray, moist to wet, homogenous, HCl not tested. 3 feet: Medium dense poorly graded GRAVEL. 4 feet: grades to loose GRAVEL with sand.		
				22			D-2 / GP	5 3 7 (10)			
5											
	2										
				22			D-3 / GP	14 10 7 (17)	grades to medium dense.		
				22			D-4 / GP	4 10 4 (14)			
10	3										
				17			D-5 / GP	4 3 3 (6)	grades to loose.		
	4										
				33			D-6 / GP	12 16 10 (26)	grades to dense.		
15											
	5			22			D-7 / GP	6 6 5 (11)	16 to 40 feet: Well graded to poorly graded GRAVEL with sand and occasional lenses of medium dense well graded SAND with gravel, occasional cobbles, subangular, medium dense to dense, light brown to gray, moist to wet, homogenous, HCl not tested. 16 feet: Medium dense well graded GRAVEL with sand and trace of decayed wood.		
				17			D-8 / GW	16 36 13	grades to dense well graded GRAVEL with sand.		
	6										
20											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-018-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(49)			
	7										
				44			D-9 SW	4 10 12 (22)	grades to medium dense well graded SAND with gravel.		
25											
	8										
	9			28			D-10 GW	15 14 19 (33)	grades to dense well graded GRAVEL with sand.		
30											
	10			100			C-11 GP(C)		grades to poorly graded GRAVEL with sand and cobbles.		
35											
	11			44			D-12 GW	20 15 14 (29)	grades to dense well graded GRAVEL with sand.		
	12										
40									40 to 61 feet: Silty fine SAND or sandy SILT, medium dense to dense, light brown to gray, moist to wet, homogenous, HCl not tested. 40 feet: Medium dense silty SAND/sandy SILT.		
	13										
				67			D-13 SM-ML	6 9 9			
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-018-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(18)			
	14										
	15			33			D-14 SM-ML	6 8 9 (17)			
50											
	16										
				50			UD-15 ML		grades to sandy SILT.		
55											
	17										
	18			44			D-16 SM-ML	12 14 13 (27)	grades to dense silty SAND/sandy SILT.		
60											
									61 to 77 feet: ELASTIC SILT, very stiff, gray, wet, medium plasticity, medium to rapid dilitancy, homogenous, occasionally laminated, HCl not tested.		
	19										
				56			D-17 MH	7 9 11 (20)			
65											
	20										
	21			67			D-18 MH	8 9 15			
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-018-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(24)			
	22										
				67			D-19 / MH	10 12 11 (23)			
75	23										
									77 to 87 feet: Lean CLAY, very stiff, light brown, medium plasticity, laminated to homogenous, HCl not tested. 77 feet: homogenous.		
	24			56			D-20 / CL	8 9 10 (19)			
80											
	25										
				100			D-21 / CL	7 9 10 (19)	grades to laminated.		
85	26										
									87 to 106.5 feet: Poorly to well graded GRAVEL with sand, subrounded to subangular, medium dense, gray, wet, homogenous, HCl not tested and poorly to well graded SAND with gravel, subrounded to subangular, dense to very dense, gray, moist, homogenous, HCl not tested. 87 feet: Medium dense well graded GRAVEL with sand.		
	27			33			D-22 / GW	13 9 3 (12)			
90											
	28										
				56			D-23 / GP	13 11 13	grades to medium dense poorly graded GRAVEL with sand.		
95											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-018-07

Job No. 33758613.04000 SR 90 Elevation 2525.9 ft (769.9 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(24)			
	30			56			D-24 / SW	6 11 16 (27)	grades to dense well graded SAND with gravel.		
100											
	31										
105	32			100			D-25 / SP	20 25 33 (58)	grades to very dense poorly graded SAND with gravel.		
									Bottom of boring at 106.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 8/14/07: 26.4 feet.		
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Sheet 1 of 6

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Drilling Contractor WSDOT Field Exploration Unit

Inspector Kranti Maturi / Xiangdong Han

Start July 15, 2007 Completion July 18, 2007 Well ID# Not Applicable

Equipment CME-850 (track rig) with autohammer

Station 1218+67 Offset 56'L Casing HW, HQ

Method Wet Rotary

Northing 1079491.694 Easting 1749979.843 Latitude 47°23'24.635"N

Longitude 121°22'58.304"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 16.5 feet: Poorly graded silty GRAVEL/GRAVEL with sand, occasional boulders, medium dense to very dense, light gray to grayish-brown, wet, homogenous, HCl not tested.		
									0 feet: Very dense poorly graded GRAVEL with sand and trace silt.		
	1			47			D-1 GP	41 48 28 (76)			
5											
	2			47			D-2 GM	9 11 10 (21)	grades to medium dense silty GRAVEL with sand.		
				27			D-3 GM	10 9 35 (44)	grades to dense.		
10	3										
				27			D-4 GP	3 2 13 (15)	grades to medium dense poorly graded GRAVEL with sand.		
	4			33			D-5 GP	11 16 13 (29)	grades to dense.		
15											
	5			13			D-6 GP	110 for 5"	grades to poorly graded GRAVEL with sand and boulder.		
				10			C-7 GP		16.5 to 28 feet: Poorly to well graded GRAVEL with sand, angular, medium dense, dark gray with brown fines, wet, homogenous, HCl not tested.		
				32			D-8 GW	11 8 10			
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 2 of 6

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(18)			
	7			45			D-9 / GW	17 20 15 (35)			
25											
	8										
				55			D-10 / SM	9 5 6 (11)	28 to 75 feet: Silty SAND or sandy SILT with occasional poorly graded fine SAND or SILT with sand, loose to medium dense, brown to gray, wet, homogenous, HCl not tested.		
	9										
30									28 feet: Loose silty SAND		
	10			78			D-11 / SM	4 4 6 (10)			
35											
	11										
				88			D-12 / SP	5 6 10 (16)	grades to medium dense poorly graded SAND.		
	12										
40											
	13			78			D-13 / SM	5 9 11 (20)	grades to medium dense silty SAND.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 3 of 6

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14										
				33			D-14 / ML	4 4 6 (10)	grades to loose SILT with sand.		
	15										
50											
	16			67			D-15 / ML	4 6 7 (13)	grades to medium dense sandy SILT.		
55											
	17										
				83			D-16 / SM	6 7 9 (16)	grades to medium dense silty SAND.		
	18										
60											
	19										
				80			D-17 / SM	5 8 10 (18)			
65											
	20										
				17			D-18 / ML	4 4 5 (9)	grades to loose SILT.		
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 4 of 6

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	22			12			D-19 / ML	5 5 6 (11)			
75	23			85			UD-20 / CL-ML		75 to 81.5 feet: CLAY/SILT, stiff, gray to brown, wet, homogenous, HCl not tested. TV = 0.12 ksf.		
	24			83			D-21 / CL-ML	5 4 5 (9)			
80											
	25			40			D-22 / SW	18 12 13 (25)	81.5 to 113 feet: Poorly graded to well graded GRAVEL with sand with occasional well graded SAND with gravel, becomes clean from 88' to 113', subangular to angular, loose to dense, dark gray, wet, homogenous, HCl not tested. 81.5 feet: Dense well graded SAND with gravel.		
85	26										
	27			40			D-23 / GP	7 8 7 (15)	grades to medium dense poorly graded sandy GRAVEL.		
90	28										
				6			D-24 / GW	3 5 1 (6)	grades to loose well graded GRAVEL with sand.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 5 of 6

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29										
	30			23			D-25 / GW	6 8 19 (27)	grades to dense.		
100											
	31										
				23			D-26 / GP	5 9 5 (14)	grades to medium dense poorly graded.		
105	32										
	33			28			D-27 / GW	10 5 5 (10)	grades to loose well graded.		
110											
	34										
				45			D-28 / SP	13 11 7 (18)	113 to 129.5 feet: Poorly graded SAND with gravel, subangular to angular, medium dense to very dense, gray to dark gray, wet, homogenous, HCl not tested.		
115	35								113 feet: Medium dense.		
	36			34			D-29 / SP	17 17 26 (43)	grades to dense.		
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-019-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 6 of 6

Project I-90 Snoqualmie Pass East

Driller Danny Henderson Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	37										
125	38										
	39			45			D-30 / SP	40 29 34 (63)	grades to very dense.		
130									Bottom of boring at 129.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
	40										
135	41										
	42										
140	43										
145	44										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-020-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Project I-90 Snoqualmie Pass East

Driller Danny Lic# 2742

Drilling Contractor WSDOT Field Exploration Unit

Inspector Suren Balendra

Start June 26, 2007 Completion June 27, 2007 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1218+69 Offset 152'L Casing HW, HQ Method Wet Rotary

Northing 1079558.002 Easting 1750049.163 Latitude 47°23'25.297"N Longitude 121°22'57.307"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				78			D-1 / SW	7 38 30 (68)	0 to 13.5 feet: Poorly graded GRAVEL with sand or well to poorly graded SAND with gravel and occasional cobbles, subrounded to angular, very dense, brown to gray, moist to wet, homogenous, HCl not tested. 0 feet: Very dense well graded SAND with grass.		
	1			61			D-2 / GP	16 43 50 for 4.5"	grades to poorly graded GRAVEL with sand.		
5											
	2			1			D-3 / GP	53 for 6"			
				58			D-4 / SP	20 28 28 (56)	grades to poorly graded SAND with gravel.		
10	3										
				89			C-5 / GP(C)		grades to poorly graded GRAVEL with sand and cobbles.		
				61			D-6 / SW	34 30 35 (65)	grades to well graded SAND with gravel.		
	4								13.5 feet to 32 feet: Poorly graded GRAVEL with sand or well to poorly graded SAND with gravel and occasional cobbles, subrounded to angular, medium dense to dense, brown to gray, moist to wet, homogenous, HCl not tested.		
15				33			D-7 / SW	4 14 14 (28)	13.5 feet: Dense well graded SAND with gravel.	▽	
	5										
				39			D-9 / SP	9 10 9 (19)	grades to medium dense poorly graded SAND with gravel.		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-020-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Danny Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				14			D-10 GP	8 19 14 (33)	grades to dense poorly graded GRAVEL with sand.		
	7			36			C-11 GP(C)		grades to poorly graded GRAVEL with cobbles.		
25											
	8			33			D-12 SW	12 16 15 (31)	grades to well graded SAND with gravel.		
				58			D-13 SW	12 19 27 (46)			
	9										
30											
									32 to 50 feet: Poorly graded silty fine SAND, medium dense, light gray to brown, wet, homogenous, HCl not tested.		
	10			0			D-14 SM	11 10 11 (22)			
35											
	11										
				78			D-15 SM	5 7 9 (16)			
	12										
40											
	13			56			D-16 SM	4 7 7 (14)			
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-020-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Danny Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14										
				47			D-17 / SM	4 5 8 (13)			
	15										
50									50 to 74 feet: SILT, occasionally with sand, medium stiff to stiff, brown to gray, wet, homogenous, HCl not tested. PP= 0.75 to 2.0 tsf. 50 feet: medium stiff SILT, rapid dilitancy. PP=0.75 tsf.		
	16										
				56			D-18 / ML	4 5 6 (11)			
55											
	17										
				67			D-19 / ML	2 3 3 (6)	grades to medium stiff SILT.		
	18										
60											
	19										
				83			D-20 / ML	5 4 4 (8)			
65											
	20										
				75			D-21 / ML	5 6 9 (15)	grades to stiff SILT, PP=1.25 tsf.		
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-020-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Danny Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	22										
				94			D-22 / ML	4 21 21 (42)	grades to very stiff SILT, slow dilitancy, PP=2 tsf.		
75	23								74 to 101 feet: Poorly graded GRAVEL with sand or well graded SAND with gravel, subrounded to subangular, medium dense to very dense, brown to gray, wet, homogenous, HCl not tested. 74 feet: Very dense poorly graded GRAVEL with sand.		
	24			42			D-23 / GP	23 33 39 (72)			
80				44			C-24 / GP				
	25										
				0			D-25 / GP	6 7 7 (14)	grades to medium dense. 10 to 15% fluid loss.		
85	26			29			C-26 / GP		100% fluid loss.		
	27			33			D-27 / SW	7 10 7 (17)	grades to medium dense well graded SAND with gravel.		
90				0			D-27A / SW				
	28										
95				31			D-28 / SW	15 12 11			

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-020-07

Job No. 33758613.04000 SR 90 Elevation 2519.5 ft (767.9 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Danny Lic# 2742

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			29			C-29 / GP	(23)	grades to very dense poorly graded GRAVEL with sand.		
	30			4			D-30 / GP	20 29 21 (50)			
100											
	31								Bottom of boring at 101 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 6/27/07 at 08:00: 15.2 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 1 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Drilling Contractor WSDOT Field Exploration Unit

Inspector Tom Jackson

Start August 3, 2007 Completion August 8, 2007 Well ID# Not Applicable

Equipment CME 45 (skid rig) w/auto-hammer

Station 1220+12 Offset 30'R Casing HW, HQ

Method Wet Rotary

Northing 1079286.9 Easting 1750021.8 Latitude 47° 23' 22.617"N

Longitude -121° 22' 57.6588"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 17 feet: Poorly to well graded GRAVEL with sand with occasional wood and medium dense SILT with trace sand and gravel, subangular to angular, medium dense to very dense, light brown to greenish or bluish gray, moist, homogenous, HCl not tested.		
	1			11			D-1 / GW	7 11 12 (23)	0 feet: Medium dense well graded GRAVEL with sand.		
5				33			D-2 / GW	11 13 7 (20)			
	2										
				8			D-3 / GP	7 29 12 (41)	grades to dense poorly graded.		
10	3			33			D-4 / GW	7 13 16 (29)	grades to dense well graded.		
	4			44			D-5 / GW	5 20 38 (58)	grades to very dense.		
15				83			D-6 / OL	(1)	14.5 to 16.5 feet: Decayed wood was encountered.		
	5								grades to medium dense SILT with trace of fine sand and gravel.		
				67			D-7 / ML	6 7 7 (14)	17 to 45 feet: SILT to sandy SILT or SILT with sand, locally changes to silty fine SAND, generally medium dense, light brown to gray, moist to wet, homogenous, occasionally laminated, HCl not tested. 17 feet: Medium dense sandy SILT.		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 2 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			D-8 / ML	5 8 10 (18)	grades to SILT with sand.		
	7										
25				67			D-9 / ML	5 7 8 (15)	grades to sandy SILT.		
	8										
	9										
30				67			D-10 / ML	4 6 9 (15)	grades to SILT.		
	10										
35				72			D-11 / ML	5 8 9 (17)			
	11										
	12										
40				72			D-12 / ML	3 4 5 (9)	grades to loose.		
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 3 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				67			D-13 / SW	1 1 7 (8)	45 to 102 feet: Well graded to poorly graded GRAVEL with sand and occasional well graded to poorly graded SAND and silty SAND layers and cobbles, subangular to angular, dense, light brown to bluish gray to gray, wet, homogenous, HCl not tested.		
	14								45 feet: Loose well graded fine to medium SAND, loose.		
	15										
50				44			D-14 / SW	7 17 16 (33)	grades to dense well graded SAND with gravel.		
	16										
55				33			D-15 / GW	12 13 14 (27)	grades to dense well graded GRAVEL with sand.		
	17										
	18										
60				33			D-16 / SM	5 9 9 (18)	grades to medium dense silty SAND with gravel.		
	19										
65				22			D-17 / GW	13 22 18 (40)	grades to dense well graded GRAVEL with sand.		
	20										
									grades to dense GRAVEL with cobbles.		
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 4 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				44			D-18 / SP	8 18 14 (32)	grades to dense poorly graded SAND with gravel.		
	22										
75	23			56			D-19 / GW	10 13 19 (32)	grades to dense well graded GRAVEL with sand.		
	24										
80				44			D-20 / GW	14 13 14 (27)			
	25										
85	26			56			D-21 / GW	19 22 15 (37)			
	27										
90				33			D-22 / GW	19 33 30 (63)	grades to very dense.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 5 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			22			D-23 / GW	13 22 50 for 5" (50)			
				80			C-24 / GP(C)		grades to very dense GRAVEL with cobbles.		
	30			33			D-25 / GW	6 15 18 (33)	grades to dense GRAVEL with sand.		
100											
	31								102 to 120.33 feet: Silty SAND with gravel with occasional layers of dense well graded SAND, very dense, gray, wet, homogenous, HCl not tested. 102 feet: Dense well graded SAND with gravel.		
105	32			100			D-26 / SW	7 13 21 (34)			
	33								grades to dense silty SAND with gravel.		
110				67			D-27 / SM	11 18 31 (49)			
	34										
115	35			67			D-28 / SM	25 23 41 (64)	grades to very dense.		
	36										
120											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-021-07

Job No. 33758613.04000 SR 90 Elevation 2502.1 ft (762.6 m)

Sheet 6 of 6

Project I-90 Snoqualmie Pass East

Driller Bobby Haller Lic# 2779

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-29 SM	50 for 4"			
									Bottom of boring at 120.33 feet depth below ground surface. Backfilled to ground surface with bentonite chips.		
	37										
	38										
125											
	39										
130											
	40										
	41										
135											
	42										
140											
	43										
	44										
145											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-022-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2525.3 ft (769.7 m)

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Drilling Contractor WSDOT Field Exploration Unit

Inspector Xiangdong Han / Suren Balendra

Start July 24, 2007 Completion July 26, 2007 Well ID# Not Applicable

Equipment CME-850 (track rig) with autohammer

Station 1220+19 Offset 48'L Casing HW, HQ

Method Wet Rotary

Northing 1079375.644 Easting 1750079.631 Latitude 47°23'23.501"N

Longitude 121°22'56.835"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				45			D-1 GP	19 12 10 (22)	0 to 14 feet: Poorly graded GRAVEL with or without sand, angular to subangular, medium dense to very dense, brown and gray, moist to wet, homogenous, HCl not tested.		
									0 feet: Medium dense GRAVEL with sand.		
	1										
5											
									grades to GRAVEL.		
	2			0			D-2 GP	3 5 13 (18)			
				6			D-3 GP	33 10 54 (64)	grades to very dense.		
10	3										
				6			D-4 GP	13 9 11 (20)	grades to medium dense.		
	4										
				40			D-5 GP	7 16 9 (25)	14 to 35 feet: Poorly graded GRAVEL or silty SAND with gravel, subangular to subrounded, medium dense to very dense, brown to gray, wet, homogenous, HCl not tested.		
15									14 feet: Dense GRAVEL with sand, trace of silt, medium dense.		
	5										
				16			D-6 GP	23 53 for 6" (53)	grades to very dense GRAVEL.		
				0			D-7 GP	30 29 5	no recovery. grades to dense (gravel/cobbles?)		
20	6										

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-022-07

Job No. 33758613.04000 SR 90 Elevation 2525.3 ft (769.7 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(34)			
	7										
				0			D-7A / GP	15 14 24 (38)			
25										▽	
	8										
	9			40			D-8 / GP	5 22 32 (54)	grades to very dense.		
30											
	10										
				37			D-9 / SM	13 16 15 (31)	grades to dense silty SAND.		
35									35 to 64 feet: Poorly graded silty fine SAND/SAND, loose to medium dense, brown, wet, homogenous, HCl not tested. 35 feet: Loose poorly graded SAND/silty SAND.		
	11										
	12			83			D-10 / SP-SM	2 4 6 (10)			
40											
	13										
				90			D-11 / SM	5 8 8	grades to medium dense silty SAND.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-022-07

Job No. 33758613.04000 SR 90 Elevation 2525.3 ft (769.7 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(16)			
	14										
	15			83			D-12 / SM	7 9 10 (19)			
50											
	16										
				80			D-13 / SM	3 3 4 (7)	grades to loose.		
55											
	17										
	18			77			D-14 / SM	4 4 5 (9)			
60											
	19										
				77			D-15 / ML	4 4 6 (10)	64 to 77 feet: SILT, stiff, light brown to brown, rapid dilitancy, wet, homogenous, occasionally laminated, HCl not tested and occasional layers of medium dense well graded SAND. 64 feet: Stiff SILT.		
65	20			25			UD-16 / ML				
	21			83			D-17 / ML	2 2 11			
70											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-022-07

Job No. 33758613.04000 SR 90 Elevation 2525.3 ft (769.7 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(13)			
	22										
				53			D-18 / SW	6 8 9 (17)	grades to medium dense well graded SAND.		
75	23										
									77 to 100.5 feet: Well graded SAND or poorly graded GRAVEL with sand , subrounded to subangular, generally medium dense to very dense, brown to gray, wet, homogenous, HCl not tested.		
	24			57			D-19 / SW	8 12 17 (29)	77 feet: dense well graded SAND.		
80											
	25										
				17			D-20 / GP	13 18 15 (33)	grades to poorly graded GRAVEL with sand.		
85	26										
	27			60			D-21 / SW	11 13 11 (24)	grades to medium dense well graded SAND with silty gravel.		
90											
	28										
				40			D-22 / SW	13 13 15	grades to dense well graded SAND with gravel.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-022-07

Job No. 33758613.04000 SR 90 Elevation 2525.3 ft (769.7 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(28)			
	30										
100				37			D-23 / SW	15 31 33 (64)	grades to very dense.		
	31								Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/26/07 at 07:00: 25.9 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-023-07

Sheet 1 of 5

Job No. 33758613.04000 SR 90 Elevation 2519.8 ft (768.0 m)

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Drilling Contractor WSDOT Field Exploration Unit

Inspector Xiangdong Han

Start July 19, 2007 Completion July 24, 2007 Well ID# Not Applicable

Equipment CME-850 (track rig) with autohammer

Station 1220+17 Offset 162'L Casing HW, HQ

Method Wet Rotary

Northing 1079455.093 Easting 1750161.524 Latitude 47°23'24.294"N

Longitude 121°22'55.658"W

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									0 to 11 feet: Poorly graded GRAVEL with sand and trace of silt, subangular, dense, dark grayish brown, moist to wet, homogeneous, HCl not tested, and poorly graded SAND with gravel and trace of silt, subangular, very dense, dark grayish brown, moist, homogenous, HCl not tested.		
	1								0 feet: Poorly graded GRAVEL with sand and trace of silt.		
5				55			D-1 / GP	2 16 20 (46)	grades to Poorly graded SAND with gravel and trace of silt.		
	2			55			D-2 / SP	38 52 for 6" (>50)			
10	3			67			D-3 / SP	33 29 45 (74)			
									11 to 32 feet: Poorly graded GRAVEL with sand and with or without trace of silt and clay, subangular to angular, medium dense to very dense, gray to brown, moist to wet, homogenous, HCl not tested.		
	4			33			D-4 / GP	13 20 32 (52)	11 feet: Very dense poorly graded GRAVEL with sand and with trace of silt and clay.		
15				7			D-5 / GP	20 9 7 (16)	grades to medium dense GRAVEL with trace of sand.		
	5			10			D-6 / GP	110 for 4 "	grades to very dense GRAVEL with sand.	▽	
	6			5			D-7 / GP	110 for 1 "	grades to very dense GRAVEL.		
20											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-023-07

Job No. 33758613.04000 SR 90 Elevation 2519.8 ft (768.0 m)

Sheet 2 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No. / WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	7										
25				45			D-8 / GP	10 9 9 (18)	grades to medium dense GRAVEL with sand.		
	8										
30	9			50			D-9 / GP	15 25 55 (80)	grades to very dense.		
	10								32 to 54.5 feet: Poorly graded SAND or silty SAND / sandy SILT or medium stiff SILT/CLAY, loose to medium dense, brown, moist to wet, homogenous, HCl not tested.		
35				83			D-10 / SP-ML	3 6 7 (13)	32 feet: Medium dense poorly graded SAND or sandy SILT.		
	11										
40	12			100			D-11 / SM	5 5 8 (13)	grades to medium dense silty SAND.		
	13										
45				100			D-12 / SM-ML	3 4 4	grades to loose poorly graded silty SAND/sandy SILT.		

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-023-07

Job No. 33758613.04000 SR 90 Elevation 2519.8 ft (768.0 m)

Sheet 3 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(8)			
	14										
	15			80			D13 / ML	4 3 5 (8)	grades to medium stiff SILT.		
50											
				100			UD-14 / CL		grades to medium stiff CLAY.		
	16										
				90			D-15 / SW	9 23 21 (44)			
55									54.5 to 100.5 feet: Well graded to poorly graded SAND with gravel or poorly graded GRAVEL with sand, medium dense to very dense, brown to gray, moist to wet, homogenous, HCl not tested.		
	17								54.5 feet: Dense, well graded SAND with gravel.		
	18			60			D-16 / SW	5 6 9 (15)	grades to medium dense SAND with trace of gravel.		
60											
	19										
				45			D-17 / SW	6 7 7 (14)			
65											
	20										
	21			45			D-18 / SW	9 10 10			
70											

DRAFT ROCKN BORINGS I-90 10082007.GPJ 6/3/08

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-023-07

Job No. 33758613.04000 SR 90 Elevation 2519.8 ft (768.0 m)

Sheet 4 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								(20)			
	22										
				56			D-19 / GP	12 15 14 (29)	grades to dense poorly graded GRAVEL with sand.		
75	23										
	24			45			D-20 / SP	12 14 12 (26)	grades to dense poorly graded SAND with gravel.		
80											
	25										
				40			D-21 / GP	10 11 8 (19)	grades to medium dense poorly graded GRAVEL, with trace of clay and silt.		
85	26										
	27			33			D-22 / SW	7 6 8 (14)	grades to medium dense well graded SAND with trace of gravel and silt.		
90											
	28										
				67			D-23 / SM	5 8 9	grades to silty SAND with trace of gravel.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. GCB-023-07

Job No. 33758613.04000 SR 90 Elevation 2519.8 ft (768.0 m)

Sheet 5 of 5

Project I-90 Snoqualmie Pass East

Driller Vince Johnson Lic# 2532

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No./ WSDOT Symbol	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29							(17)			
	30			55			D-24 / SP	65 49 25 (74)	grades to very dense poorly graded SAND with gravel and trace of silt.		
100											
	31								Bottom of boring at 100.5 feet depth below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 7/24/07: 17.9 feet.		
105	32										
	33										
110											
	34										
115	35										
	36										
120											

APPENDIX A.2
PREVIOUS BORINGS

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-01-06 (OW)

Sheet 1 of 3

Job No. 33758573 SR 90 Elevation 2536.0 ft (773.0 m)

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang

Start June 8, 2006 Completion June 13, 2006 Well ID# H-01-06 (OW) Equipment CME 45 (skid rig) w/auto-hammer

Station 1208+02 Offset 46'R Casing HWT Method Wet Rotary

Northing 751955.99 Easting 1420758.28 Latitude _____ Longitude _____

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				80			D-1	8 13 19 (32)	Well graded GRAVEL, subangular, dense, dark gray, moist, homogenous, no HCl reaction. Recovered = 1.2 feet.		
				52			C-2		Top 0.8 feet: Poorly graded GRAVEL (fine) with sand, subangular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.8 feet.		
	1										
5									Bottom 1.8 feet: Poorly graded GRAVEL with cobbles, angular, dense, light gray, wet, homogenous, no HCl reaction. Recovered = 1.8 feet.		
	2			41			D-3	9 18 13 (31)	Poorly graded GRAVEL (fine) with sand, angular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.6 feet.		
				83			C-3A		Poorly graded GRAVEL with cobbles, angular, dense, light gray, wet, homogenous, weak HCl reaction. Recovered = 2.9 feet.		
10	3										
				46			C-4		Poorly graded GRAVEL with cobbles, angular, dense, light gray, wet, homogenous, no HCl reaction (Water lost rapidly, rig wobbled when drilling). Recovered = 2.3 feet.		
	4										
15											
	5			40			D-5	3 6 8 (14)	Well graded silty SAND with gravel, angular to subangular, medium dense, dark gray, wet, homogenous. Recovered = 0.6 feet.		
				0			C-5A				
	6										
20											

ROCKN BORING.GPJ 11/17/06,8:57:42 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2536.0 ft (773.0 m)

HOLE No. H-01-06 (OW)

Sheet 2 of 3

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									No recovery (material likely washed away).		
	7			87			D-6	1 2 2 (4)	SILT with sand (trace organics), soft, yellowish brown to dark brown, wet, homogenous, no HCl reaction. Recovered = 1.3 feet.		
25	8			66			D-7	19 15 19 (34)	Well graded silty SAND with gravel, subangular, dense, yellowish brown to gray, wet, homogenous, no HCl reaction. Recovered = 1.0 foot.		
30	9										
	10			66			D-8	13 14 13 (27)	Well graded SAND, subangular, medium dense, light gray, wet, homogenous, no HCl reaction. Recovered = 1.0 foot.		
35	11			80			D-9	14 50/4"	Well graded SAND with gravel, subangular, very dense, dark gray, wet, stratified, no HCl reaction.		
	12			92 / 1.0			C-10		ANDESITE, light bluish gray to light olive gray, fine to medium grained, moderately weathered, moderately strong rock (R3). No HCl reaction. Discontinuities are moderately spaced, and in fair condition. CR = 92%, RQD = 65%, FF = 1.		
40	13			88 / 1.0			C-11		ANDESITE, light bluish gray, fine grained, slightly weathered, moderately weak (R2) (based on Point Load Test Result). No HCl reaction. Discontinuities are closely to moderately spaced, and in fair to poor condition. CR = 88%, RQD = 78%, FF = 1.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2536.0 ft (773.0 m)

HOLE No. H-01-06 (OW)

Sheet 3 of 3

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			100 / 1.0			C-12		ANDESITE, light bluish gray, fine to medium grained, fresh, strong to moderately strong rock (R4 to R3). Weak HCl reaction. Discontinuities are widely to closely spaced, and are in fair condition. CR = 100%, RQD = 94%, FF=1.		
	15										
50											
	16			98 / 0.2			C-13		ANDESITE, light bluish gray, fine grained, fresh, strong rock (R4). Weak HCl reaction. Discontinuities are widely spaced, and in fair condition. CR = 98%, RQD = 98%, FF = 0.2.		
55											
	17								Bottom of boring at 56.0 feet below ground surface. Installed 1-inch diameter PVC observation well: 1. Backfilled from 37.0 feet to 56.0 feet with bentonite chips. 2. Installed 1-inch diameter observation well: - PVC screen interval with 0.010-inch slots: 12.0 to 37.0 feet - PVC riser: 1.6 feet above ground surface to 10.0 feet - Sand filter pack: 9.0 to 37.0 feet 3. Backfilled from 1.3 to 9.0 feet with bentonite chips. 4. Installed quikcrete surface seal (0 to 1.3 feet) and protective steel casing (2.5-inch I.D., 3 feet long).		
	18										
60											
	19								Water level measurements (below existing ground surface): - 6/13/06 at 07:00: 17.3 feet prior to resuming drilling with casing depth 23.0 feet. - 6/19/06 at 14:50: 19.5 feet in observation well.		
65											
	20										
	21										
70											

ROCKN BORING.GPJ 11/17/06,8:57:42 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-02-06

Job No. 33758573 SR 90 Elevation 2534.5 ft (772.5 m)

Sheet 1 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Kerry Cooper Lic# 2552

Drilling Contractor WSDOT Field Exploration Unit

Inspector Kranti Maturi

Start June 15, 2006 Completion June 15, 2006 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1209+27 Offset 66'L Casing HQ Method Wet Rotary

Northing 751984.96 Easting 1420923.22 Latitude _____ Longitude _____

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-1	4 12 11 (23)	Well graded silty SAND with gravel (top soil with trace organics), subangular, medium dense, dark brown, moist, homogenous, no HCl reaction. Recovered = 1.5 feet.		
	1								Driller noted difficult drilling started at approximately 3 feet.		
				0				50/2"	No recovery.		
5											
	2										
				33			D-2	38 40 36 (76)	Poorly graded GRAVEL, subangular, very dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.5 feet.		
10	3										
	4										
				47			D-3	12 18 36 (54)	Well graded GRAVEL with sand, subangular, very dense, brown, wet, homogenous, no HCl reaction. Recovered = 0.7 feet.	▽	
15	5										
									Sandy SILT (trace organics, charcoal), very soft, brown, moist to wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
				73			D-4	0 1			
20	6										

ROCKN BORING.GPJ 11/17/06,9:00:12 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2534.5 ft (772.5 m)

HOLE No. H-02-06

Sheet 2 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								1 (2)			
	7										
25				73			D-5	20 24 27 (51)	Well graded GRAVEL with sand, subangular, very dense, yellowish brown, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	8										
30	9			40			D-6	7 15 15 (30)	Well graded GRAVEL with sand, subangular to subrounded, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.6 feet.		
	10										
35				67			D-7	5 6 11 (17)	Poorly graded silty SAND (fine), medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	11										
40	12			27			D-8	52/6"	Well graded silty SAND with gravel, subangular, dense, yellowish brown, moist to wet, homogenous, no HCl reaction. Recovered = 0.4 feet.		
	13			0 / 100 / 4.7			C-9	50/6"	No recovery. BASALT, dark gray, fine grained, moderately to highly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in poor condition. CR = 100%, RQD = 0%, FF = 4.67.		
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2534.5 ft (772.5 m)

HOLE No. H-02-06

Sheet 3 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) (20 40 60 80)	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			100 / >10			C-10		BASALT, dark gray, fine grained, moderately to highly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in very poor condition. CR = 100%, RQD = 0%, FF >10		
	15										
50				100 / 5.2			C-11		BASALT, dark gray, fine grained, slightly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in poor condition. CR = 100%, RQD = 41%, FF = 5.2. (Note: Strong HCl reaction in some of the disontinuities due to probable calcite.)		
	16										
55				100 / 4.0			C-12		BASALT, medium light gray, fine grained, slightly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in poor to very poor condition. [Clay infilling] CR = 100%, RQD = 36%, FF = 4. (Note: Strong HCl reaction in some of the discontinuities due to probable calcite.)		
	17										
	18										
60				100 / 3.0			C-13		BASALT, medium light gray, fine grained, moderately weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in very poor condition. CR = 100%, RQD = 40%, FF = 3. (Note: Strong HCl reaction in some of the discontinuities due to probable calcite.)		
	19										
65				100 / 1.6			C-14		TUFF, medium light gray, medium grained, slightly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced, and in poor condition. CR = 100%, RQD = 74%, FF = 1.6.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2534.5 ft (772.5 m)

HOLE No. H-02-06

Sheet 4 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Kerry Cooper Lic# 2552

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	22			100 / 1.2			C-15		TUFF, medium light gray, medium grained, slightly weathered, strong rock (R4). Weak HCl reaction. Discontinuities are very closely spaced to moderately spaced, and in fair condition. CR = 100%, RQD = 78%, FF = 1.2.		
75	23								Bottom of boring at 75.0 feet below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 6/15/06 at 16:30: 15.0 feet with casing depth 75.0 feet.		
	24										
80											
	25										
85	26										
	27										
90											
	28										
95											

ROCKN BORING.GPJ 11/17/06,9:00:13 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-03-06 (OW)

Sheet 1 of 4

Job No. 33758573 SR 90 Elevation 2527.4 ft (770.4 m)

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang

Start June 13, 2006 Completion June 15, 2006 Well ID# H-03-06 (OW) Equipment CME 45 (skid rig) w/auto-hammer

Station 1211+22 Offset 62'R Casing HWT Method Wet Rotary

Northing 751769.72 Easting 1421014.4 Latitude _____ Longitude _____

County Kittitas Subsection SE 1/4 of SE1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				80			D-0	4 9 8 (17)	Well graded SAND with gravel, subangular, medium dense, dark gray, moist, homogenous, no HCl reaction. Recovered = 1.2 feet.		
5	1			67			D-1	8 9 12 (21)	Poorly graded GRAVEL (fine) with sand, angular, medium dense, yellowish brown, wet, homogenous, no HCl reaction. Recovered = 1.0 foot.		
	2			70			C-2		Poorly graded GRAVEL with cobbles, angular, light bluish gray, wet, homogenous, weak HCl reaction. Recoverd = 2.9 feet.		
10	3			47			D-3	8 7 22 (29)	Poorly graded GRAVEL with sand, subangular, dense, yellowish brown, wet, homogenous, no HCl reaction. Recovered = 0.7 feet.		
	4			26			C-4		Poorly graded GRAVEL (coarse) with cobbles, angular to subangular, brown,wet, homogenous, no HCl reaction. Recovered = 0.9 feet.		
15	5			93			D-5	1 1 1 (2)	Organic SILT with sand, very loose, dark gray, wet, homogenous, no HCl reaction. Pocket Penetrometer = 0.5 tsf. Recovered = 1.4 feet.		
20	6										

ROCKN BORING.GPJ 11/17/06,9:01:02 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2527.4 ft (770.4 m)

HOLE No. H-03-06 (OW)

Sheet 2 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									(Driller noted difficult drilling due to presence of wood.)		
				40			D-6	2 1 2 (3)	PEAT (contains wood), soft, dark brown, wet, stratified, no HCl reaction. Recovered = 0.6 feet (contains fine gravel <10%).		
	7			100			C-7		PEAT (contains vegetative matter), soft, dark, wet, homogenous, no HCl reaction. Pocket Penetrometer = 0.4 tsf.		
				23			C-8		Recovered = 1 foot.		
25									Well graded GRAVEL, subangular, gray, wet, homogenous, no HCl reaction. Recovered = 0.9 feet.		
	8			80			D-9	10 12 12 (24)	Poorly graded SAND (fine), medium dense, light brown, wet, stratified, no HCl reaction. Recovered = 1.2 feet.		
	9										
30				80			D-10	5 11 8 (19)	Poorly graded silty SAND (fine), medium dense, light brown to gray, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
	10										
35				73			D-11	2 4 4 (8)	Poorly graded silty SAND (fine), loose, light gray, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	11										
	12										
40				73			D-12	6 6 7 (13)	Poorly graded silty SAND (fine), medium dense, yellowish gray, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

Job No. 33758573 SR 90 Elevation 2527.4 ft (770.4 m)

HOLE No. H-03-06 (OW)

Sheet 3 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			67			D-13	6 8 6 (14)	Poorly graded silty SAND (fine), medium dense, light gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	15										
50				87			D-14	5 5 5 (10)	SILT, loose, gray, wet, homogenous, no HCl reaction. Recovered = 1.3 feet.		
	16										
55				67			D-15	4 6 6 (12)	Poorly graded silty SAND (fine), medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	17										
	18										
60				80			D-16	5 5 5 (10)	Sandy SILT, loose, gray, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
	19										
65				93			D-17	4 8 9 (17)	SILT, medium dense, gray, wet, homogenous, no HCl reaction. Pocket Penetrometer = 1.25 tsf, Torvane = 2 kip/sf. Recovered = 1.4 feet.		
	20										
	21										
70											

ROCKN BORING.GPJ 11/17/06,9:01:02 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-03-06 (OW)

Job No. 33758573 SR 90 Elevation 2527.4 ft (770.4 m)

Sheet 4 of 4

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				73			D-18	3 1 4 (5)	Sandy SILT, loose, gray, wet, homogenous, no HCl reaction. Pocket Penetrometer = 0.5 tsf, Torvane = 0.25 kip/sf. Recovered = 1.1 feet.		
	22										
75	23			60			D-19	10 12 50/3"	Well graded SAND with gravel, angular to subangular, very dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.9 feet.		
				57			C-20		Poorly graded GRAVEL, subangular to subrounded, very dense, light gray, wet, homogenous, no HCl reaction. Recovered = 1.8 feet.		
	24										
80				81 / 2.0			C-21		ANDESITE, medium light gray, fine grained, slightly weathered to fresh, strong rock (R4). No HCl reaction. Discontinuities are moderately spaced, and in fair condition. CR = 100%, RQD = 68%, FF = 2.		
	25			98 / 2.0			C-22		ANDESITE, medium gray, fine grained, fresh, moderately strong rock (R4). No HCl reaction. Discontinuities are moderately spaced, and in fair condition. CR = 100%, RQD = 68%, FF = 2.		
85	26			100 / 1.0			C-23		ANDESITE, medium light gray, fine grained, fresh, strong rock (R4). No HCl reaction. Discontinuities are moderately spaced to closely spaced, and in good condition. CR = 100%, RQD = 100%, FF = 1.		
	27								Bottom of boring at 85.5 feet below ground surface. Installed 1-inch diameter PVC observation well: 1. Backfilled from 34.0 feet to 85.5 feet with bentonite chips. 2. Installed 1-inch diameter observation well: - PVC screen interval with 0.010-inch slots: 9.0 to 34.0 feet - PVC riser: 1.7 feet above surface to 6.0 feet - Sand filter pack: 6.0 to 34.0 feet 3. Backfilled from 1.3 to 6.0 feet with bentonite chips. 4. Installed quickcrete surface seal (0 to 1.3 feet) and protective steel casing (2.5-inch I.D., 3 feet long).		
90	28								Water level measurements (below existing ground surface): - 6/15/06 at 07:45: 14.0 feet prior to resuming drilling with casing depth 83.0 feet. - 6/19/06 at 14:55: 11.3 feet in observation well.		
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-04-06

Sheet 1 of 5

Job No. 33758573 SR 90 Elevation 2519.3 ft (767.9 m)

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang

Start June 15, 2006 Completion June 21, 2006 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1219+88 Offset 145'L Casing HWT Method Wet Rotary

Northing 751361.08 Easting 1421813.12 Latitude _____ Longitude _____

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				87			D-1	1 5 21 (26)	Top 0.5 feet: vegetable roots. Well graded silty SAND with gravel, subangular, dense, gray, moist, stratified, no HCl reaction. Recovered = 1.3 feet.		
	1								(Note: Rig wobbled when drilling at 3-foot depth.)		
5				40			D-2	22 22 21 (43)	Poorly graded GRAVEL with sand, angular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.6 feet. (Note: Fine sand was flushed out when drilling with advancer, and wobbling and noisy when drilling.)	▽	
	2										
10	3			87			D-3	28 24 15 (39)	Poorly graded GRAVEL with sand, angular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.3 feet. (Note: Rig wobbling and noisy when drilling.)		
	4										
15	5			13			D-4	16 8 5 (13)	Well graded SAND with gravel, angular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.2 feet.		
20	6			67			D-5	11	Poorly graded GRAVEL with sand, angular to		

ROCKN BORING.GPJ 11/17/06,9:07:37 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-04-06

Job No. 33758573 SR 90 Elevation 2519.3 ft (767.9 m)

Sheet 2 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
								18 20 (38)	subangular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	7										
25				67			D-6	11 15 10 (25)	Poorly graded GRAVEL with sand, angular, dense, brown, wet, stratified, no HCl reaction. Recovered = 1 foot.		
	8										
	9										
30				93			D-7	3 7 8 (15)	Poorly graded SAND (fine to medium), medium dense, brown, wet, homogenous, no HCl reaction. Recovered = 1.4 feet.		
	10										
35				80			D-8	7 9 10 (19)	Poorly graded SAND (fine), medium dense, brown, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
	11										
	12										
40				67			D-9	6 5 5 (10)	Sandy SILT, loose, brown, wet, homogenous with trace wood pieces, no HCl reaction. Recovered = 1 foot.		
	13										
45											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-04-06

Job No. 33758573 SR 90 Elevation 2519.3 ft (767.9 m)

Sheet 3 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			80			D-10	3 6 7 (13)	Poorly graded silty SAND (fine), medium dense, light gray to brown, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
	15										
50				87			D-11	4 7 11 (18)	Poorly graded SAND (fine), medium dense, brown, wet, homogenous, no HCl reaction. Recovered = 1.3 feet.		
	16										
55				93			D-12	4 6 7 (13)	Poorly graded silty SAND (fine), medium dense, brown, wet, stratified, no HCl reaction. Recovered = 1.4 feet.		
	17										
	18										
60				73			D-13	4 4 7 (11)	SILT, medium dense, brown, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	19										
65				87			D-14	5 7 7 (14)	SILT with sand, medium dense, gray, wet, homogenous, no HCl reaction. Pocket Penetrometer = 0.5 tsf, Torvane = 3.0 kip/sf. Recovered = 1.3 feet.		
	20										
	21										
70											

ROCKN BORING.GPJ 11/17/06,9:07:38 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-04-06

Job No. 33758573 SR 90 Elevation 2519.3 ft (767.9 m)

Sheet 4 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				27			D-15	24 23 16 (39)	Poorly graded GRAVEL, angular to subangular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.4 feet.		
	22										
75	23			53			D-16	11 13 8 (21)	Poorly graded GRAVEL with sand, angular to subangular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.8 feet.		
	24										
80				53			D-17	11 8 10 (18)	Poorly graded GRAVEL with sand, subangular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.8 feet.		
	25										
85	26			73			D-18	8 6 7 (13)	Well graded GRAVEL with sand, subangular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	27										
90				67			D-19	8 10 9 (19)	Well graded GRAVEL with sand, angular to subangular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-04-06

Job No. 33758573 SR 90 Elevation 2519.3 ft (767.9 m)

Sheet 5 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. / FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			53			D-20	5 11 8 (19)	Poorly graded GRAVEL with sand, angular to subangular, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.8 feet.		
									Bottom of boring at 96.5 feet below ground surface. Backfilled to ground surface with bentonite chips. Water level measurements (below existing ground surface): - 6/21/06 at 06:30: 4.25 feet with casing depth 96.0 feet.		
	30										
100											
	31										
105	32										
	33										
110											
	34										
115	35										
	36										
120											

ROCKN BORING.GPJ 11/17/06,9:07:38 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-05-06

Sheet 1 of 5

Job No. 33758573 SR 90 Elevation 2524.9 ft (769.6 m)

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Drilling Contractor WSDOT Field Exploration Unit

Inspector Ken Yang

Start June 27, 2006 Completion June 29, 2006 Well ID# Not Applicable Equipment CME 45 (skid rig) w/auto-hammer

Station 1222+52 Offset 9'L Casing HWT Method Wet Rotary

Northing 751072.05 Easting 1421894.3 Latitude _____ Longitude _____

County Kittitas Subsection SE 1/4 of SE 1/4 Section 15 Range 11E Township 22N

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				100			D-1	6 5 10 (15)	Well graded silty SAND with gravel, angular, medium dense, gray, dry, homogenous, no HCl reaction. Recovered = 1.5 feet.		
				33			C-2		Well graded SAND, subangular, medium dense, gray, wet, stratified, no HCl reaction. Recovered = 0.5 feet.		
	1			80			C-3		Poorly graded GRAVEL with sand and cobbles, subangular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
5											
	2			0				20 13 11 (24)	No recovery.		
				29			C-4		Poorly graded GRAVEL with cobbles, angular to subrounded, dense, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
10	3										
				40			D-5	19 15 5 (20)	Poorly graded GRAVEL with sand, angular, medium dense, dark gray, wet, homogenous, no HCl reaction. Recovered = 0.6 feet.	▽	
	4			62			C-6		Poorly graded GRAVEL with cobbles, subangular to subrounded, gray, wet, homogenous, no HCl reaction. Recovered = 2.8 feet.		
15											
	5			40			D-7	8 4 5 (9)	Poorly graded silty SAND with gravel, subangular, loose, gray, wet, homogenous, no HCl reaction. Recovered = 0.6 feet.		
	6			52			C-8		Poorly graded GRAVEL with cobbles, angular to subangular, gray, wet, homogenous, no HCl reaction. (Note: Contains several small 1/2-inch pieces of wood.)		
20											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-05-06

Job No. 33758573 SR 90 Elevation 2524.9 ft (769.6 m)

Sheet 2 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
									Recovered = 2.6 feet.		
	7										
				67			D-9	17 18 18 (36)	Poorly graded GRAVEL with sand, subangular, dense, gray to dark gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
25				100			C-10		Well graded GRAVEL, subangular to subrounded, dense, gray, wet, homogenous, weak HCl reaction. (Note: contains one piece of 1-inch wood.) Recovered = 2 feet.		
	8										
				20			D-11	11 16 18 (34)	Poorly graded GRAVEL with sand, angular to subrounded, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.3 feet.		
				100			C-12		Poorly graded GRAVEL with sand, angular to subrounded, dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.5 feet.		
	9										
30											
	10										
				60			D-13	11 13 22 (35)	Poorly graded GRAVEL with sand, angular, dense, gray, wet, homogenous, no HCl reaction. Recovered = 0.9 feet.		
35											
	11										
	12										
40				100			D-14	4 6 7 (13)	Poorly graded SAND (fine), medium dense, brown to gray, wet, homogenous, no HCl reaction. Recovered = 1.5 feet.		
	13										
45											

ROCKN BORING.GPJ 11/17/06,9:08:33 A11

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-05-06

Job No. 33758573 SR 90 Elevation 2524.9 ft (769.6 m)

Sheet 3 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	14			87			D-15	4 4 6 (10)	Poorly graded silty SAND (fine), loose, light brown, wet, homogenous, no HCl reaction. Recovered = 1.3 feet.		
	15										
50				87			D-16	5 11 13 (24)	Poorly graded silty SAND (fine), medium dense, light brown, wet, homogenous, no HCl reaction. Recovered = 1.3 feet.		
	16										
55				93			D-17	5 7 9 (16)	Poorly graded silty SAND (fine), medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.4 feet.		
	17										
	18										
60				67			D-18	5 5 4 (9)	Poorly graded SAND (fine), loose, gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	19										
65				53			D-19	5 6 6 (12)	Sandy SILT, medium dense, gray to brown, wet, stratified, no HCl reaction. Recovered = 0.8 feet.		
	20										
	21										
70											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-05-06

Job No. 33758573 SR 90 Elevation 2524.9 ft (769.6 m)

Sheet 4 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
				60			D-20	5 6 7 (13)	SILT, medium dense, yellowish brown, wet, homogenous, no HCl reaction. Pocket Penetrometer = 0.4 tsf, Torvane = 0.8 kip/sf. Recovered = 0.9 feet.		
	22										
75	23			100			D-21	4 5 5 (10)	SILT, loose, yellowish brown, wet,homogenous, no HCl reaction. Pocket Penetrometer = 0.5 tsf, Torvane = 1.2 kip/sf. Recovered = 1.5 feet.		
	24										
80				67			D-22	14 17 23 (40)	Poorly graded SAND (fine), dense, light gray, wet, homogenous, no HCl reaction. Recovered = 1 foot.		
	25										
85	26			60			D-23	8 13 13 (26)	Well graded SAND, subrounded, dense, light brownish gray, wet, homogenous, no HCl reaction. Recovered = 0.9 feet.		
	27										
90				73			D-24	12 12 10 (22)	Well graded SAND, medium dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.1 feet.		
	28										
95											

Washington State Department of Transportation

LOG OF TEST BORING

URS

Start Card _____

HOLE No. H-05-06

Job No. 33758573 SR 90 Elevation 2524.9 ft (769.6 m)

Sheet 5 of 5

Project WSDOT I-90 Snoqualmie Pass East

Driller Mike Harvey Lic# 2599

Depth (ft)	Meters (m)	Profile	Rock Quality Designation (%) 20 40 60 80	% Rec. FF	Rock Strength	Sample Type	Sample No.	Blows/6" SPT (N)	Description of Material	Groundwater	Instrument
	29			80			D-25	12 13 18 (31)	Poorly graded SAND (fine to medium), dense, gray, wet, homogenous, no HCl reaction. Recovered = 1.2 feet.		
									Bottom of boring at 96.5 feet below ground surface. Backfilled to ground surface with bentonite chips.		
	30								Water level measurements (below existing ground surface): - 6/28/06: 11.7 feet after 30 minute drilling break. - 6/29/06 at 06:10: 11.2 feet prior to resuming drilling at casing depth 86.0 feet.		
100											
	31										
105	32										
	33										
110											
	34										
115	35										
	36										
120											

ROCKN BORING.GPJ 11/17/06,9:08:33 A11

H-1-70A

I. F. 26.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
Copy to Bridge Engineer
Copy to District Engineer
Copy to

LOG OF TEST BORING

S.H. S.R. 90 Section Hyak to Top of Easton Hill Job No. L-3398
Hole No. H-1 Sub Section L^W Line Over Gold Creek: Pier 1 Cont. Sec. 1901-R
Station L^W 146+00 Offset On ℄ Ground El. 2502.0
Type of Boring Auger 8C48-2 Casing Auger W.T. El. 2501.0
Inspector Calvin Lockwood Date 20-21 April, 1970 Sheet 1 of 4

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				CREEK BED:
				SAND, GRAVEL & COBBLES - Loose to
				compact, slightly silty, all sizes
			9 Std.	
			5 Pen	
	8		3 1	
			5	
5				
			11 Std.	
			12 Pen	
	25		13 2	
			12	
10				
			18 Std.	
			17 Pen	
	30		13 3	
			9	
15				SAND - compact, brown, slightly silty
				all sizes
			8 Std.	(Saturated)
			12 Pen	
	26		14 4	
			9	
20				SAND - Slightly compact to compact, brown

. F. 26.66-A (Rev. 5-67)

Hole No. H-1 Sub Section L^W Line Over Gold Creek: Pier 1 Sheet 2 of 4

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				Slightly silty, fine
			8 Std.	(Saturated)
			10 Pen	
	19		9 5	
			10	
25				
			8 Std.	
			11 Pen	
	24		13 6	
			20	
30				
			9 Std.	(Trace fine gravel)
			9 Pen	
	21		12 7	
			12	
35				
			11 Std.	SILT & SAND - Compact, brown, fine
			13 Pen	(Saturated)
	27		14 8	
			16	
40				
			6 Std.	(Saturated)
			7 Pen	
	14		7 9	
			10	
45				

F. 26.66-A (Rev. 5-67)

Hole No. H-1 Sub Section L^W Line over Gold Creek: Pier 1 Sheet 3 of 4

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			7 Std.	
			8 Pen	
	29		21 10	
			30	
50				SAND & GRAVEL - Dense to slightly
				compact to dense, brown, slightly silty,
				all sizes
			16 Std.	
			23 Pen	
	53		30 11	
			21	
55				
			14 Std.	
			15 Pen	
	30		15 12	
			16	
60				
			12 Std.	
			12 Pen	
	24		12 13	
			31	
65				
			9 Std.	
			10 Pen	
	17		7 14	
			9	
70				

F. 26.66-A (Rev. 5-67)

Hole No. H-1 Sub Section LW Line over Gold Creek: Pier 1 Sheet 4 of 4

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			16 Std	
			26 Pen	
	58		32 15	
			30	
75				
			22 Std	
			27 Pen	
	58		31 16	
			38	
80				TEST BORING STOPPED AT 79.5
				Water Level: -1.0 same as nearby creek
				Samples wet throughout hole

H-2-70A

H. F. 26.66 (Rev. 5-67)

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

Original to Materials Engineer
Copy to Bridge Engineer
Copy to District Engineer
Copy to _____

LOG OF TEST BORING

S.H. _____ S.R. 90 Section Hyak to Top of Easton Hill Job No. 3398
Hole No. H-2 Sub Section I^W Line Over Gold Creek: Pier 4 Cont. Sec. 1901-R
Station I^W 147+43 Offset On ℄ Ground El. 2502.0
Type of Boring Auger & 8C48-2 Casing Auger 77.5 3" Casing 77.5-101.5 W.T. El. 2501.0
Inspector Calvin Lockwood Date 21-23 April 1970 Sheet 1 of 5

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				SAND, GRAVEL & COBBLES - Slightly
				compact to dense, brown, slightly silty
			7 Std.	all sizes
			9 Pen	
	20		11 1	
			17	
5				
			7 Std.	
			8 Pen	
	16		8 2	
			9	
10				
			22 Std.	
			30 Pen	
	68		38 3	
15				
				SAND - slightly compact to compact
				brown, slightly silty, fine
			9 Std.	
			12 Pen	
	24		12 4	
			14	
20				

F. 26.66-A (Rev. 5-67)

Hole No. H-2 Sub Section L^W Line over gold creek: Pier 4 Sheet 2 of 5

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			5 Std.	
			6 Pen	
	14		8 5	
			7	
25				
			6 Std.	
			7 Pen	
	19		12 6	
			14	
30				
			5 Std.	(Saturated)
			5 Pen	
	12		7 7	
			7	
35				
			4 Std.	(Saturated)
			6 Pen	
	12		6 8	
			8	
40				
			3 Std.	(Saturated)
			4 Pen	
	8		4 9	SILT & SAND - Loose to compact, grey, fine
			5	
45				

F. 26.66-A (Rev. 5-67)

Hole No. H-2 Sub Section L^W Line over Gold Creek: Pier 4 Sheet 3 of 5

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			9 Std.	(Saturated)
			8 Pen	
	16		8 10	
			7	
50				
			7 Std.	(Saturated)
			6 Pen	
	13		7 11	
			9	
55				
			7 Std.	(Saturated)
			8 Pen	
	17		9 12	
			19	
60				
			9 Std.	
			13 Pen	
	29		16 13	SILT & SAND - compact, brown, fine
			20	
65				
			10 Std.	
			14 Pen	
	29		15 14	
			19	
70				

I. F. 26.66-A (Rev. 5-67)

Hole No. H-2 Sub Section L^W Line over Gold Creek: Pier 4 Sheet 4 of 5

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			14 Std.	(Possibly false blow count. Bit on piece of gravel at 73.0 Probably about 50 blows per ft. average)
			86 Pen	
	112		26 15	SAND & GRAVEL - Very dense to compact to
			24	
75				Very dense, brown, slightly silty to clean
				all sizes
			Std.	
			25 Pen	
			16 16	
	28		12	
			11	
80				
				(Slight artesian flow at 83.0 area)
85				
			10 Std.	
	25		14 Pen	
			11 17	
			14	
90				
			15 Std.	
	27		15 Pen	
			12 18	
			9	
95				

F. 26.66-A (Rev. 5-67)

Hole No. H-2 Sub Section L^W Line over Gold Creek: Pier 4 Sheet 5 of 5

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				(Casing drove harder at 95.5 onward)
			38 Std.	
	66		32 Pen	
			34 19	
			36	
100				
			Std.	
			42 Pen	(Brown & Grey this sample)
			50 20	
	108		58	TEST BORING STOPPED AT 103.0
105				
				Auger to 77.5 - Trouble with cobbles near
				surface - attempted to go further with
				mud and only got to 85.0, lost too much mud
				so wash bored in 3" casing from 77.5 to 101.5
				Lost a lot of water in washing down
				from 77.5 to 101.5
				Samples wet throughout hole
				Water Level: -1.0 same as nearby creek
				Auger came out very hard from 77.5 to 7.5
				with trouble with auger hanging up on
				cobbles in 7.0 vicinity

APPENDIX B
LABORATORY TESTING DATA

Table B-1
Summary of Laboratory Testing Results

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
H-01-06(OW)	D-1	1.5	GW	3.0	87.6	12.4	0.0				-	-	-	-	-
H-02-06	D-4	19.0	OL	68.2	-	-	-				NP	NP	NP	-	-
H-03-06(OW)	D-2	5.0	GP	10.9	55.4	37.6	6.9				-	-	-	-	-
	D-5	16.5	OL	52.3	-	-	-				-	-	-	9.9	-
	D-6	21.5	Pt	66.4	-	-	-				-	-	-	12.3	-
	C-7	23.0	Pt	94.7/81.0	-	-	-				NP	NP	NP	20.5	-
	D-11	35.0	SM	35.8	0.0	60.9	36.4		2.7		-	-	-	-	-
	D-14	50.0	ML	31.8	0.0	7.9	80.8		11.4		-	-	-	-	-
	D-18	70.0	ML	24.4	0.0	8.0	82.9		9.1		-	-	-	-	-
H-04-06	D-9	40.0	ML	31.0	0.0	34.9	59.9		5.2		-	-	-	-	-
	D-13	60.0	ML	32.9	0.0	2.9	90.9		6.1		-	-	-	-	-
H-05-06	D-15	45.0	ML	29.2	0.0	52.4	44.9		2.7		-	-	-	-	-
	D-21	75.0	ML	39.0	0.0	0.1	78.9		21.0		-	-	-	-	-
GCB-002-07	D-2	5.5-7.0	GP	2.0	71.2	24.9	4.0				-	-	-	-	-
	D-7	13.0-14.5	GM-SM/OL	7.4	48.6	40.2	11.2				-	-	-	-	-
	C-10	17.0-18.0	GC	6.0	73.7	14.4	12.0				-	-	-	-	-
	D-11	18.0-19.5	SM-ML	29.6	8.7	41.7	46.1	48.1	3.5	1.5	-	-	-	-	-
	D-12	20.5-22.0	SP	7.3	34.9	57.9	7.2				-	-	-	-	-
	D-13	25.5-27.0	SW-GW	7.0	46.4	50.3	3.2				-	-	-	-	-
	D-14	29.0-30.5	SM	7.1	26.4	47.2	26.4				-	-	-	-	-
	D-15	34.0-35.5	ML	23.7	3.9	37.7	58.3				-	-	-	-	-
	D-16	39.0-40.5	CL-ML	22.8	0.0	3.0	81.9	91.0	15.1	6.0	25	19	6	-	-
	D-17	44.0-45.5	SM	33.9	16.5	56.6	26.9				-	-	-	-	-
GCB-003-07	D-5	13.5-14.0	SM-OL	24.7	-	-	-				-	-	-	2.4	-
	D-6	15.0-16.5	GW	-	-	-	-				-	-	-	-	7,700

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-003-07	D-10T	26.0-27.5	ML	-	-	-	-				-	-	-	-	3,200
	D-10B	26.0-27.5	ML	-	-	-	-				-	-	-	-	4,650
GCB-004-07	D-9	18.5-20.0	OL	76.6	-	-	-				-	-	-	3.3	-
	D-12	30-31.5	ML	32.4	0.0	32.0	68.0				-	-	-	-	-
	D-13	35-36.5	ML	30.7	0.0	35.6	64.4				-	-	-	-	-
	D-14	40-41.5	ML	26.3	0.0	44.4	55.6				-	-	-	-	-
	D-15	45-46.5	SM	23.2	0.0	53.3	46.7				-	-	-	-	-
	D-16	50-51.5	ML	26.5	0.0	18.9	81.1				22	20	2	-	-
	D-17	55-56.5	CL-ML	26.3	0.0	4.1	95.9				21	14	7	-	-
	D-18	60-61.5	CL-ML	25.9	0.0	8.0	92.0				21	14	7	-	-
	D-19	65-66.5	CL	32.5	0.0	0.4	99.6				34	19	15	-	-
	D-20	70-71.5	CL-ML	25.3	0.0	28.8	71.2				20	15	5	-	-
	D-21	75-76.5	ML	23.2	0.0	47.8	52.2				22	19	3	-	-
	D-22	80-81.5	ML	22.7	0.0	31.0	69.0				-	-	-	-	-
	D-23	85-86.5	ML	27.4	0.0	10.9	89.1				20	20	NP	-	-
GCB-005-07	D-1	0.0-1.5	SM	2.0	29.4	58.6	12.0				-	-	-	-	-
	D-2	2.0-3.5	SP	7.4	34.7	58.3	7.0				-	-	-	-	-
	D-4	6.0-7.5	GW-SW	6.0	44.5	46.2	9.3				-	-	-	-	-
	D-7	11.0-12.5	GW-SW	7.3	42.1	50.4	7.5				-	-	-	-	-
	D-9	13.5-15.0	GW	7.0	56.3	35.5	8.2				-	-	-	-	-
	D-12	18.5-20.0	GW-SW	7.1	46.2	47.3	6.5				-	-	-	-	-
	D-13	25.0-26.5	GP-SP	23.7	44.7	46.6	8.7				-	-	-	-	-
	D-14	30.0-31.5	SP	33.9	0.0	93.9	6.0				-	-	-	-	-
	D-15	35.0-36.5	SM	25.6	0.0	70.3	28.5	29.7	1.2	0.0	-	-	-	-	-
	D-16 T	40.0-40.5	SP	29.1	0.1	91.9	8.0				-	-	-	-	-
	D-17 T	45.0-45.5	SP	27.1	0.0	93.1	6.9				-	-	-	-	-
	D-19	50.7-52.2	ML	36.3	0.0	13.8	80.0	81.5	6.3	4.8	-	-	-	-	-

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-005-07	D-20	55.0-56.5	ML	26.9	0.0	10.8	89.2				-	-	-	-	-
	D-21	60.0-61.5	SM	26.6	0.0	83.4	16.6				-	-	-	-	-
	D-22	65.0-66.5	ML	26.9	0.0	25.8	74.2				-	-	-	-	-
	D-23	70.0-71.5	ML	34.7	0.0	0.0	54.3	80.0	45.7	20.0	-	-	-	-	-
	D-25	75.0-76.5	ML	28.1	0.0	34.5	65.5				-	-	-	-	-
	D-27	85.0-86.5	ML	28.6	0.0	36.5	63.5				-	-	-	-	-
	D-30	100.0-101.5	SM	8.4	19.5	63.6	16.9				-	-	-	-	-
GCB-007-07	D-2	2.5-4.0	SM-GM	7.8	42.8	43.0	14.3				-	-	-	-	-
	D-3	5.5-6.5	SM-GM	10.1	44.6	41.3	14.1				-	-	-	-	-
	D-4	7.5-9.0	SM-GM	8.2	44.6	43.6	11.8				-	-	-	-	-
	D-5	10.0-11.5	SM-GM	4.8	45.4	44.3	10.3				-	-	-	-	-
	D-6	12.5-14.0	SM/OL	60.3	3.4	62.1	30.3	33.5	4.2	1.0	-	-	-	5.0	-
	UD-7	14.0-16.0	SM/OL	-	-	-	-				-	-	-	-	3,400
	D-8	17.5-19.0	SM/OL	47.2	2.5	57.0	40.5				-	-	-	-	-
	D-11	25.0-26.5	SM	26.8	5.5	54.1	40.4				-	-	-	-	-
	D-12	30.0-31.5	SP	27.1	0.7	92.9	6.4				-	-	-	-	-
	D-13	35.0-36.5	SP	40.5	1.6	92.2	6.2				-	-	-	-	-
	D-14	40.0-41.5	SM	31.4	0.0	67.9	32.1				-	-	-	-	-
	D-15	45.0-46.5	ML	24.5	0.0	42.7	57.3				-	-	-	-	-
	D-16	50.0-51.5	SM	28.2	0.0	80.2	19.8				-	-	-	-	-
	D-17	55.0-56.5	SM	28.3	0.0	58.8	41.2				-	-	-	-	-
	D-18 T	60.0-60.5	ML	28.7	0.1	6.7	93.2				-	-	-	-	-
	D-18 B	60.5-61.5	ML	31.2	0.0	0.0	99.0				-	-	-	-	-
	UD-19	65.0-67.0	CL	36.7	-	-	-				31	21	10	-	-
	D-20	70.0-71.5	SM	33.7	0.0	65.4	34.6				-	-	-	-	-
	D-21	75.0-76.5	SM	23.3	0.0	72.6	27.4				-	-	-	-	-

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-009-07	D-1	3.0-4.5	SM-GM	9.2	40.2	48.1	11.6				-	-	-	-	-
	D-2	5.0-6.5									-	-	-	-	-
	D-5	11.5-13	GW	10.3	71.1	27.0	2.0				-	-	-	-	-
	D-6	13.0-14.5	SM/OL	15.5	28.9	57.6	13.5				-	-	-	-	-
	D-7	15.0-16.5	GM	14.3	39.9	29.4	30.1	30.5	0.6	0.25	-	-	-	-	-
	D-8	18.0-19.5	GW	12.8	56.0	36.1	7.9				-	-	-	-	-
	D-9	20.0-21.5									-	-	-	-	-
	D-10	25.0-26.5	GW	13.1	64.2	32.0	3.8				-	-	-	-	-
	D-11	30.0-31.5									-	-	-	-	-
	D-13	36.5-38.0	SM	30.9	0.0	74.5	25.5				-	-	-	-	-
	D-14	40.0-41.5	ML	26.0	0.0	0.0	55.5	82.0	44.5	18	-	-	-	-	-
	D-15	45.0-46.5	SM	27.7	0.6	55.5	43.9				-	-	-	-	-
	D-16	50.0-51.5									-	-	-	-	-
	D-17	55.0-56.5	ML	31.3	0.0	28.6	71.4				-	-	-	-	-
	D-18	60.0-61.5	SP-SM	25.5	0.0	90.4	9.6				-	-	-	-	-
	D-19	65.0-66.5	ML	28.4	0.0	34.5	65.5				-	-	-	-	-
	D-20	70.0-71.5	SM-ML	28.8	0.0	49.5	50.5				-	-	-	-	-
	D-21	75.0-76.5	CL	32.8	-	-					26	17	9	-	-
	UD-22-2	80.2-80.6	SP	34.1	2.2	89.2	7.5	8.2	1.1	0.4	-	-	-	-	-
	D-24	85.0-86.5	SM	24.8	4.0	66.1	29.9				-	-	-	-	-
GCB-010-07	D-5	11.5-13.0	SM/OL	44.6	-	-	-				-	-	-	2.2	-
	D-7	16.5-18	SM	1.67	2.5	66.2	31.3				-	-	-	-	-
	UD-8	20.0-20.8	ML	44.8	-	-	-				28	24	4	-	-
	D-10	29.0-30.5	SM	29.0	0.0	89.8	9.0	10.2	1.2	0.0	-	-	-	-	-
	D-12	39.0-40.5	ML	24.5	0.0	31.1	68.9				-	-	-	-	-
	D-13	44-45.5	SM	30.9	0.0	77.9	22.1				-	-	-	-	-
	D-14	49-50.5	SM	32.2	0.0	53.3	46.7				-	-	-	-	-

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-010-07	D-15	54-55.5	SM	28.6	0.0	61.9	38.1				NP	NP	NP	-	-
	D-16	59-60.5	ML	34.7	0.0	0.3	99.7				28	25	3	-	-
	D-17	64-65.5	ML	31.5	0.0	6.6	93.4				27	23	4	-	-
	D-18	69-70.5	SM	7.4	24.8	64.4	10.8				-	-	-	-	-
	D-19	74-75.5	SM	21.0	6.3	80.6	13.2				-	-	-	-	-
	D-20	79-80.5	SM	12.1	2.0	68.6	29.4				-	-	-	-	-
	D-21	84-85.5	SM	21.8	0.0	66.9	33.1				-	-	-	-	-
	D-22	89-90.5	ML	29.0	0.0	27.6	72.4				NP	NP	NP	-	-
	D-23	94-95.5	SM	17.7	0.2	88.7	11.0				-	-	-	-	-
GCB-011-07	D-7	9.0-10.5	SM	46.7	-	-	-				-	-	-	2.7	-
GCB-013-07	D-5	8.0-9.5	GW	5.8	55.8	37.7	6.5				-	-	-	-	-
	D-8	14.0-15.5	GW	7.6	59.6	35.7	4.7				-	-	-	-	-
	D-10	19.0-20.5	GW	6.3	57.7	38.6	3.7				-	-	-	-	-
	D-11	23.0-24.5	GW	7.6	57.1	36.5	6.4				-	-	-	-	-
	D-14	33.0-34.5	SM	29.7	0.4	64.7	34.9				-	-	-	-	-
	D-15	39.0-40.5	SM	28.2	0.5	88.5	10.9				-	-	-	-	-
	D-16	44.0-45.5	ML	27.0	0.1	35.6	64.3				-	-	-	-	-
	UD-17	49.0-50.0	ML	29.3	0.0	41.5	58.5				-	-	-	-	-
	D-18	54.0-55.5	ML	32.6	0.0	25.3	74.7				-	-	-	-	-
	D-19	59.0-60.5	ML-SM	28.8	0.1	44.2	55.7				-	-	-	-	-
	D-20	64.0-65.5	ML	30.6	0.0	1.9	98.1				-	-	-	-	-
	UD-21A	69.0-71.0	ML	33.9	0.3	0.9	98.8				-	-	-	-	-
	UD-21B	69.0-71.0	ML	33.1	0.0	0.0	63.0	99.5	37.0	0.5	-	-	-	-	-
GCB-014-07	C-8	12.5-13.5	OL	57.4	-	-	-				-	-	-	8.4	
	D-10	16.5-18.0	OL	51.5	-	-	-				-	-	-	6.3	

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-015-07	D-6	17.5-19.0	SM-OL	-	-	-	-				-	-	-	-	11,000
GCB-017-07	D-7	11.0-12.5	GW	7.6	61.5	34.1	4.4				-	-	-	-	-
	D-11	16.0-17.5	SP	9.9	35.3	59.2	5.5				-	-	-	-	-
	D-13	23.5-25.0	GP	8.1	73.1	24.5	2.5				-	-	-	-	-
	D-14	28.5-30.0	SP	18.3	7.3	85.2	7.5				-	-	-	-	-
	D-15	34.0-35.5	SM-ML	28.7	0.2	51.1	48.7				-	-	-	-	-
	D-16	39.0-40.5	SM-ML	27.5	0.0	54.8	45.2				-	-	-	-	-
	D-17	44.0-45.5	ML	27.4	0.0	42.0	58.0				-	-	-	-	-
	D-18	49.0-50.5	SM	26.0	0.0	79.0	21.0				-	-	-	-	-
	D-19	54.0-55.5	ML	27.3	0.0	37.9	62.1				-	-	-	-	-
	D-20	59.0-60.5	SM	27.6	0.0	78.3	21.7				-	-	-	-	-
	D-21	64.0-65.5	ML	28.1	0.0	14.4	85.6				-	-	-	-	-
	D-22	69.0-70.5	ML	31.6	0.0	1.0	99.0				-	-	-	-	-
	D-23	74.0-75.0	ML	30.1	0.0	0.5	60.9	87.5	38.6	12.0	-	-	-	-	-
	D-24	79.0-80.5	SP	18.1	0.2	97.9	2.0				-	-	-	-	-
	D-25	84.0-85.5	SP	10.3	34.6	60.0	5.4				-	-	-	-	-
	D-26	89.0-90.5	SP	11.0	35.1	57.3	7.7				-	-	-	-	-
GCB-018-07	UD-15	54.0-56.0	ML	25.2	-	-	-				26	24	2	-	-
GCB-019-07	D-1	3.0-4.5	GP	8.6	72.8	23.1	4.1				-	-	-	-	-
	D-2	6.0-7.5	GM	10.0	44.1	29.1	26.8				-	-	-	-	-
	D-3	8.0-9.5	GM	23.8	44.5	30.9	24.6				-	-	-	-	-
	D-4	11.0-12.5	GP	16.6	69.4	24.4	6.1				-	-	-	-	-
	D-5	13.0-14.5	GP	11.9	56.9	34.5	8.6				-	-	-	-	-
	D-8	19.0-20.5	GW	6.9	63.8	32.5	3.7				-	-	-	-	-
	D-9	23.0-24.5									-	-	-	-	-

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-019-07	D-10	28.0-29.5	SM	31.9	0.0	88.3	11.7				-	-	-	-	-
	D-11	33.0-34.5	SM	30.2	0.0	89.2	10.8	10.8	0	0	-	-	-	-	-
	D-12	38.0-39.5	SP	26.8	0.0	92.0	8.0				-	-	-	-	-
	D-13	43.0-44.5	SM	26.9	0.0	87.8	12.2				-	-	-	-	-
	D-14	48.0-49.5	ML	33.0	0.0	15.8	84.2				-	-	-	-	-
	D-15	53.0-54.5	ML	29.0	0.0	35.4	61.6	62.1	3.0	2.5	-	-	-	-	-
	D-16	58.0-59.5	SM	25.3	0.0	88.6	11.4				-	-	-	-	-
	D-18	68.0-69.5	ML	29.7	0.0	9.3	90.7				-	-	-	-	-
	D-19	73.0-74.5	ML	32.8	0.0	2.7	97.3				-	-	-	-	-
	UD-20	75.0-77.0	CL-ML	27.9	0.0	0.2	93.8	96.8	6.0	3.0	26	22	4	-	-
	D-22	83.0-84.5	SW-GW	11.4	43.1	49.5	7.4				-	-	-	-	-
	D-24	93.0-94.5	GW	6.6	73.6	25.8	0.6				-	-	-	-	-
	D-25	98.0-99.5									-	-	-	-	-
	D-27	108.0-109.5	GW	9.6	58.7	39.6	1.6				-	-	-	-	-
GCB-020-07	D-14	33.0-34.5	SM	25.9	0.0	82.8	17.2				-	-	-	-	-
	D-15	38-39.5	SM	25.6	6.7	58.6	34.7				-	-	-	-	-
	D-16	43-44.5	SM	27.9	0.0	70.7	29.3				-	-	-	-	-
	D-17	48-49.5	SM	22.5	0.0	78.4	21.6				NP	NP	NP	-	-
	D-18	53-54.5	ML	46.7	0.0	8.7	91.3				23	21	2	-	-
	D-19	58.0-59.5	ML	22.6	0.0	6.8	93.2				-	-	-	-	-
	D-20	63-64.5	ML	23.6	0.0	1.7	98.3				26	25	1	-	-
	D-21	68-69.5	ML	27.7	0.0	1.0	99				26	25	1	-	-
GCB-021-07	D-2	5.0-6.5	GW	7.5	66.6	30.8	2.7				-	-	-	-	-
	D-4	10.0-11.5	GW	10.3	71.1	26.5	2.4				-	-	-	-	-
	D-5	12.5-14.0	GW	7.9	56.1	39.9	4.0				-	-	-	-	-
	D-6	15.0-16.5	OL	751.2	-	-	-				-	-	-	27.1	-

Table B-1
Summary of Laboratory Testing Results (continued)

Boring No.	Sample No.	Sample Depth (ft)	USCS/ WSDOT Classification	Water Content (%)	Grain Size Analysis						Atterberg Limits			Organic Content (%)	Resistivity (·cm)
					Gravel (%)	Sand (%)	Silt (%)		Clay (%)		LL	PL	PI		
							>0.005 mm	>0.002 mm	<0.005 mm	<0.002 mm					
GCB-021-07	D-7	17.5-19.0	ML	25.1	11.3	20.8	67.9				-	-	-	-	-
	D-8	20.0-21.5	ML	26.9	0.0	26.3	70.2	72.2	3.5	1.5	-	-	-	-	-
	D-9	25.0-26.5	ML	27.8	1.6	31.7	66.7				-	-	-	-	-
	D-10	30.0-31.5	ML	24.2	0.0	3.4	96.6				-	-	-	-	-
	D-11	35.0-36.5	ML	26.8	0.0	1.7	98.3				25	22	3	-	-
	D-12	40.0-41.5	ML	33.8	0.0	0.9	84.1	93.1	15.0	6.0	-	-	-	-	-
	D-13	45.0-46.5	SW	17.2	7.1	85.6	7.3				-	-	-	-	-
	D-14	50.0-51.5	GW-SW	11.3	46.0	49.0	5.0				-	-	-	-	-
	D-15	55.0-56.5	GW	16.8	72.4	26.4	1.2				-	-	-	-	-
	D-16	60.0-61.5	SM	12.4	36.2	49.9	13.9				-	-	-	-	-
	D-17	65.0-66.5	GW	8.6	79.9	19.8	0.3				-	-	-	-	-
	D-18	70.0-71.5	SP	10.8	33.0	60.4	6.6				-	-	-	-	-
GCB-022-07	D-5	14.0-15.5	GP	-	-	-	-				-	-	-	-	19,000
	UD-16	66.0-68.0	ML	31.5	-	-	-				26	23	3	-	-
GCB-023-07	UD-14	51.0-53.0	CL	34.4	-	-	-				30	21	9	-	15,000

Abbreviations: USCS - Unified Soil Classification System; WSDOT - Washington State Department of Transportation; LL - liquid limit; PL - plastic limit; PI - plasticity index; NP - non-plastic.

