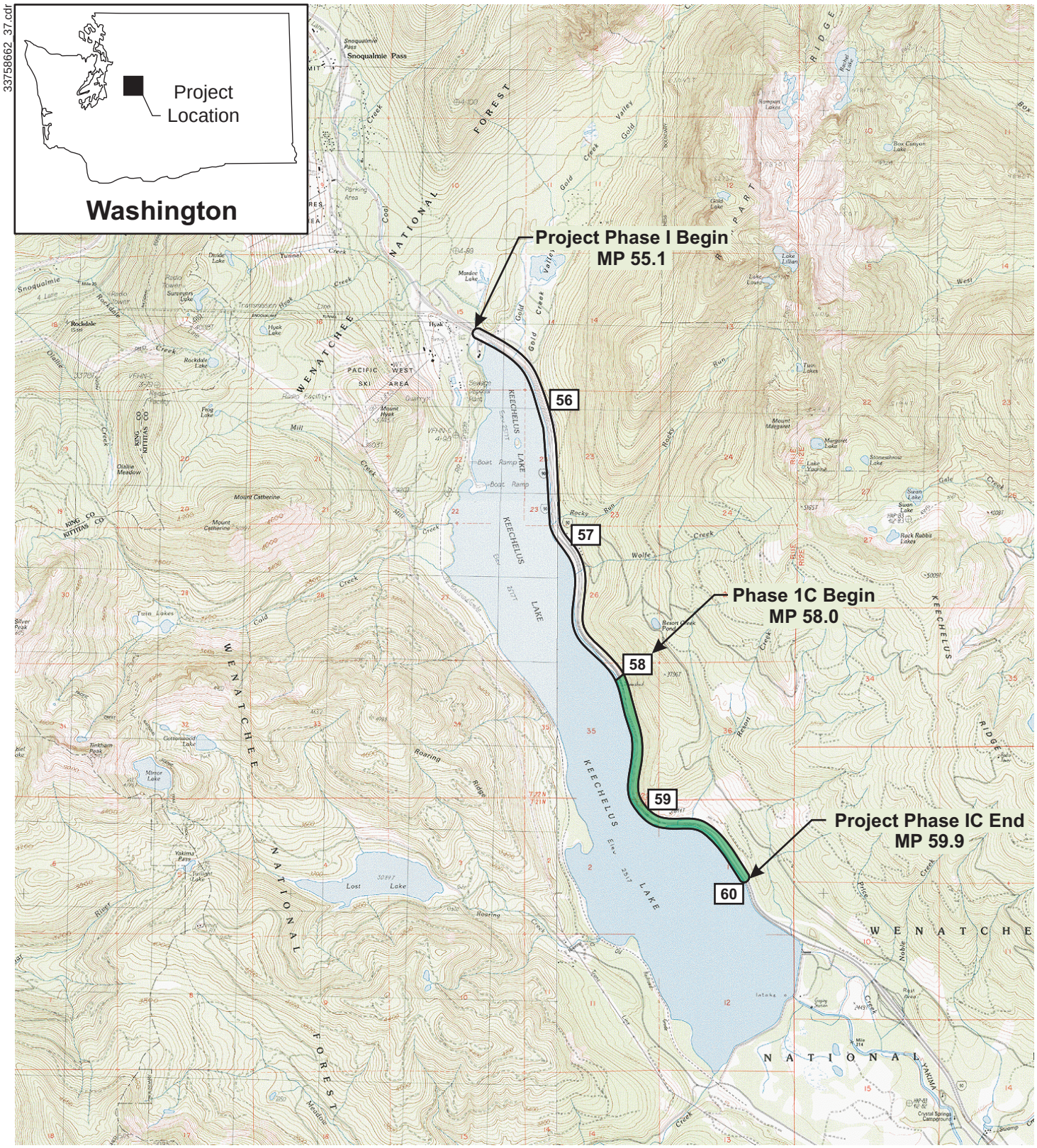


Map created with TOPO!™ © 1997 Wildflower Productions, www.topo.com, based on USGS topographic map

59 Milepost

0 1 2

Scale in Miles

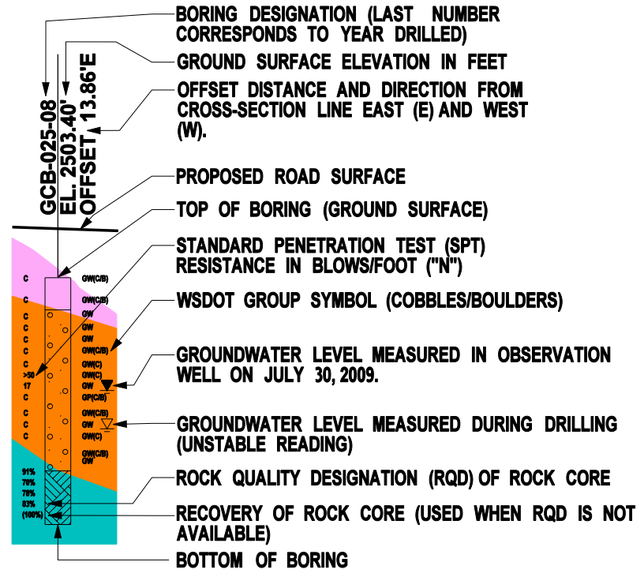
Figure 1.1

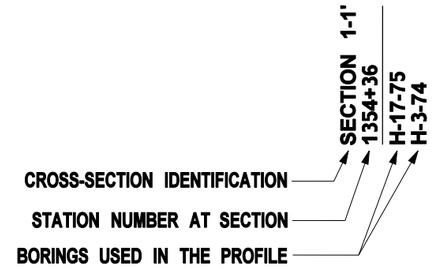
Vicinity Map

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
- GRAVEL WITH SAND/COBBLES/BOULDERS
- BEDROCK

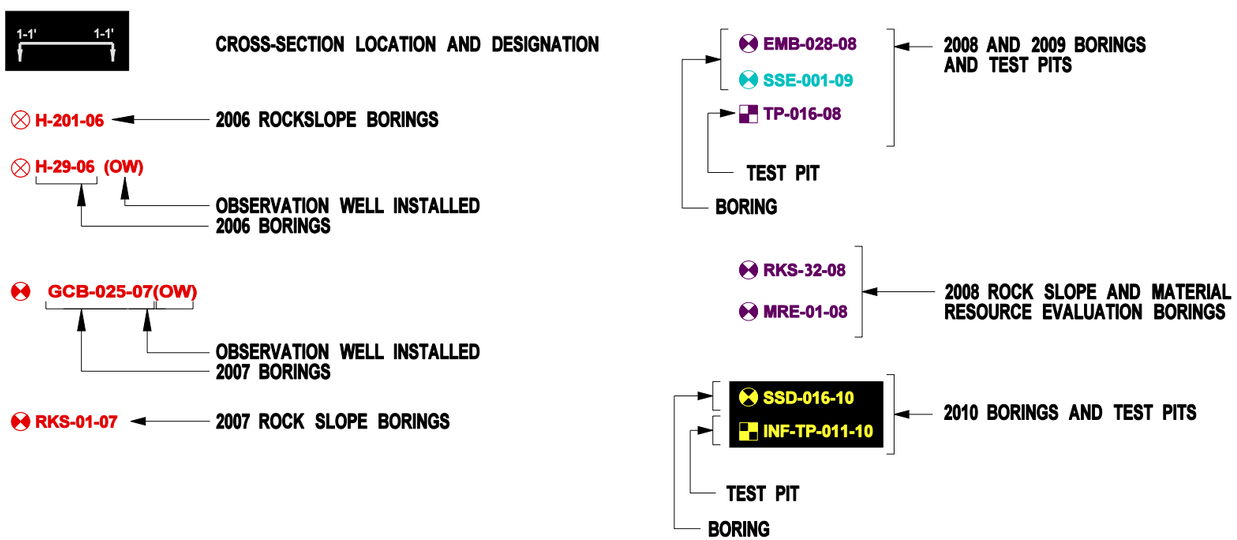




ABBREVIATIONS

EB	EASTBOUND
EMB	EMBANKMENT
CUL	CULVERT
L	OFFSET LEFT OF THE CONSTRUCTION CENTERLINE
MRE	MATERIAL RESOURCE EVALUATION
R	OFFSET RIGHT OF THE CONSTRUCTION CENTERLINE
RCB	RESORT CREEK BRIDGES
RCW	RESORT CREEK WALL
RKS	ROCKSLOPE
SCB	SLIDE CURVE BRIDGE
SCW	SLIDE CURVE WALL
SSD	SNOWSHED
SSE	SIGN STRUCTURE
TCC	TOWNSEND CREEK CULVERT
WB	WESTBOUND

BORING LEGEND



PROFILE AND CROSS-SECTION NOTES

1. REFER TO APPENDIX A FOR BORING LOGS.

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

3. 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.

4. THE SOIL STRATA WERE INTERPRETED BASED ON AVAILABLE AND APPLICABLE GEOTECHNICAL AND GEOLOGIC INFORMATION. THE STRATIFICATION LINES SHOWN ON THE PROFILES AND THE CROSS-SECTIONS ARE BASED ON INTERPRETATIONS BETWEEN WIDELY SPACED BORINGS AND THUS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES. ACTUAL TRANSITIONS MAY VARY FROM THOSE SHOWN.

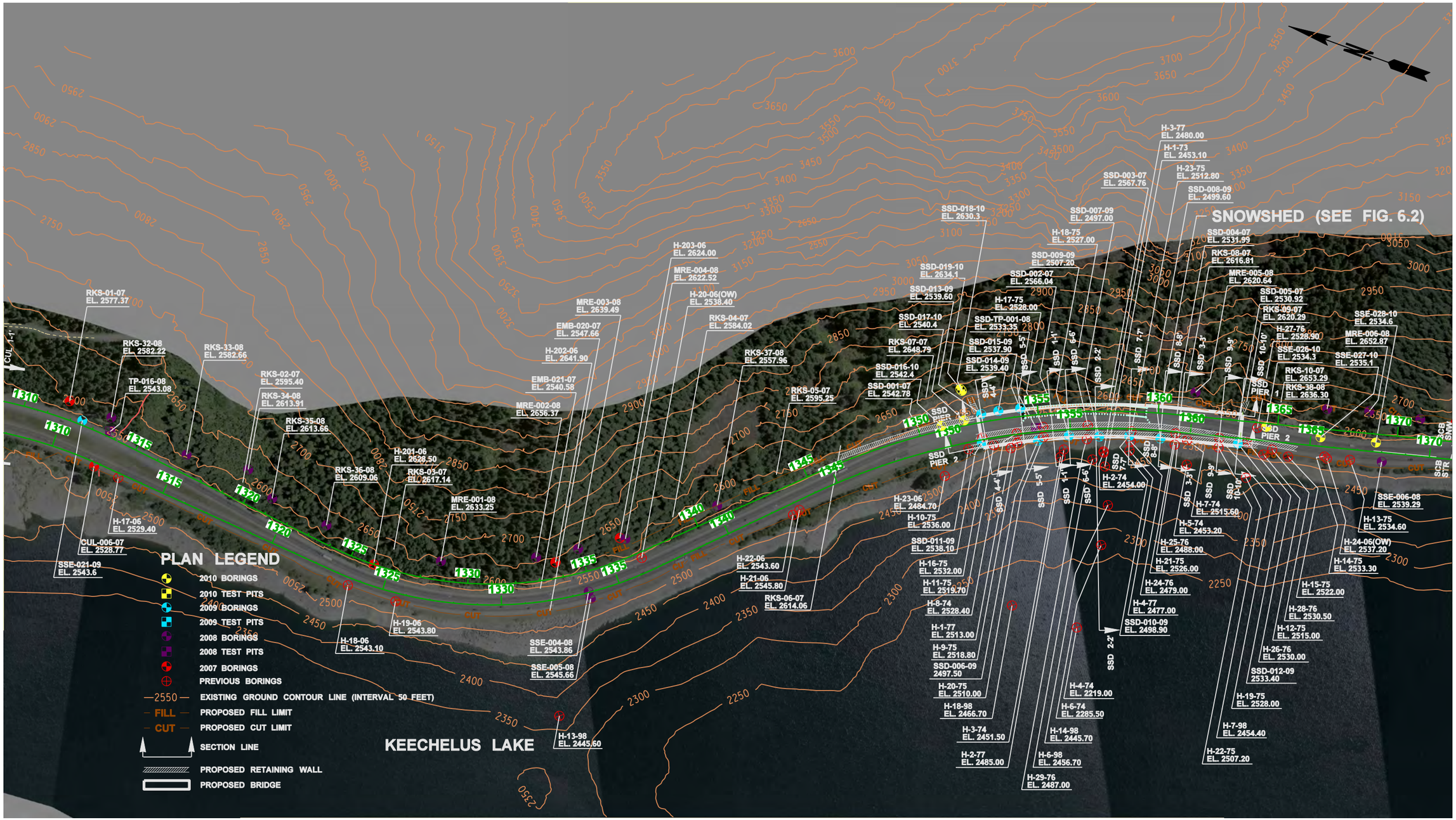
5. EXAGGERATION OF VERTICAL SCALE FOR PURPOSES OF PRESENTATION CAUSES TRENDS IN SOIL STRATA TO APPEAR MORE PRONOUNCED THAN THOSE WHICH ACTUALLY EXIST.

6. OVERBURDEN UPSLOPE OF THE ROADWAY TYPICALLY IS NOT SHOWN IN THE CROSS SECTIONS. OVERBURDEN THICKNESS INFORMATION IS SHOWN IN WYLLIE & NORRISH 2009b, 2009c, AND 2008.

7. THE EB AND WB SUBSURFACE PROFILES WERE INTERPRETED USING SOIL STRATA INTERPRETED AT CROSS-SECTIONS AT CONSTRUCTION CENTERLINES OF THE EB AND WB CONSTRUCTION CENTERLINES RESPECTIVELY.

8. THE GRAPHIC LOG WITH SPT VALUES AND WSDOT GROUP SYMBOLS IS NOT SHOWN ON THE PROFILES WHERE SPACE IS LIMITED.

9. WATER LEVELS MEASURED DURING DRILLING THAT ARE SHOWN ON THE DRAWINGS MAY BE UNSTABLE AND SHALL NOT BE USED FOR ANY DESIGN, ANALYSES OR CONSTRUCTION PURPOSES.



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ENTERED BY	brenda_mcintosh				CONTRACT NO.		LOCATION NO.
CHECKED BY	Dave Walker				Y-9764		
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX

DATE

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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

SITE PLAN AND BORING LOCATION MAP

FIGURE 2.2A

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Exploration Plans\Plan Sheet 04 with picture.dgn				REGION NO.	STATE	FED.AID PROJ.NO.
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CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY	Y-9764		

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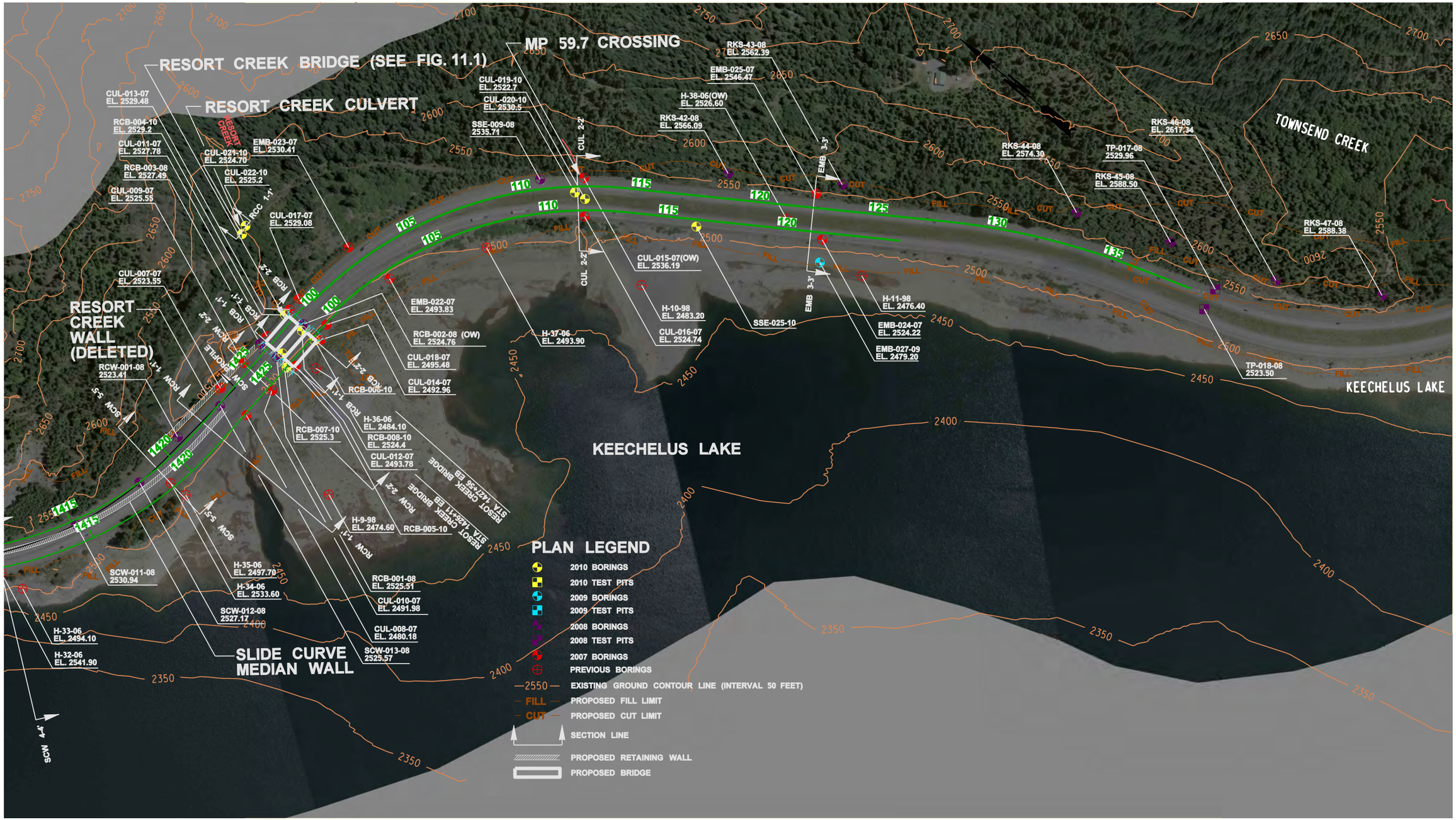
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SITE PLAN AND BORING LOCATION MAP

FIGURE 2.2B



0 400 800 SCALE 1" = 400'

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Exploration Plans\Plan Sheet 05 with picture.dgn				REGION NO.	STATE	FED.AID PROJ.NO.
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ENTERED BY	brenda_mcintosh				CONTRACT NO.		LOCATION NO.
CHECKED BY	Dave Walker				Y-9764		
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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

SITE PLAN AND BORING LOCATION MAP

FIGURE 2.2C

0 400 800
SCALE 1" = 400'

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Exploration Plans\Plan Sheet 06 with picture.dgn				REGION NO.	STATE	FED.AID PROJ.NO.
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ENTERED BY	brenda_mcintosh				CONTRACT NO.		LOCATION NO.
CHECKED BY	Dave Walker				Y-9764		
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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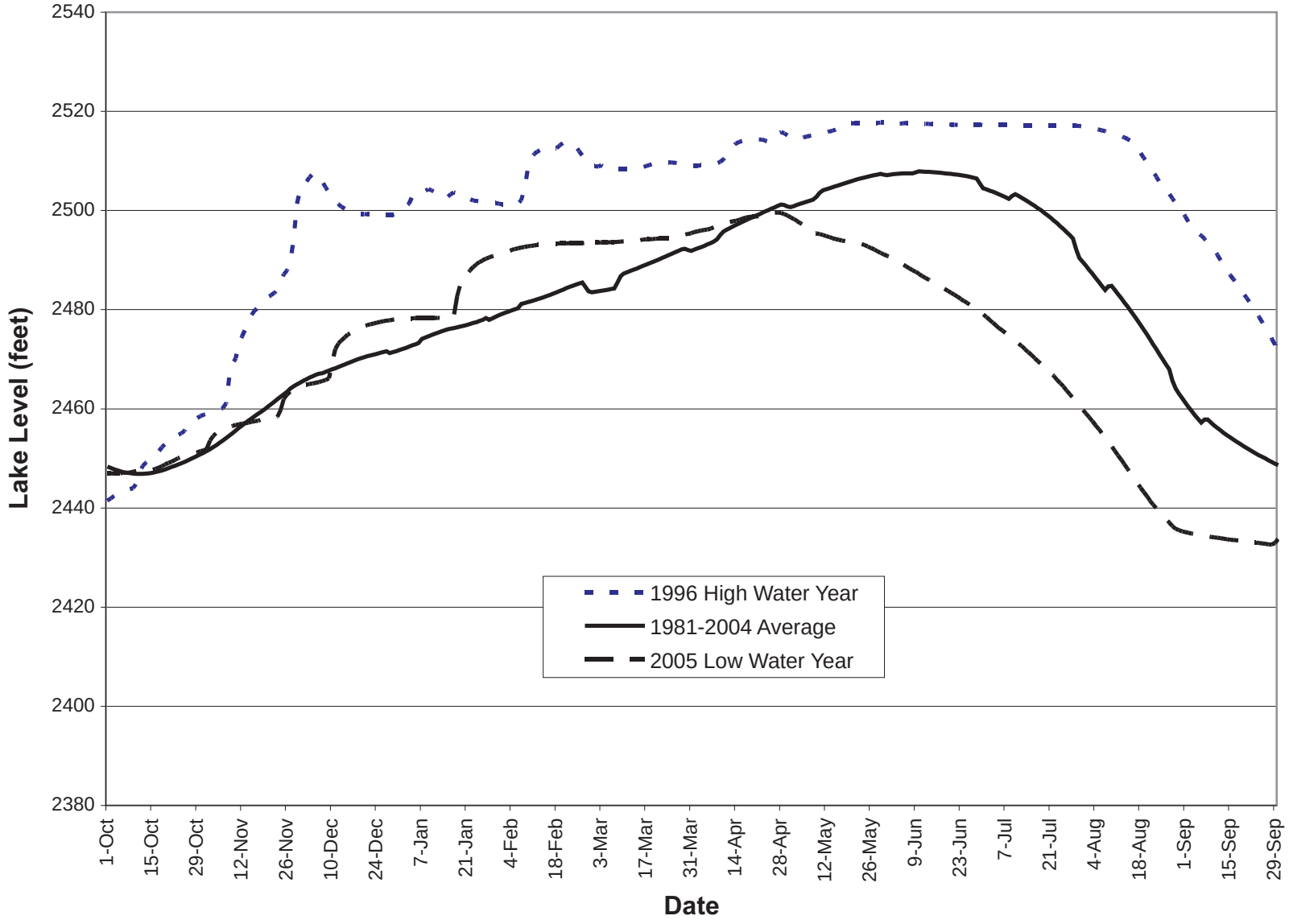
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

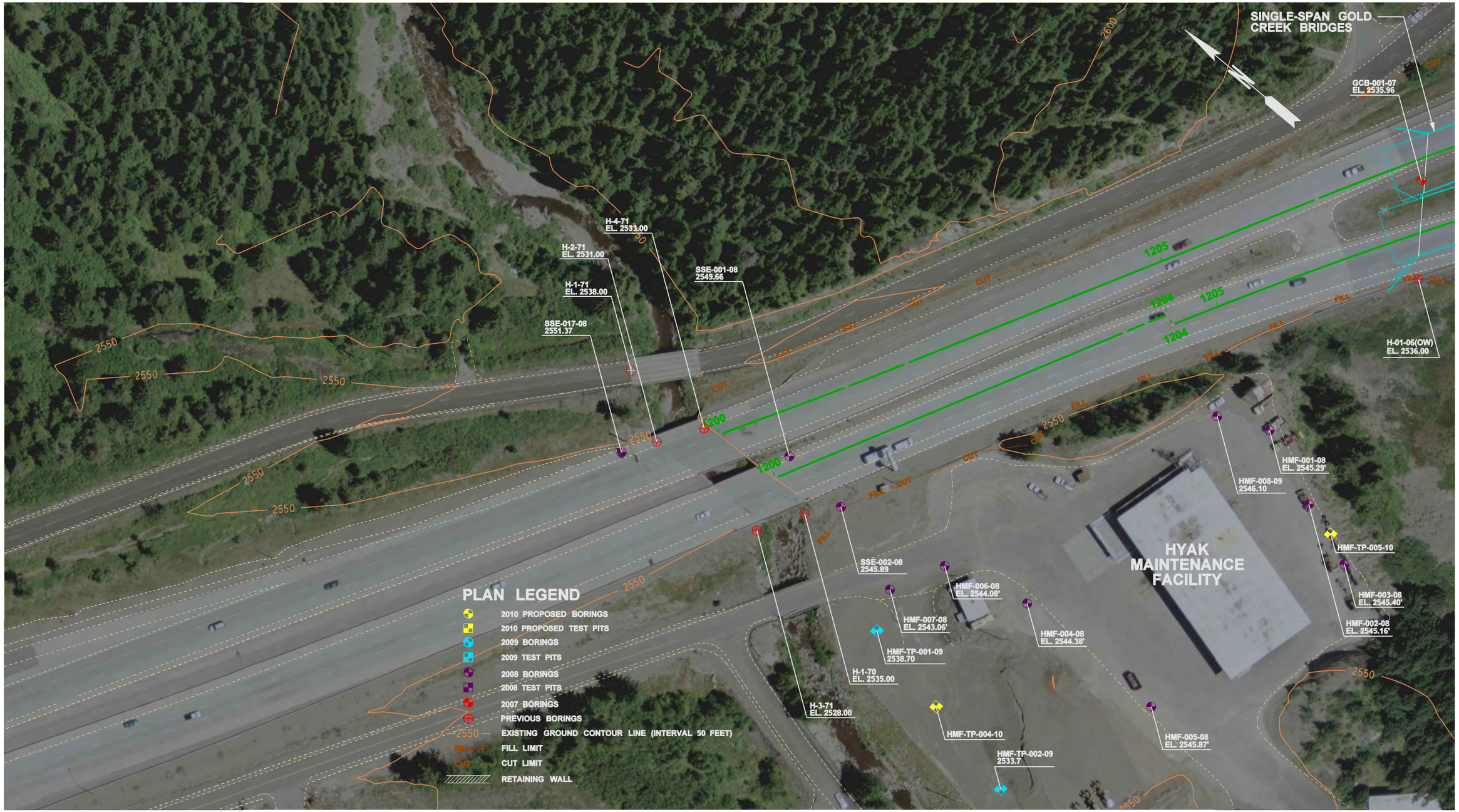
SITE PLAN AND BORING LOCATION MAP

FIGURE
2.2D



Job No. 33758638

Figure 2.3
Keechelus Lake Reservoir Levels



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ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker				CONTRACT NO. Y-9764	LOCATION NO.	
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			P.E. STAMP BOX DATE

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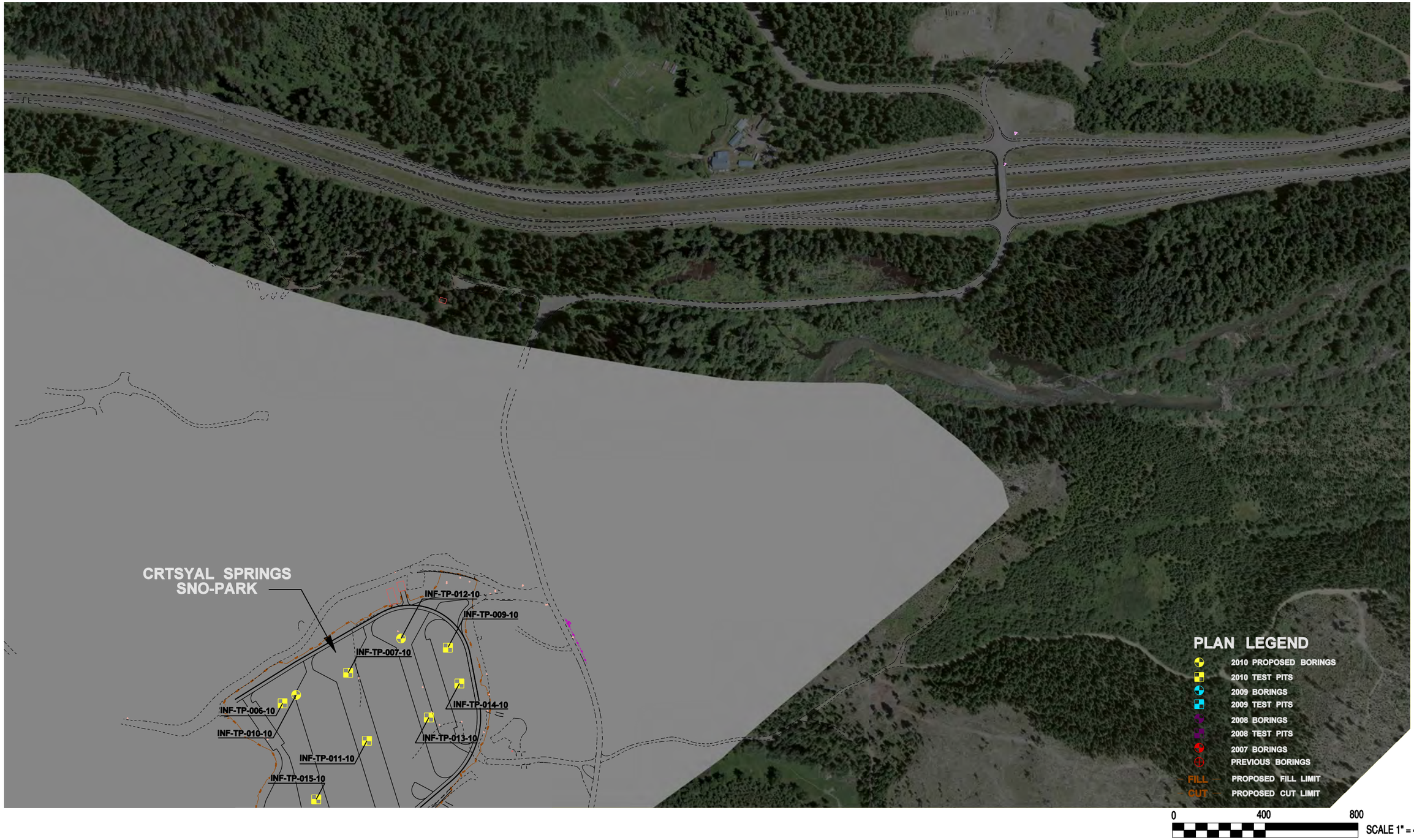
SITE PLAN AND BORING LOCATION MAP-OFFSITE STORMWATER MITIGATION FACILITIES AT HYAK MAINTENANCE FACILITY

FIGURE 2.4



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ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY	Y-9764		

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SITE PLAN AND BORING LOCATION PLAN - OFFSITE
STORMWATER FACILITIES AT CRYSTAL SPRINGS SNO-PARK

FIGURE
2.5

0 50 100
SCALE IN FEET

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Sheets with Aerials_2010\Alignment Plan Sheets.dgn						
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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6A

0 50 100
SCALE IN FEET

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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6B

0 50 100
SCALE IN FEET

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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6C

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Sheets with Aerials_2010\Alignment Plan Sheets.dgn				REGION NO.	STATE	FED.AID PROJ.NO.
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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6D

0 50 100
SCALE IN FEET

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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6E

0 50 100
SCALE IN FEET

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CHECKED BY					CONTRACT NO.		LOCATION NO.
PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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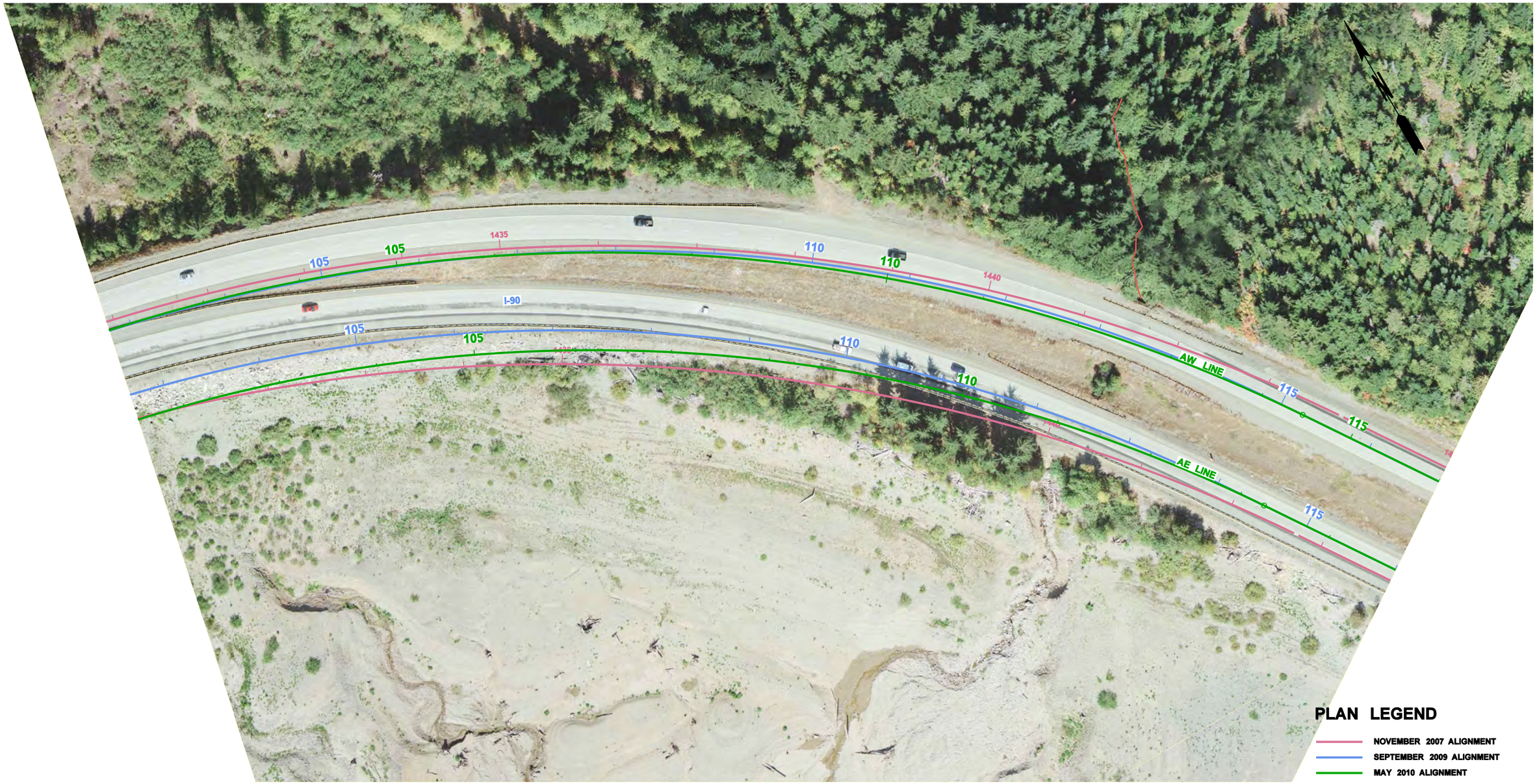
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6F



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CHECKED BY					CONTRACT NO.		LOCATION NO.
PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6G

PLAN LEGEND

- NOVEMBER 2007 ALIGNMENT
- SEPTEMBER 2009 ALIGNMENT
- MAY 2010 ALIGNMENT

0 50 100
SCALE IN FEET

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DESIGNED BY	
ENTERED BY	
CHECKED BY	
PROJ. ENGR.	
REGIONAL ADM.	

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
CONTRACT NO.		LOCATION NO.