Table B-2
Rock Point Load Test Results

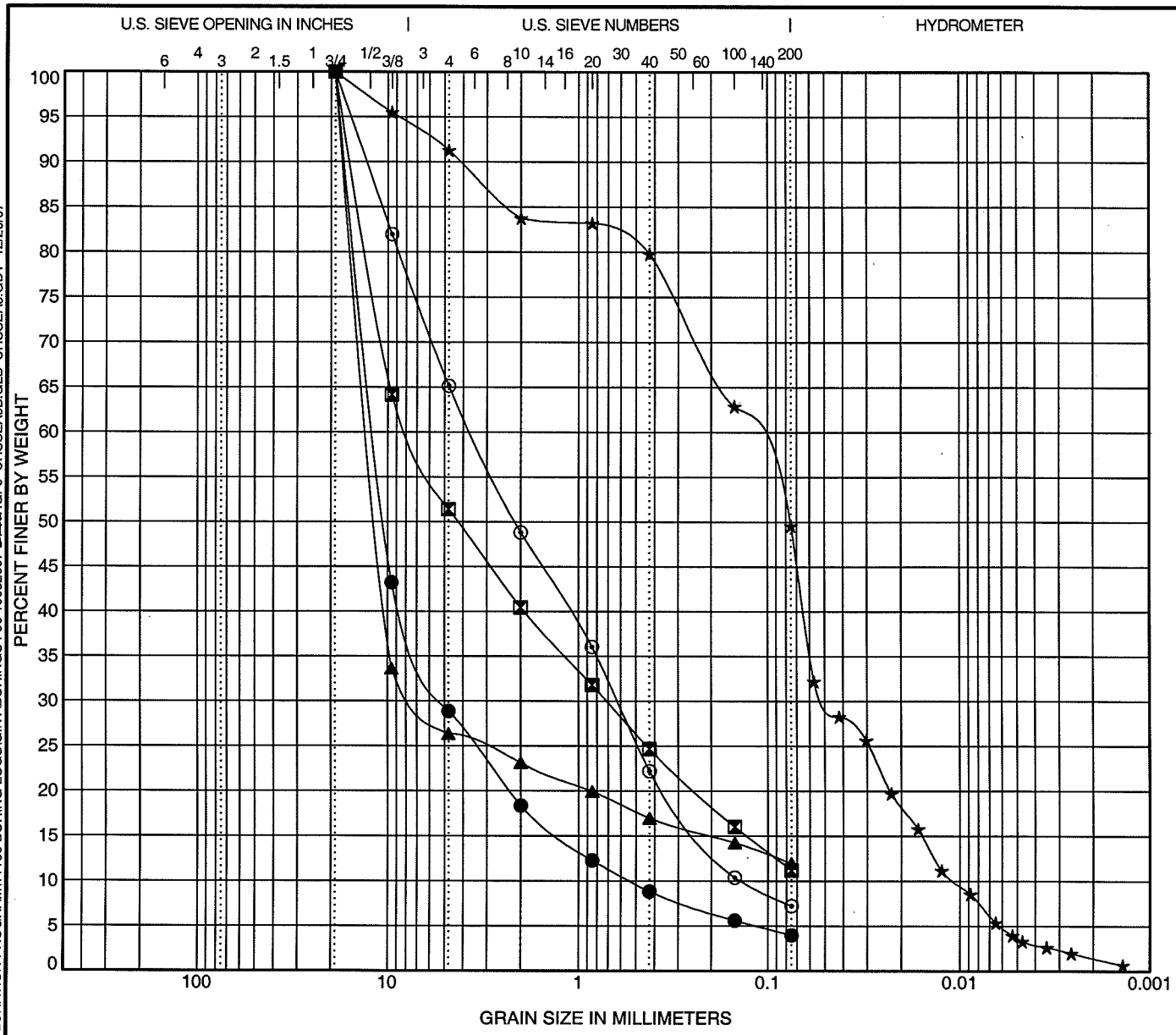
Boring ID/ Sample #	Depth (ft)	Rock Type	Weathering State [1]	Test Type [2]	Dia.[3] (mm)	Width [4] (mm)	D_e [5] (mm)	Unconfined Compressive Strength, q_u [6] ksi	ISRM [7] Class.	ISRM Description	Failure [8] Type
H-01-06/ C11	41.82	Andesite	II	D	65.0	85.3	65.00	3.9	R2	Moderately weak	1
H-01-06 / C11	41.5-41.82	Andesite	II	A	97.5	65.0	89.85	3.2	R1	Very weak	5
H-01-06/ C11	41.82-42.1	Andesite	II	A	85.3	65.0	84.02	3.0	R1	Very weak	2
					Average for H-01-06:			3.4	R1	Very weak	
H-03-06/ C21	82.63	Andesite	I	D	65.0	91.4	65.00	27.6	R4	Strong	1
H-03-06/ C21	82.26-82.59	Andesite	I	A	100.6	65.0	91.24	13.5	R3	Moderately strong	2
H-03-06/ C21	82.6-82.9	Andesite	I	A	91.4	65.0	86.99	17.0	R4	Strong	2
					Average for sample C21:			19.4	R4	Strong	
H-03-06/ C22	83.1	Andesite	I	D	65.0	61.0	65.00	10.6	R3	Moderately strong	1
					Average for H-03-06:			15.0	R4	Strong	
GCB-001-07/C13	37.60	Andesite	II	D	45	60	45.00	3.4	R1	Very weak	1
GCB-001-07/C13	41	Andesite	II	A	87	45.06	70.65	3.4	R1	Very weak	5
					Average for sample C13:			3.4	R1	Very weak	
GCB-001-07/C14	43	Andesite	I	A	97	44.96	74.52	5.9	R2	Moderately weak	5
GCB-001-07/C14	43	Andesite	I	D	45.1	50	45.10	13.3	R3	Moderately strong	1
					Average for sample C14:			9.6	R3	Moderately strong	
					Average for GCB-001-07:			6.5	R2	Moderately weak	
GCB-002-07/C19	50.65	Andesite	I	D	60.7	60.0	60.72	5.6	R2	Moderately weak	1
GCB-002-07/C19	51.95	Andesite	I	A	63.0	60.7	69.78	7.5	R3	Moderately strong	2
					Average for sample C19:			6.6	R2	Moderately weak	
GCB-002-07/C20	58.2	Andesite	I	D	60.7	68.0	60.72	12.2	R3	Moderately strong	1
GCB-002-07/C20	58.55	Andesite	I	A	71.0	60.7	74.08	10.3	R3	Moderately strong	2
					Average for sample C20:			11.2	R3	Moderately strong	
					Average for GCB-002-07:			8.9	R3	Moderately strong	
GCB-003-07/C20	75.1	Andesite	I	A	56.1	44.8	56.57	4.6	R2	Moderately weak	2

Table B-2 (continued)
Rock Point Load Test Results

Boring ID/ Sample #	Depth (ft)	Rock Type	Weathering State [1]	Test Type [2]	Dia.[3] (mm)	Width [4] (mm)	D_e [5] (mm)	Unconfined Compressive Strength, q_u [6] ksi	ISRM [7] Class.	ISRM Description	Failure [8] Type
GCB-003-07/C20	75.6	Andesite	I	D	44.8	55.0	44.80	8.1	R3	Moderately strong	1
					Average for sample C20:			6.4	R2	Moderately weak	
GCB-003-07/C21	78.4	Andesite	I	D	45.0	58.0	45	9.4	R3	Moderately strong	1
GCB-003-07/C21	80.1	Andesite	I	A	70.3	45.0	63.47	11.8	R3	Moderately strong	2
					Average for sample C21:			10.6	R3	Moderately strong	
					Average for GCB-003-07:			8.5	R3	Moderately strong	
GCB-005-07/C31	103.4	Andesite	I-II	A	40.0	44.8	47.77	29.9	R5	Very strong	2
GCB-005-07/C31	103.55	Andesite	I-II	D	44.8	59.0	44.80	16.8	R4	Strong	1
					Average for sample C31:			23.3	R4	Strong	
GCB-005-07/C32	109.35	Andesite	I-II	A	76.0	44.8	65.84	5.9	R2	Moderately weak	5
GCB-005-07/C32	109.7	Andesite	I-II	D	45.0	54.0	45.00	19.4	R4	Strong	1
GCB-005-07/C32	110.7	Andesite	I-II	A	42.0	44.8	48.95	25.2	R4	Strong	2
					Average for sample C32:			16.8	R4	Strong	
					Average for GCB-005-07:			20.1	R4	Strong	

Notes:
1. Weathering State: I - Fresh; II - Slightly weathered; III - Moderately weathered; IV - Highly weathered; V - Completely weathered
2. Test Type: A = Axial; D = Diametral
3. Diameter: The loaded side initial dimension
4. Width: For axial and irregular specimens, second dimension value to calculate De
5. D_e - Equivalent diameter: for diametral specimens, same as diameter, otherwise it is the square root of 4*Diameter*Width/π
6. Unconfined Compression Strength, q_u: taken as 24.5*$I_{s(50)}$ in MPa for 65 mm core size, and 22* $I_{s(50)}$ in MPa for 45 mm core size based on Table 1 in ASTM D 5731-02
7. ISRM Classification: R0: 0.28 to 1.03 MPa (0.04 to 0.15 ksi); R1: 1.03 to 24.8 MPa (0.15 to 3.6 ksi); R2: 24.8 to 50.3 MPa (3.6 to 7.3 ksi); R3: 50.3 to 103.4 MPa (7.3 to 15 ksi); R4:103.4 to 200 MPa (15 to 29 ksi); R5: > 200 MPa (>29 ksi).
8. Failure Type: 1 - Diametral normal failure; 2 - Axial normal failure; 3 - Block normal failure; 4 - Diametral, chipped failure; 5 - Axial, sheared at angle

APPENDIX B.1
2007 LABORATORY TESTING DATA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-002-07 5.5 ft.	Poorly-graded GRAVEL with sand				4.01	21.75
⊠	GCB-002-07 13.0 ft.	Silty GRAVEL with sand				1.07	121.06
▲	GCB-002-07 17.0 ft.	Silty GRAVEL				88.02	304.80
★	GCB-002-07 18.0 ft.	Silty SAND				1.67	12.13
⊙	GCB-002-07 20.5 ft.	Poorly-graded SAND with gravel				0.79	26.26

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-002-07 5.5 ft.	19.05	11.691	5.023	0.538	71.2	24.9	4.0	
⊠	GCB-002-07 13.0 ft.	19.05	7.6	0.715		48.6	40.2	11.2	
▲	GCB-002-07 17.0 ft.	19.05	12.546	6.742		73.7	14.4	12.0	
★	GCB-002-07 18.0 ft.	19.05	0.129	0.048	0.011	8.7	41.7	49.6	
⊙	GCB-002-07 20.5 ft.	19.05	3.618	0.628	0.138	34.9	57.9	7.2	

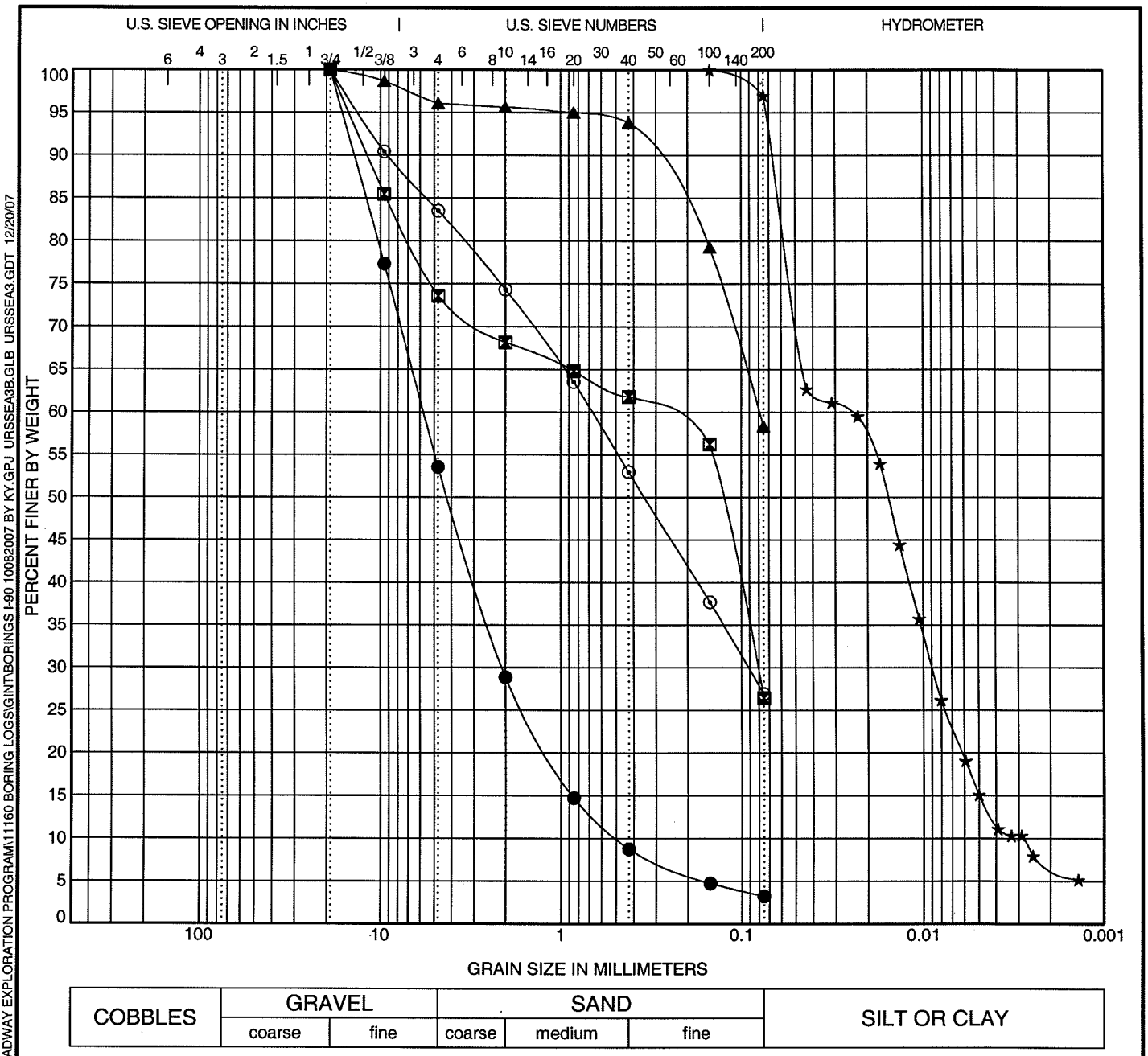
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-1

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 [redacted].GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-002-07 25.5 ft.	Well-graded SAND with gravel				1.54	11.68
⊠	GCB-002-07 29.0 ft.	Silty SAND with gravel					
▲	GCB-002-07 34.0 ft.	Sandy SILT					
★	GCB-002-07 39.0 ft.	CLAY-SILT	25	19	6	1.12	8.77
⊙	GCB-002-07 44.0 ft.	Silty SAND with gravel					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-002-07 25.5 ft.	19.05	5.737	2.083	0.491	46.4	50.3	3.2	
⊠	GCB-002-07 29.0 ft.	19.05	0.302	0.082		26.4	47.2	26.4	
▲	GCB-002-07 34.0 ft.	19.05	0.079			3.9	37.7	58.3	
★	GCB-002-07 39.0 ft.	0.15	0.025	0.009	0.003	0.0	3.0	97.0	
⊙	GCB-002-07 44.0 ft.	19.05	0.674	0.092		16.5	56.6	26.9	

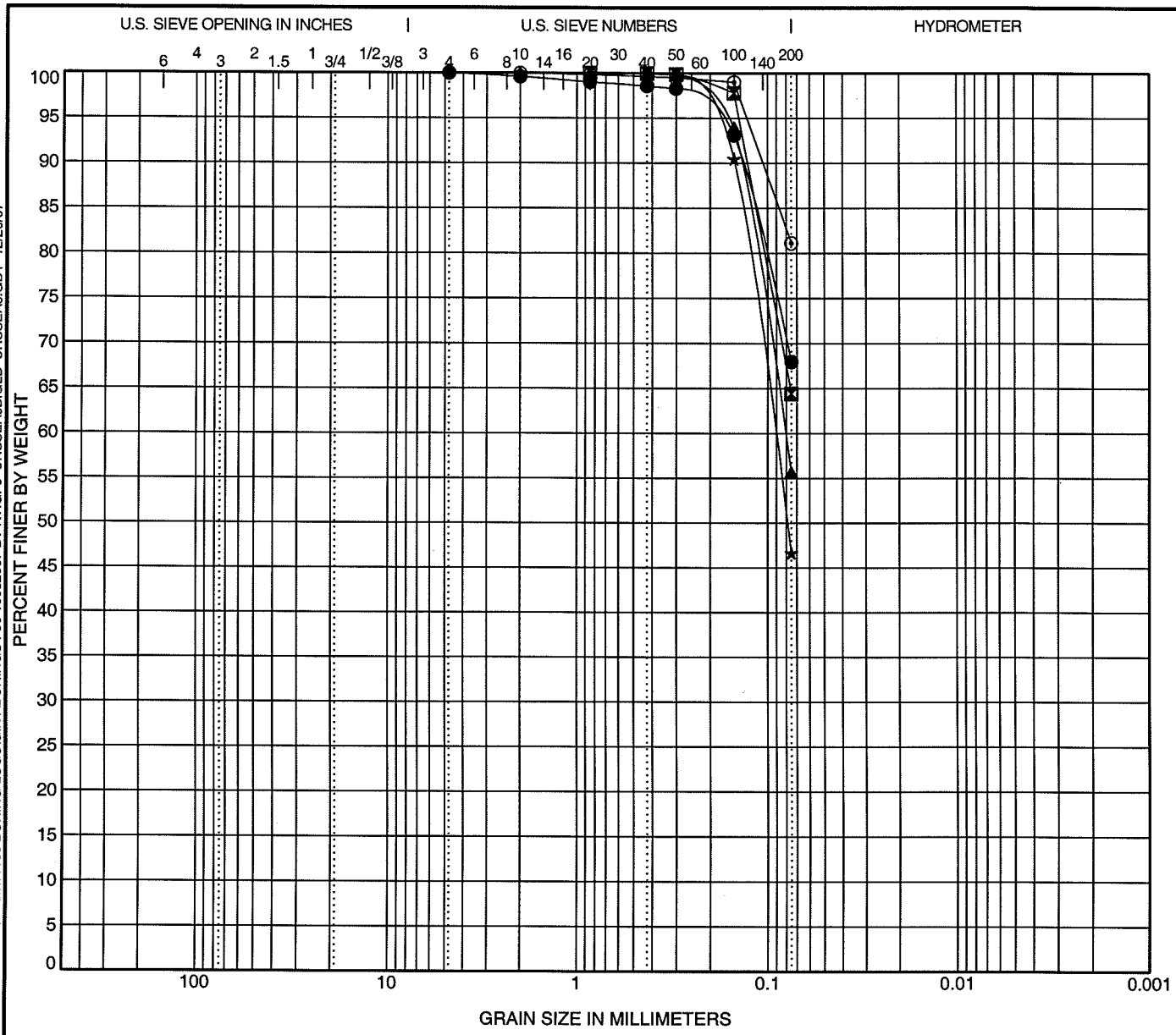
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-2

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-004-07 30.0 ft.	Sandy SILT					
⊠	GCB-004-07 35.0 ft.	Sandy SILT					
▲	GCB-004-07 40.0 ft.	Sandy SILT					
★	GCB-004-07 45.0 ft.	Silty SAND, fine					
⊙	GCB-004-07 50.0 ft.	SILT with Sand	22	20	2		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-004-07 30.0 ft.	4.75				0.0	32.0	68.0	
⊠	GCB-004-07 35.0 ft.	0.85				0.0	35.6	64.4	
▲	GCB-004-07 40.0 ft.	2	0.081			0.0	44.4	55.6	
★	GCB-004-07 45.0 ft.	2	0.093			0.0	53.3	46.7	
⊙	GCB-004-07 50.0 ft.	4.75				0.0	18.9	81.1	

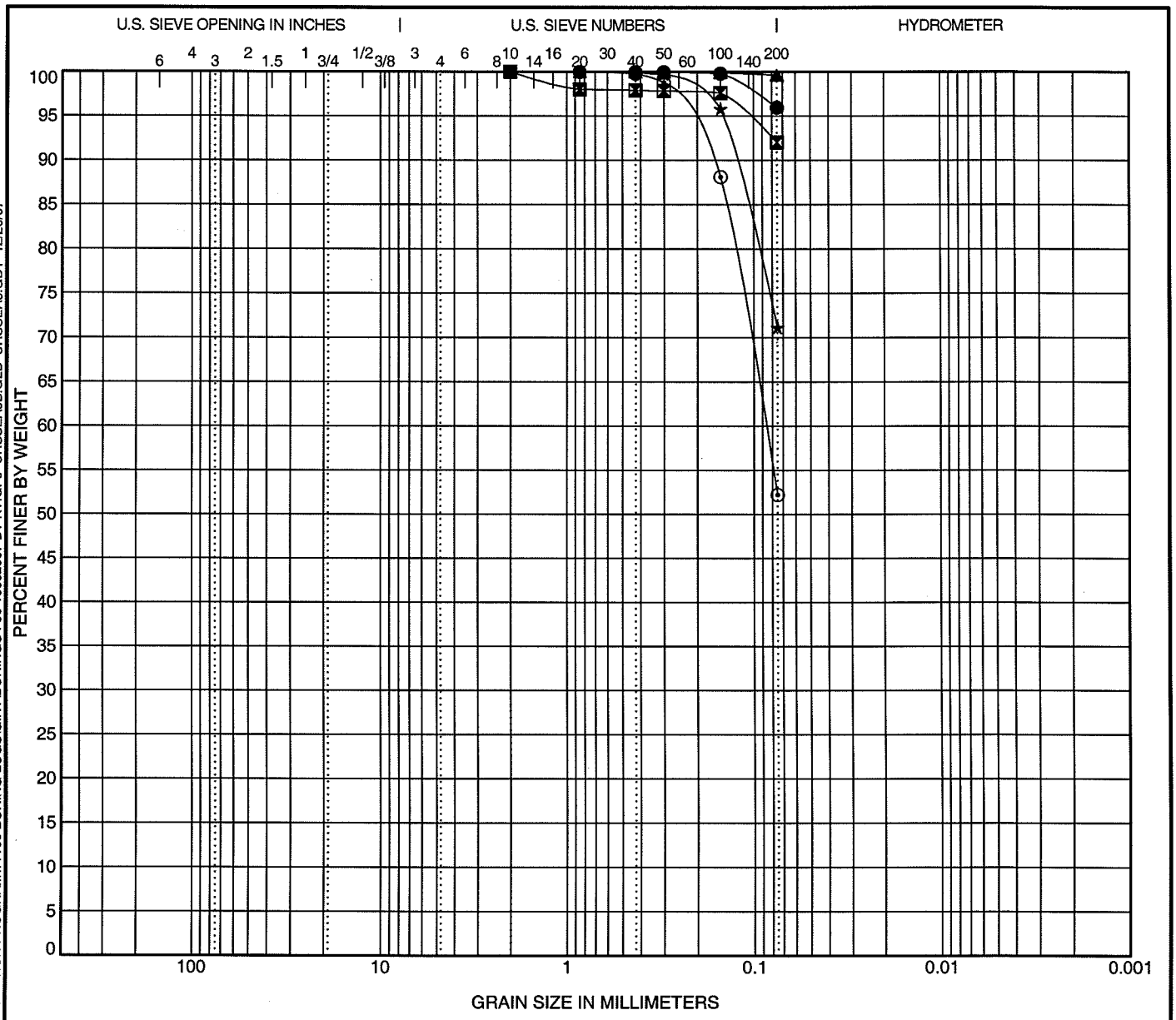
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-3

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-004-07 55.0 ft.	SILT-CLAY	21	14	7		
⊠	GCB-004-07 60.0 ft.	SILT-CLAY	21	14	7		
▲	GCB-004-07 65.0 ft.	Lean CLAY	34	19	15		
★	GCB-004-07 70.0 ft.	SILT-CLAY with Sand	20	15	5		
⊙	GCB-004-07 75.0 ft.	Sandy SILT	22	19	3		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-004-07 55.0 ft.	2				0.0	4.1	95.9	
⊠	GCB-004-07 60.0 ft.	2				0.0	8.0	92.0	
▲	GCB-004-07 65.0 ft.	2				0.0	0.4	99.6	
★	GCB-004-07 70.0 ft.	2				0.0	28.8	71.2	
⊙	GCB-004-07 75.0 ft.	2	0.087			0.0	47.8	52.2	

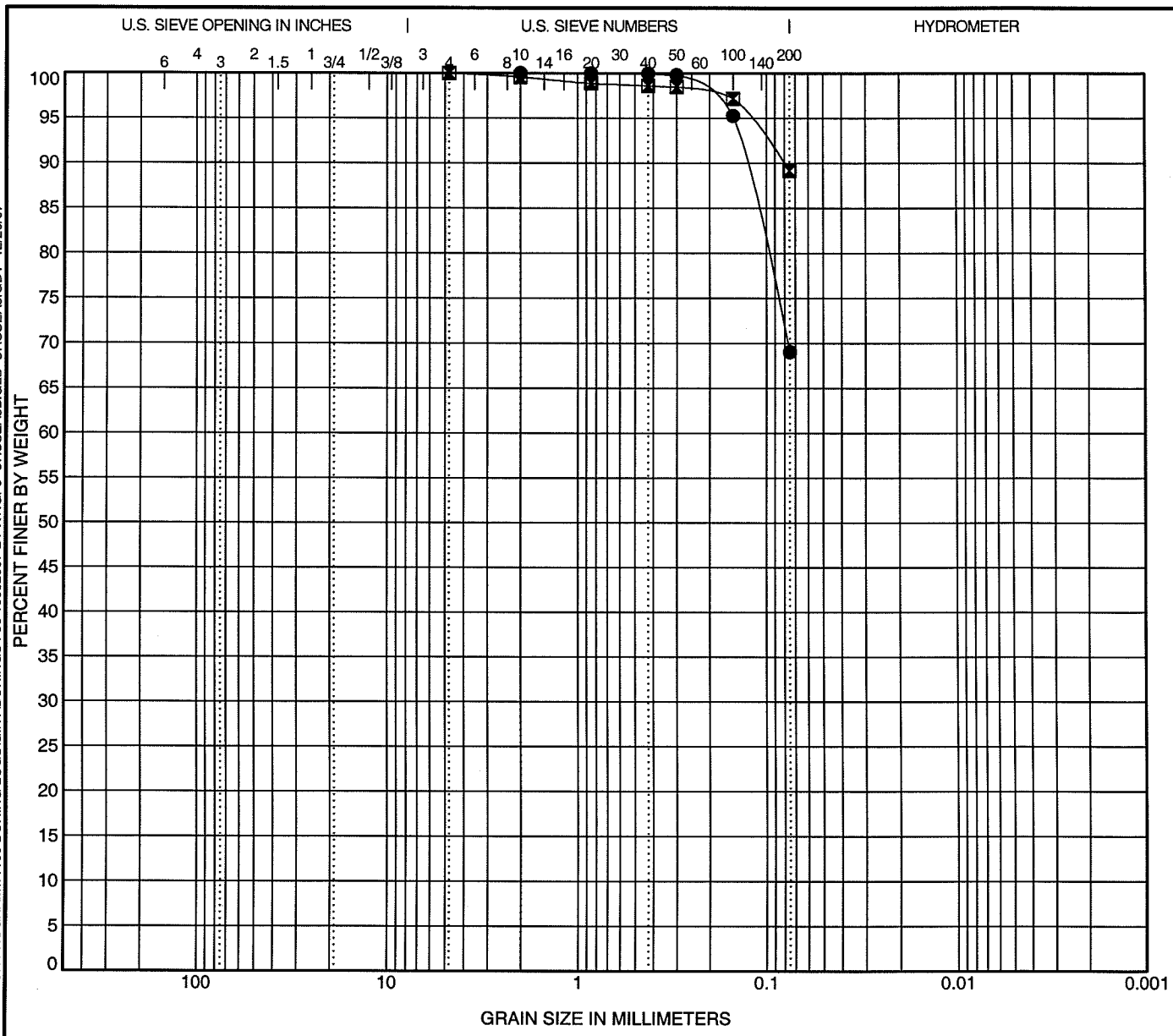
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-4

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**GCB-004-07 80.0 ft.**	**Sandy SILT**					
⊠	**GCB-004-07 85.0 ft.**	**SILT**	**20**	**20**	**NP**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**GCB-004-07 80.0 ft.**	**2**				**0.0**	**31.0**	**69.0**	
⊠	**GCB-004-07 85.0 ft.**	**4.75**				**0.0**	**10.9**	**89.1**	

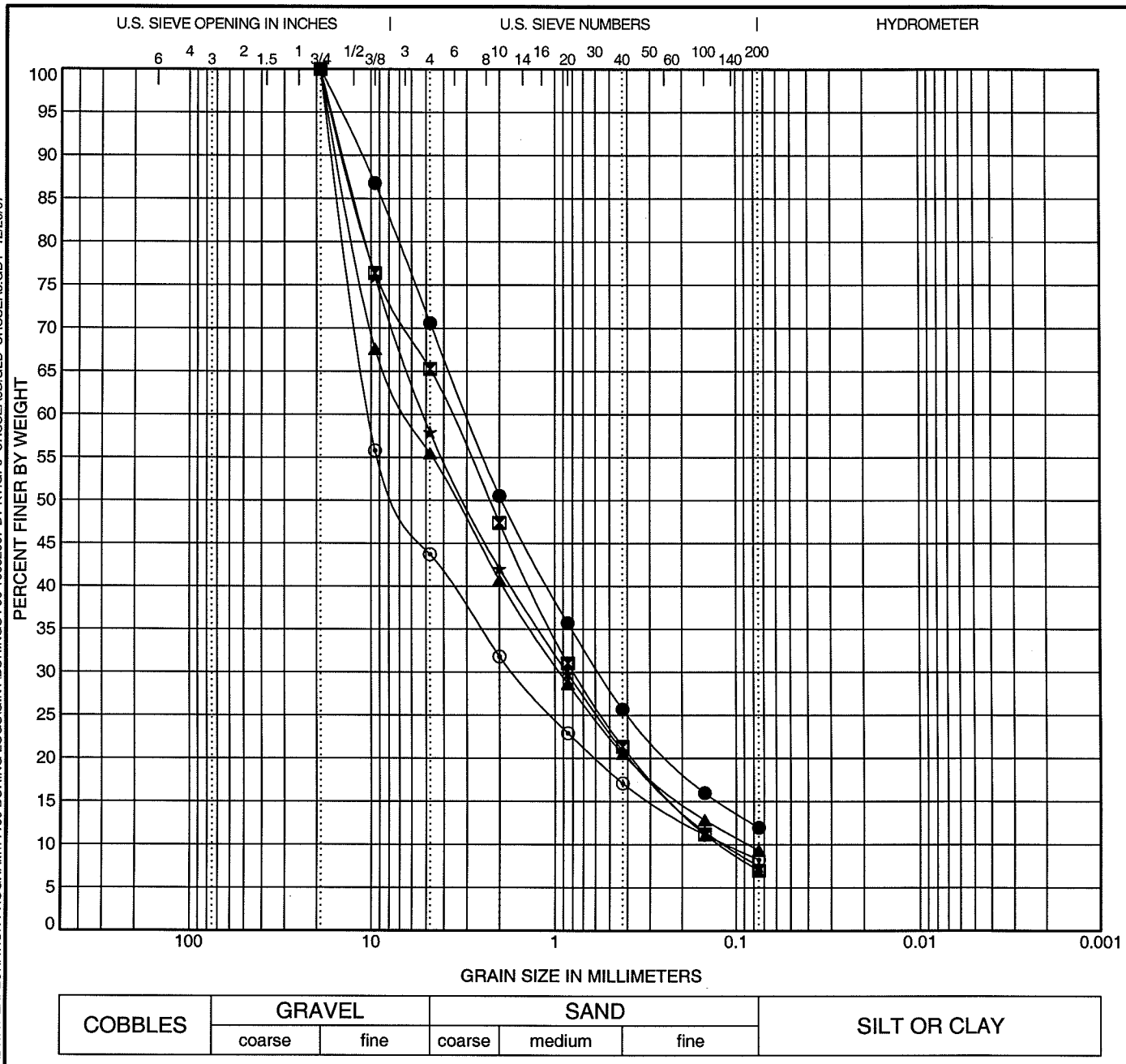
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-5

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-005-07 0.0 ft.	**Silty SAND with gravel**				**2.04**	**56.30**
⊠	GCB-005-07 2.0 ft.	**Well-graded SAND with gravel**				**1.37**	**29.82**
▲	GCB-005-07 6.0 ft.	**Well-graded SAND with gravel**				**1.66**	**71.65**
★	GCB-005-07 11.0 ft.	**Well-graded SAND with gravel**				**1.24**	**44.19**
⊙	GCB-005-07 13.5 ft.	**Well-graded GRAVEL with sand**				**2.43**	**88.88**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-005-07 0.0 ft.	**19.05**	**3.009**	**0.573**		**29.4**	**58.6**	**12.0**	
⊠	GCB-005-07 2.0 ft.	**19.05**	**3.682**	**0.789**	**0.123**	**34.7**	**58.3**	**7.0**	
▲	GCB-005-07 6.0 ft.	**19.05**	**6.161**	**0.936**	**0.086**	**44.5**	**46.2**	**9.3**	
★	GCB-005-07 11.0 ft.	**19.05**	**5.146**	**0.862**	**0.116**	**42.1**	**50.4**	**7.5**	
⊙	GCB-005-07 13.5 ft.	**19.05**	**10.173**	**1.681**	**0.114**	**56.3**	**35.5**	**8.2**	

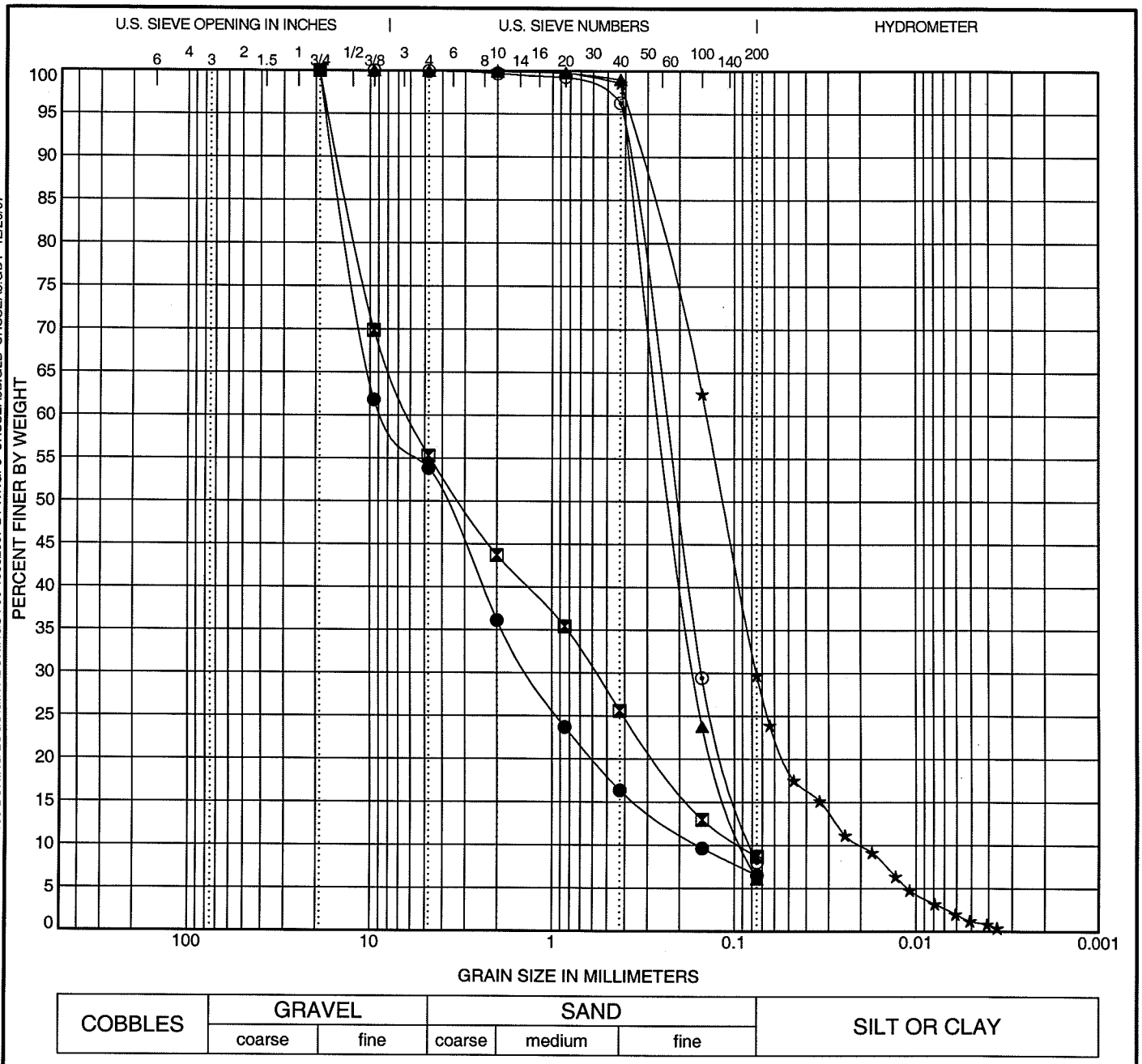
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-6

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 1008 2007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-005-07 18.5 ft.	**Well-graded SAND with gravel**				1.34	51.31
⊠	GCB-005-07 25.0 ft.	**Poorly-graded SAND with gravel**				0.61	64.10
▲	GCB-005-07 30.0 ft.	**Poorly-graded SAND**				1.23	2.83
★	GCB-005-07 35.0 ft.	**Silty SAND**				2.00	7.09
⊙	GCB-005-07 40.0 ft.	**Poorly-graded SAND**				1.19	3.02

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-005-07 18.5 ft.	19.05	8.135	1.314	0.159	46.2	47.3	6.5	
⊠	GCB-005-07 25.0 ft.	19.05	5.946	0.58	0.093	44.7	46.6	8.7	
▲	GCB-005-07 30.0 ft.	9.525	0.248	0.164	0.088	0.0	93.9	6.0	
★	GCB-005-07 35.0 ft.	2	0.142	0.075	0.02	0.0	70.3	29.7	
⊙	GCB-005-07 40.0 ft.	9.525	0.241	0.151	0.08	0.1	91.9	8.0	

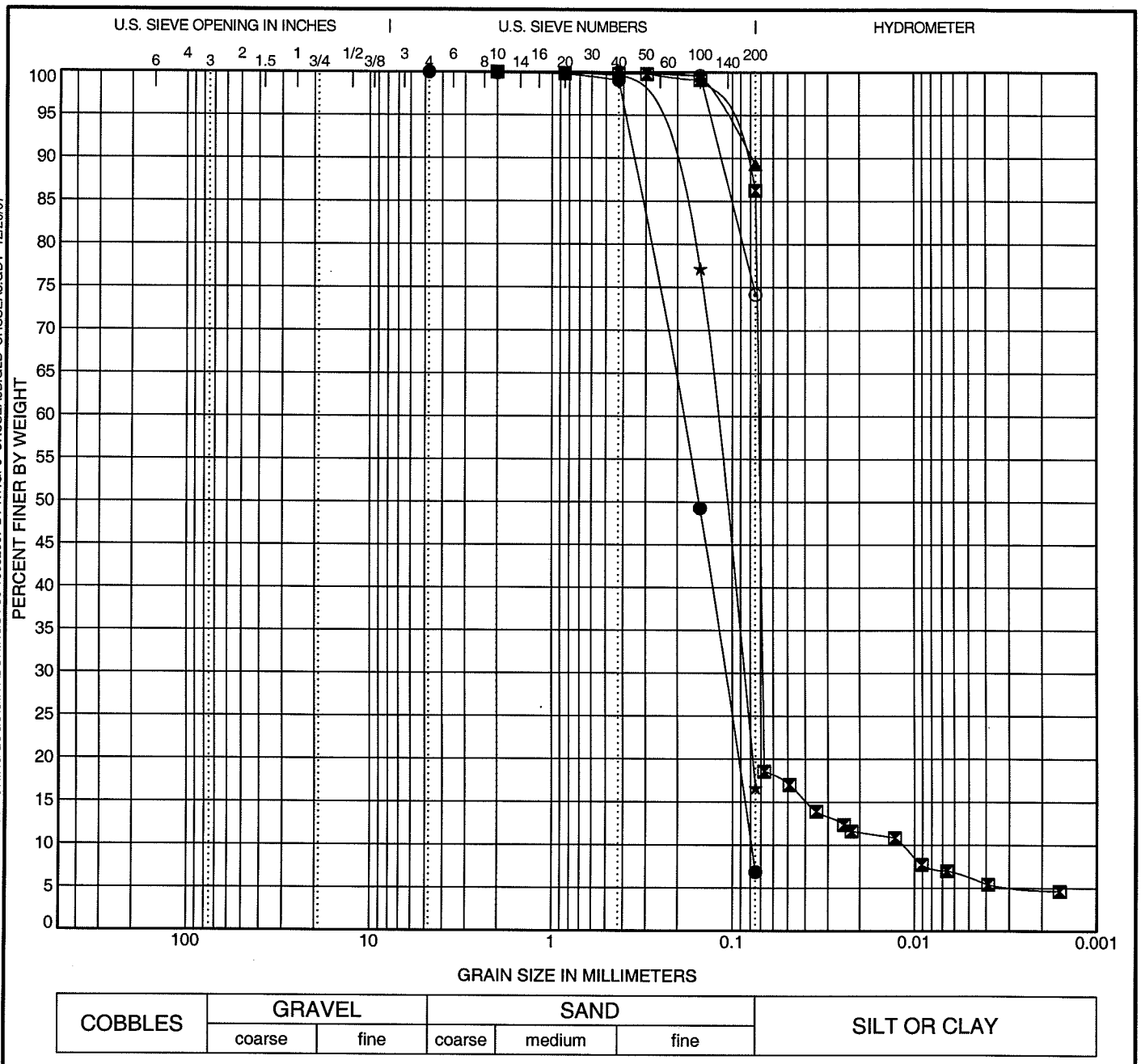
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-7

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-005-07 45.0 ft.	**Poorly-graded SAND**				**0.81**	**2.38**
⊠	GCB-005-07 50.7 ft.	**SILT**				**5.58**	**6.15**
▲	GCB-005-07 55.0 ft.	**SILT**					
★	GCB-005-07 60.0 ft.	**Silty SAND**					
⊙	GCB-005-07 65.0 ft.	**SILT with sand**					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-005-07 45.0 ft.	**4.75**	**0.188**	**0.109**	**0.079**	**0.0**	**93.1**	**6.9**	
⊠	GCB-005-07 50.7 ft.	**2**	**0.072**	**0.068**	**0.012**	**0.0**	**13.8**	**86.3**	
▲	GCB-005-07 55.0 ft.	**2**				**0.0**	**10.8**	**89.2**	
★	GCB-005-07 60.0 ft.	**2**	**0.123**	**0.087**		**0.0**	**83.4**	**16.6**	
⊙	GCB-005-07 65.0 ft.	**0.425**				**0.0**	**25.8**	**74.2**	

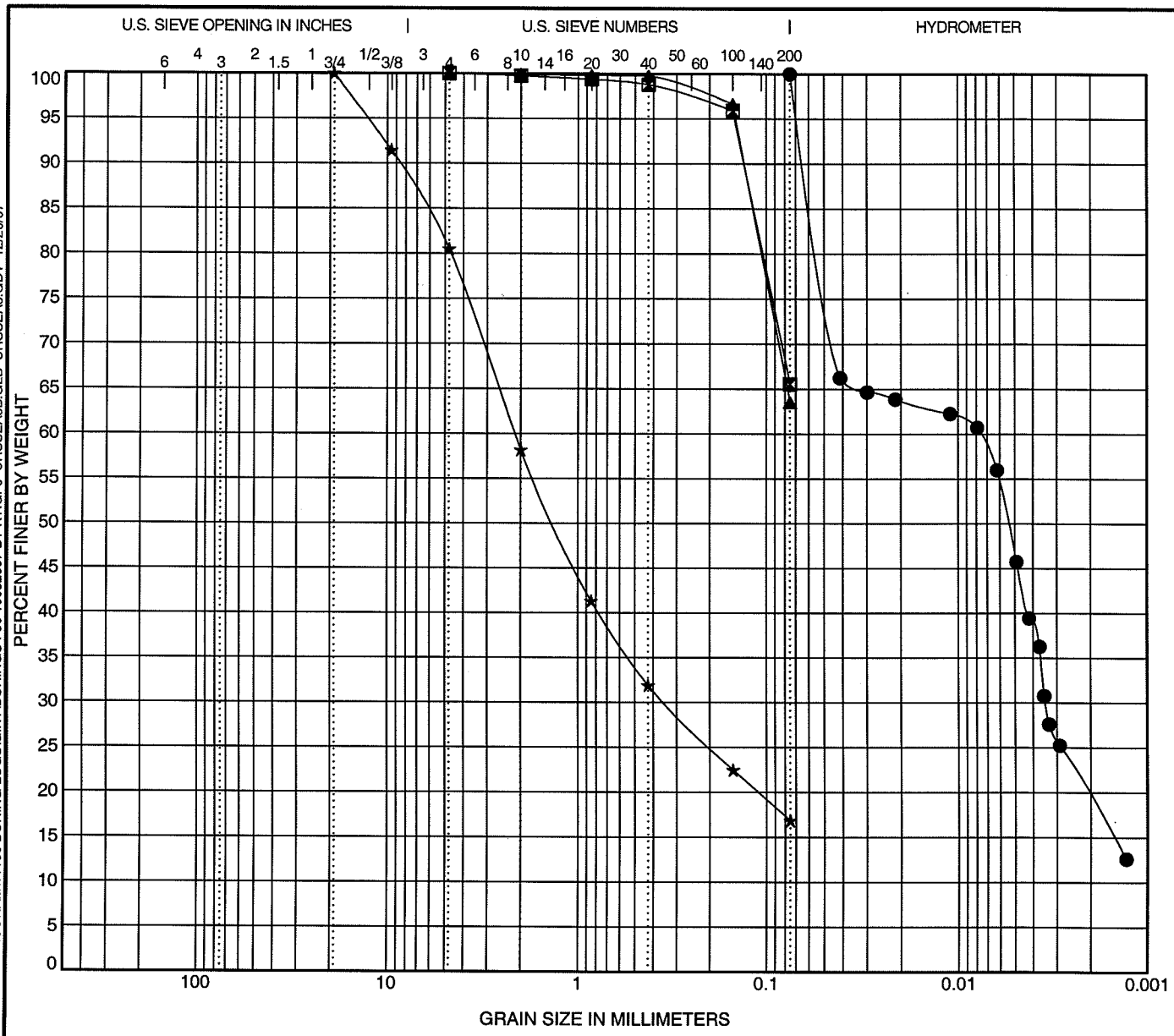
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-8

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-005-07 70.0 ft.	SILT					
⊠	GCB-005-07 75.0 ft.	Sandy SILT					
▲	GCB-005-07 85.0 ft.	Sandy SILT					
★	GCB-005-07 100.0 ft.	Silty SAND with gravel					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-005-07 70.0 ft.	0.075	0.008	0.003		0.0	0.0	100.0	
⊠	GCB-005-07 75.0 ft.	4.75				0.0	34.5	65.5	
▲	GCB-005-07 85.0 ft.	4.75				0.0	36.5	63.5	
★	GCB-005-07 100.0 ft.	19.05	2.146	0.345		19.5	63.6	16.9	

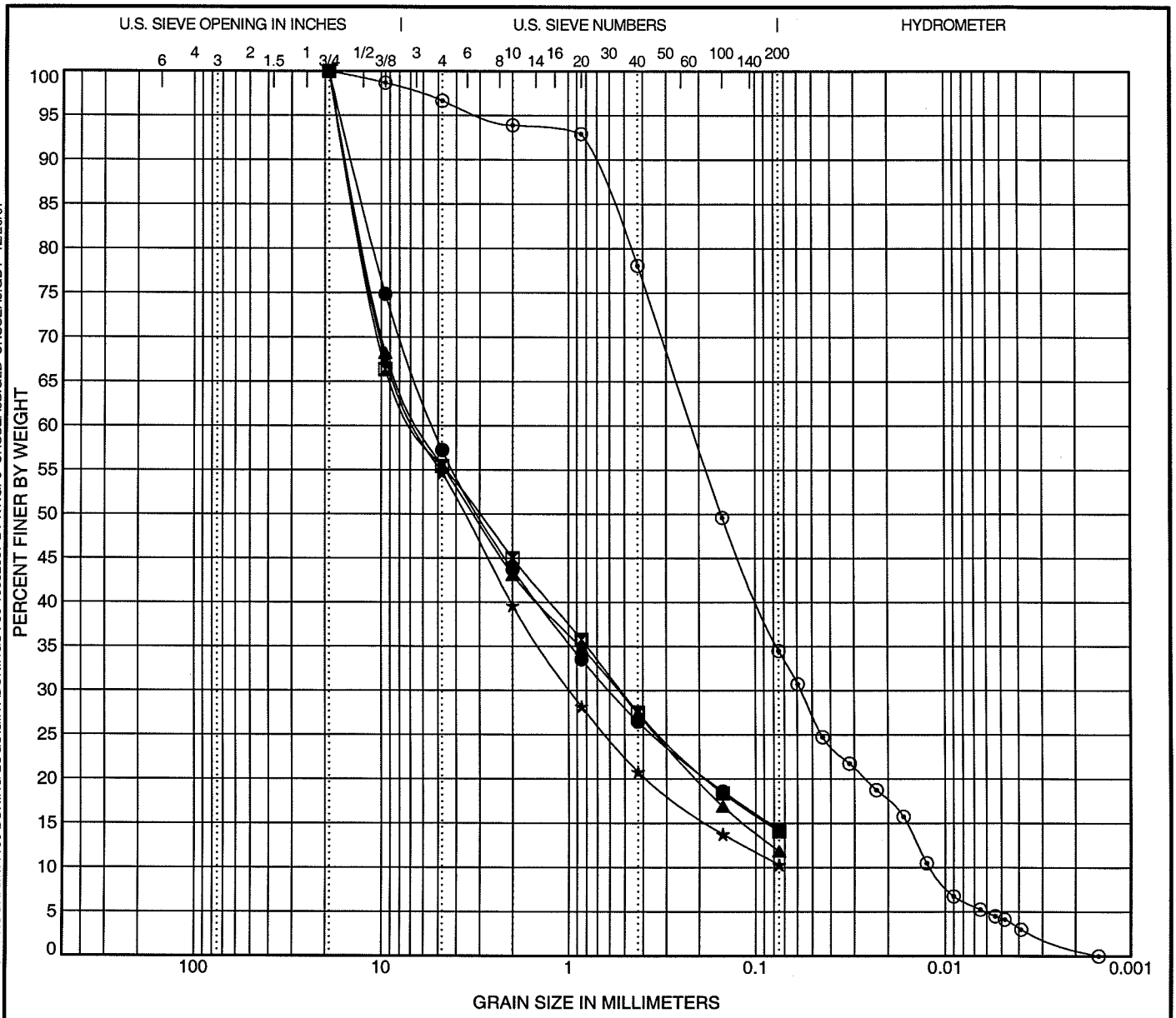
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-9

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	GCB-007-07	2.5 ft.	Silty SAND with gravel					
⊠	GCB-007-07	5.5 ft.	Silty GRAVEL with sand					
▲	GCB-007-07	7.5 ft.	Silty GRAVEL with sand				0.82	104.19
★	GCB-007-07	10.0 ft.	Silty GRAVEL with sand				2.12	90.09
⊙	GCB-007-07	12.5 ft.	Silty SAND				1.25	18.33

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-007-07	2.5 ft.	19.05	5.297	0.601		42.8	43.0	14.3	
⊠	GCB-007-07	5.5 ft.	19.05	6.355	0.524		44.6	41.3	14.1	
▲	GCB-007-07	7.5 ft.	19.05	6.089	0.542		44.6	43.6	11.8	
★	GCB-007-07	10.0 ft.	19.05	6.35	0.975		45.4	44.3	10.3	
⊙	GCB-007-07	12.5 ft.	19.05	0.219	0.057	0.012	3.4	62.1	34.5	

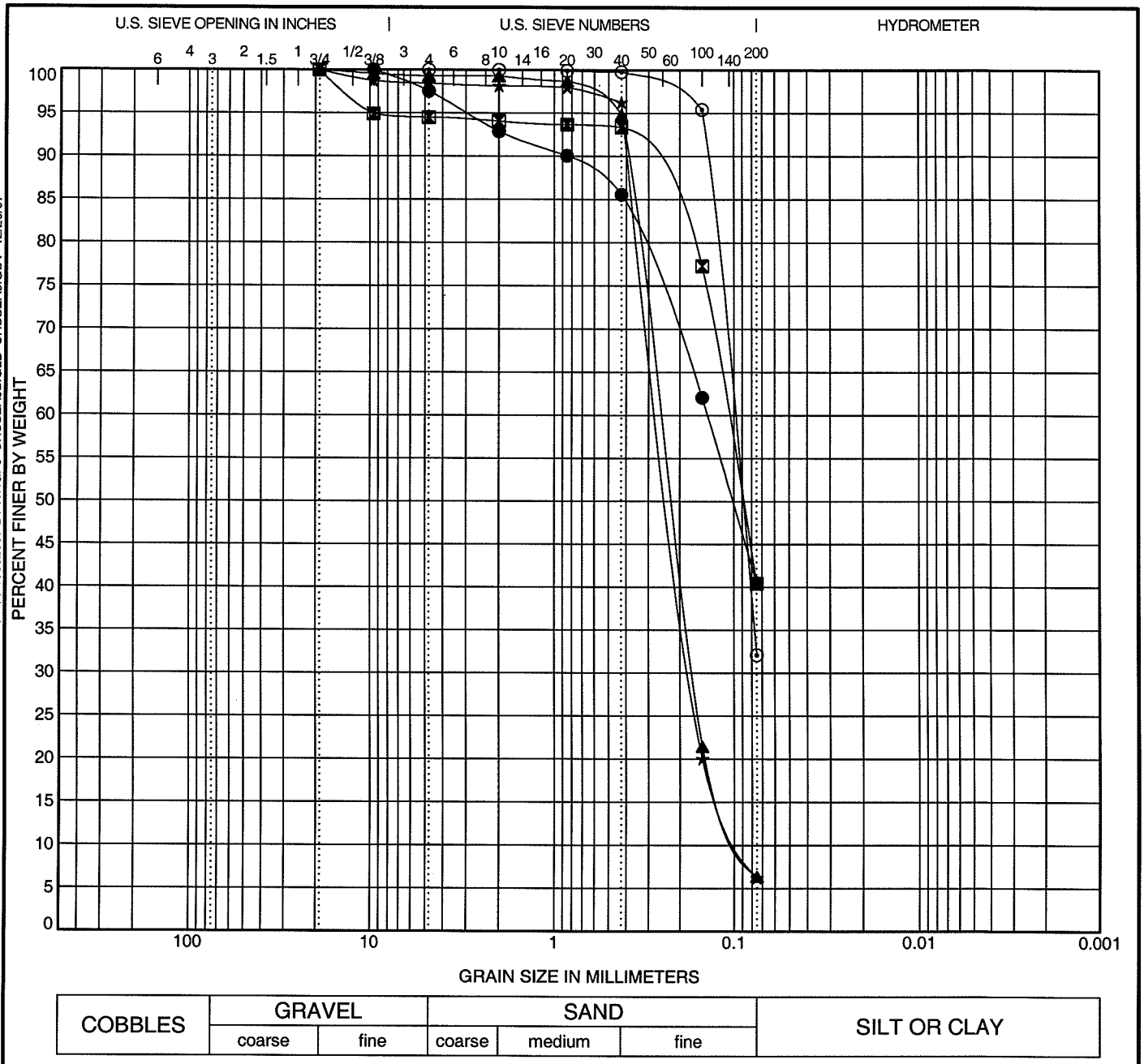
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-10

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-007-07 17.5 ft.	**Silty SAND**					
⊠	GCB-007-07 25.0 ft.	**Silty SAND**					
▲	GCB-007-07 30.0 ft.	**Poorly-graded SAND**				**1.25**	**2.93**
★	GCB-007-07 35.0 ft.	**Poorly-graded SAND**				**1.26**	**2.86**
⊙	GCB-007-07 40.0 ft.	**Silty SAND**					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-007-07 17.5 ft.	**9.525**	**0.14**			**2.5**	**57.0**	**40.5**	
⊠	GCB-007-07 25.0 ft.	**19.05**	**0.108**			**5.5**	**54.1**	**40.4**	
▲	GCB-007-07 30.0 ft.	**19.05**	**0.259**	**0.169**	**0.089**	**0.7**	**92.9**	**6.4**	
★	GCB-007-07 35.0 ft.	**19.05**	**0.259**	**0.172**	**0.091**	**1.6**	**92.2**	**6.2**	
⊙	GCB-007-07 40.0 ft.	**4.75**	**0.102**			**0.0**	**67.9**	**32.1**	

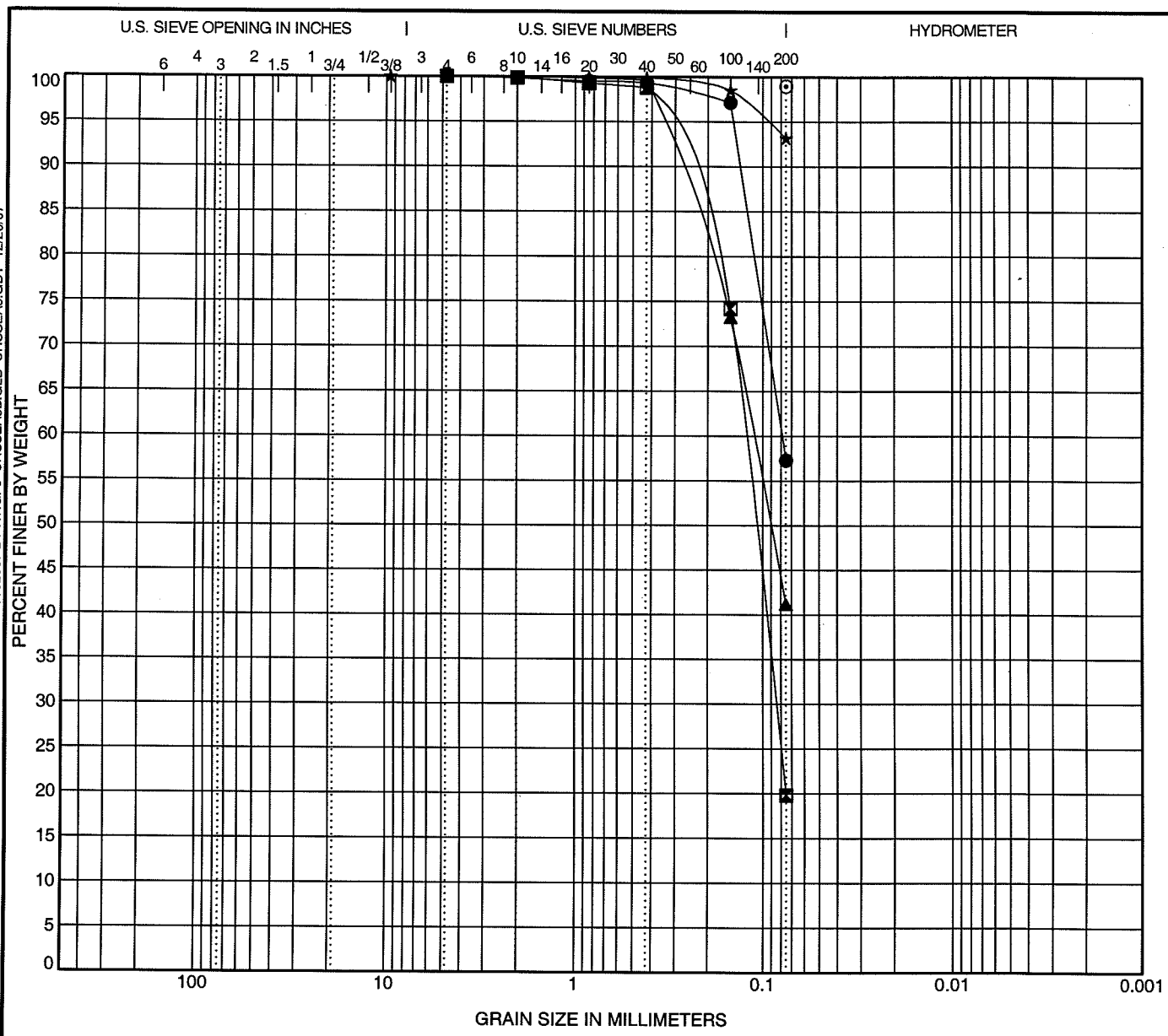
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-11

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-007-07 45.0 ft.	Sandy SILT					
⊠	GCB-007-07 50.0 ft.	Silty SAND					
▲	GCB-007-07 55.0 ft.	Silty SAND					
★	GCB-007-07 60.0 ft.	SILT					
⊙	GCB-007-07 60.5 ft.	SILT					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-007-07 45.0 ft.	4.75	0.079			0.0	42.7	57.3	
⊠	GCB-007-07 50.0 ft.	4.75	0.125	0.085		0.0	80.2	19.8	
▲	GCB-007-07 55.0 ft.	4.75	0.113			0.0	58.8	41.2	
★	GCB-007-07 60.0 ft.	9.525				0.1	6.7	93.2	
⊙	GCB-007-07 60.5 ft.	0.075				0.0	0.0	99.0	

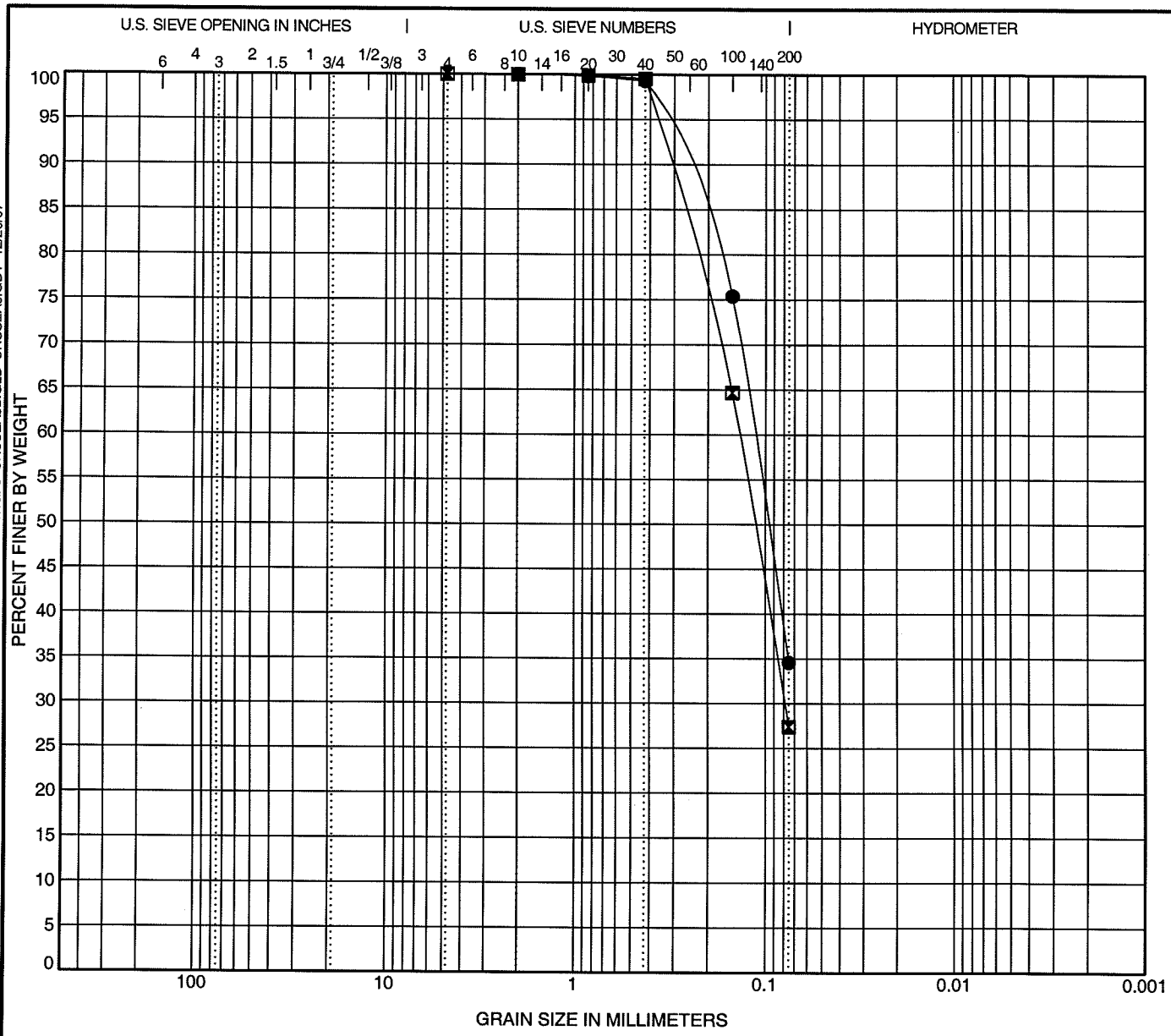
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-12

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**GCB-007-07 70.0 ft.**	**Silty SAND**					
⊠	**GCB-007-07 75.0 ft.**	**Silty SAND**					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**GCB-007-07 70.0 ft.**	**2**	**0.116**			**0.0**	**65.4**	**34.6**	
⊠	**GCB-007-07 75.0 ft.**	**4.75**	**0.138**	**0.079**		**0.0**	**72.6**	**27.4**	

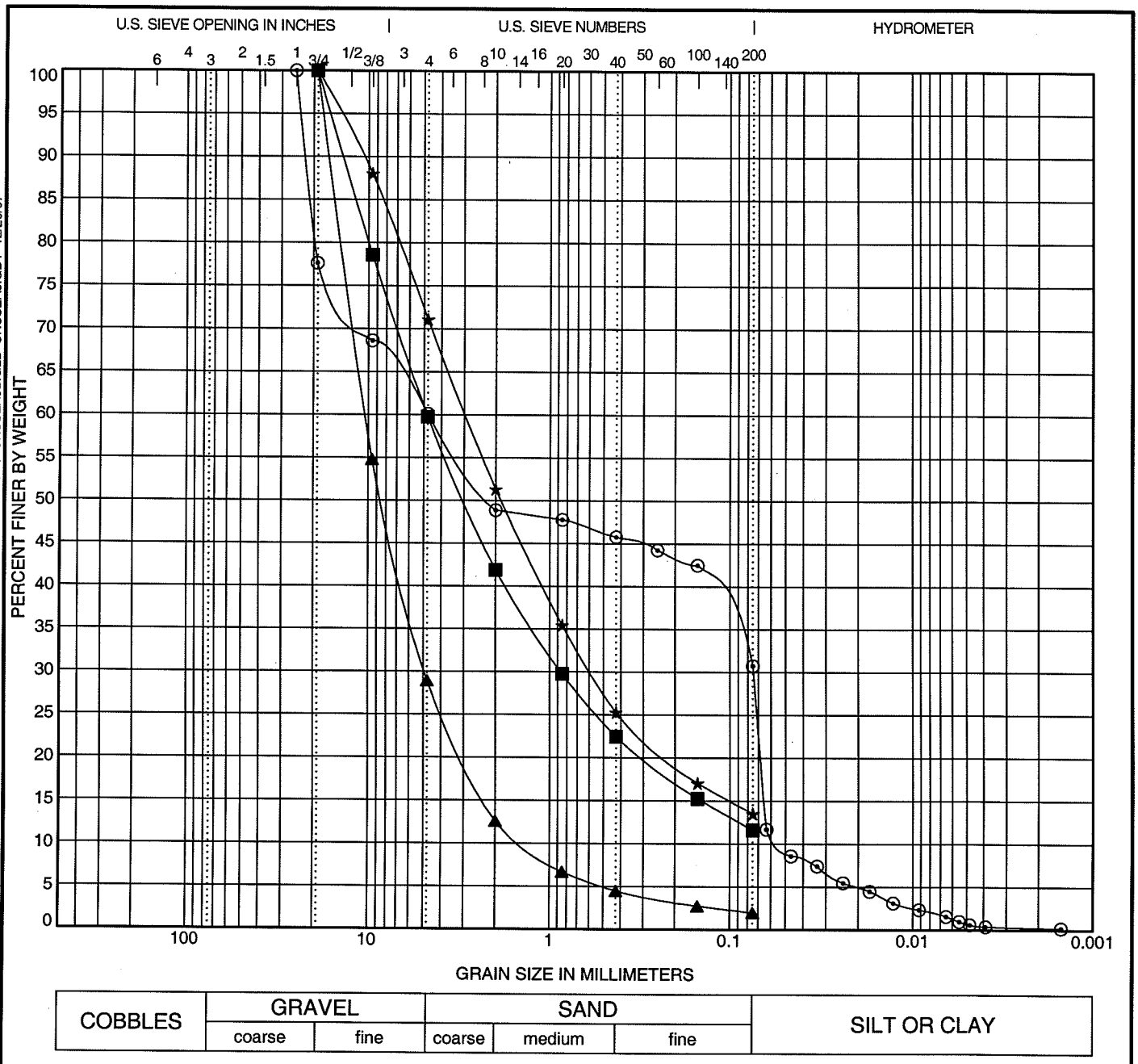
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-13

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	GCB-009-07	3.0 ft.	Silty SAND with gravel				2.83	86.90
⊠	GCB-009-07	5.0 ft.	Silty SAND with gravel				2.83	86.90
▲	GCB-009-07	11.5 ft.	Well-graded GRAVEL with sand				1.69	7.50
★	GCB-009-07	13.0 ft.	Silty SAND with gravel					
⊙	GCB-009-07	15.0 ft.	Silty GRAVEL with sand				0.02	87.95

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-009-07	3.0 ft.	19.05	4.792	0.865		40.2	48.1	11.6	
⊠	GCB-009-07	5.0 ft.	19.05	4.792	0.865		40.2	48.1	11.6	
▲	GCB-009-07	11.5 ft.	19.05	10.317	4.891	1.376	71.1	27.0	2.0	
★	GCB-009-07	13.0 ft.	19.05	2.925	0.587		28.9	57.6	13.5	
⊙	GCB-009-07	15.0 ft.	25	4.714	0.075	0.054	39.9	29.4	30.7	

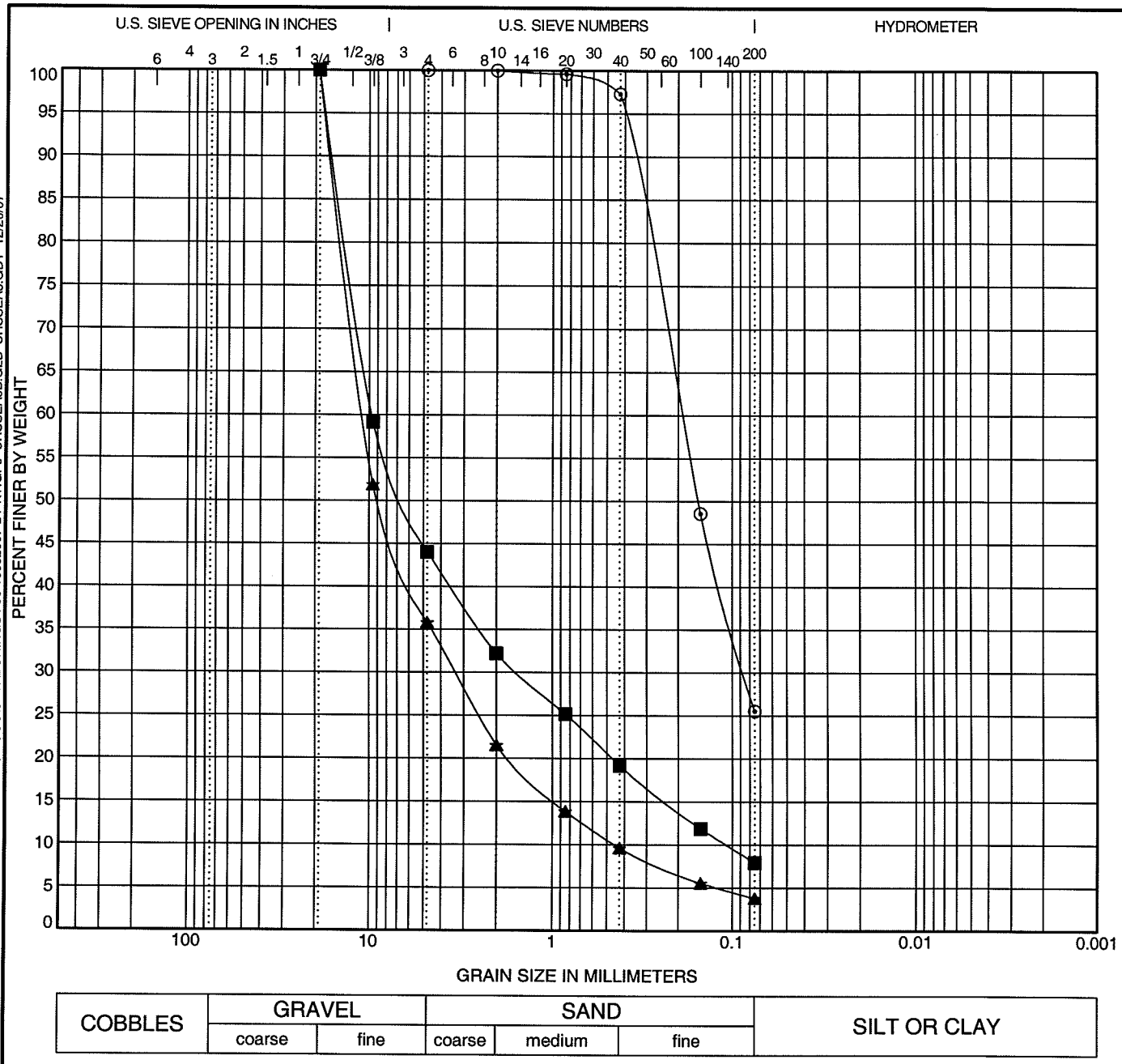
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-14

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-009-07 18.0 ft.	Well-graded GRAVEL with sand				2.24	89.55
⊠	GCB-009-07 20.0 ft.	Well-graded GRAVEL with sand				2.24	89.55
▲	GCB-009-07 25.0 ft.	Well-graded GRAVEL with sand				2.31	23.63
★	GCB-009-07 30.0 ft.	Well-graded GRAVEL with sand				2.31	23.63
⊙	GCB-009-07 36.5 ft.	Silty SAND					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-009-07 18.0 ft.	19.05	9.662	1.529	0.108	56.0	36.1	7.9	
⊠	GCB-009-07 20.0 ft.	19.05	9.662	1.529	0.108	56.0	36.1	7.9	
▲	GCB-009-07 25.0 ft.	19.05	10.709	3.345	0.453	64.2	32.0	3.8	
★	GCB-009-07 30.0 ft.	19.05	10.709	3.345	0.453	64.2	32.0	3.8	
⊙	GCB-009-07 36.5 ft.	4.75	0.192	0.086		0.0	74.5	25.5	

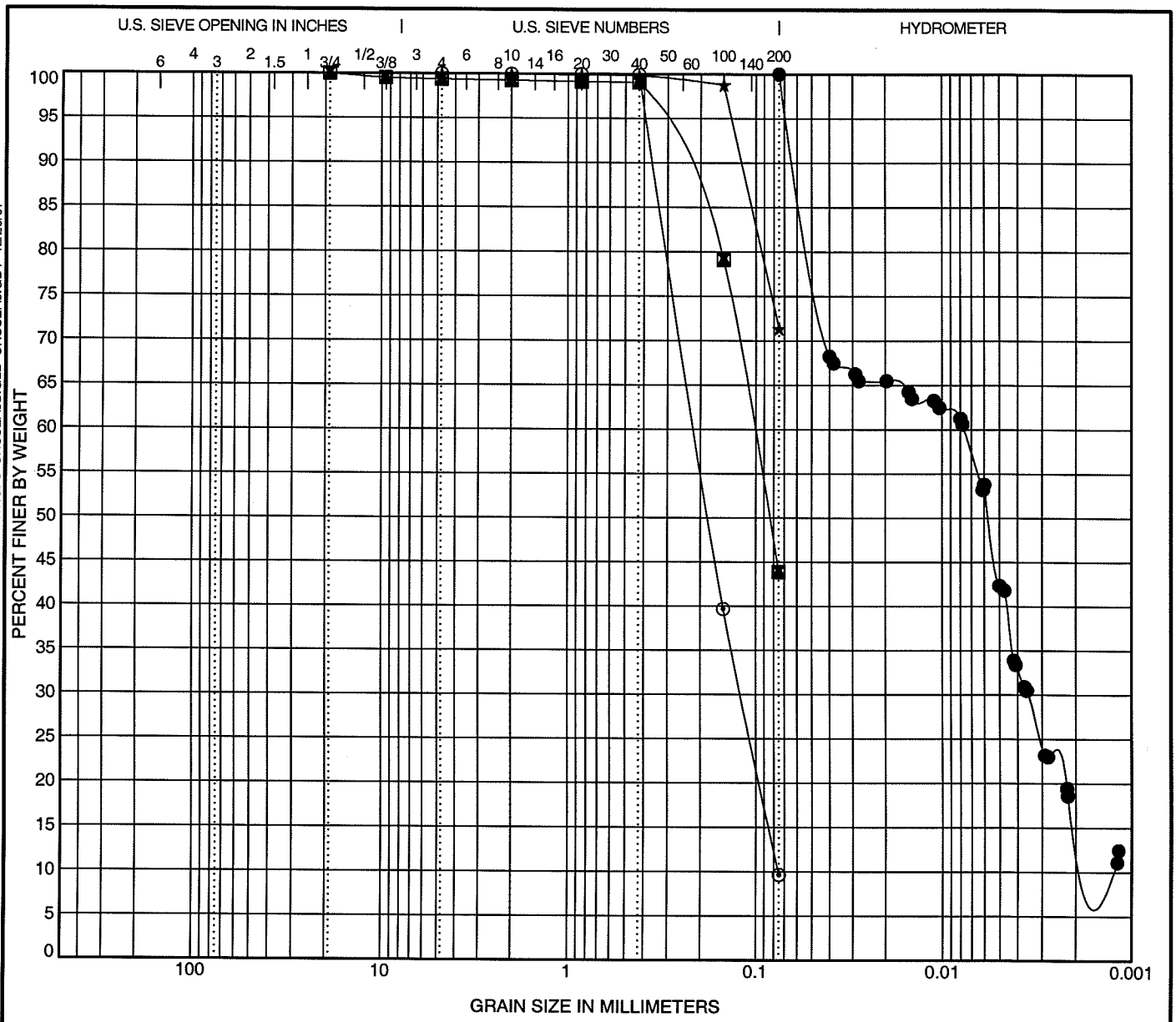
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-15

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-009-07 40.0 ft.	Clayey SILT					
⊠	GCB-009-07 45.0 ft.	Silty SAND					
▲	GCB-009-07 50.0 ft.	Silty SAND					
★	GCB-009-07 55.0 ft.	SILT with sand					
⊙	GCB-009-07 60.0 ft.	Poorly-graded SAND				0.89	2.82

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-009-07 40.0 ft.	0.075	0.008	0.004		0.0	0.0	55.5	44.5
⊠	GCB-009-07 45.0 ft.	19.05	0.103			0.6	55.5	43.9	
▲	GCB-009-07 50.0 ft.	19.05	0.103			0.6	55.5	43.9	
★	GCB-009-07 55.0 ft.	4.75				0.0	28.6	71.4	
⊙	GCB-009-07 60.0 ft.	4.75	0.213	0.12	0.076	0.0	90.4	9.6	

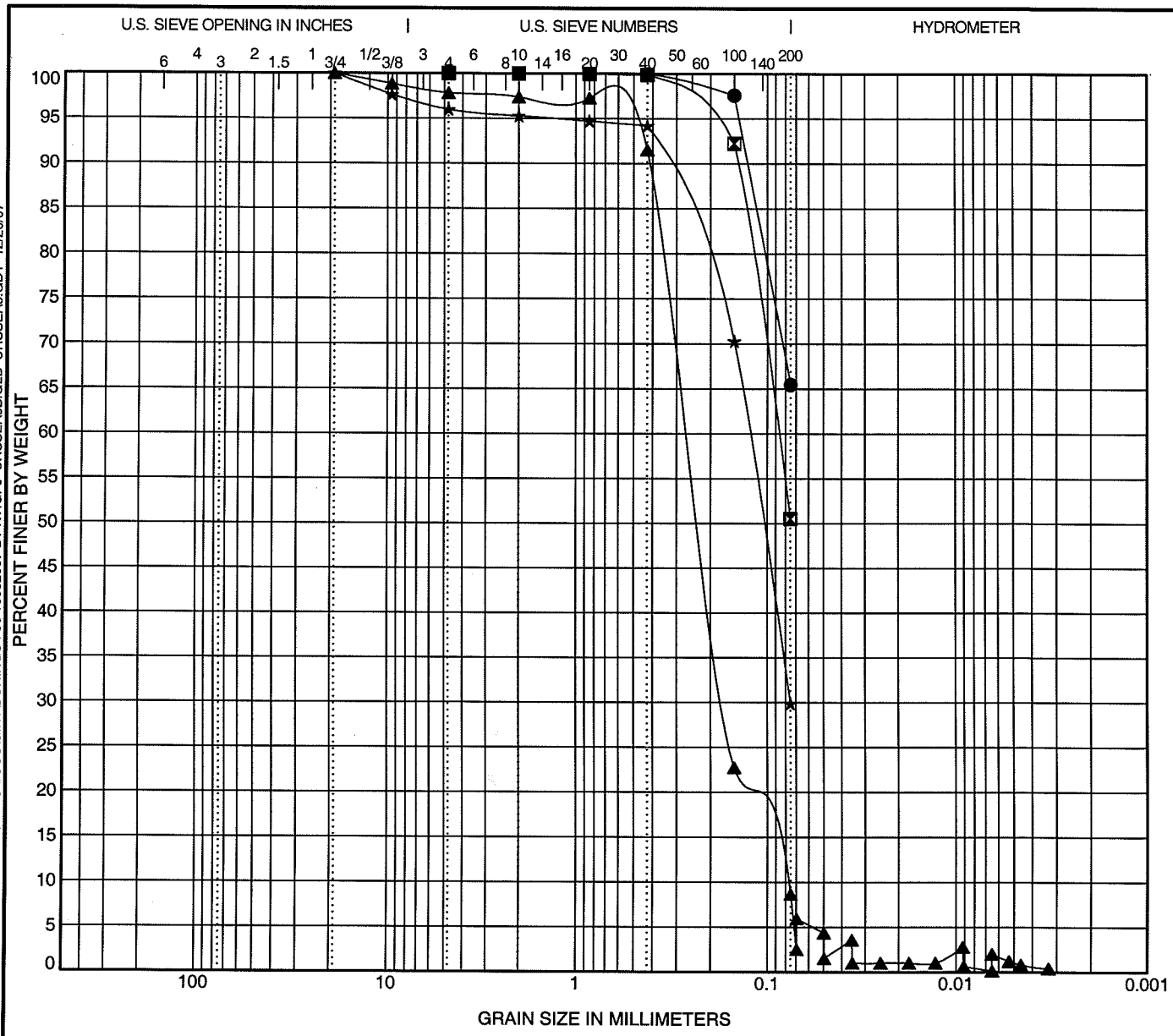
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-16

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-009-07 65.0 ft.	Sandy SILT					
⊠	GCB-009-07 70.0 ft.	Sandy SILT					
▲	GCB-009-07 80.2 ft.	Poorly-graded SAND				1.33	3.29
★	GCB-009-07 85.0 ft.	Silty SAND, fine					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-009-07 65.0 ft.	4.75				0.0	34.5	65.5	
⊠	GCB-009-07 70.0 ft.	4.75	0.088			0.0	49.5	50.5	
▲	GCB-009-07 80.2 ft.	19.05	0.264	0.167	0.08	2.2	89.2	8.2	0.4
★	GCB-009-07 85.0 ft.	19.05	0.126	0.075		4.0	66.1	29.9	

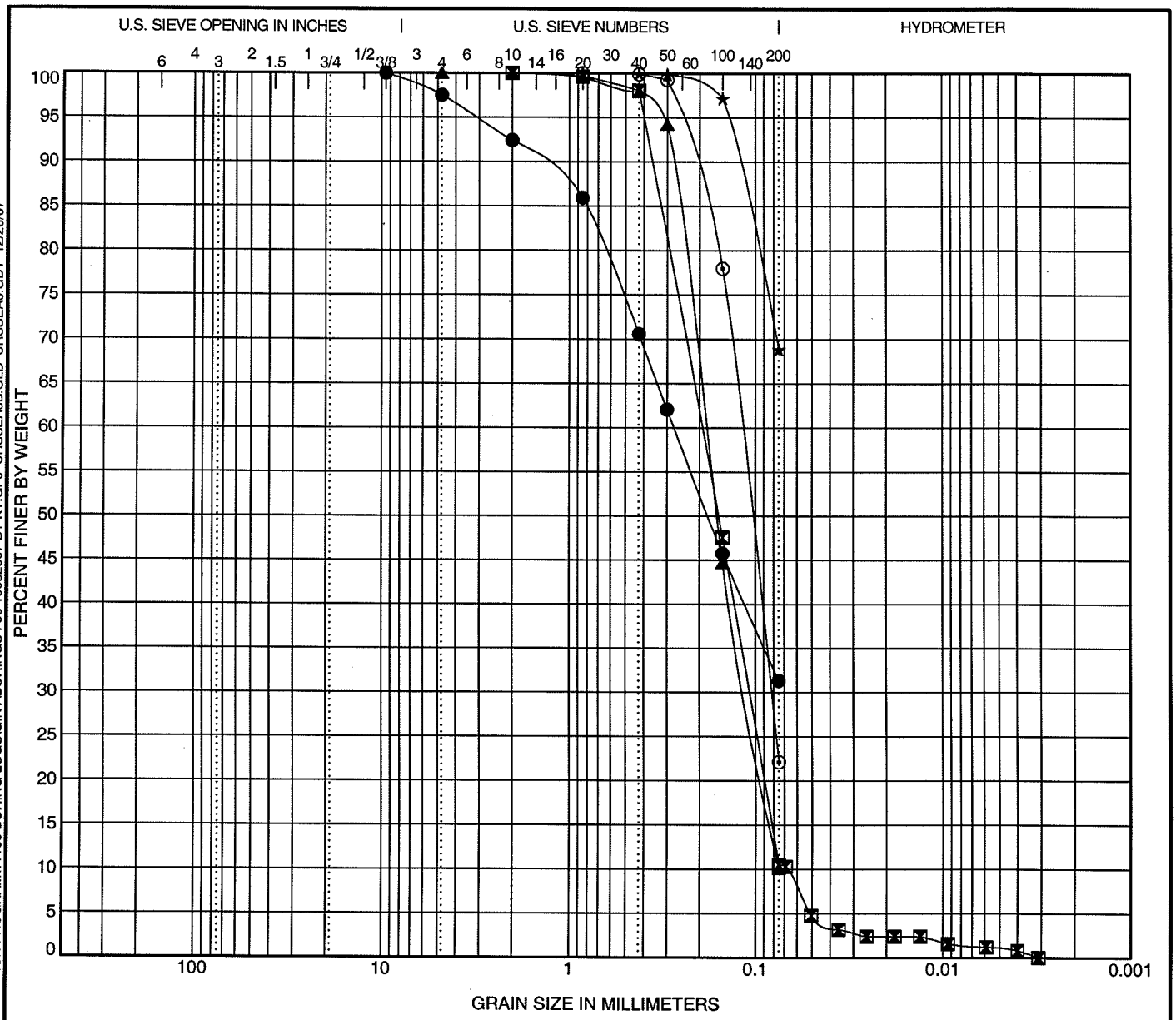
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-17

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-010-07 16.5 ft.	Silty SAND					
⊠	GCB-010-07 29.0 ft.	Silty SAND, fine				0.89	2.86
▲	GCB-010-07 29.5 ft.	Silty SAND, fine				0.90	2.48
★	GCB-010-07 39.0 ft.	Sandy SILT					
⊙	GCB-010-07 44.0 ft.	Silty SAND, fine					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-010-07 16.5 ft.	9.5	0.275			2.5	66.2	31.3	
⊠	GCB-010-07 29.0 ft.	2	0.194	0.108	0.068	0.0	89.5	10.5	
▲	GCB-010-07 29.5 ft.	4.75	0.186	0.112		0.0	89.9	10.1	
★	GCB-010-07 39.0 ft.	0.85				0.0	31.1	68.9	
⊙	GCB-010-07 44.0 ft.	0.85	0.12	0.083		0.0	77.9	22.1	

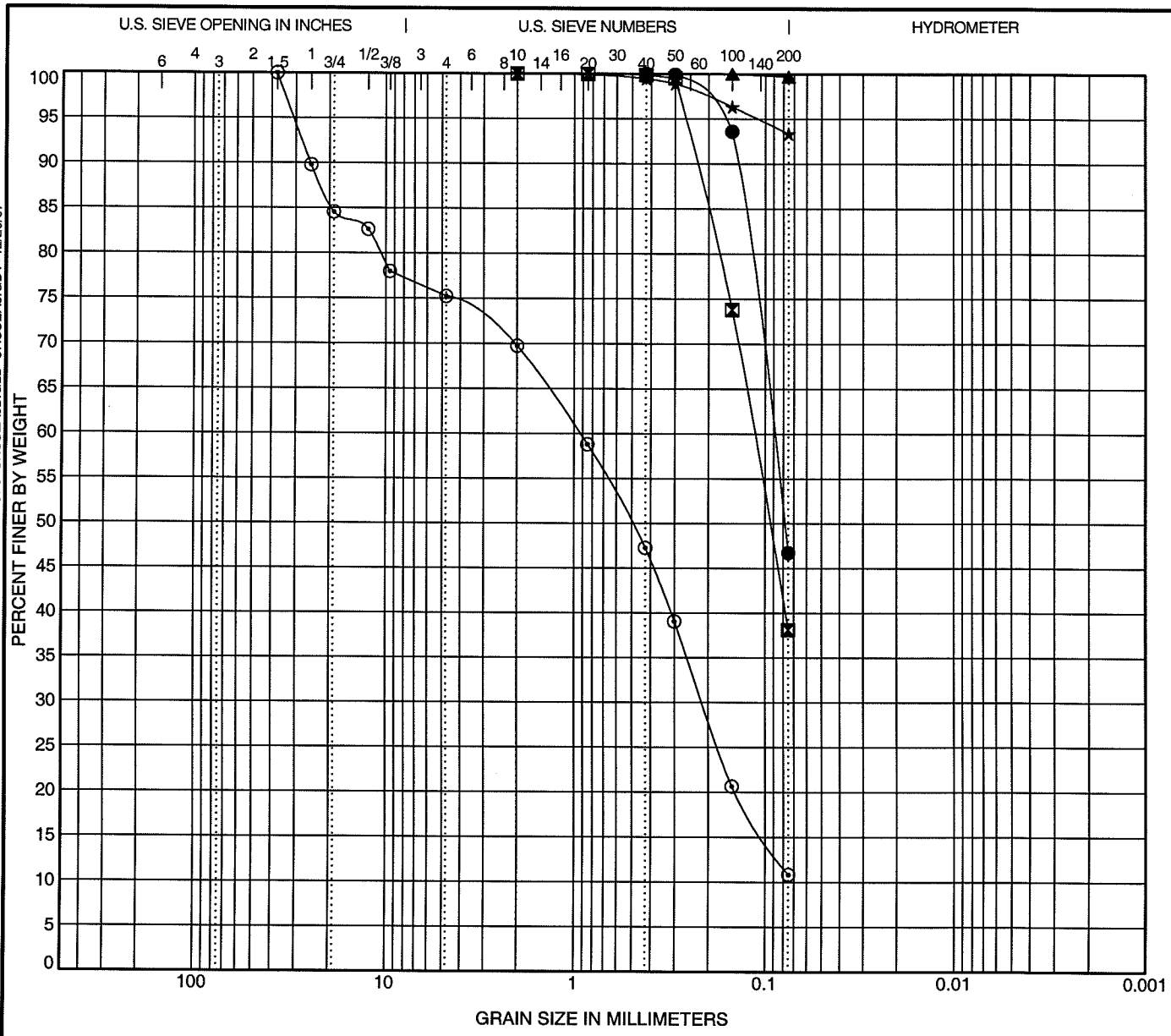
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-18

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-010-07 49.0 ft.	Silty SAND, fine					
⊠	GCB-010-07 54.0 ft.	Silty SAND, fine	NP	NP	NP		
▲	GCB-010-07 59.0 ft.	SILT	28	25	3		
★	GCB-010-07 64.0 ft.	SILT	27	23	4		
⊙	GCB-010-07 69.0 ft.	Silty SAND with gravel				0.69	13.20

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-010-07 49.0 ft.	0.425	0.091			0.0	53.3	46.7	
⊠	GCB-010-07 54.0 ft.	2	0.115			0.0	61.9	38.1	
▲	GCB-010-07 59.0 ft.	0.15				0.0	0.3	99.7	
★	GCB-010-07 64.0 ft.	2				0.0	6.6	93.4	
⊙	GCB-010-07 69.0 ft.	37.5	0.933	0.213		24.8	64.4	10.8	

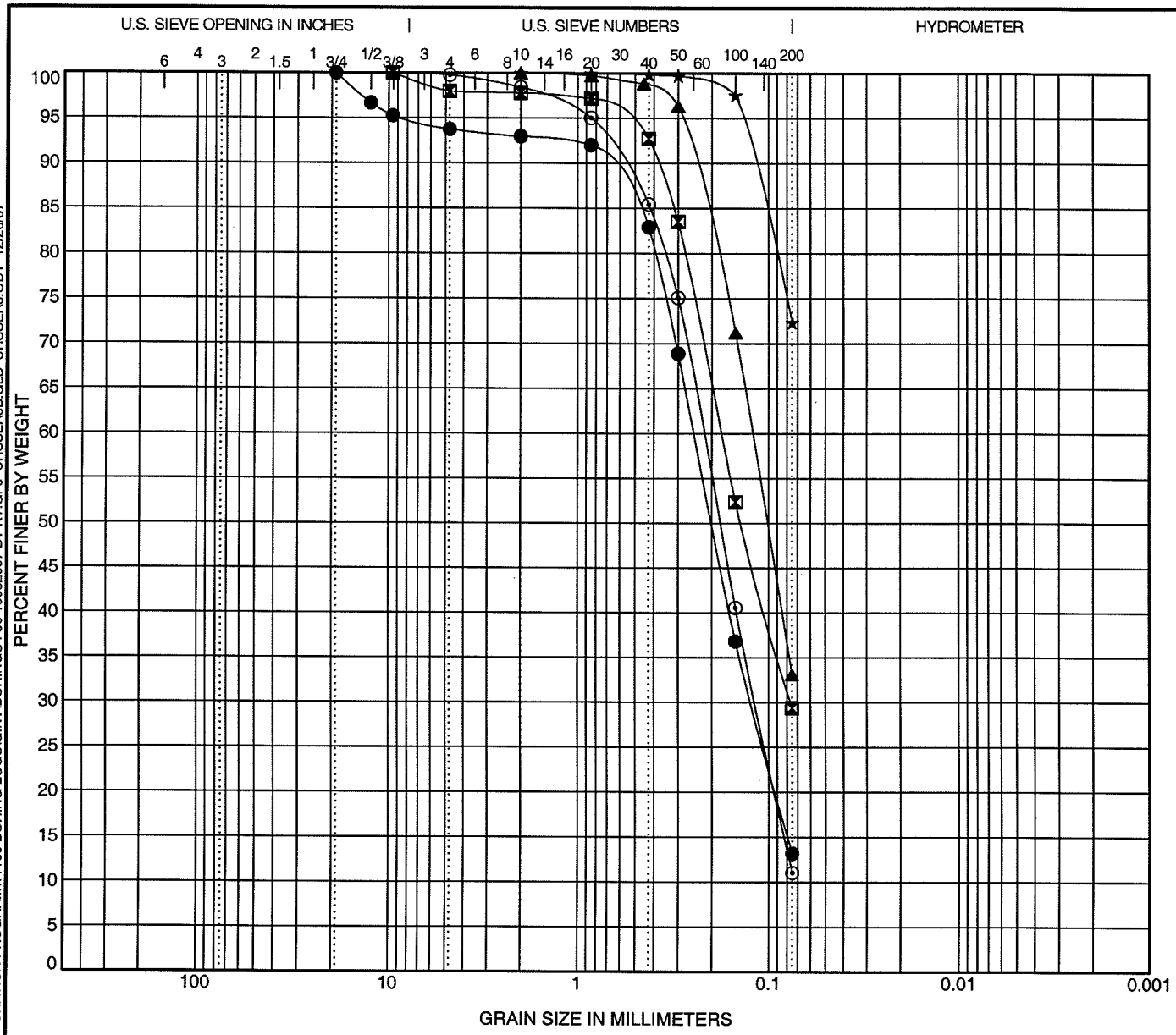
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-19

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-010-07 74.0 ft.	Silty SAND, fine to medium					
⊠	GCB-010-07 79.0 ft.	Silty SAND, fine					
▲	GCB-010-07 84.0 ft.	Silty SAND, fine					
★	GCB-010-07 89.0 ft.	Sandy SILT	NP	NP	NP		
⊙	GCB-010-07 94.0 ft.	Silty SAND, fine to medium				0.84	3.03

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-010-07 74.0 ft.	19	0.248	0.123		6.3	80.6	13.2	
⊠	GCB-010-07 79.0 ft.	9.525	0.178	0.076		2.0	68.6	29.4	
▲	GCB-010-07 84.0 ft.	2	0.122			0.0	66.9	33.1	
★	GCB-010-07 89.0 ft.	2				0.0	27.6	72.4	
⊙	GCB-010-07 94.0 ft.	9.525	0.222	0.117		0.2	88.7	11.0	

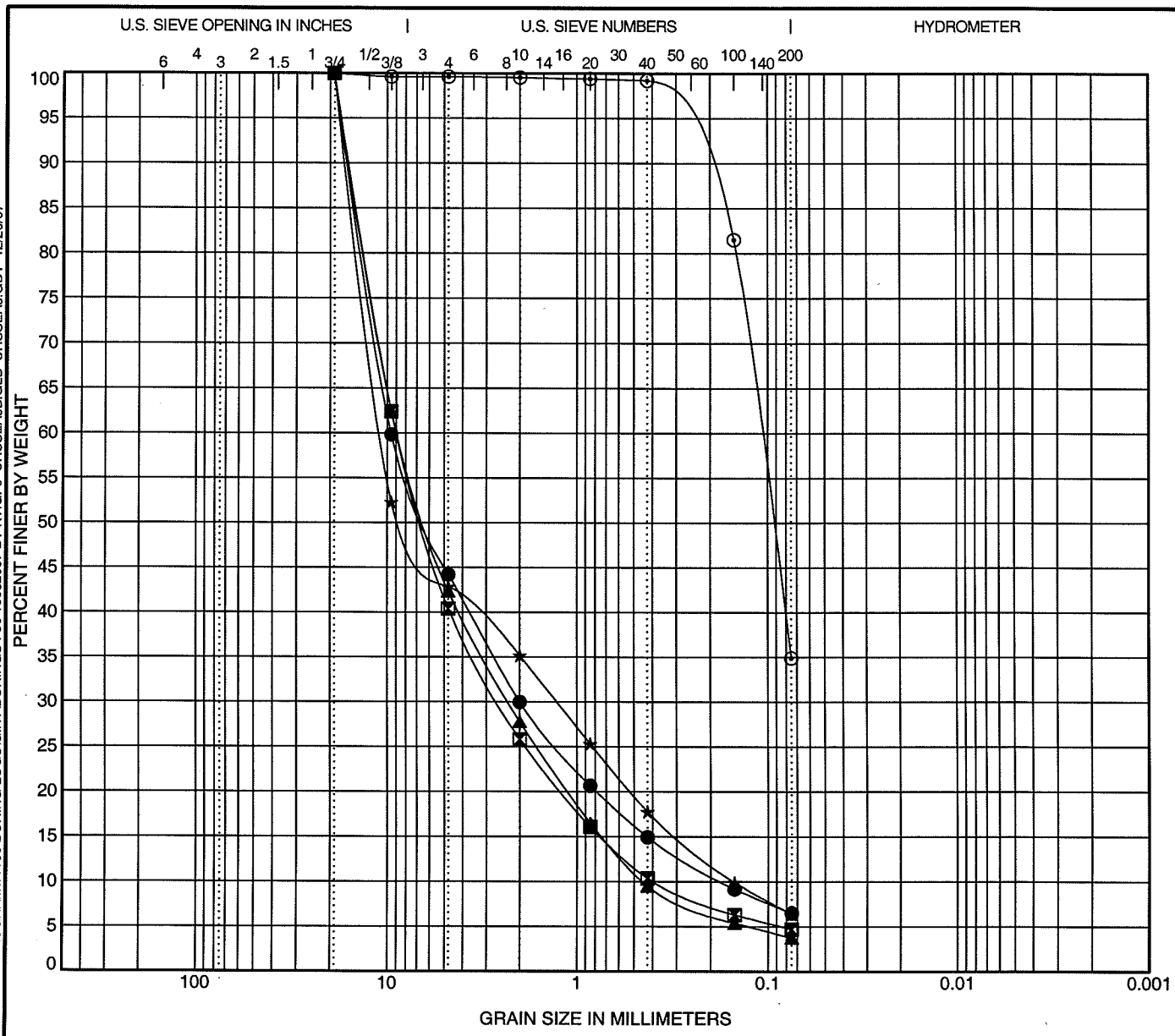
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-20

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-013-07 7.5 ft.	**Well-graded GRAVEL with sand**				**2.41**	**54.74**
⊠	GCB-013-07 14.0 ft.	**Well-graded GRAVEL with sand**				**1.93**	**22.80**
▲	GCB-013-07 19.0 ft.	**Well-graded GRAVEL with sand**				**1.33**	**19.61**
★	GCB-013-07 23.0 ft.	**Well-graded GRAVEL with sand**				**1.01**	**70.02**
⊙	GCB-013-07 33.0 ft.	**Silty SAND**					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-013-07 7.5 ft.	**19.05**	**9.553**	**2.006**	**0.175**	**55.8**	**37.7**	**6.5**	
⊠	GCB-013-07 14.0 ft.	**19.05**	**8.83**	**2.566**	**0.387**	**59.6**	**35.7**	**4.7**	
▲	GCB-013-07 19.0 ft.	**19.05**	**8.768**	**2.286**	**0.447**	**57.7**	**38.6**	**3.7**	
★	GCB-013-07 23.0 ft.	**19.05**	**10.654**	**1.278**	**0.152**	**57.1**	**36.5**	**6.4**	
⊙	GCB-013-07 33.0 ft.	**19.05**	**0.109**			**0.4**	**64.7**	**34.9**	

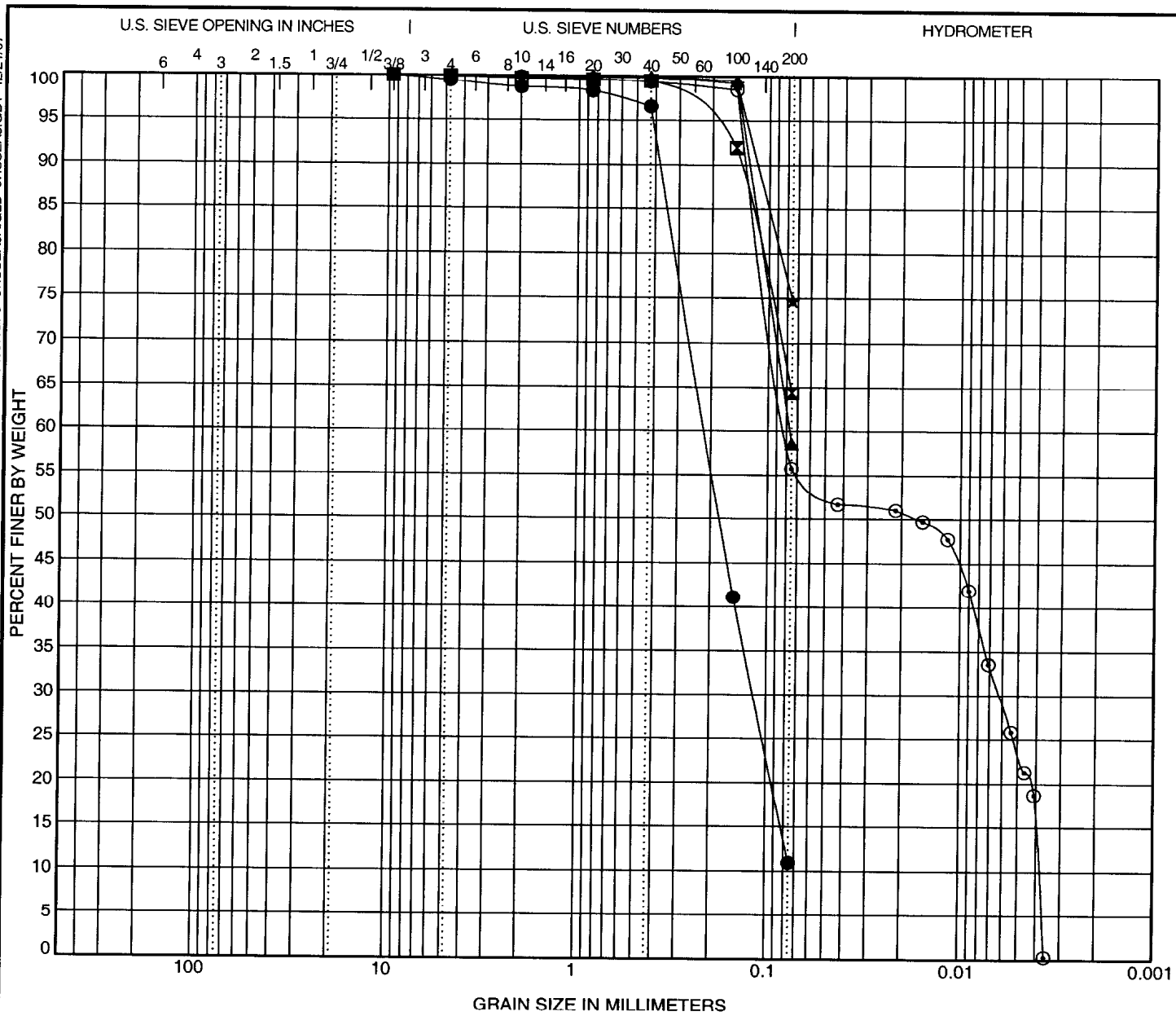
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-21

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-013-07 39.0 ft.	Silty SAND				0.86	2.91
⊠	GCB-013-07 44.0 ft.	Sandy SILT					
▲	GCB-013-07 49.0 ft.	Sandy SILT					
★	GCB-013-07 54.0 ft.	SILT with sand					
⊙	GCB-013-07 59.0 ft.	Sandy SILT				0.13	20.85

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-013-07 39.0 ft.	9.525	0.214	0.116		0.5	88.5	10.9	
⊠	GCB-013-07 44.0 ft.	9.525				0.1	35.6	64.3	
▲	GCB-013-07 49.0 ft.	0.85	0.077			0.0	41.5	58.5	
★	GCB-013-07 54.0 ft.	4.75				0.0	25.3	74.7	
⊙	GCB-013-07 59.0 ft.	9.525	0.08	0.006	0.004	0.1	44.2	55.7	

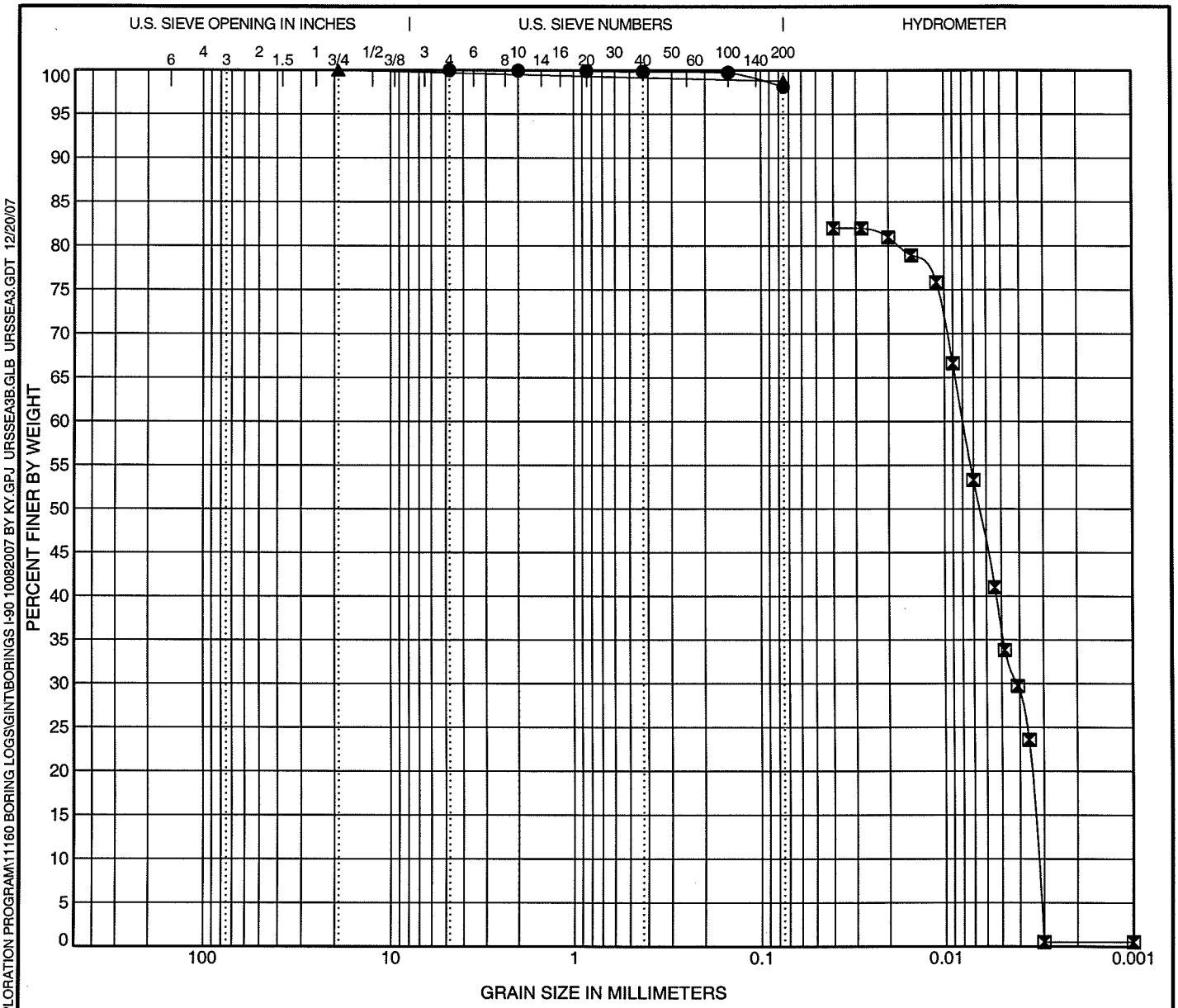
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-22

US_GRAIN_SIZE T:\WSDOT I-90 SNOQUALMIE PASS\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007.GPJ URSSEA3A.GLB URSSEA3.GDT 12/21/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-013-07 64.0 ft.	SILT					
⊠	GCB-013-07 69.0 ft.	SILT				0.67	2.46
▲	GCB-013-07 70.0 ft.	SILT					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-013-07 64.0 ft.	4.75				0.0	1.9	98.1	
⊠	GCB-013-07 69.0 ft.	0.04	0.008	0.004	0.003	0.0	0.0		
▲	GCB-013-07 70.0 ft.	19.05				0.3	0.9	98.8	

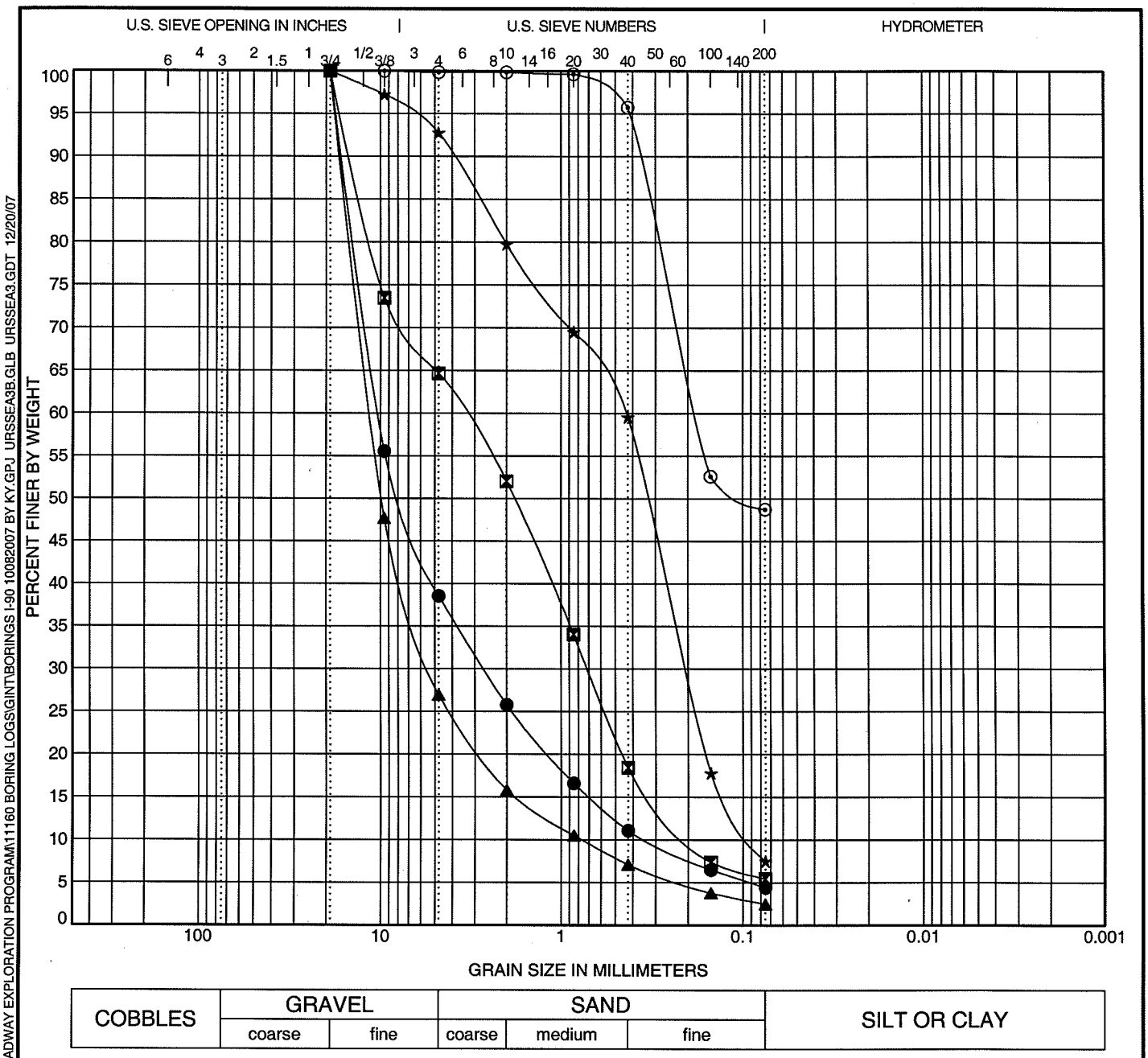
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-23

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-017-07 11.0 ft.	Well-graded GRAVEL with sand				2.09	30.70
⊠	GCB-017-07 16.0 ft.	Poorly-graded SAND with gravel				0.76	18.00
▲	GCB-017-07 23.5 ft.	Poorly-graded GRAVEL with sand				3.21	14.56
★	GCB-017-07 28.5 ft.	Poorly-graded SAND				1.07	4.94
⊙	GCB-017-07 34.0 ft.	Silty SAND					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-017-07 11.0 ft.	19	10.207	2.665	0.332	61.5	34.1	4.4	
⊠	GCB-017-07 16.0 ft.	19	3.453	0.711	0.192	35.3	59.2	5.5	
▲	GCB-017-07 23.5 ft.	19.05	11.212	5.265	0.77	73.1	24.5	2.5	
★	GCB-017-07 28.5 ft.	19.05	0.438	0.203	0.089	7.3	85.2	7.5	
⊙	GCB-017-07 34.0 ft.	9.525	0.179			0.2	51.1	48.7	

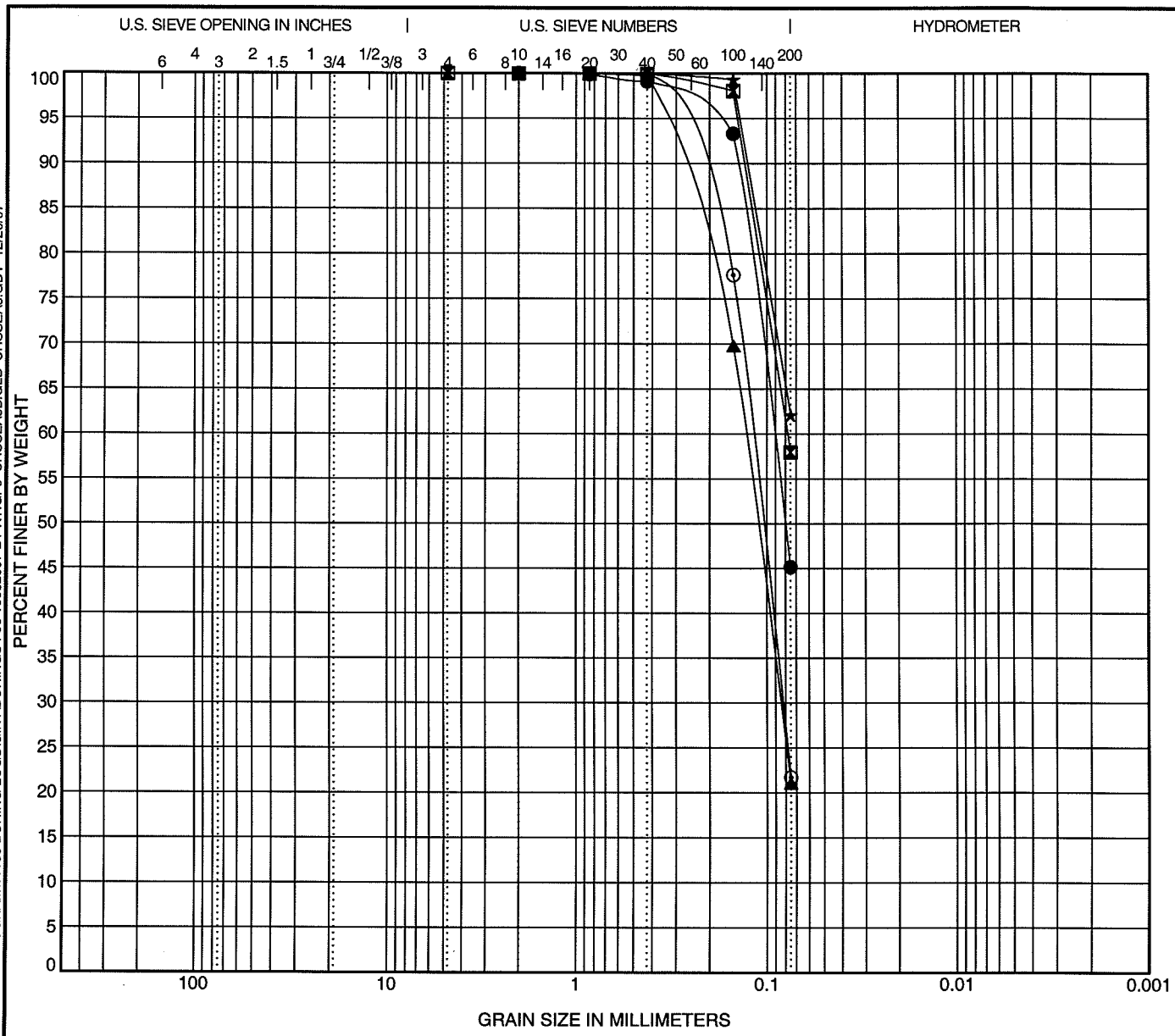
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-24

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-017-07 39.0 ft.	Silty SAND					
⊠	GCB-017-07 44.0 ft.	Sandy SILT					
▲	GCB-017-07 49.0 ft.	Silty SAND					
★	GCB-017-07 54.0 ft.	Sandy SILT					
⊙	GCB-017-07 59.0 ft.	Silty SAND					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-017-07 39.0 ft.	2	0.093			0.0	54.8	45.2	
⊠	GCB-017-07 44.0 ft.	4.75	0.078			0.0	42.0	58.0	
▲	GCB-017-07 49.0 ft.	2	0.131	0.085		0.0	79.0	21.0	
★	GCB-017-07 54.0 ft.	2				0.0	37.9	62.1	
⊙	GCB-017-07 59.0 ft.	0.85	0.121	0.083		0.0	78.3	21.7	

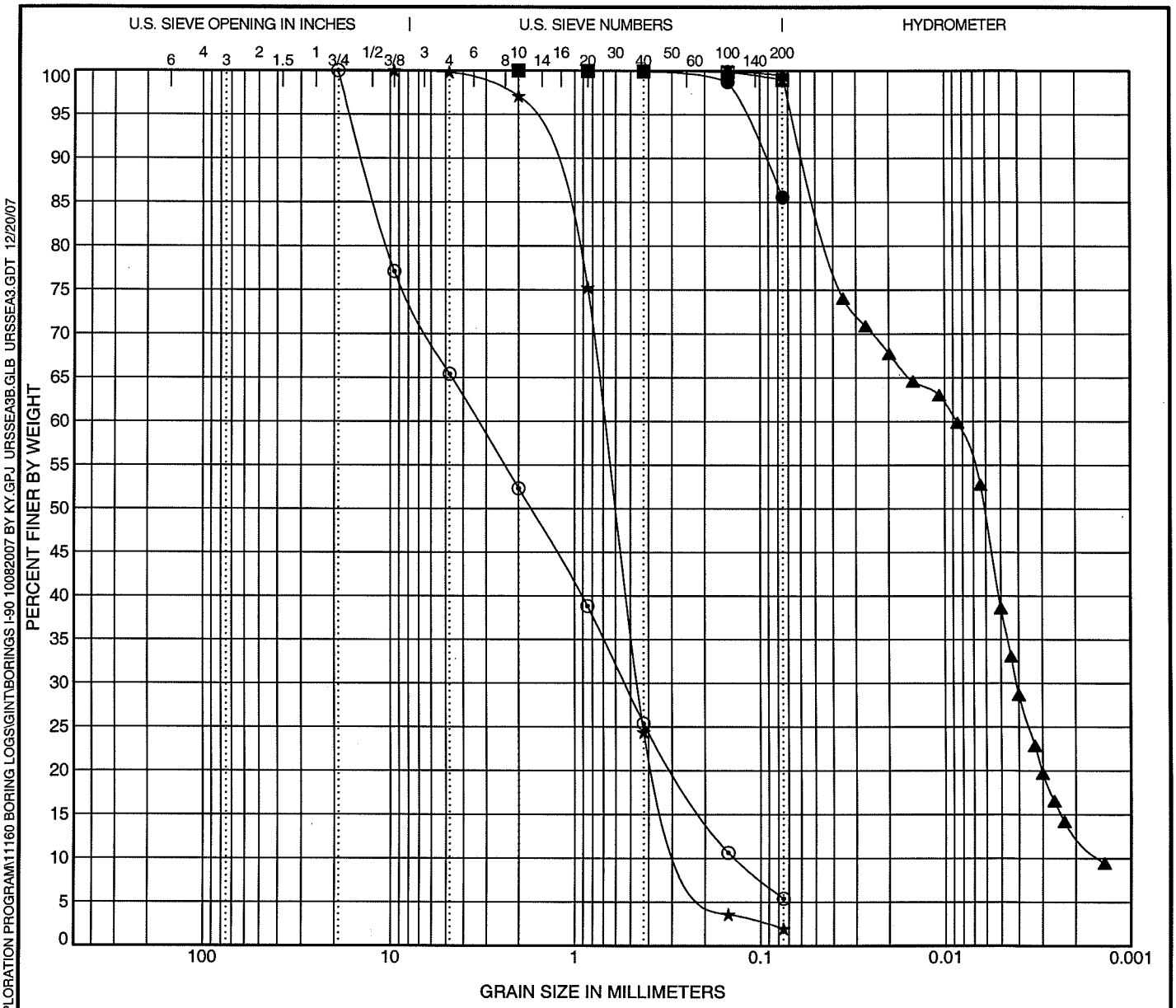
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-25

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-017-07 64.0 ft.	SILT					
⊠	GCB-017-07 69.0 ft.	SILT					
▲	GCB-017-07 74.0 ft.	SILT				1.33	5.79
★	GCB-017-07 79.0 ft.	Poorly-graded SAND				1.47	3.34
⊙	GCB-017-07 84.0 ft.	Poorly-graded SAND with gravel				0.63	24.08

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-017-07 64.0 ft.	2				0.0	14.4	85.6	
⊠	GCB-017-07 69.0 ft.	2				0.0	1.0	99.0	
▲	GCB-017-07 74.0 ft.	0.15	0.009	0.004	0.001	0.0	0.5	99.5	
★	GCB-017-07 79.0 ft.	9.525	0.69	0.459	0.207	0.2	97.9	2.0	
⊙	GCB-017-07 84.0 ft.	19.05	3.323	0.539	0.138	34.6	60.0	5.4	

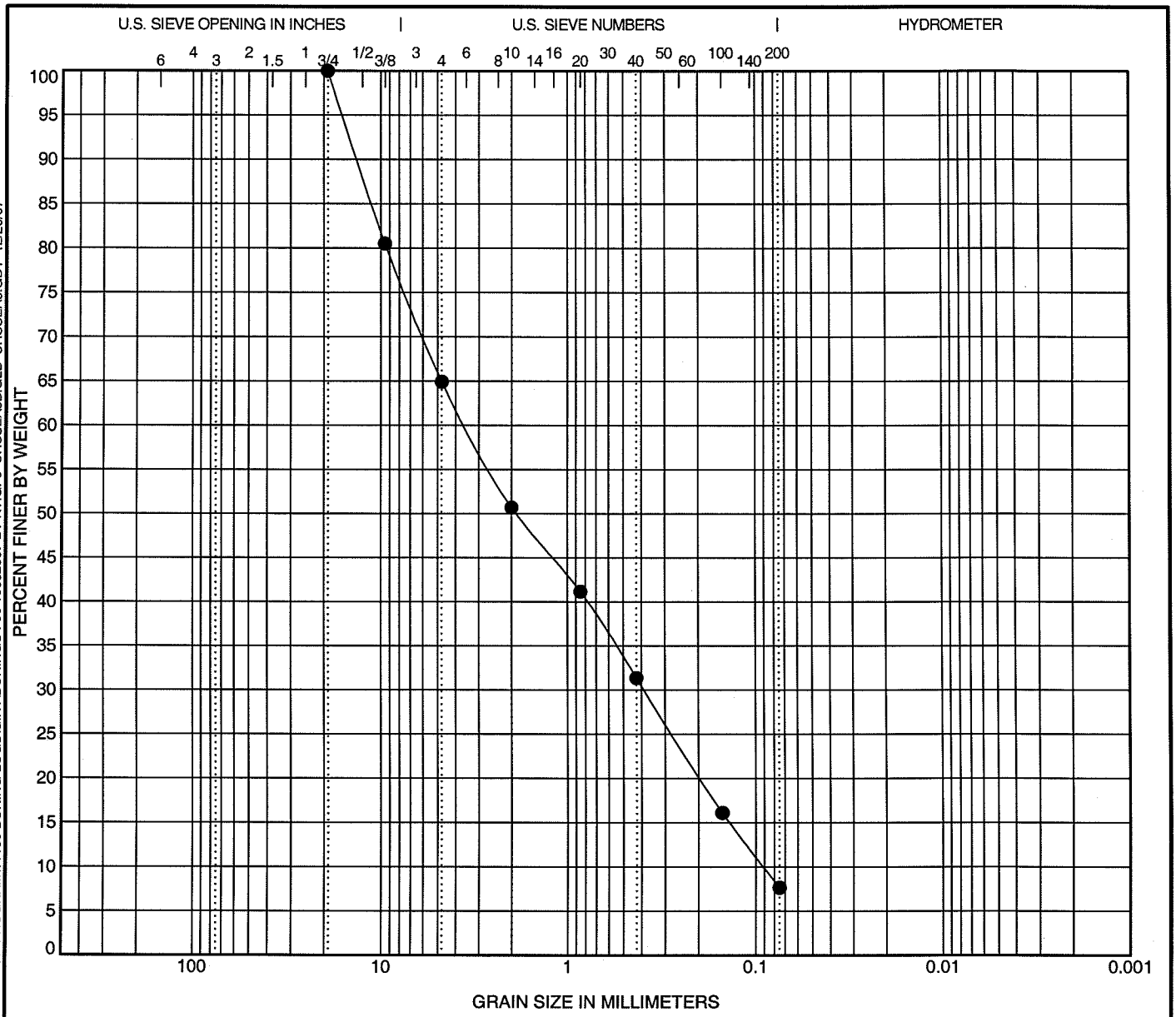
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-26

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**GCB-017-07 89.0 ft.**	**Poorly-graded SAND with gravel**				**0.47**	**38.73**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**GCB-017-07 89.0 ft.**	**19.05**	**3.521**	**0.387**	**0.091**	**35.1**	**57.3**	**7.7**	

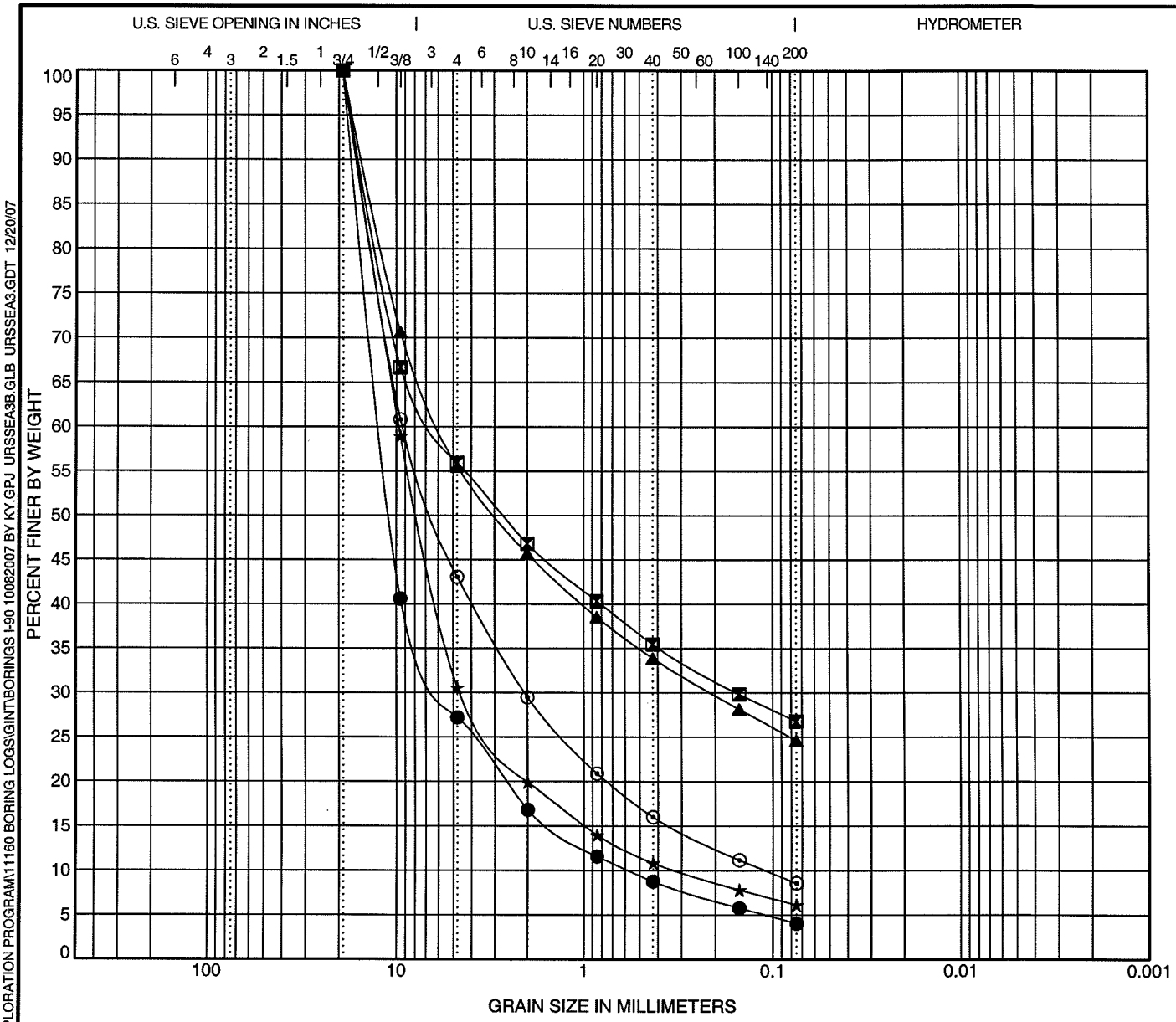
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-27

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	GCB-019-07	3.0 ft.	**Poorly-graded GRAVEL with sand**				**4.39**	**20.74**
⊠	GCB-019-07	6.0 ft.	**Silty GRAVEL with sand**					
▲	GCB-019-07	8.0 ft.	**Silty GRAVEL with sand**					
★	GCB-019-07	11.0 ft.	**Poorly-graded GRAVEL with sand**				**6.68**	**30.46**
⊙	GCB-019-07	13.0 ft.	**Poorly-graded GRAVEL with sand**				**4.24**	**84.32**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-019-07	3.0 ft.	**19.05**	**11.945**	**5.496**	**0.576**	**72.8**	**23.1**	**4.1**	
⊠	GCB-019-07	6.0 ft.	**19.05**	**6.187**	**0.155**		**44.1**	**29.1**	**26.8**	
▲	GCB-019-07	8.0 ft.	**19.05**	**5.837**	**0.21**		**44.5**	**30.9**	**24.6**	
★	GCB-019-07	11.0 ft.	**19.05**	**9.697**	**4.541**	**0.318**	**69.4**	**24.4**	**6.1**	
⊙	GCB-019-07	13.0 ft.	**19.05**	**9.225**	**2.068**	**0.109**	**56.9**	**34.5**	**8.6**	

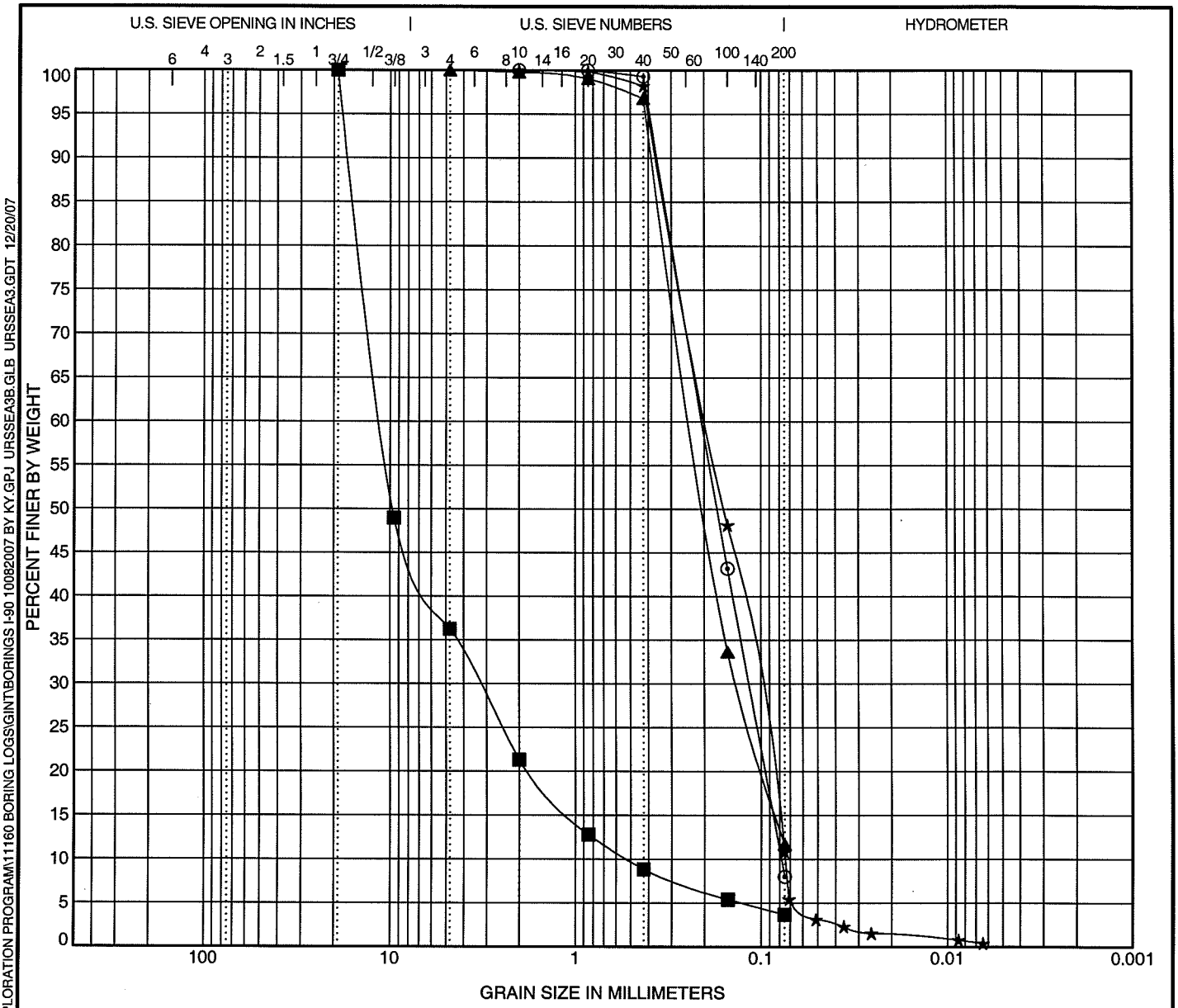
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-28

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-019-07 19.0 ft.	Well-graded GRAVEL with sand				1.90	21.25
⊠	GCB-019-07 23.0 ft.	Well-graded GRAVEL with sand				1.90	21.25
▲	GCB-019-07 28.0 ft.	Silty SAND				1.09	3.26
★	GCB-019-07 33.0 ft.	Silty SAND				0.80	2.58
⊙	GCB-019-07 38.0 ft.	Poorly-graded SAND				0.84	2.63

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-019-07 19.0 ft.	19.05	11.064	3.311	0.521	63.8	32.5	3.7	
⊠	GCB-019-07 23.0 ft.	19.05	11.064	3.311	0.521	63.8	32.5	3.7	
▲	GCB-019-07 28.0 ft.	4.75	0.232	0.134		0.0	88.3	11.7	
★	GCB-019-07 33.0 ft.	2	0.192	0.107	0.074	0.0	89.2	10.8	
⊙	GCB-019-07 38.0 ft.	2	0.205	0.116	0.078	0.0	92.0	8.0	

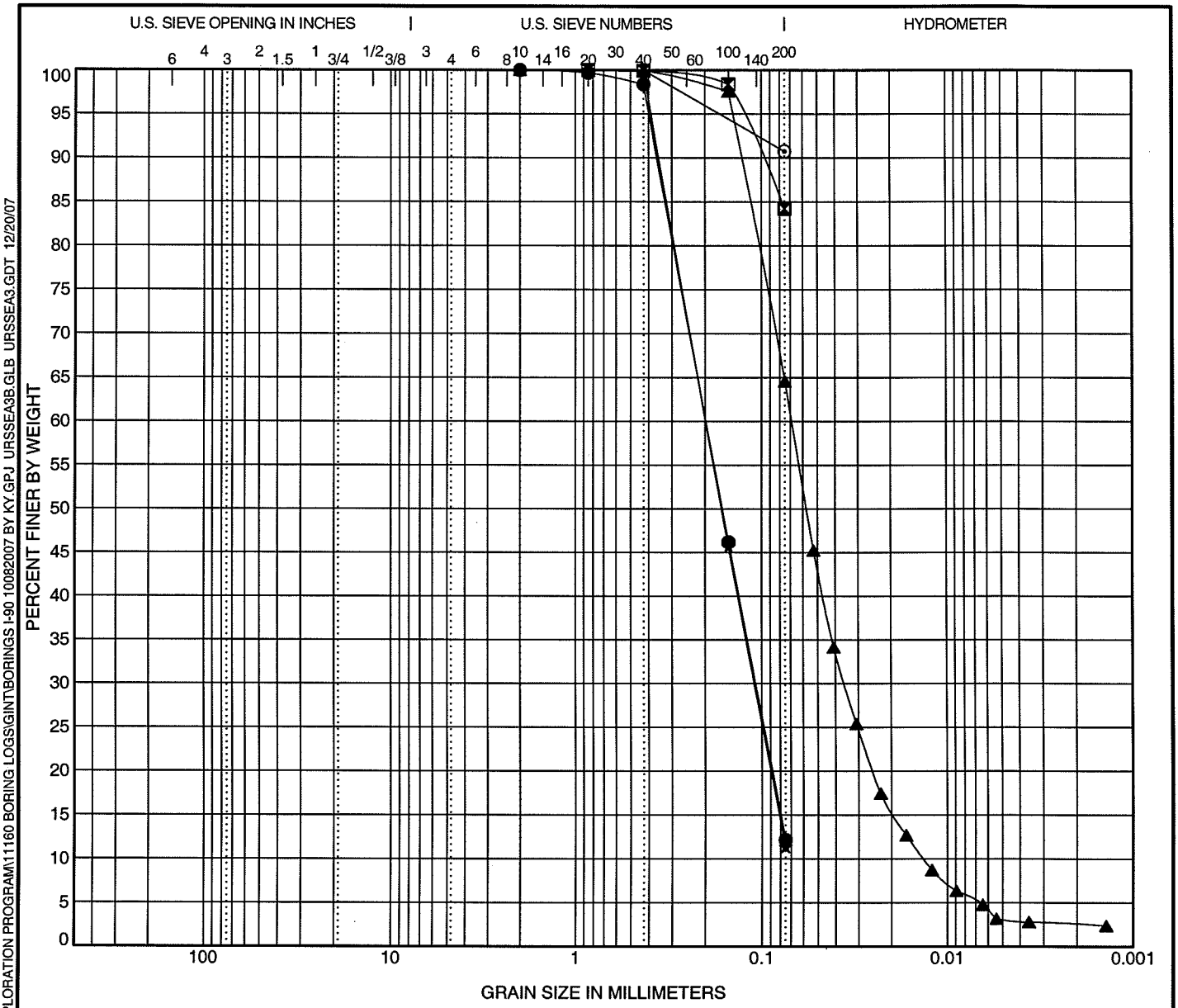
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-29

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-019-07 43.0 ft.	Silty SAND				0.82	2.75
⊠	GCB-019-07 48.0 ft.	SILT with sand					
▲	GCB-019-07 53.0 ft.	Sandy SILT				1.38	5.14
★	GCB-019-07 58.0 ft.	Silty SAND				0.83	2.71
⊙	GCB-019-07 68.0 ft.	SILT					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-019-07 43.0 ft.	2	0.198	0.108		0.0	87.8	12.2	
⊠	GCB-019-07 48.0 ft.	0.85				0.0	15.8	84.2	
▲	GCB-019-07 53.0 ft.	2	0.069	0.036	0.013	0.0	35.4	64.6	
★	GCB-019-07 58.0 ft.	0.85	0.198	0.109		0.0	88.6	11.4	
⊙	GCB-019-07 68.0 ft.	0.425				0.0	9.3	90.7	

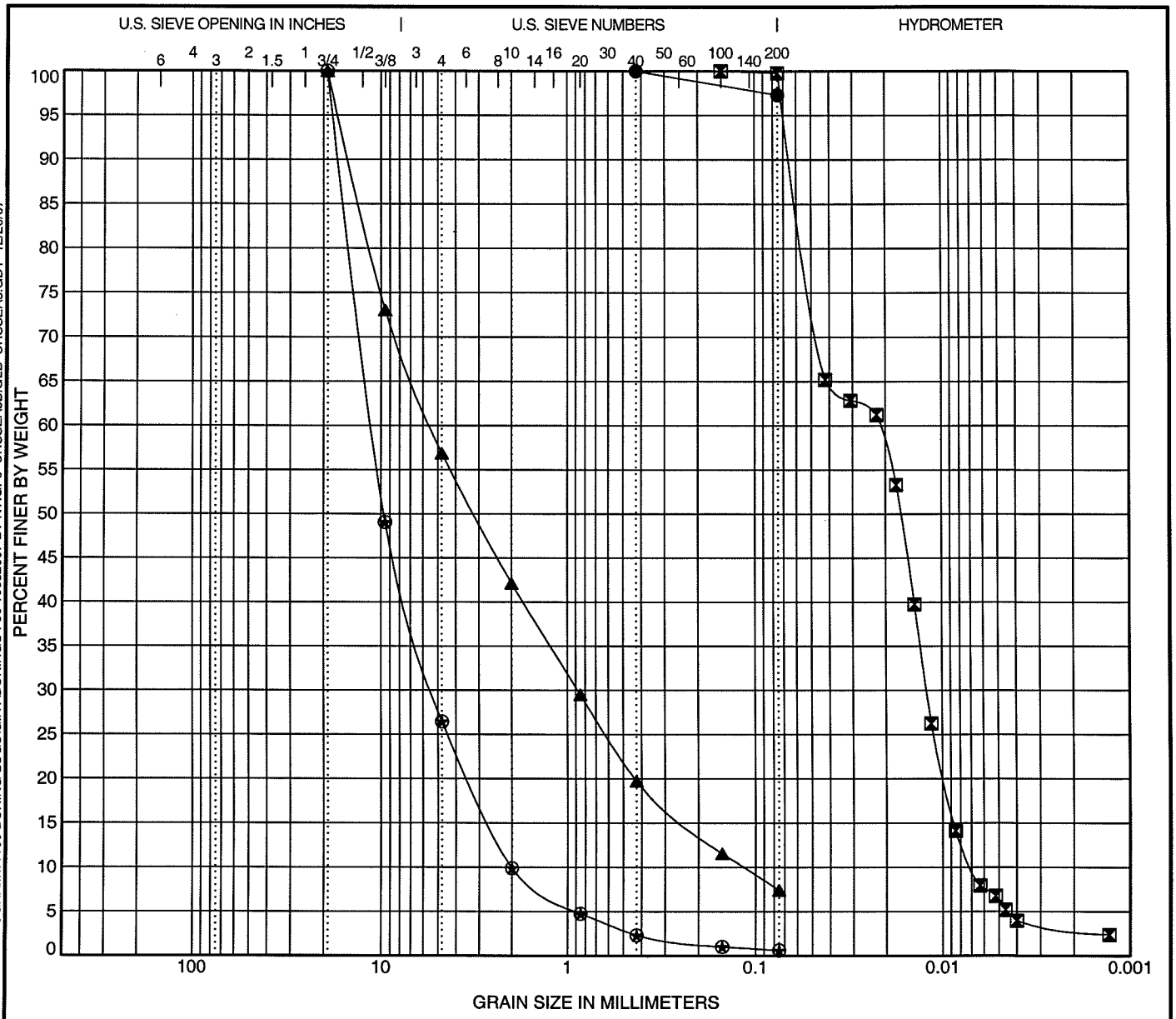
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-30

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-019-07 73.0 ft.	SILT					
⊠	GCB-019-07 75.0 ft.	CLAY-SILT	26	22	4	0.97	3.08
▲	GCB-019-07 83.0 ft.	Well-graded GRAVEL with sand or SAND with gravel				1.23	46.99
★	GCB-019-07 93.0 ft.	Well-graded GRAVEL with sand				1.26	5.50
⊙	GCB-019-07 98.0 ft.	Well-graded GRAVEL with sand				1.26	5.50

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-019-07 73.0 ft.	0.425				0.0	2.7	97.3	
⊠	GCB-019-07 75.0 ft.	0.15	0.021	0.012	0.007	0.0	0.2	99.8	
▲	GCB-019-07 83.0 ft.	19.05	5.434	0.88	0.116	43.1	49.5	7.4	
★	GCB-019-07 93.0 ft.	19.05	11.055	5.3	2.011	73.6	25.8	0.6	
⊙	GCB-019-07 98.0 ft.	19.05	11.055	5.3	2.011	73.6	25.8	0.6	

GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East

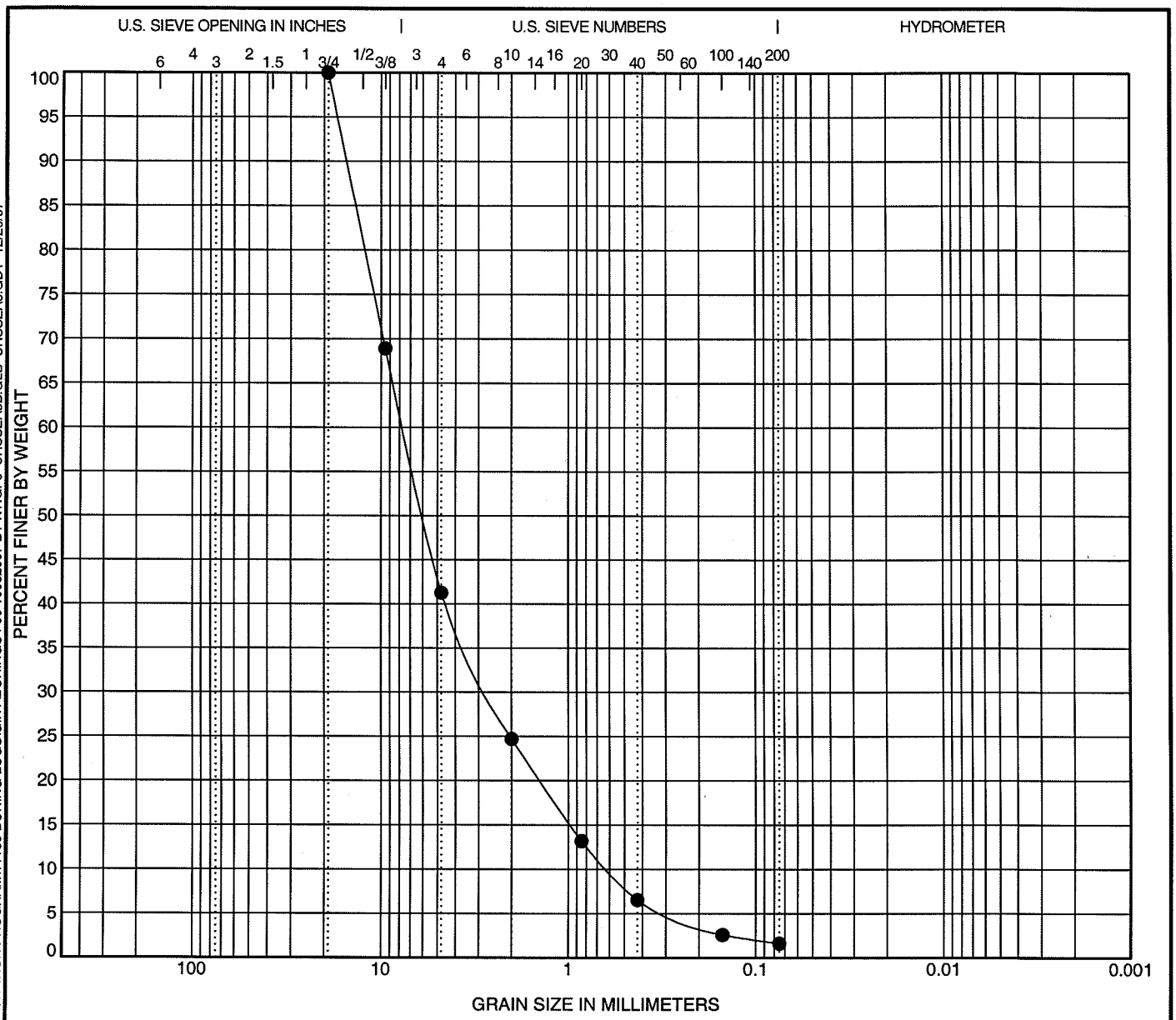
Project Location: I-90 Hyak to Keechelus Dam, WA

Project Number: 33758613.04000

Figure B-31

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**GCB-019-07 108.0 ft.**	**Well-graded GRAVEL with sand**				**1.50**	**12.48**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**GCB-019-07 108.0 ft.**	**19.05**	**7.612**	**2.638**	**0.61**	**58.7**	**39.6**	**1.6**	

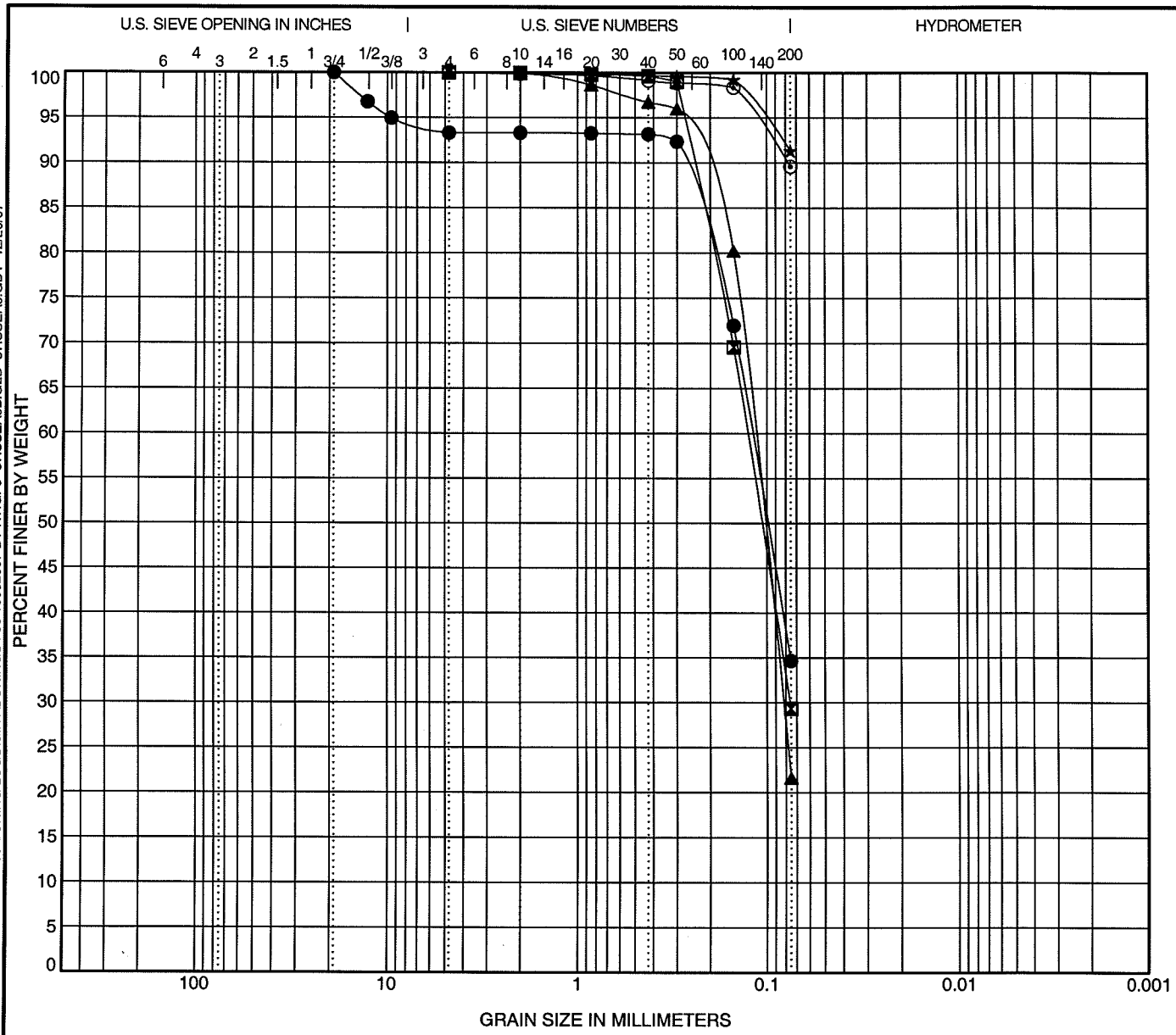
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-32

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-020-07 38.0 ft.	Silty SAND, fine					
⊠	GCB-020-07 43.0 ft.	Silty SAND, fine					
▲	GCB-020-07 48.0 ft.	Silty SAND, fine	NP	NP	NP		
★	GCB-020-07 53.0 ft.	SILT	23	21	2		
⊙	GCB-020-07 58.0 ft.	SILT					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-020-07 38.0 ft.	19	0.12			6.7	58.6	34.7	
⊠	GCB-020-07 43.0 ft.	4.75	0.127	0.076		0.0	70.7	29.3	
▲	GCB-020-07 48.0 ft.	4.75	0.118	0.083		0.0	78.4	21.6	
★	GCB-020-07 53.0 ft.	2				0.0	8.7	91.3	
⊙	GCB-020-07 58.0 ft.	4.75				0.0	10.4	89.6	

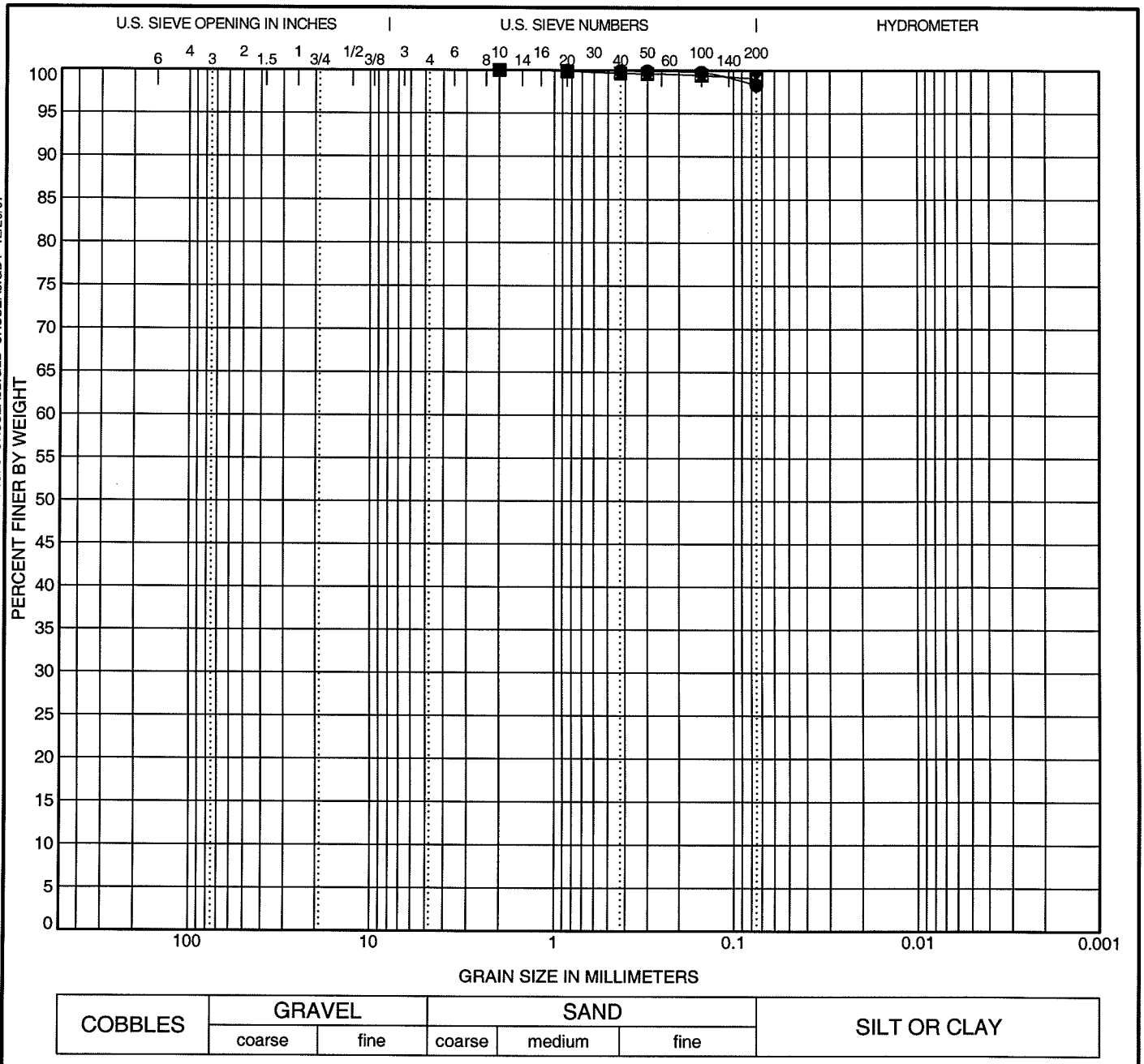
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-33

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-020-07 63.0 ft.	SILT	26	25	1		
⊠	GCB-020-07 68.0 ft.	SILT	26	25	1		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-020-07 63.0 ft.	2				0.0	1.7	98.3	
⊠	GCB-020-07 68.0 ft.	2				0.0	1.0	99.0	

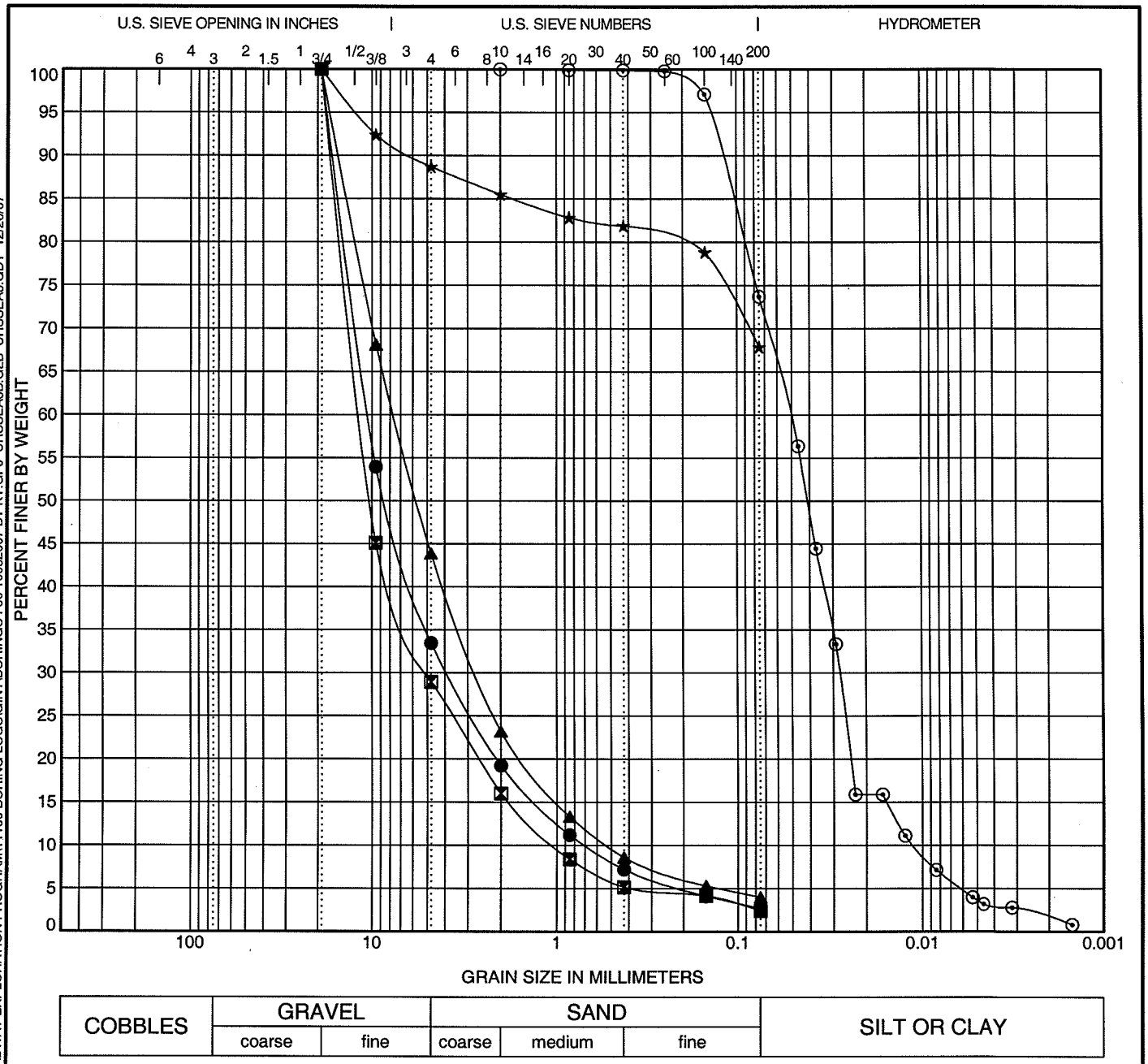
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-34

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-021-07 5.0 ft.	Well-graded GRAVEL with sand				2.06	15.11
⊠	GCB-021-07 10.0 ft.	Well-graded GRAVEL with sand				2.12	11.30
▲	GCB-021-07 12.5 ft.	Well-graded GRAVEL with sand				1.80	14.46
★	GCB-021-07 17.5 ft.	Sandy SILT					
⊙	GCB-021-07 20.0 ft.	SILT with sand				1.36	4.59

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-021-07 5.0 ft.	19.05	10.433	3.853	0.691	66.6	30.8	2.7	
⊠	GCB-021-07 10.0 ft.	19.05	11.498	4.981	1.018	71.1	26.5	2.4	
▲	GCB-021-07 12.5 ft.	19.05	7.547	2.659	0.522	56.1	39.9	4.0	
★	GCB-021-07 17.5 ft.	19.05				11.3	20.8	67.9	
⊙	GCB-021-07 20.0 ft.	2	0.051	0.028	0.011	0.0	26.3	73.7	

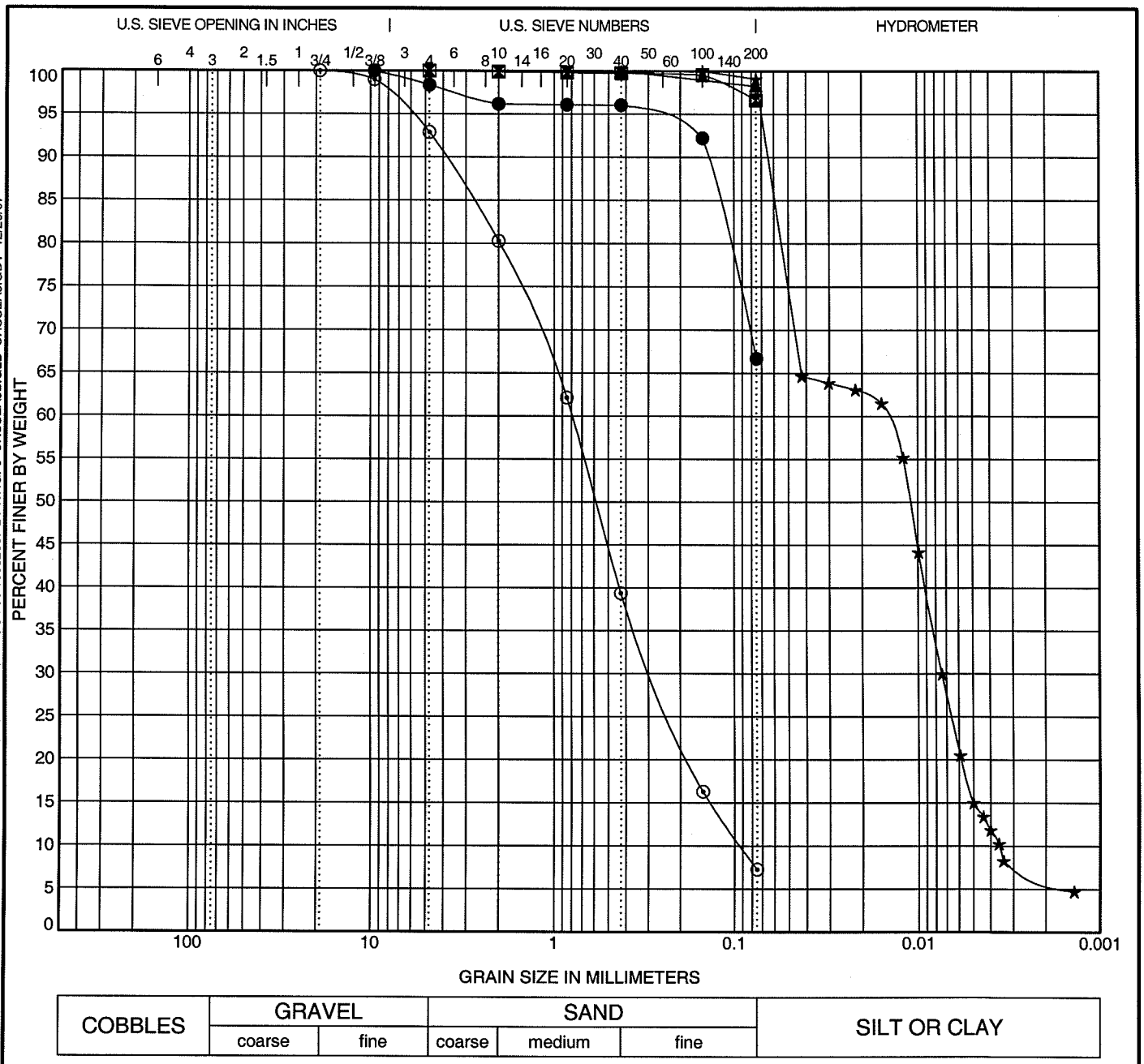
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-35

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-021-07 25.0 ft.	Sandy SILT					
⊠	GCB-021-07 30.0 ft.	SILT					
▲	GCB-021-07 35.0 ft.	SILT	25	22	3		
★	GCB-021-07 40.0 ft.	SILT				1.04	4.12
⊙	GCB-021-07 45.0 ft.	Well-graded SAND				1.05	8.61

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-021-07 25.0 ft.	9.525				1.6	31.7	66.7	
⊠	GCB-021-07 30.0 ft.	4.75				0.0	3.4	96.6	
▲	GCB-021-07 35.0 ft.	0.425				0.0	1.7	98.3	
★	GCB-021-07 40.0 ft.	0.15	0.015	0.007	0.004	0.0	0.9	99.1	
⊙	GCB-021-07 45.0 ft.	19.05	0.796	0.278	0.093	7.1	85.6	7.3	

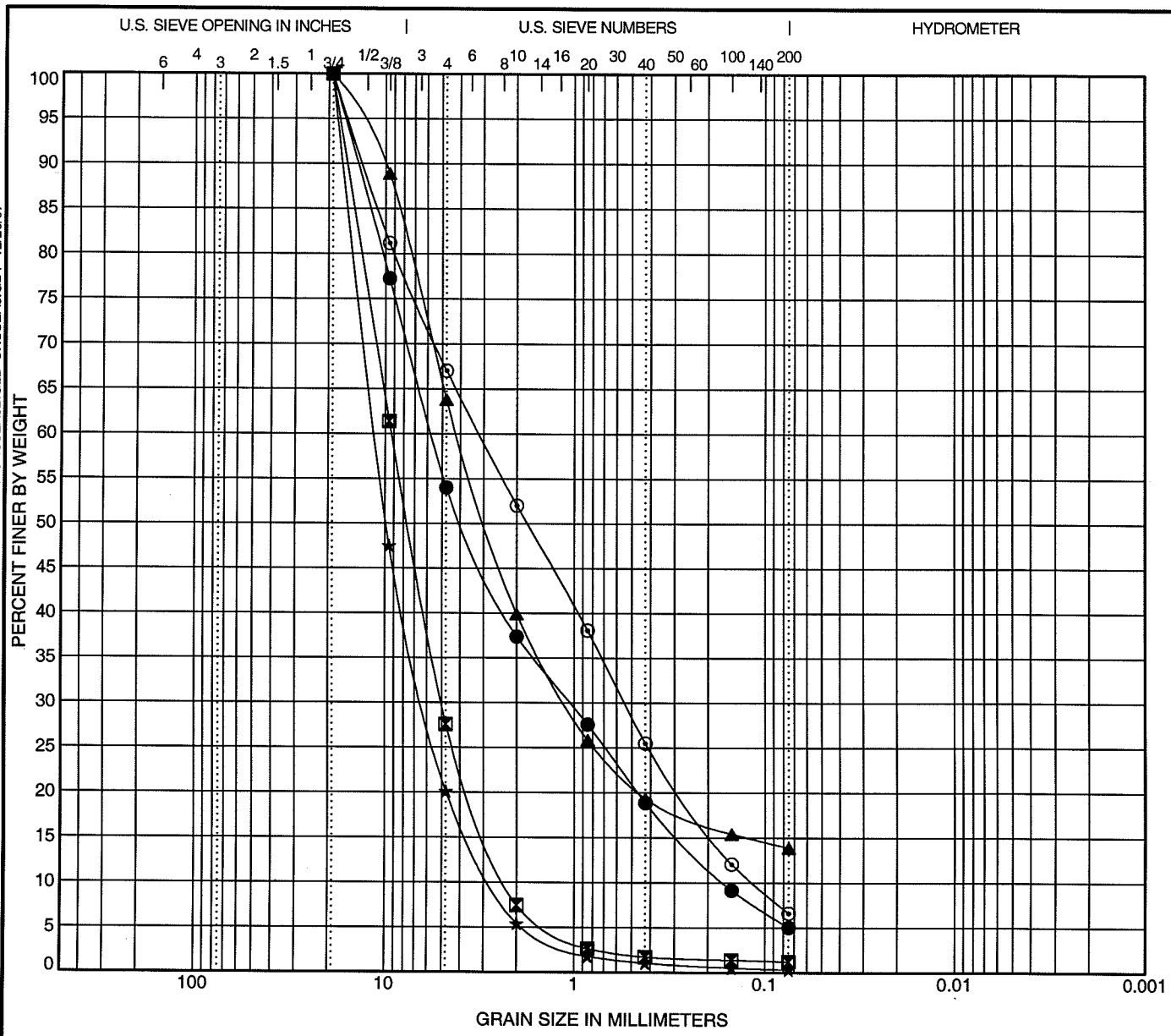
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-36

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	GCB-021-07 50.0 ft.	**Well-graded SAND with gravel**				**1.18**	**34.61**
⊠	GCB-021-07 55.0 ft.	**Well-graded GRAVEL with sand**				**1.21**	**4.15**
▲	GCB-021-07 60.0 ft.	**Silty SAND with gravel**					
★	GCB-021-07 65.0 ft.	**Well-graded GRAVEL with sand**				**1.27**	**4.28**
⊙	GCB-021-07 70.0 ft.	**Poorly-graded SAND with gravel**				**0.81**	**27.48**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCB-021-07 50.0 ft.	**19.05**	**5.682**	**1.05**	**0.164**	**46.0**	**49.0**	**5.0**	
⊠	GCB-021-07 55.0 ft.	**19.05**	**9.256**	**4.992**	**2.232**	**72.4**	**26.4**	**1.2**	
▲	GCB-021-07 60.0 ft.	**19.05**	**4.139**	**1.096**		**36.2**	**49.9**	**13.9**	
★	GCB-021-07 65.0 ft.	**19.05**	**11.233**	**6.107**	**2.622**	**79.9**	**19.8**	**0.3**	
⊙	GCB-021-07 70.0 ft.	**19.05**	**3.168**	**0.545**	**0.115**	**33.0**	**60.4**	**6.6**	

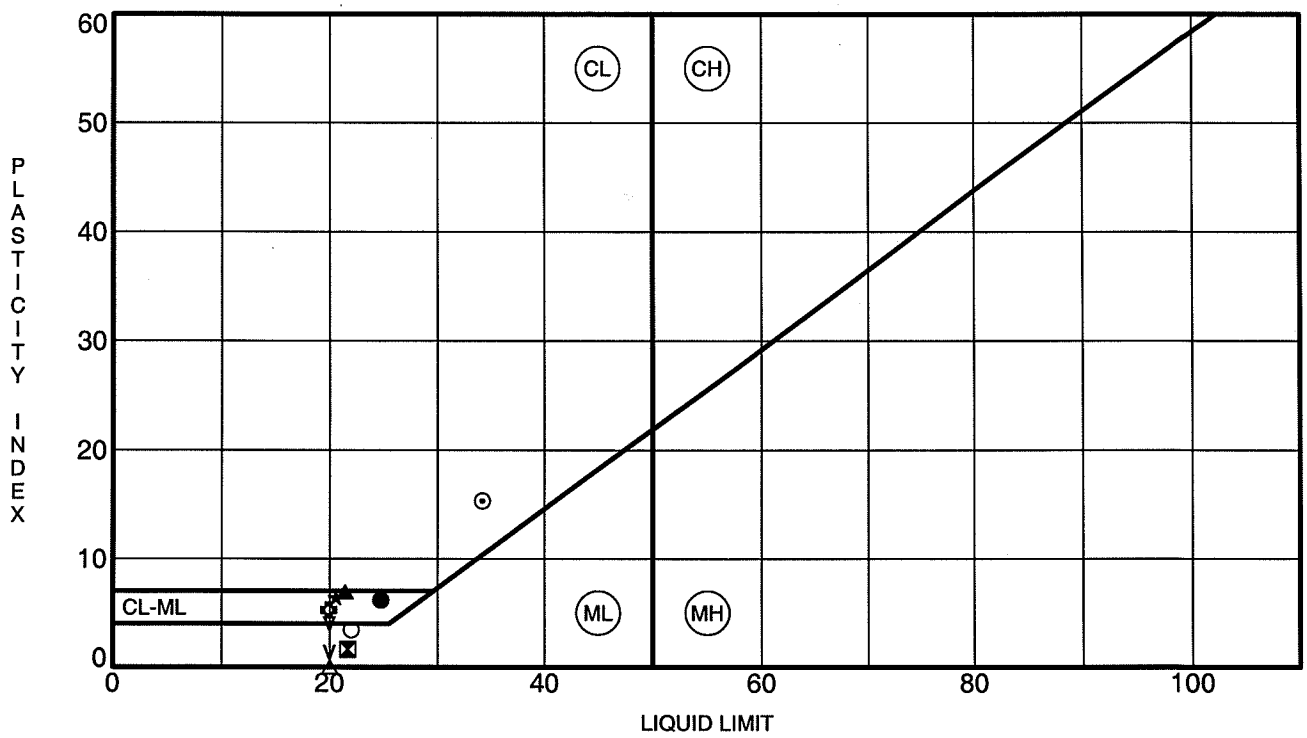
GRAIN SIZE DISTRIBUTION

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

Figure B-37

URS

US_GRAIN_SIZE W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	GCB-002-07	39.0 ft	25	19	6	22.78	CLAY-SILT
⊠	GCB-004-07	50.0 ft	22	20	2	26.5	SILT with Sand
▲	GCB-004-07	55.0 ft	21	14	7	26.3	SILT-CLAY
★	GCB-004-07	60.0 ft	21	14	7	25.9	SILT-CLAY
⊙	GCB-004-07	65.0 ft	34	19	15	32.5	Lean CLAY
✿	GCB-004-07	70.0 ft	20	15	5	25.3	SILT-CLAY with Sand
○	GCB-004-07	75.0 ft	22	19	3	23.2	Sandy SILT
△	GCB-004-07	85.0 ft	20	20	NP	27.4	SILT