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I-90 Snoqualmie Pass East
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CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6H

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Sheets with Aerials_2010\Alignment Plan Sheets.dgn				REGION NO.	STATE	FED.AID PROJ.NO.
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PROJ. ENGR.							
REGIONAL ADM.		REVISION	DATE	BY			

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

CURRENT AND SUPERSEDED ALIGNMENTS

FIGURE
2.6I

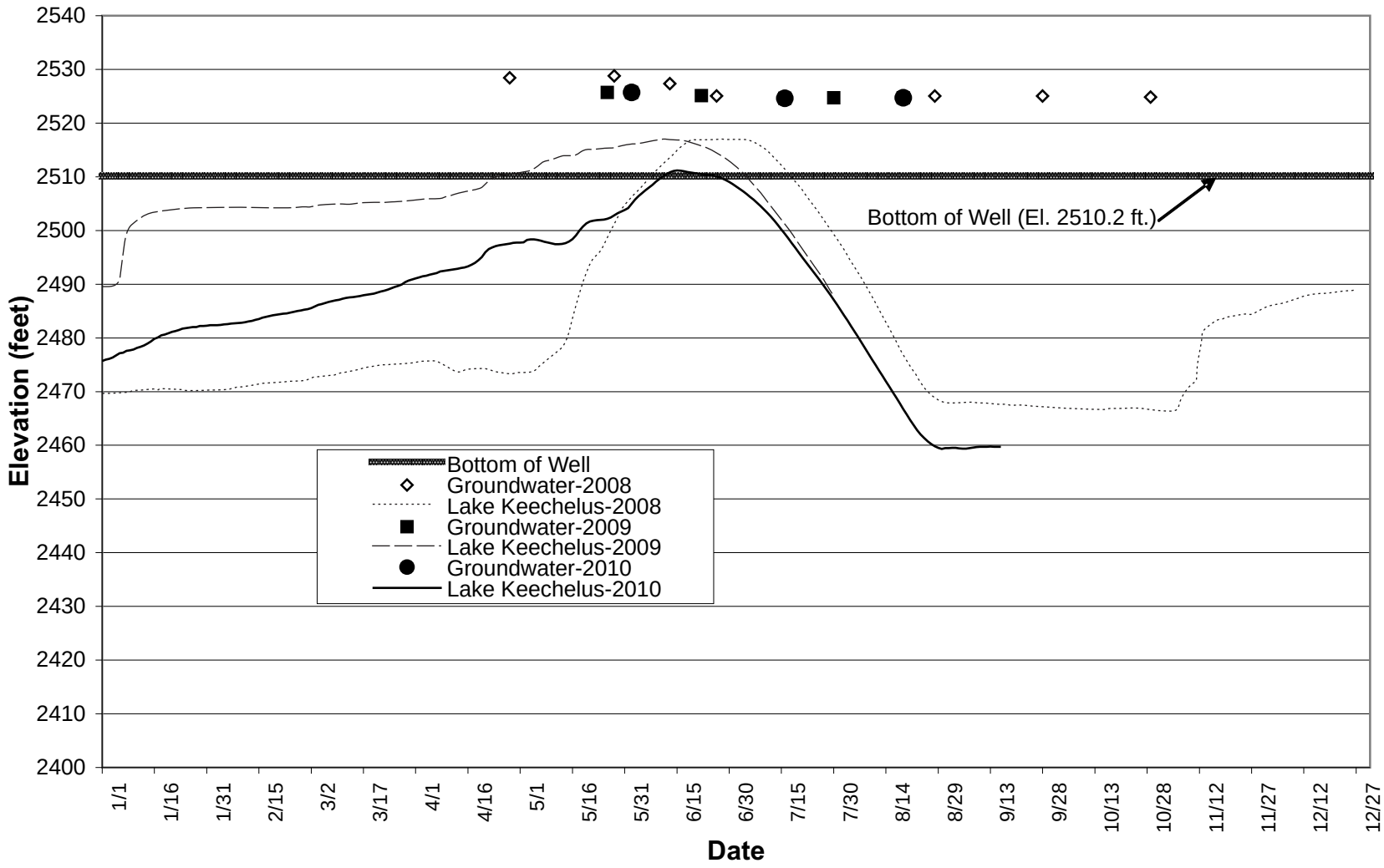


Figure 3.1

Groundwater Levels, CUL-015-07 (OW)

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

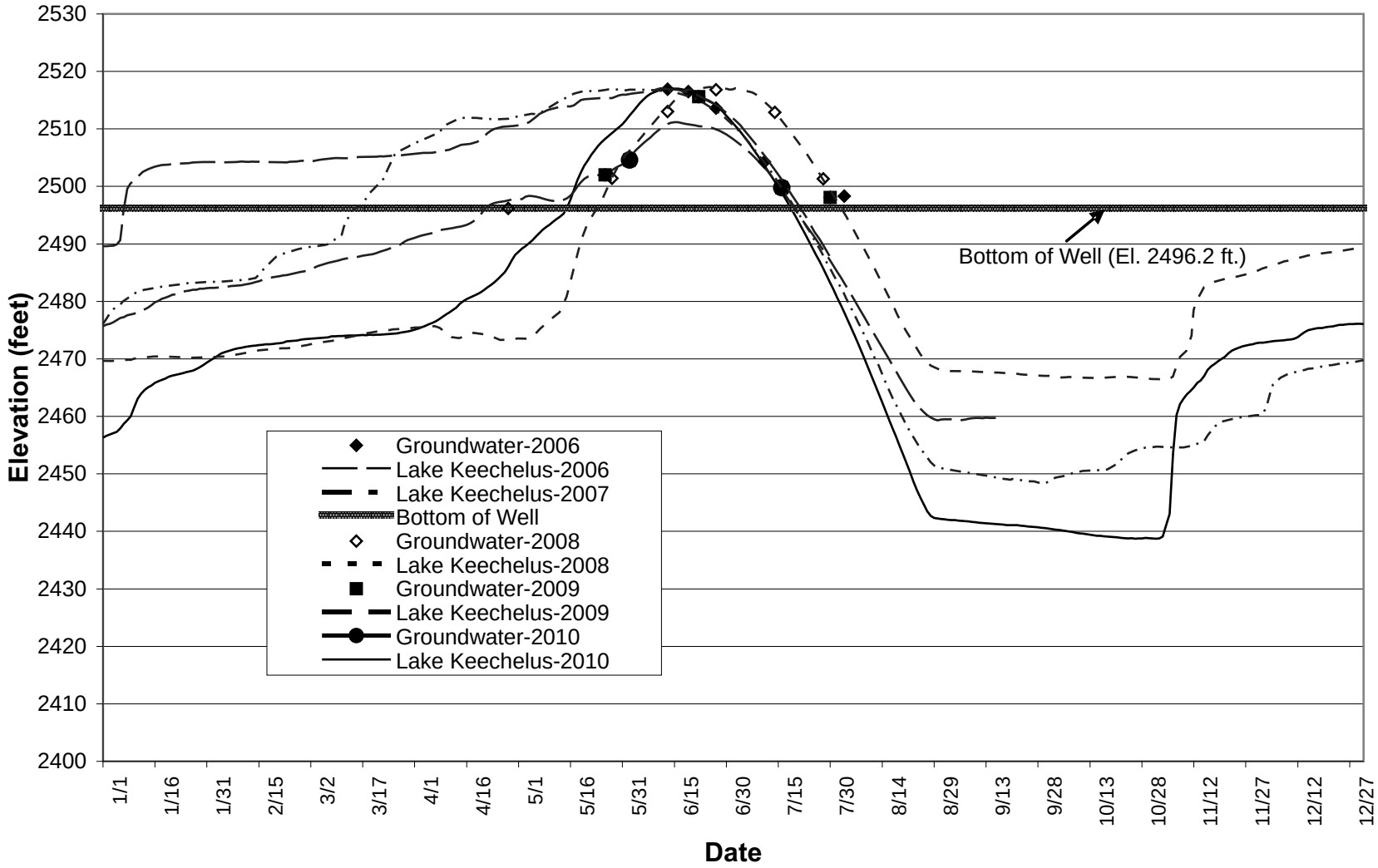


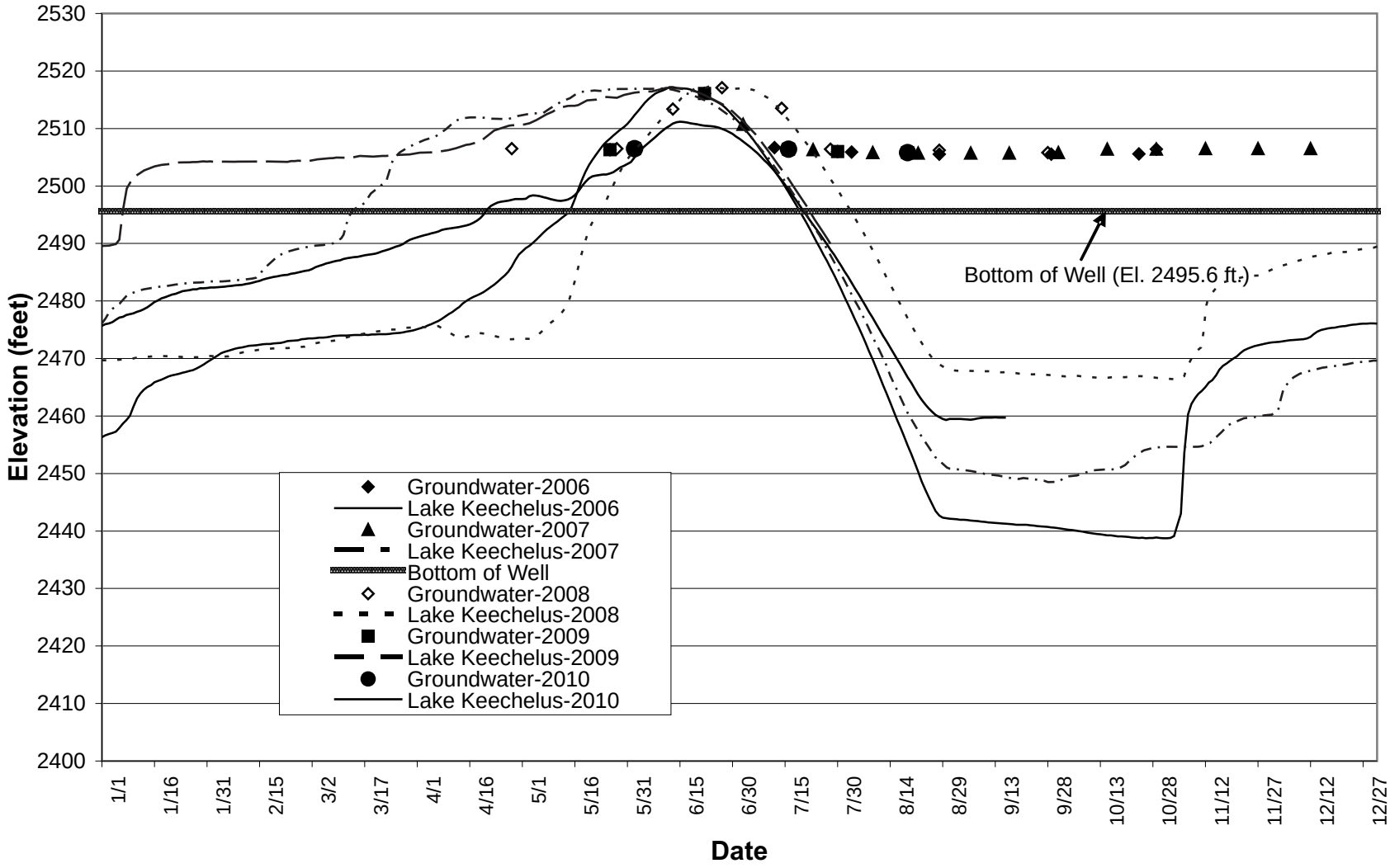
Figure 3.2

Groundwater Levels, H-24-06 (OW)

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting



Job No. 33758662

Figure 3.3
Groundwater Levels, H-38-06 (OW)

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

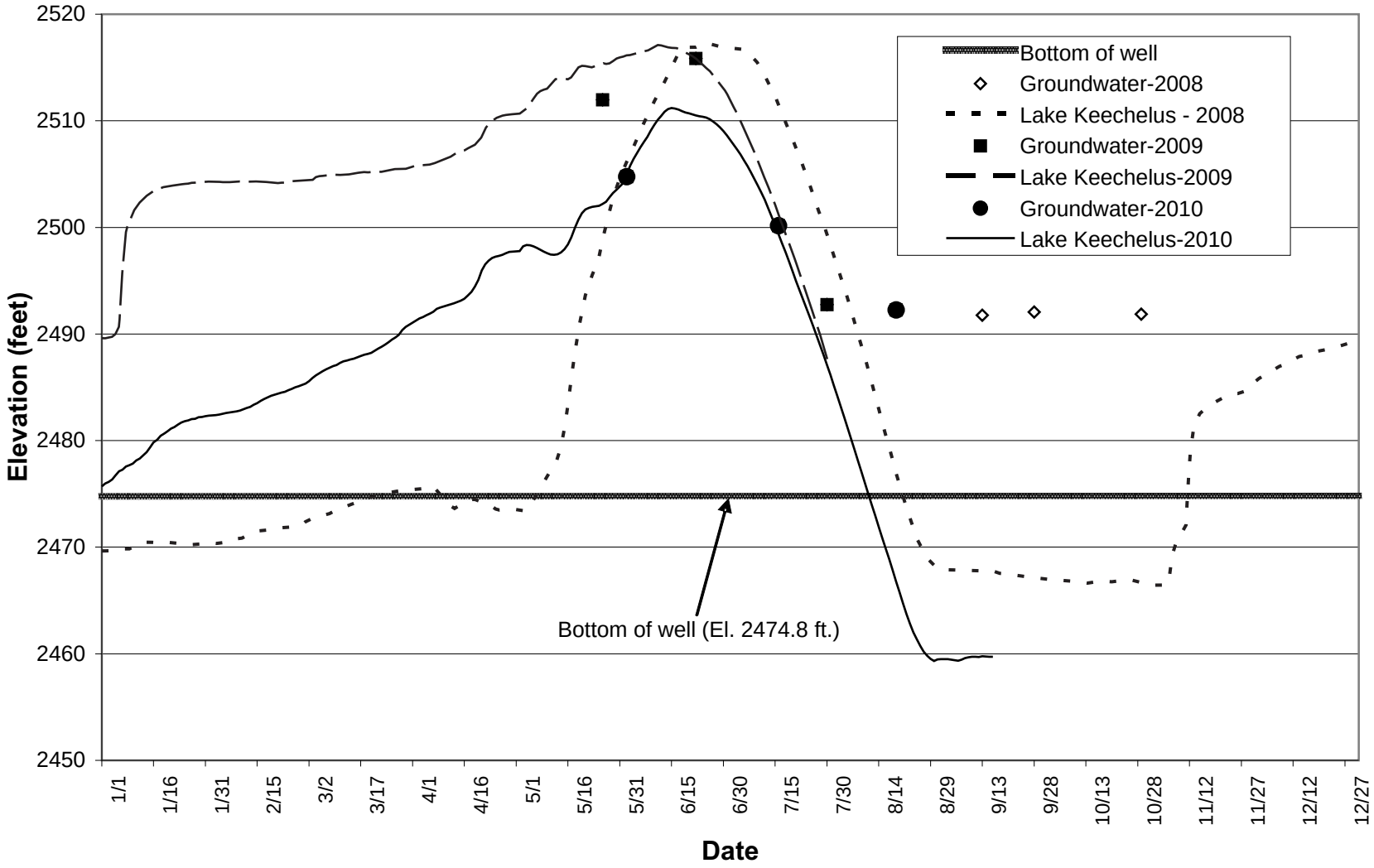


Figure 3.4

Groundwater Levels, RCB-002-08 (OW)

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

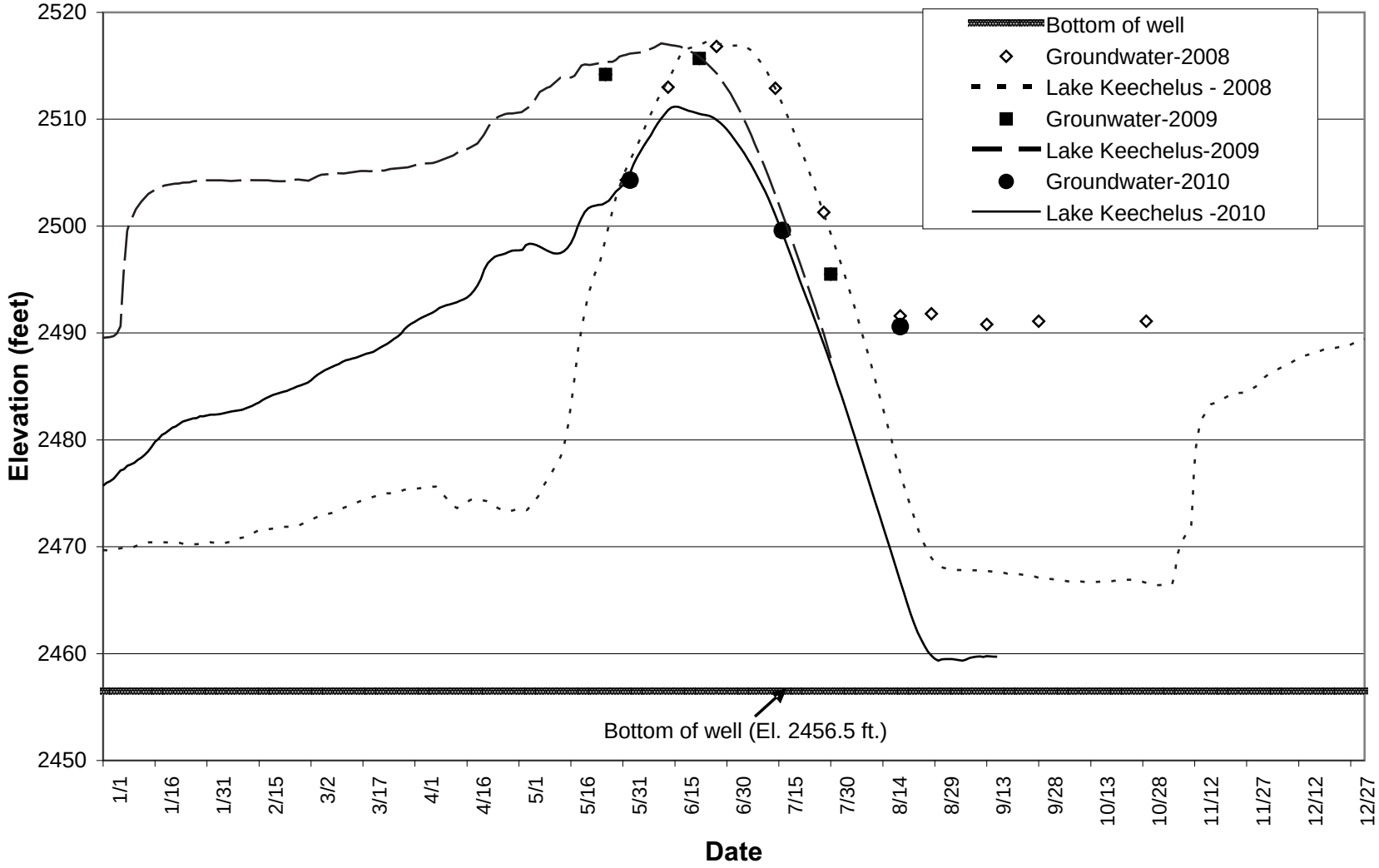


Figure 3.5

Groundwater Levels, RCB-003-08 (OW)

Job No. 33758662

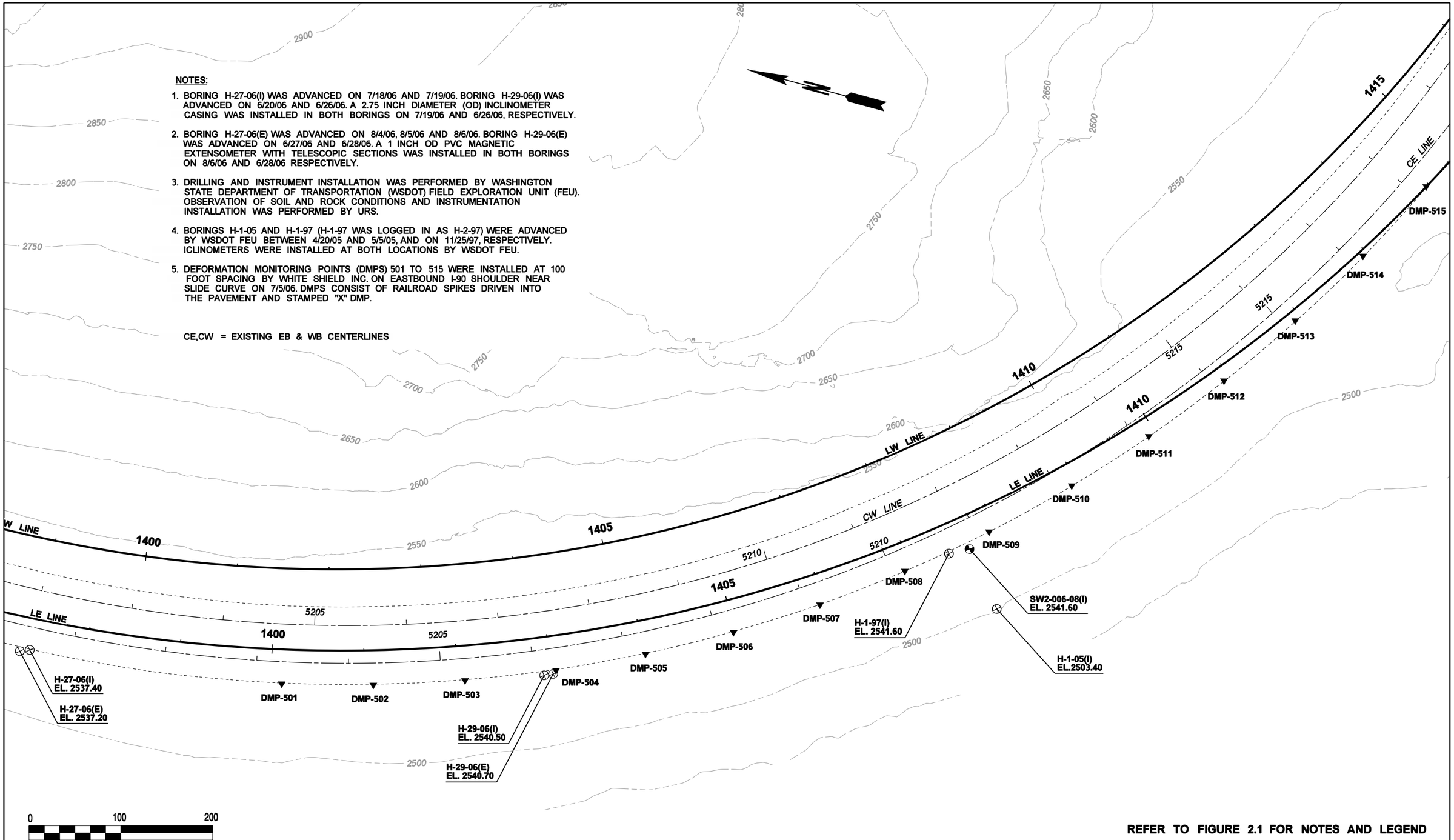
URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

NOTES:

1. BORING H-27-06(I) WAS ADVANCED ON 7/18/06 AND 7/19/06. BORING H-29-06(I) WAS ADVANCED ON 6/20/06 AND 6/26/06. A 2.75 INCH DIAMETER (OD) INCLINOMETER CASING WAS INSTALLED IN BOTH BORINGS ON 7/19/06 AND 6/26/06, RESPECTIVELY.
2. BORING H-27-06(E) WAS ADVANCED ON 8/4/06, 8/5/06 AND 8/6/06. BORING H-29-06(E) WAS ADVANCED ON 6/27/06 AND 6/28/06. A 1 INCH OD PVC MAGNETIC EXTENSOMETER WITH TELESCOPIC SECTIONS WAS INSTALLED IN BOTH BORINGS ON 8/6/06 AND 6/28/06 RESPECTIVELY.
3. DRILLING AND INSTRUMENT INSTALLATION WAS PERFORMED BY WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) FIELD EXPLORATION UNIT (FEU). OBSERVATION OF SOIL AND ROCK CONDITIONS AND INSTRUMENTATION INSTALLATION WAS PERFORMED BY URS.
4. BORINGS H-1-05 AND H-1-97 (H-1-97 WAS LOGGED IN AS H-2-97) WERE ADVANCED BY WSDOT FEU BETWEEN 4/20/05 AND 5/5/05, AND ON 11/25/97, RESPECTIVELY. ICLINOMETERS WERE INSTALLED AT BOTH LOCATIONS BY WSDOT FEU.
5. DEFORMATION MONITORING POINTS (DMPS) 501 TO 515 WERE INSTALLED AT 100 FOOT SPACING BY WHITE SHIELD INC. ON EASTBOUND I-90 SHOULDER NEAR SLIDE CURVE ON 7/5/06. DMPS CONSIST OF RAILROAD SPIKES DRIVEN INTO THE PAVEMENT AND STAMPED "X" DMP.

CE,CW = EXISTING EB & WB CENTERLINES



REFER TO FIGURE 2.1 FOR NOTES AND LEGEND

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DATE	9/28/2010						
DESIGNED BY	Kranti Maturi						
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
33758662		
CONTRACT NO.		LOCATION NO.
Y-9764		

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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

SLIDE CURVE EMBANKMENT INSTRUMENTATION PLAN

FIGURE 3.6

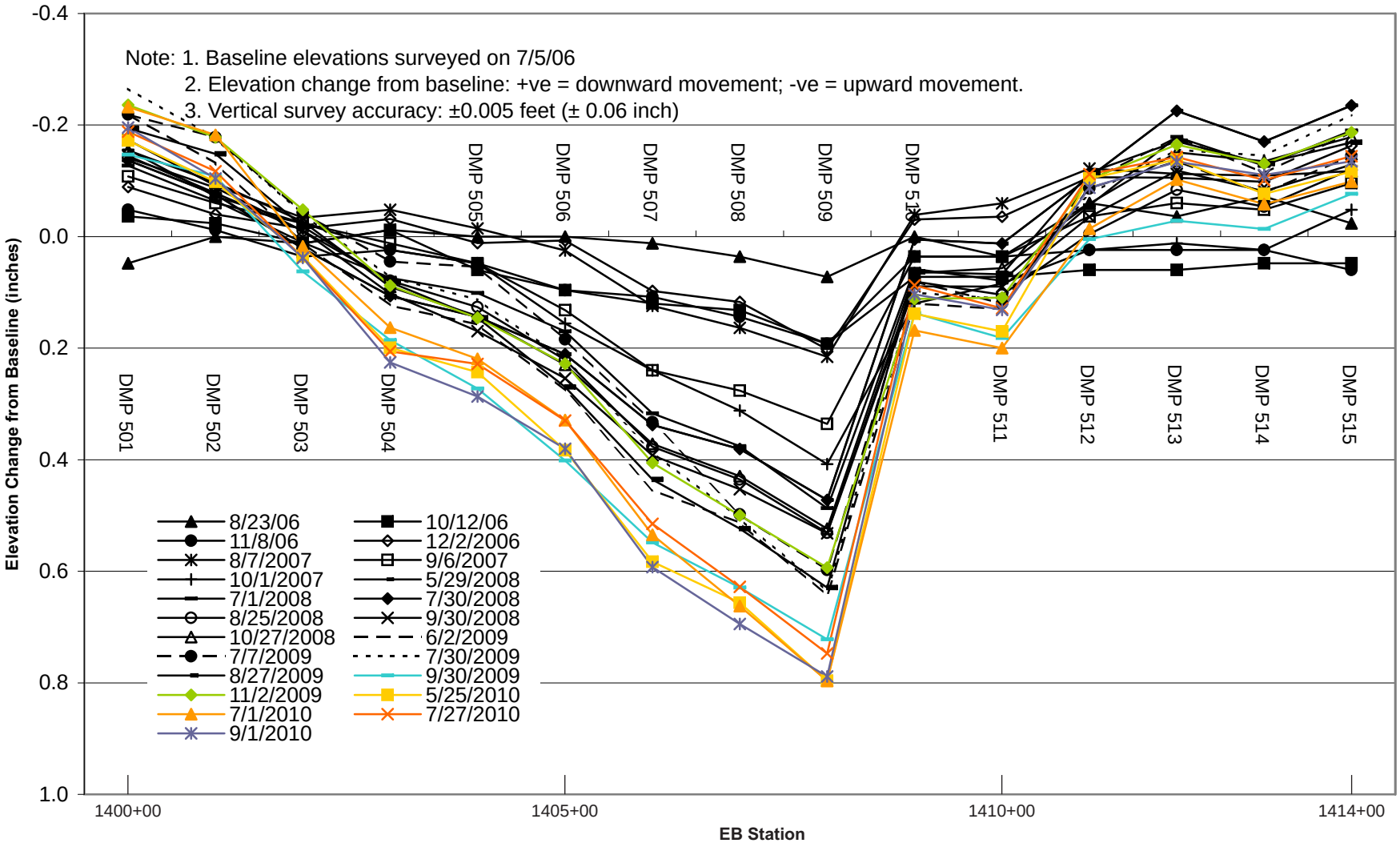


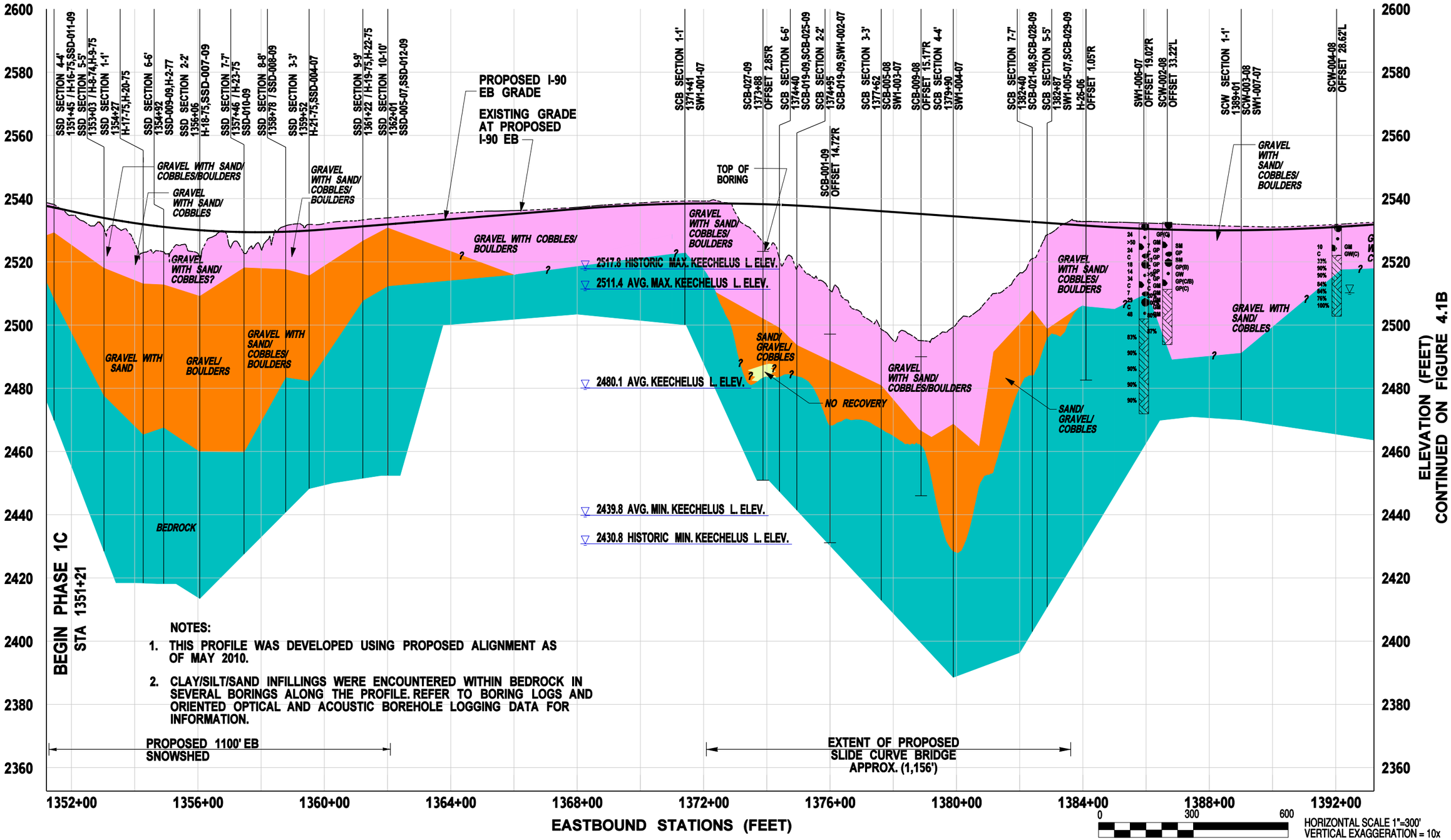
Figure 3.7

Deformation Monitoring Point Measurements

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting



NOTES:

1. THIS PROFILE WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. CLAY/SILT/SAND INFILLINGS WERE ENCOUNTERED WITHIN BEDROCK IN SEVERAL BORINGS ALONG THE PROFILE. REFER TO BORING LOGS AND ORIENTED OPTICAL AND ACOUSTIC BOREHOLE LOGGING DATA FOR INFORMATION.

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DATE	9/27/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

P.E. STAMP BOX | DATE

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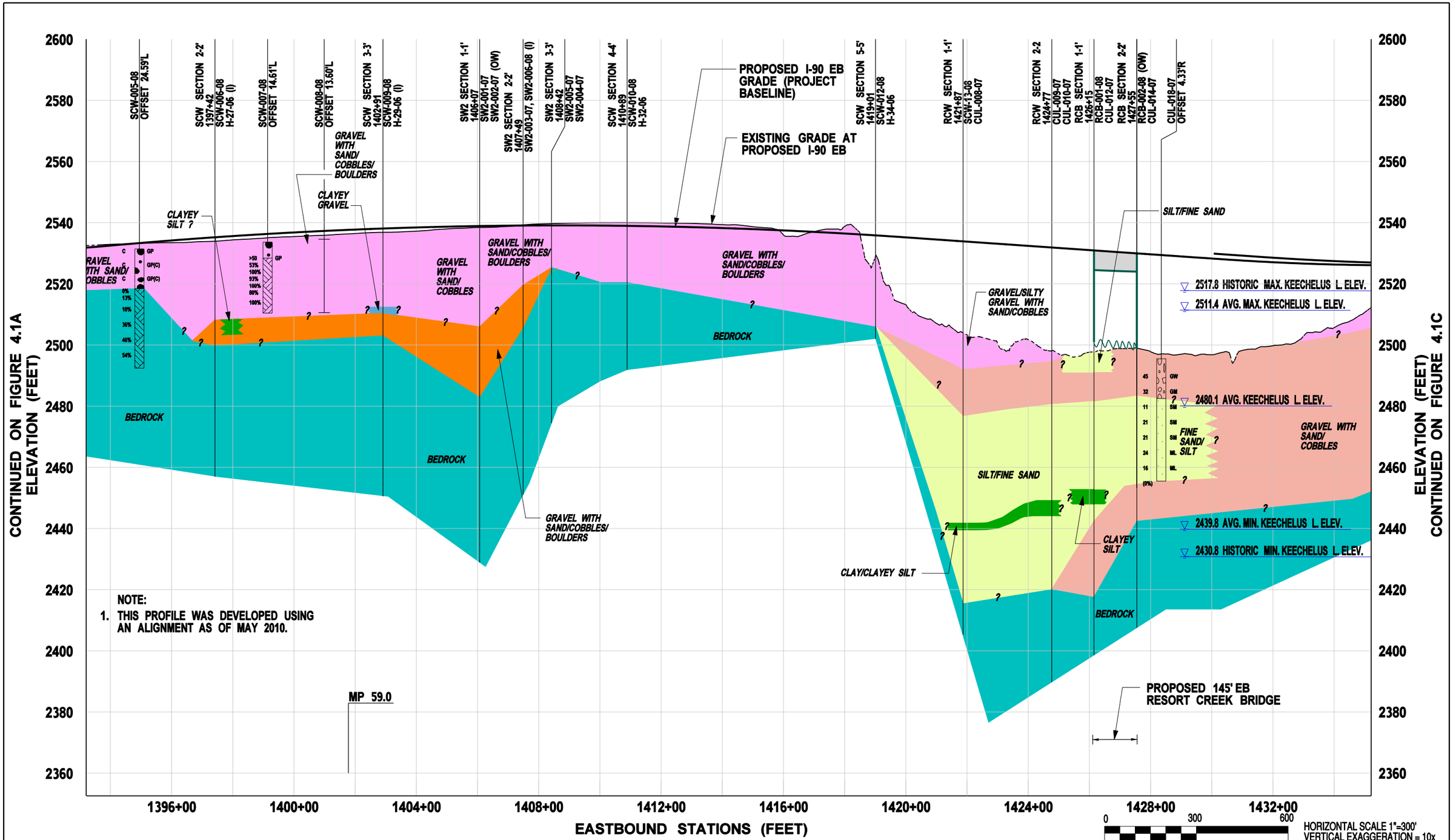
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

EB SUBSURFACE PROFILE

FIGURE 4.1A



NOTE:

1. THIS PROFILE WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

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JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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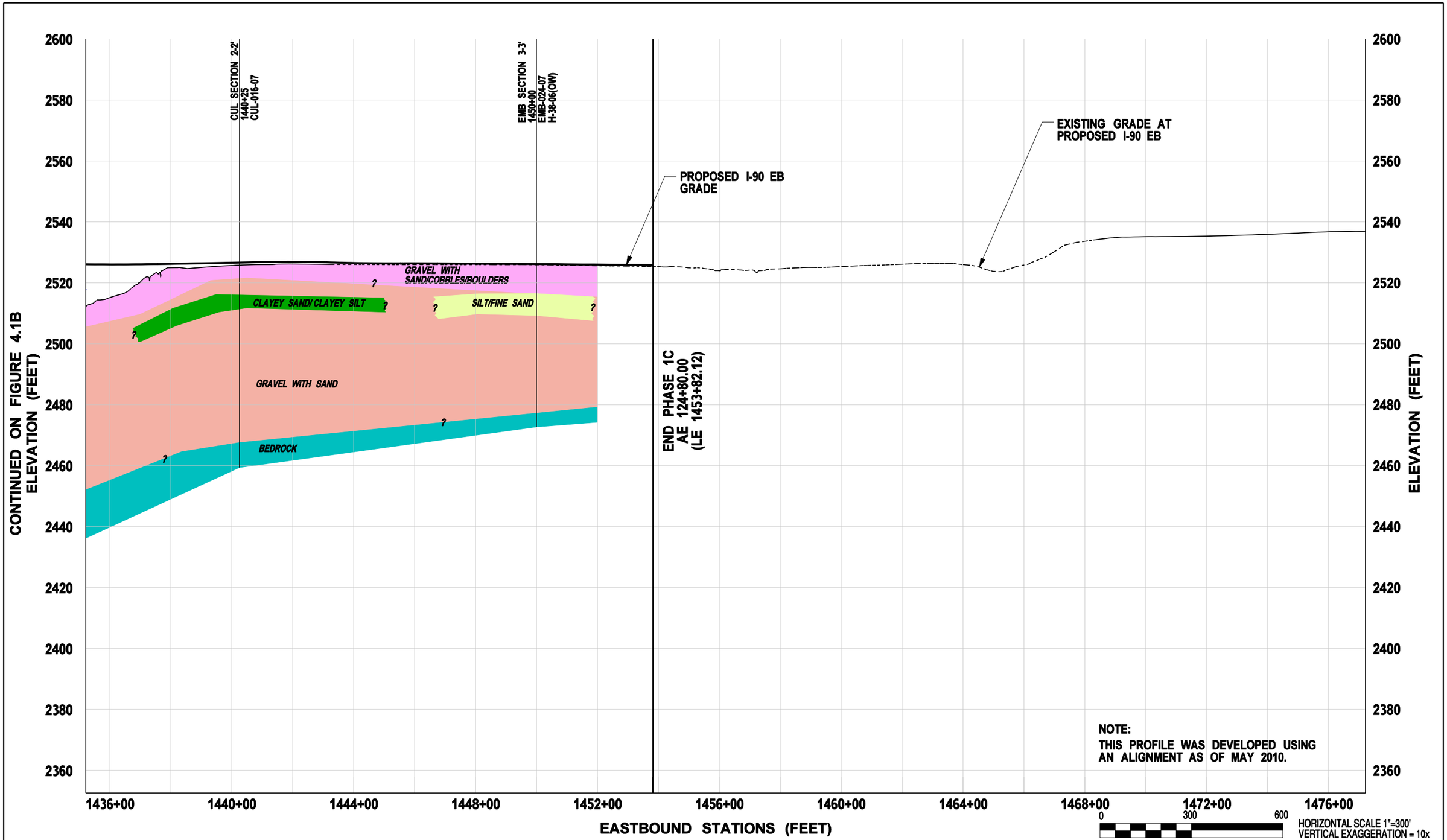
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