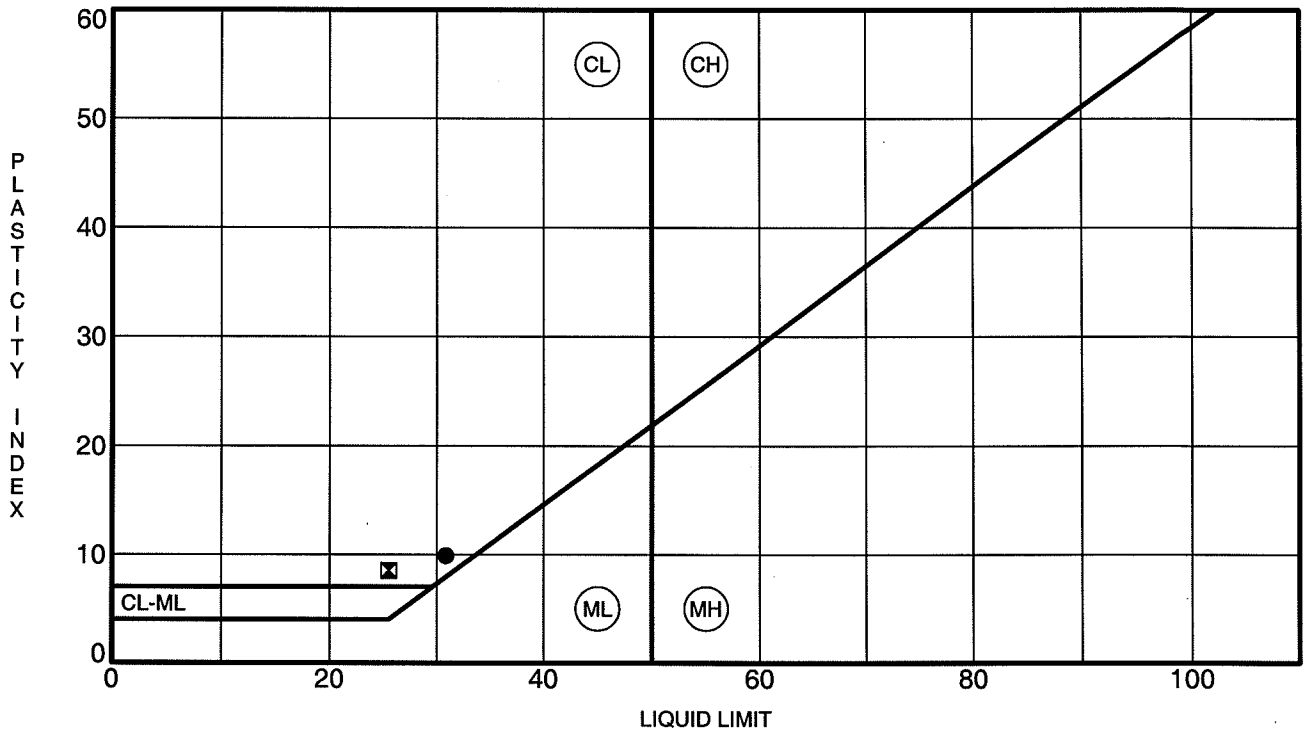
ATTERBERG LIMITS RESULTS

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-38

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	GCB-007-07	65.0 ft	31	21	10	31.68	Lean CLAY
⊠	GCB-009-07	75.0 ft	26	17	9	34.8	Lean CLAY

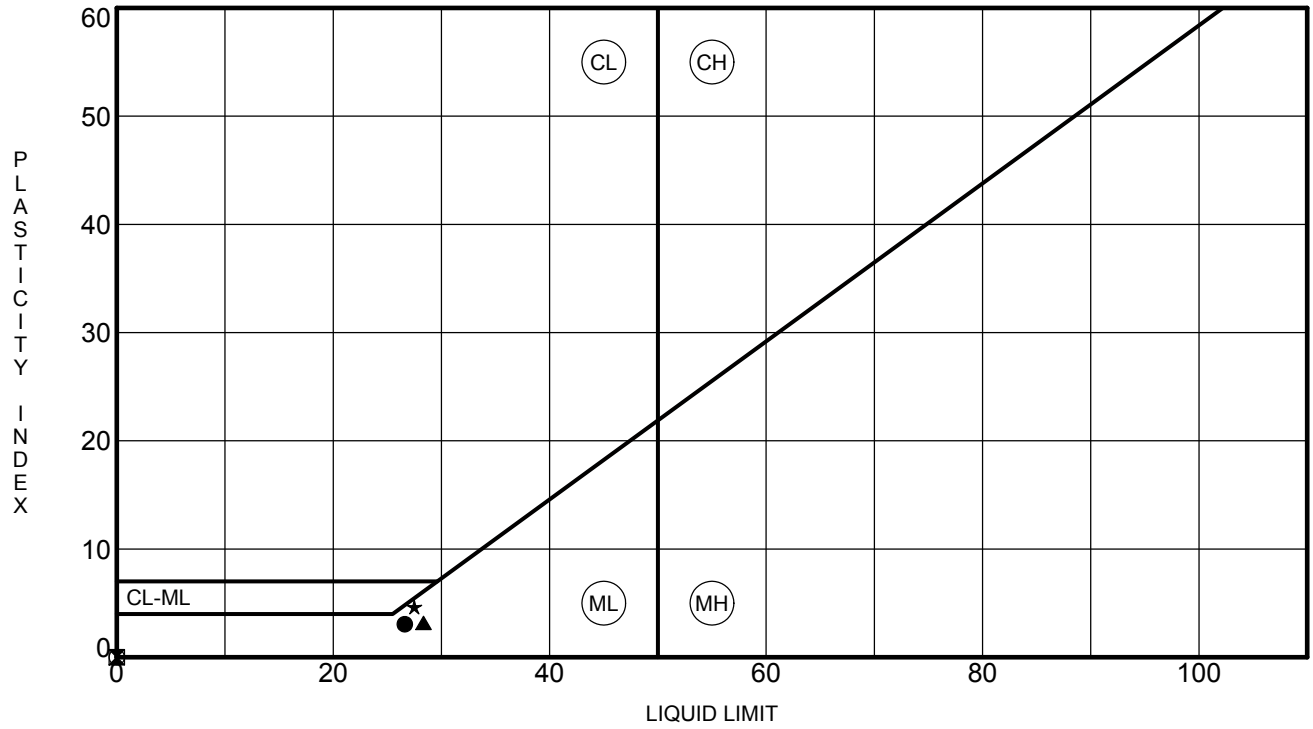
ATTERBERG LIMITS RESULTS

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-39

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	**GCB-010-07**	**20.0 ft**	**27**	**24**	**3**	**44.8**	**SILT**
⊠	**GCB-010-07**	**54.0 ft**	**NP**	**NP**	**NP**	**28.6**	**Silty SAND, fine**
▲	**GCB-010-07**	**59.0 ft**	**28**	**25**	**3**	**34.7**	**SILT**
★	**GCB-010-07**	**64.0 ft**	**27**	**23**	**4**	**31.5**	**SILT**
⊙	**GCB-010-07**	**89.0 ft**	**NP**	**NP**	**NP**	**29.0**	**Sandy SILT**

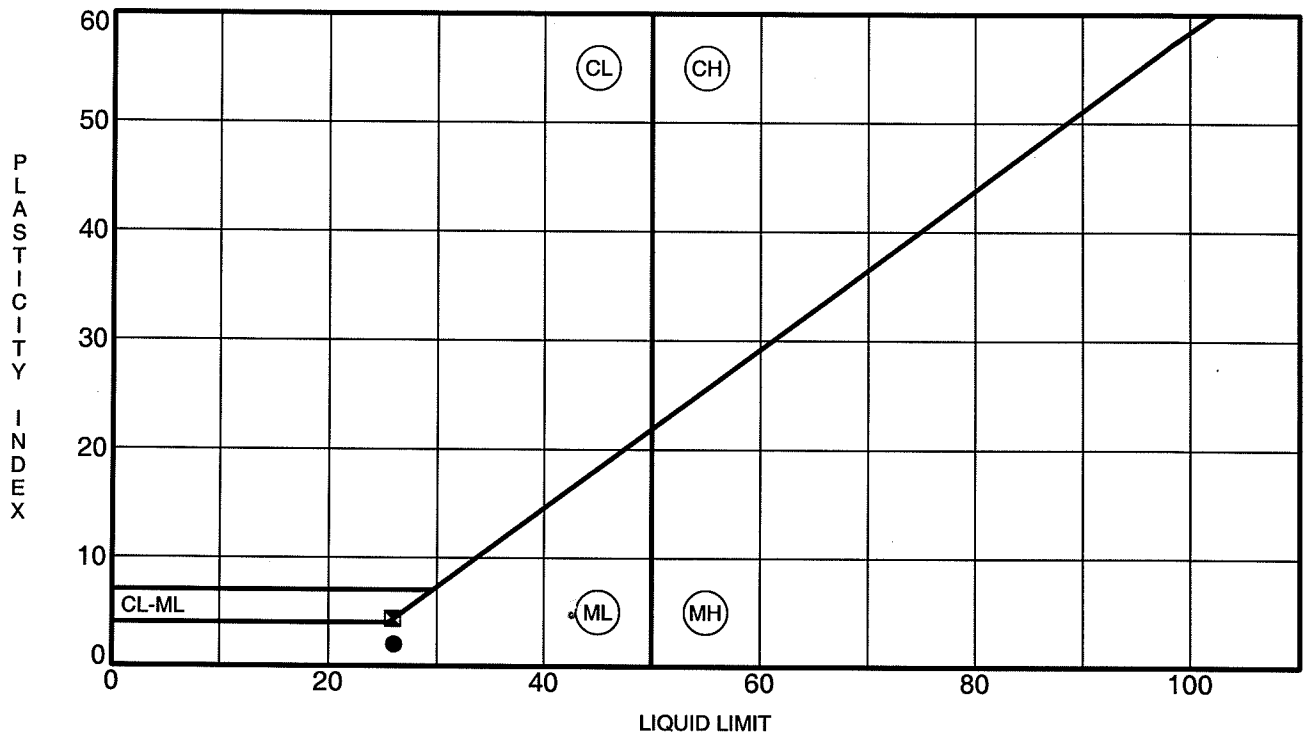
ATTERBERG LIMITS RESULTS

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-40

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007.GPJ URSSEA3B.GLB URSSEA3.GDT 2/12/08



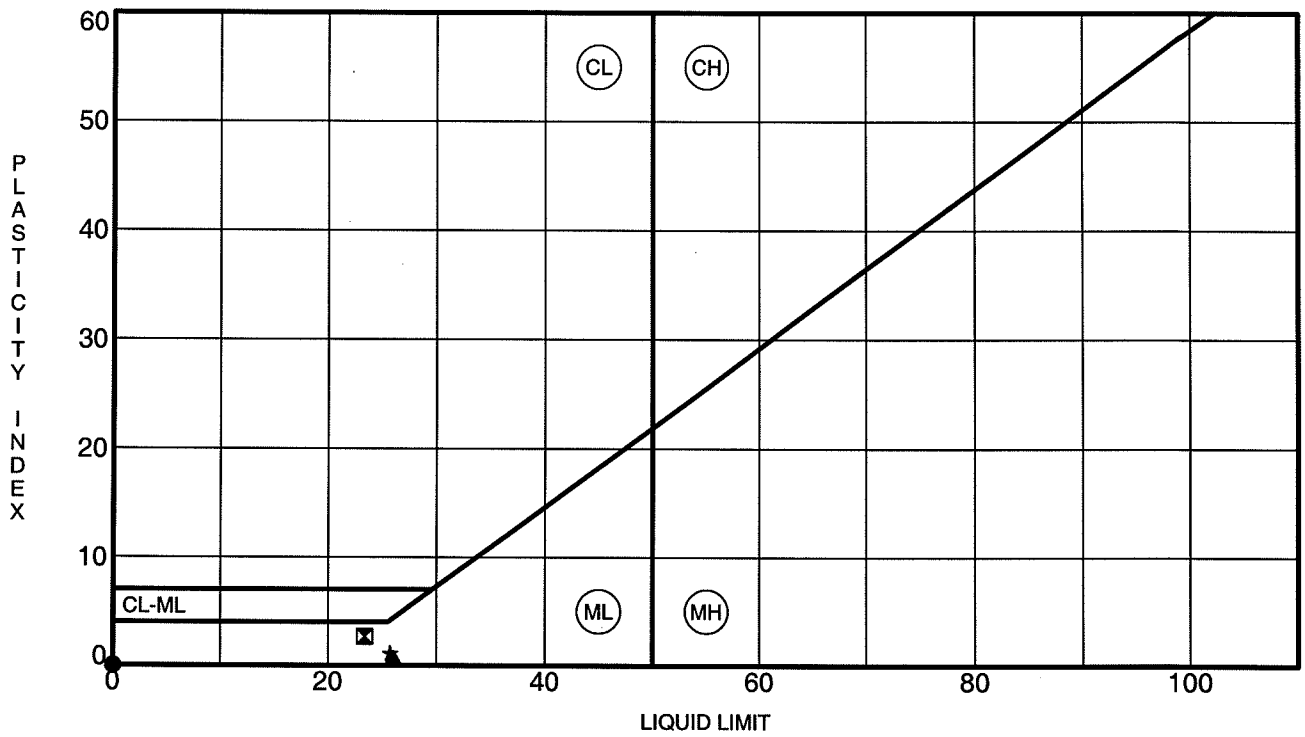
	Specimen Identification		LL	PL	PI	Moisture	Classification
●	**GCB-018-07**	**54.0 ft**	**26**	**24**	**2**	**25.23**	**SILT**
⊠	**GCB-019-07**	**75.0 ft**	**26**	**22**	**4**	**27.88**	**CLAY-SILT**

ATTERBERG LIMITS RESULTS

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	GCB-020-07	48.0 ft	NP	NP	NP	22.5	Silty SAND, fine
⊠	GCB-020-07	53.0 ft	23	21	2	46.7	SILT
▲	GCB-020-07	63.0 ft	26	25	1	23.6	SILT
★	GCB-020-07	68.0 ft	26	25	1	27.7	SILT

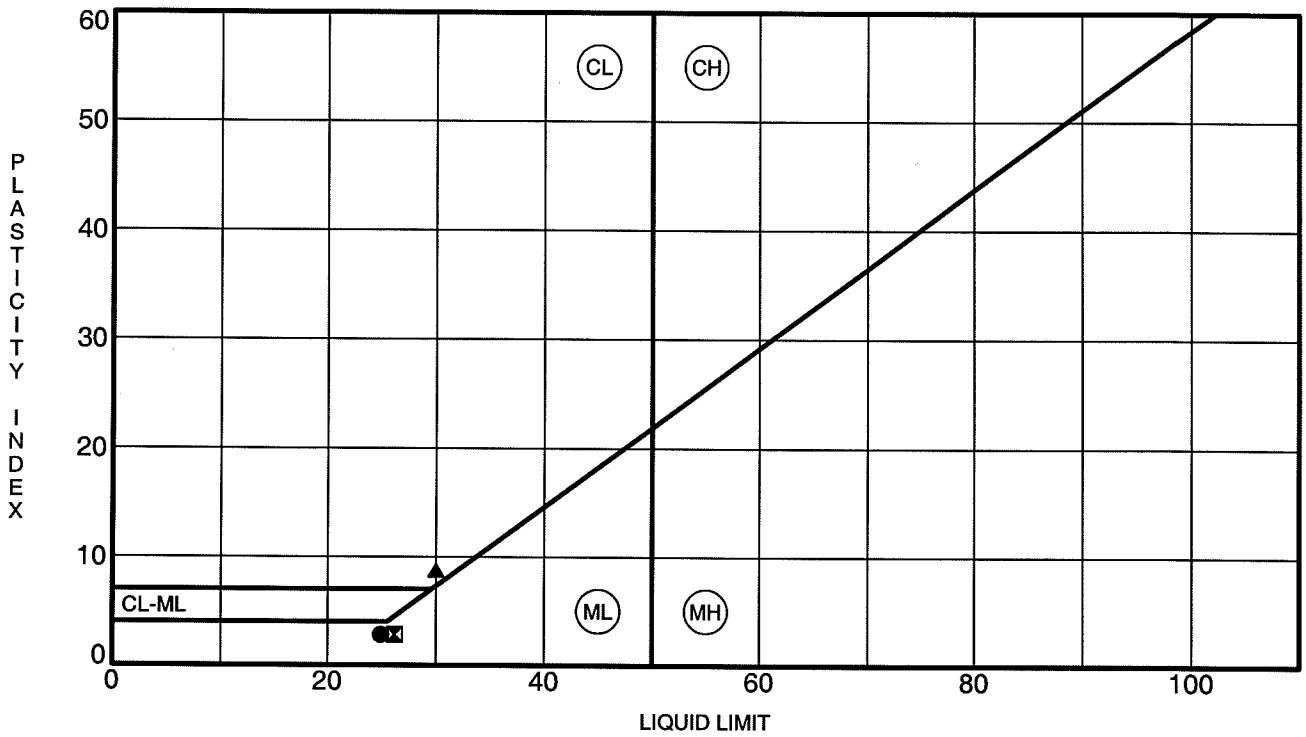
ATTERBERG LIMITS RESULTS

Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-42

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	GCB-021-07	35.0 ft	25	22	3	26.78	SILT
⊠	GCB-022-07	66.0 ft	26	23	3	31.51	SILT
▲	GCB-023-07	51.0 ft	30	21	9	34.39	Lean CLAY

ATTERBERG LIMITS RESULTS

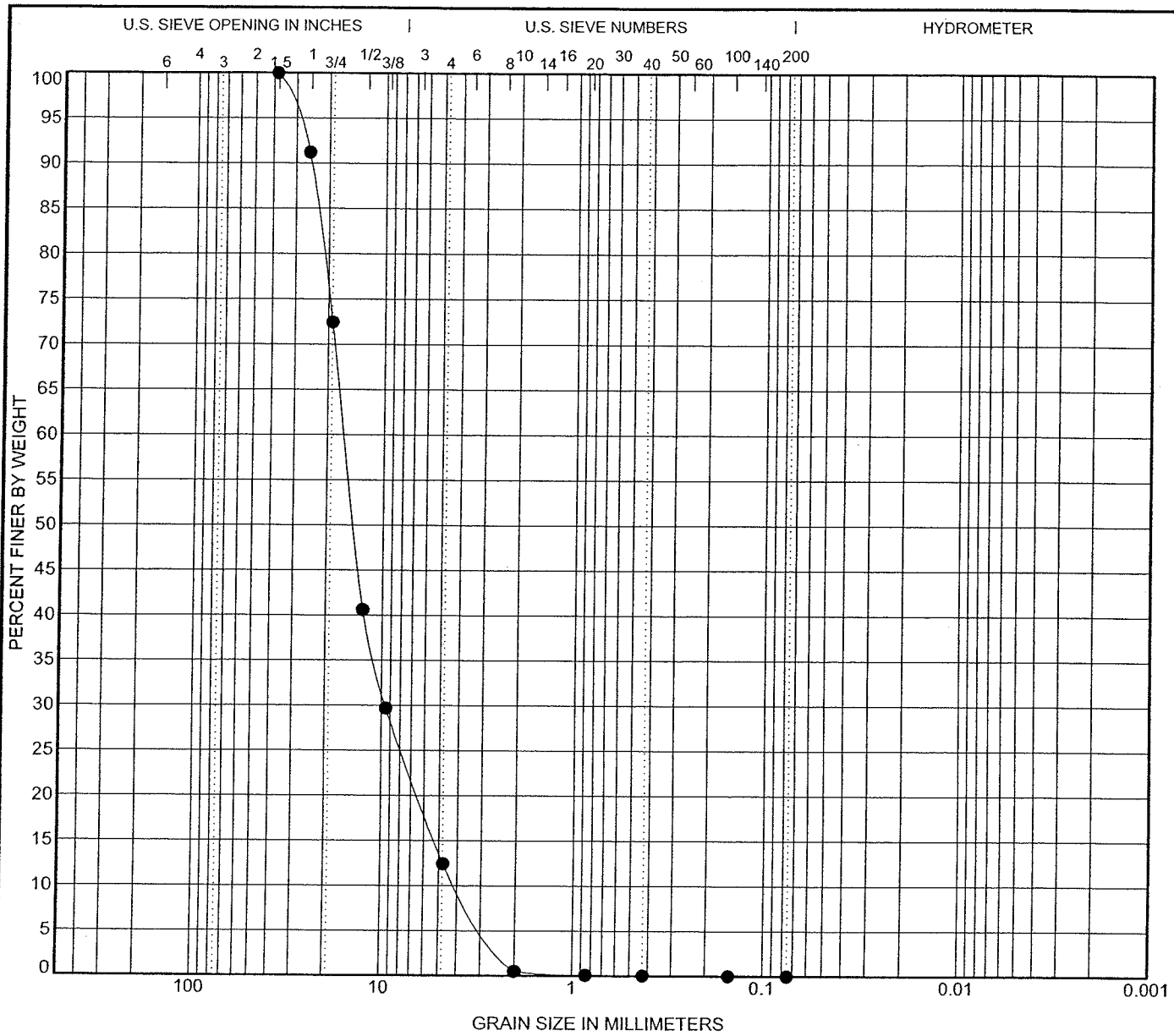
Project: I-90 Snoqualmie Pass East
Project Location: I-90 Hyak to Keechelus Dam, WA
Project Number: 33758613.04000

URS

Figure B-43

US_ATTERBERG_LIMITS W:\11000 2007 GEOTECHNICAL EXPLORATION PROGRAM\11100 ROADWAY EXPLORATION PROGRAM\11160 BORING LOGS\GINT\BORINGS I-90 10082007 BY KY.GPJ URSSEA3B.GLB URSSEA3.GDT 12/20/07

APPENDIX B.2
PREVIOUS LABORATORY TESTING DATA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**H-01-06 (OW) 1.5 ft.**	**Well-graded GRAVEL**				**1.42**	**4.07**

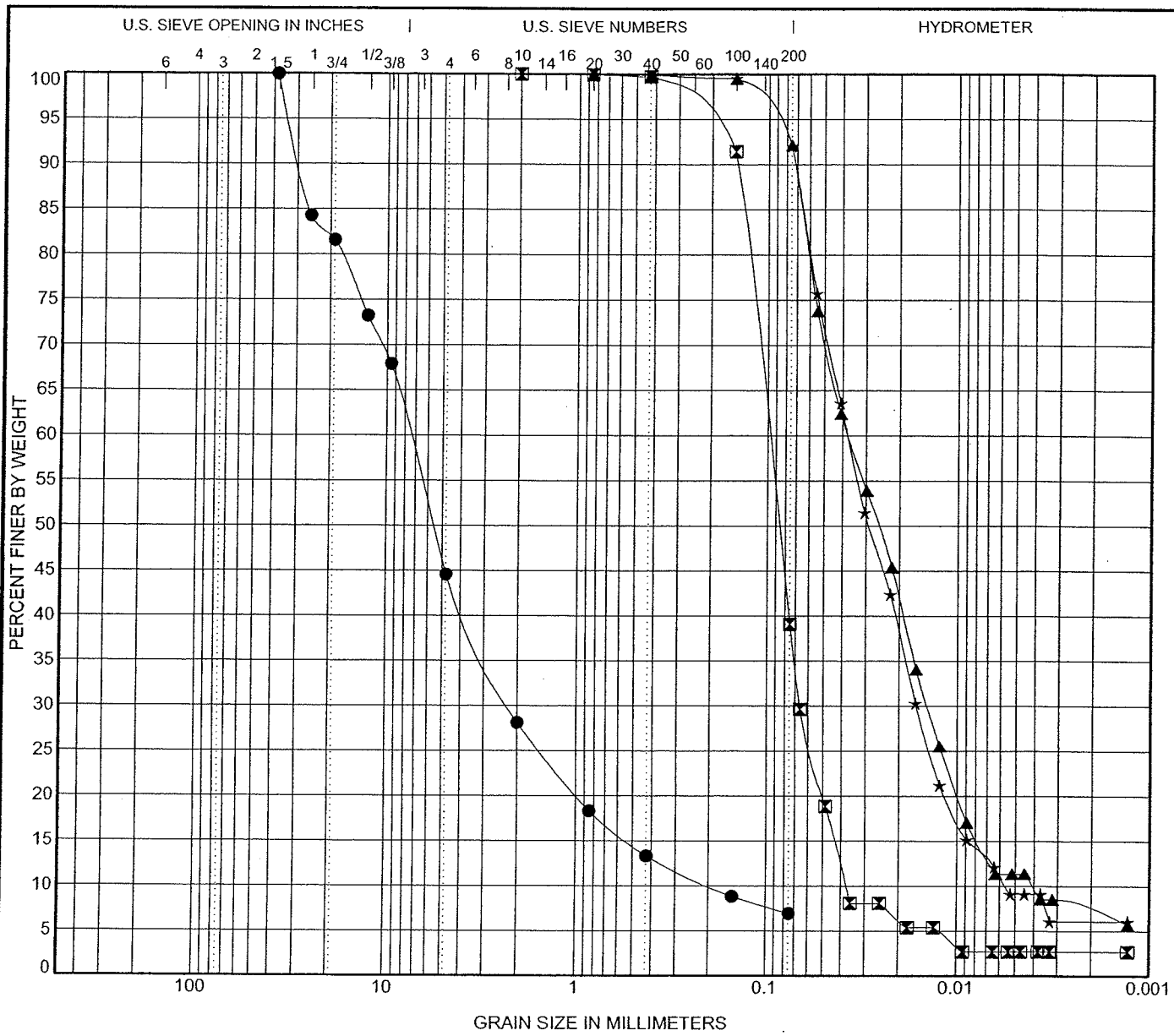
	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**H-01-06 (OW) 1.5 ft.**	**38.1**	**16.232**	**9.582**	**3.983**	**87.6**	**12.4**	**0.0**	

GRAIN SIZE DISTRIBUTION

Project: WSDOT I-90 Snoqualmie Pass East
Project Location: Hyak to Keechelus Dam, Washington (MP-55 to MP-60)
Project Number: 33758573

URS

US_GRAIN_SIZE \\SEAOCEAN\163\WSDOT\~1\5000FI~1\5600FI~1\5602BO~1\BORING.GPJ URSSEA3A.GLB URSSEA3.GDT 9/13/06 Seattle, WA 98121-2158



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	H-03-06 (OW) 5.0 ft.	Poorly-graded GRAVEL with Sand				3.31	38.24
⊠	H-03-06 (OW)35.0 ft.	Silty SAND				1.18	2.64
▲	H-03-06 (OW)50.0 ft.	SILT				1.33	9.10
★	H-03-06 (OW)70.0 ft.	SILT				1.26	6.68

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	H-03-06 (OW) 5.0 ft.	38.1	7.512	2.209	0.196	55.4	37.6	6.9	
⊠	H-03-06 (OW)35.0 ft.	2	0.099	0.066	0.038	0.0	60.9	36.4	2.7
▲	H-03-06 (OW)50.0 ft.	0.85	0.037	0.014	0.004	0.0	7.9	80.8	11.4
★	H-03-06 (OW)70.0 ft.	0.85	0.037	0.016	0.006	0.0	8.0	82.9	9.1

GRAIN SIZE DISTRIBUTION

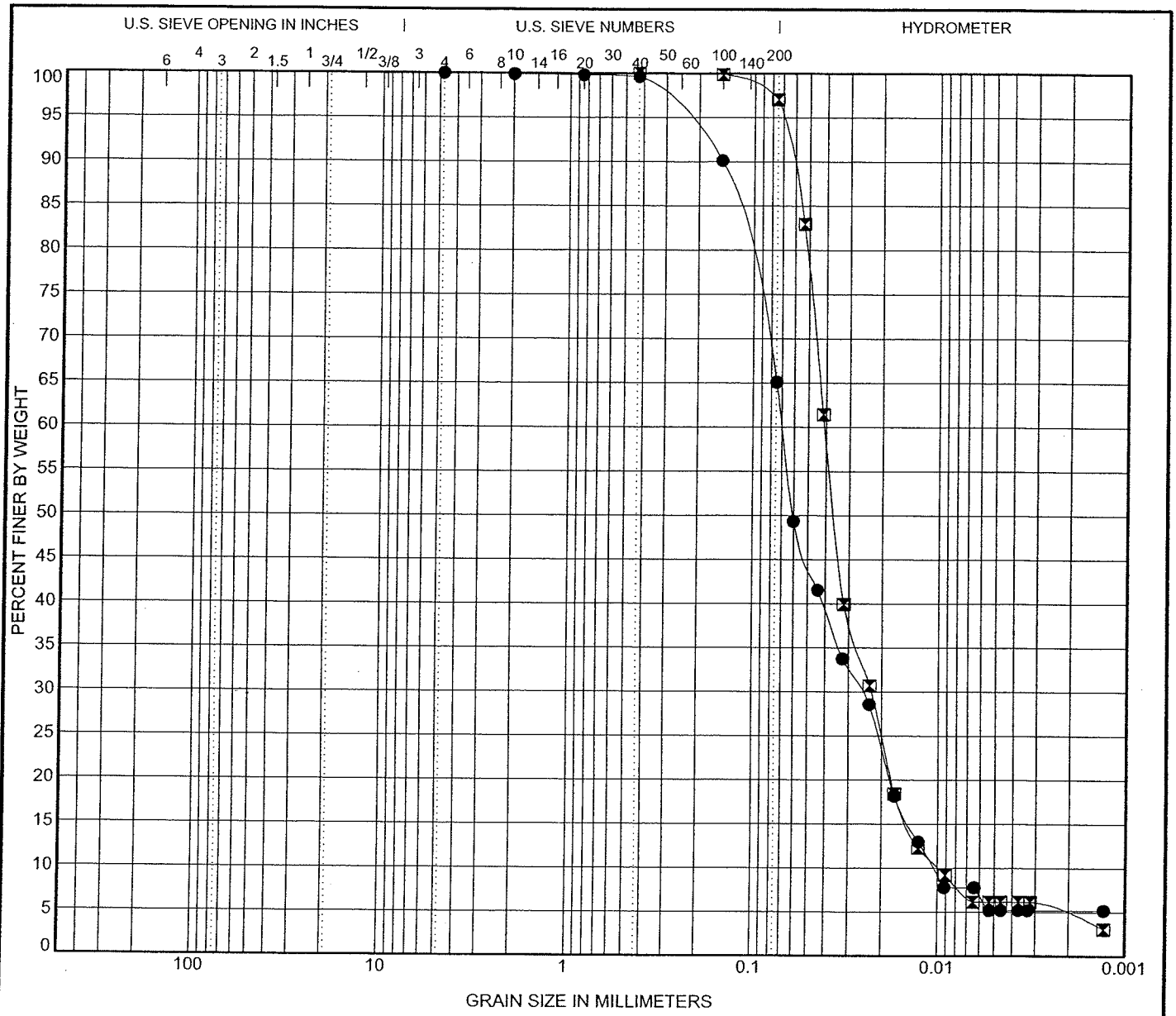
Project: WSDOT I-90 Snoqualmie Pass East

Project Location: Hyak to Keechelus Dam, Washington (MP-55 to MP-60)

Project Number: 33758573

URS

US_GRAIN_SIZE \\SEAOCEAN\163\WSDOT\~1\5000FI~1\5600FI~1\5602BO~1\BORING.GPJ URSSEA3A.GLB URSSEA3.GDT 9/13/06 Seattle, WA 98121-2158



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	H-04-06	40.0 ft.	Sandy SILT				0.88	6.61
⊠	H-04-06	60.0 ft.	SILT				1.29	4.11

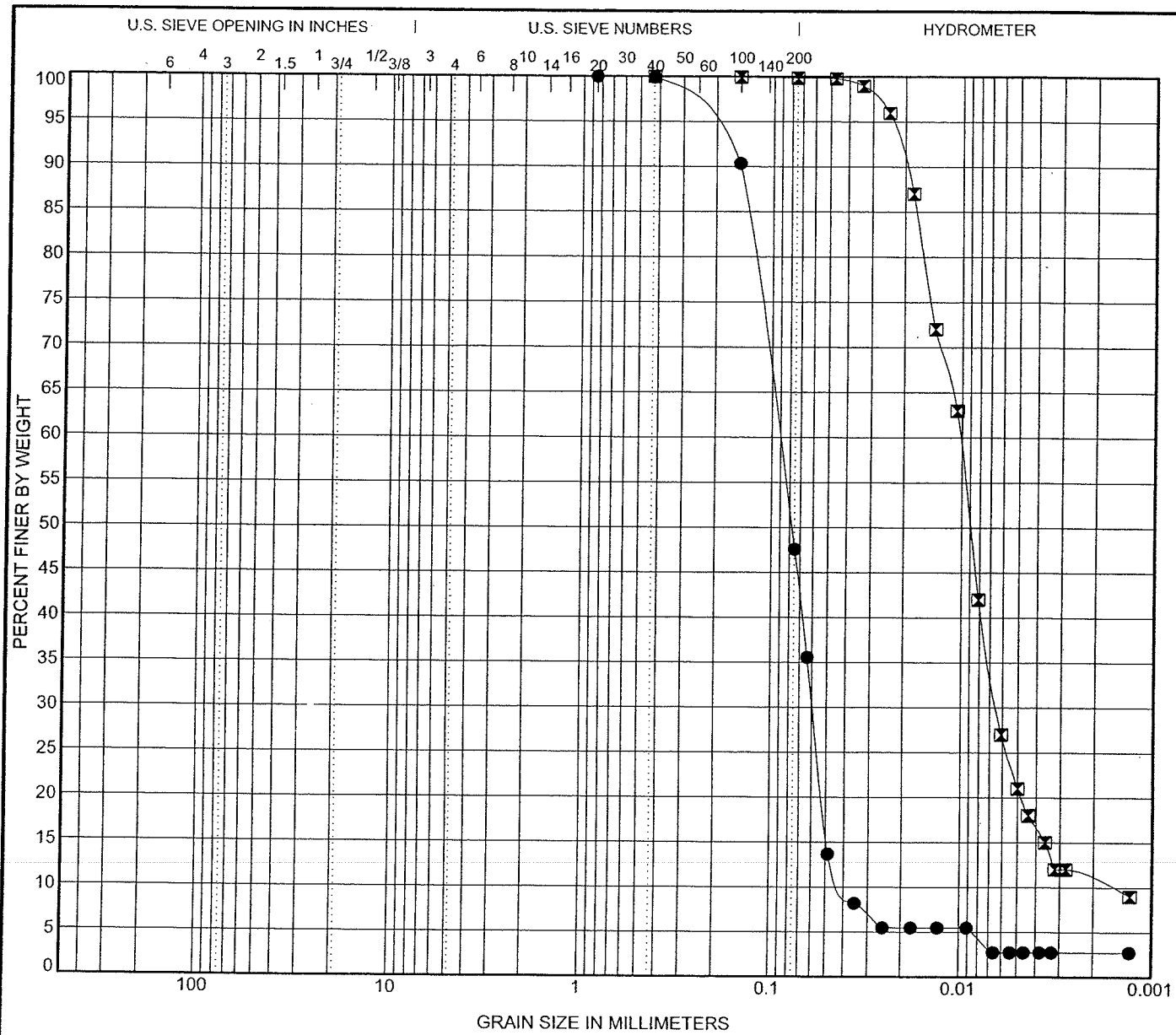
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	H-04-06	40.0 ft.	4.75	0.07	0.025	0.011	0.0	34.9	59.9	5.2
⊠	H-04-06	60.0 ft.	0.425	0.041	0.023	0.01	0.0	2.9	90.9	6.1

GRAIN SIZE DISTRIBUTION

Project: WSDOT I-90 Snoqualmie Pass East
Project Location: Hyak to Keechelus Dam, Washington (MP-55 to MP-60)
Project Number: 33758573

URS

US_GRAIN_SIZE \\SEAOCEAN\163\WSDOT\~1\5000FI~1\5600FI~1\5602BO~1\BORING.GPJ URSSEA3A.GLB URSSEA3.GDT 9/13/06 Seattle, WA 98121-2158



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	H-05-06	45.0 ft.	Silty SAND				0.98	2.35
⊠	H-05-06	75.0 ft.	SILT				2.43	6.08

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	H-05-06	45.0 ft.	0.85	0.092	0.059	0.039	0.0	52.4	44.9	2.7
⊠	H-05-06	75.0 ft.	0.425	0.01	0.006	0.002	0.0	0.1	78.9	21.0

GRAIN SIZE DISTRIBUTION

Project: WSDOT I-90 Snoqualmie Pass East
Project Location: Hyak to Keechelus Dam, Washington (MP-55 to MP-60)
Project Number: 33758573

URS

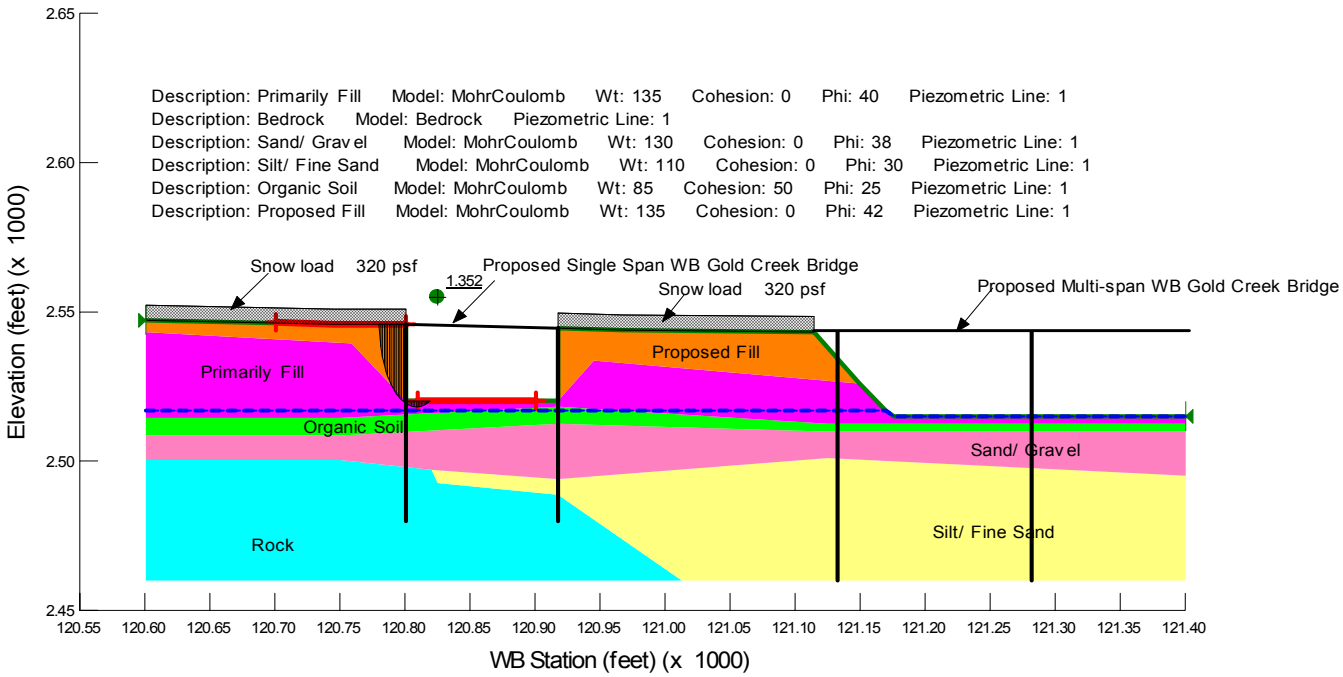
US_GRAIN_SIZE \\SEAOCEAN\163\WSDOT\~1\5000FI~1\5600FI~1\5602BO~1\BORING.GPJ URSSEA3A.GLB URSSEA3.GDT 9/13/06 Seattle, WA 98121-2158

APPENDIX C
LIQUEFACTION ANALYSES

APPENDIX D
SLOPE STABILITY ANALYSES

Single-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.35

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Static Rev 2 WB Profile Sta 1206 00-1214 00-St-SS-WE-H-r2.gsz

Job No. 33758579

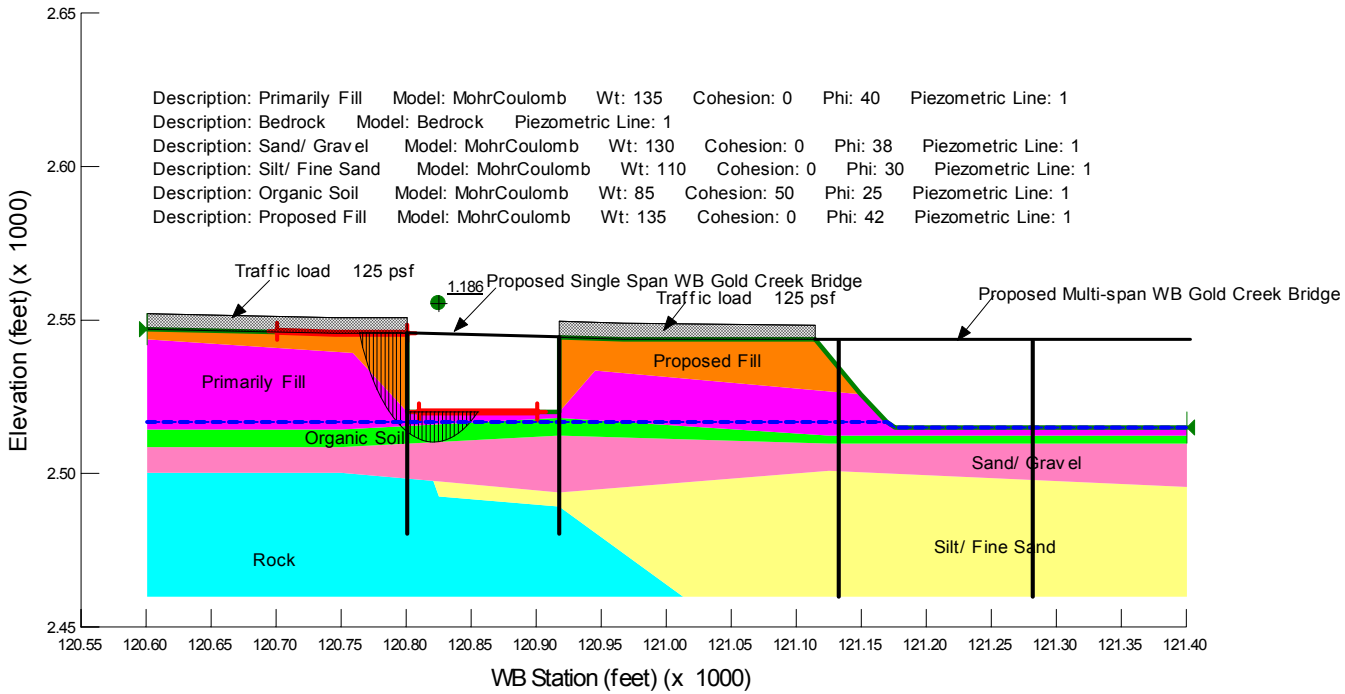
Figure D1

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.19

Loading: Seismic (Kh 0.5PGA, Kv 0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Static Rev 2 WB Profile Sta 1206 00-1214 00-Se-SS-WE-H-r2.gsz

Job No. 33758579

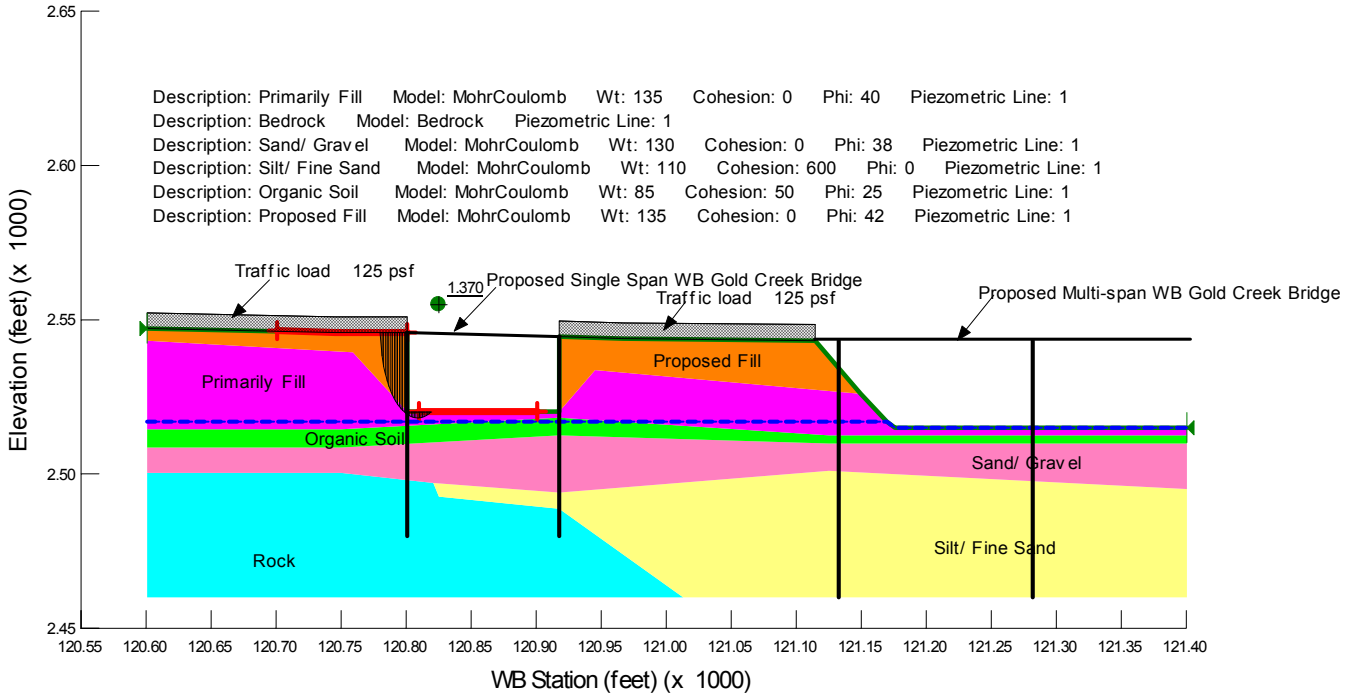
Figure D2

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.37

Loading: Seismic (Kh 0, Kv 0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WBProfile Static Rev 2 WBProfile Sta 1206 00-1214 00-Se-re-SS-WE-H-r2.gsz

Job No. 33758579

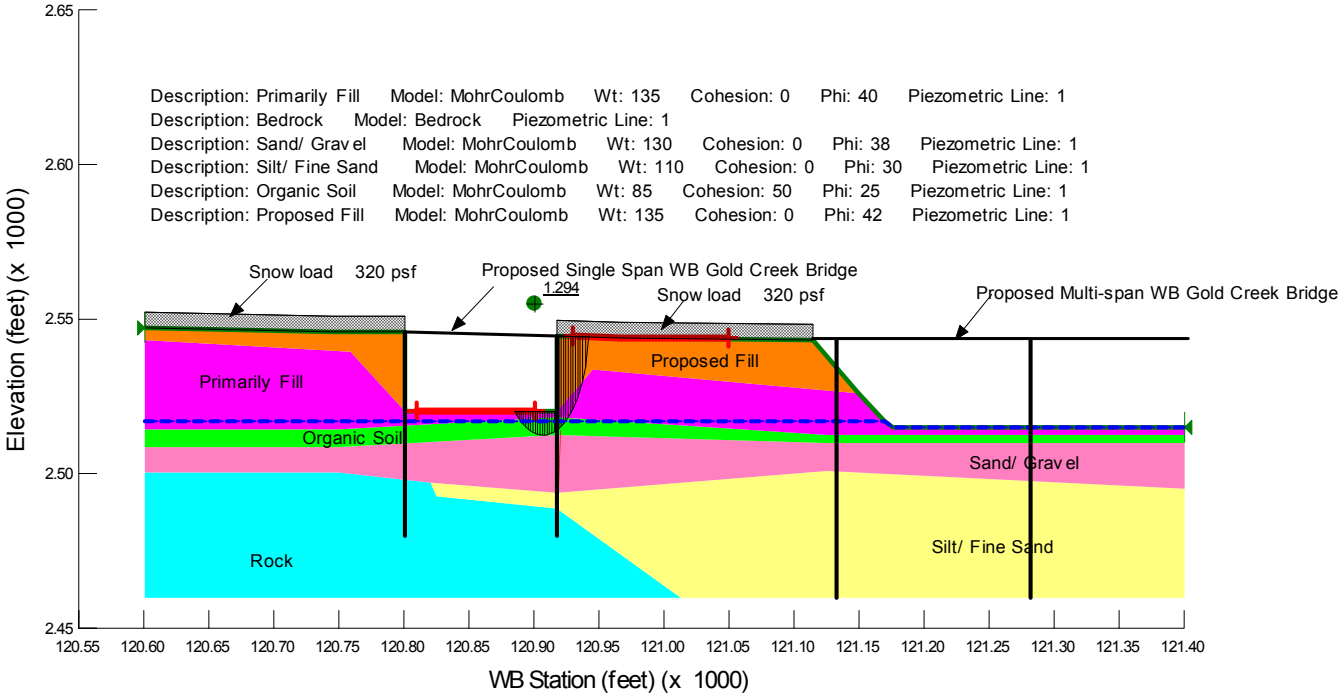
Figure D3

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Longitudinal, East Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.29

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Static Rev 2 WB Profile Sta 1206 00-1214 00-St-SS-EE-H-r2.gsz

Job No. 33758579

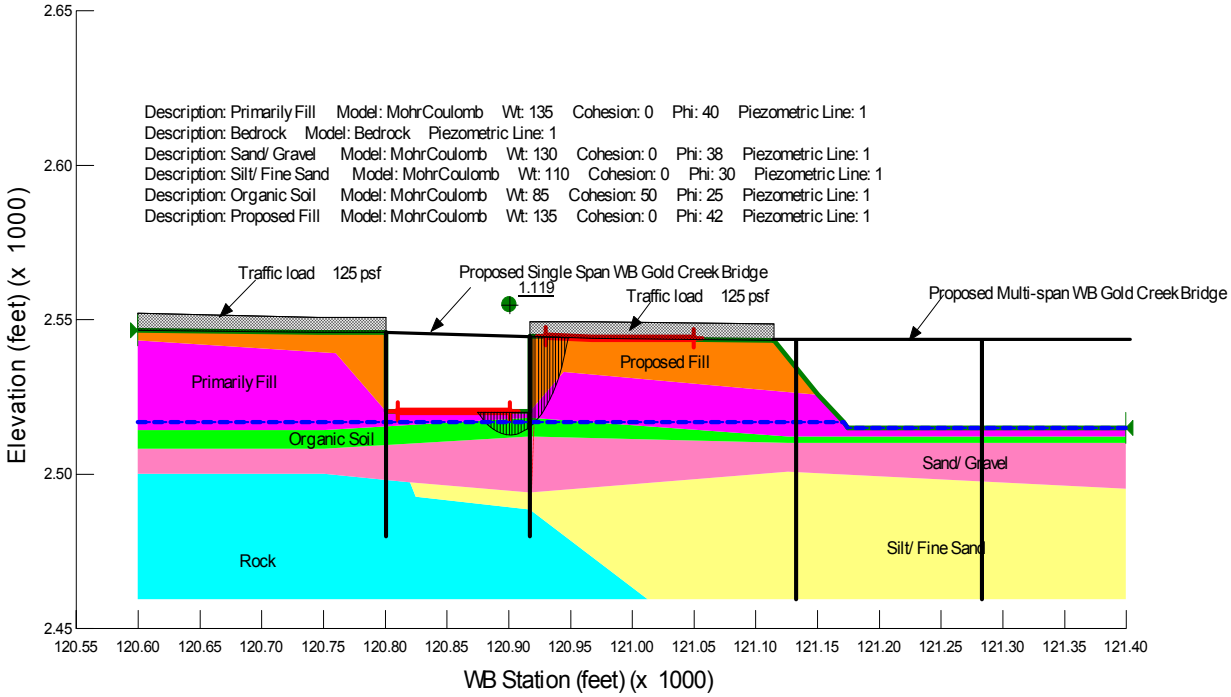
Figure D4

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Longitudinal, East Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.12

Loading: Seismic (Kh 0.5PGA, Kv 0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Seismic Rev 2 WB Profile Sta 1206 00-1214 00-Se-SS-EE-H-r2.gsz

Job No. 33758579

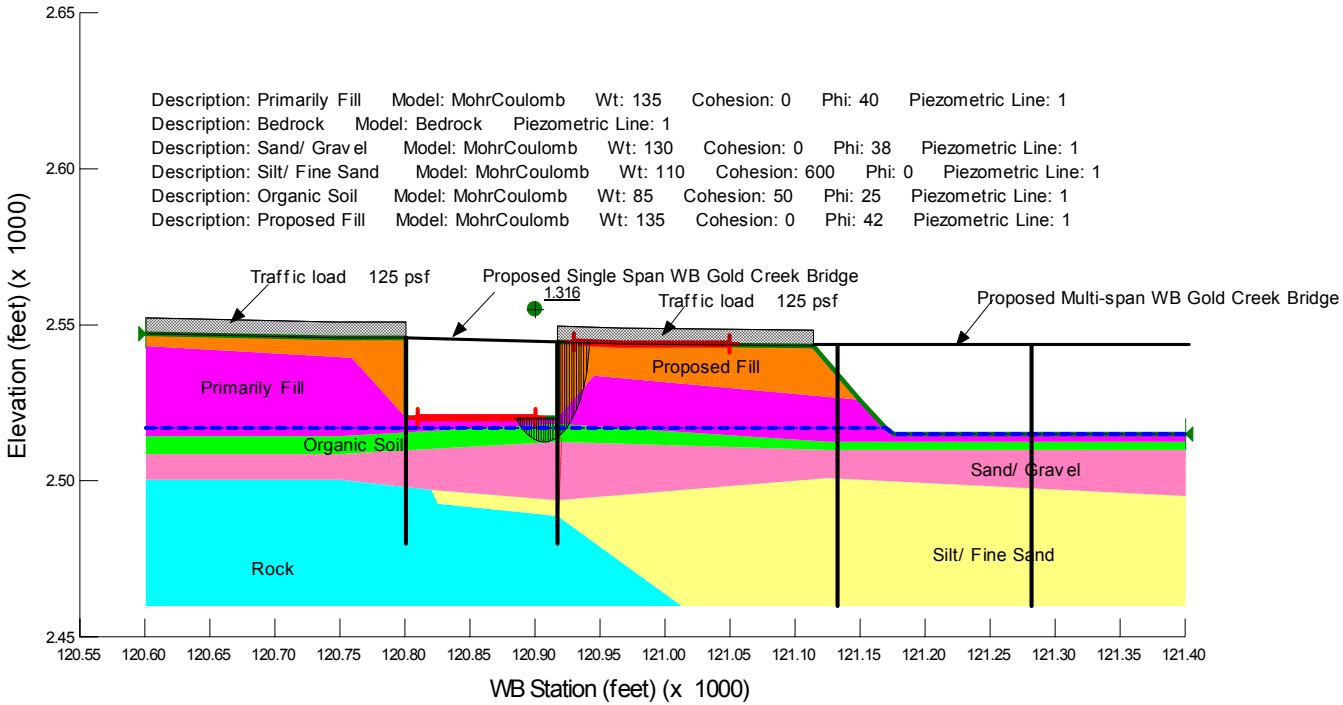
Figure D5

URS

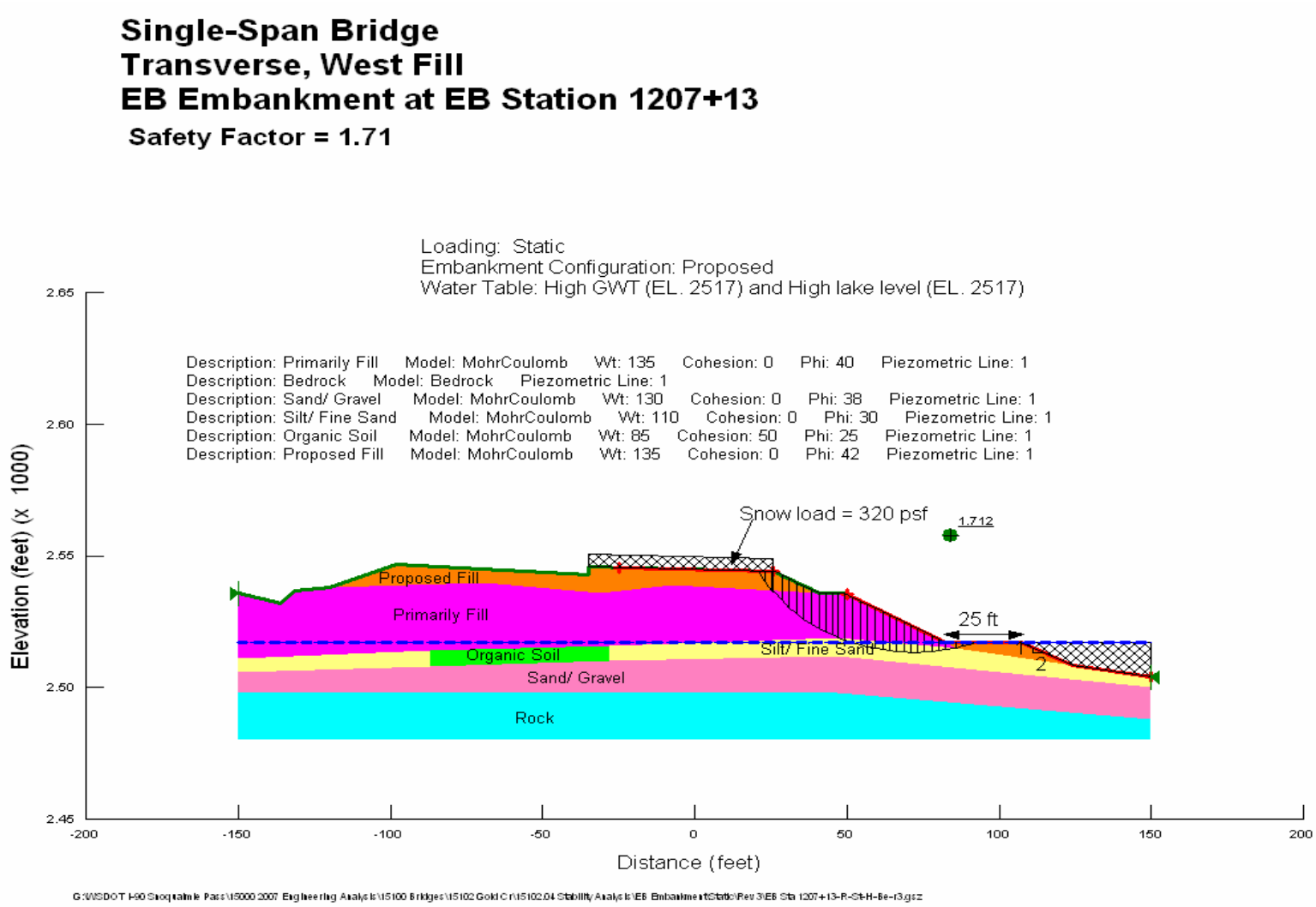
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Longitudinal, East Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.32

Loading: Seismic (Kh 0, Kv 0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Seismic Rev 2 WB Profile Sta 1206 00-1214 00-Se-re-SS-EE-H-r2.gsz



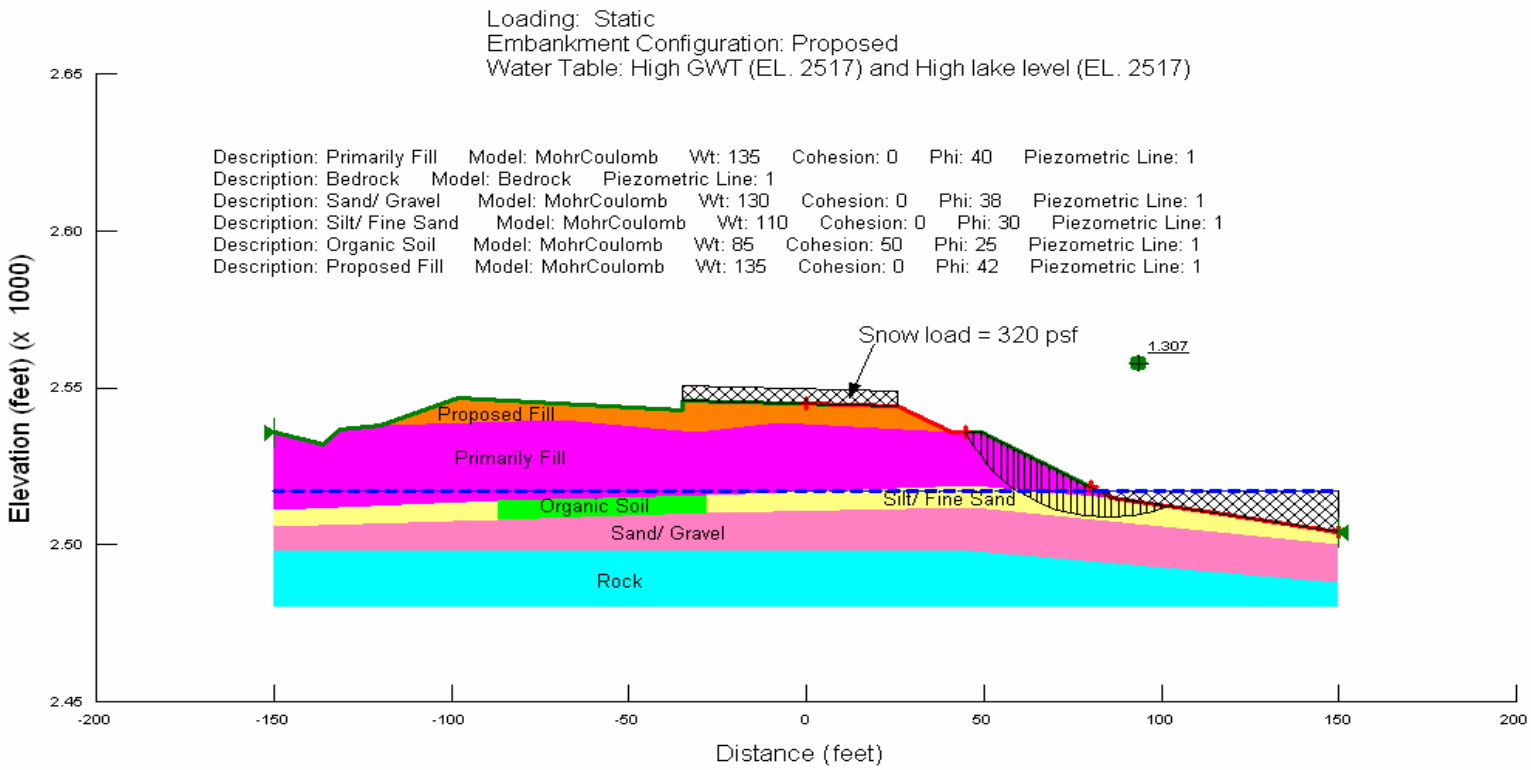
Job No. 33758579

Figure D7

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.31*

*Found lower F.S. than the reported value but to show the clear failure surface we did not report it here



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold C n\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\EB Sta 1207+13-R-Sh-Loc-H-r2.gsz

Job No. 33758579

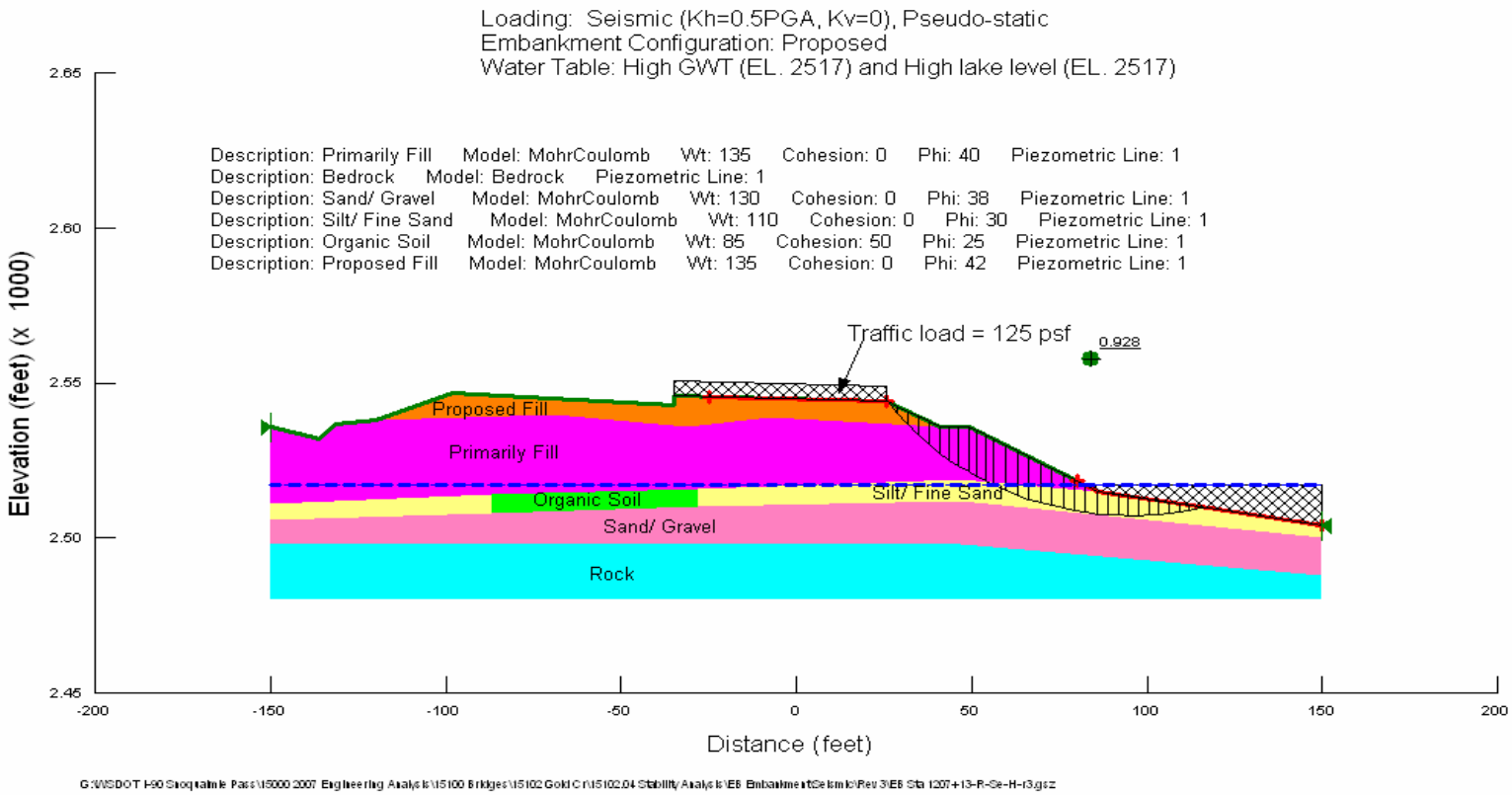
Figure D8

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 0.93



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold C r\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\EB Sta 1207+13-R-Se-H-r3.gsz

Job No. 33758579

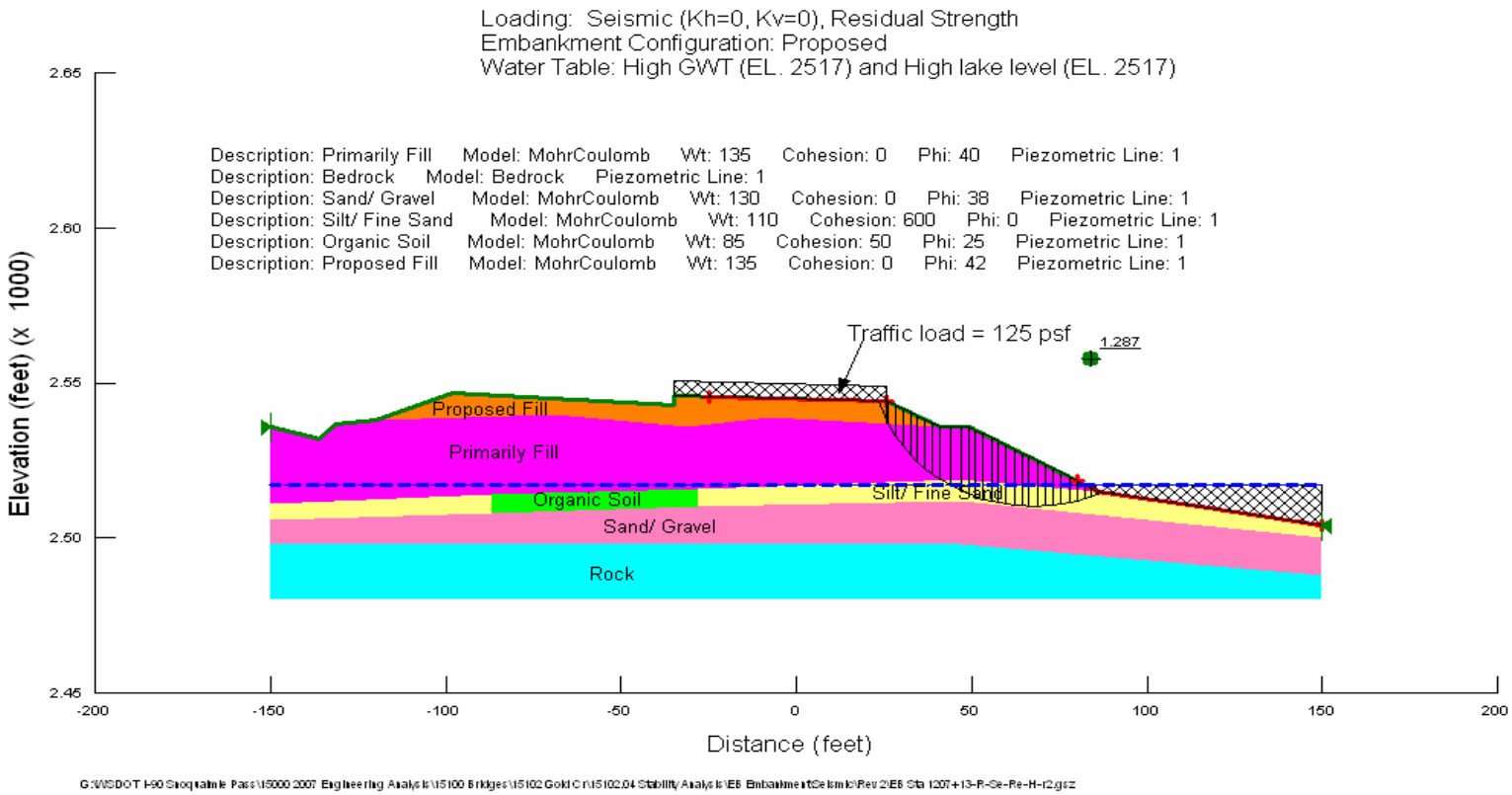
Figure D9

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.29



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold C r\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1207+13-R-Se-Re-H-r2.gsz

Job No. 33758579

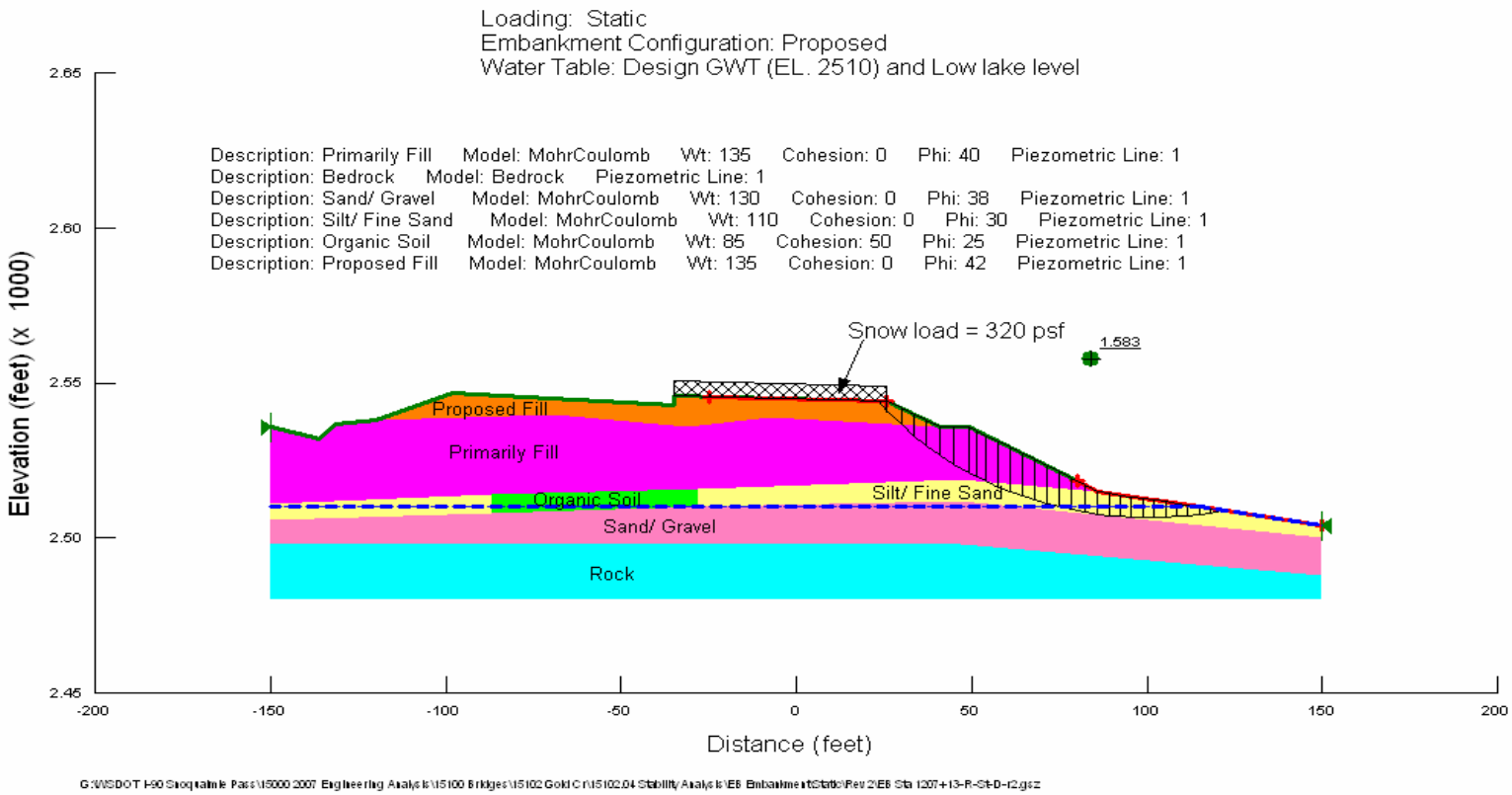
Figure D10

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.58



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold C n\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\EB Sta 1207+13-R-Sft-D-r2.gsz

Job No. 33758579

Figure D11

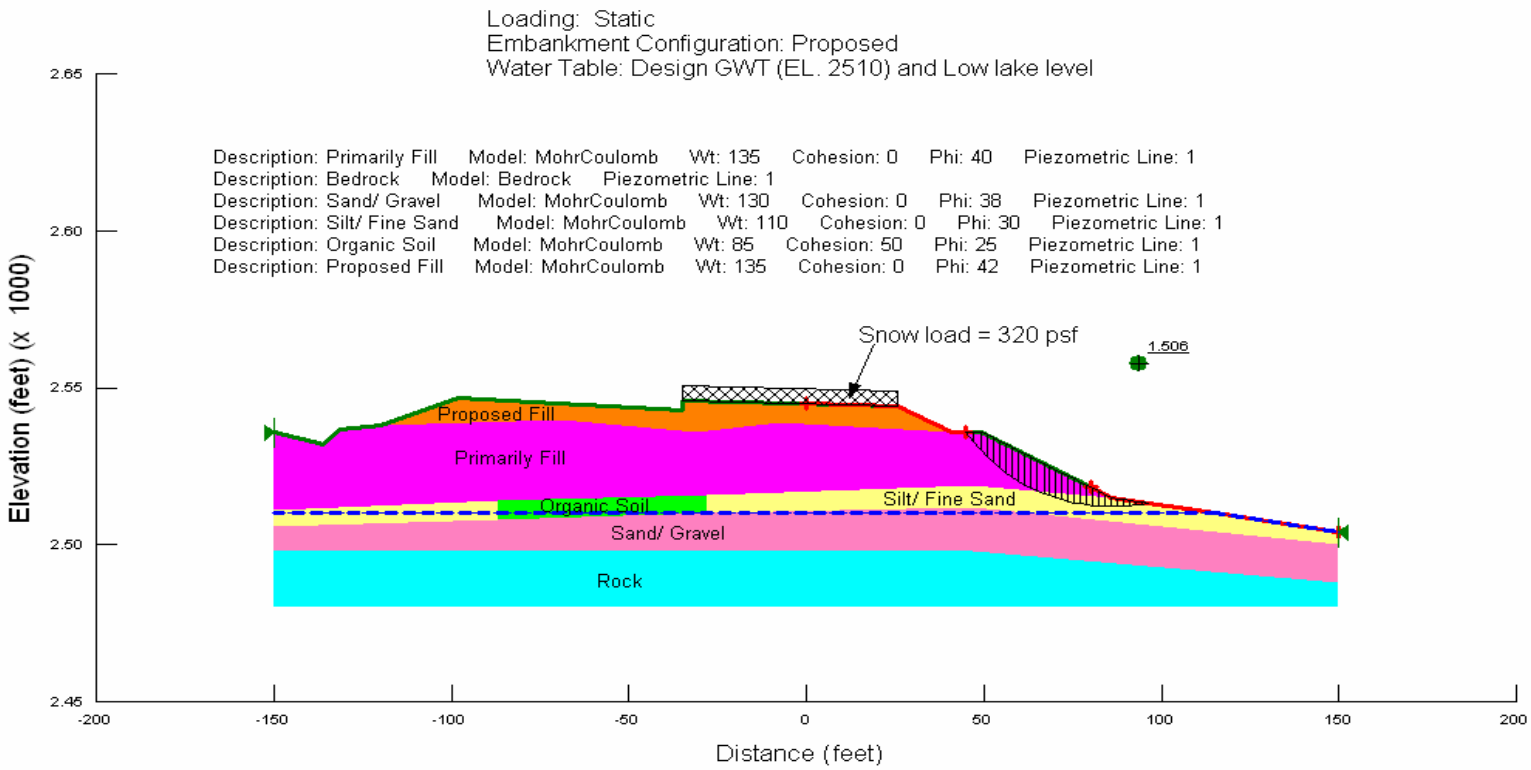
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.51*

*Found lower F.S. than the reported value but to show the clear failure surface we did not report it here



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold C n\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\EB Sta 1207+13-R-Sft-Loc-D-r2.gsz

Job No. 33758579

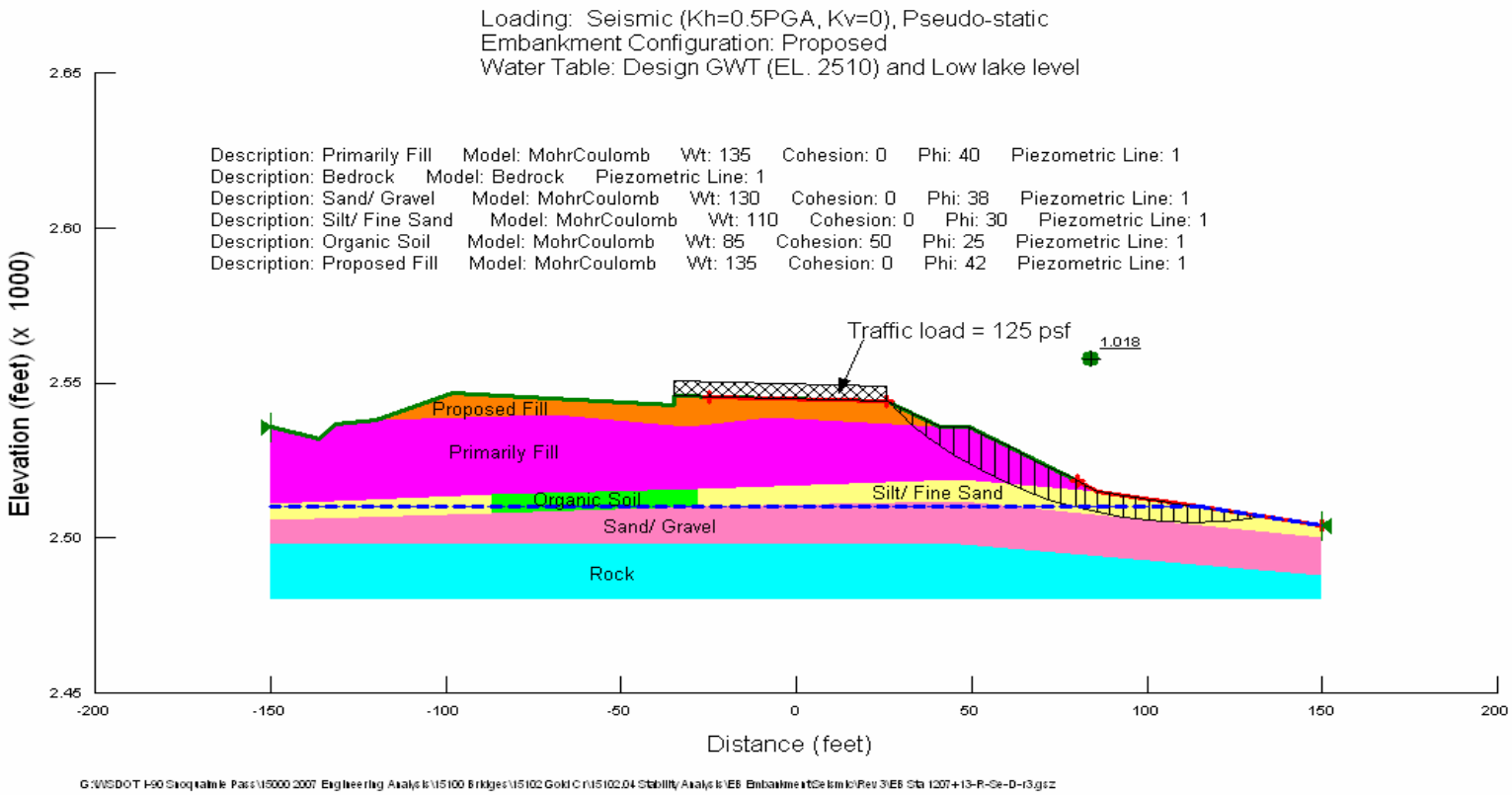
Figure D12

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.02



Job No. 33758579

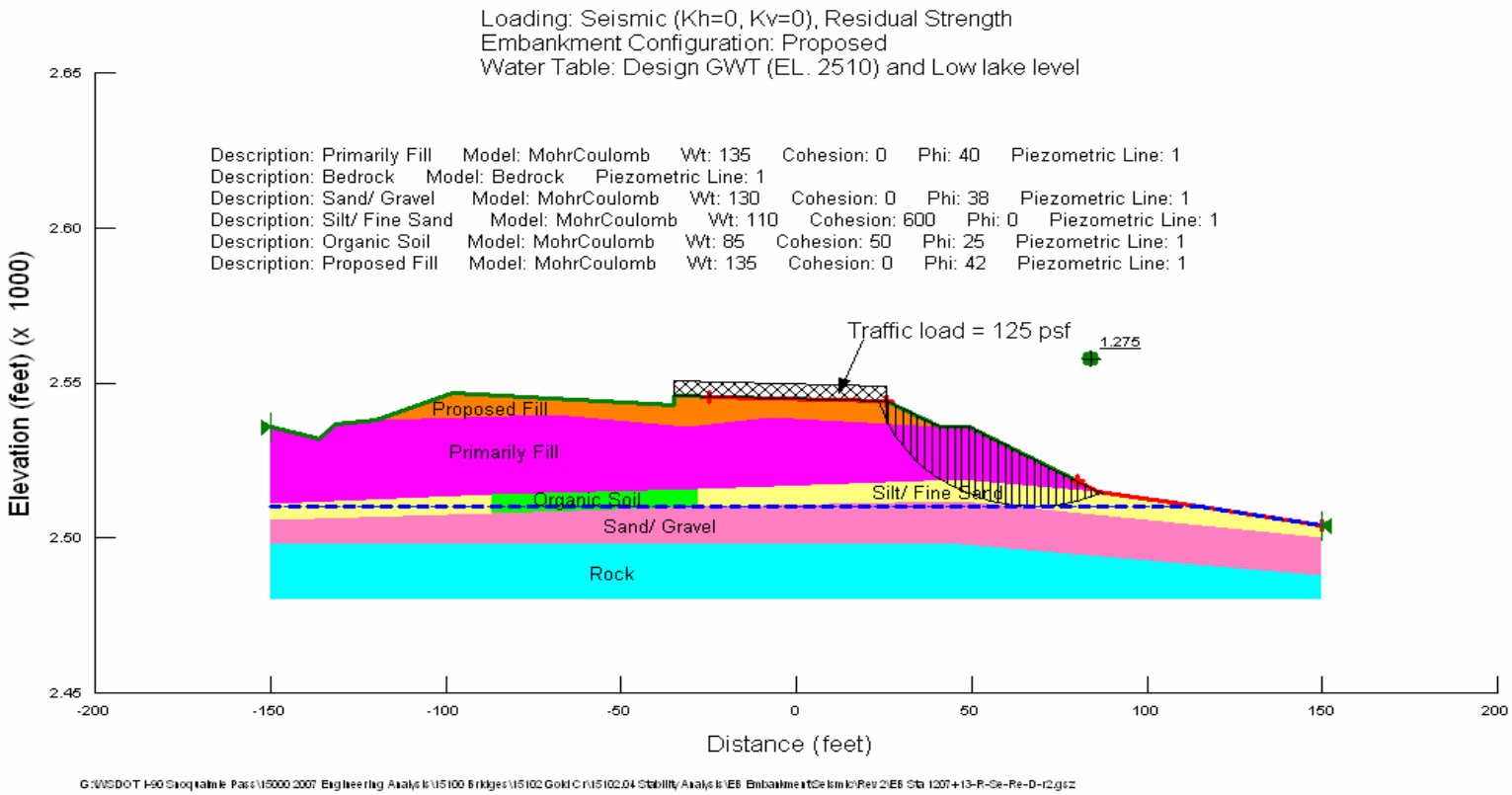
Figure D13

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.28



Job No. 33758579

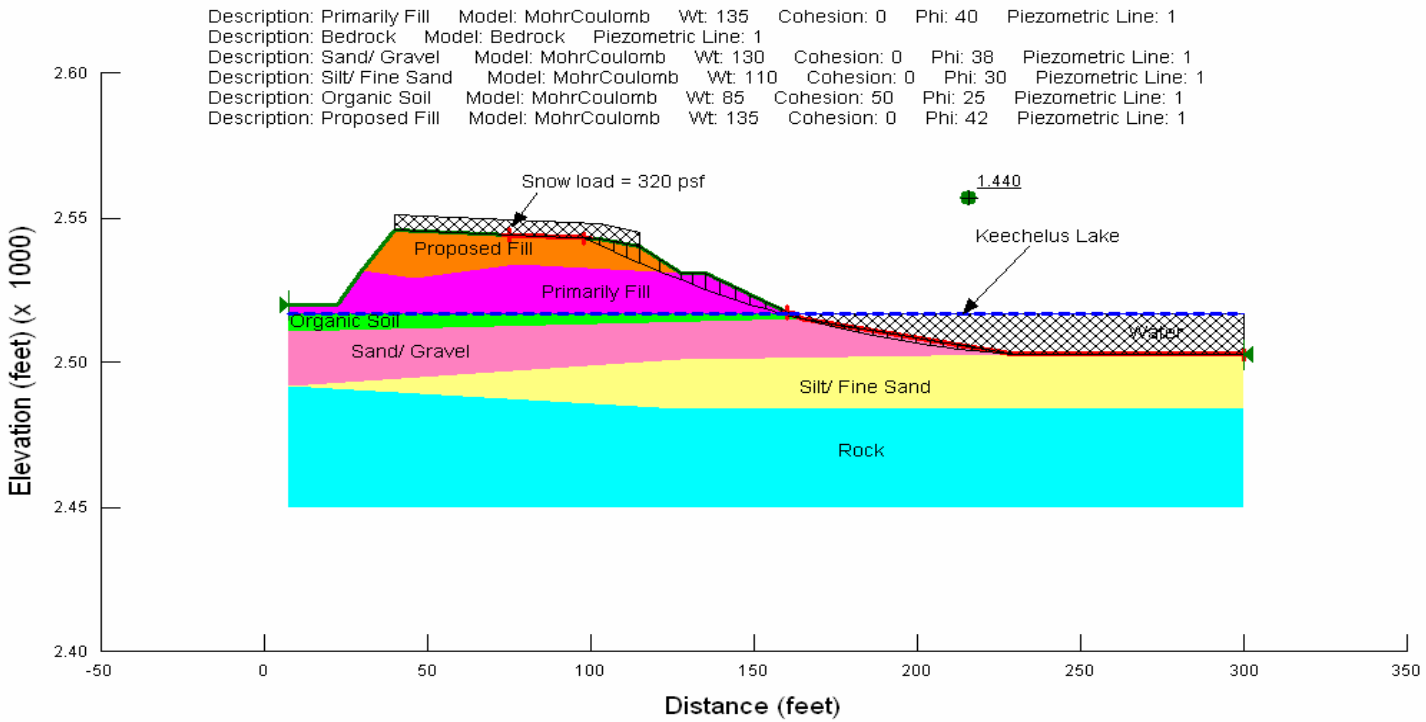
Figure D14

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.44

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Stab\Rev 2\WB Sta 1209+00-R-St-H- r2.gsz

Job No. 33758579

Figure D15

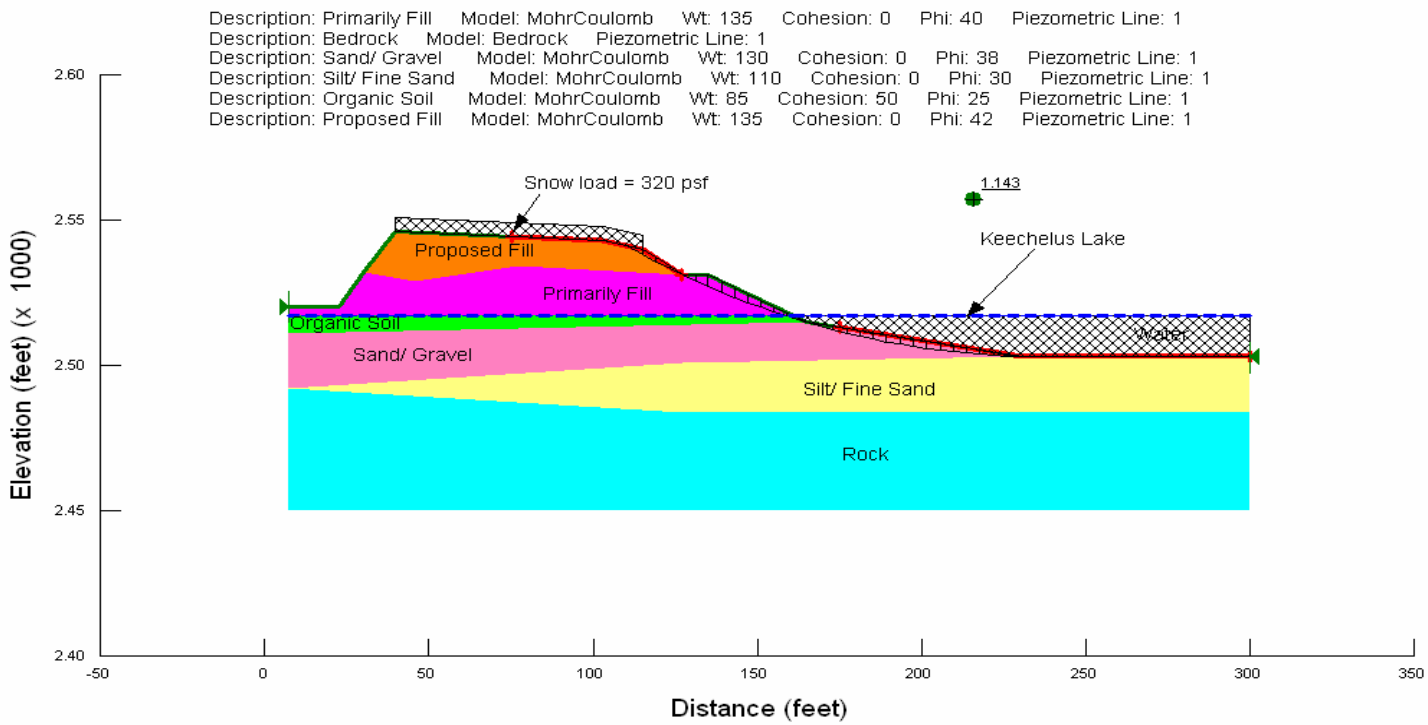
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.14*

* Found lower F.S. than the reported value but to show the clear failure surface we did not report it here.