EB SUBSURFACE PROFILE

FIGURE 4.1B



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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
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		

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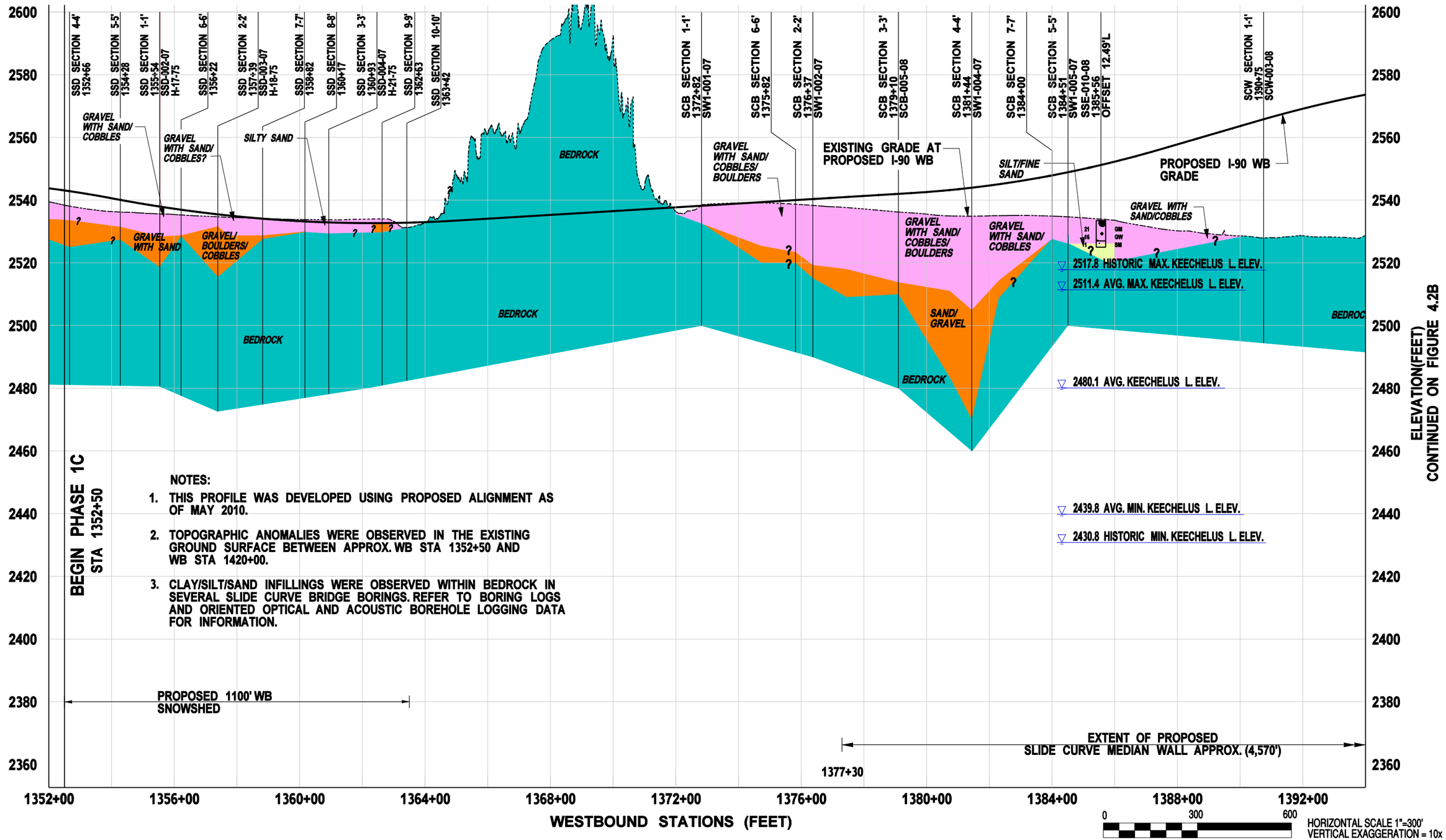
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

EB SUBSURFACE PROFILE

FIGURE 4.1C



NOTES:

1. THIS PROFILE WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. TOPOGRAPHIC ANOMALIES WERE OBSERVED IN THE EXISTING GROUND SURFACE BETWEEN APPROX. WB STA 1352+50 AND WB STA 1420+00.
3. CLAY/SILT/SAND INFILLINGS WERE OBSERVED WITHIN BEDROCK IN SEVERAL SLIDE CURVE BRIDGE BORINGS. REFER TO BORING LOGS AND ORIENTED OPTICAL AND ACOUSTIC BOREHOLE LOGGING DATA FOR INFORMATION.

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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JOB NUMBER 33758623

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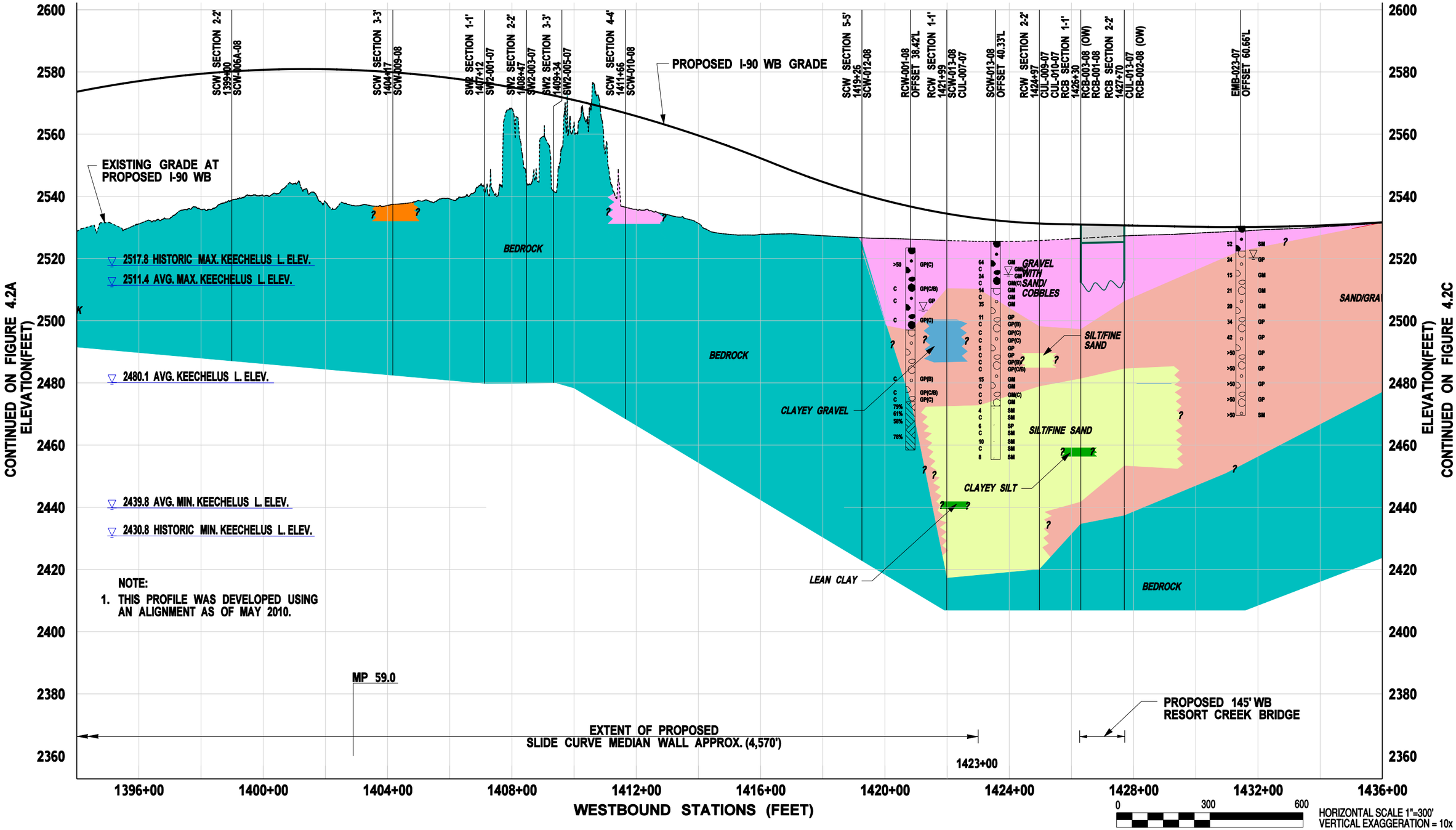
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

WB SUBSURFACE PROFILE

FIGURE 4.2A



NOTE:
1. THIS PROFILE WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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JOB NUMBER 33758623

CONTRACT NO. Y-9764

LOCATION NO.

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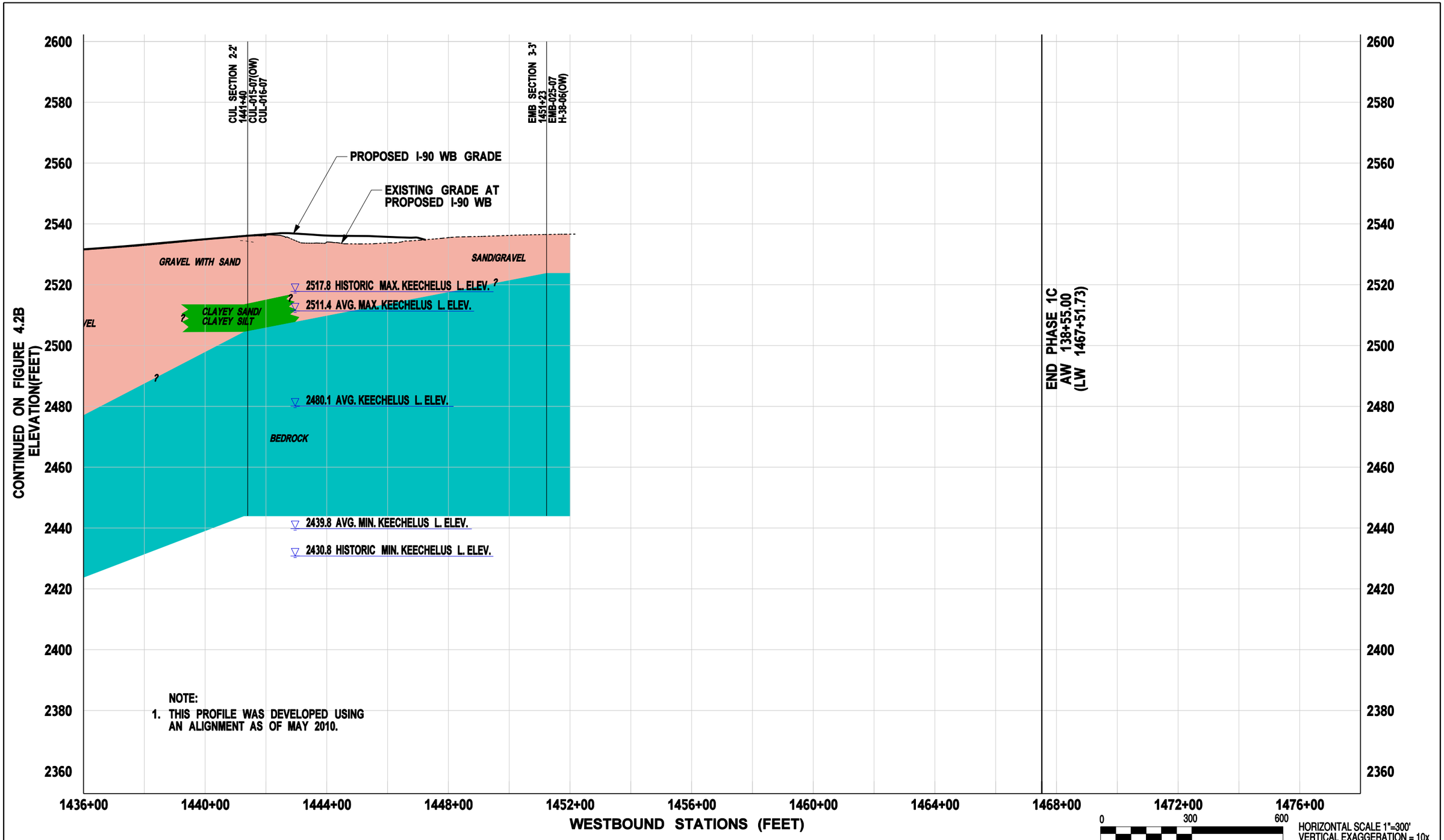
Washington State Department of Transportation

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

WB SUBSURFACE PROFILE

FIGURE 4.2B



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DATE	11/30/2010						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker/Ken Yang				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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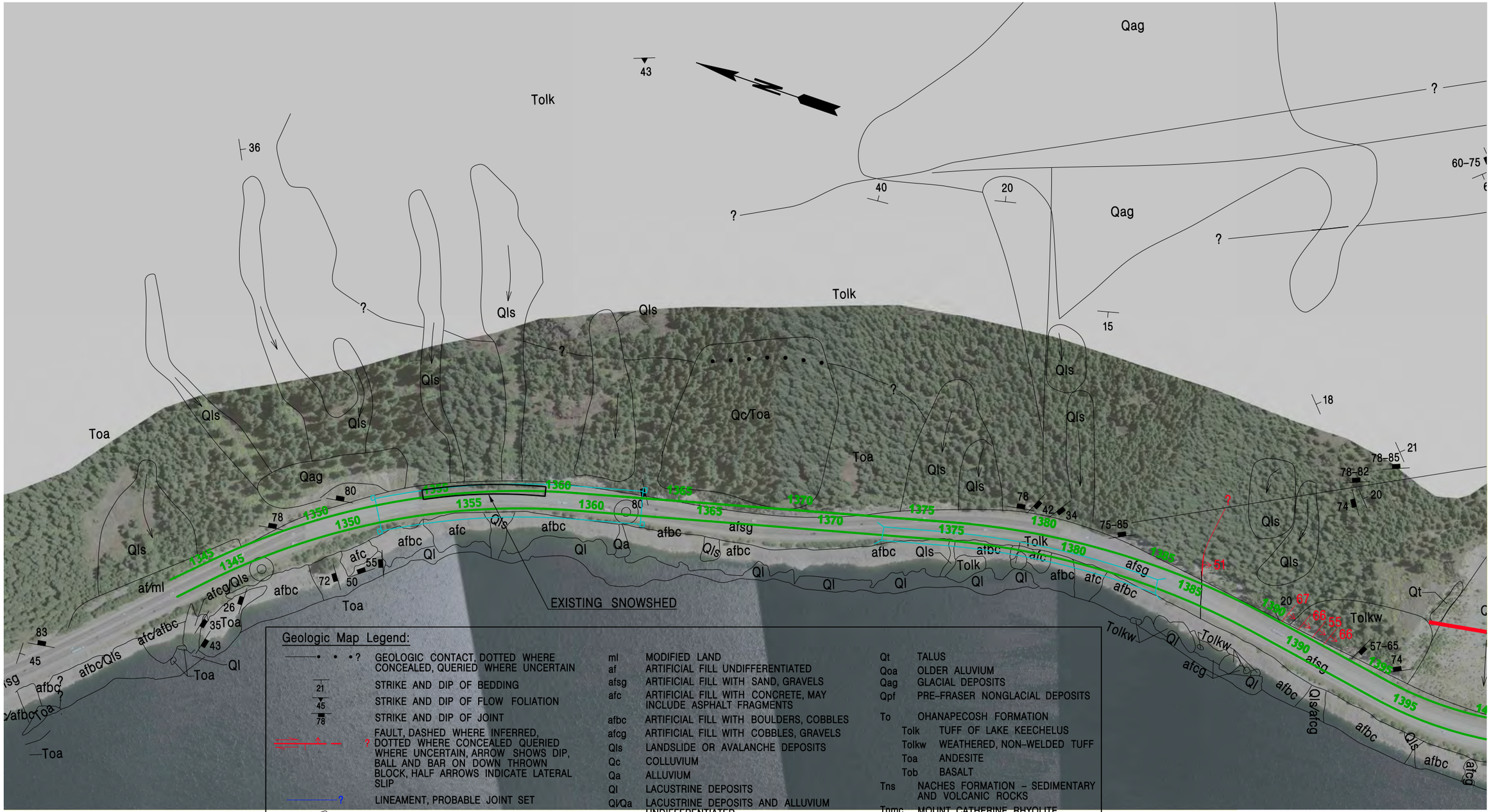
Washington State
Department of Transportation

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

WB SUBSURFACE PROFILE

FIGURE
4.2C



Geologic Map Legend:

- GEOLOGIC CONTACT, DOTTED WHERE CONCEALED, QUERIED WHERE UNCERTAIN
- STRIKE AND DIP OF BEDDING
- STRIKE AND DIP OF FLOW FOLIATION
- STRIKE AND DIP OF JOINT
- FAULT, DASHED WHERE INFERRED, DOTTED WHERE CONCEALED QUERIED WHERE UNCERTAIN, ARROW SHOWS DIP, BALL AND BAR ON DOWN THROWN BLOCK, HALF ARROWS INDICATE LATERAL SLIP
- LINEAMENT, PROBABLE JOINT SET
- LANDSLIDE (Qls) OR AVALANCHE

ml	MODIFIED LAND
af	ARTIFICIAL FILL UNDIFFERENTIATED
afsg	ARTIFICIAL FILL WITH SAND, GRAVELS
afc	ARTIFICIAL FILL WITH CONCRETE, MAY INCLUDE ASPHALT FRAGMENTS
afbc	ARTIFICIAL FILL WITH BOULDERS, COBBLES
afcg	ARTIFICIAL FILL WITH COBBLES, GRAVELS
Qls	LANDSLIDE OR AVALANCHE DEPOSITS
Qc	COLLUVIUM
Qa	ALLUVIUM
Ql	LACUSTRINE DEPOSITS
Ql/Qa	LACUSTRINE DEPOSITS AND ALLUVIUM UNDIFFERENTIATED
Qt	TALUS
Qoa	OLDER ALUVIUM
Qag	GLACIAL DEPOSITS
Qpf	PRE–FRASER NONGLACIAL DEPOSITS
To	OHANAPECOSH FORMATION
Tolk	TUFF OF LAKE KEECHELUS
Tolkw	WEATHERED, NON–WELDED TUFF
Toa	ANDESITE
Tob	BASALT
Tns	NACHES FORMATION – SEDIMENTARY AND VOLCANIC ROCKS
Tnmc	MOUNT CATHERINE RHYOLITE

SOURCE: MODIFIED FROM TABOR ET AL. (2000) BASED ON MAPPING BY URS.

0 400 800 SCALE 1" = 400'

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DESIGNED BY	
ENTERED BY	brenda_mcintosh
CHECKED BY	
ASST. PROJ. MNGR.	
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

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

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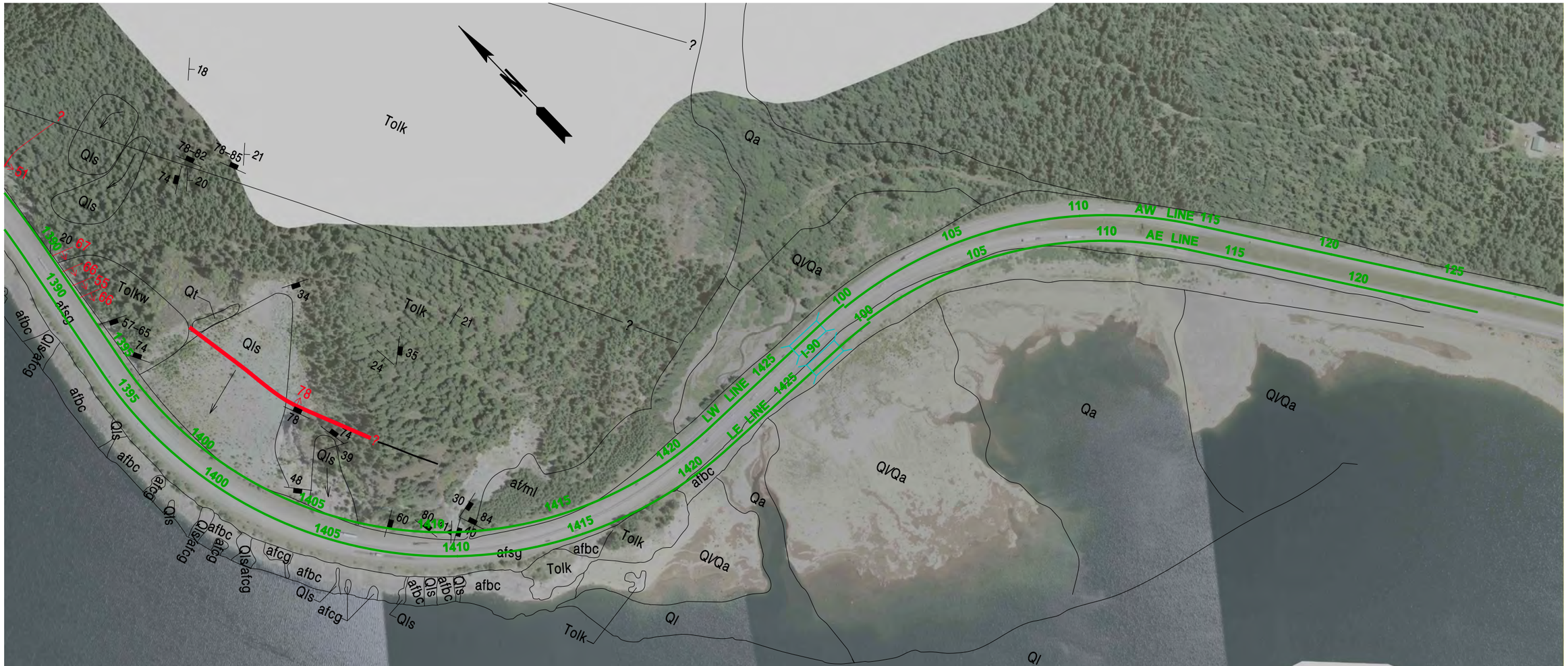
Washington State Department of Transportation

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

GEOLOGIC MAP

FIGURE 4.3A



Geologic Map Legend:

—— • • • ?	GEOLOGIC CONTACT, DOTTED WHERE CONCEALED, QUERIED WHERE UNCERTAIN	ml	MODIFIED LAND	Qt	TALUS
21	STRIKE AND DIP OF BEDDING	af	ARTIFICIAL FILL UNDIFFERENTIATED	Qoa	OLDER ALUVIUM
45	STRIKE AND DIP OF FLOW FOLIATION	afsg	ARTIFICIAL FILL WITH SAND, GRAVELS	Qag	GLACIAL DEPOSITS
78	STRIKE AND DIP OF JOINT	afc	ARTIFICIAL FILL WITH CONCRETE, MAY INCLUDE ASPHALT FRAGMENTS	Qpf	PRE-FRASER NONGLACIAL DEPOSITS
?	FAULT, DASHED WHERE INFERRED, DOTTED WHERE CONCEALED QUERIED WHERE UNCERTAIN, ARROW SHOWS DIP, BALL AND BAR ON DOWN THROWN BLOCK, HALF ARROWS INDICATE LATERAL SLIP	afbc	ARTIFICIAL FILL WITH BOULDERS, COBBLES	To	OHANAPECOSH FORMATION
		afcg	ARTIFICIAL FILL WITH COBBLES, GRAVELS	Tolk	TUFF OF LAKE KEECHELUS
?	LINEAMENT, PROBABLE JOINT SET	Qls	LANDSLIDE OR AVALANCHE DEPOSITS	Tolkw	WEATHERED, NON-WELDED TUFF
	LANDSLIDE (Qls) OR AVALANCHE	Qc	COLLUVIUM	Toa	ANDESITE
		Qa	ALLUVIUM	Tob	BASALT
		Ql	LACUSTRINE DEPOSITS	Tns	NACHES FORMATION – SEDIMENTARY AND VOLCANIC ROCKS
		Ql/Qa	LACUSTRINE DEPOSITS AND ALLUVIUM UNDIFFERENTIATED	Tnmc	MOUNT CATHERINE RHYOLITE

SOURCE: MODIFIED FROM TABOR ET AL. (2000) BASED ON MAPPING BY URS.

0 400 800
SCALE 1" = 400'

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DATE	12/1/2010
DESIGNED BY	
ENTERED BY	brenda_mcintosh
CHECKED BY	
ASST. PROJ. MNGR.	
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

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

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

GEOLOGIC MAP

FIGURE 4.3B

33758662_04.cdr

Notes

1354 - LW station

SSD 1-1' - Subsurface cross section

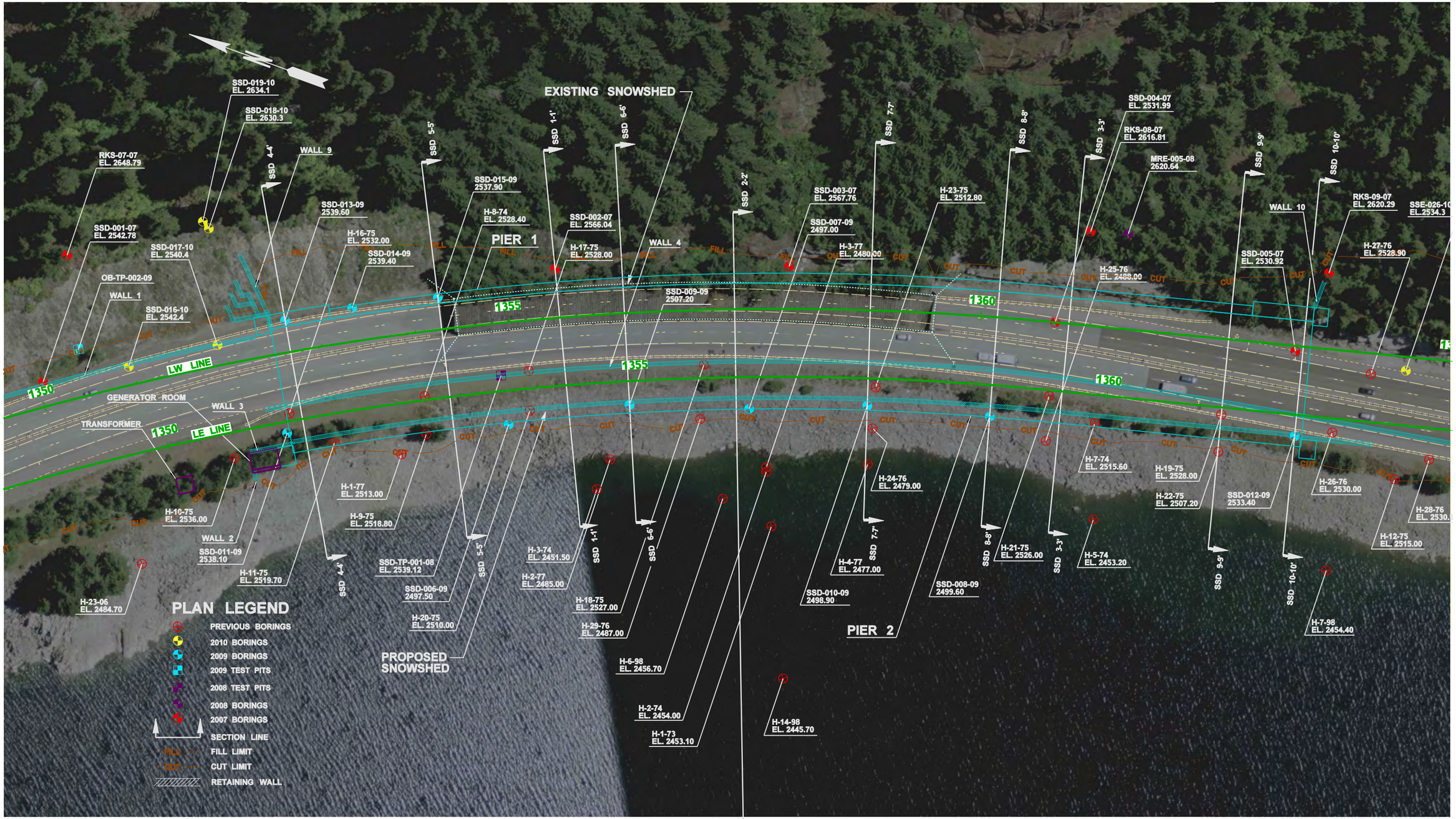
Job No. 33758662

Figure 6.1

Elevation of Proposed Snowshed Site

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting



0 100 200
SCALE 1" = 100'

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DATE	12/1/2010						
DESIGNED BY	Ken Yang				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	KM/DW/MM				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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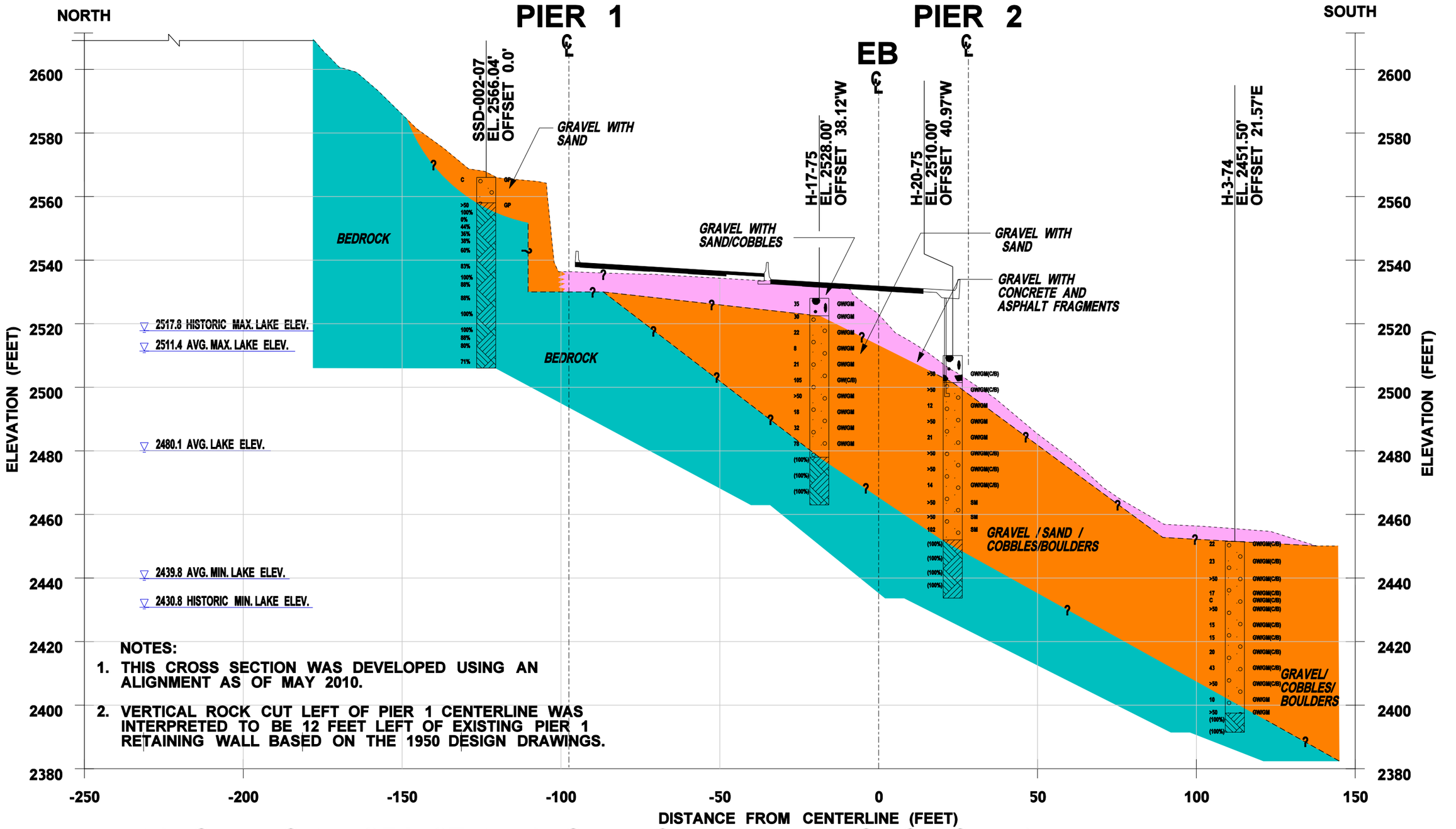
Hyak to Keechelus Dam, Washington

SNOWSHED BORING AND TEST PIT LOCATIONS

FIGURE 6.2



NOTES:

1. THIS CROSS SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.
2. VERTICAL ROCK CUT LEFT OF PIER 1 CENTERLINE WAS INTERPRETED TO BE 12 FEET LEFT OF EXISTING PIER 1 RETAINING WALL BASED ON THE 1950 DESIGN DRAWINGS.

EB STATION 1354+27 (WB STATION 1355+54) SNOWSHED

0 30 60

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

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DATE	10/11/2010
DESIGNED BY	Dave Walker
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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Washington State Department of Transportation

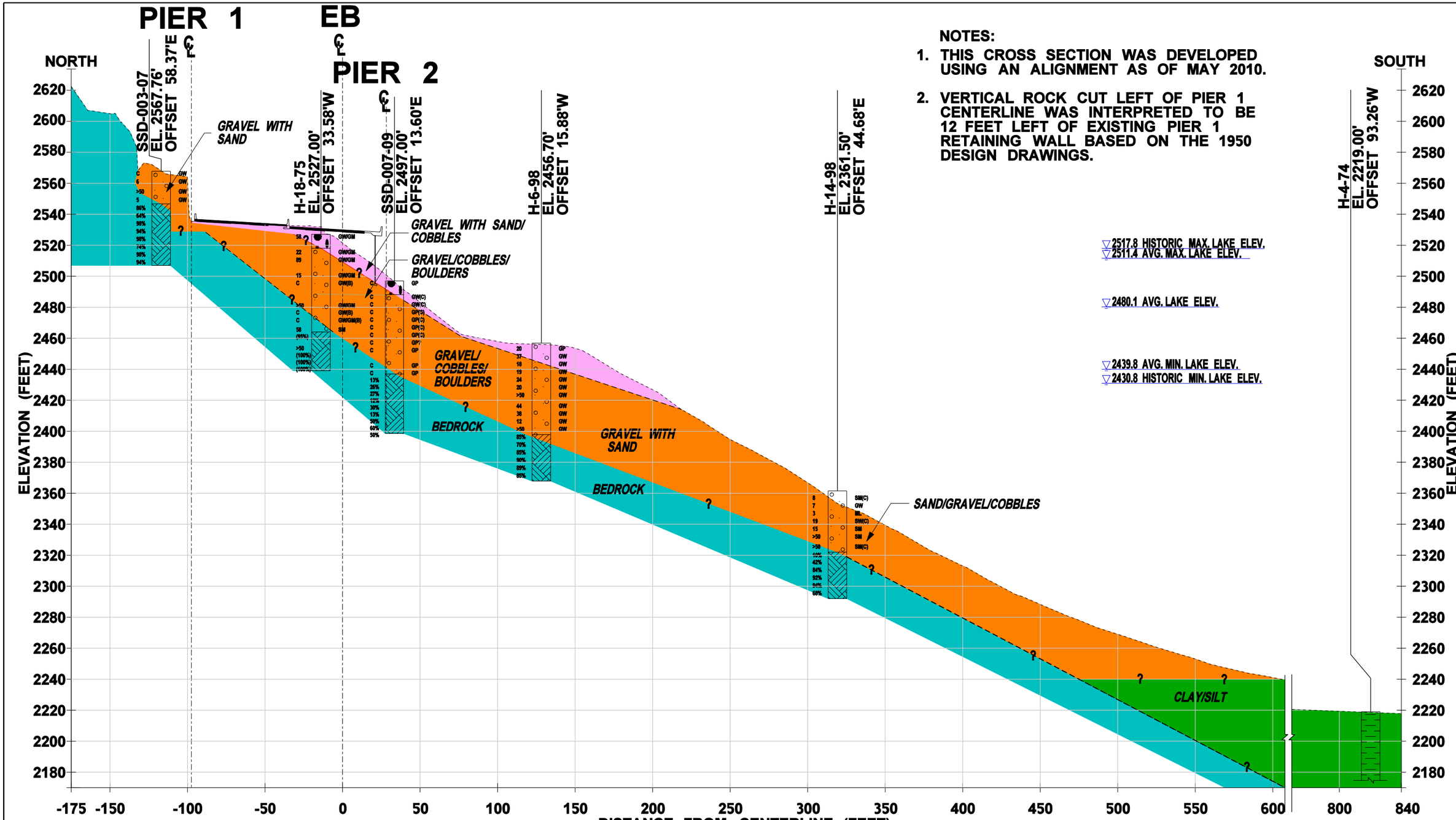
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 1-1'

FIGURE 6-3

NOTES:

1. THIS CROSS SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.
2. VERTICAL ROCK CUT LEFT OF PIER 1 CENTERLINE WAS INTERPRETED TO BE 12 FEET LEFT OF EXISTING PIER 1 RETAINING WALL BASED ON THE 1950 DESIGN DRAWINGS.