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1209+00-R-St-Loc-H- r2.gsz

Job No. 33758579

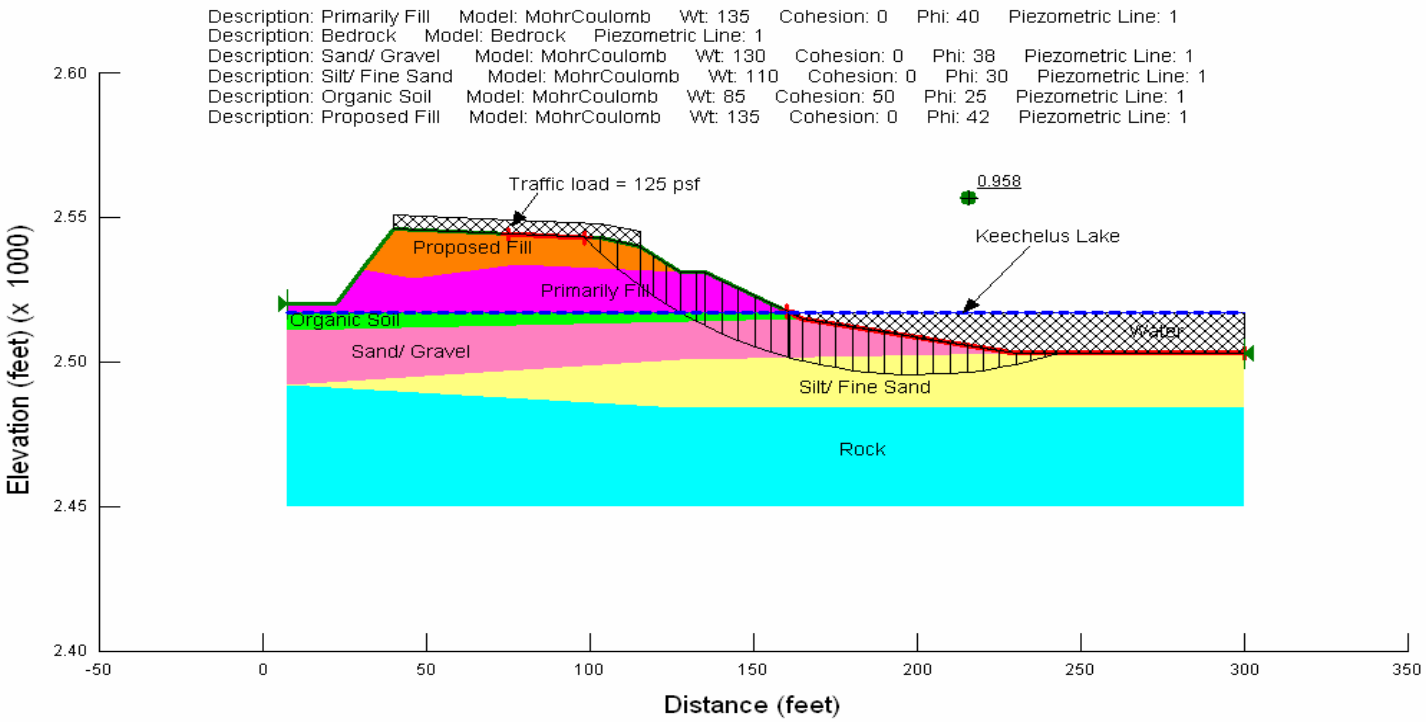
Figure D16

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 0.96

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1209+00-R-Se-H- r3.gsz

Job No. 33758579

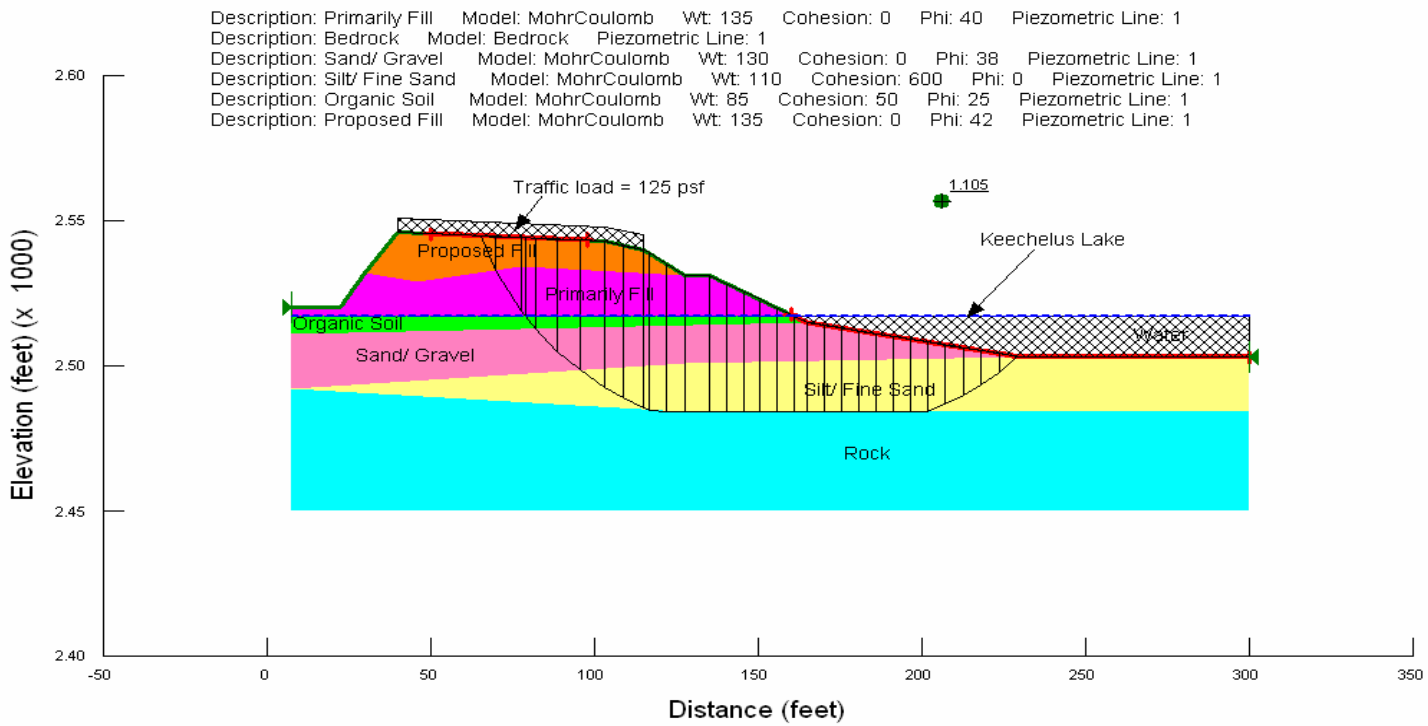
Figure D17

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.11

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1209+00-R-Se-Re-H- r2.gsz

Job No. 33758579

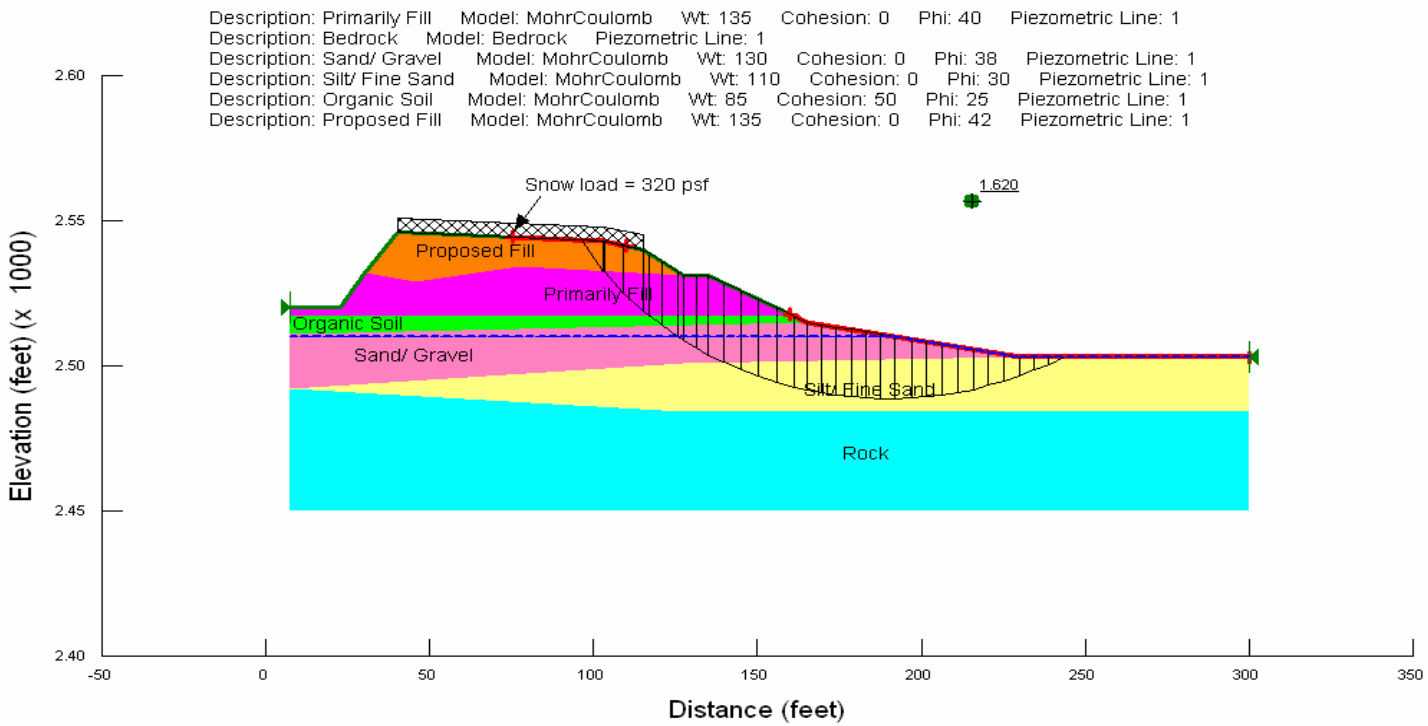
Figure D18

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.62

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1209+00-R-St-D- r2.gsz

Job No. 33758579

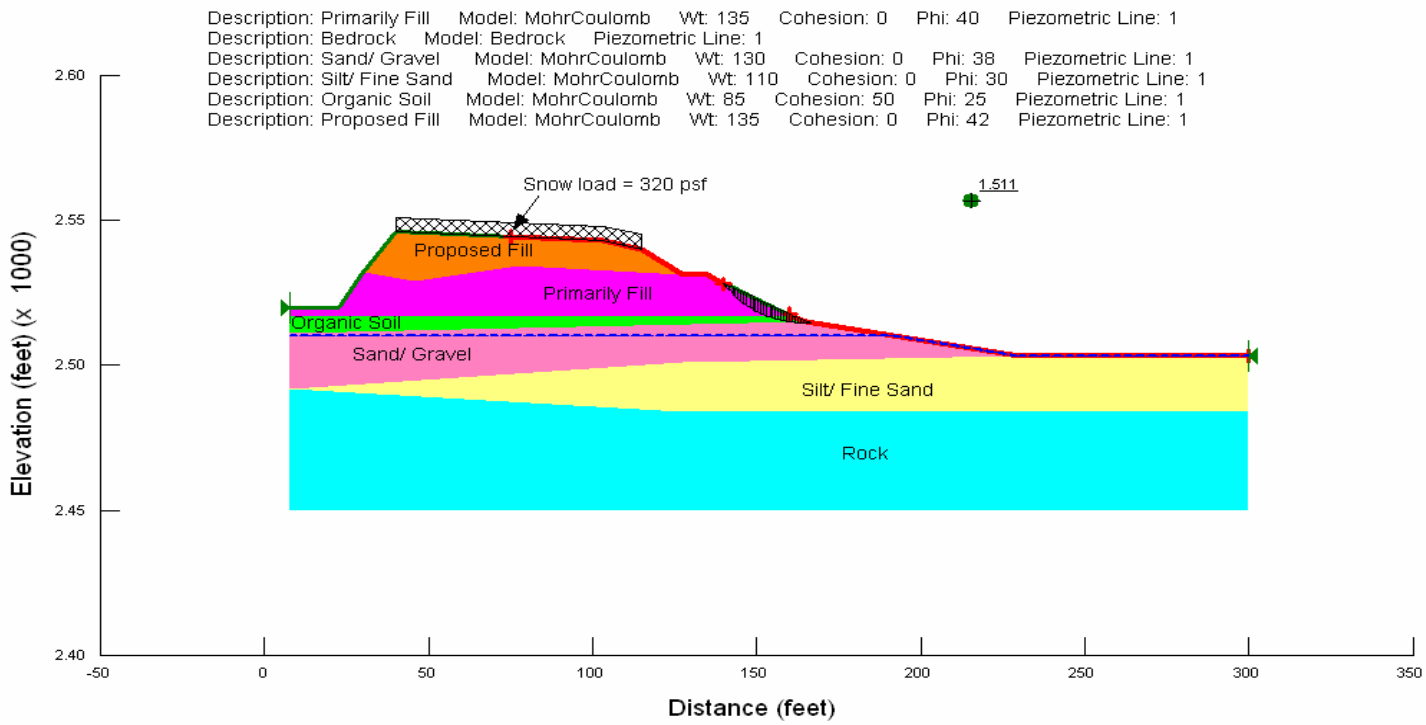
Figure D19

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.51

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1209+00-R-St-Loc-D- r2.gsz

Job No. 33758579

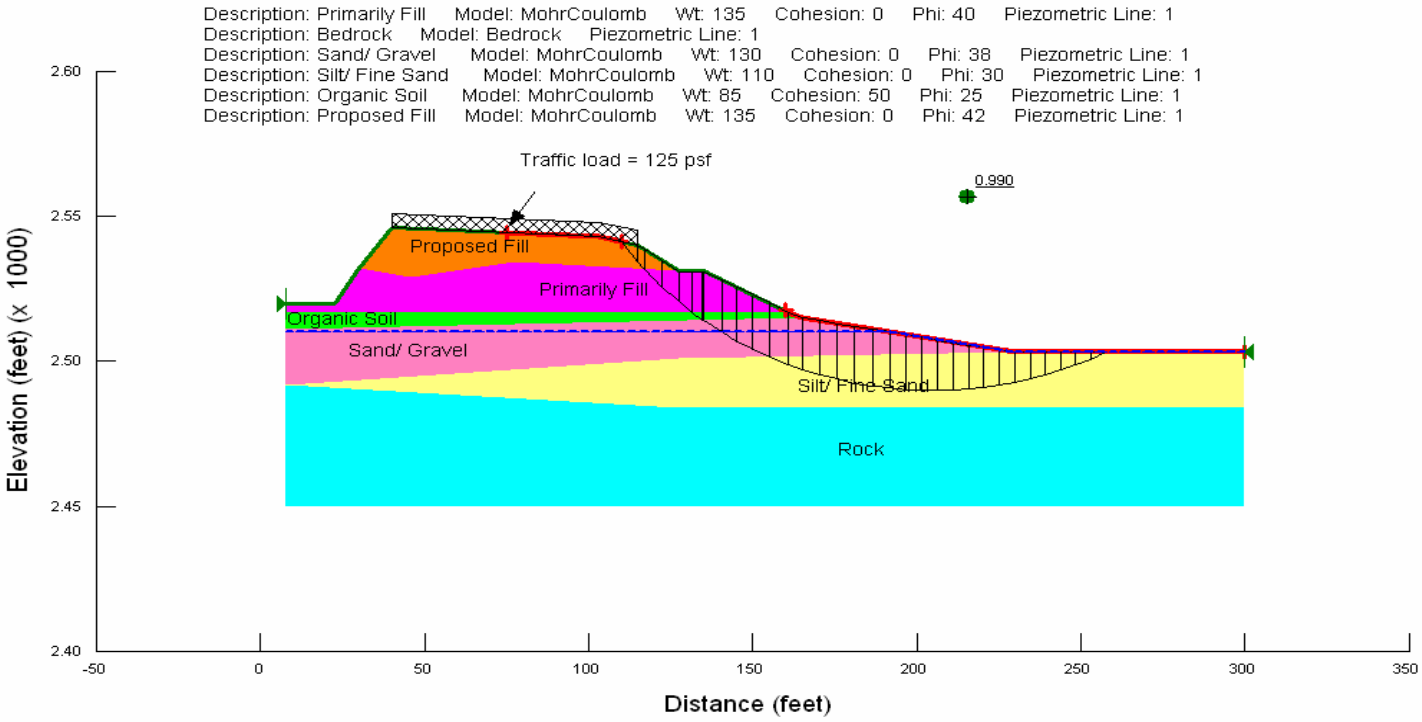
Figure D20

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 0.99

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1209+00-R-Se-D- r3.gsz

Job No. 33758579

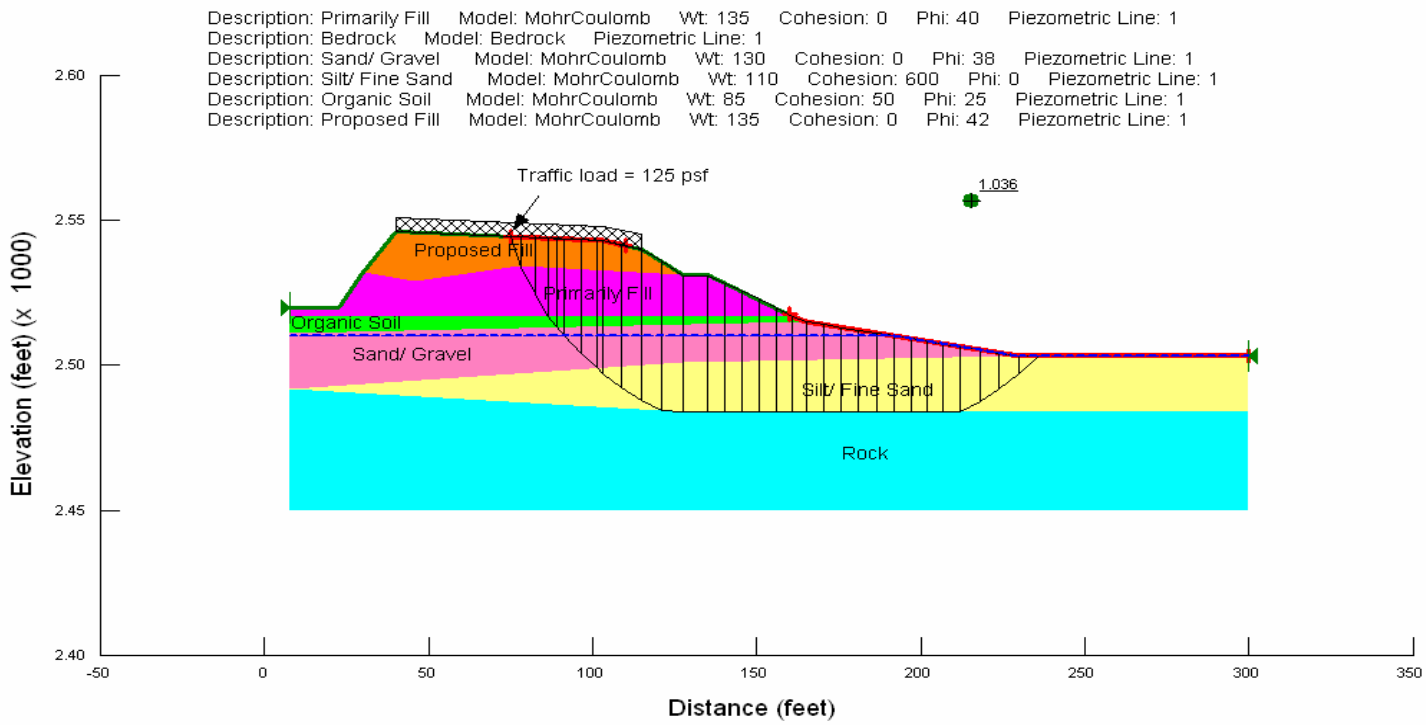
Figure D21

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.04

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



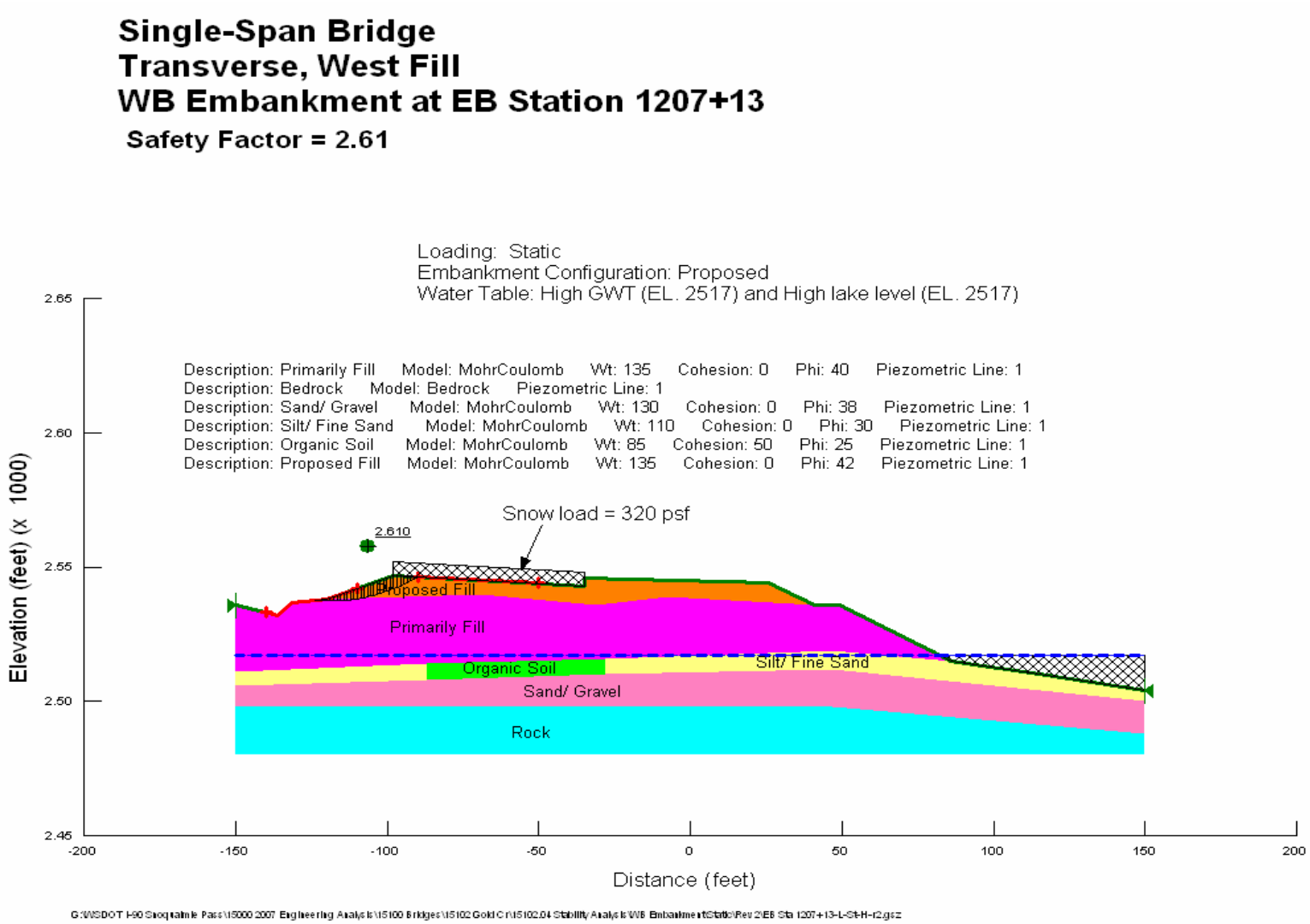
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\WB Sta 1209+00-R-Se-Re-D- r2.gsz

Job No. 33758579

Figure D22

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

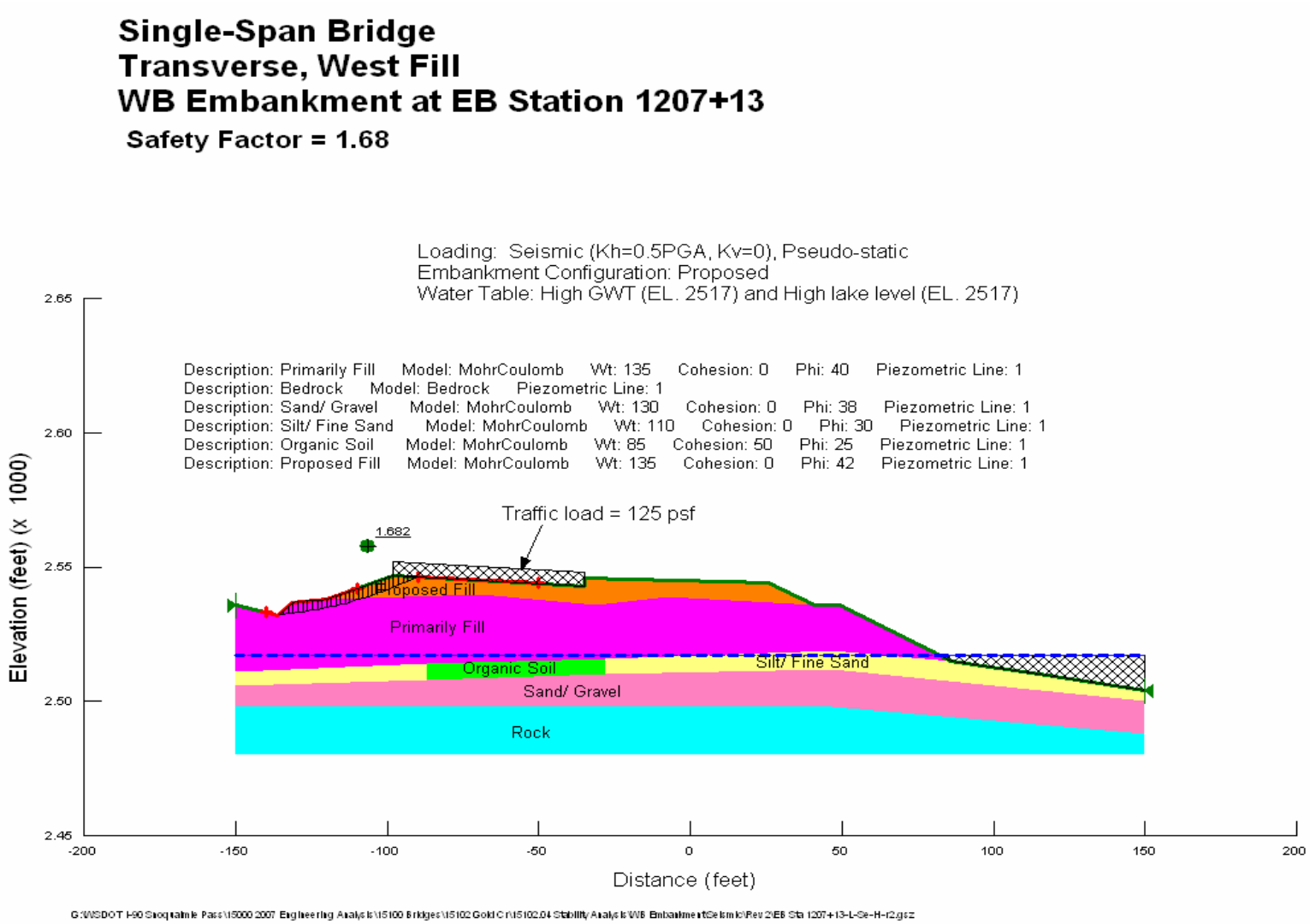


Job No. 33758579

Figure D23

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758579

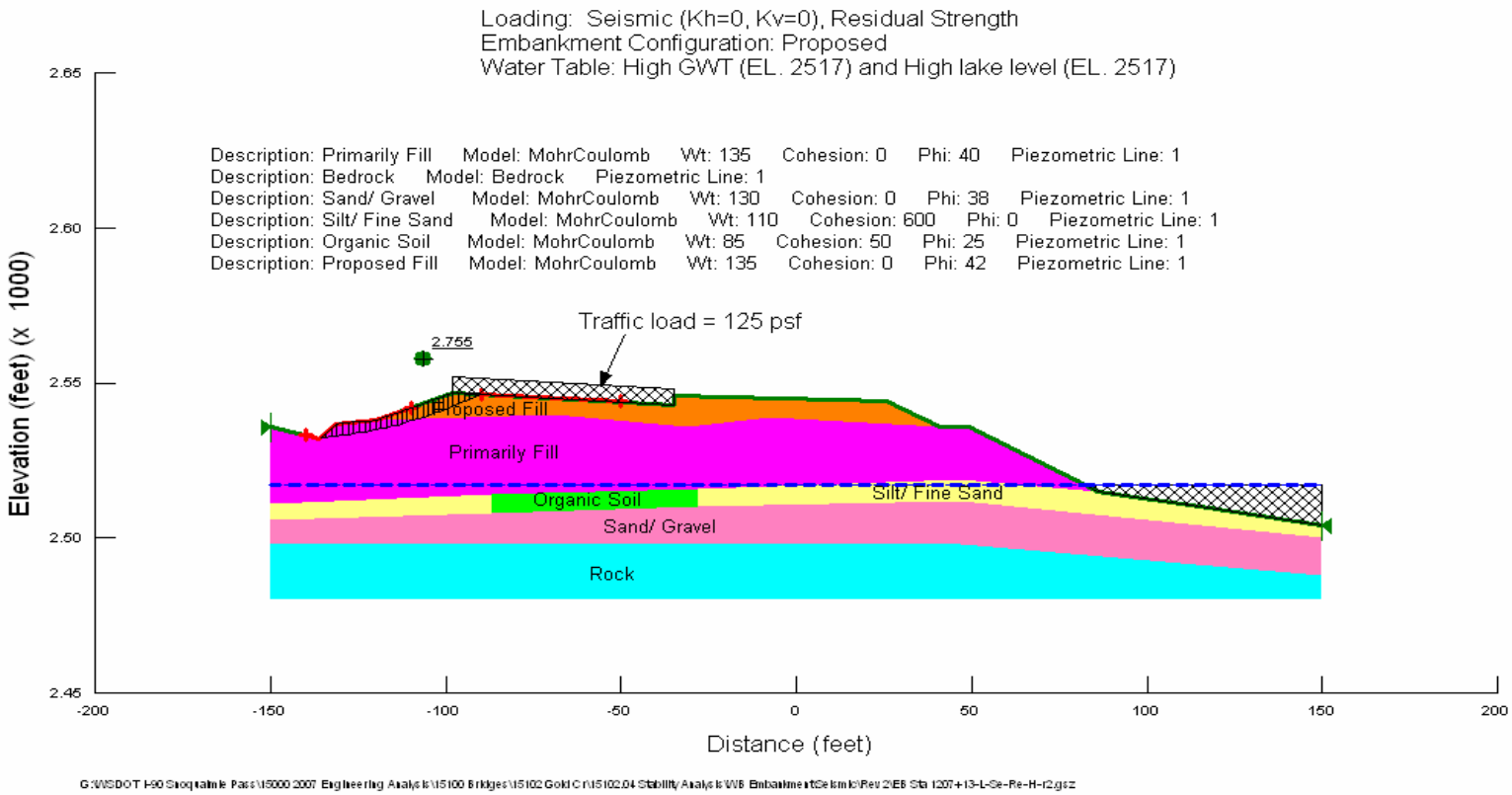
Figure D24

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
WB Embankment at EB Station 1207+13

Safety Factor = 2.76



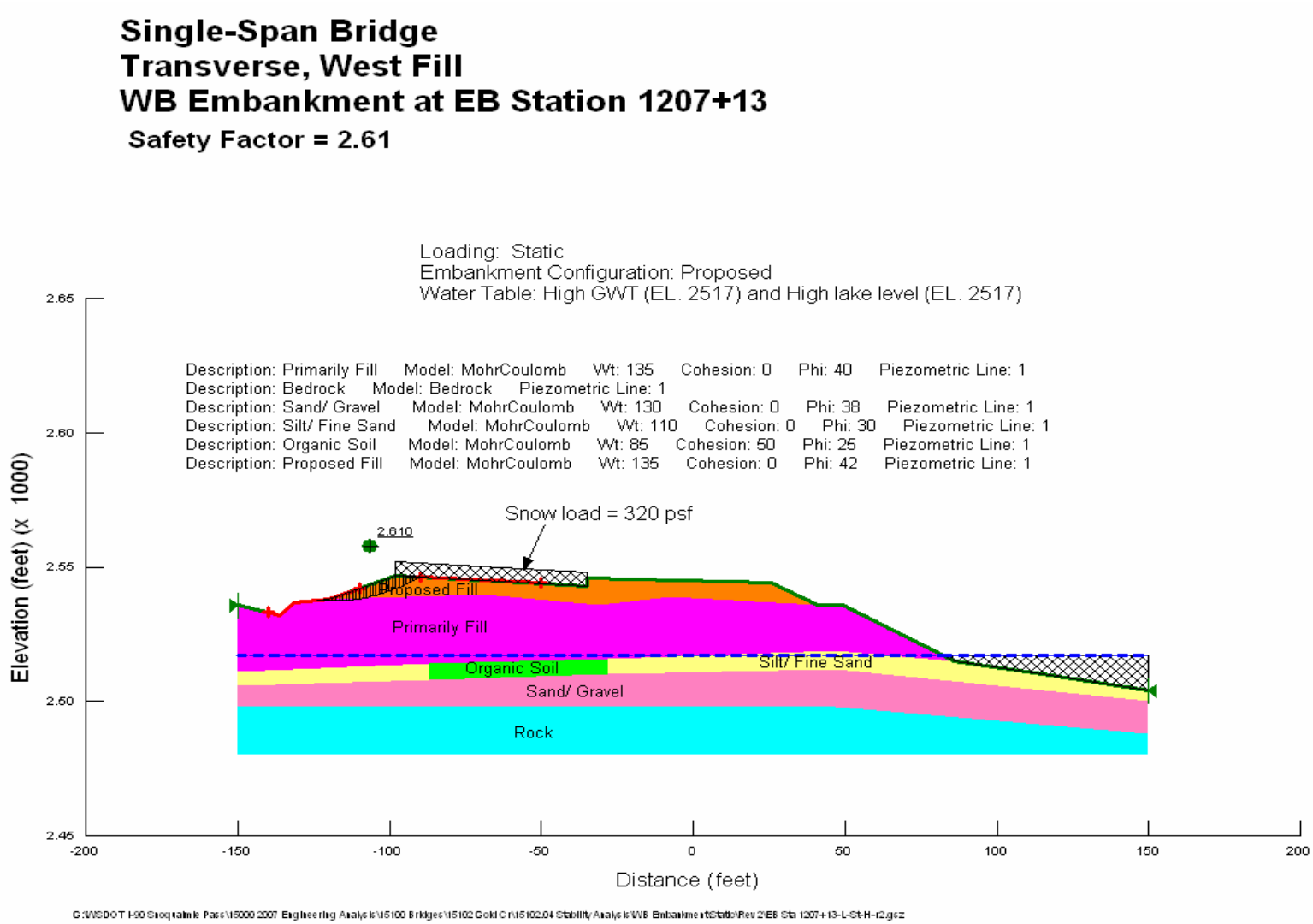
G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold C n\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\EB Sta 1207+13-L-Se-Re-H-r2.gsz

Job No. 33758579

Figure D25

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758579

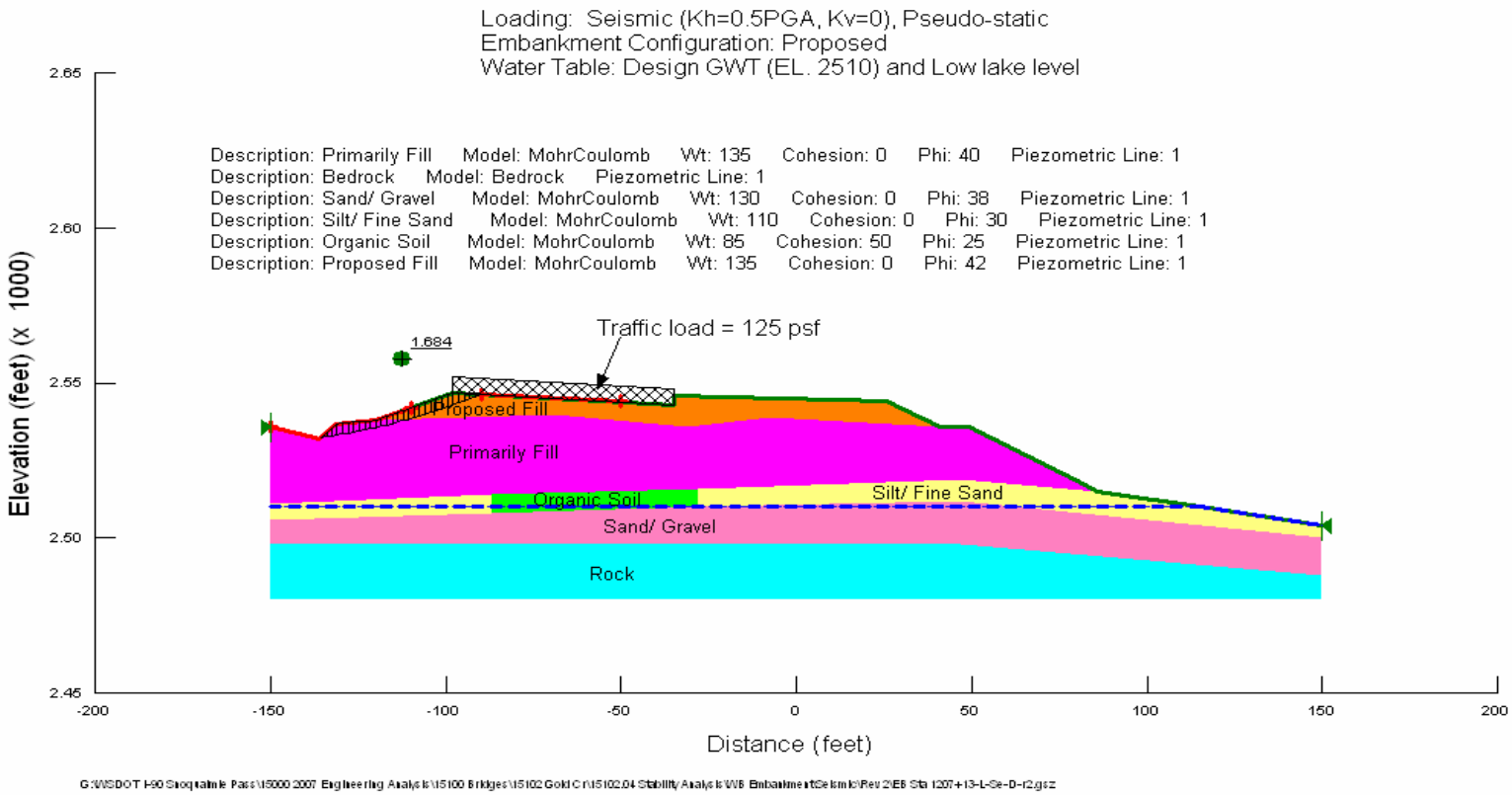
Figure D26

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
WB Embankment at EB Station 1207+13

Safety Factor =1.68



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold C r\15102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\EB Sta 1207+13-L-Se-D-r2.gsz

Job No. 33758579

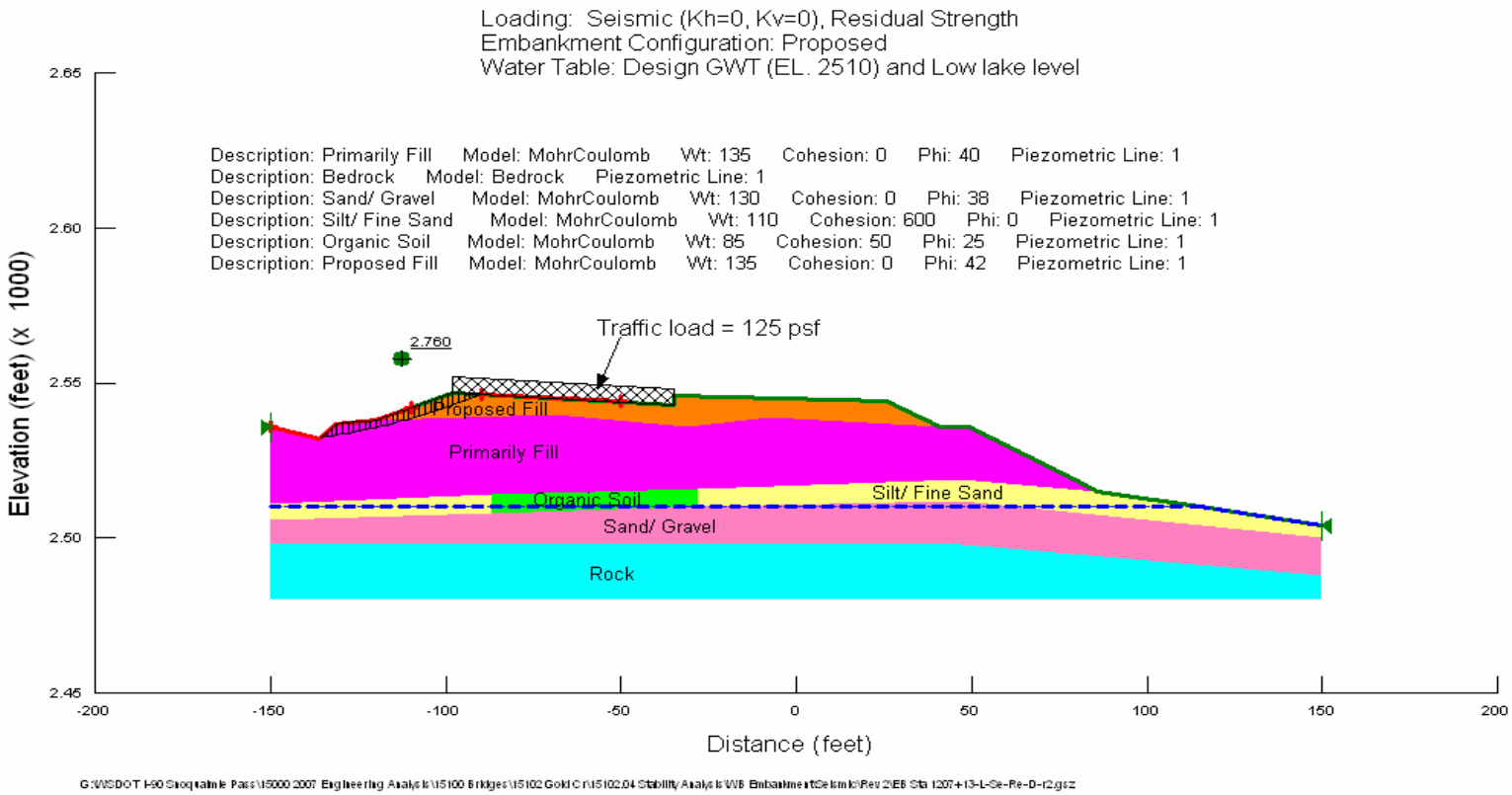
Figure D27

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
WB Embankment at EB Station 1207+13

Safety Factor =2.76



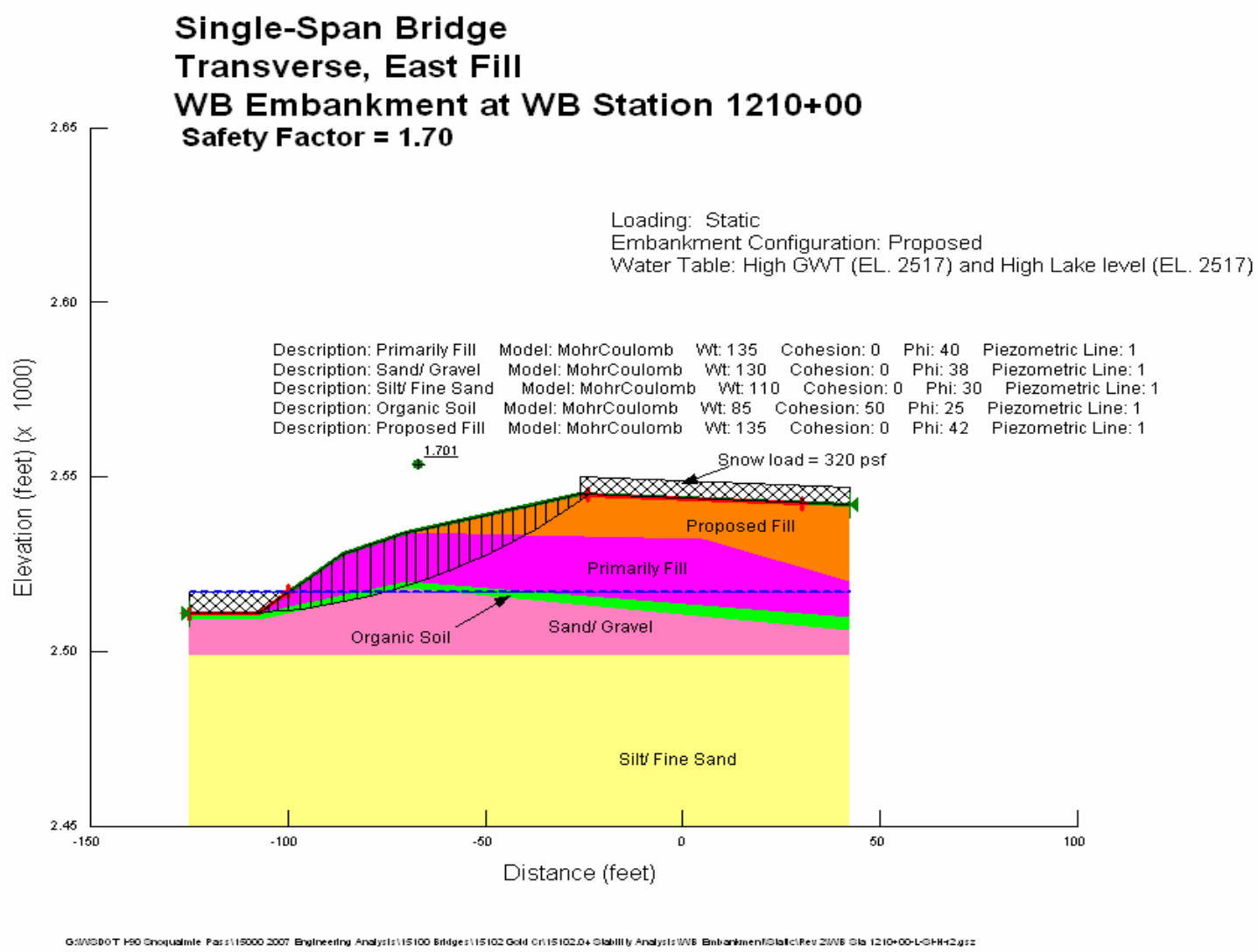
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold C r\15102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\EB Sta 1207+13-L-Se-Re-D-r2.gsz

Job No. 33758579

Figure D28

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

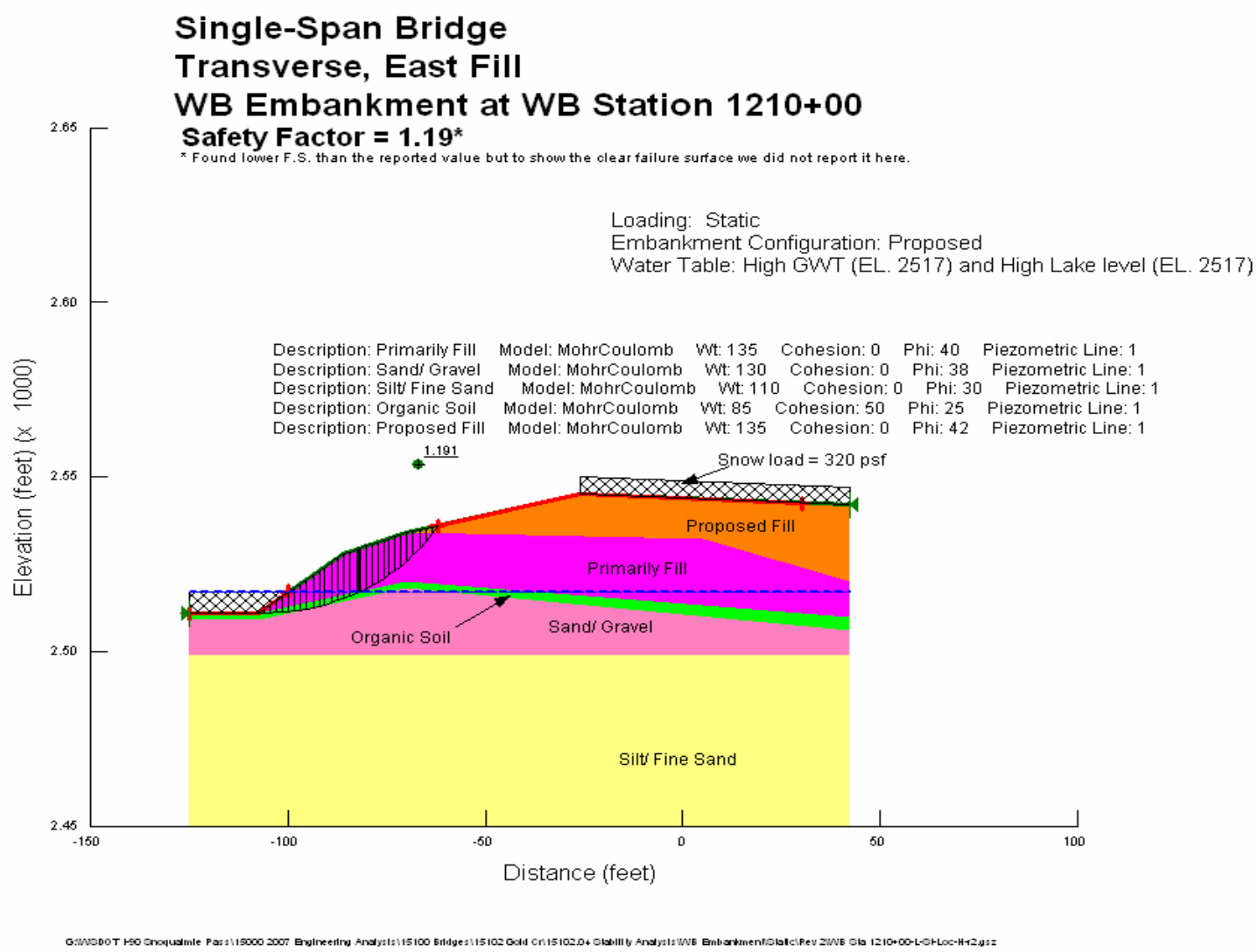


Job No. 33758579

Figure D29

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

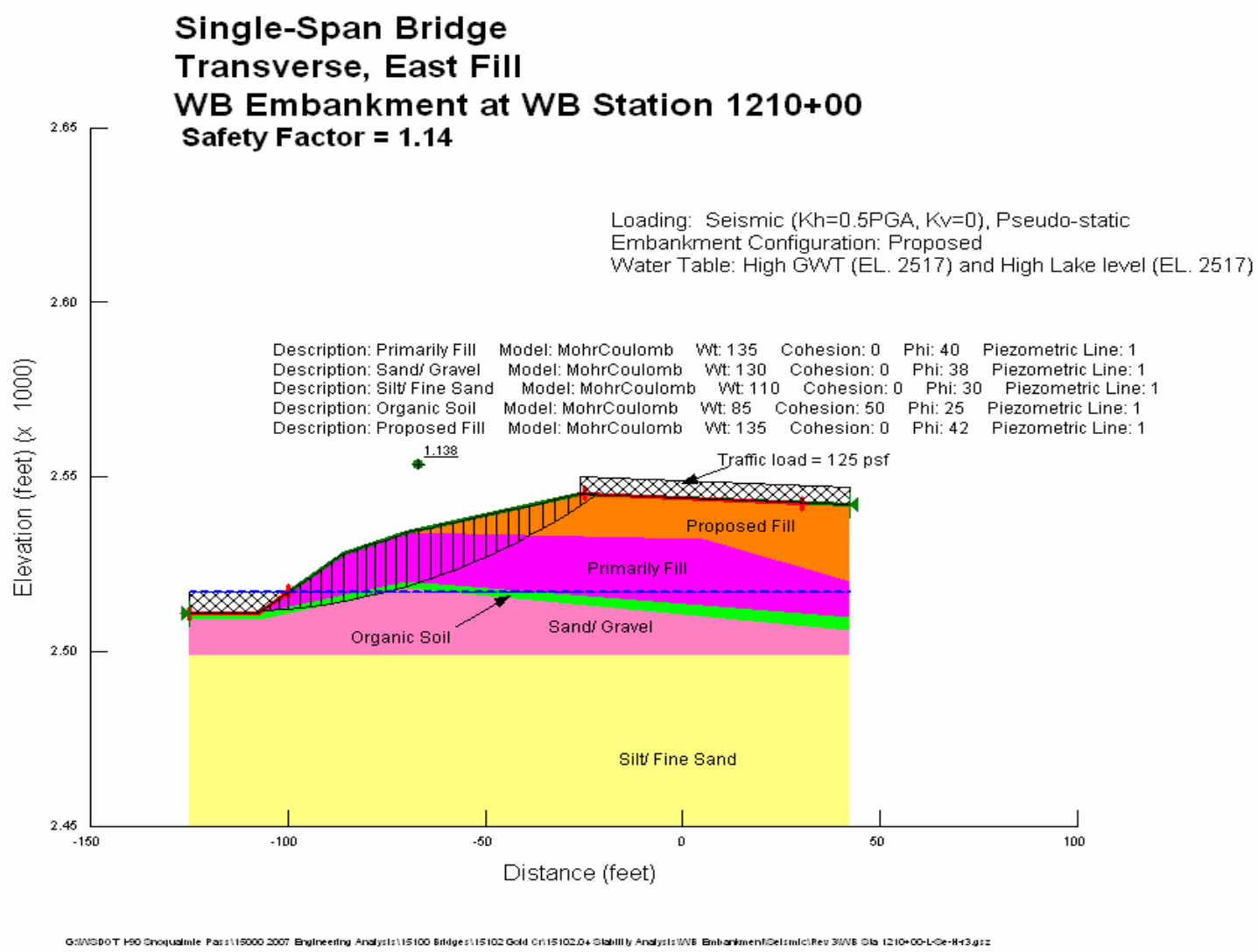


Job No. 33758579

Figure D30

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

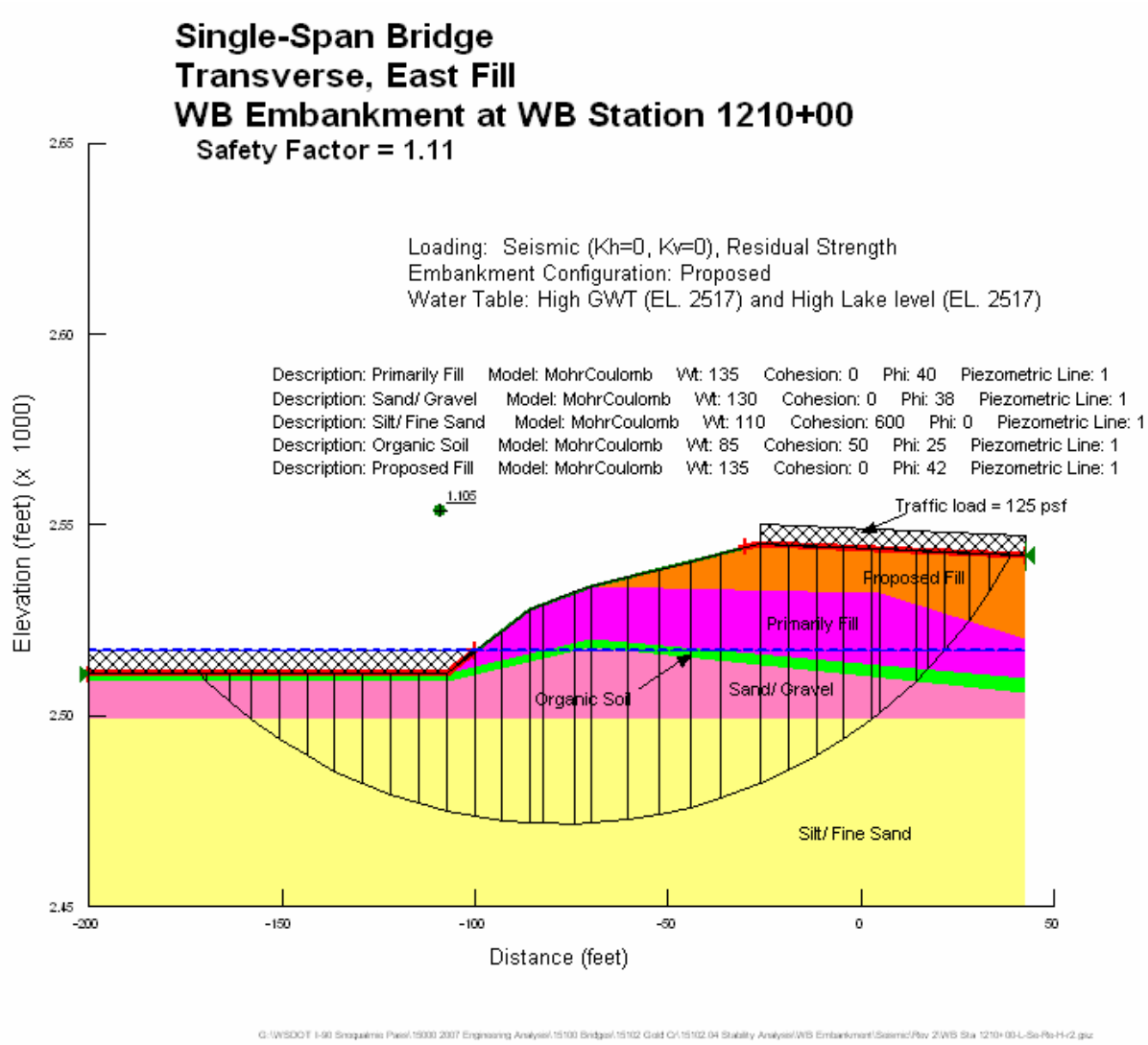


Job No. 33758579

Figure D31

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

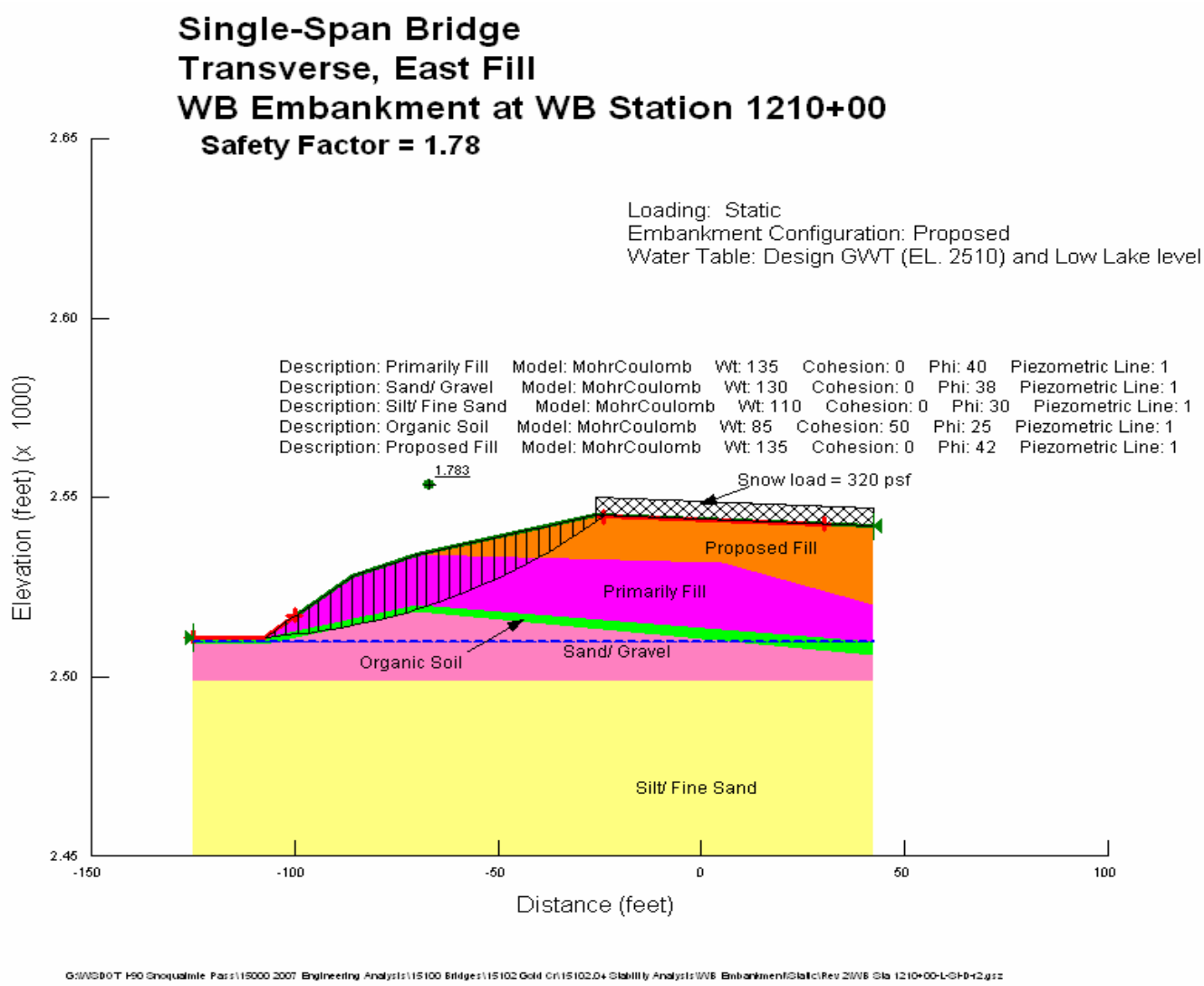


Job No. 33758579

Figure D32

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

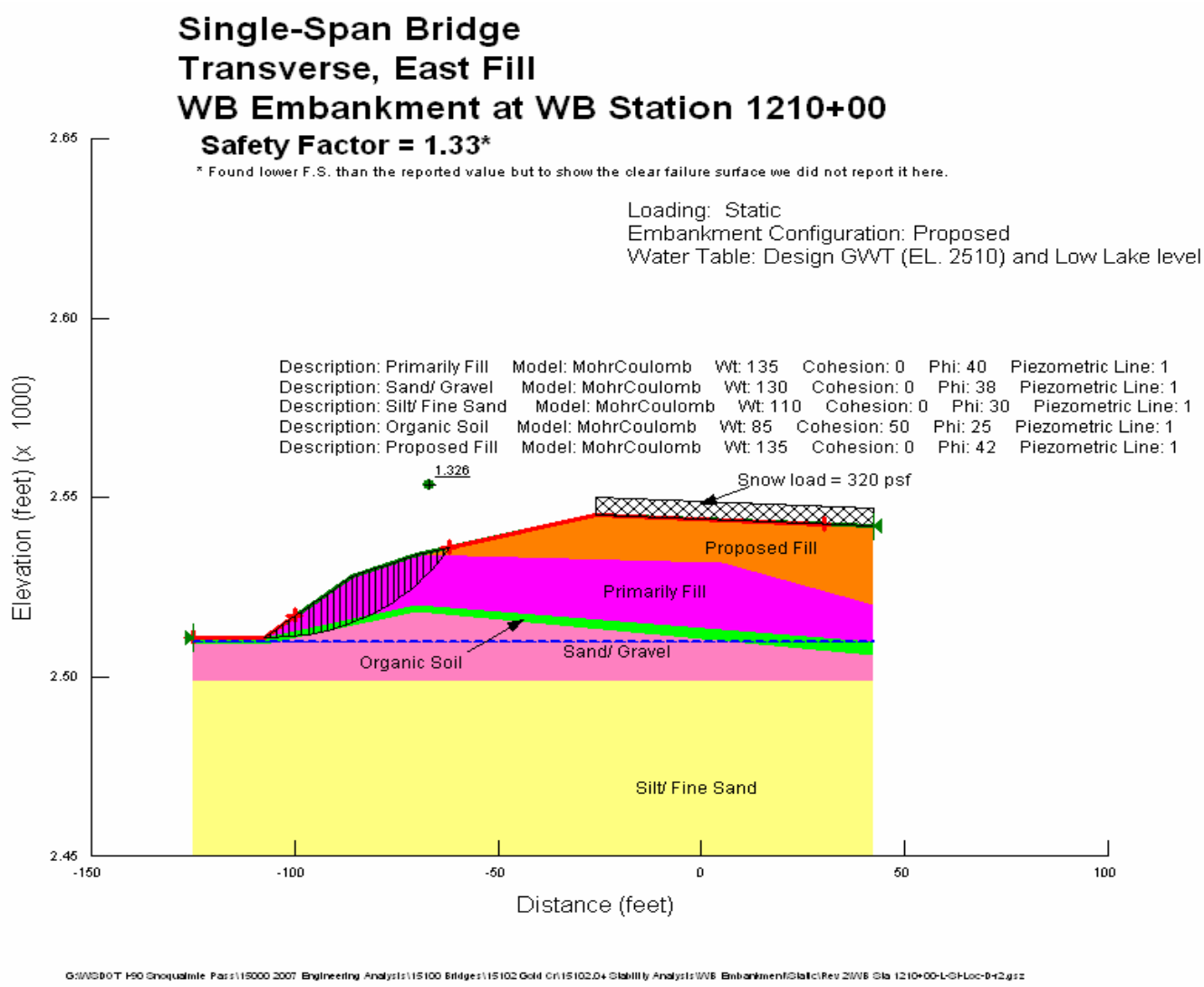


Job No. 33758579

Figure D33

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

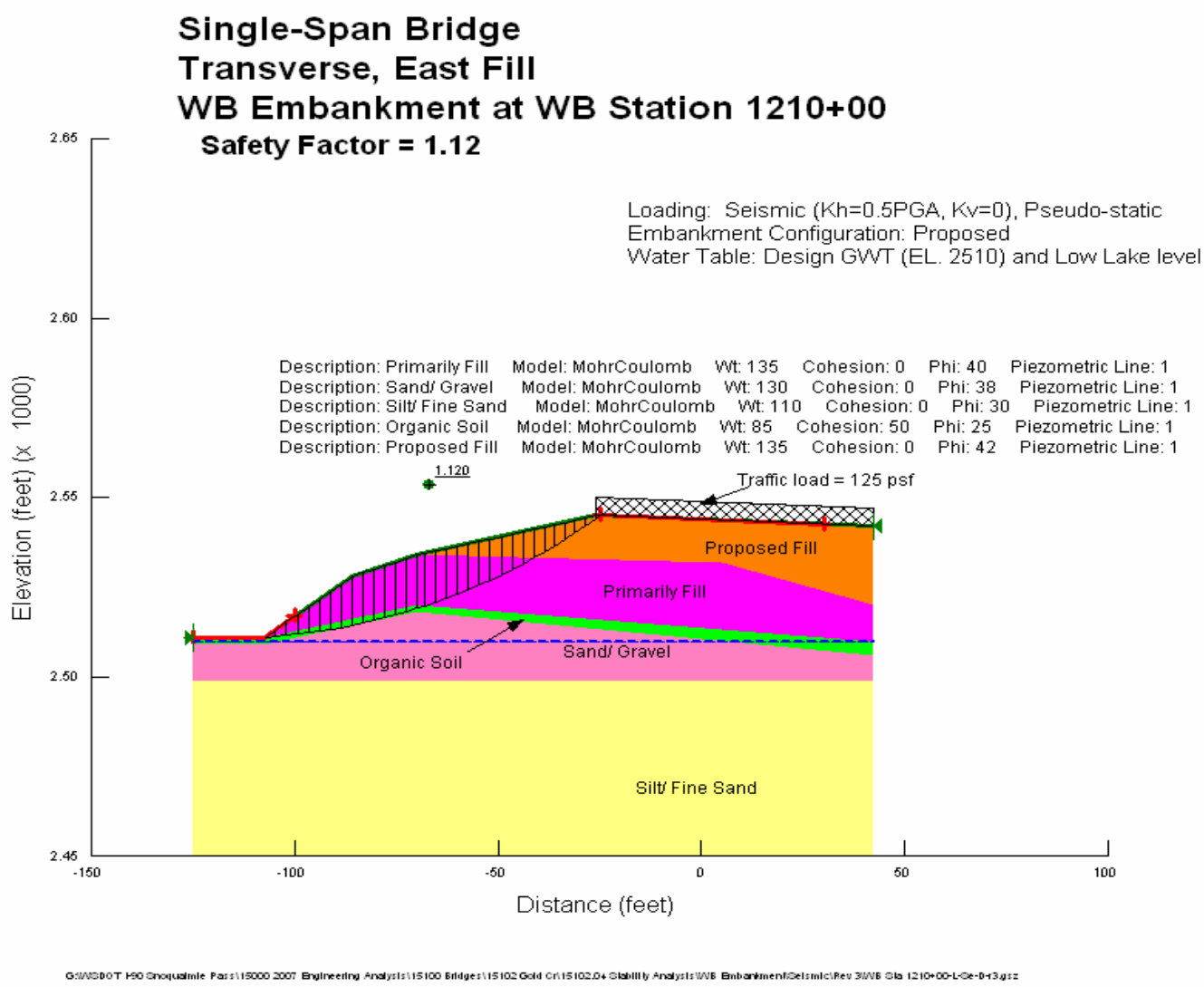


Job No. 33758579

Figure D34

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

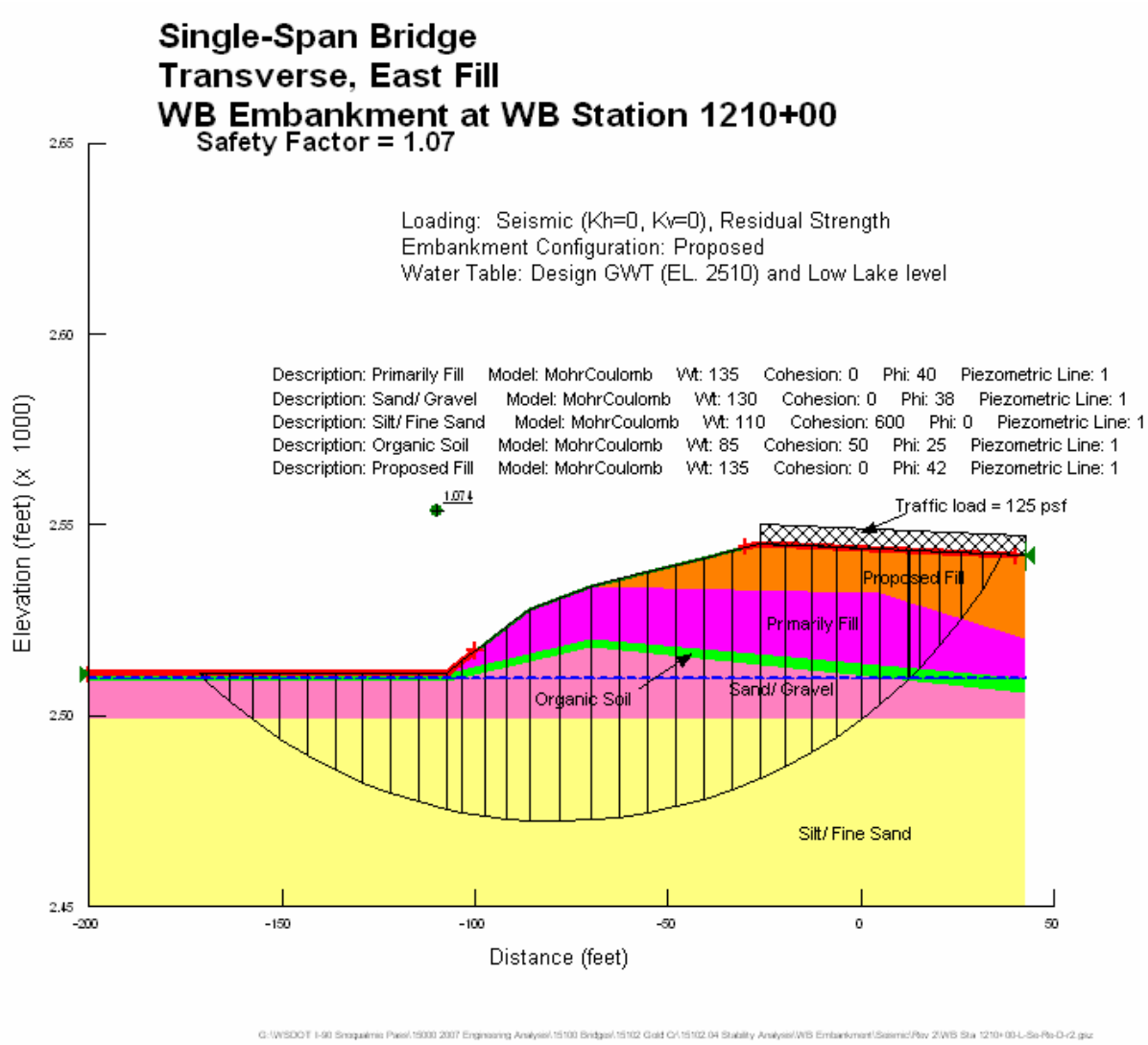


Job No. 33758579

Figure D35

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758579

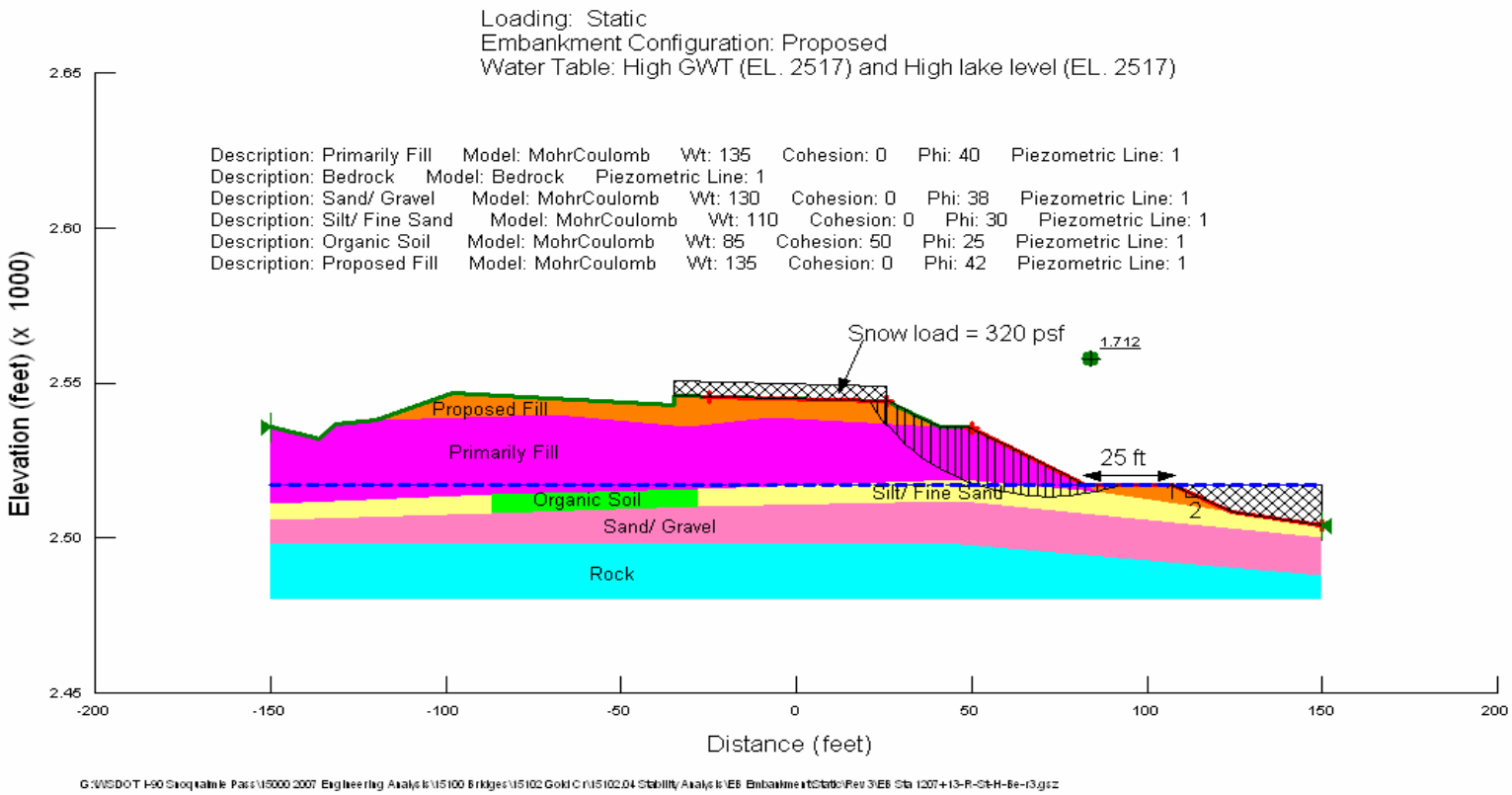
Figure D36

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.71



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Creek\15102.04 Stability Analysis\EB Embankment\Static\Rev 3\EB Sta 1207+13-R-Sft-H-Be-r3.gsz