EB STATION 1356+06 (WB STATION 1357+39) SNOWSHED

0 60 120

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

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DATE	10/11/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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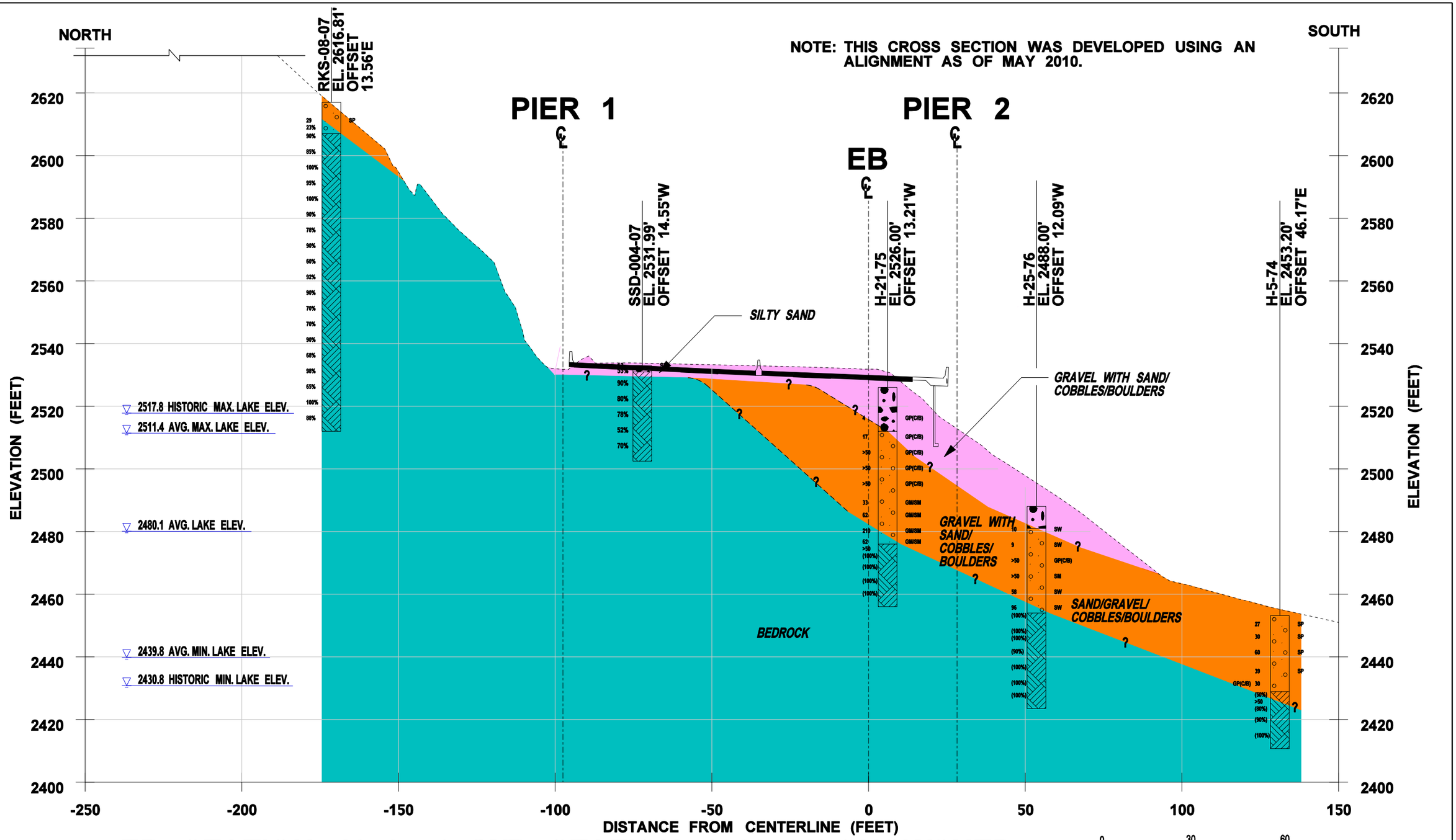
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

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

SNOWSHED (SSD) - CROSS SECTION 2-2'

FIGURE 6.4



EB STATION 1359+52 (WB STATION 1360+93) SNOWSHED

0 30 60

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

FILE NAME	\\seaocean\163\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Snowshed\P1234_RS_snowshed _Section_3.dgn
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DATE	10/11/2010
DESIGNED BY	Dave Walker
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764

LOCATION NO.

P.E. STAMP BOX DATE

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

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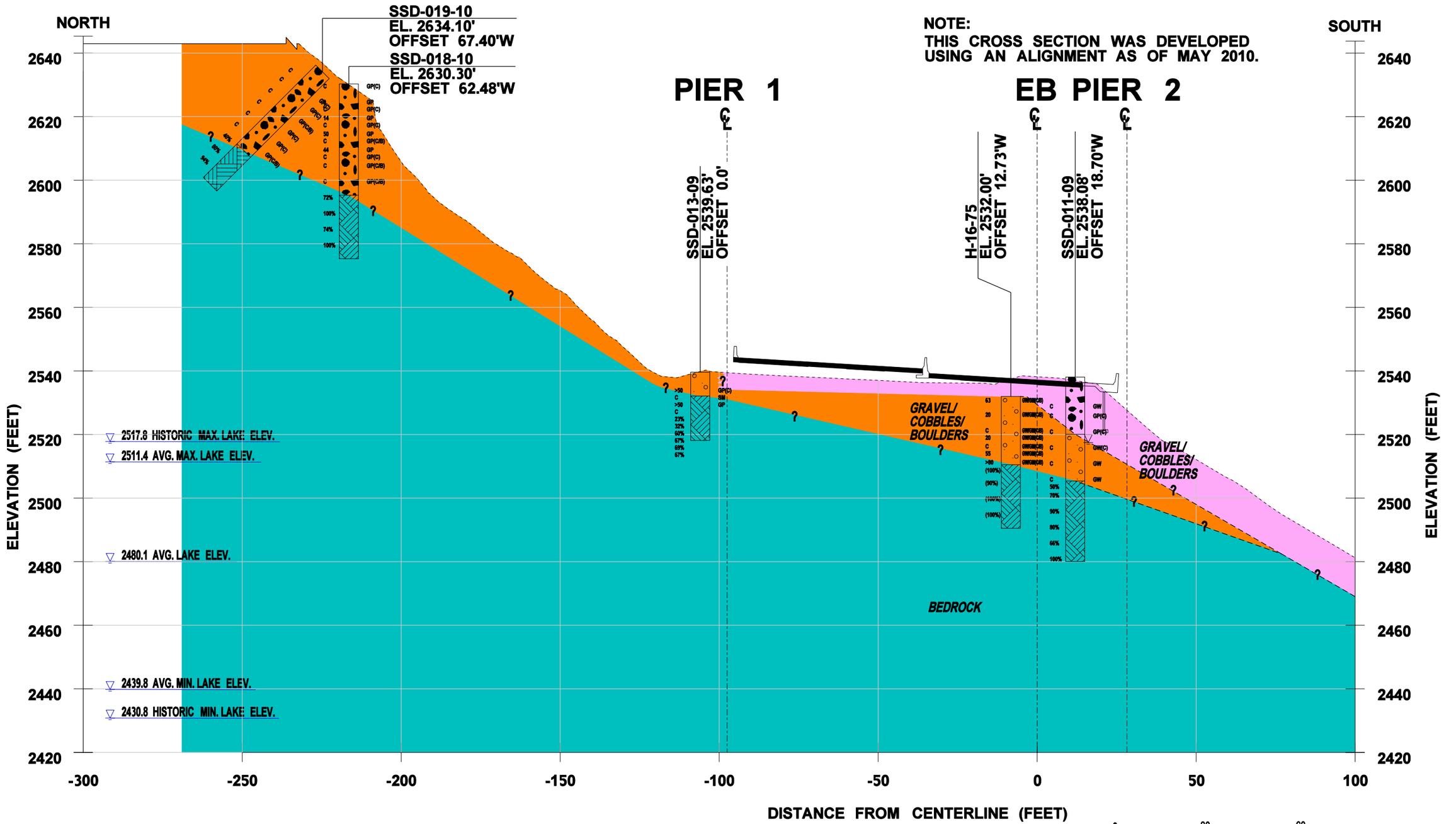
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 3-3'

FIGURE 6.5



EB STATION 1351+45 (WB STATION 1352+66) SNOWSHED

0 30 60

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

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TIME	4:40:45 PM						
DATE	10/11/2010						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	Dave Walker				CONTRACT NO. Y-9764		LOCATION NO.
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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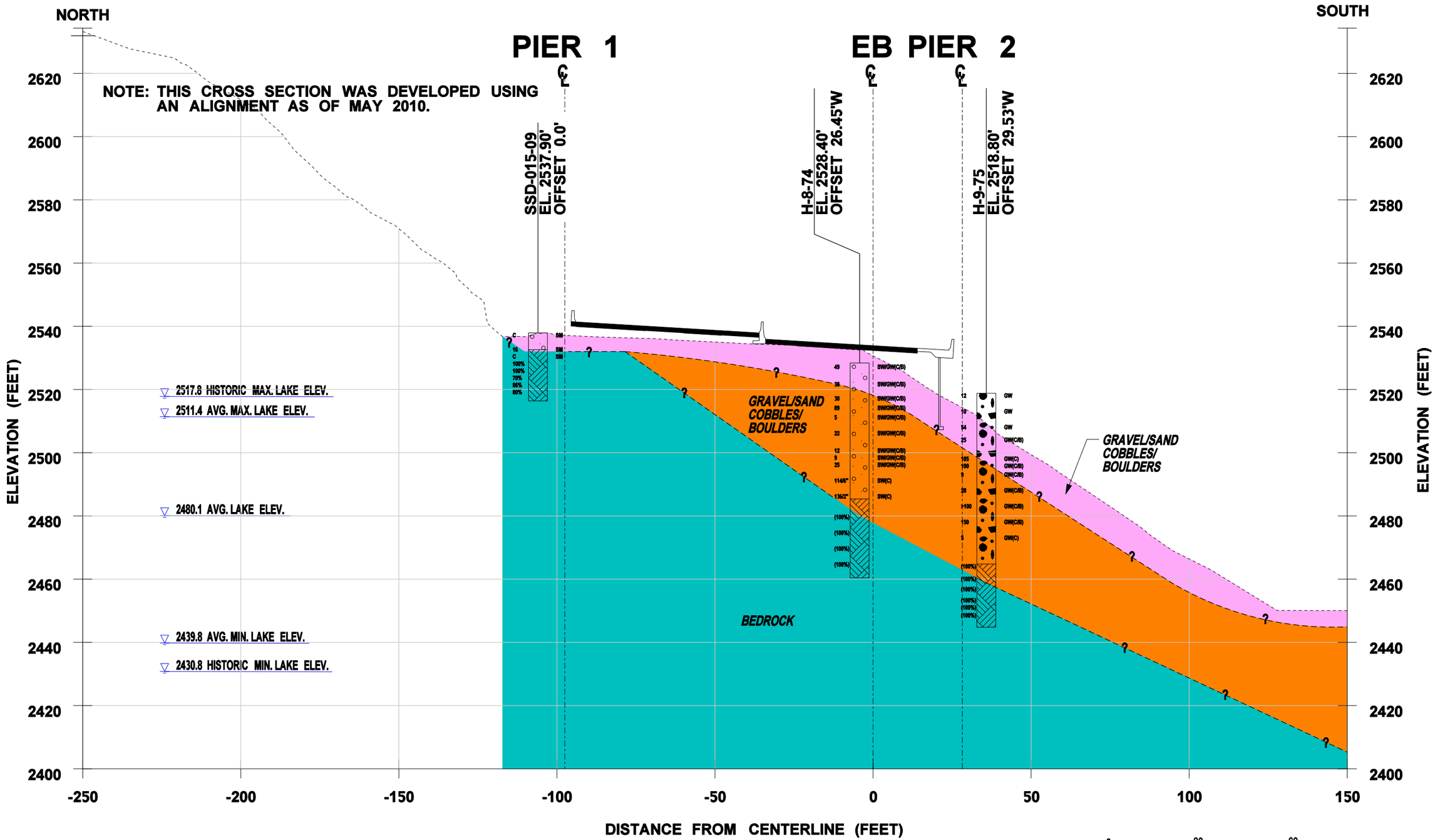
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 4-4'

FIGURE 6.6



EB STATION 1353+03 (WB STATION 1354+28) SNOWSHED

0 30 60

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

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DATE	10/11/2010				JOB NUMBER		
DESIGNED BY	Dave Walker				33758623		
ENTERED BY	brenda_mcintosh				CONTRACT NO.		LOCATION NO.
CHECKED BY	Dave Walker				Y-9764		
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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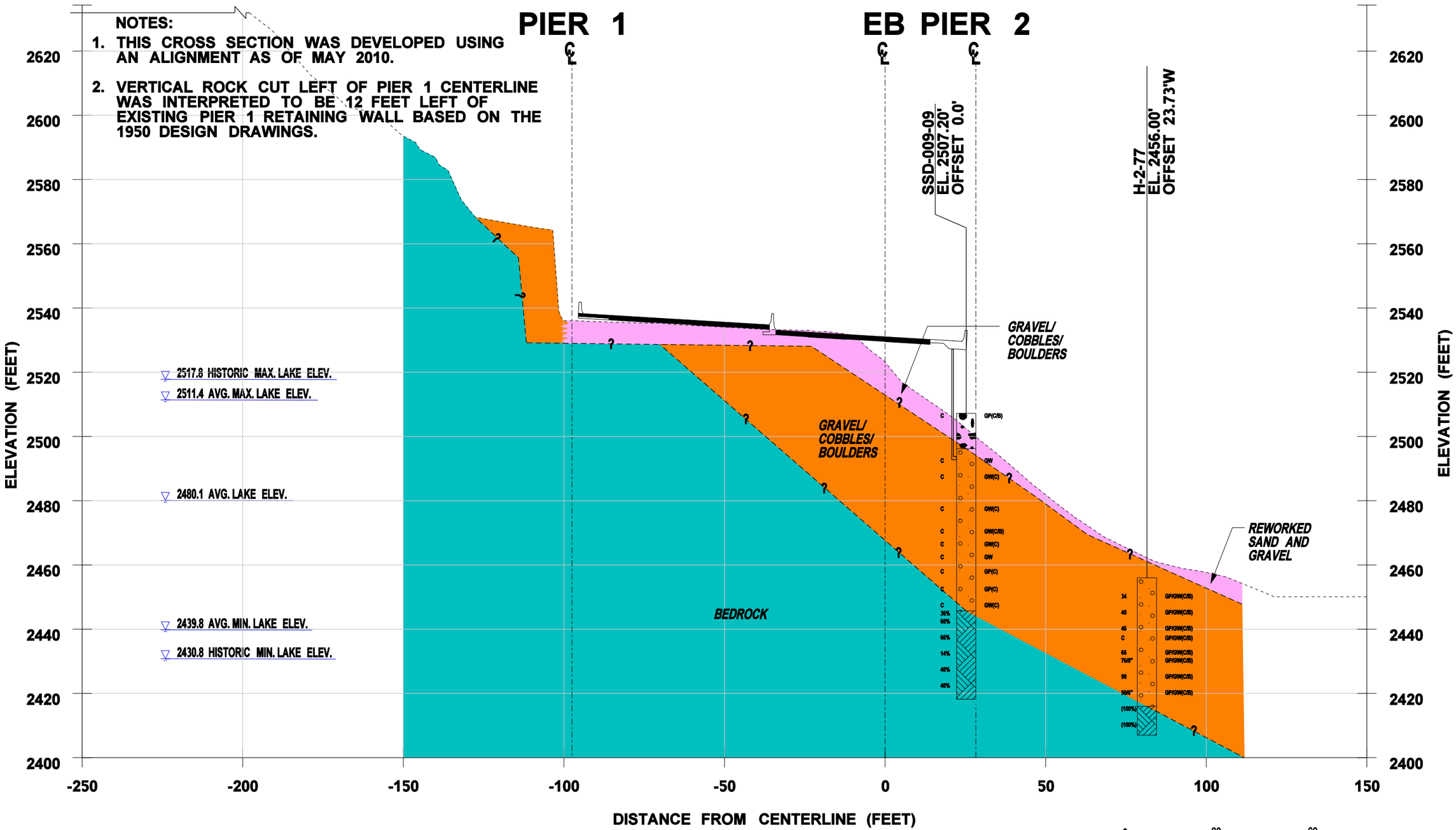
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 5-5'

FIGURE 6.7

NOTES:

1. THIS CROSS SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.
2. VERTICAL ROCK CUT LEFT OF PIER 1 CENTERLINE WAS INTERPRETED TO BE 12 FEET LEFT OF EXISTING PIER 1 RETAINING WALL BASED ON THE 1950 DESIGN DRAWINGS.



EB STATION 1354+92 (WB STATION 1356+22) SNOWSHED

0 30 60

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

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DESIGNED BY	Dave Walker
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
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		

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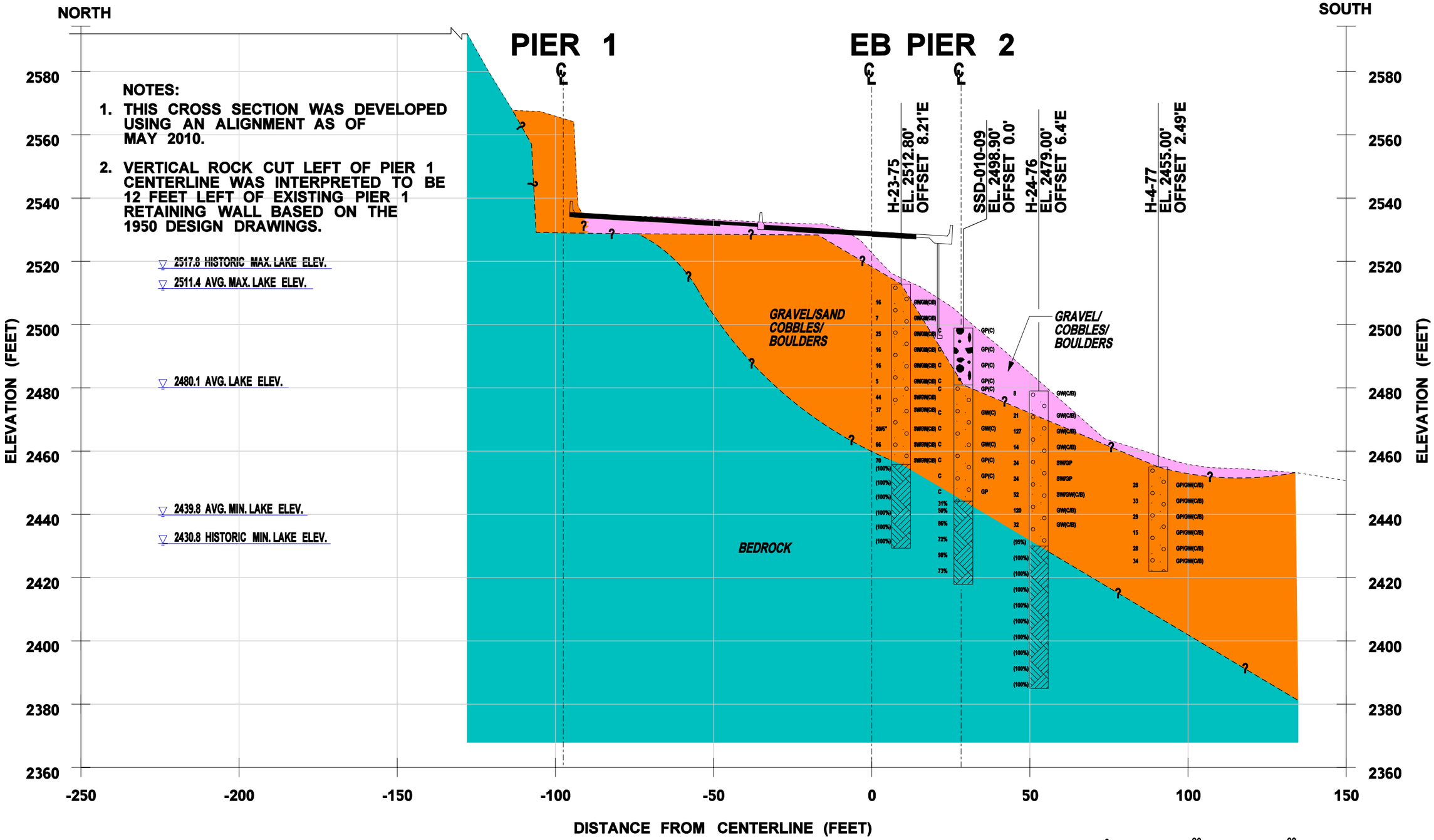
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 6-6'

FIGURE 6.8



EB STATION 1357+46 (WB STATION 1358+82) SNOWSHED

0 30 60

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

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TIME	4:47:27 PM
DATE	10/11/2010
DESIGNED BY	Dave Walker
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764

LOCATION NO.