Job No. 33758579

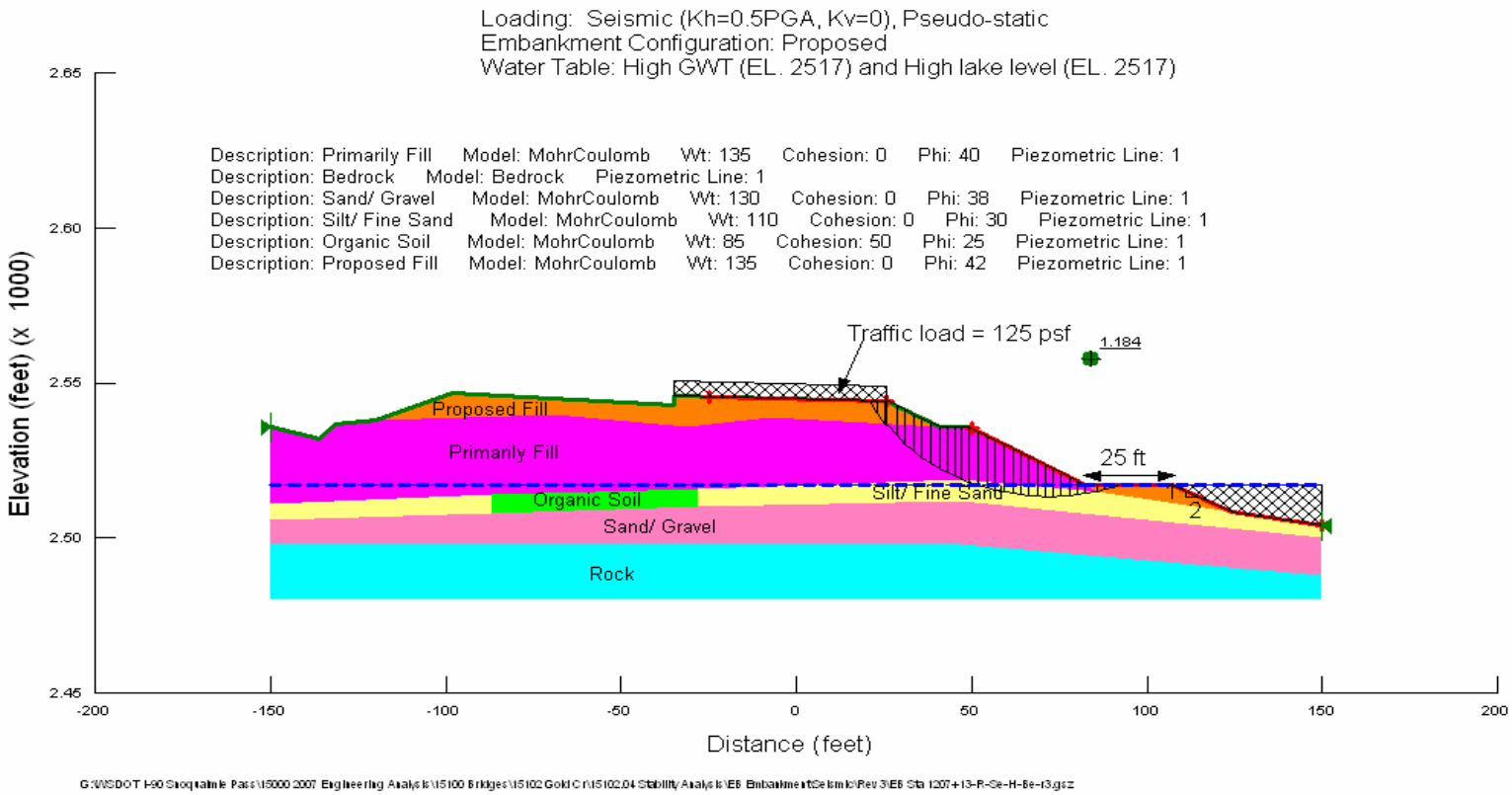
Figure D37

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.18



Job No. 33758579

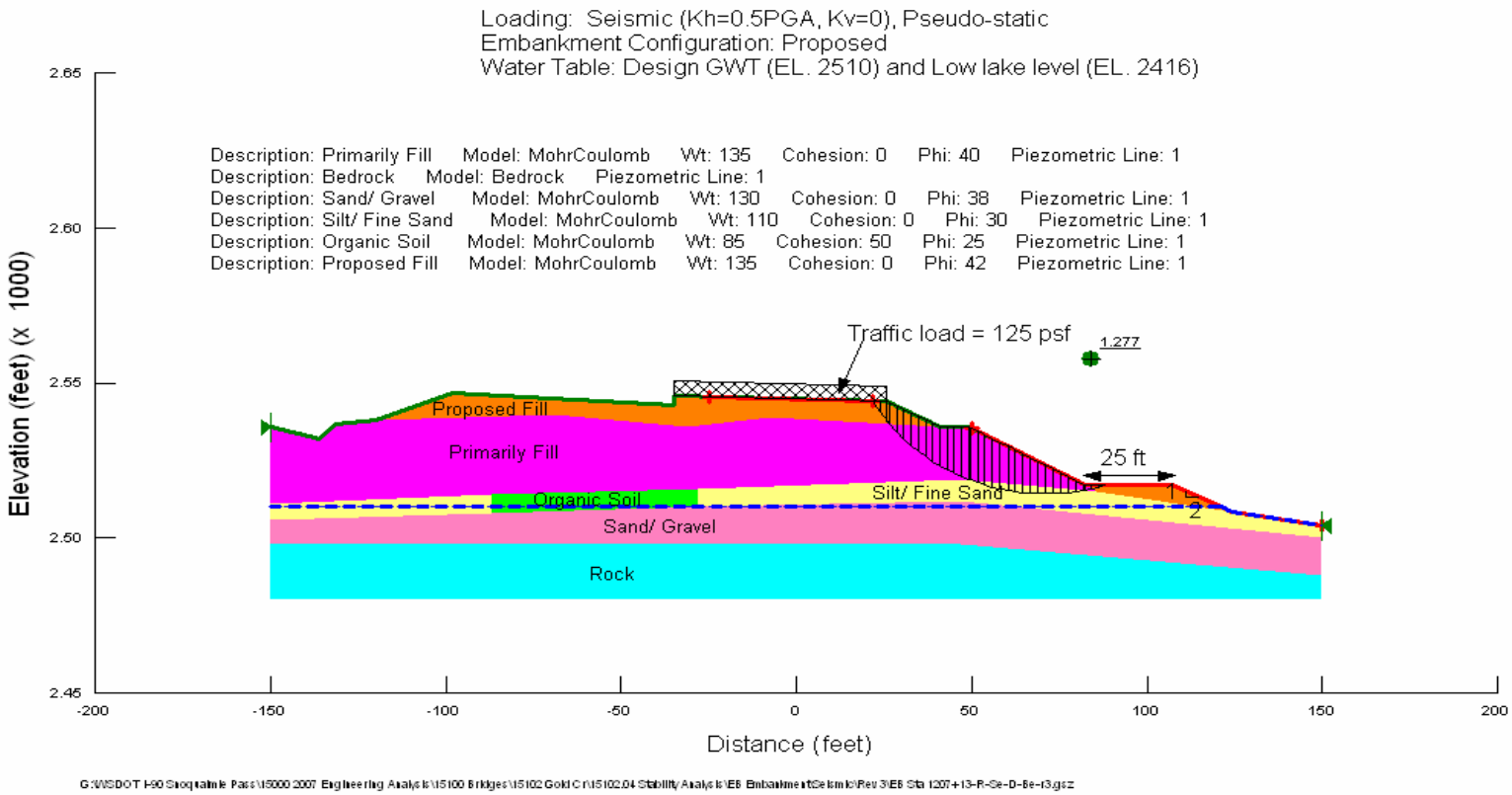
Figure D38

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.28



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold C n\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\EB Sta 1207+13-R-Se-D-Se-r3.gsz

Job No. 33758579

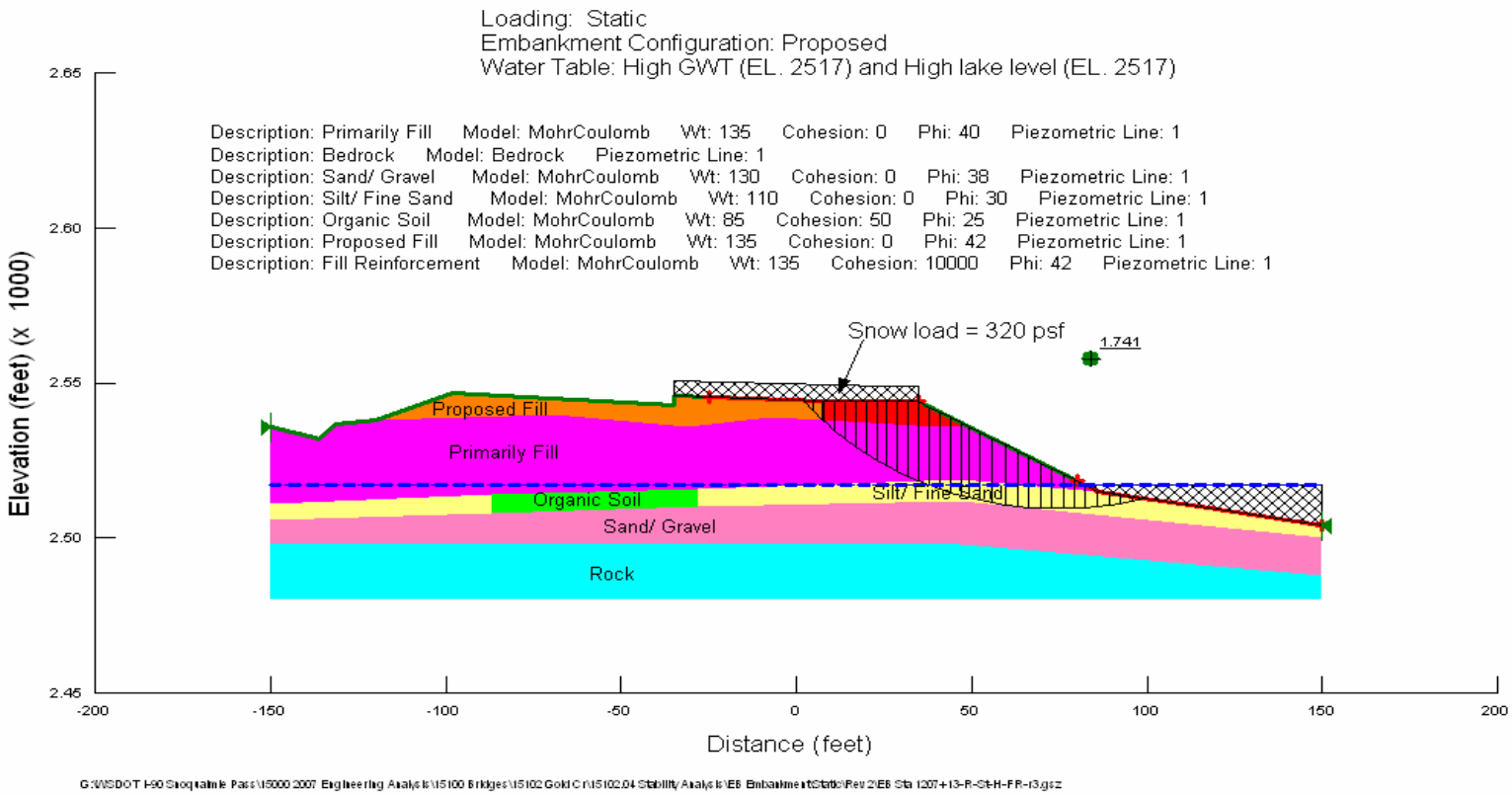
Figure D39

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.74



Job No. 33758579

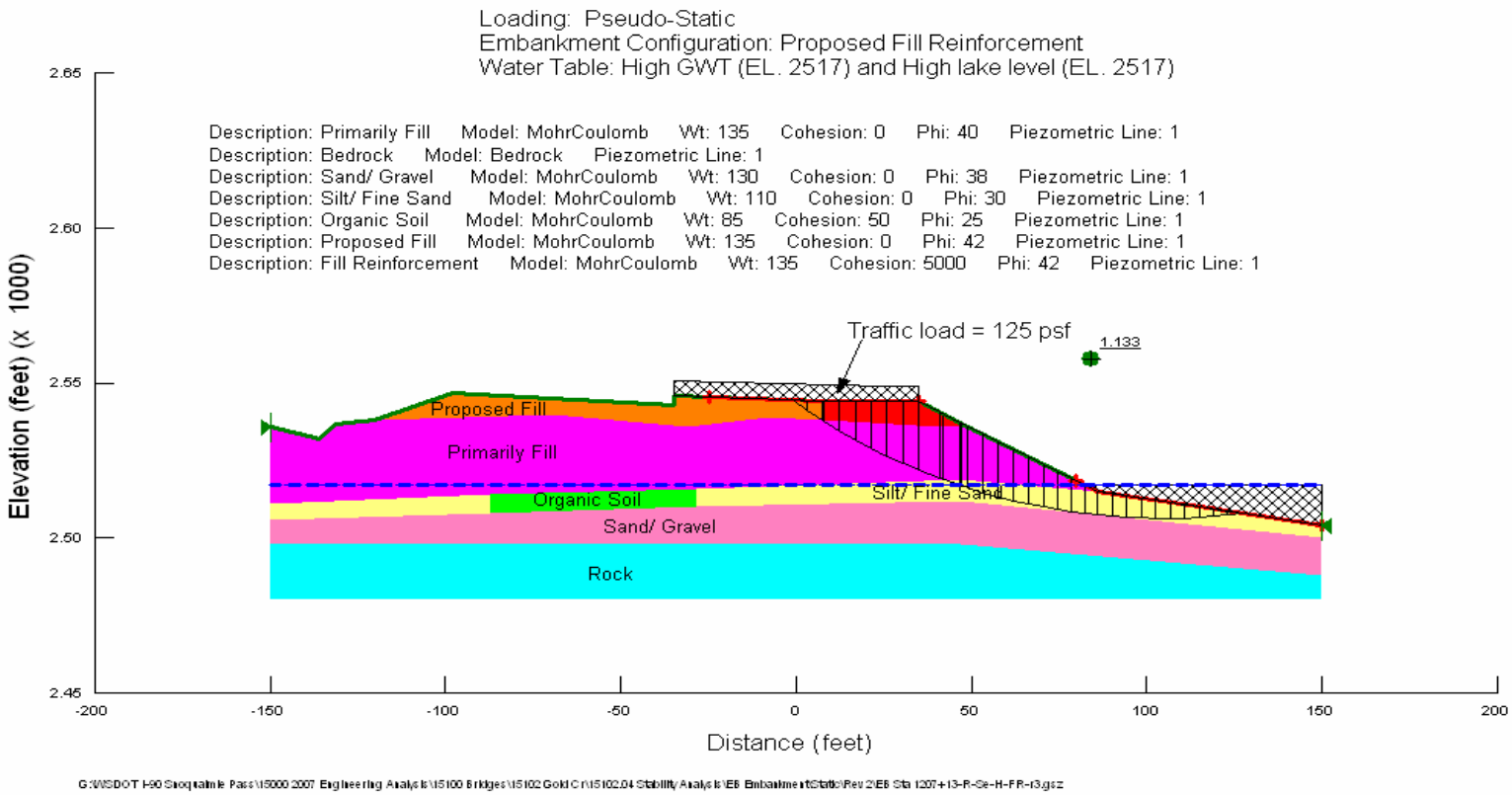
Figure D40

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, West Fill
EB Embankment at EB Station 1207+13

Safety Factor = 1.13



Job No. 33758579

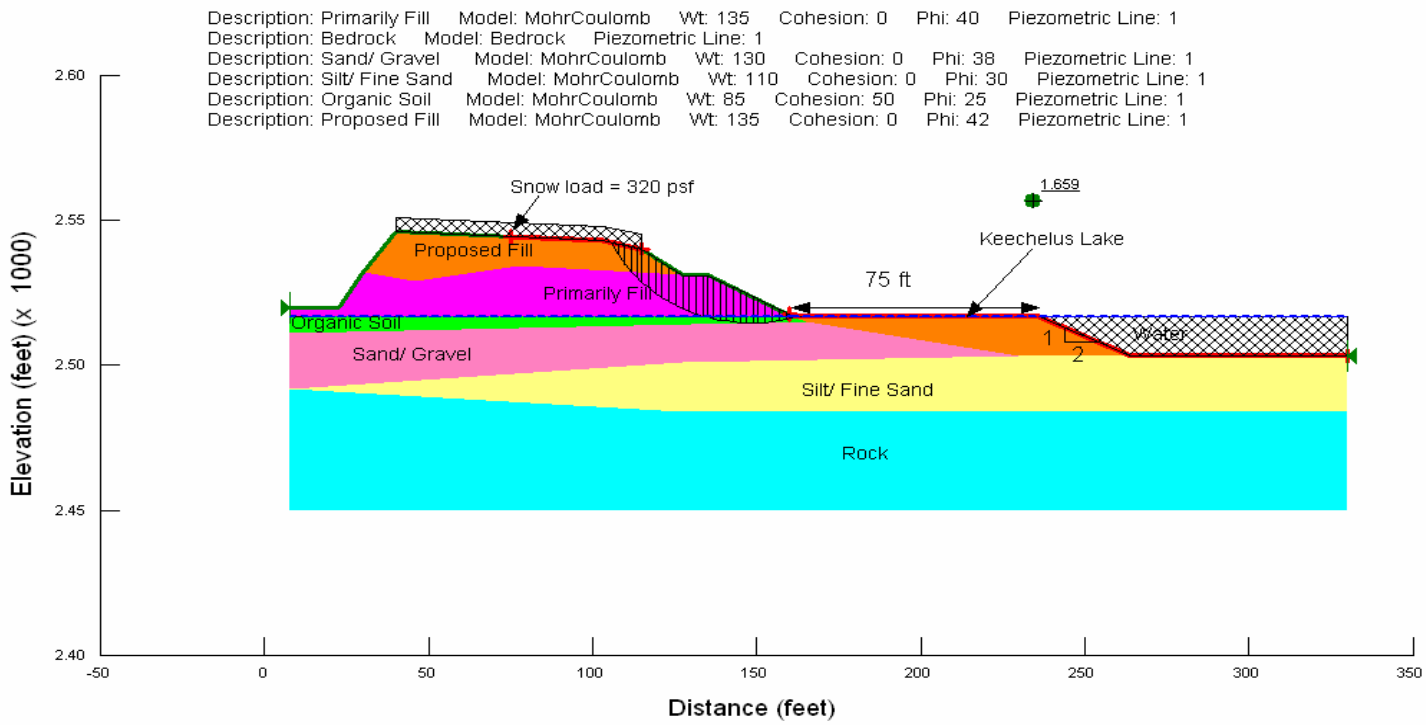
Figure D41

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.70

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 3\WB Sta 1209+00-R-St-H- Be-r3.gsz

Job No. 33758579

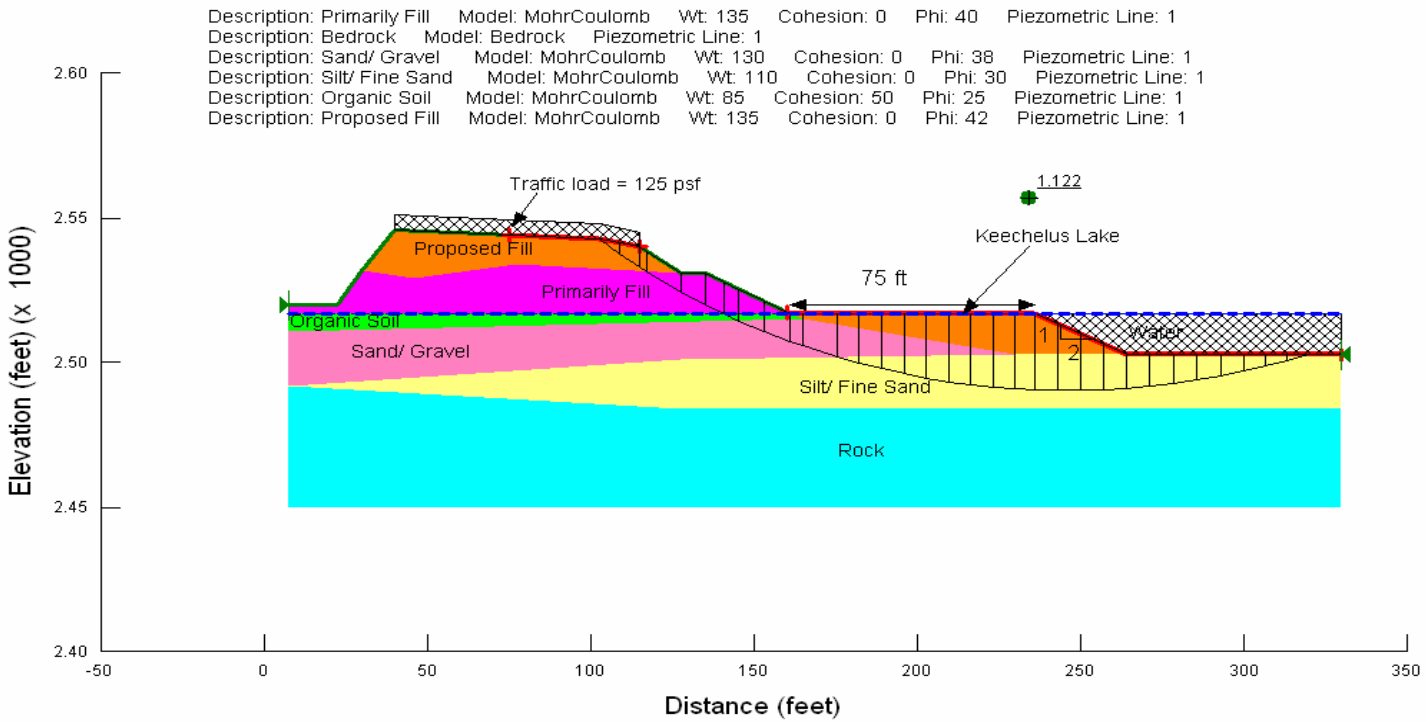
Figure D42

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.12

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1209+00-R-Se-H- Se-r3.gsz

Job No. 33758579

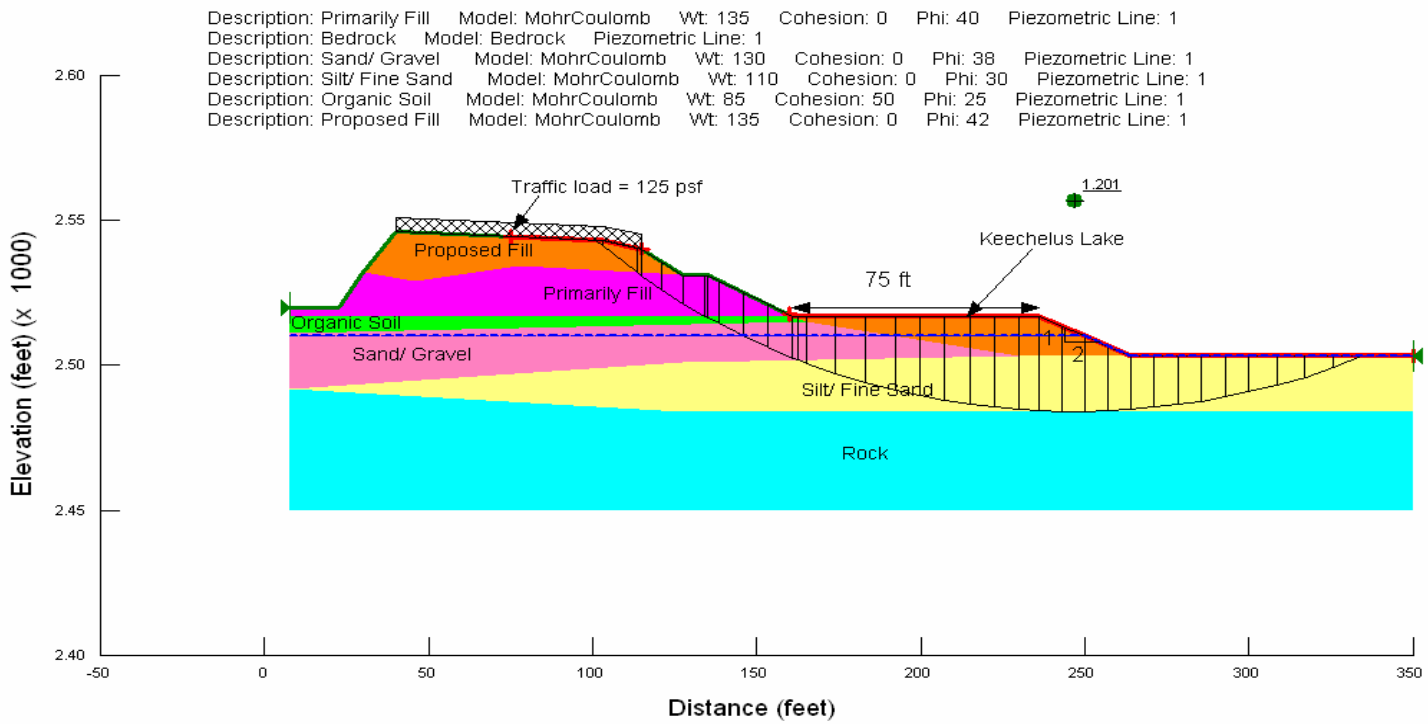
Figure D43

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.20

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level (EL. 2416)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1209+00-R-Se-D- Be-r3.gsz

Job No. 33758579

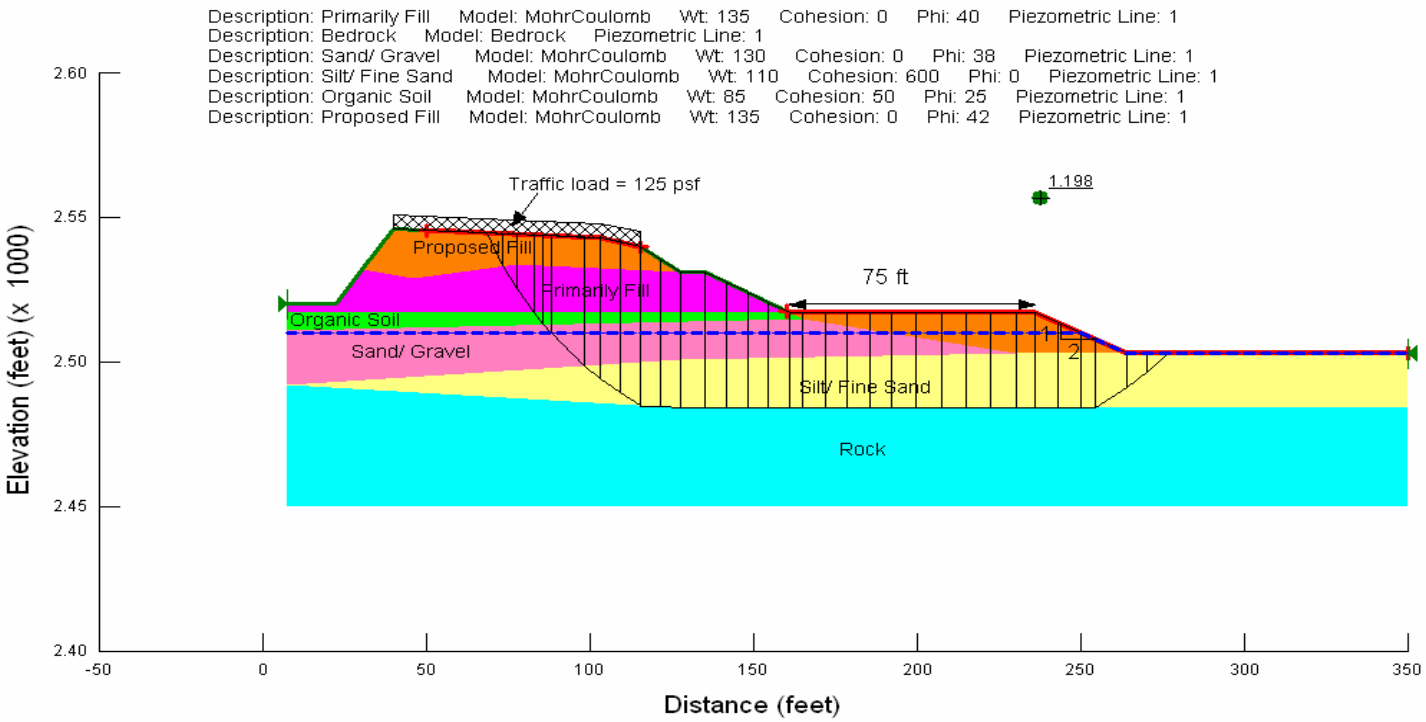
Figure D44

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Single-Span Bridge
Transverse, East Fill
EB Embankment at WB Station 1209+00
Safety Factor = 1.20

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level (EL. 2416)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1209+00-R-Se-Re-D- Be-r3.gsz

Job No. 33758579

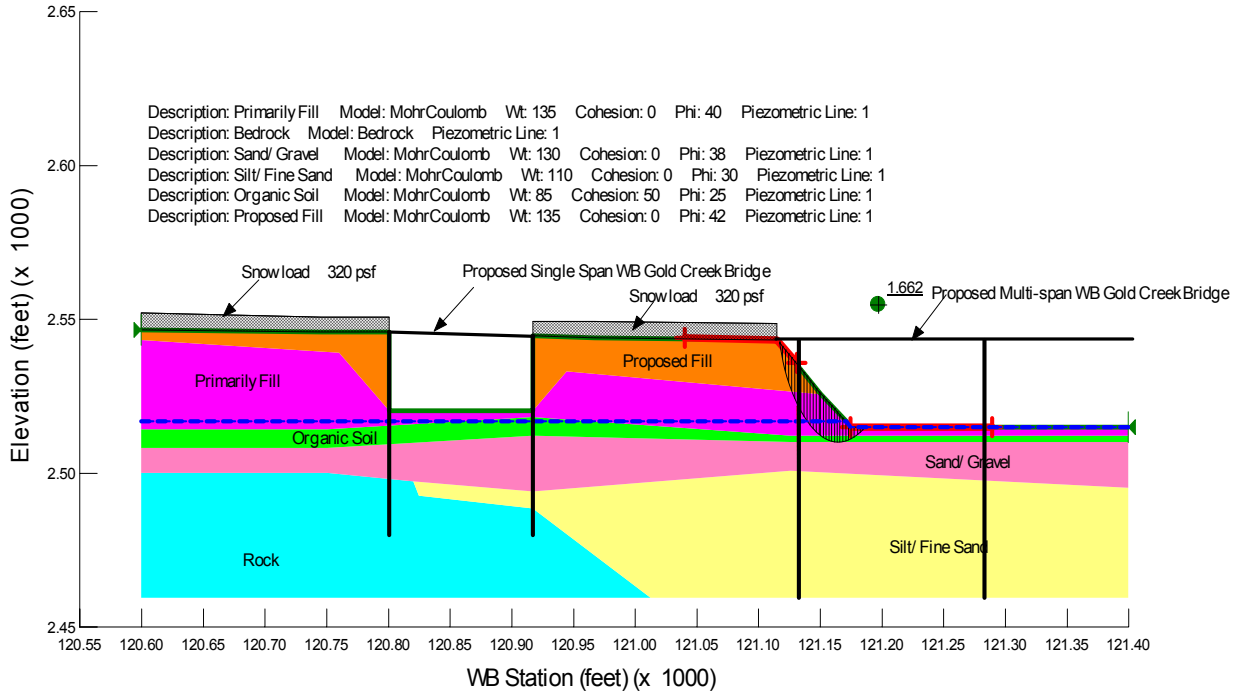
Figure D45

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.66

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WB Profile Static Rev 2 WB Profile Sta 1206 00-1214 00-St-MS-WE-H-r2.gsz

Job No. 33758579

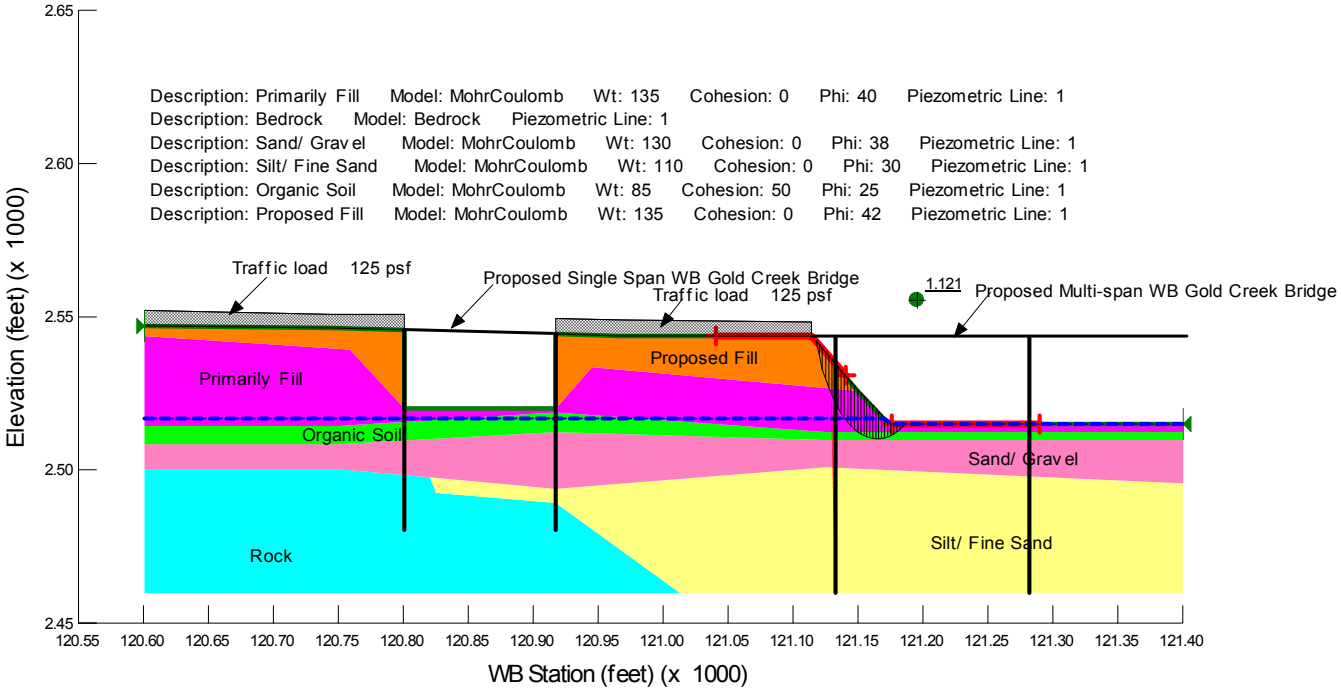
Figure D46

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.12

Loading: Seismic (Kh 0.5PGA, Kv 0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WBProfile Static Rev 2 WBProfile Sta 1206 00-1214 00-Se-MS-WE-H-r2.gsz

Job No. 33758579

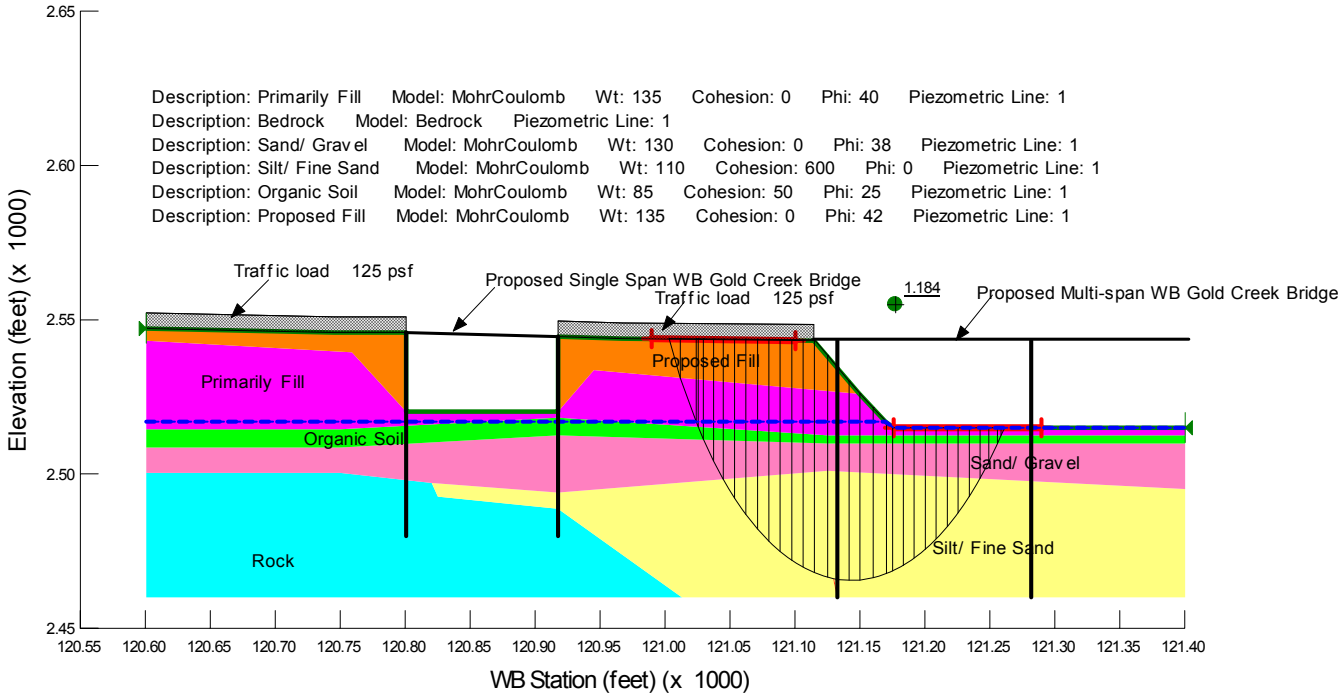
Figure D47

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Longitudinal, West Fill
WB Profile between Station 1206 00 to 1214 00
Safety Factor 1.18

Loading: Seismic (Kh 0, Kv 0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517)



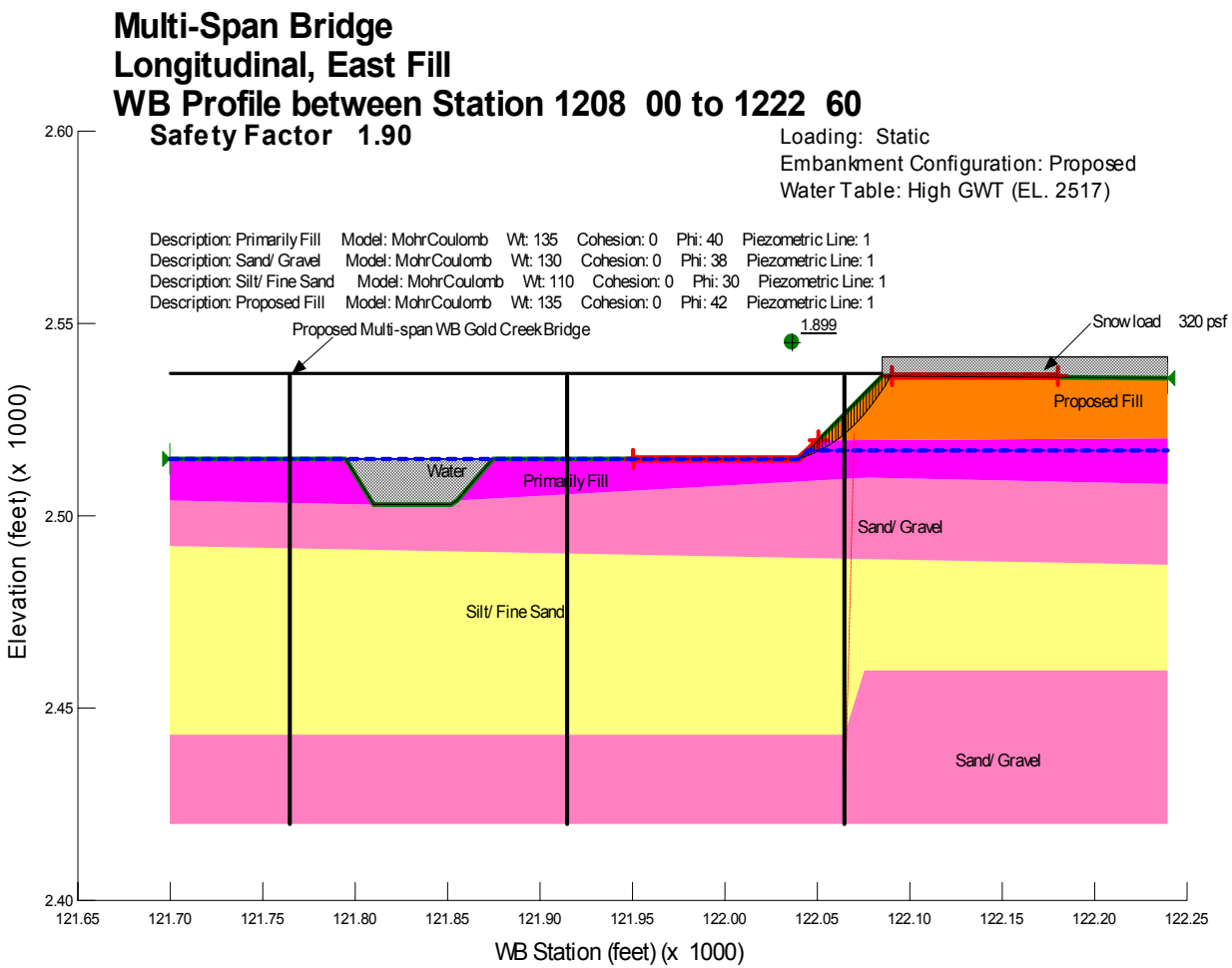
G:WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis WBProfile Static Rev 2 WBProfile Sta 1206 00-1214 00-Se-Re-MS-WE-H-r2.gsz

Job No. 33758579

Figure D48

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

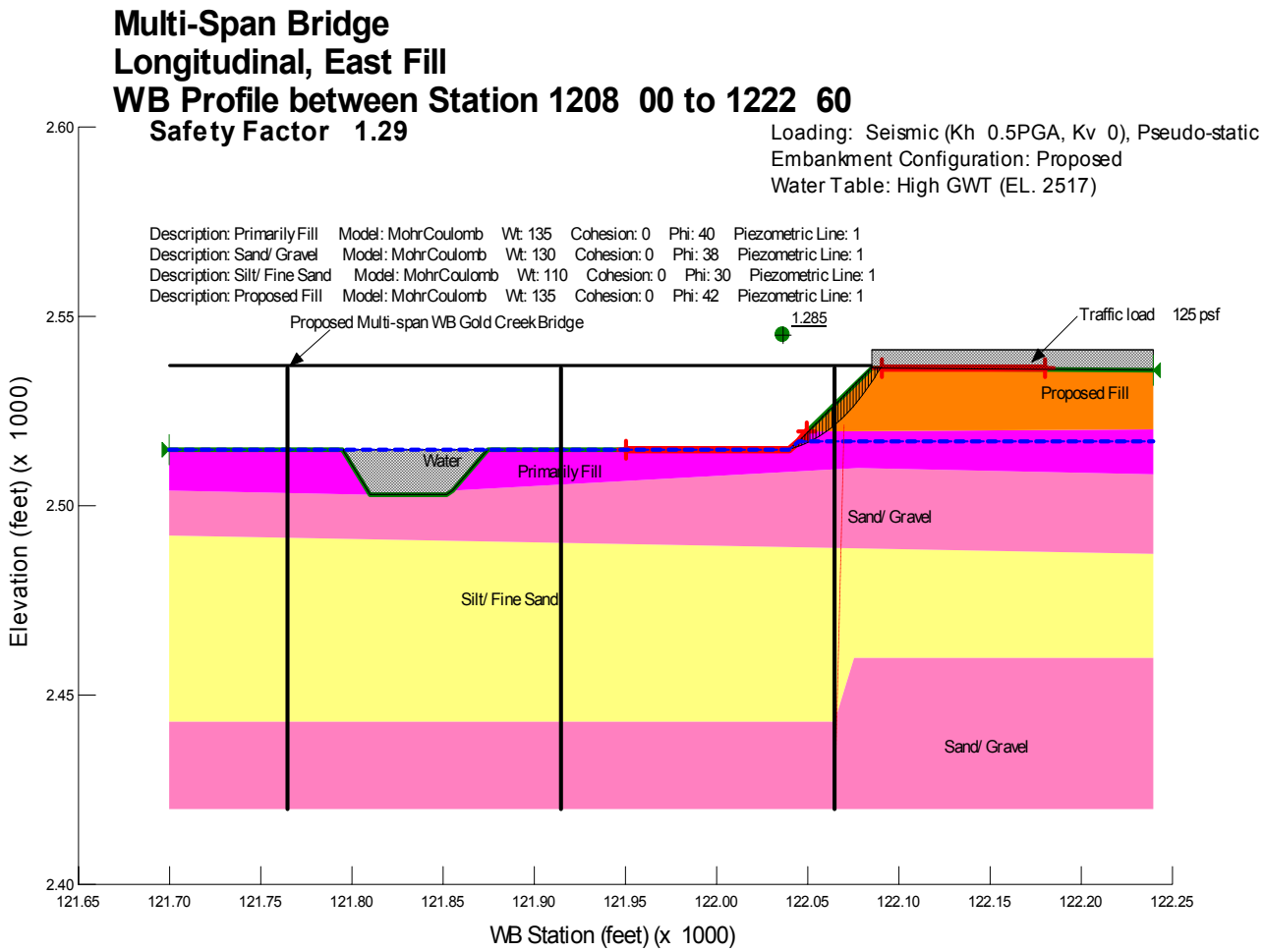


Job No. 33758579

Figure D49

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

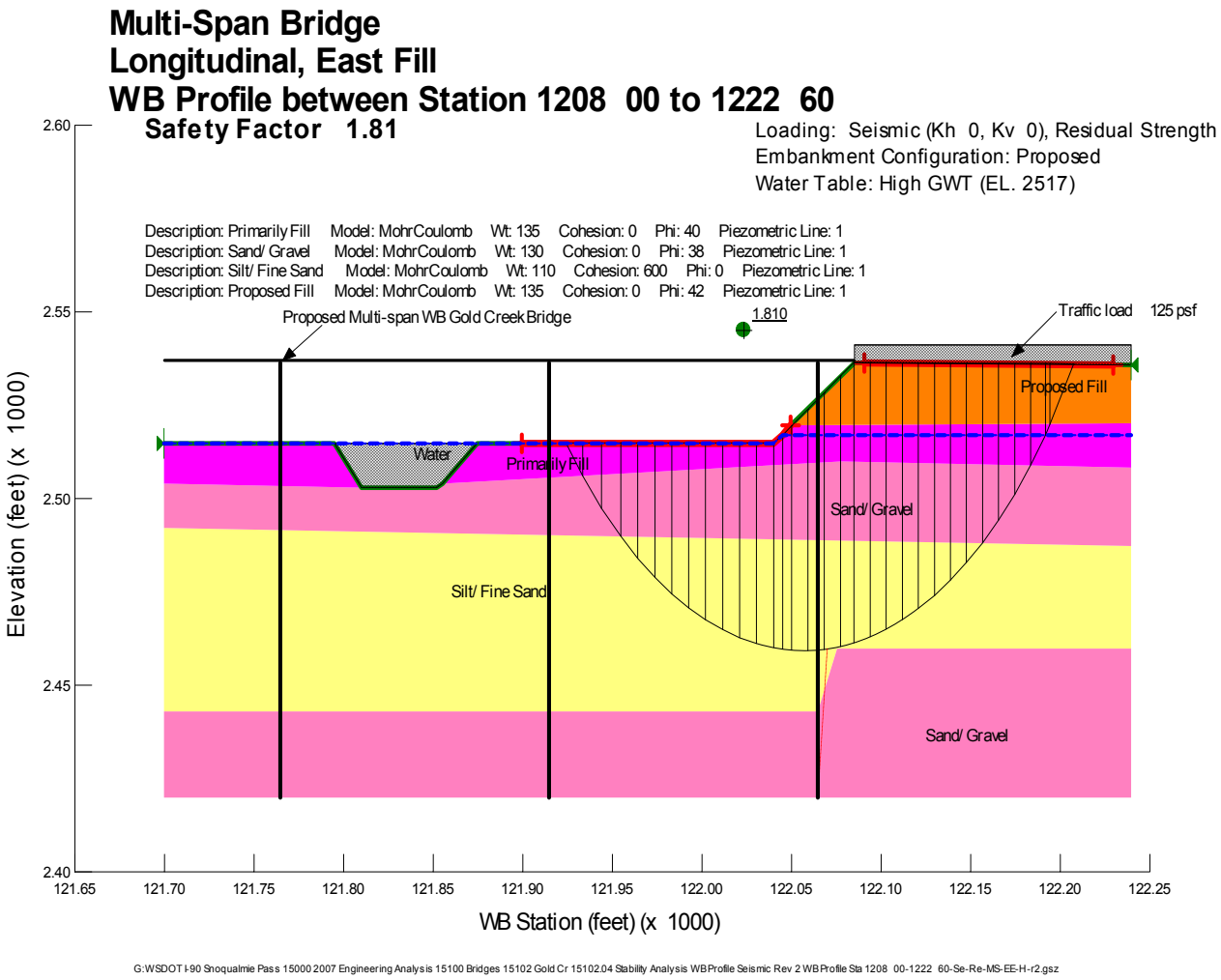


Job No. 33758579

Figure D50

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758579

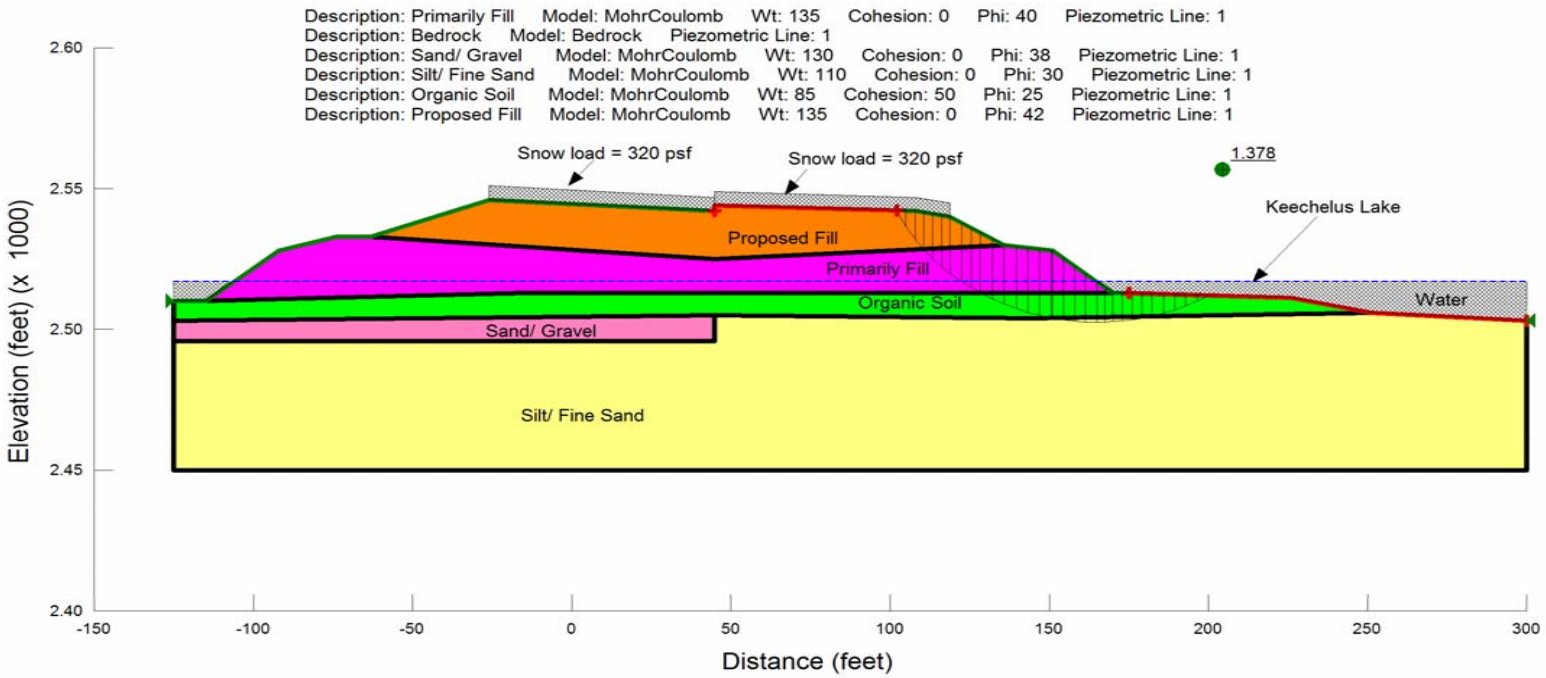
Figure D51

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.38

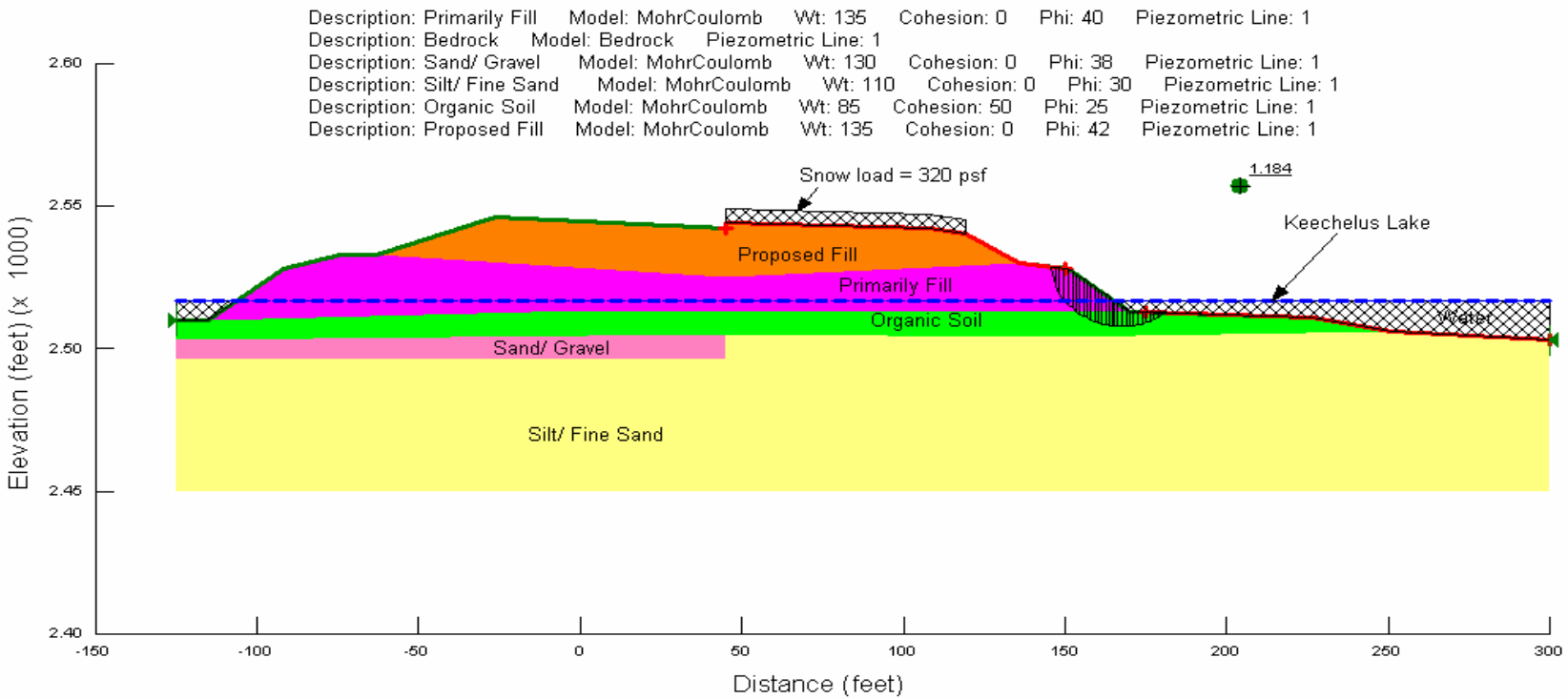
Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1210+50-R-St-H-r3-040208.g

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.18

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1210+50-R-Sl-Loc-H-r2.gsz

Job No. 33758579

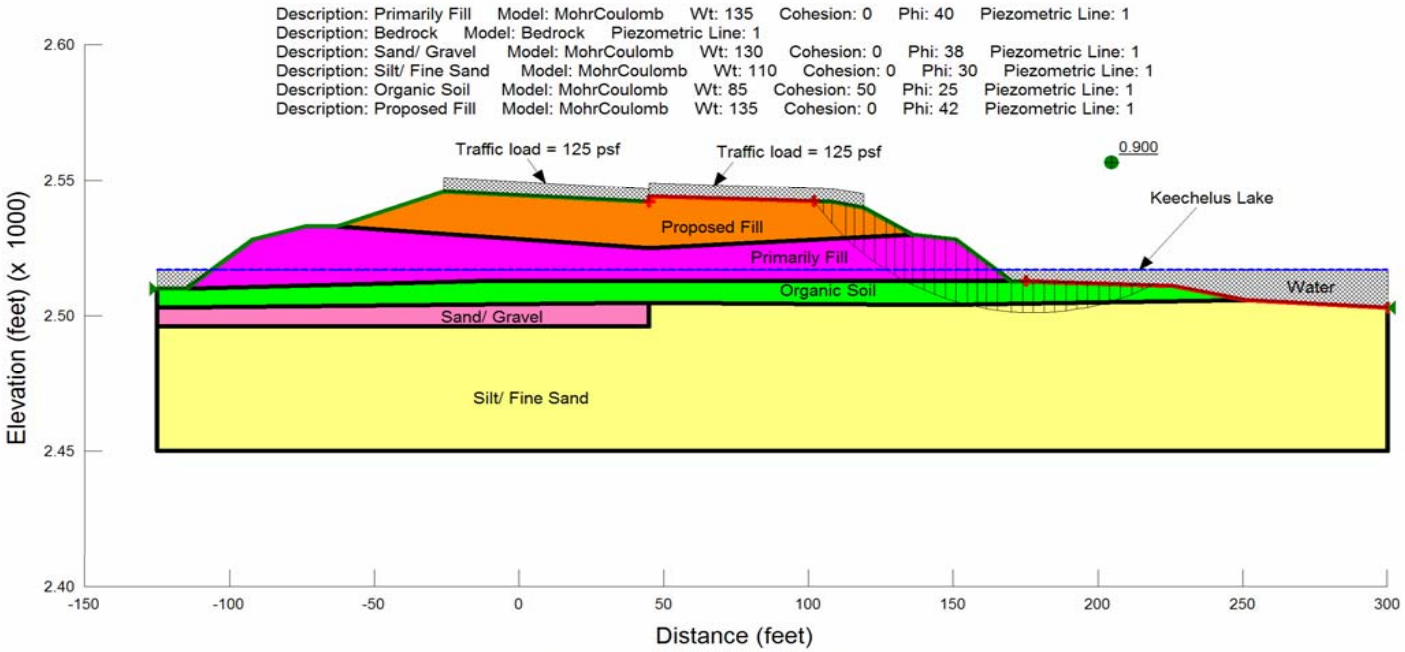
Figure D53

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 0.90

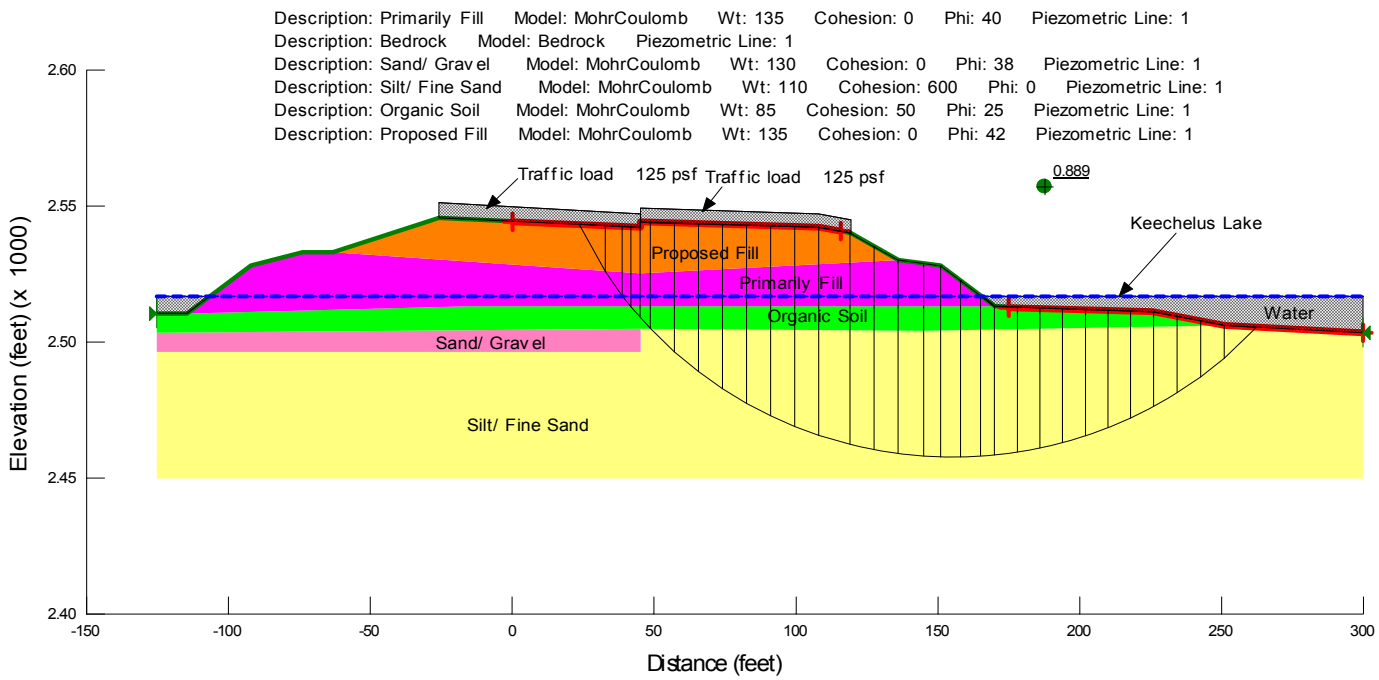
Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Se-H-r3-040208.gsz

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210 50
Safety Factor 0.89

Loading: Seismic (Kh 0, Kv 0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass 15000 2007 Engineering Analysis 15100 Bridges 15102 Gold Cr 15102.04 Stability Analysis EB Embankment Seismic Rev 2 WB Sta 1210 50-R-Se-Re-H-r2.gsz

Job No. 33758579

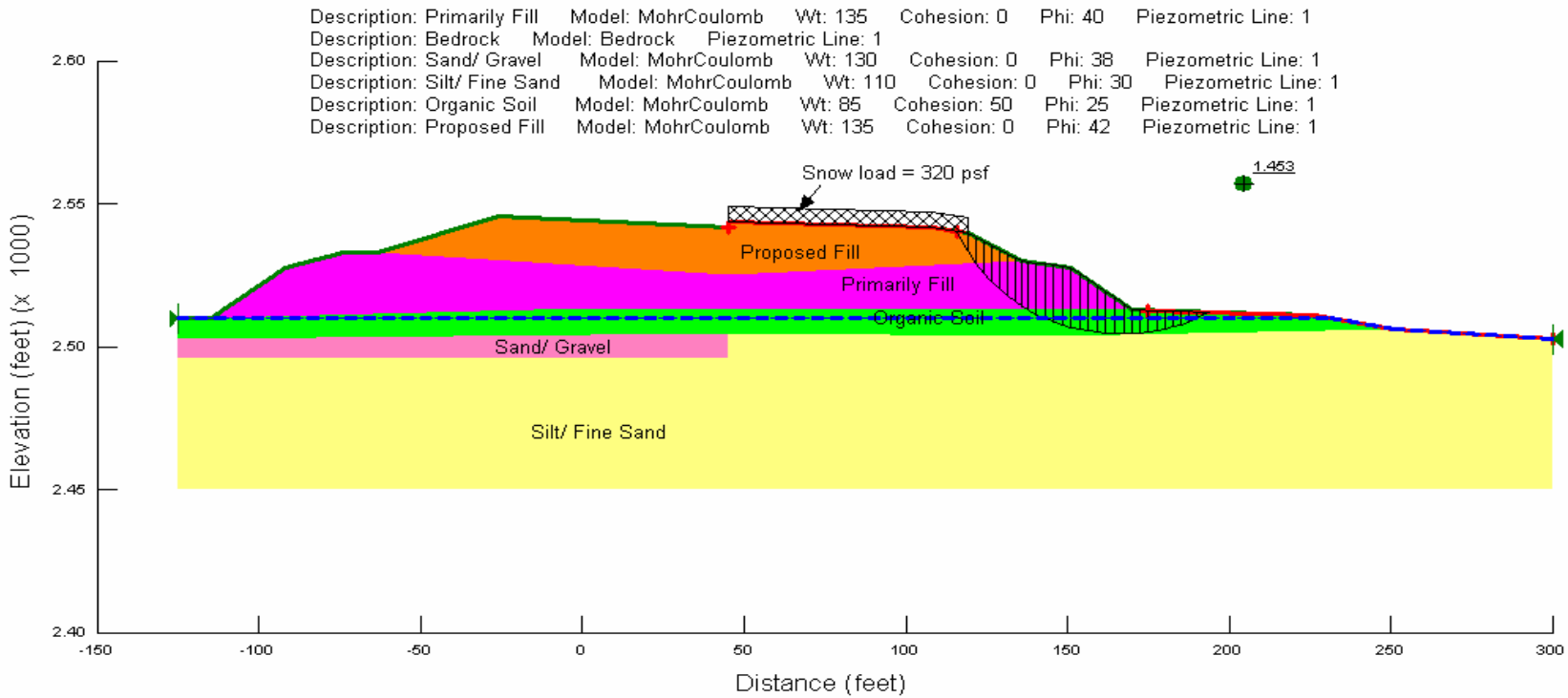
Figure D55

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.45

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1210+50-R-Sft-D-r2.gsz

Job No. 33758579

Figure D56

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

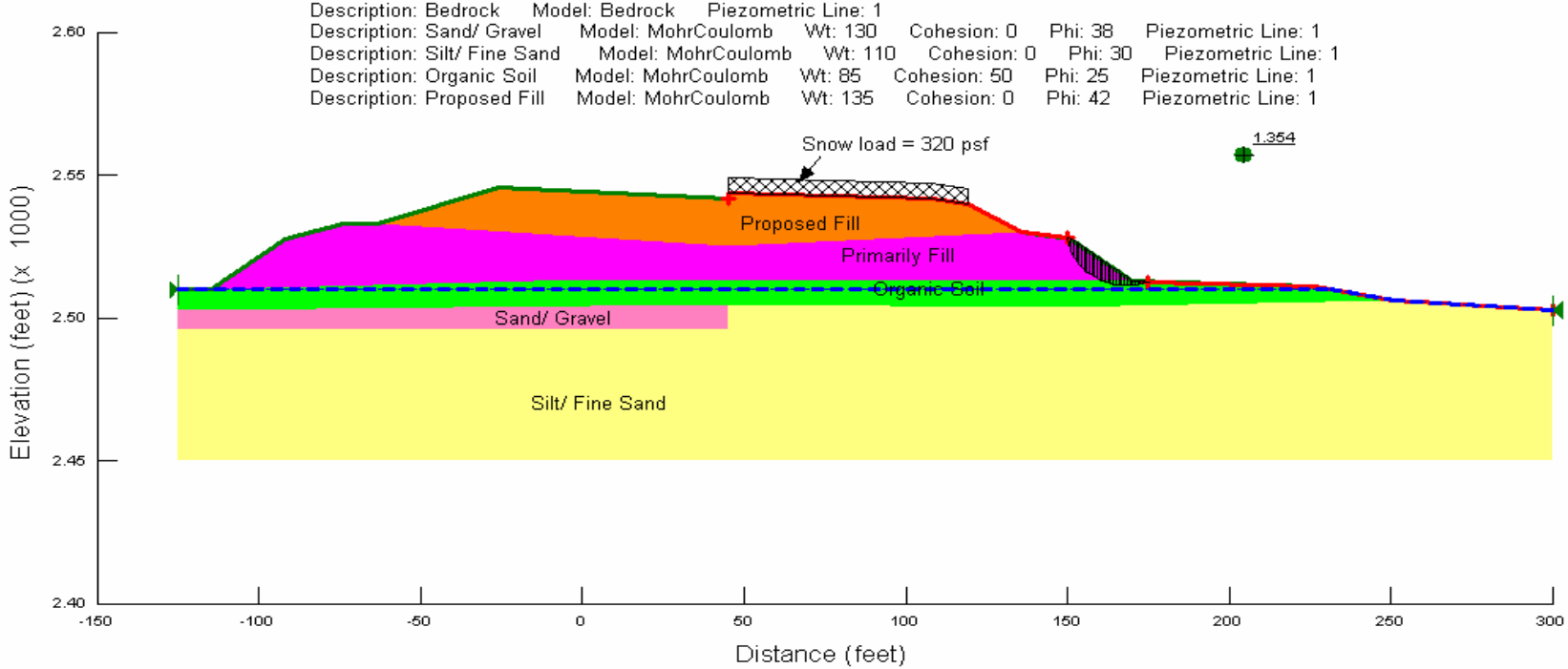
Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50

Safety Factor = 1.35*

* Found lower F.S. than the reported value but to show the clear failure surface we did not report it here.

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Static\Rev 2\WB Sta 1210+50-R-Sft-Loc-D-r2.gsz

Job No. 33758579

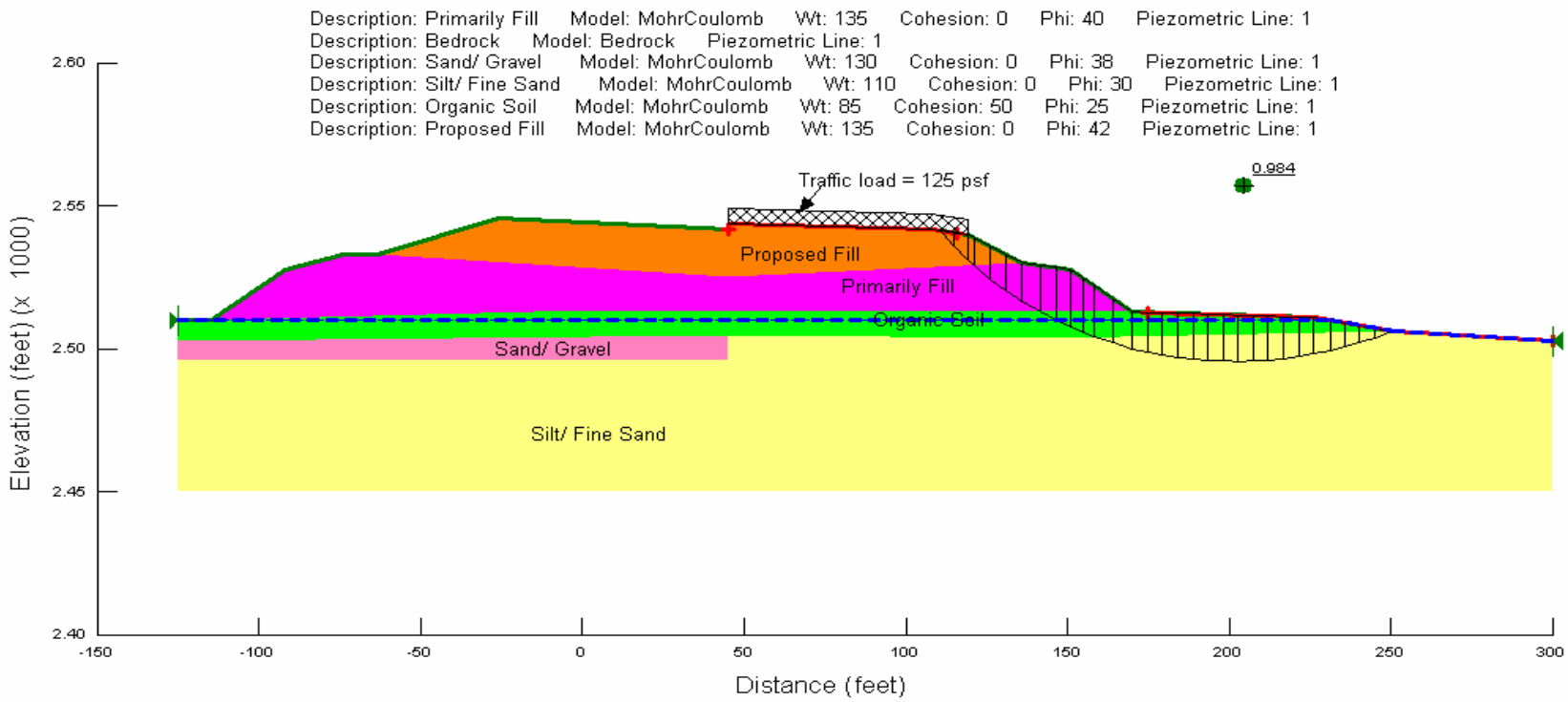
Figure D57

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor =0.98

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Se-D-r3.gsz

Job No. 33758579

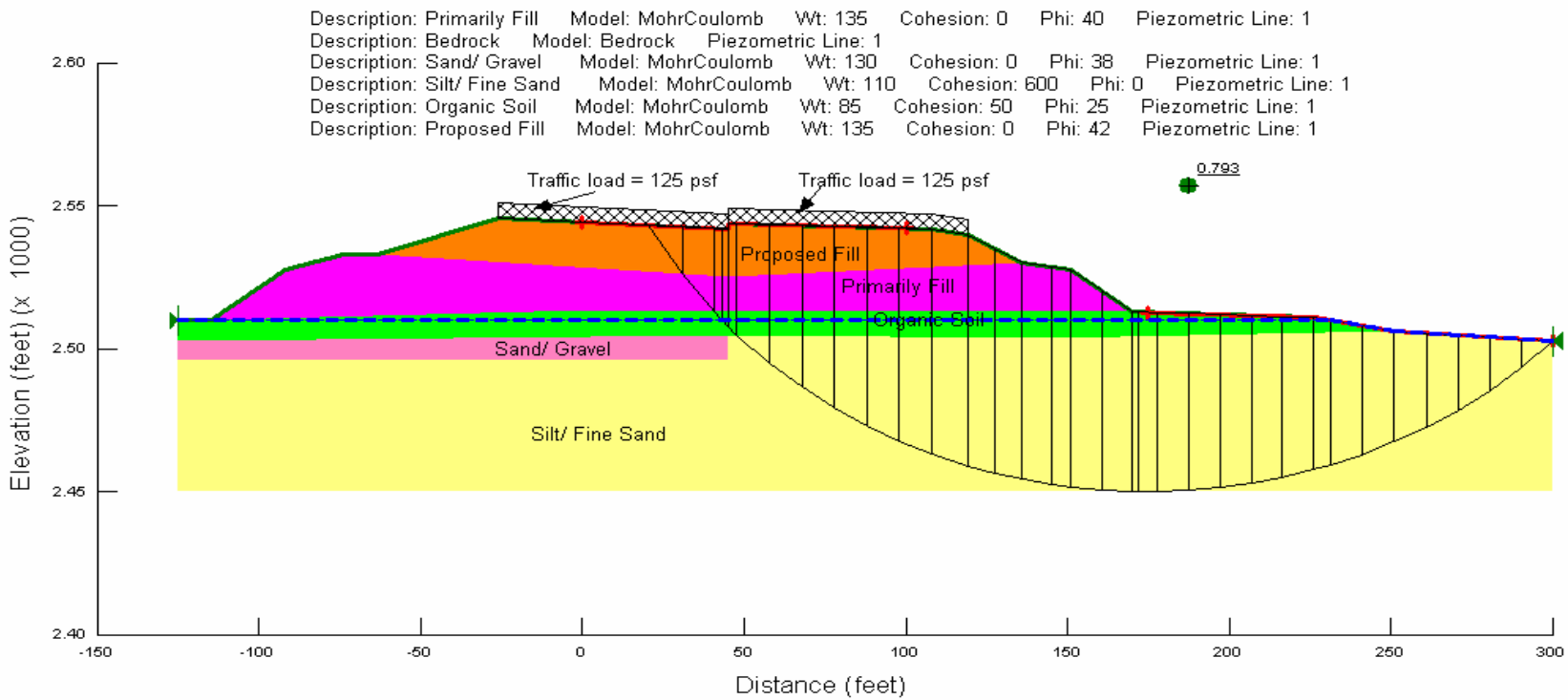
Figure D58

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor =0.79

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\WB Sta 1210+50-R-Se-Re-D-r2.gsz

Job No. 33758579

Figure D59

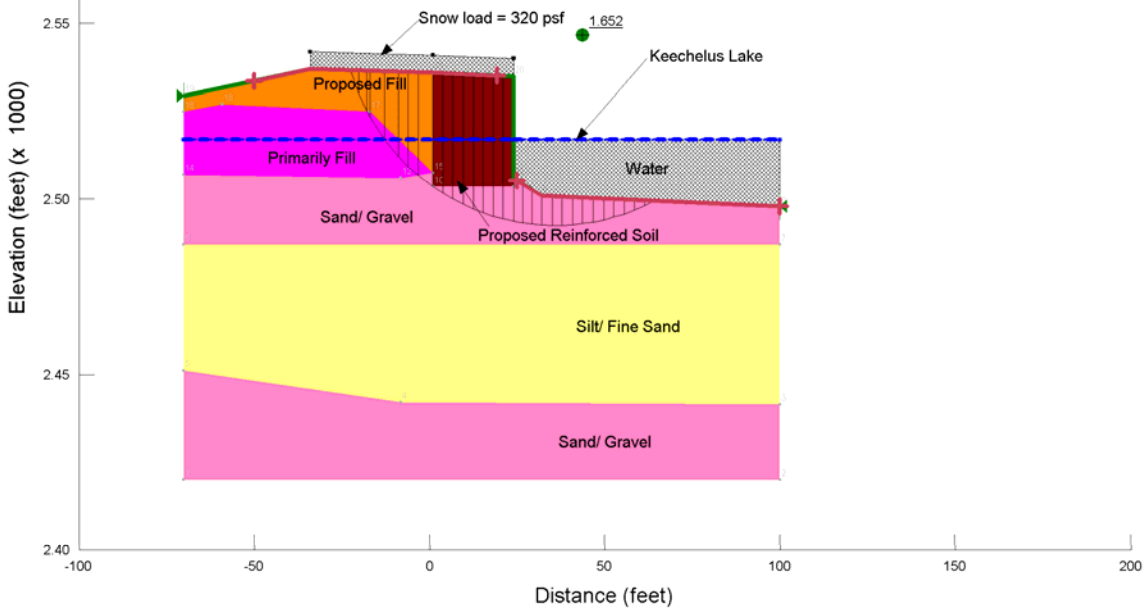
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69
Safety Factor = 1.65

Loading: Static
Embankment Configuration: Proposed prior to soil improvement
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102 04 Stability Analysis\EB Embankment\Static\Rev 2\EB Sta 1221+69-R-St-H-r2-010408.gsz

Job No. 33758579

Figure D60

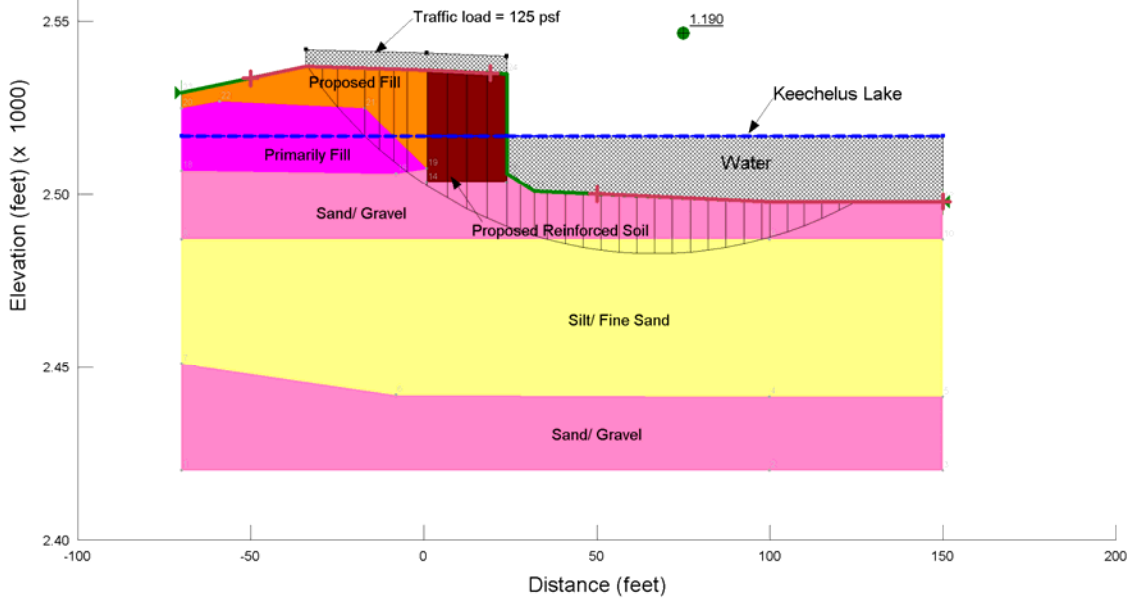
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69
Safety Factor = 1.19

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed prior to soil improvement
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Se-H-r2.gsz

Job No. 33758579

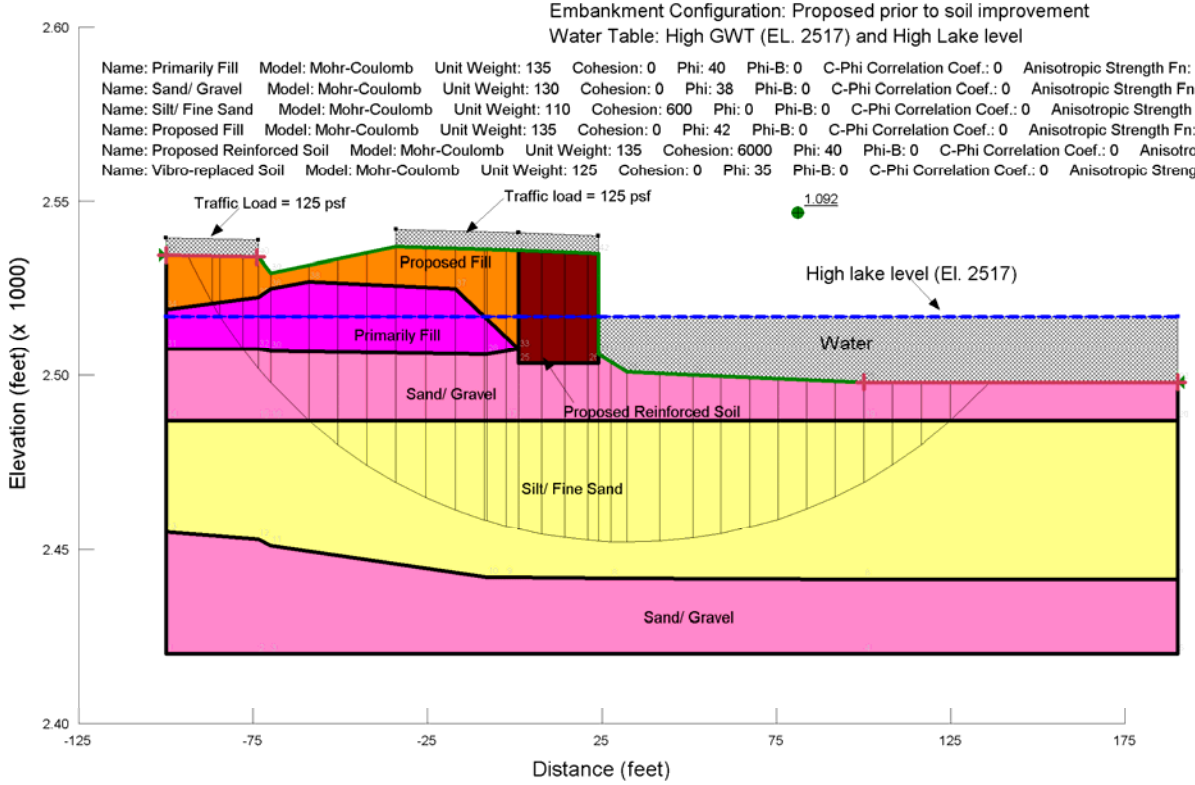
Figure D61

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69

Safety Factor = 1.09

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed prior to soil improvement
Water Table: High GWT (EL. 2517) and High Lake level

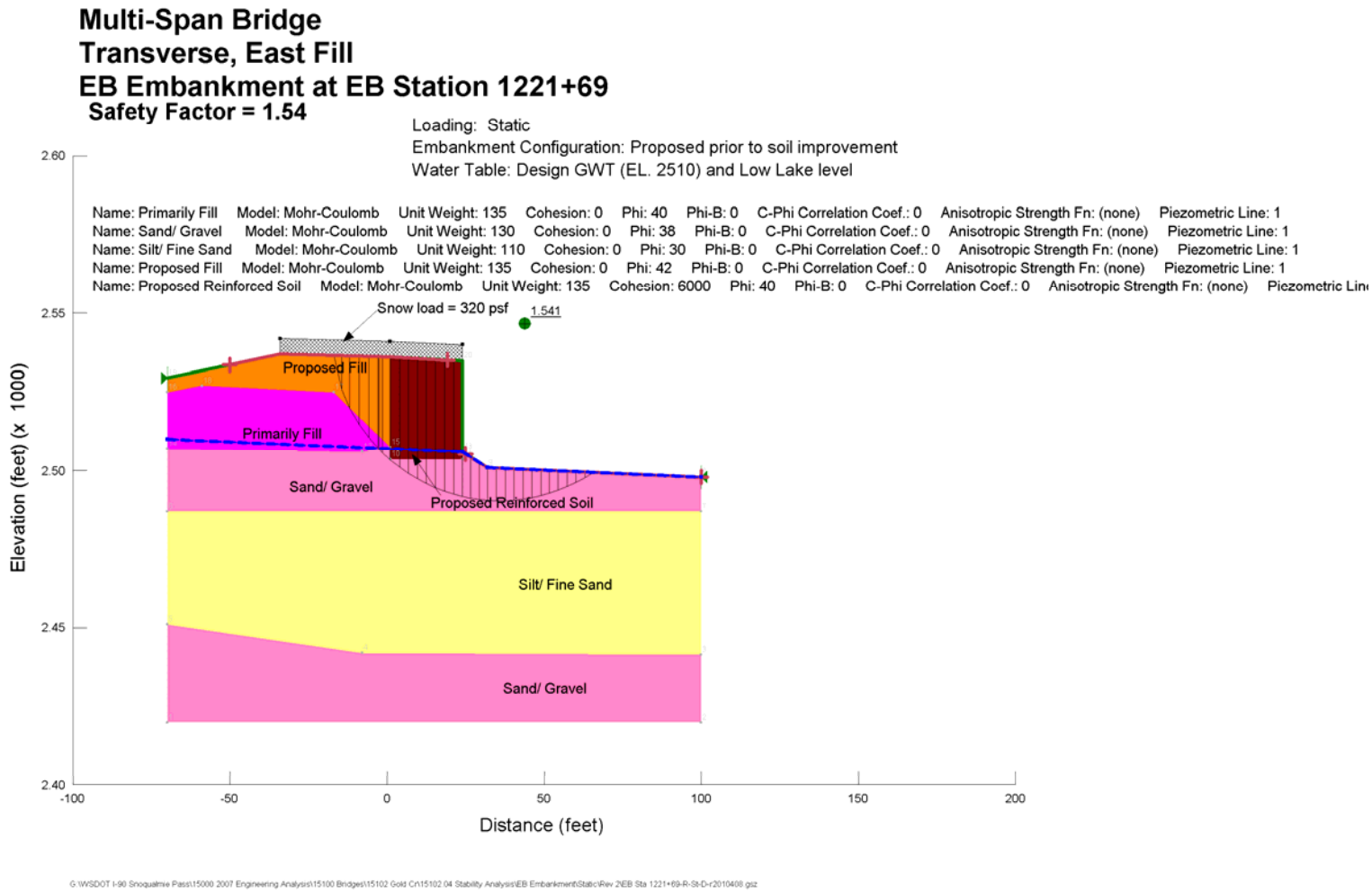
Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 600 Phi: 0 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Se-Re-H-r2.gsz

Job No. 33758579

Figure D62



Job No. 33758579

Figure D63

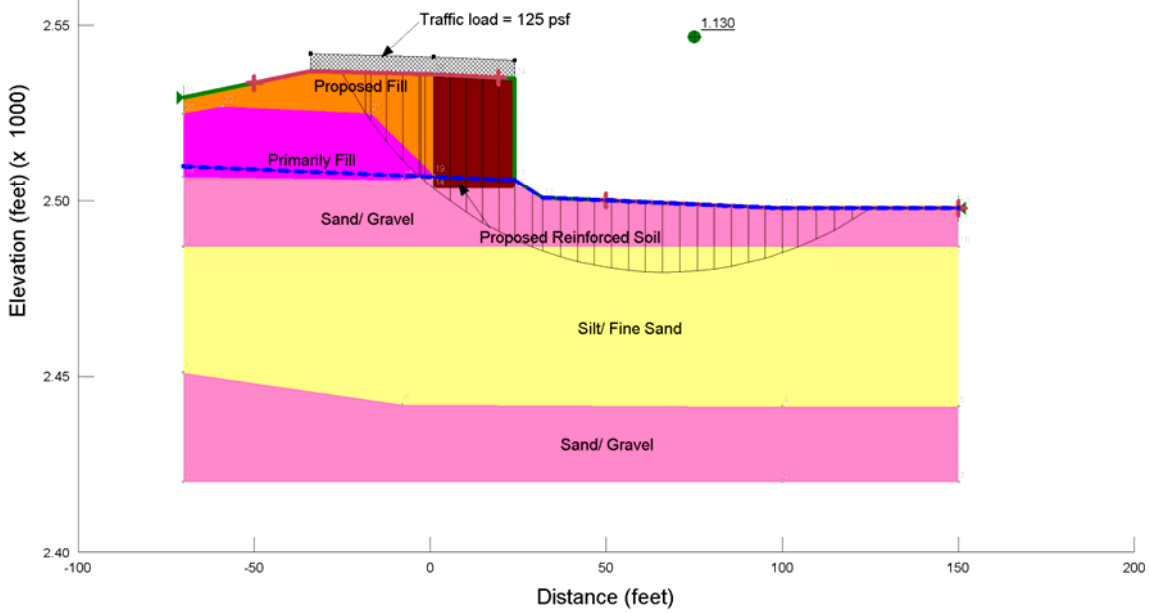
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69
Safety Factor = 1.13

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed prior to soil improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102 04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Se-D-r2.gsz

Job No. 33758579

Figure D64

URS

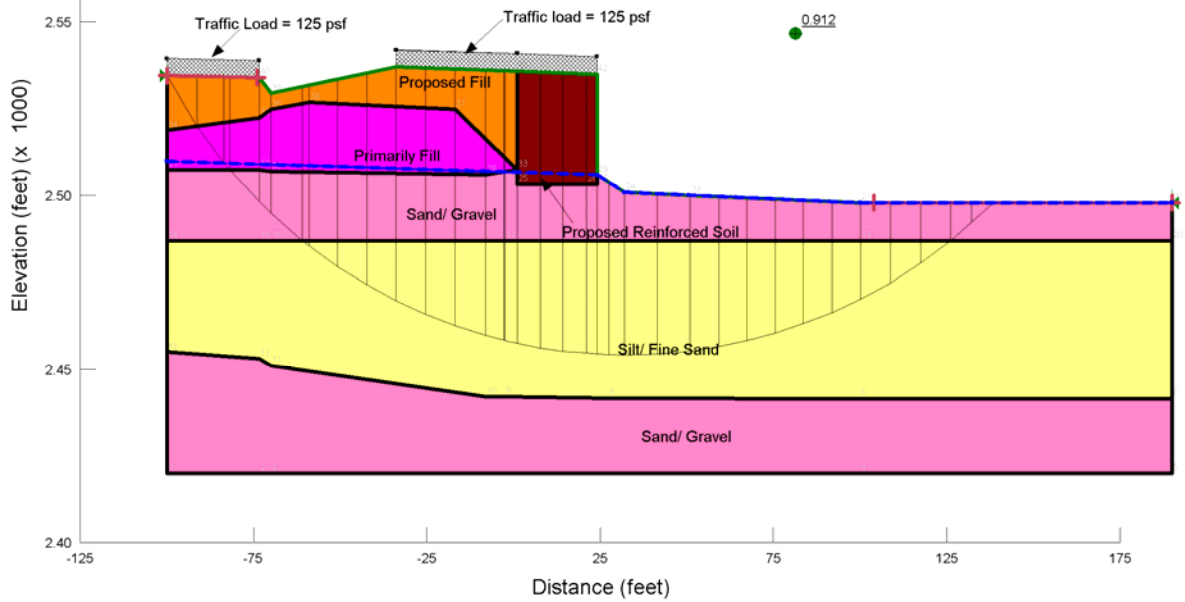
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69

Safety Factor = 0.91

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed prior to soil improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

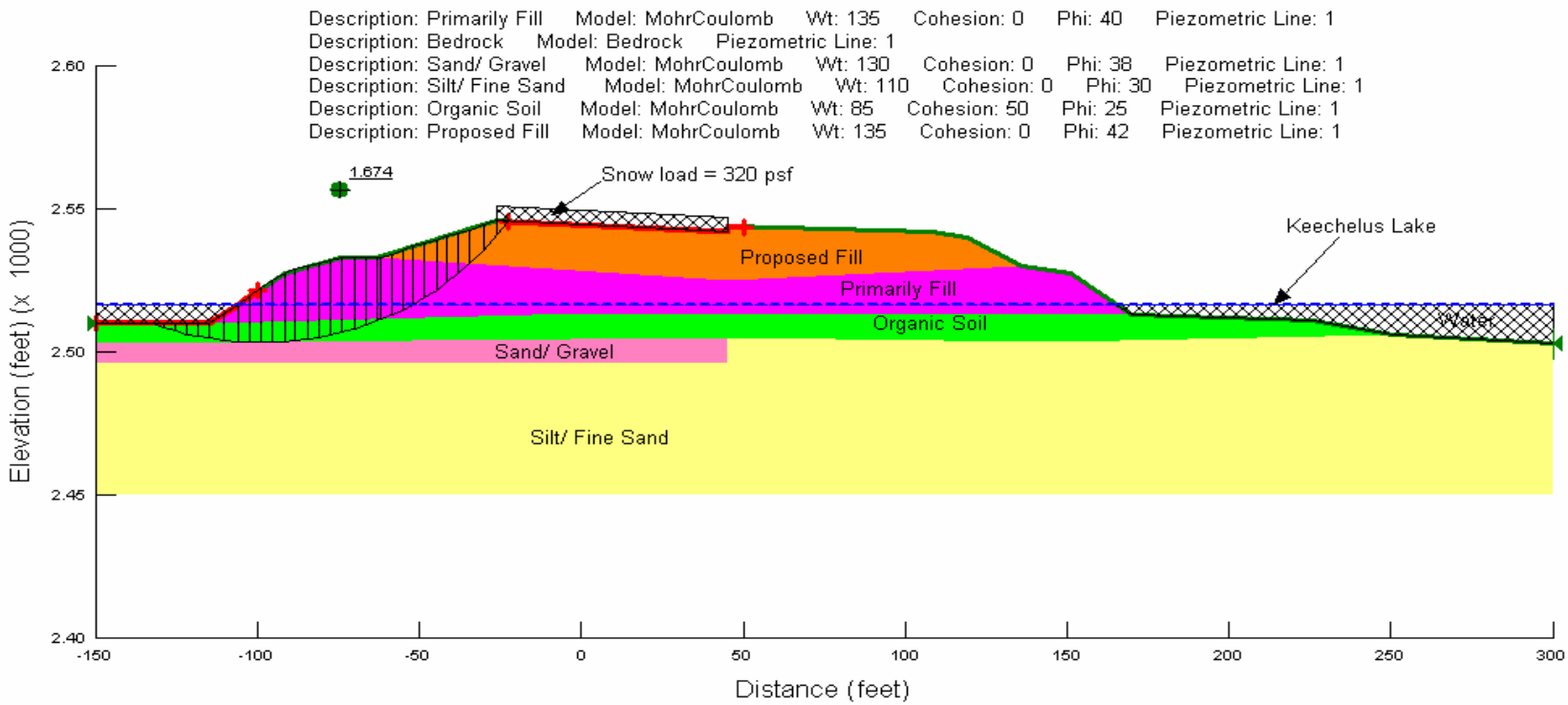
Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 600 Phi: 0 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Se-Re-D-r2.gsz

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.67

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Static\Rev 3\WB Sta 1210+50-L-St-H-r3.gsz

Job No. 33758579

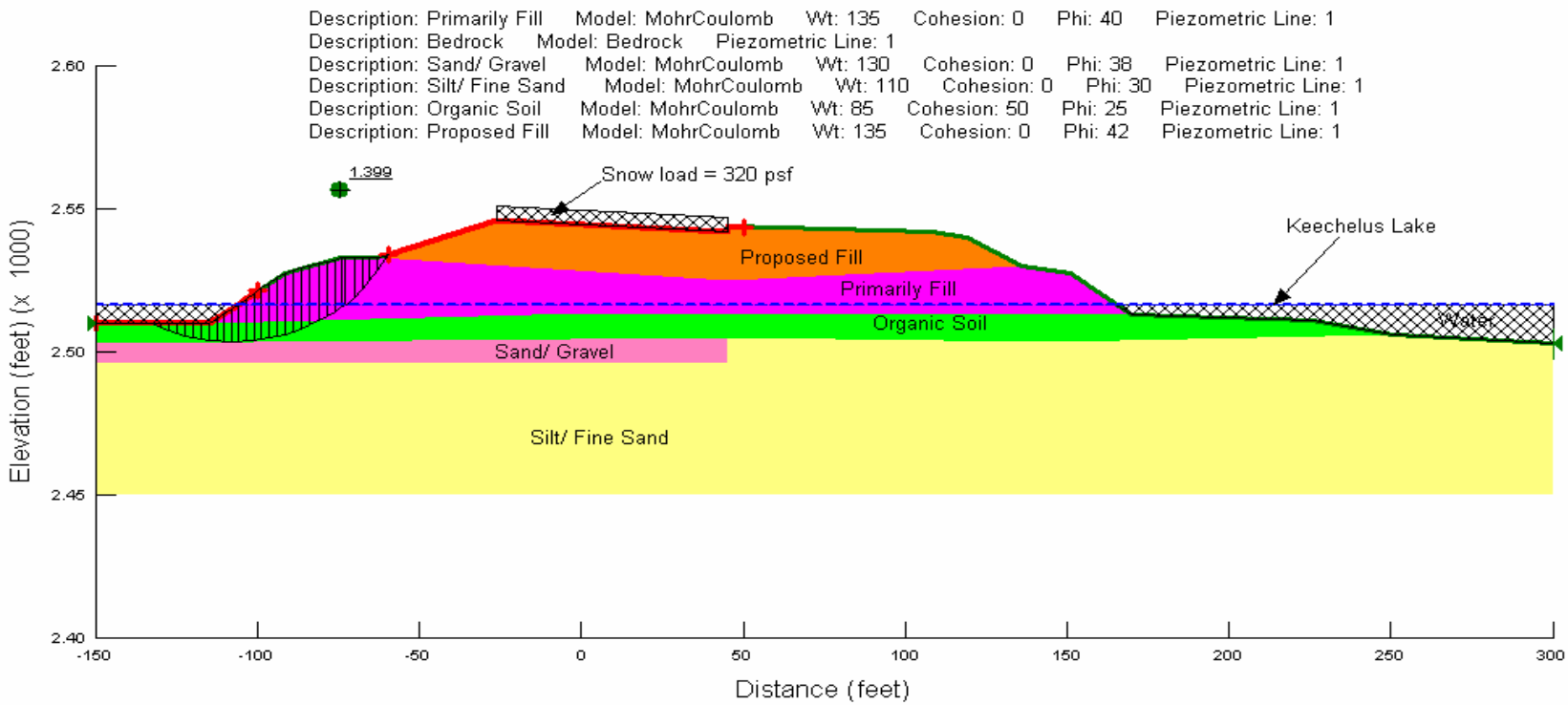
Figure D66

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.40*

Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Static\Rev 3\WB Sta 1210+50-L-St-Loc-H-r3.gsz

Job No. 33758579

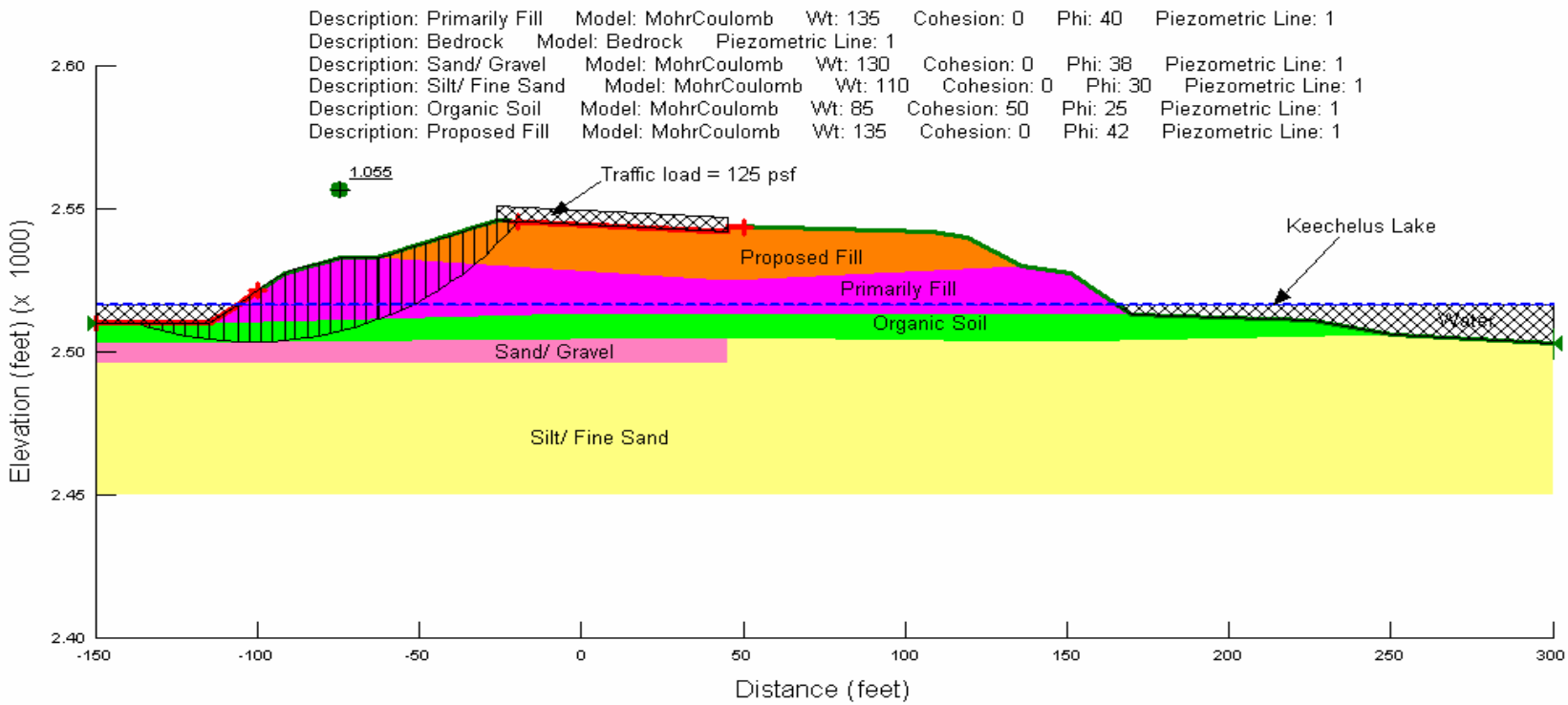
Figure D67

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.06

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 3\WB Sta 1210+50-L-Se-H-r3.gsz

Job No. 33758579

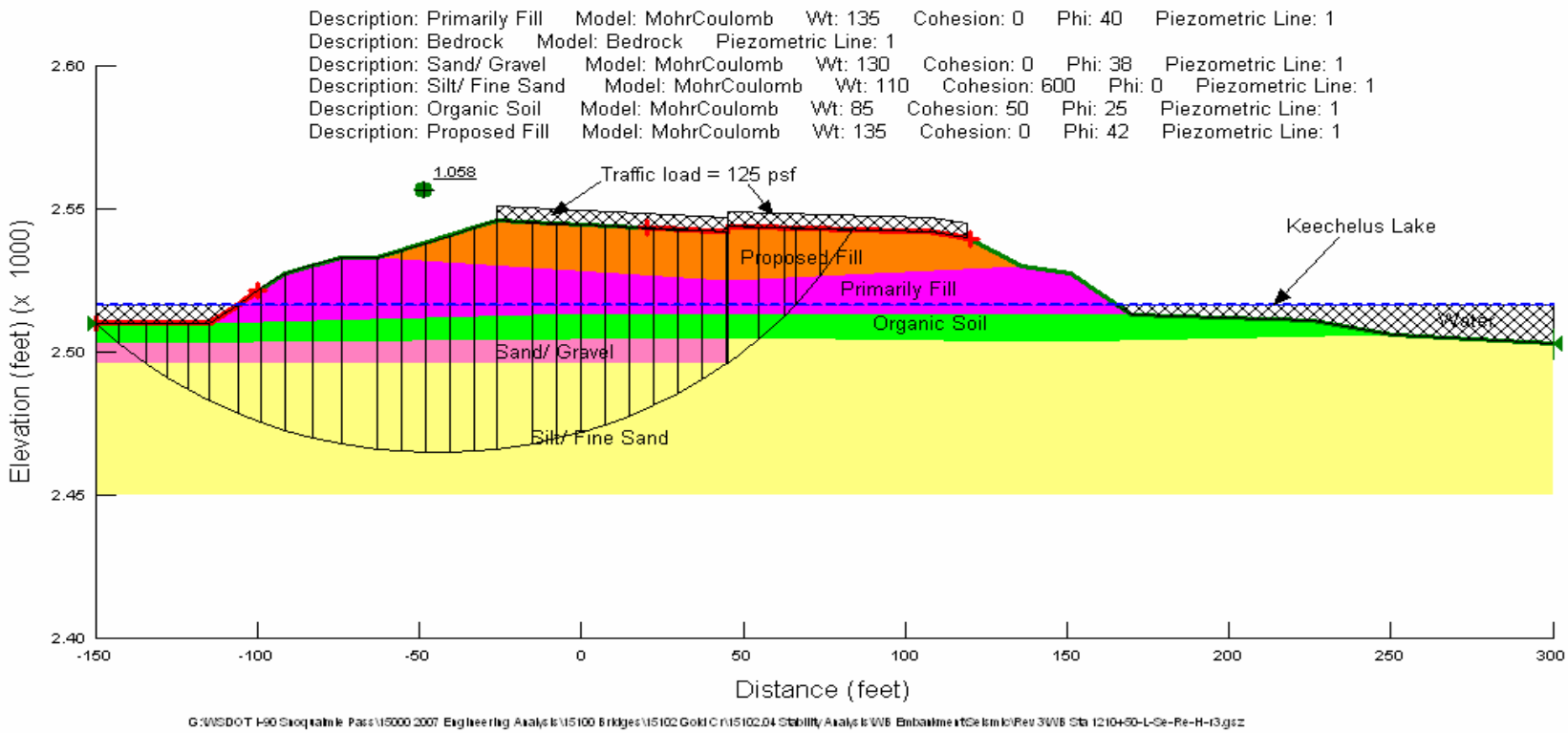
Figure D68

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.06

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 3\WB Sta 1210+50-L-Se-Re-H-r3.gsz

Job No. 33758579

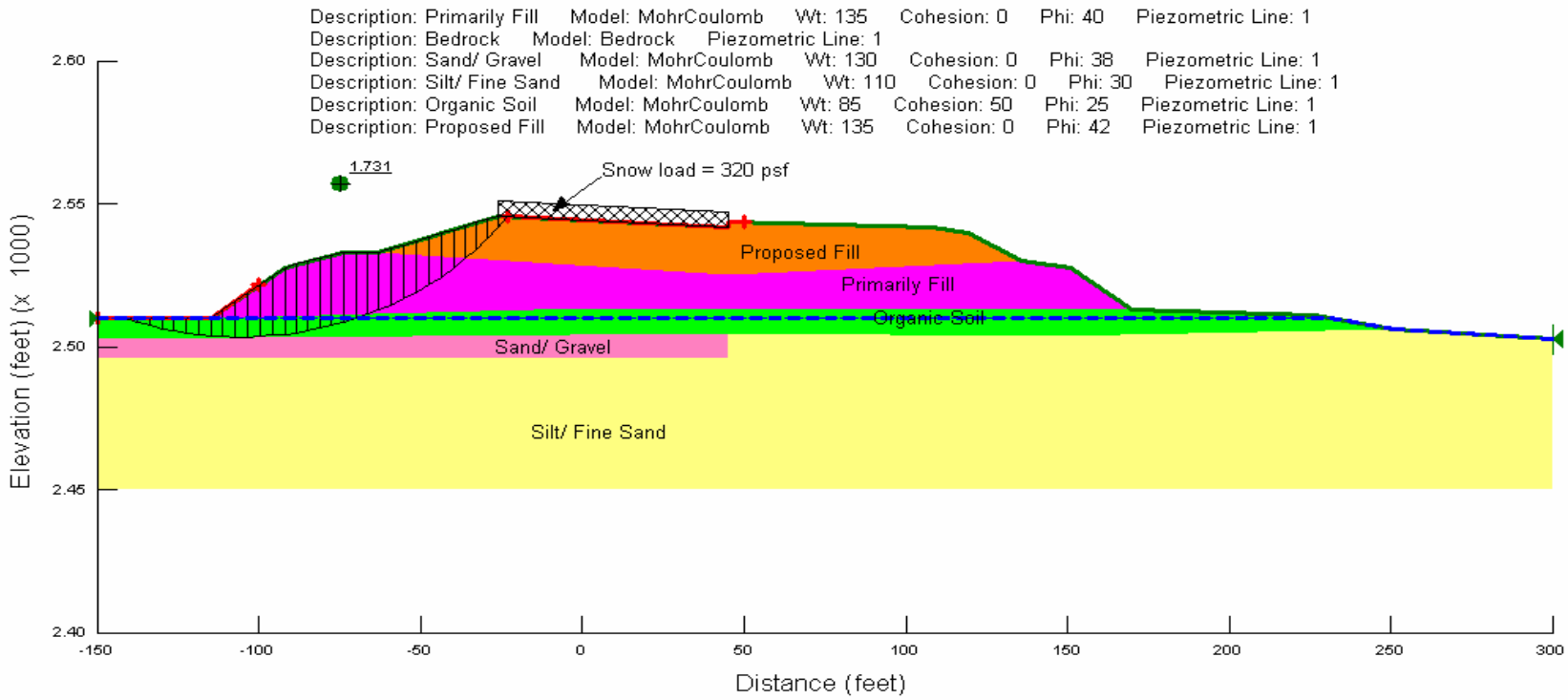
Figure D69

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.73

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\WB Embankment\Static\Rev 2\WB Sta 1210+50-L-St-D-r2.gsz

Job No. 33758579

Figure D70

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

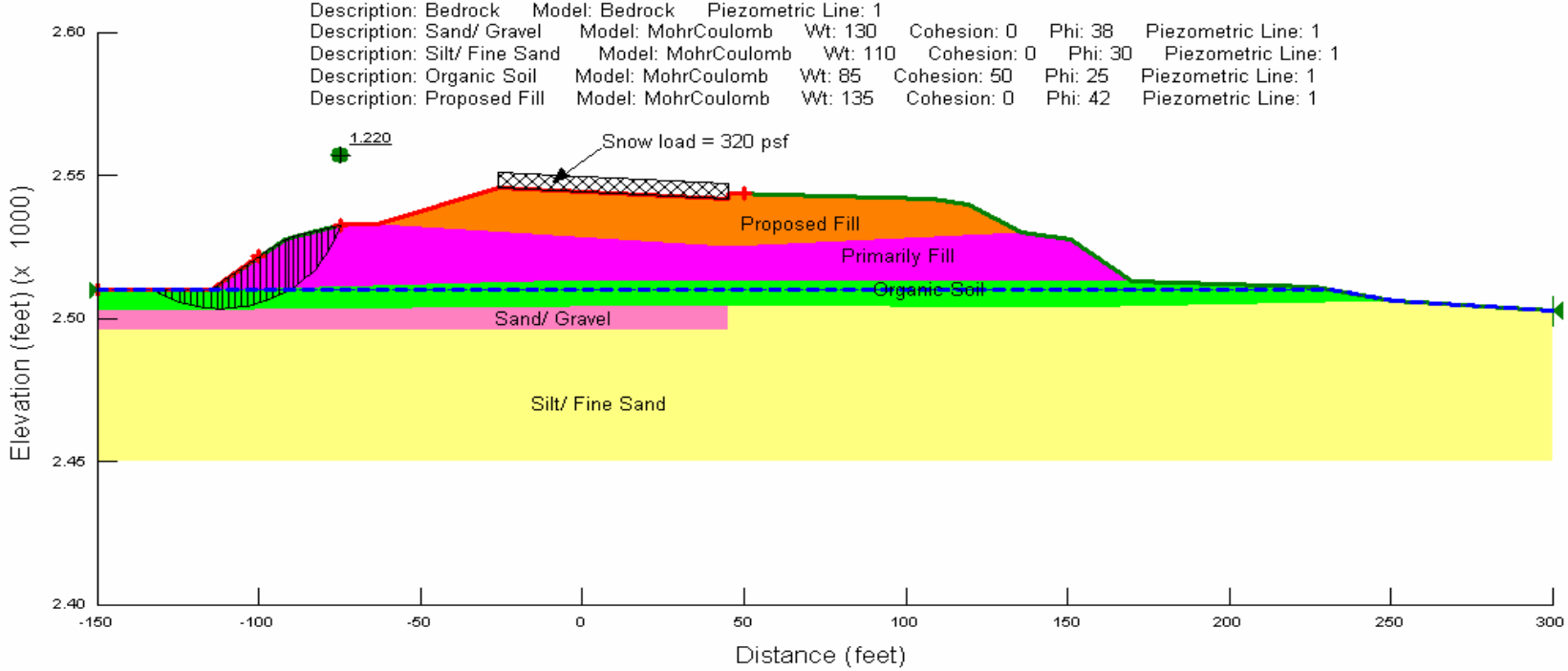
Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50

Safety Factor = 1.22*

*Found lower F.S. than the reported value but to show the clear failure surface we did not report it here

Loading: Static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Creek\15102.04 Stability Analysis\WB Embankment\Static\Rev 2\WB Sta 1210+50-L-St-Loc-D-r2.gsz

Job No. 33758579

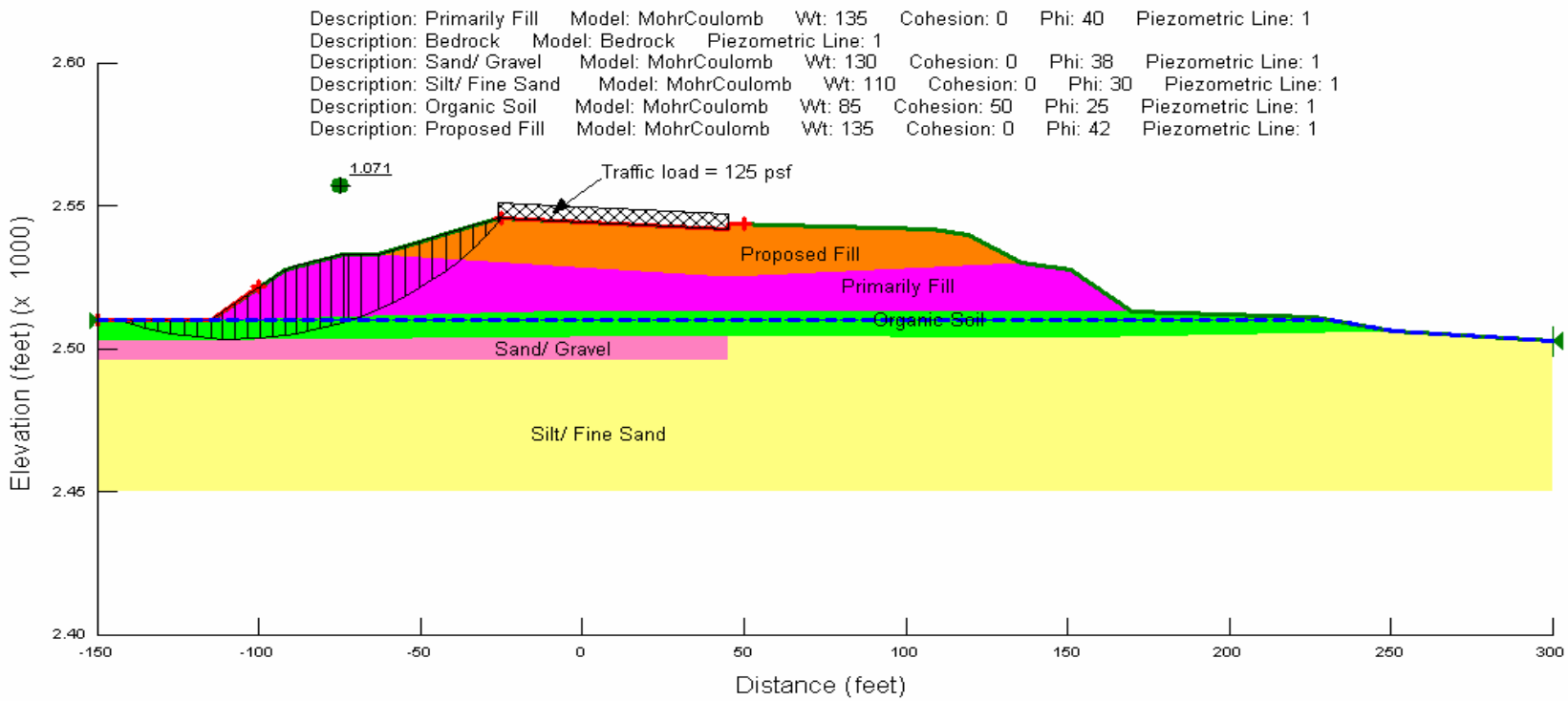
Figure D71

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.07

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Creek\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-L-Se-D-r2.gsz

Job No. 33758579

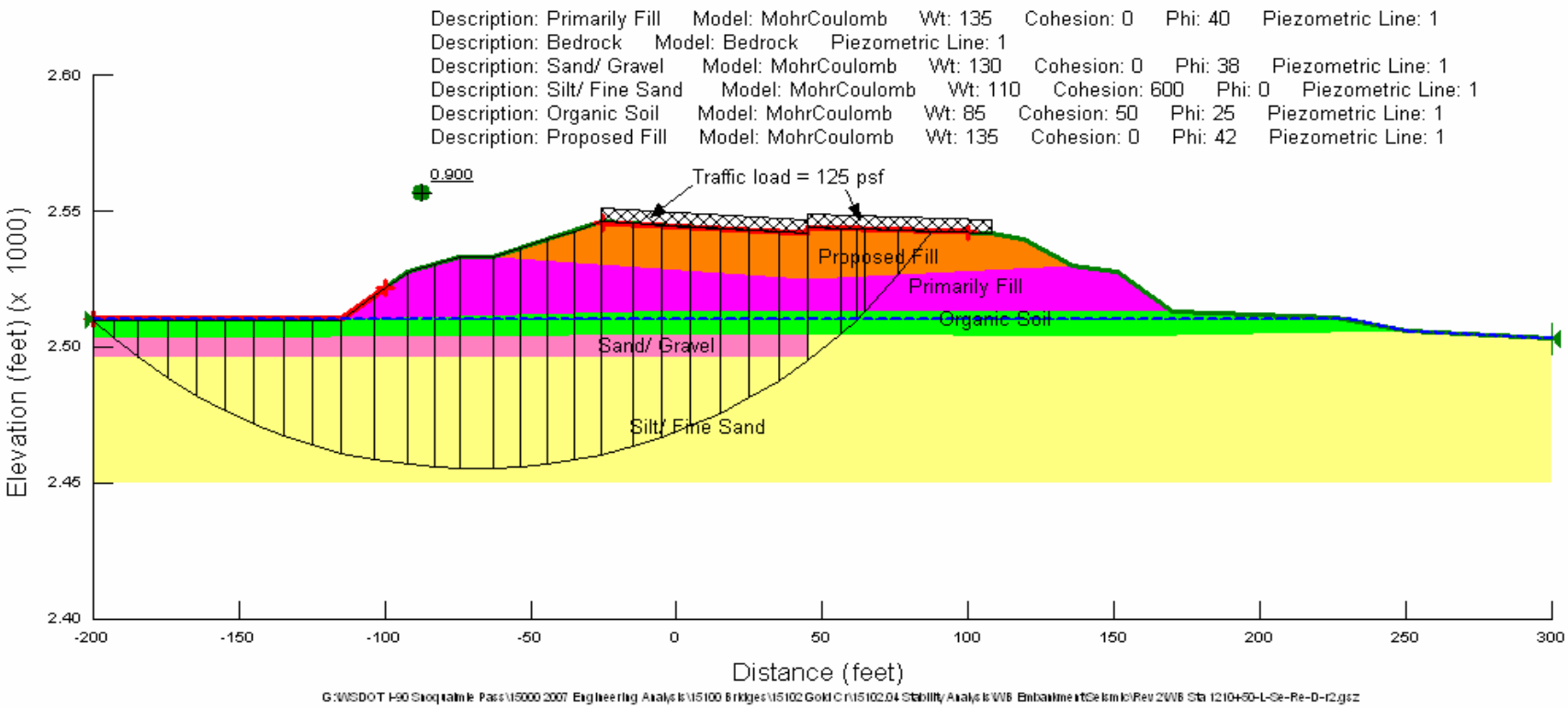
Figure D72

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 0.90

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



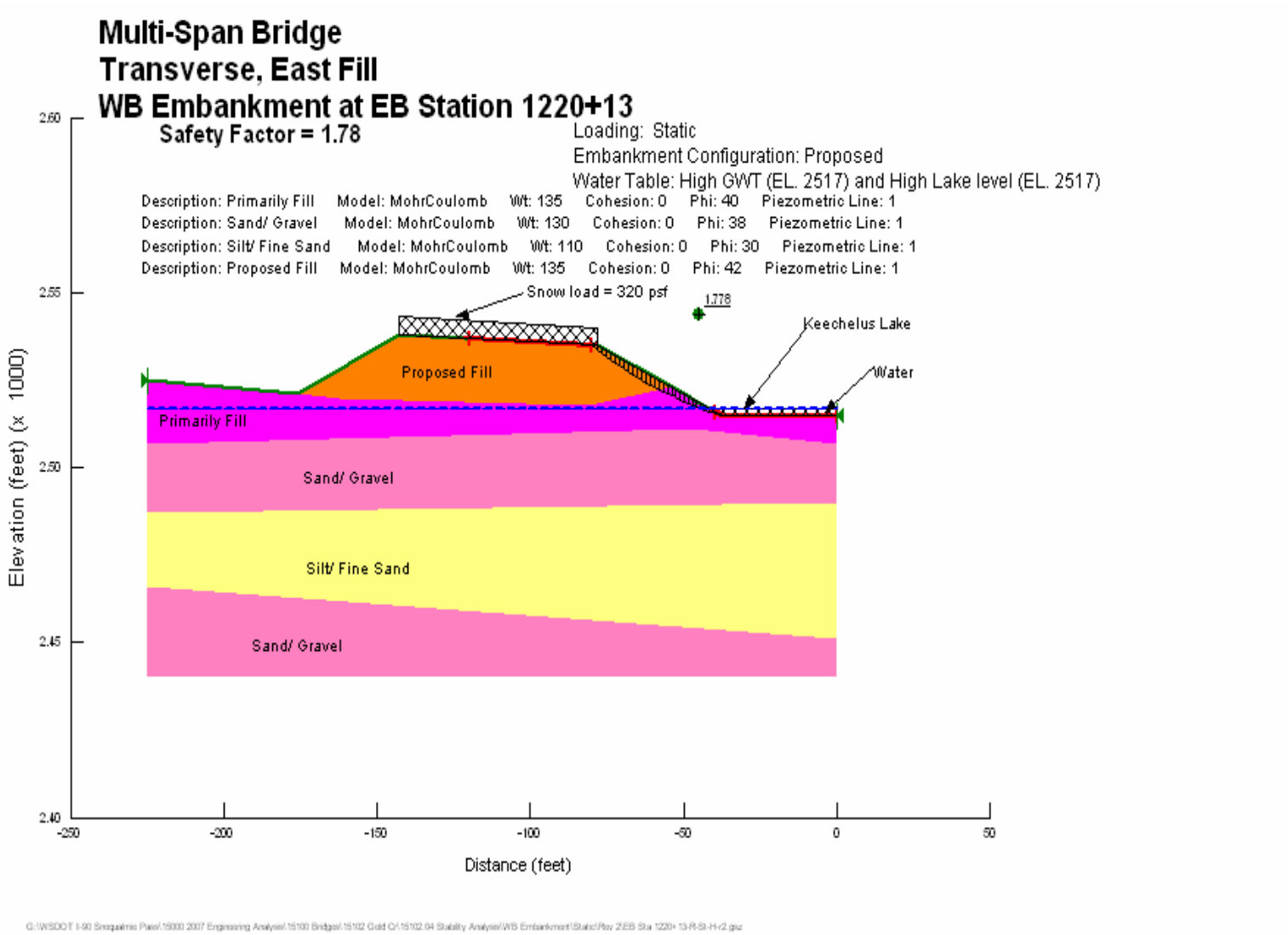
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-L-Se-Re-D-r2.gsz

Job No. 33758579

Figure D73

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

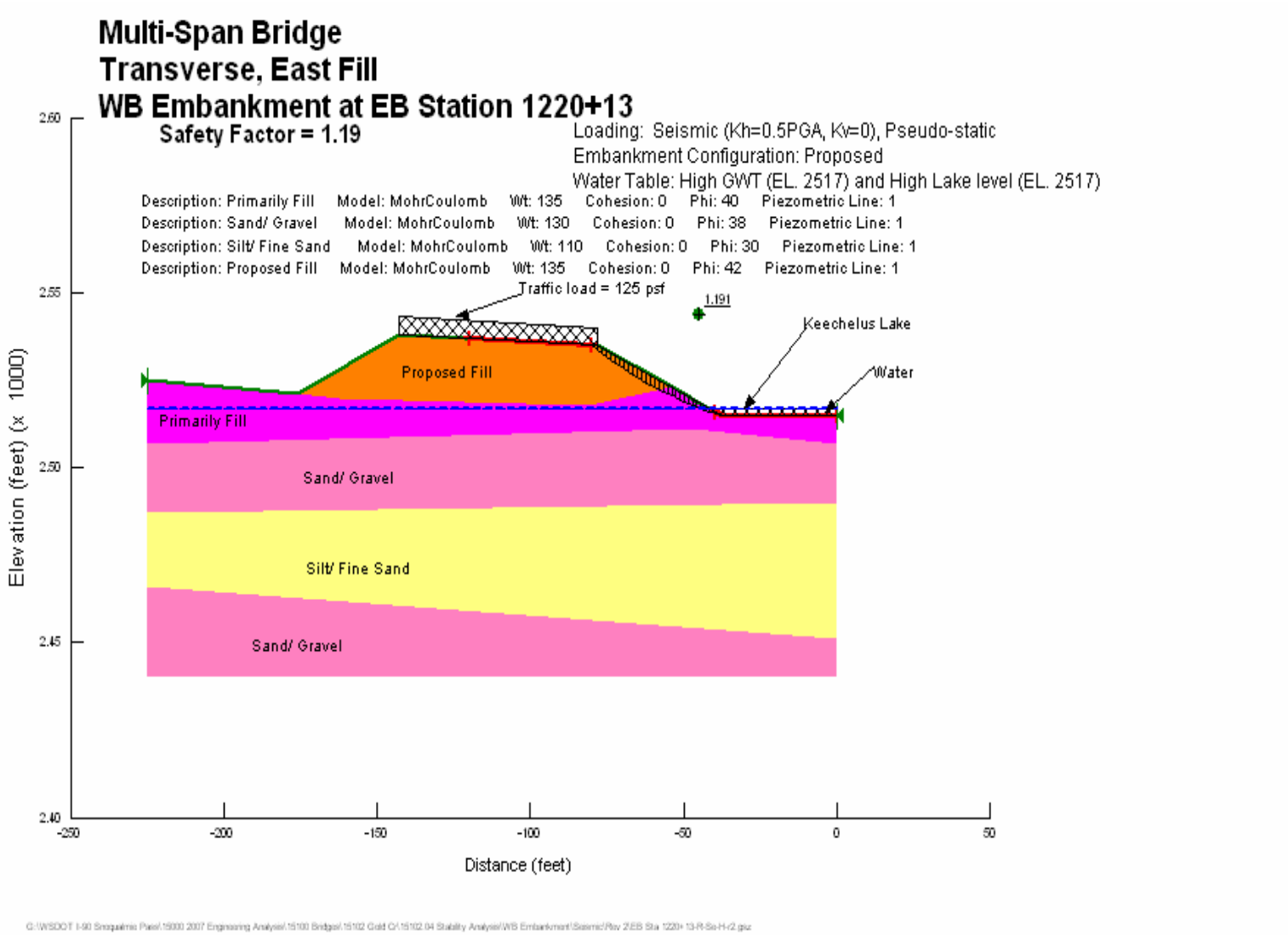


Job No. 33758579

Figure D74

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

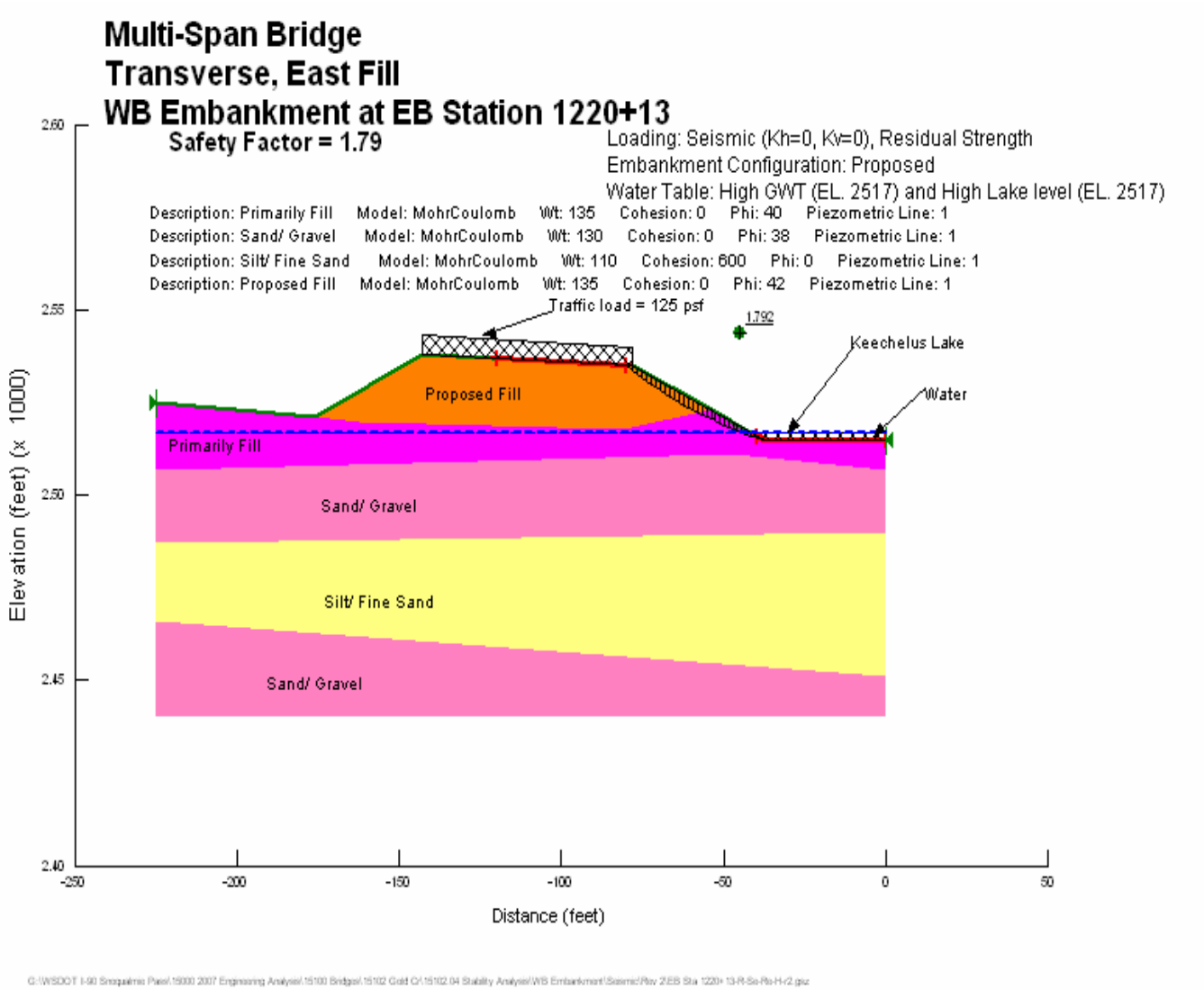


Job No. 33758579

Figure D75

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

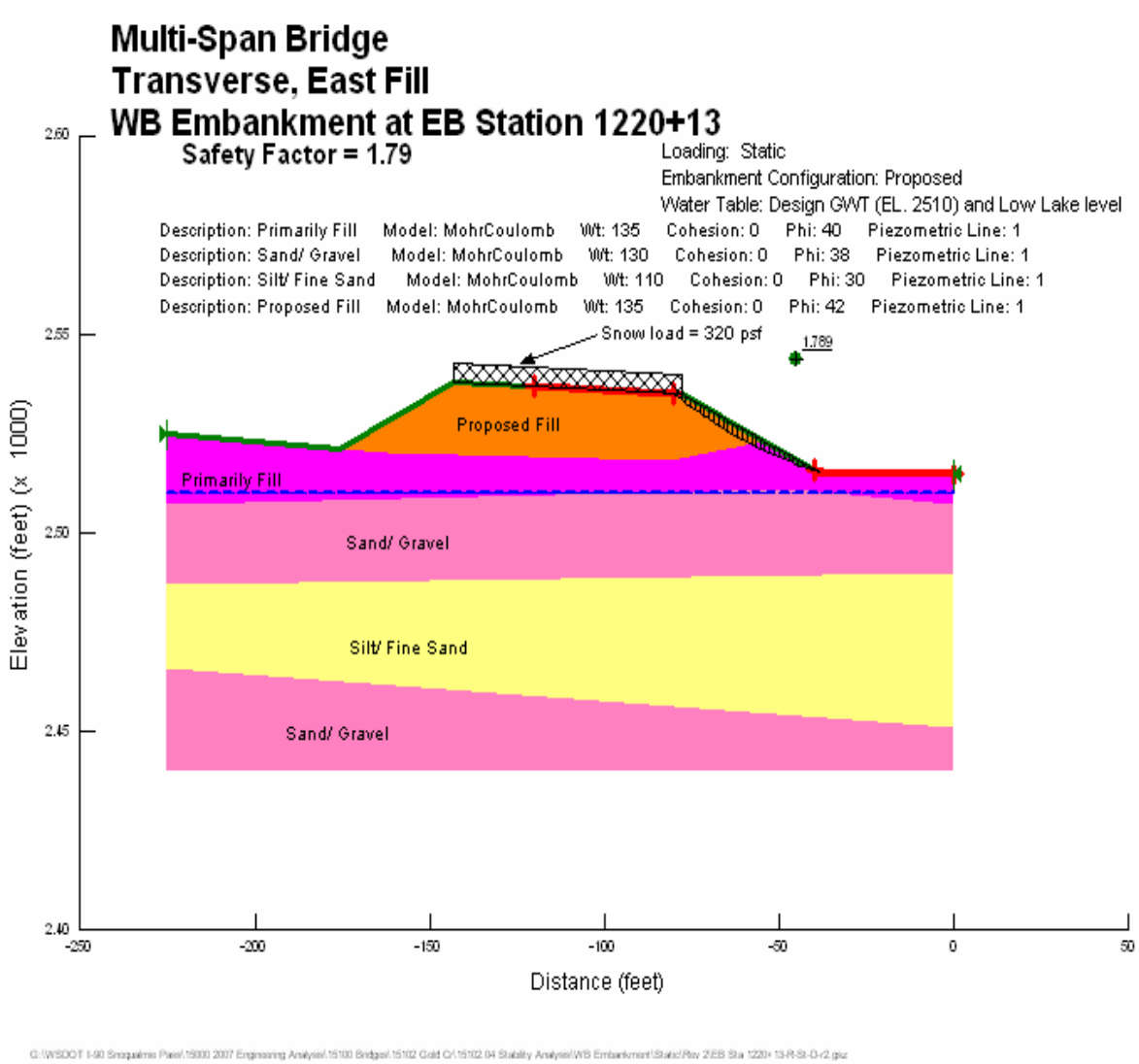


Job No. 33758579

Figure D76

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

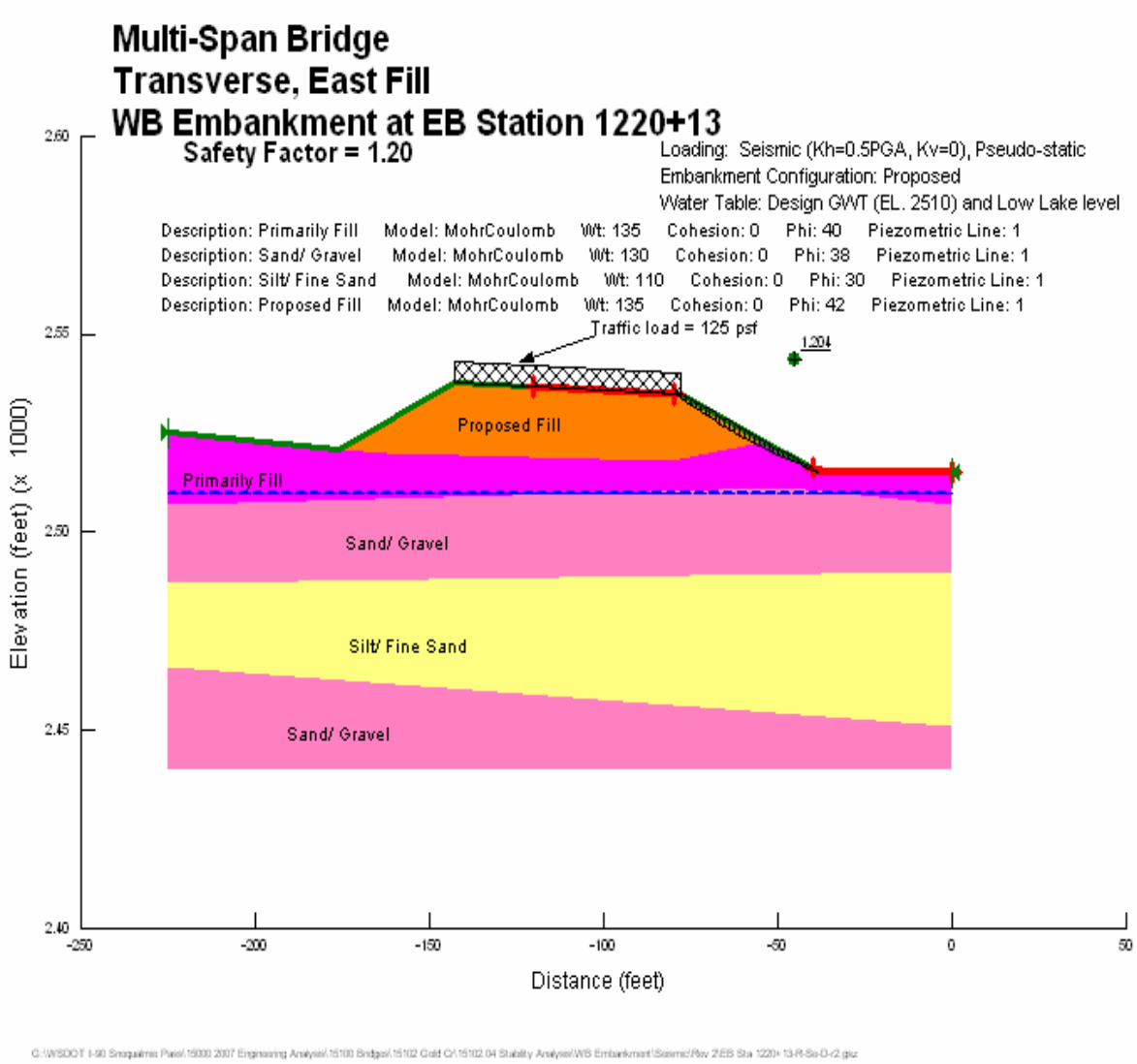


Job No. 33758579

Figure D77

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

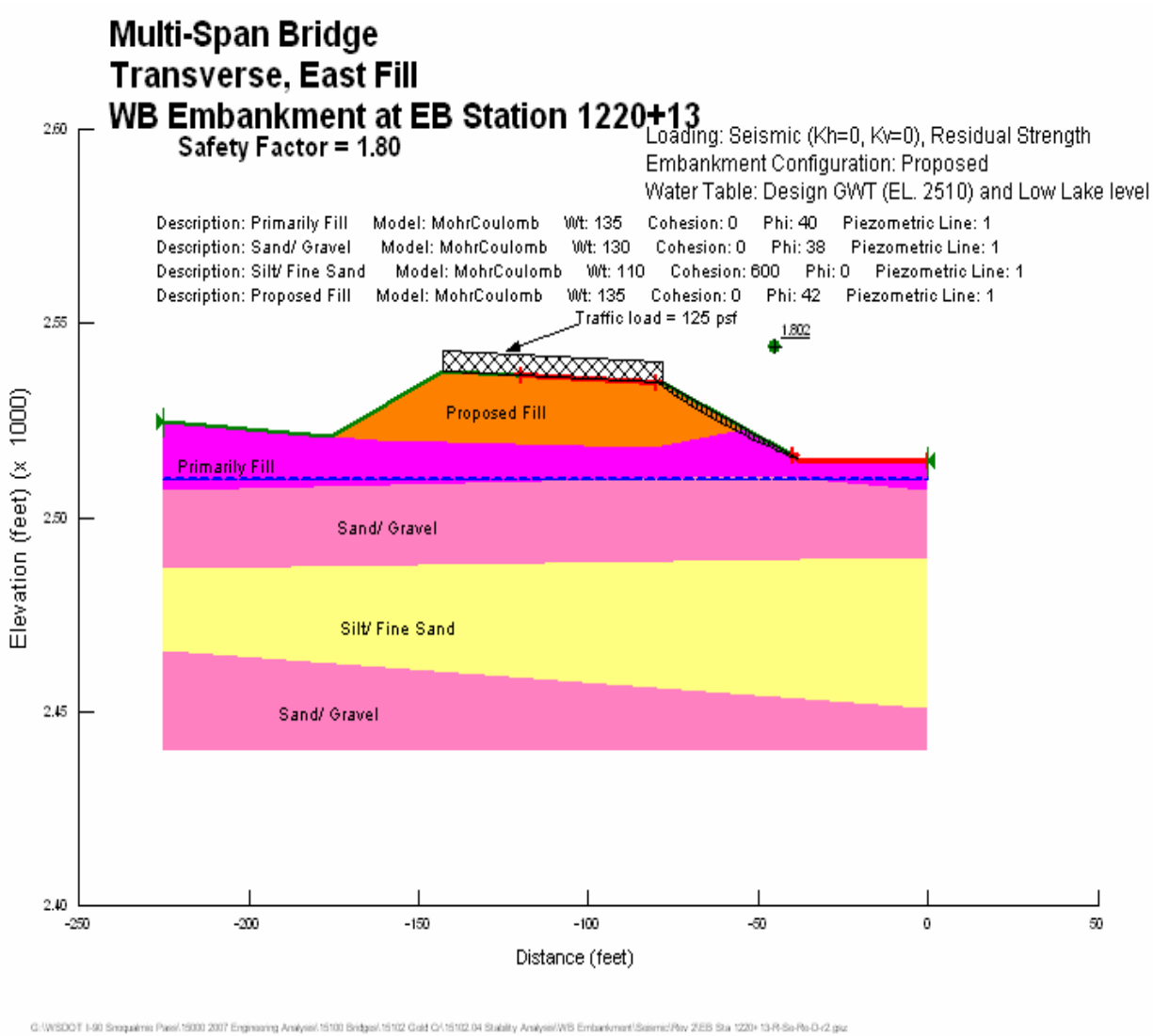


Job No. 33758579

Figure D78

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

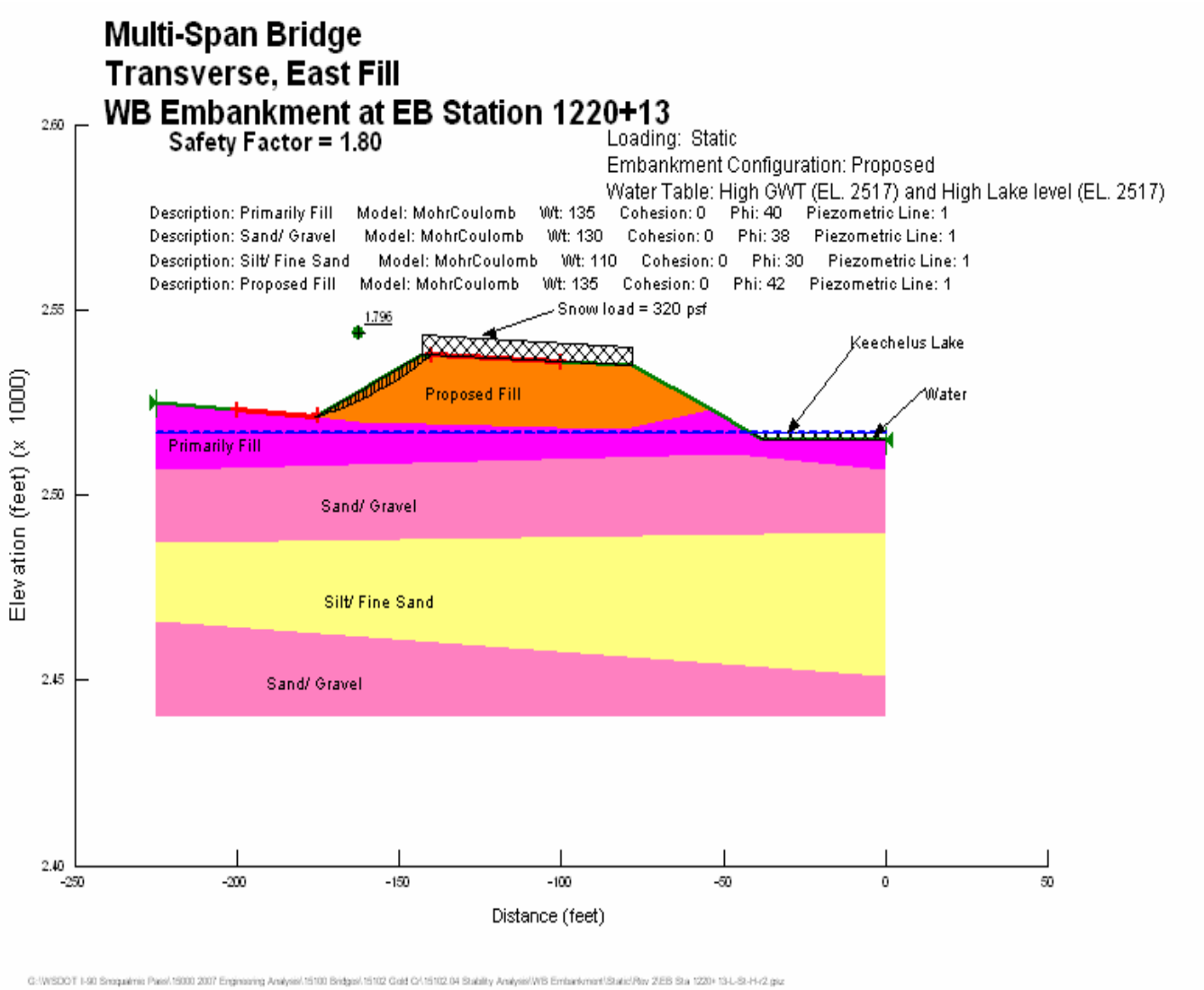


Job No. 33758579

Figure D79

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

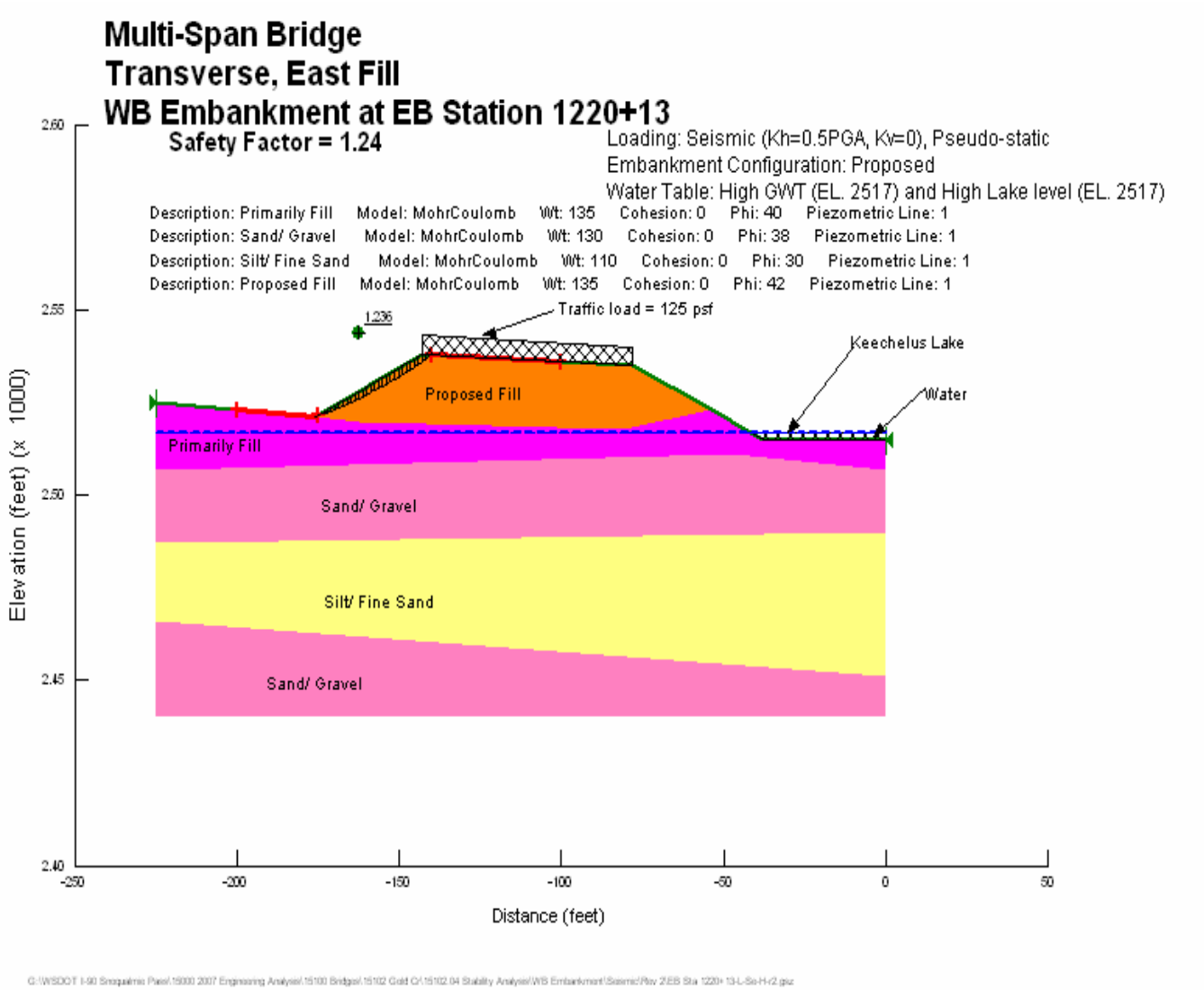


Job No. 33758579

Figure D80

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

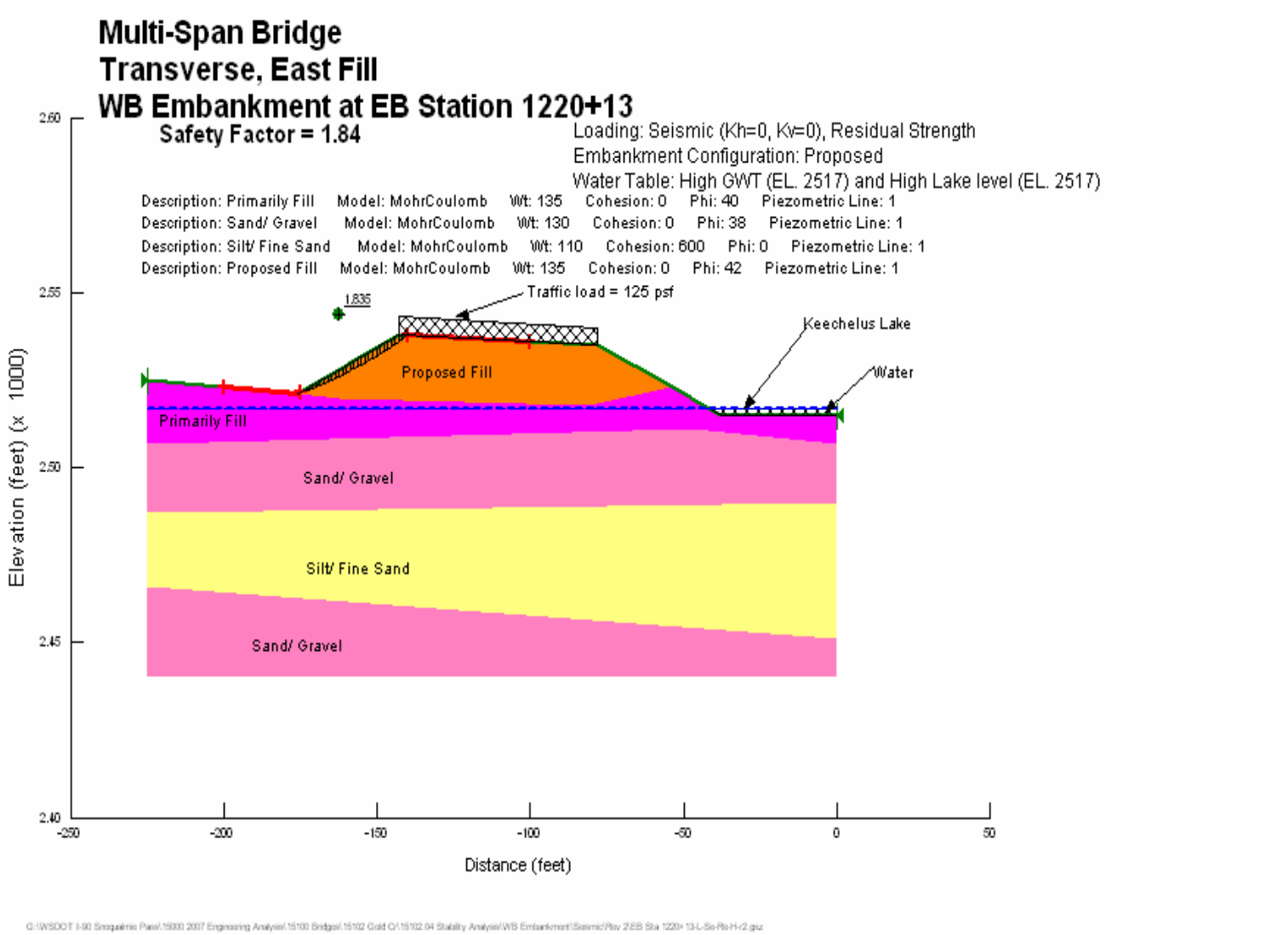


Job No. 33758579

Figure D81

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758579

Figure D82

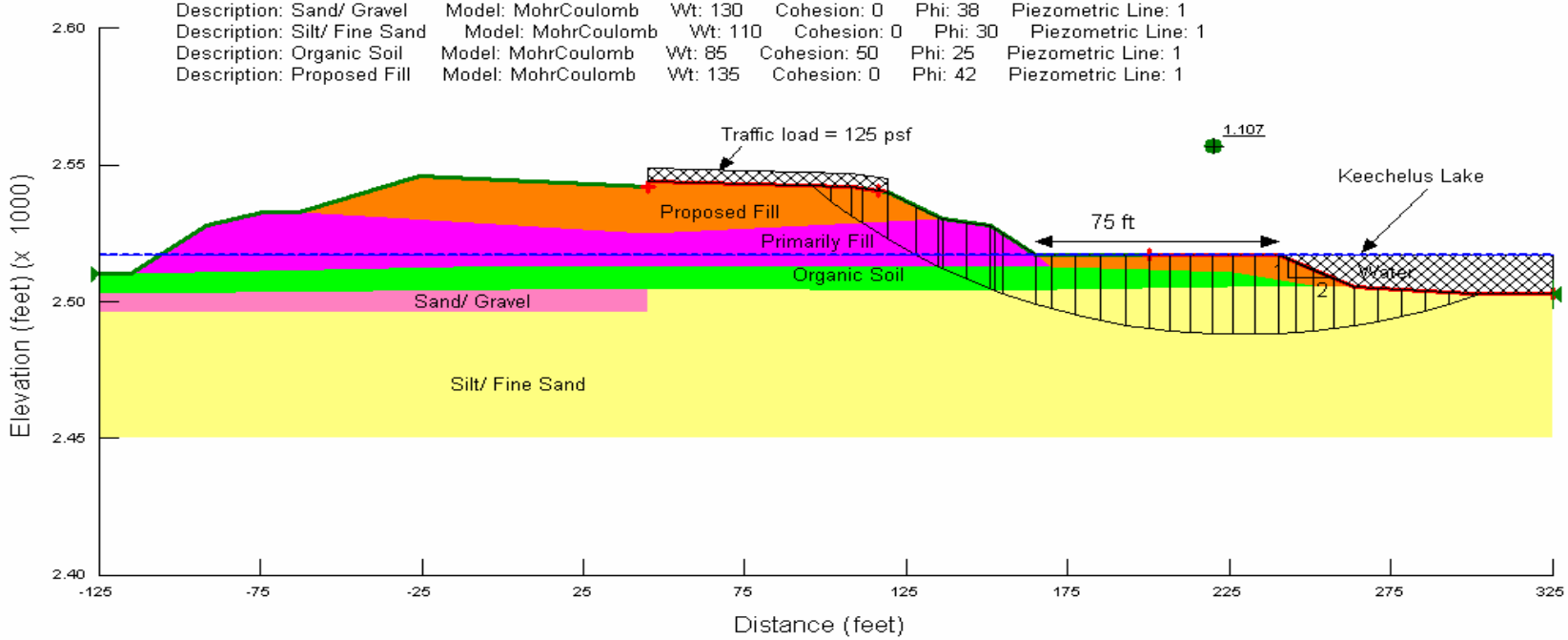
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.11

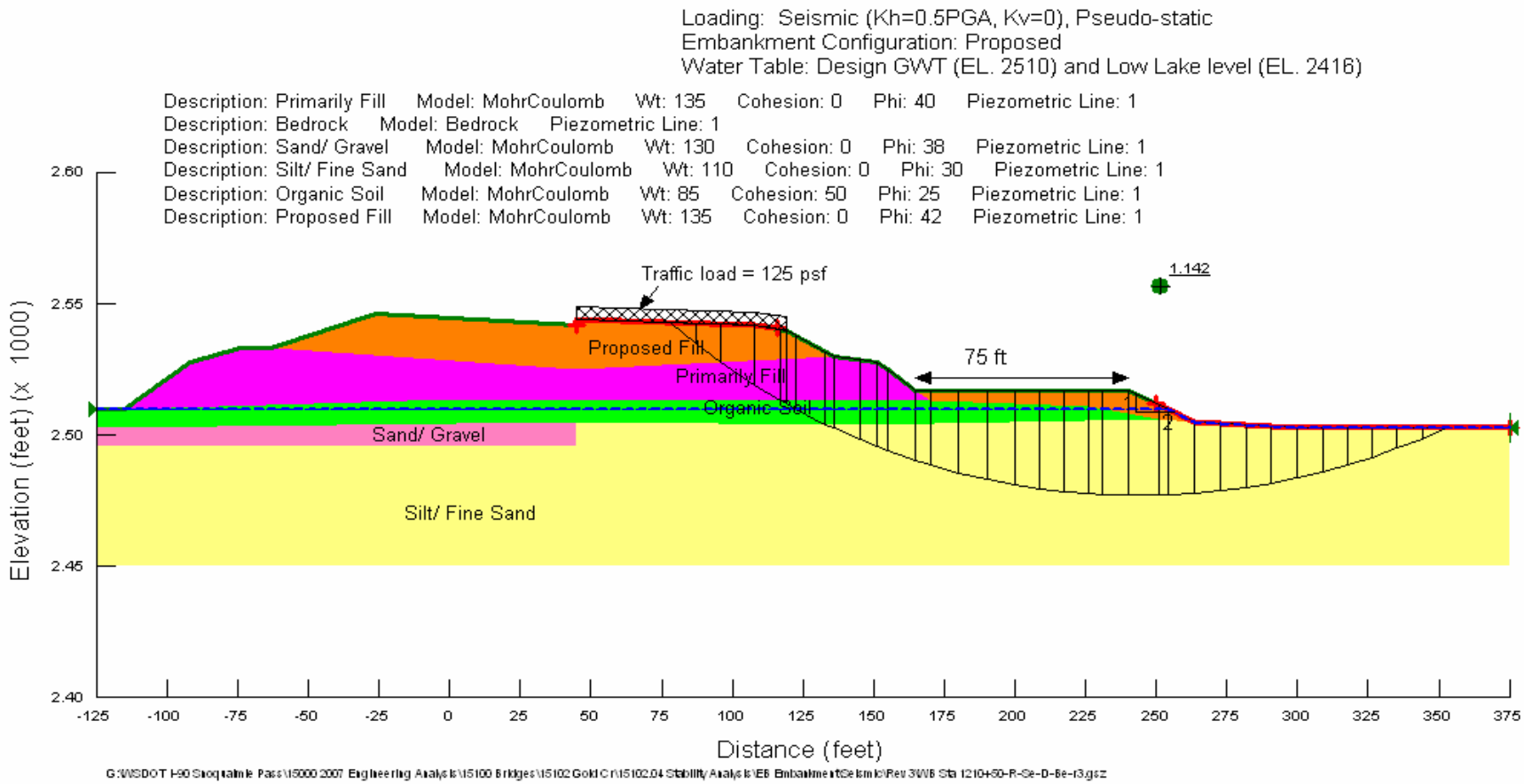
Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Se-H-Be-r3.gsz

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.14



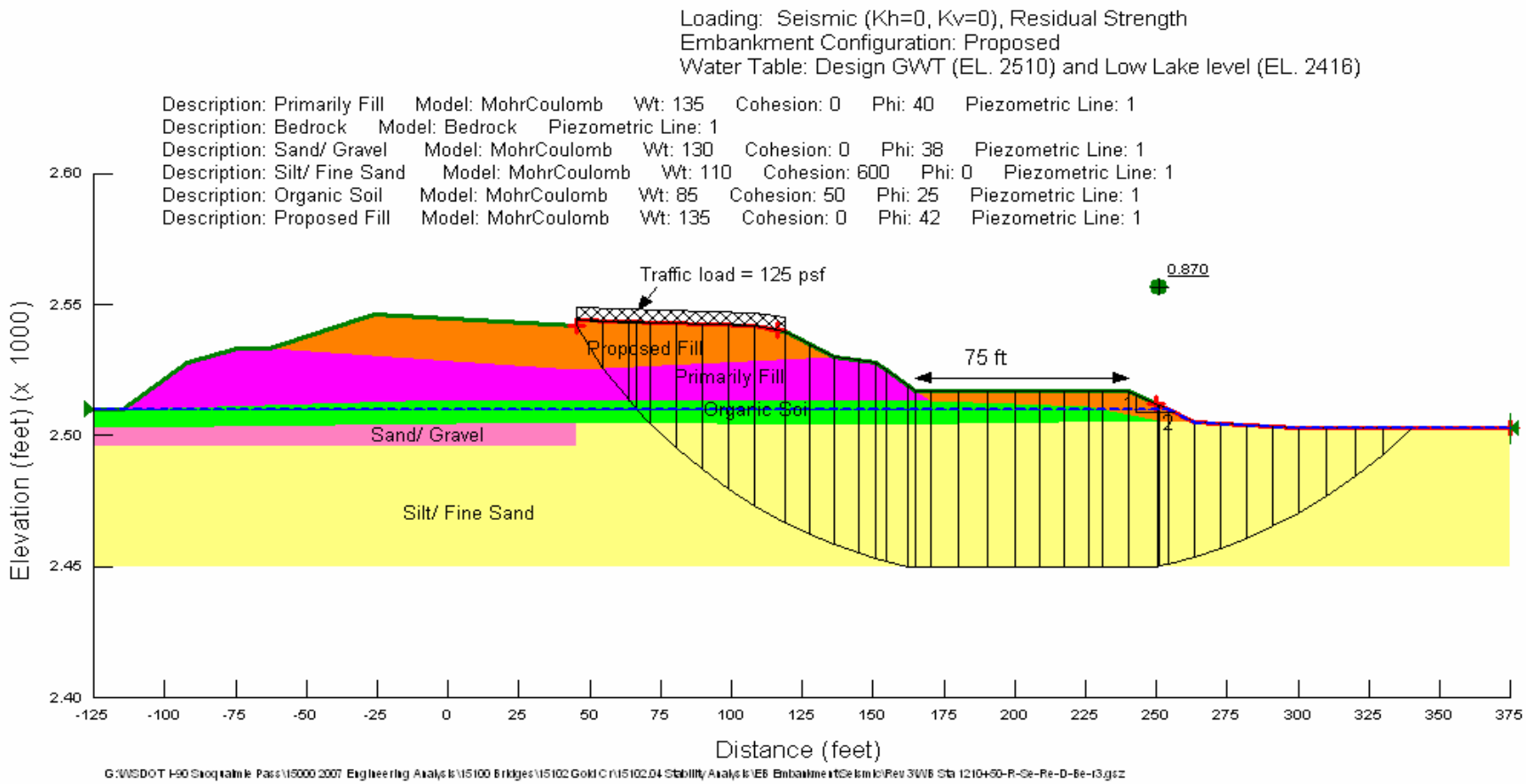
No. 33758579

Figure D84

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 0.87



No. 33758579

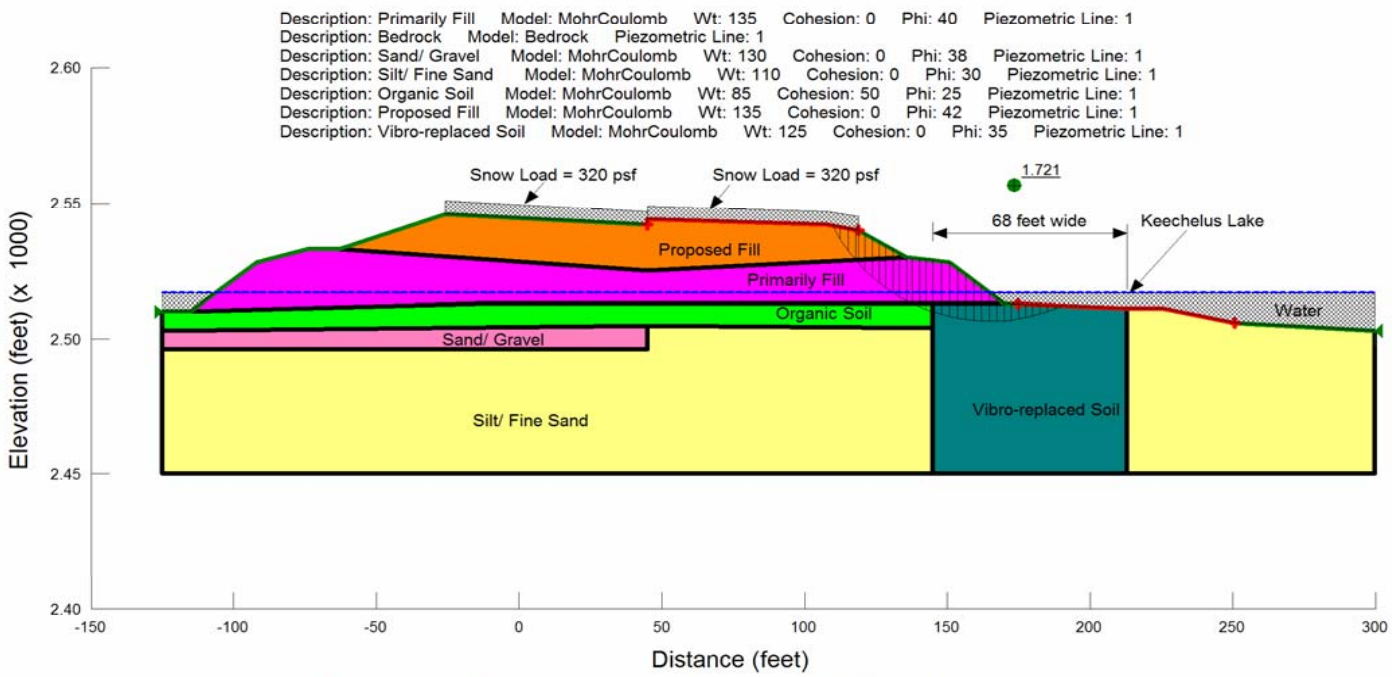
Figure D85

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.72

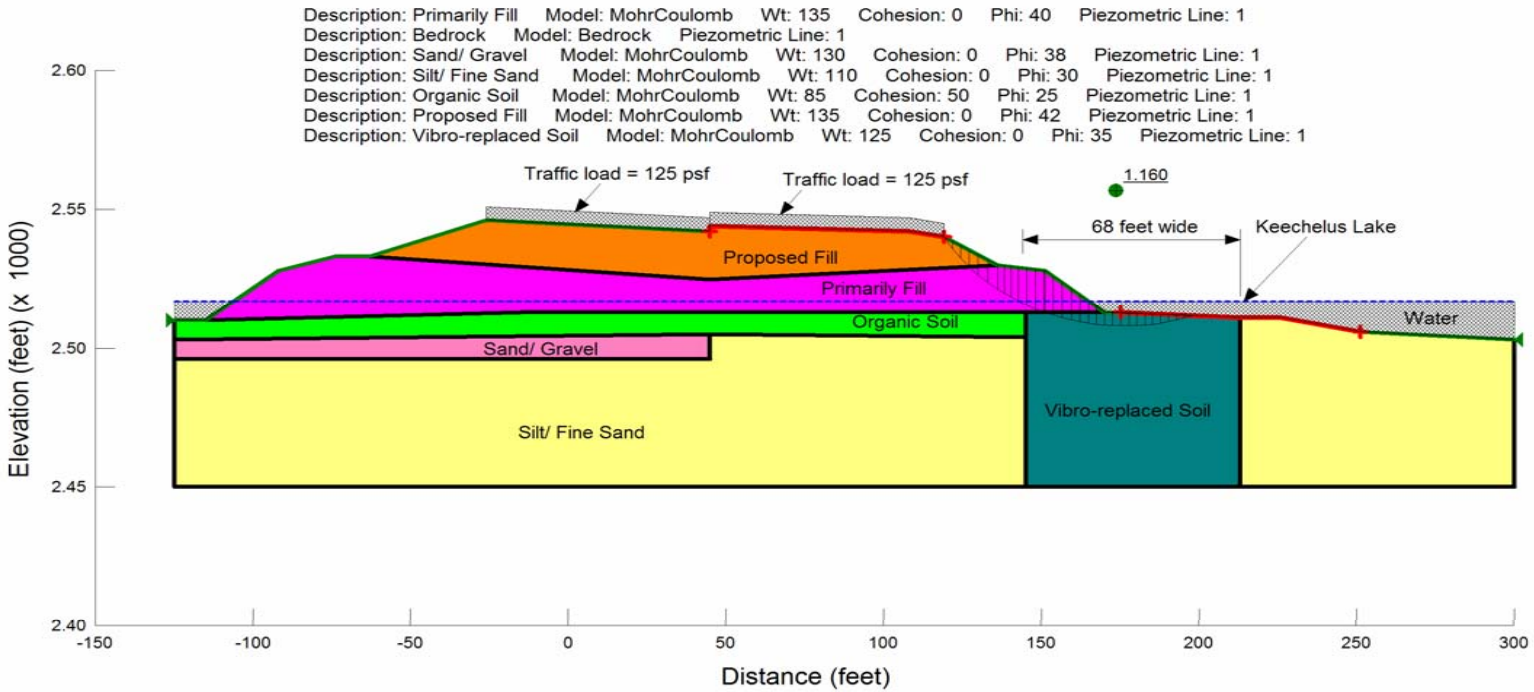
Loading: Static
Embankment Configuration: Proposed Ground Improvement
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-St-H-Gl-r3-050708.gsz

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.16

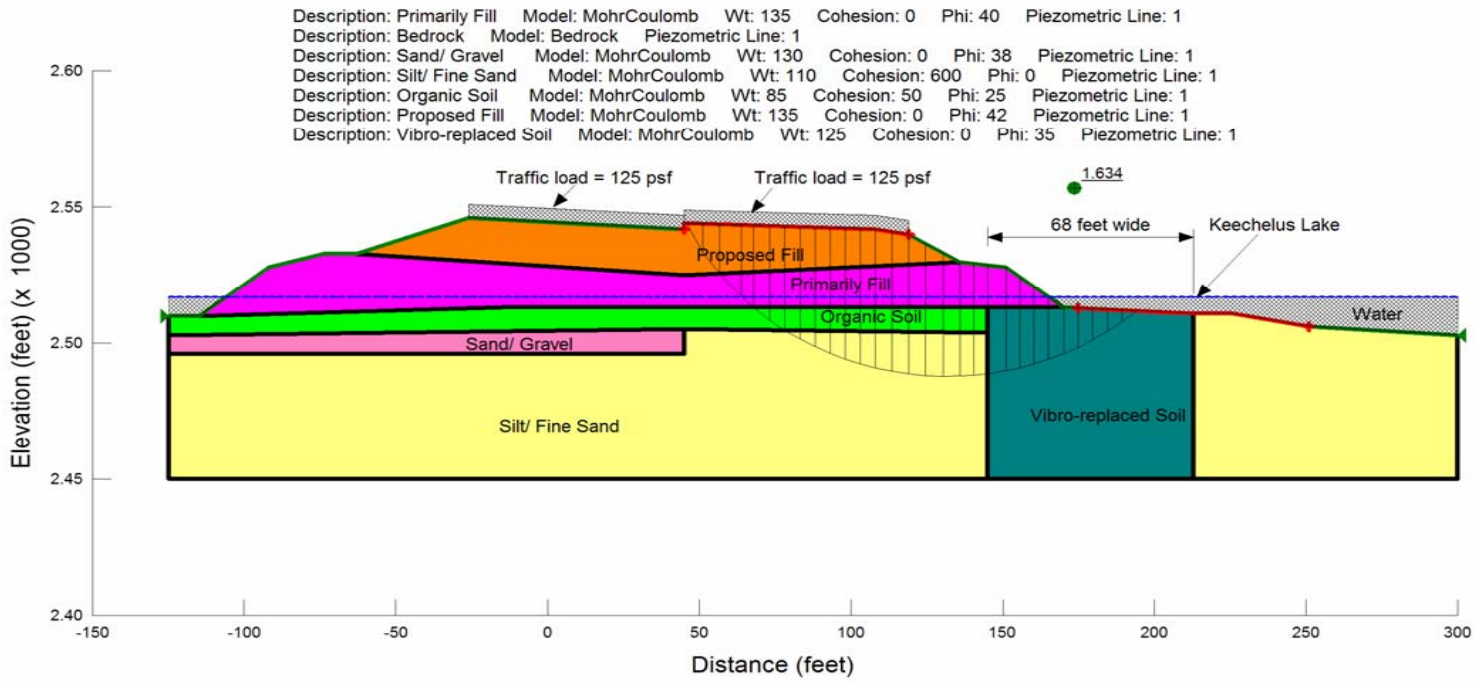
Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed Ground Improvement
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Se-H-Gl

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.63

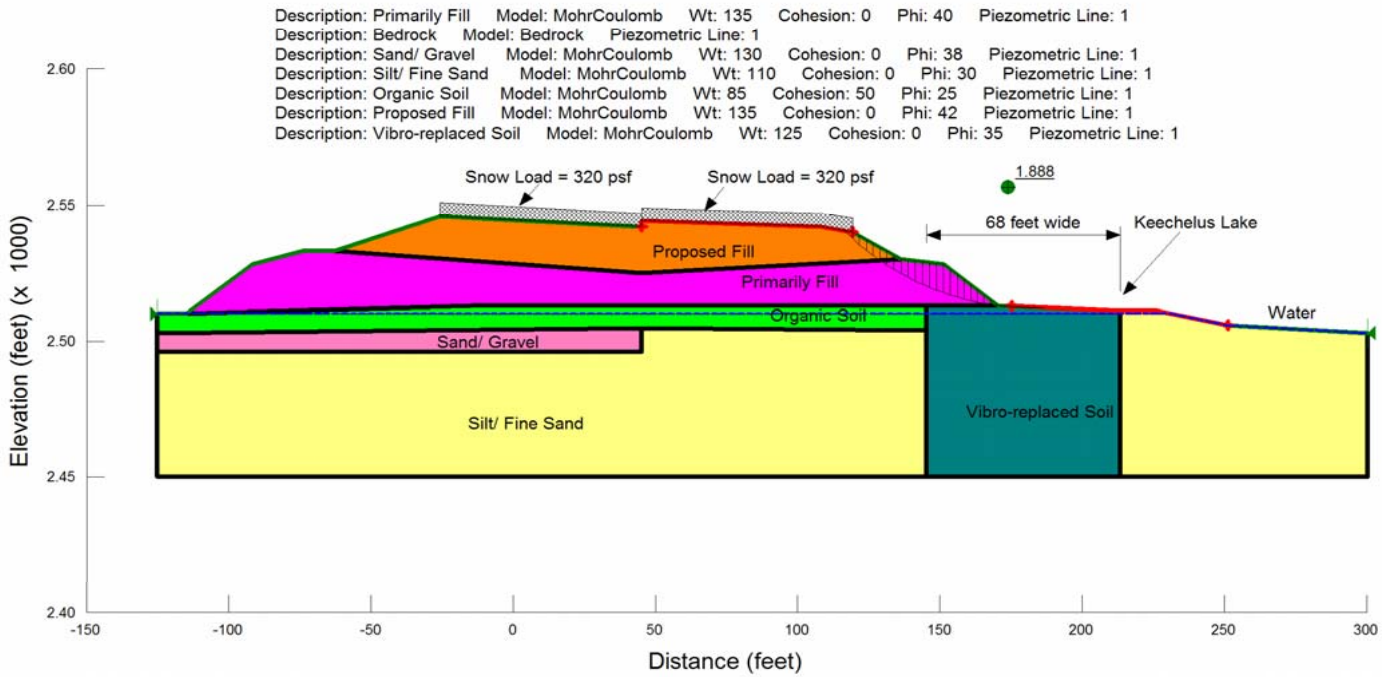
Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed Ground Improvement
Water Table: High GWT (EL. 2517) and High Lake level (EL. 2517)



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Re-H-Gl-r3-05070

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.89

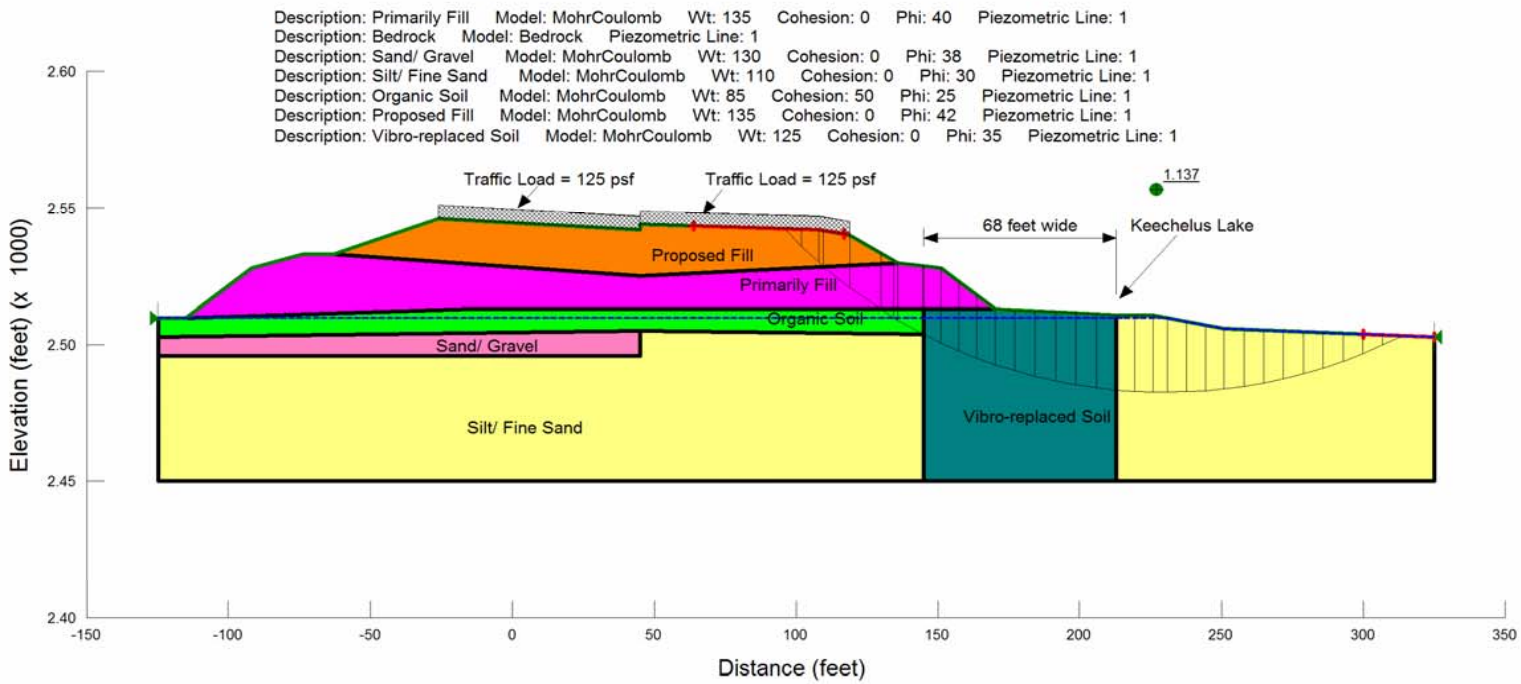
Loading: Static
Embankment Configuration: Proposed Ground Improvement
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-St-D-Gl-r3-050708.gsz

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.14

Loading: Seismic (Kh=0.5 PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed Ground Improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

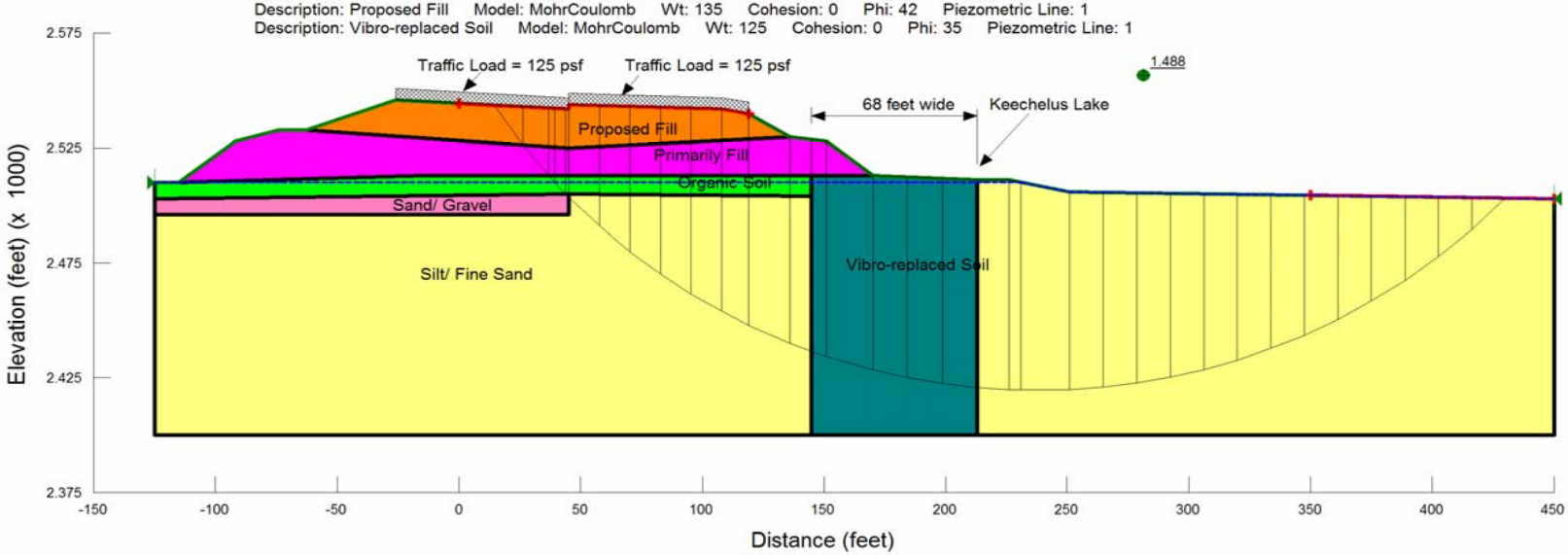


G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Se-D-Gl-r3-050708.gsz

Multi-Span Bridge
Transverse, West Fill
EB Embankment at WB Station 1210+50
Safety Factor = 1.49

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed Ground Improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 600 Phi: 0 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1
Description: Vibro-replaced Soil Model: MohrCoulomb Wt: 125 Cohesion: 0 Phi: 35 Piezometric Line: 1

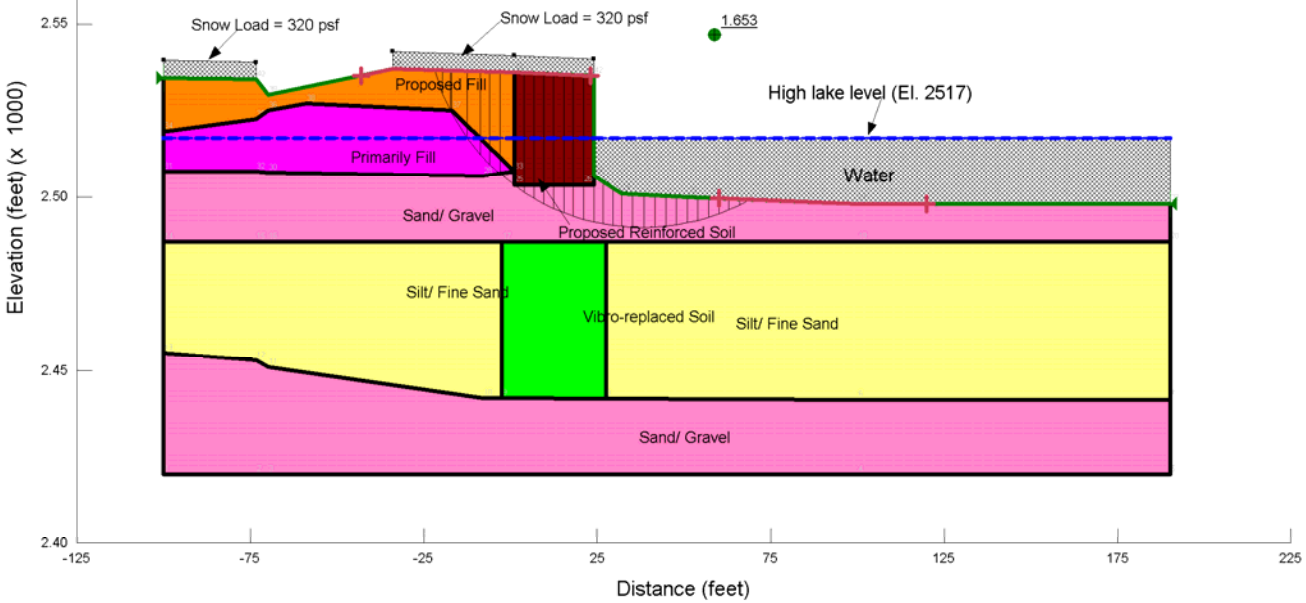


G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 3\WB Sta 1210+50-R-Re-D-GI-r3-050708.gsz

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69
Safety Factor = 1.65

Loading: Static
Embankment Configuration: Proposed after soil improvement
Water Table: High GWT (EL. 2517) and High Lake level

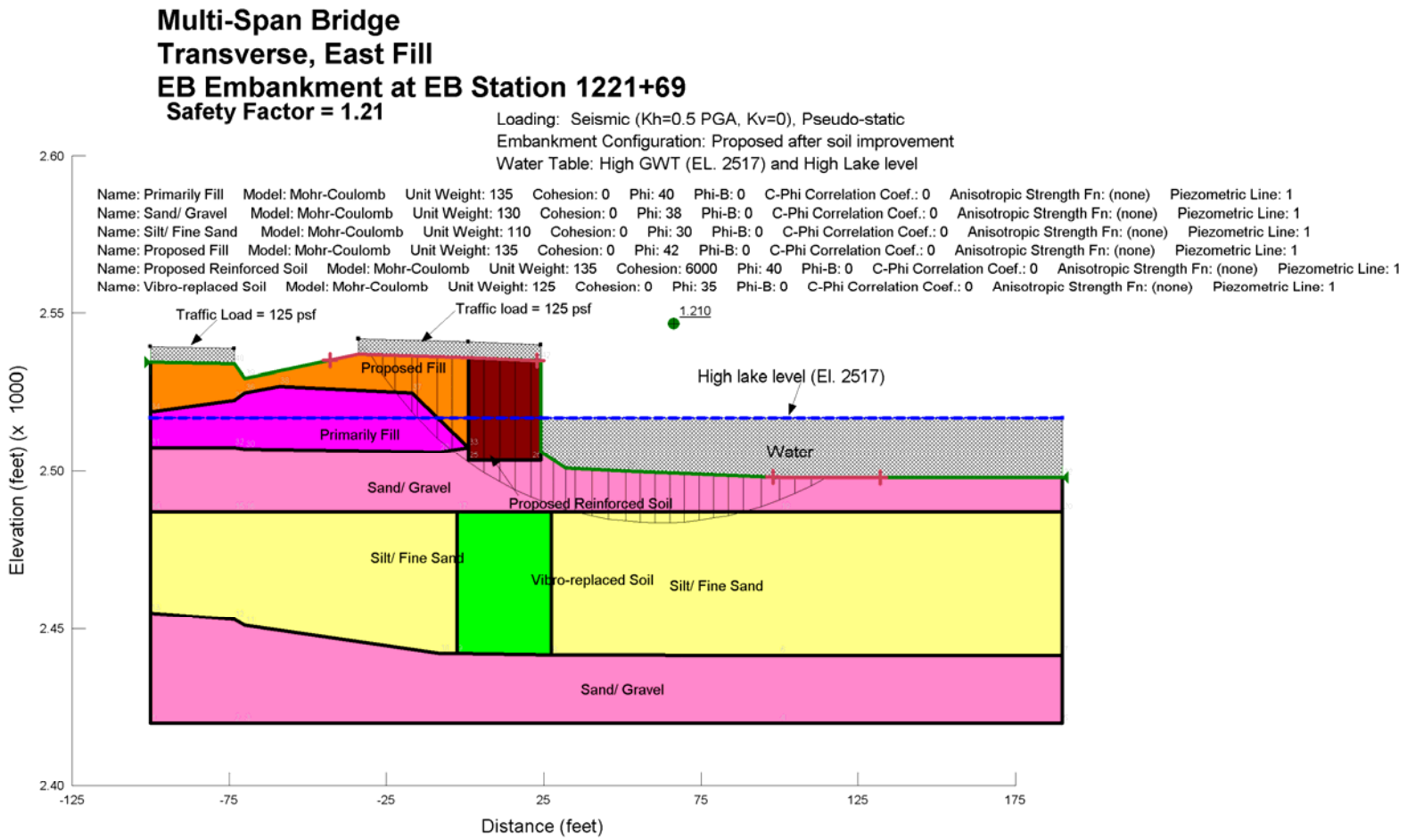
Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-St-H-vibrocompaction-30 feet wide-051808.gsz

No. 33758579

Figure D92



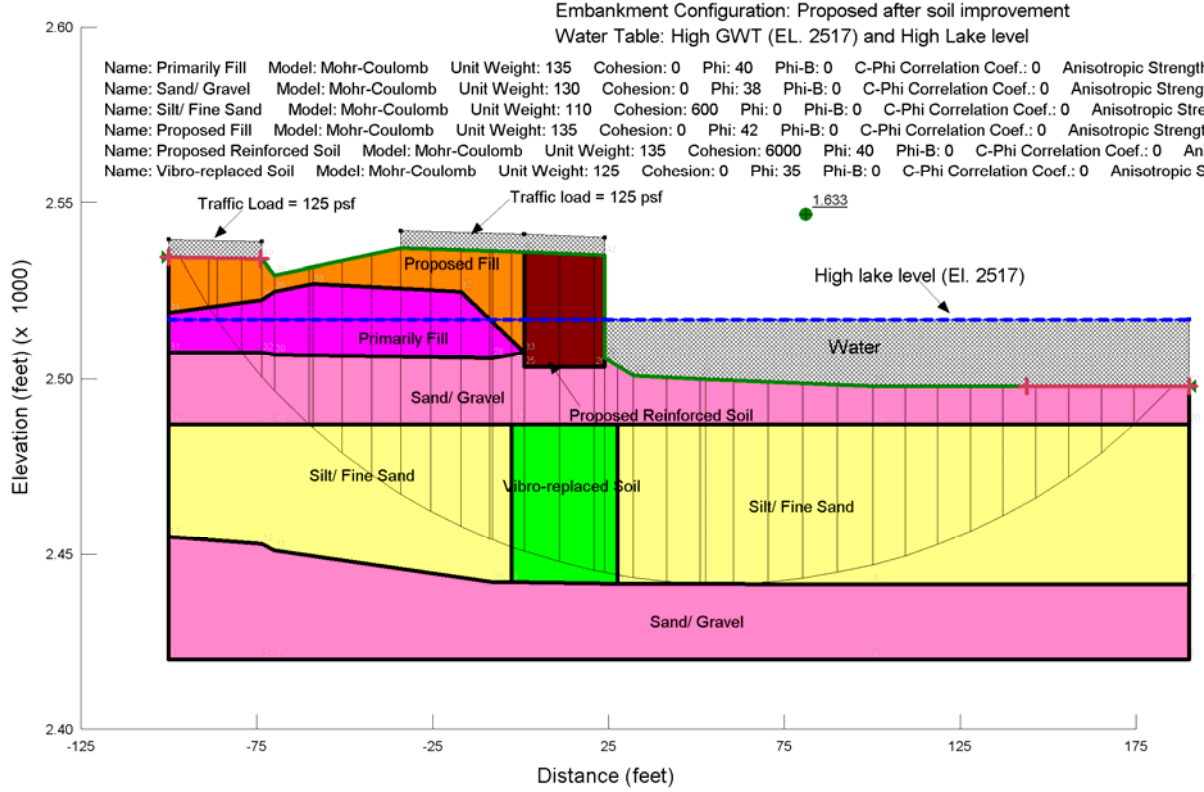
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Se-H-vibrocompaction-30 feet wide-0518(

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69

Safety Factor = 1.63

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed after soil improvement
Water Table: High GWT (EL. 2517) and High Lake level

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 600 Phi: 0 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



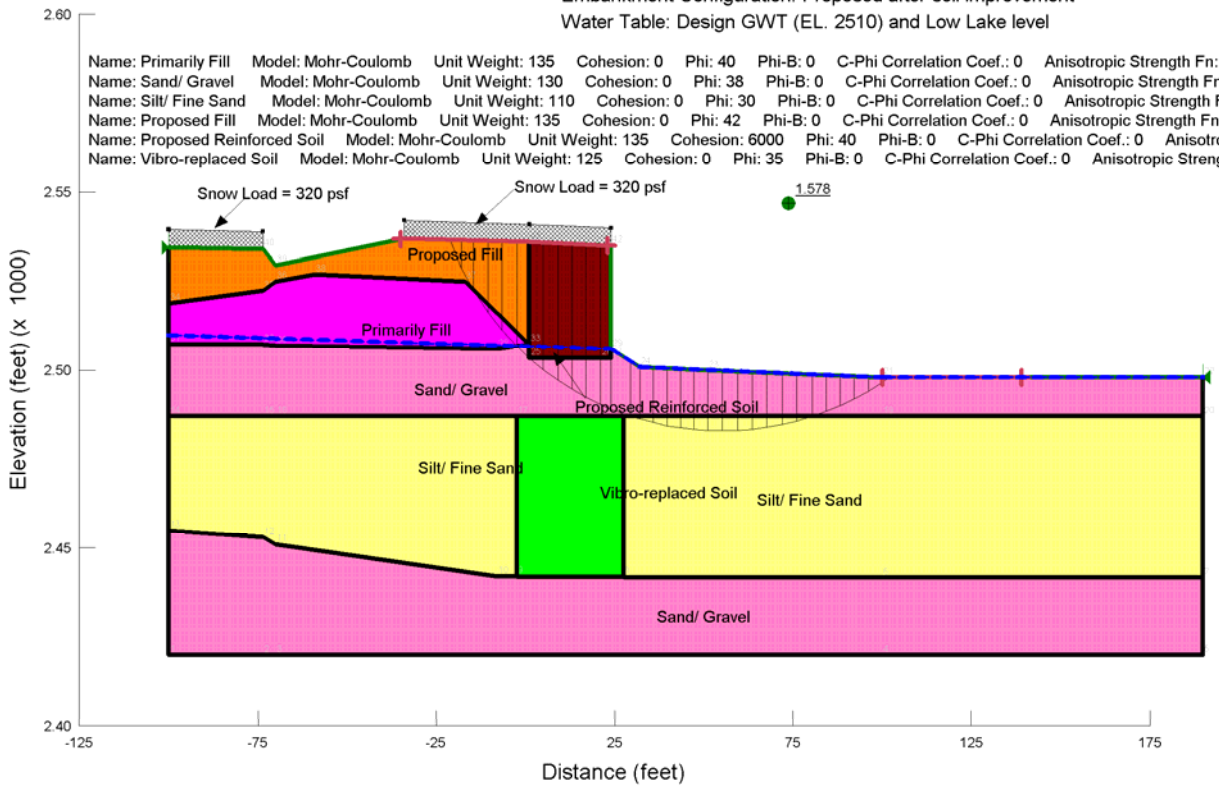
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Re-H-vibrocompaction-30 feet wide-0518

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69

Safety Factor = 1.58

Loading: Static
Embankment Configuration: Proposed after soil improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



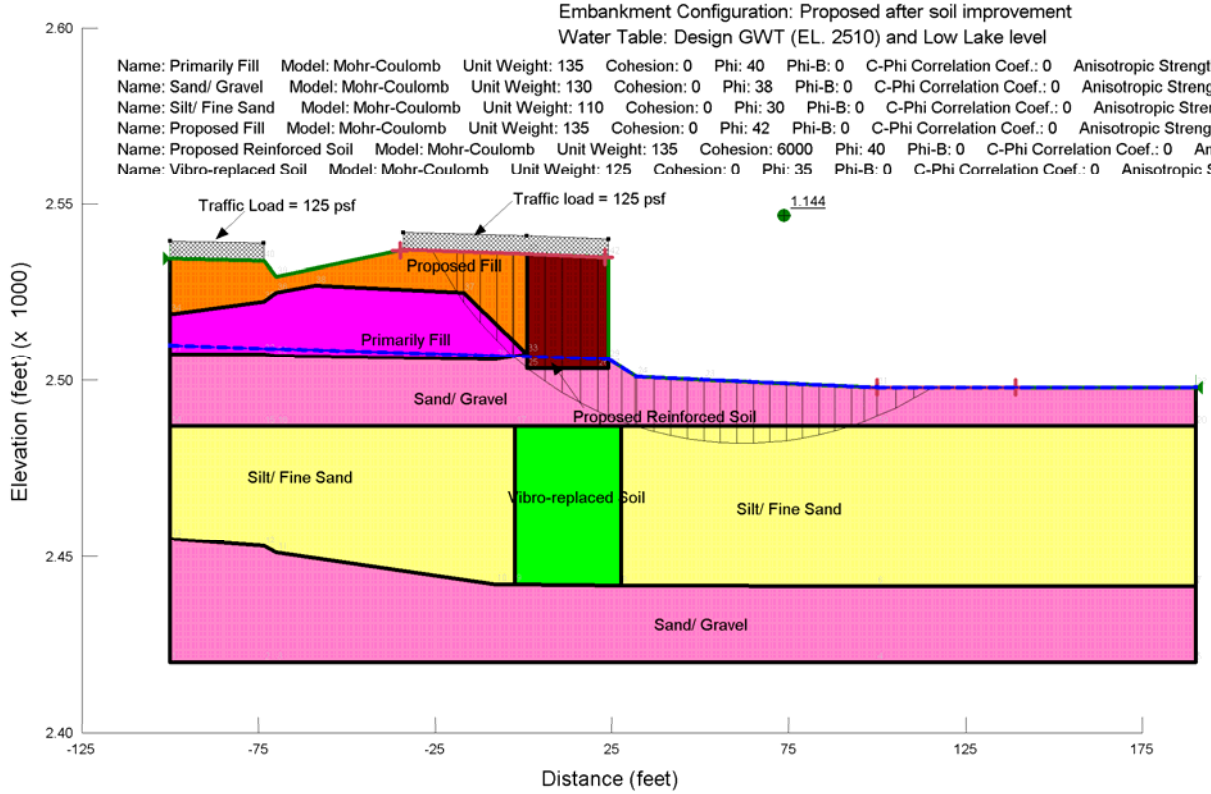
G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-St-D-vibrocompaction-30 feet wide-051808.g

Multi-Span Bridge
Transverse, East Fill
EB Embankment at EB Station 1221+69

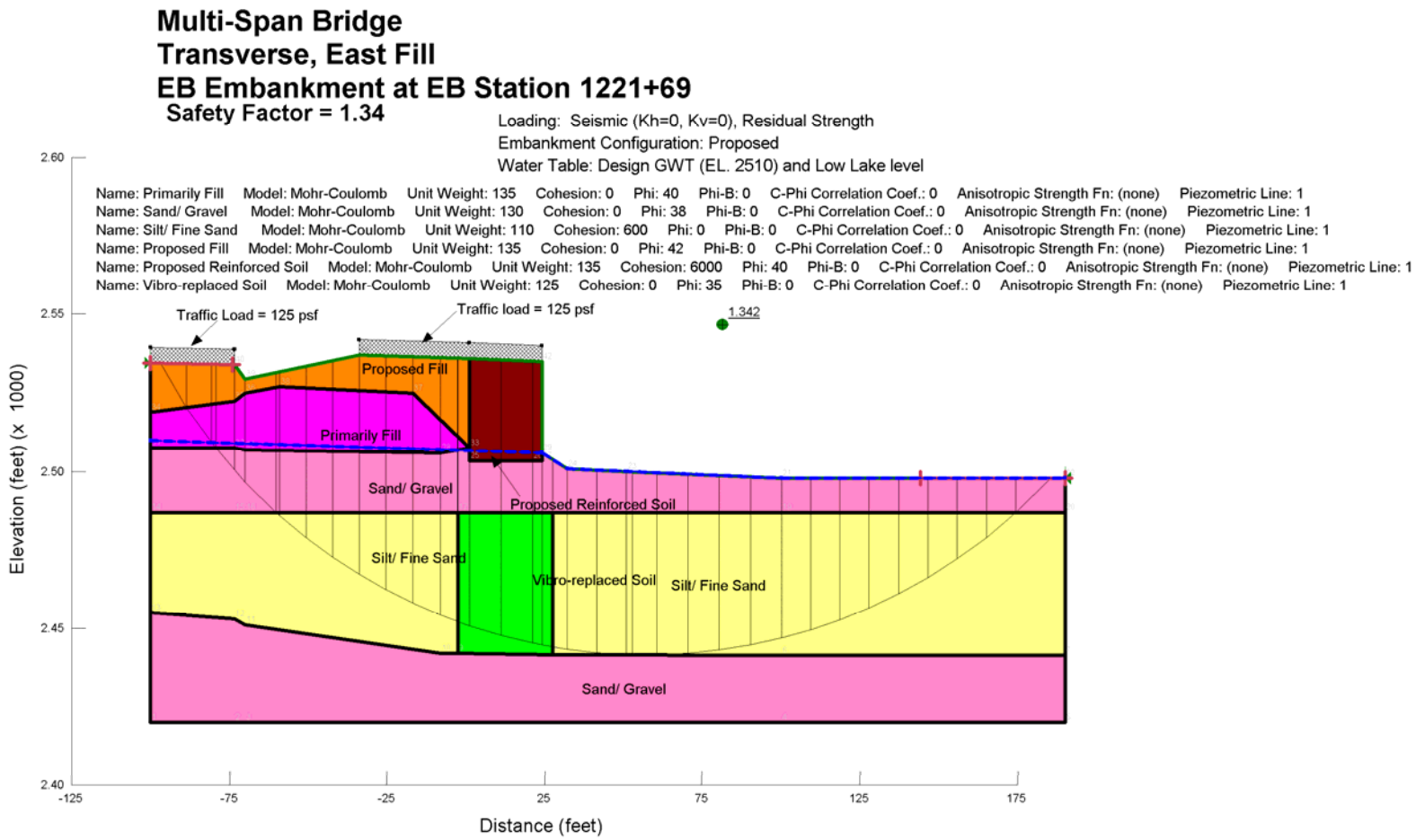
Safety Factor = 1.14

Loading: Seismic (Kh=0.5 PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed after soil improvement
Water Table: Design GWT (EL. 2510) and Low Lake level

Name: Primarily Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Sand/ Gravel Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 38 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Silt/ Fine Sand Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 30 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 42 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Proposed Reinforced Soil Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 6000 Phi: 40 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1
Name: Vibro-replaced Soil Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 35 Phi-B: 0 C-Phi Correlation Coef.: 0 Anisotropic Strength Fn: (none) Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-Se-D-vibrocompaction-30 feet wide-051808



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\EB Embankment\Seismic\Rev 2\EB Sta 1221+69-R-Re-D-vibrocompaction-30 feet wide-0518C

No. 33758579

Figure D97

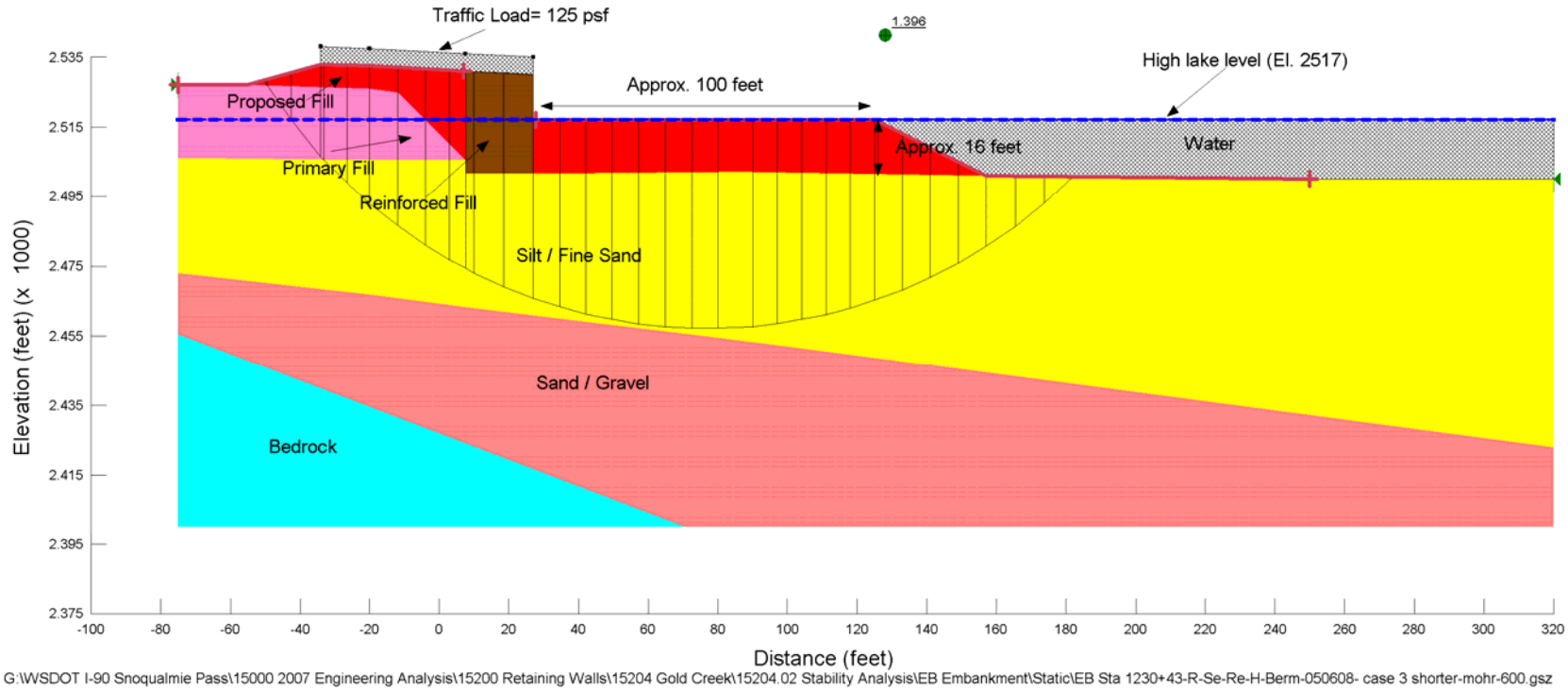
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Gold Creek Wall, Transverse
EB Embankment at EB Station 1230+43
Safety Factor = 1.40

Loading: Seismic (kh=0, kv=0), Residual Strength
Embankment Configuration: Proposed with counterberm
Water Table: High GWT and High lake level (El. 2517)

Name: Bedrock Model: Bedrock (Impenetrable) Piezometric Line: 1
Name: Primary Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 0 psf Phi: 40 ° Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 0 psf Phi: 42 ° Piezometric Line: 1
Name: SAND/GRAVEL Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: SILT/fine SAND Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 600 psf Phi: 0 ° Piezometric Line: 1
Name: Reinforced Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 12000 psf Phi: 40 ° Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15200 Retaining Walls\15204 Gold Creek\15204.02 Stability Analysis\EB Embankment\Static\EB Sta 1230+43-R-Se-Re-H-Berm-050608- case 3 shorter-mohr-600.gsz

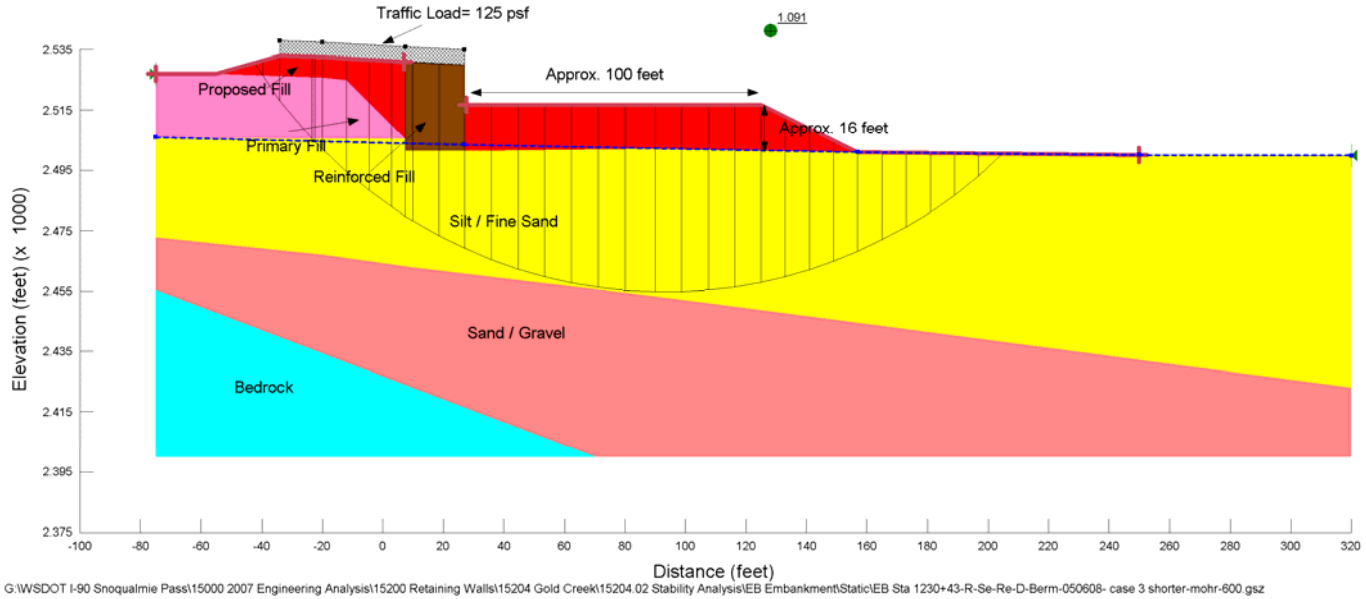
No. 33758579

Figure D98

Gold Creek Wall, Transverse
EB Embankment at EB Station 1230+43
Safety Factor = 1.09

Loading: Seismic (kh=0, kv=0), Residual Strength
Embankment Configuration: Proposed with counterberm
Water Table: Design GWT (El. 2506) and low lake level

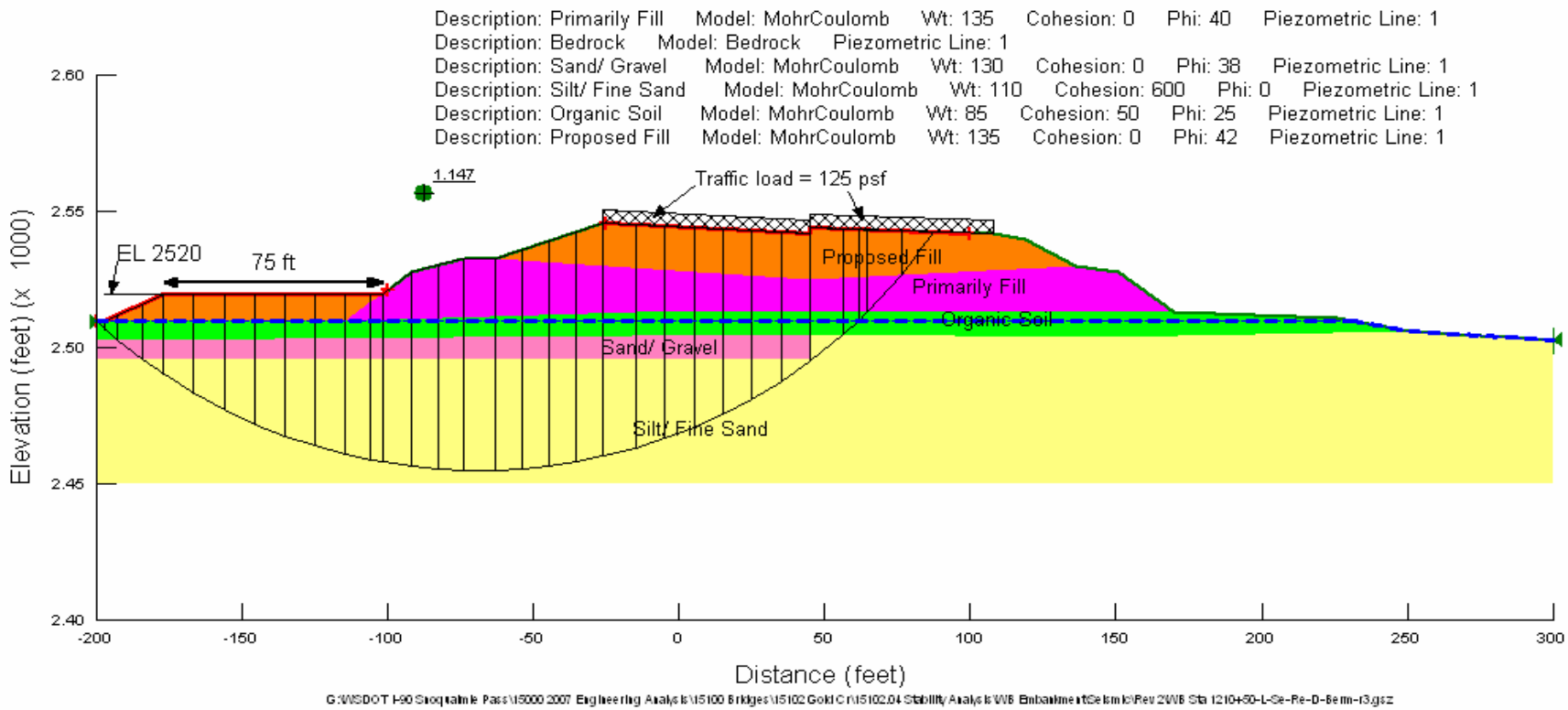
Name: Bedrock Model: Bedrock (Impenetrable) Piezometric Line: 1
Name: Primary Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 0 psf Phi: 40 ° Piezometric Line: 1
Name: Proposed Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 0 psf Phi: 42 ° Piezometric Line: 1
Name: SAND/GRAVEL Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 0 psf Phi: 38 ° Piezometric Line: 1
Name: SILT/fine SAND Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 600 psf Phi: 0 ° Piezometric Line: 1
Name: Reinforced Fill Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 12000 psf Phi: 40 ° Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15200 Retaining Walls\15204 Gold Creek\15204.02 Stability Analysis\EB Embankment\Static\EB Sta 1230+43-R-Se-Re-D-Berm-050608- case 3 shorter-mohr-600.gsz

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.15

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-L-Se-Re-D-Berm-r3.gsz

No. 33758579

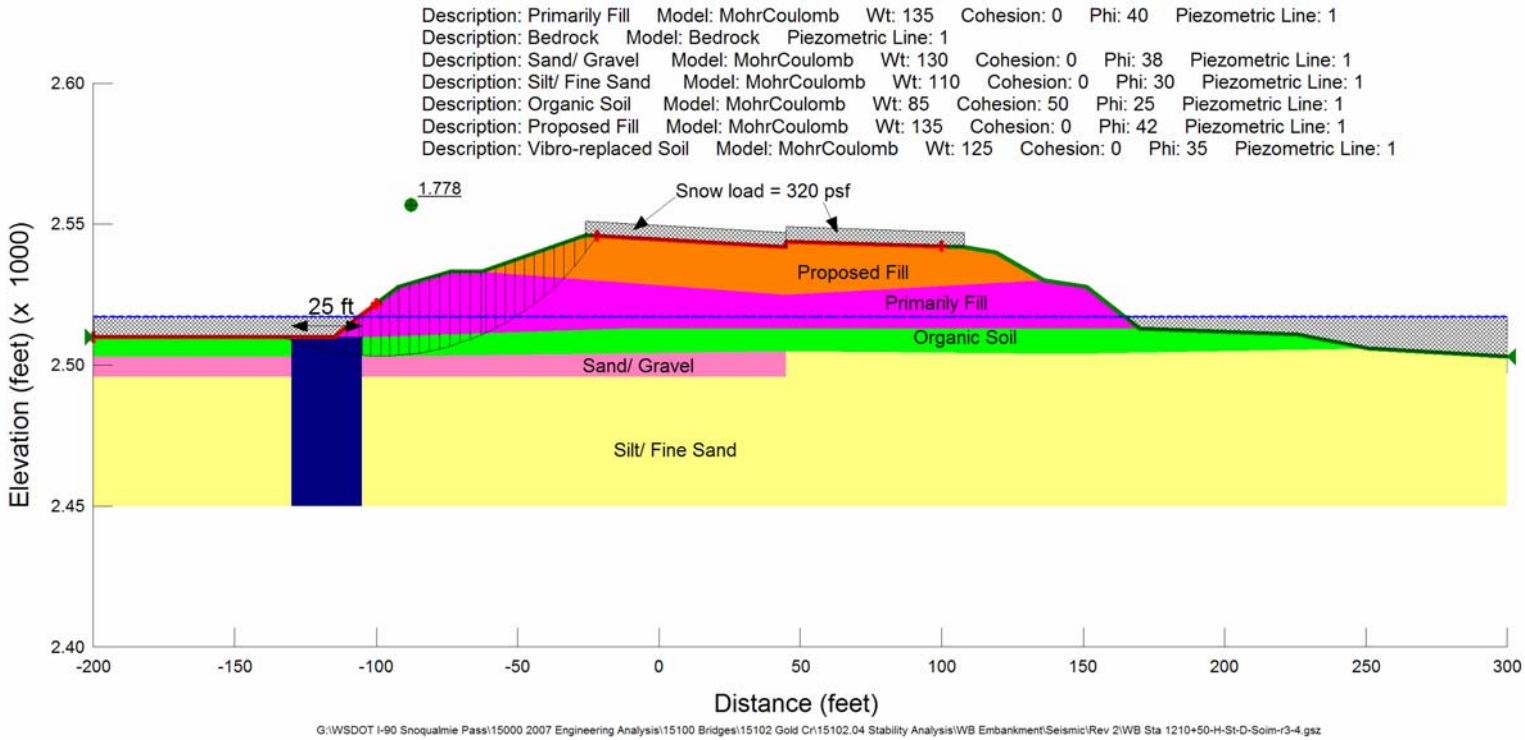
Figure D100

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.78

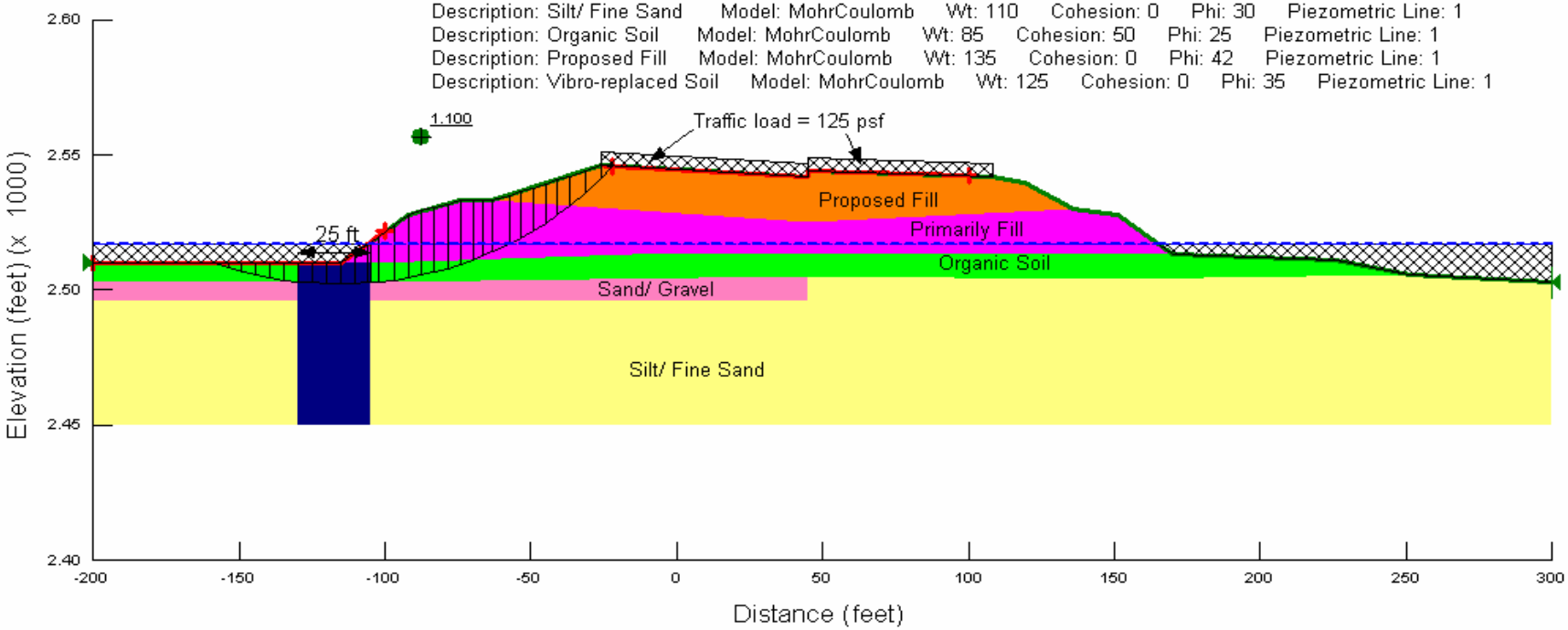
Loading: Static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level



Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.10

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1
Description: Vibro-replaced Soil Model: MohrCoulomb Wt: 125 Cohesion: 0 Phi: 35 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-H-Se-D-Soln-r3-4.gsz

No. 33758579

Figure D102

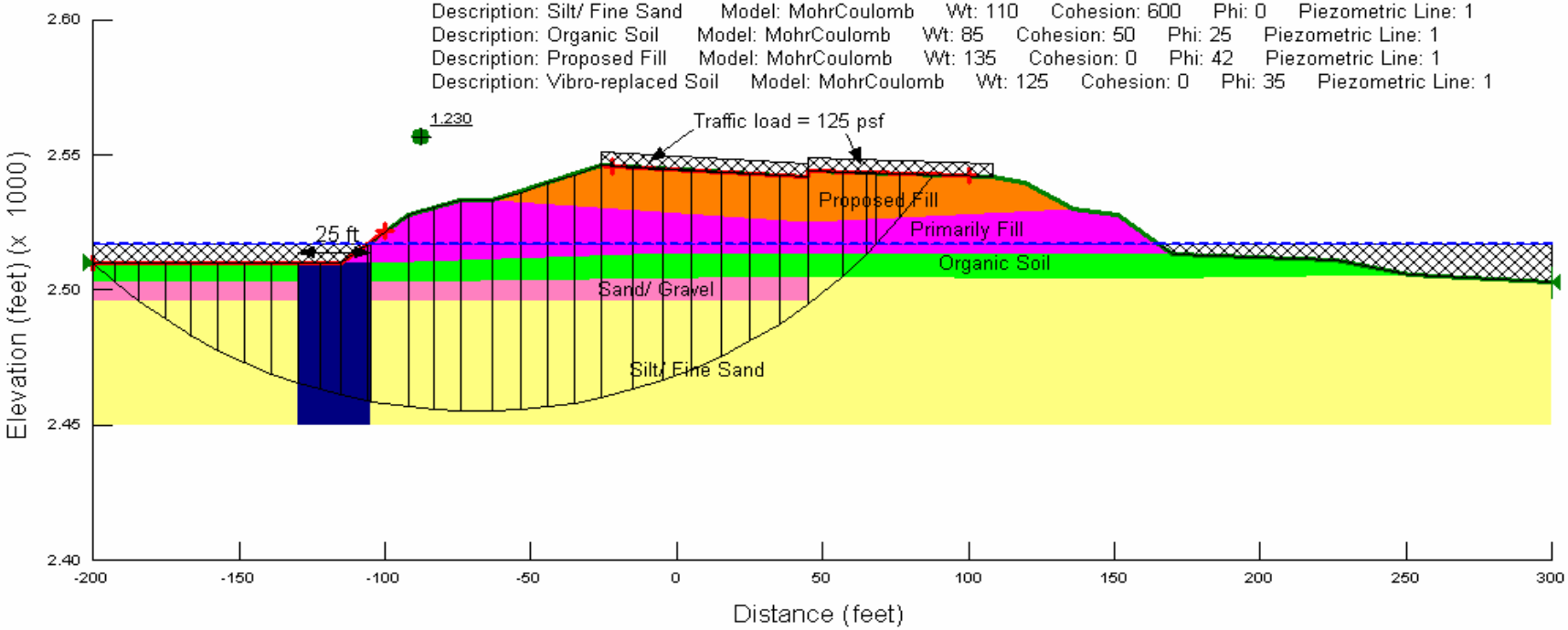
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.23

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: High GWT (EL. 2517) and High Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 600 Phi: 0 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1
Description: Vibro-replaced Soil Model: MohrCoulomb Wt: 125 Cohesion: 0 Phi: 35 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\15000 2007 Engineering Analysis\15100 Bridges\15102 Gold Cr\15102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-H-Se-Re-D-Solm-r3-4.gsz

No. 33758579

Figure D103

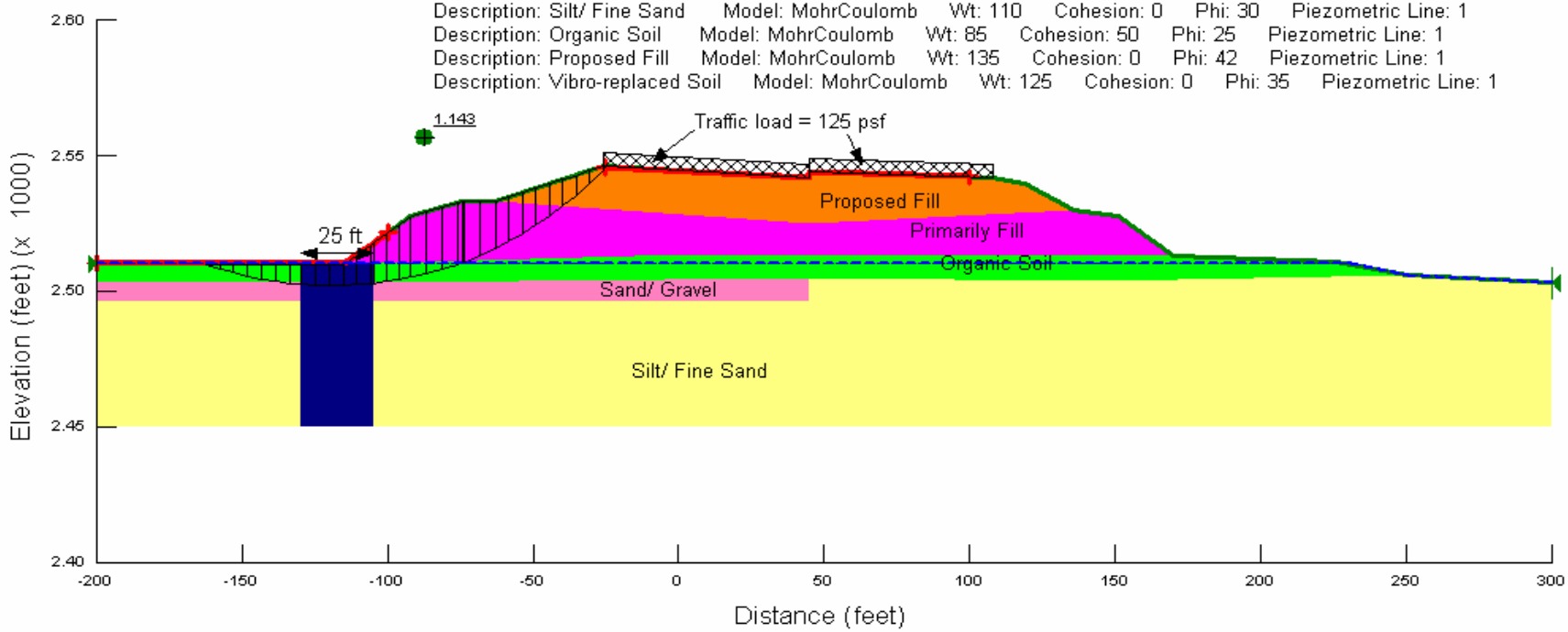
URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.14

Loading: Seismic (Kh=0.5PGA, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Bedrock Model: Bedrock Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Silt/ Fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Organic Soil Model: MohrCoulomb Wt: 85 Cohesion: 50 Phi: 25 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1
Description: Vibro-replaced Soil Model: MohrCoulomb Wt: 125 Cohesion: 0 Phi: 35 Piezometric Line: 1



G:\WSDOT I-90 Snoqualmie Pass\I5000 2007 Engineering Analysis\I5100 Bridges\I5102 Gold Cr\I5102.04 Stability Analysis\WB Embankment\Seismic\Rev 2\WB Sta 1210+50-L-Se-D-Solm-r3-4.gsz

No. 33758579

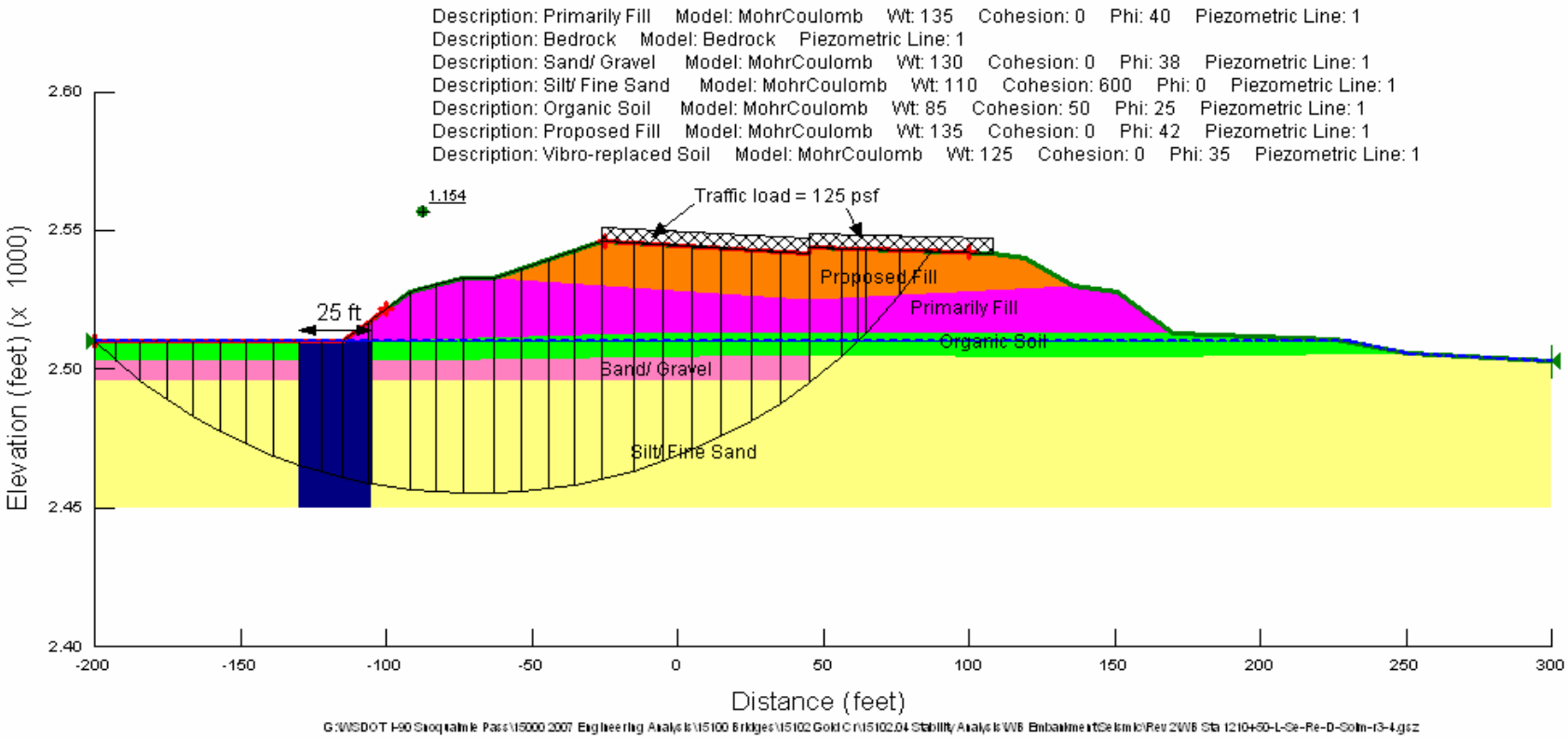
Figure D104

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Multi-Span Bridge
Transverse, West Fill
WB Embankment at WB Station 1210+50
Safety Factor = 1.15

Loading: Seismic (Kh=0, Kv=0), Residual Strength
Embankment Configuration: Proposed
Water Table: Design GWT (EL. 2510) and Low Lake level

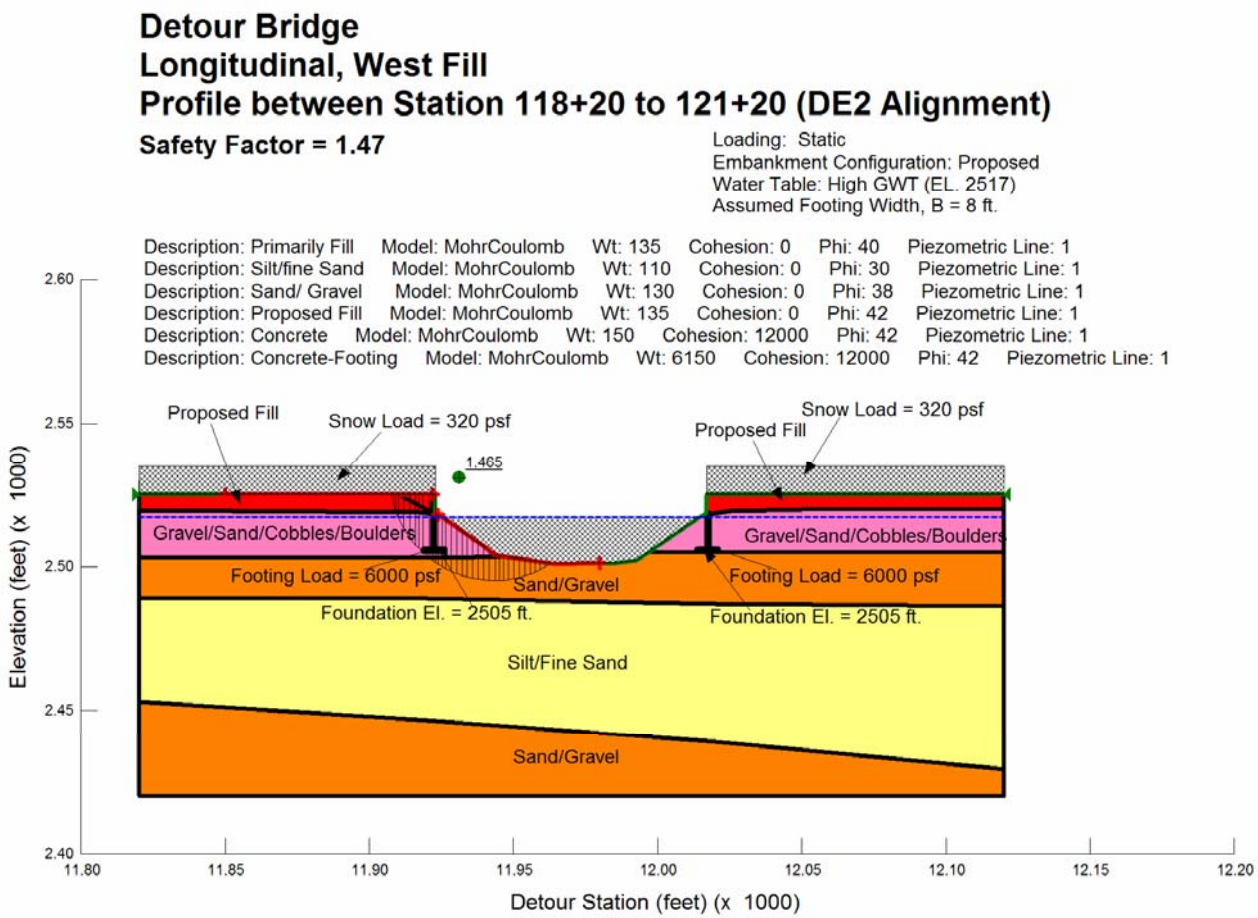


No. 33758579

Figure D105

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

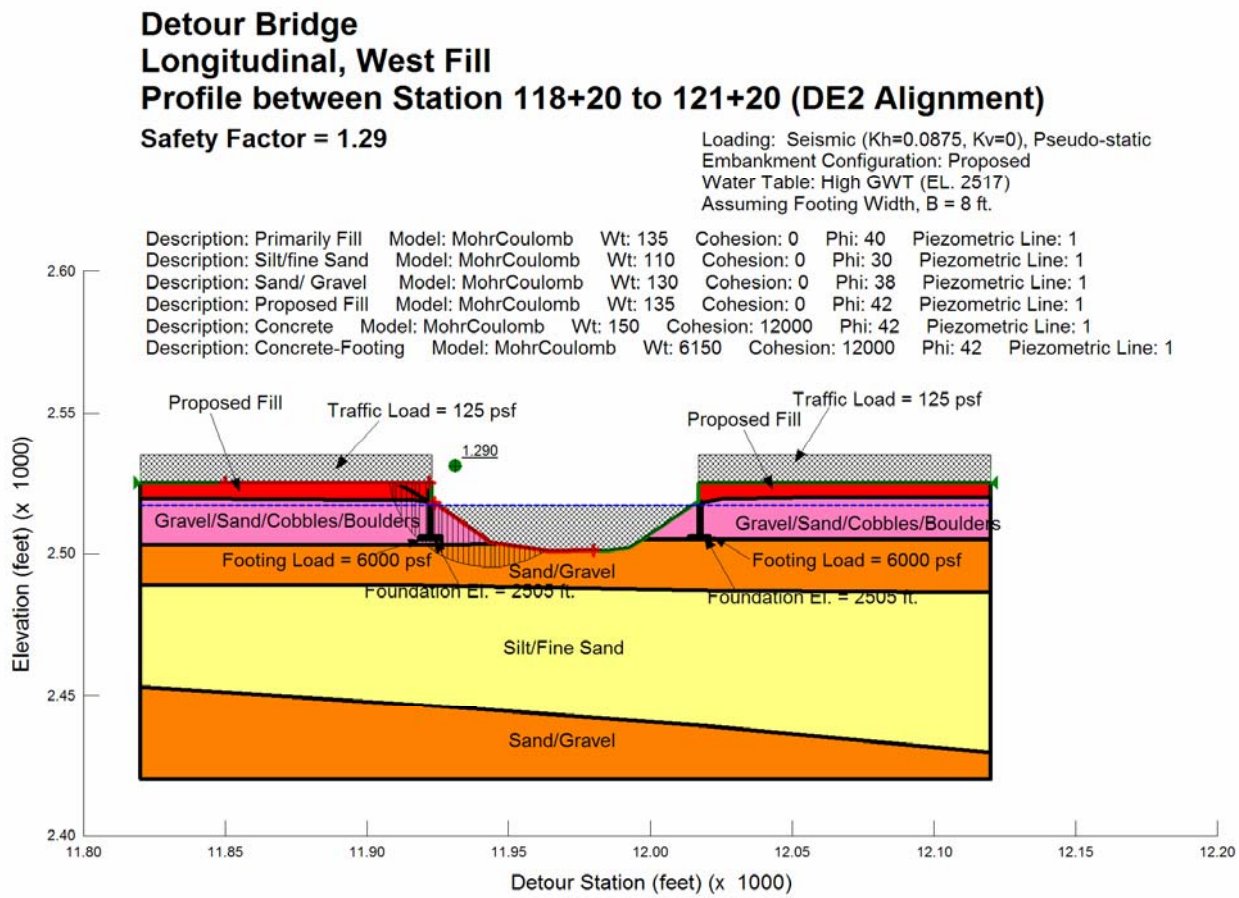


Job No. 33758623

Figure D106

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington



Job No. 33758623

Figure D107

URS

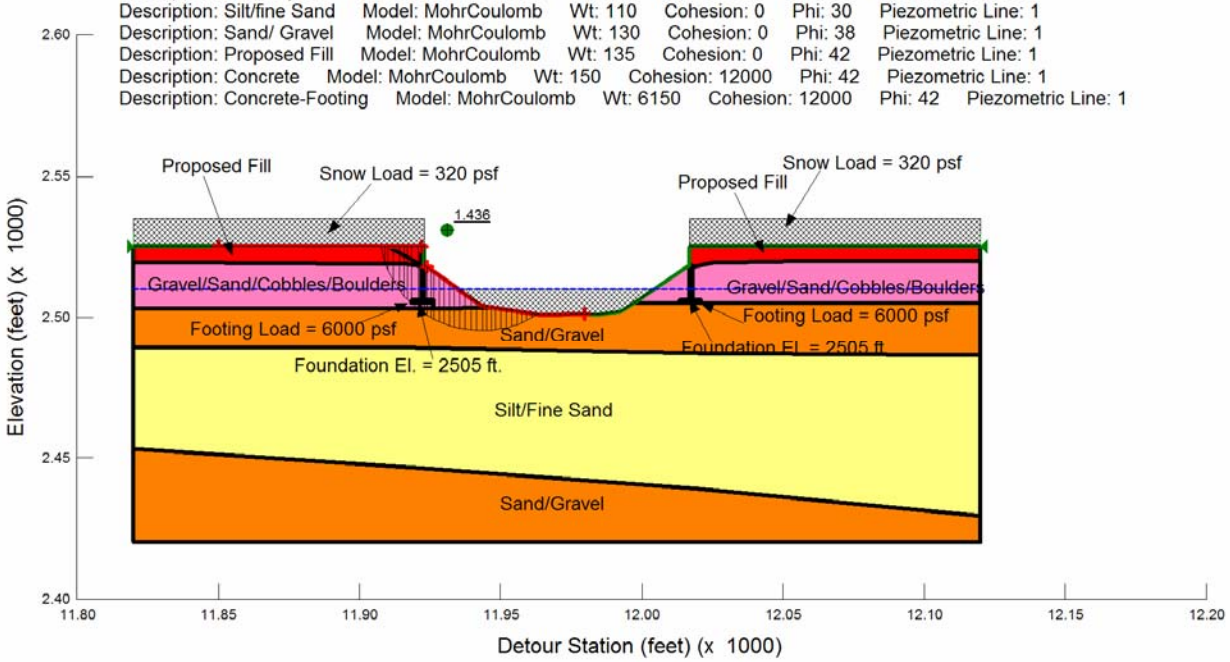
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Detour Bridge
Longitudinal, West Fill
Profile between Station 118+20 to 121+20 (DE2 Alignment)

Safety Factor = 1.44

Loading: Static
Embankment Configuration: Proposed
Water Table: Low GWT (EL. 2510)
Assumed Footing Width, B = 8 ft.

Description: Primarily Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 40 Piezometric Line: 1
Description: Silt/fine Sand Model: MohrCoulomb Wt: 110 Cohesion: 0 Phi: 30 Piezometric Line: 1
Description: Sand/ Gravel Model: MohrCoulomb Wt: 130 Cohesion: 0 Phi: 38 Piezometric Line: 1
Description: Proposed Fill Model: MohrCoulomb Wt: 135 Cohesion: 0 Phi: 42 Piezometric Line: 1
Description: Concrete Model: MohrCoulomb Wt: 150 Cohesion: 12000 Phi: 42 Piezometric Line: 1
Description: Concrete-Footing Model: MohrCoulomb Wt: 6150 Cohesion: 12000 Phi: 42 Piezometric Line: 1



Job No. 33758623

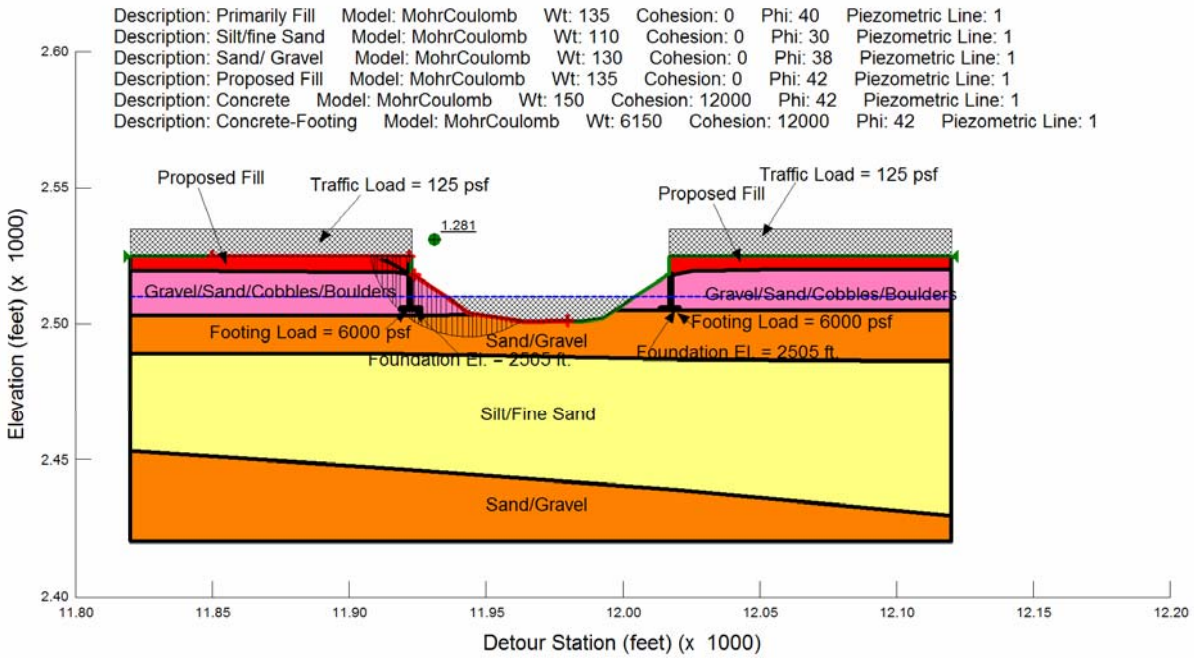
Figure D108

URS

I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

Detour Bridge
Longitudinal, West Fill
Profile between Station 118+20 to 121+20 (DE2 Alignment)
Safety Factor = 1.28

Loading: Seismic (Kh=0.0875, Kv=0), Pseudo-static
Embankment Configuration: Proposed
Water Table: Low GWT (EL. 2510)
Assumed Footing Width, B = 8 ft.



Job No. 33758623

Figure 109

APPENDIX E
DRILLED SHAFT ROCK SOCKET RESISTANCE CAPACITY

This appendix documents the technical basis for the Gold Creek bridges (GCB) drilled shaft rock socket resistances graphically presented in Figures 19, 20, and 29 through 32 and the rock mass unconfined compressive strengths listed in Table 6, Design Parameters for Lateral Load Analysis Using DFSAP.

ROCK STRENGTH CHARACTERIZATION FOR ANALYSIS AND DESIGN

The bedrock at the GCB site was characterized for intact unconfined compressive strength (q_{ui}) and Rock Mass Rating (RMR) for the purpose of evaluating and recommending rock socket bearing resistances and unconfined compressive strengths for DFSAP analysis. Andesite bedrock was encountered in seven borings located at or near the single-span bridges (Piers 1 and 2) and at or near the western end of the multi-span bridges (Pier 1). These seven borings were:

Single-Span Bridges

- GCB-001-07
- GCB-002-07
- GCB-003-07
- H-01-06
- H-02-06

Multi-Span Bridges (Pier 1)

- GCB-005-07
- H-03-06

Intact Rock Unconfined Compression, q_{ui}

Rock point load tests were conducted on a total of 24 rock specimens taken from 11 rock samples. The 11 rock samples were composed of one to three specimens. The specimens represented six of the seven borings. No tests were conducted for Boring H-02-06. The point load tests were used to estimate q_{ui} for each specimen and sample. Results are presented in Table B-2.

Specimen depth below the top of bedrock ranged from 0.1 to 11.6 feet. Specimen q_{ui} ranged from 3.0 ksi to 29.9 ksi, and averaged 11.3 ksi for the 24 tests (specimen average q_{ui} = 11.3 ksi; n = 24 specimens). The standard deviation was 7.9 ksi and the coefficient of variation was 0.70.

The unconfined compressive strength for each sample (sample q_{ui}) was calculated as the average of the specimen q_{ui} for that sample. Sample q_{ui} ranged from 3.4 ksi to 23 ksi, and averaged 11.0 ksi for the 11 samples (sample average q_{ui} = 11.0 ksi; n = 11 samples). The standard deviation was 6.5 ksi and the coefficient of variation was 0.59.

With respect to spatial differences, the sample q_{ui} grouped into two apparent subsets based on location and sample q_{ui}:

1. A lower-strength subset for the relatively shallow bedrock at the single-span bridges. These seven samples had an average q_{ui} = 7.3 ksi, standard deviation = 3.3 ksi, and coefficient of variation = 0.45 (n=7 from 2007 GCB-series borings 001, 002, and 003; and 2006 H-series borings 01 and 02)

Single-Span Bridges

The average rock strengths at the single-span bridges appeared to generally increase with depth. The depth dependence of average q_{ui} was characterized using three layers of increasing depth below the bedrock surface:

1. Rock from 0 to 5 feet, q_{ui} = 3.4 ksi
2. Rock deeper than 5 to 10 feet, q_{ui} = 5.0 ksi
3. Rock 10 feet and deeper, q_{ui} = 10.5 ksi.

An upper 5-foot thick rock layer with q_{ui} = 3.4 ksi was based on the two samples having q_{ui} = 3.4 ksi in the upper five feet of rock. Because these two samples had the lowest q_{ui} of all the samples, and with very little variability in their specimen q_{ui}, they were considered reasonably representative of shallow rock. The second rock layer with q_{ui} = 5.0 ksi was based on a conservative interpretation of the three samples between five and 10 feet of depth. While these three samples had an average q_{ui} of 7.5 ksi, their specimen q_{ui} ranged as low as 4.6 ksi; therefore, a layer q_{ui} of 5.0 ksi was chosen to provide reasonable confidence that the uncertain actual q_{ui} would not be over-estimated at any shaft location.

A q_{ui} = 10.5 ksi was assigned to the layer greater than 10 feet below the bedrock surface for two relevant reasons. The first was because the two sample q_{ui} below 10 feet were both above 10.5 ksi (11.2 ksi and 10.6 ksi). The second was to match the 10.5 ksi used for rock at the snowshed, where the rock was explored to greater depth than at the Gold Creek bridges and there was enough data to do a simple reliability-based analysis of rock strength, which was considered relevant to rock at the GCB site. In summary, URS expects the actual average intact rock strengths at the single-span bridge piers to exceed the depth assigned values of 3.4, 5.0, and 10.5 ksi.

Multi-Span Bridges

At the multi-span bridges, unlike at the single-span bridges, the rock strength appeared to be relatively high at shallow depths, with no indication of significant depth dependence (although sample depths below the top of bedrock extended only to 7.4 feet). Therefore, a single layer of average rock strength q_{ui} = 10.5 ksi was used for rock at the multi-span bridges.

A q_{ui} = 10.5 ksi was used because the four sample q_{ui} were above 10.5 ksi (10.6 ksi, 16.8 ksi, 19.4 ksi, and 23.4 ksi), and because 10.5 ksi was used for rock at the snowshed, which was considered relevant to the GCB bridges as explained in the preceding paragraph for the single-span bridges. URS expects the actual average intact rock strength at the multi-span bridge piers to exceed the assigned value of 10.5 ksi.

Rock Mass Rating, RMR

The RMRs associated with the characterized q_{ui} were based on interpretation of available data using the methodology of AASHTO 2007 Section 10.4.6.4 Rock Mass Strength. RMR is used in estimating the shaft tip resistance and the rock mass unconfined compressive strength, q_u. RMR is not used in AASHTO-FHWA method for shaft side resistance.

For the single-span bridges an RMR of 23 was interpreted for rock at or shallower than 5 feet and an RMR of 45 was interpreted for rock deeper than 5 feet. For the multi-span bridges, an RMR of 45 was used for all depths, similar to that used for the snowshed.

URS considers the RMR estimates to be rough, largely subjective approximations, as is the correlation between RMR and rock strength, which is extrapolated from limited data.

Summary

The q_{ui} and RMRs used in the rocket socket resistance analyses are summarized in the following table.

Rock Layer Depth, ft below top of bedrock surface	Intact Rock Unconfined Compressive Strength, q_{ui}, ksi	RMR
Single-Span Bridges		
0 to 5	3.4	23
>5 to 10	5.0	45
≥10	10.5	45
Multi-Span Bridges		
>0	10.5	45

ESTIMATION OF SHAFT ROCK-SOCKET BEARING RESISTANCES

Drilled shaft rock-socket resistances for shaft tip and shaft skin (side) friction were estimated as a function of rocket socket diameter (B) and total depth (D) below the bedrock surface. The estimates used the layer-average q_{ui} and RMR estimates for the rock layers with the equations and guidance from AASHTO 2007 Section 10.8.3.5.4 Estimates of Drilled Shaft Resistance in Rock.

The AASHTO methodology is largely based on the 1999 report FHWA-IF-99-025, Drilled Shafts: Construction Procedures and Design Methods, by O'Neil and Reese (FHWA 1999). FHWA 1999 was used to supplement the AASHTO guidance.

Unfactored Maximum Tip Resistance

Unfactored shaft tip resistance per square foot of shaft tip area (q_p) was calculated for each rock layer using the AASHTO-FHWA methodology with the corresponding layer-average q_{ui} and RMR estimates. The RMR estimates were used to select corresponding m and s parameters from AASHTO 2007 Table 10.4.6.4-4 as input to AASHTO Equation 10.8.3.5.4c-2 (FHWA 1999, Method 1, Equation B.15). Because the resulting tip resistance is a lower bound solution for bearing resistance, the unfactored estimate was doubled so that the factored tip resistance would not be less than the lower-bound estimate. The tip resistance estimates assumed a clean hole, with the shaft in direct contact with the rock surface.

The AASHTO-FHWA procedures use RMR with m and s parameters based on Hoek and Brown 1988, although rock shear strength was estimated using the method of Hoek, et al. 2002, in accordance with the WSDOT GDM (2006, p.5-13). URS knows of no update to the shaft design procedures for Hoek, et al. 2002.

The tip resistance estimates were sensitive to RMR, via corresponding parameters m and s, only at the threshold between the RMR interval corresponding to "poor rock, class No. IV" (RMR = 40 to 21) and the RMR interval corresponding to "fair rock, class No III" (RMR = 41 to 60). URS considered the RMR estimates to be rough approximations that do not support excessive refinement, and therefore made no attempt to interpolate m and s parameters based on a continuum of RMR. Therefore, a range

of credible RMR estimates were compatible with (and would not have changed) the shaft design parameters for tip resistance calculated using the cited method.

Unfactored Maximum and Residual Side Resistance

Unfactored ultimate (maximum) shaft side resistance per square foot of shaft circumferential area (q_s) was calculated for each rock layer using the layer-average q_{ui} as input to AASHTO Equation 10.8.3.5.4b-1. The estimate for rock fracturing effects was $\alpha_E = 0.5$ based on interpretation of Table 10.8.3.5.4b-1.

Residual shaft side resistance was calculated for each rock layer using the layer-average q_{ui} as input to FHWA Equations C.33 and C.34 (p.C-28).

The maximum and residual side resistance estimates assumed smooth rock socket sides or that the rock has been drilled using drilling slurry. As AASHTO states, significant additional shaft resistance may be achieved if the borehole is specified to be artificially roughened by grooving (AASHTO 2007 C10.8.3.5.4b). FHWA 1999 Appendix B provides further details (p.B-40 to B-42).

Limit States

Unfactored maximum shaft tip and shaft side resistances were calculated for the strength and extreme event limit states. These limit state resistances do not consider shaft load-settlement behavior or the partitioning of resistance between the shaft tip and side. As explained in the following paragraphs, the service limit state resistance accounted for both load-settlement behavior and the partitioning of resistance between the shaft tip and side.

Maximum side resistance and tip resistance do not generally occur at the same strain level, and are thus not usually additive. Generally, as shaft load and resulting settlement increase, a threshold of maximum side resistance is reached before maximum tip resistance can be mobilized. Loading beyond this threshold, which increases shaft settlement, increases tip resistance but reduces side resistance to a residual value, which is considered independent of further settlement.

The maximum available rock-socket resistance (load capacity) typically occurs with residual side resistance when full tip resistance has been mobilized. Shaft settlement at the load capacity has to be checked for acceptability. If the settlement is acceptable (e.g., less than one inch), the maximum available rock-socket resistance can be assigned to the service limit state, which was the approach used by URS.

URS calculated the service limit state resistance as the sum of the residual side resistance plus the unfactored maximum tip resistance. Settlement at the service limit state resistance was calculated using the rock-socket load-settlement analysis methodology of FHWA Appendix C (p.C-27 to C-30). For all rock socket diameters (B) and depths (D) of interest, the service limit state resistance was calculated to have a total settlement of less than one inch, not including elastic compression of the shaft above the rock socket. More precisely, calculated total settlement of the rock socket did not exceed 0.20 inches for B up to 8 feet and D up to 25 feet.

For the multi-span (D>0 feet) and the single-span (D>5 feet) bridges, the service limit state resistance exceeded the sum of the ultimate side friction resistance plus the mobilized tip resistance at the ultimate side friction. This condition was calculated to have slightly less total settlement than at the service limit state.

However, because of the very low maximum tip resistance for the single-span bridges at D<5 feet, the service limit state resistance in the upper five feet (only) was exceeded by the sum of the ultimate side friction resistance plus the mobilized tip resistance at the ultimate side friction. This condition was calculated to have slightly greater total settlement than at the service limit state.

The unfactored strength state and extreme limit state resistances may be equated to the service limit state because the service limit state represented the maximum load capacity of the rock socket, and was calculated to occur at settlements of less than one (0.20) inch. The service limit state could thus represent all limit states.

Alternatively, the unfactored strength state and extreme limit state could, arguably, be equated to the sum of the unfactored maximum tip and side resistances because that sum, when multiplied by the resistance factors, is substantially less than the service limit state resistance. This approach is obviously less conservative than using the service limit state to also represent the unfactored strength and extreme limit states.

ROCK MASS UNCONFINED COMPRESSIVE STRENGTH FOR LATERAL LOAD ANALYSIS

The Hoek, et al. (2002) method was used for estimating the unconfined compressive strength of the rock mass, q_u, from the layer RMR and average q_{ui} (unconfined compressive strength of the intact rock, represented by the rock specimens). The Geologic Strength Index (GSI), as used in Hoek et al., was related to RMR using the relationship in NCHRP 2006 (Eqn. 7, p.24); that is: GSI = RMR – 5. The disturbance factor D was set to zero, representing rock undisturbed by drilling of the rock sockets. D=0 gives a maximum value for q_u. The q_u results for the GCB are summarized in Table 6.