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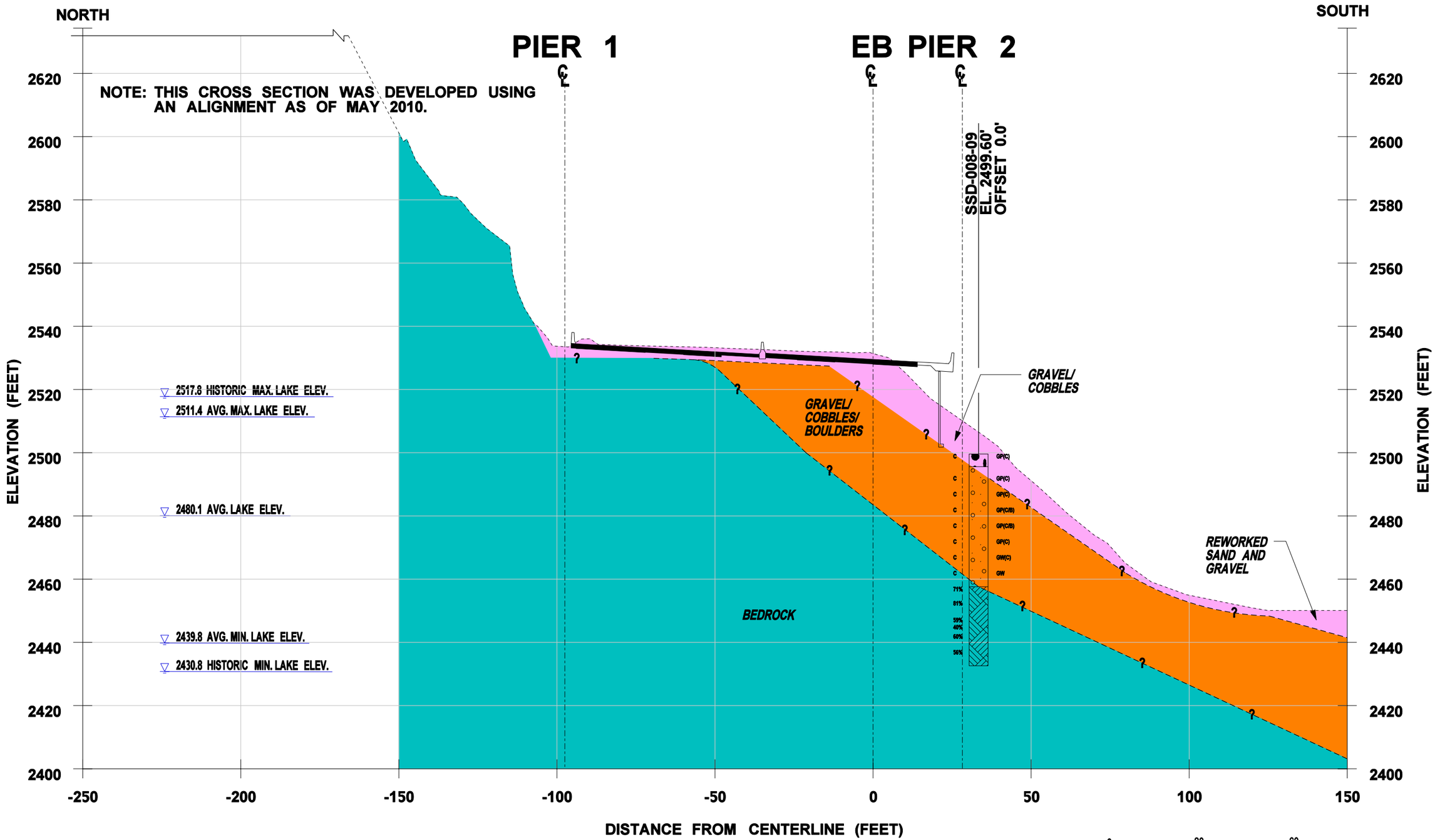
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 7-7'

FIGURE 6.9



EB STATION 1358+78 (WB STATION 1360+17) SNOWSHED

0 30 60

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

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DATE	10/11/2010				CONTRACT NO. Y-9764		LOCATION NO.
DESIGNED BY	Dave Walker						
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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I-90 Snoqualmie Pass East
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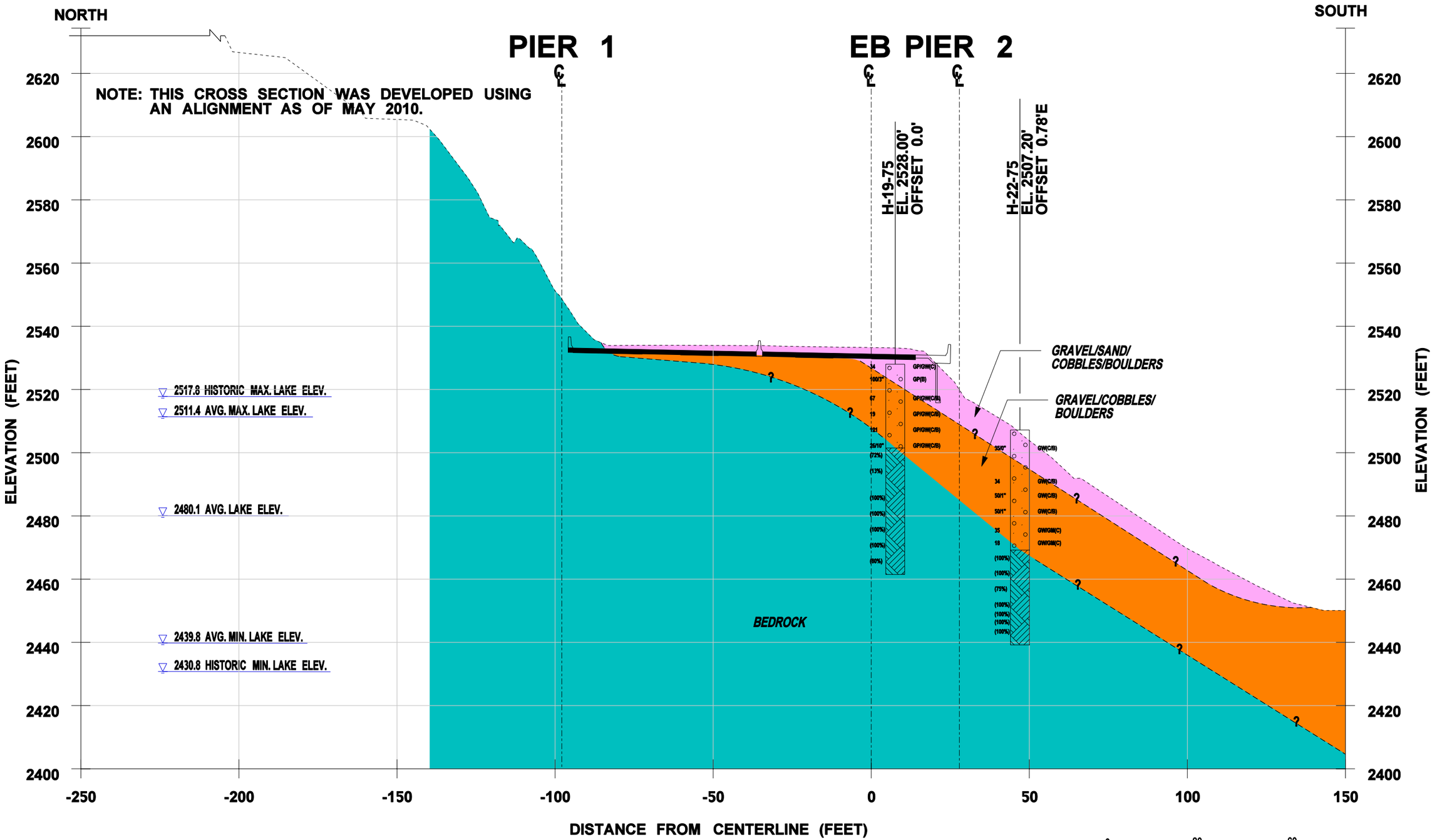
SNOWSHED (SSD) - CROSS SECTION 8-8'

FIGURE 6.10



EB STATION 1361+22 (WB STATION 1362+63) SNOWSHED

0 30 60

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

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DESIGNED BY	Dave Walker				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	Dave Walker				CONTRACT NO. Y-9764		LOCATION NO.
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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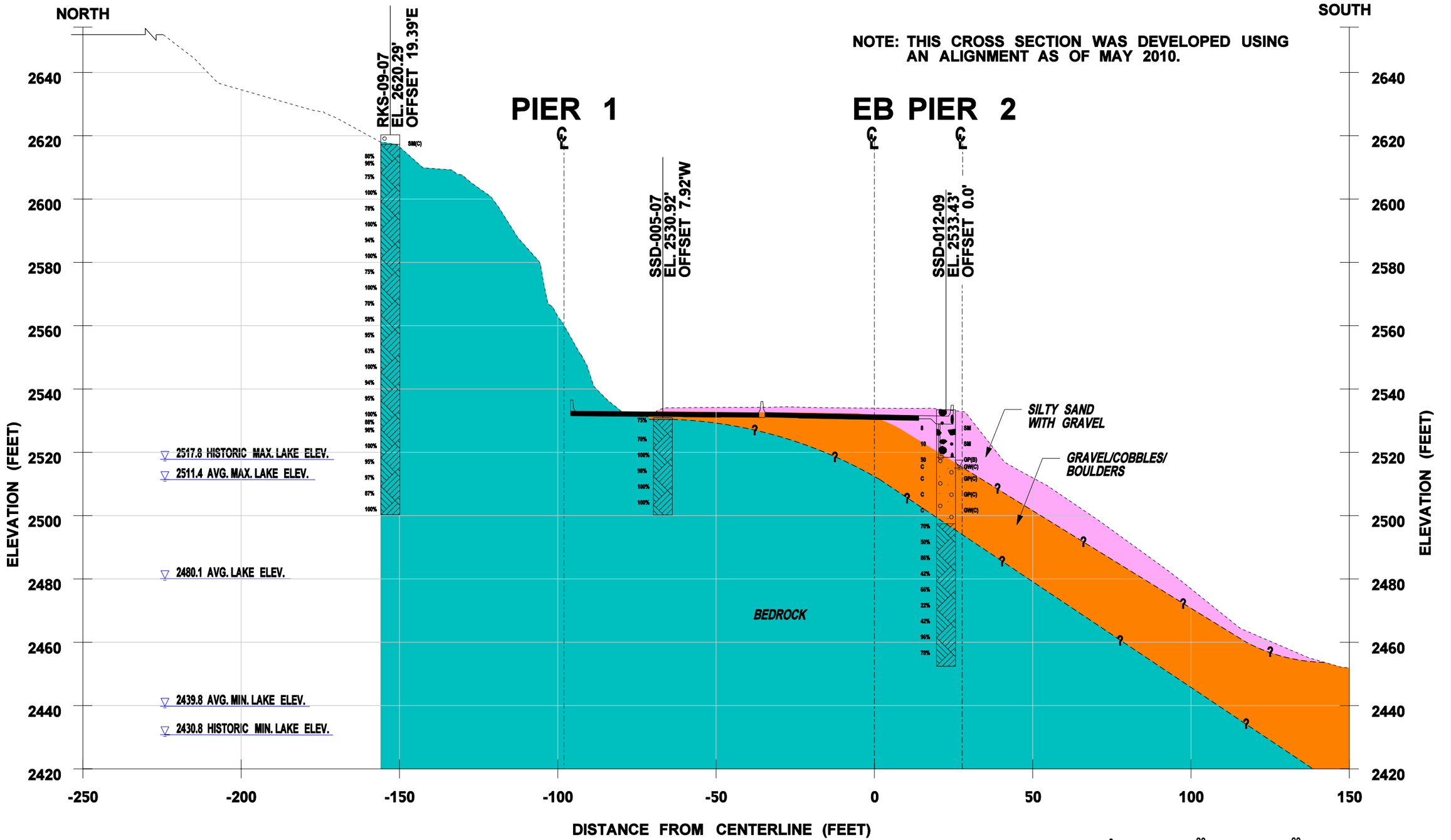
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 9-9'

FIGURE 6.11



EB STATION 1362+01 (WB STATION 1363+42) SNOWSHED

0 30 60

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

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DESIGNED BY	Dave Walker				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	Dave Walker				CONTRACT NO. Y-9764		LOCATION NO.
PROJ. MNGR.	Cecil Urlich						
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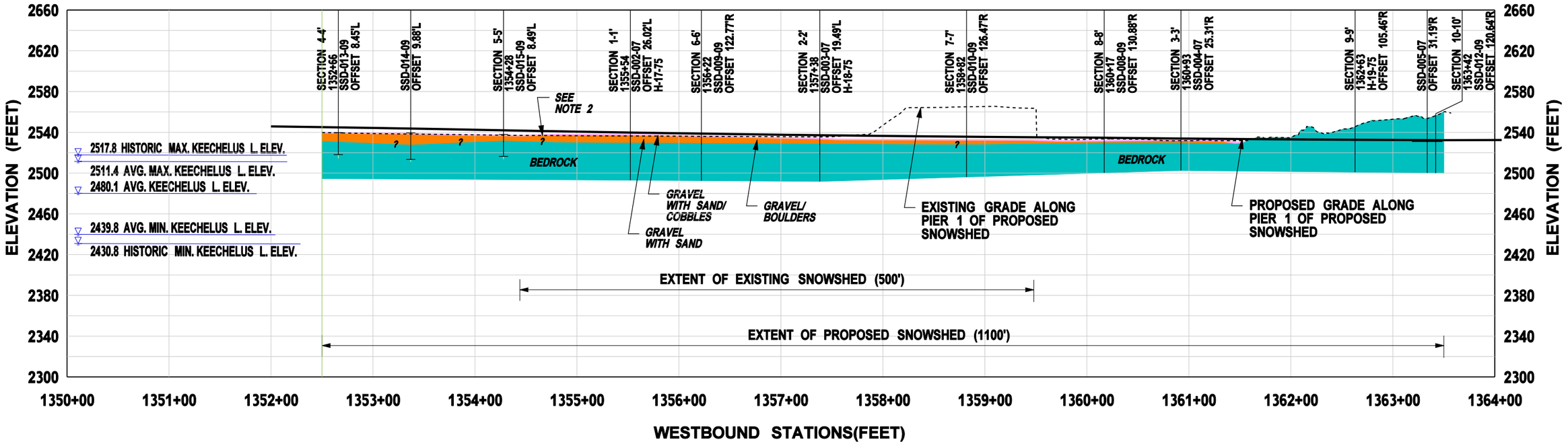
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED (SSD) - CROSS SECTION 10-10'

FIGURE 6.12



NOTES:

1. THE PIER 1 PROFILE WAS DEVELOPED USING MAY 2010 ALIGNMENT.
2. BEDROCK ELEVATION AT SSD-014-09 WAS EXTRAPOLATED USING BORING OFFSET AND ASSUMING A BEDROCK SLOPE OF 3H:1V.
3. BEDROCK ELEVATIONS BENEATH THE EXISTING SNOWSHED WERE ESTIMATED USING THE BASE OF FOOTING DEPTH SHOWN ON THE 1950 DESIGN DRAWINGS WITH A CORRECTION APPLIED TO THE ELEVATION DATUM.
4. THE PIER 1 PROPOSED GRADE WAS DEVELOPED USING OCTOBER 7, 2008 ALIGNMENT.

0 100 200

HORIZONTAL SCALE 1"=100'
VERTICAL EXAGGERATION = 1x

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TIME	4:54:23 PM
DATE	10/11/2010
DESIGNED BY	Dave Walker
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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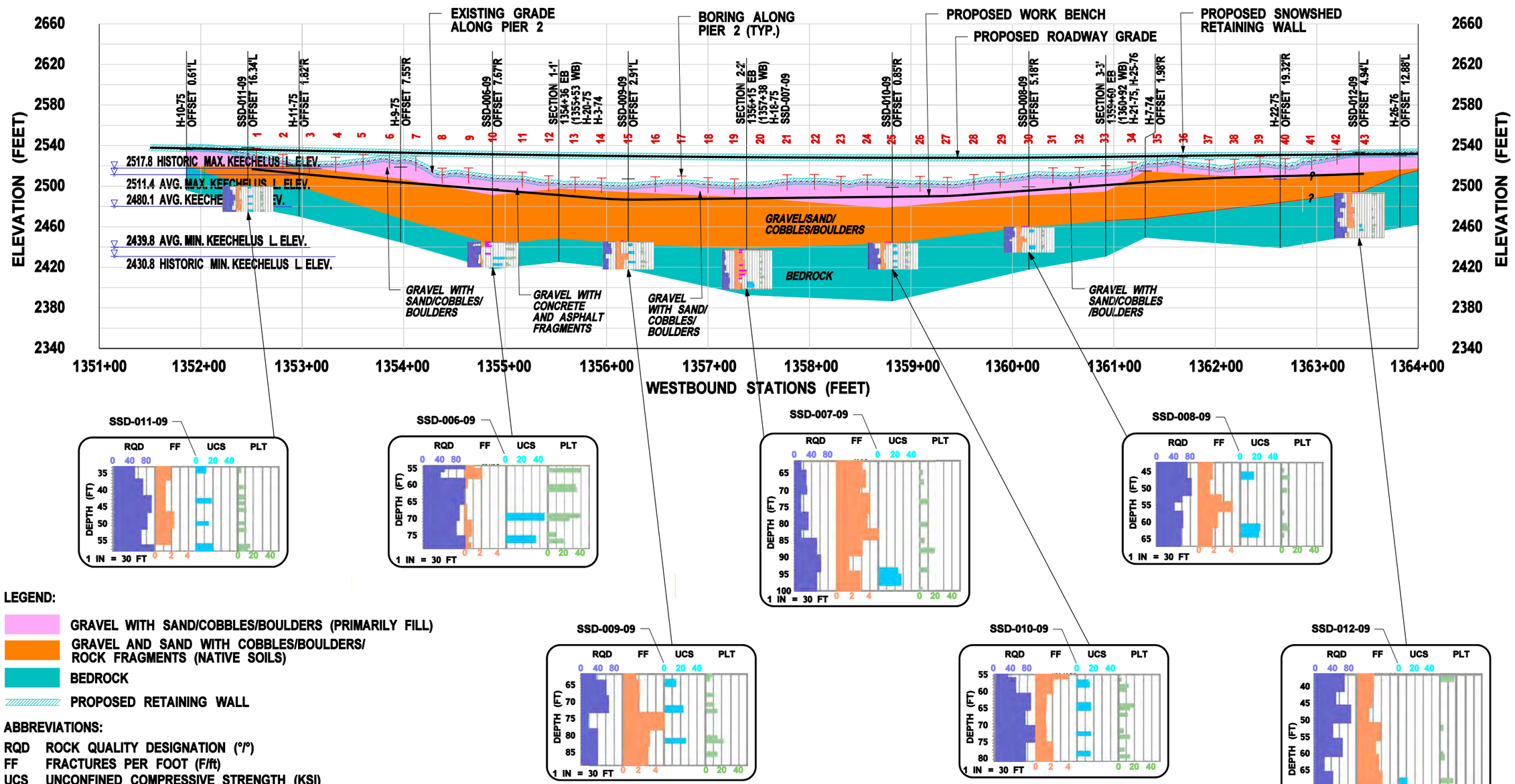
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SNOWSHED PIER 1 SUBSURFACE PROFILE

FIGURE 6.13



LEGEND:

- GRAVEL WITH SAND/COBBLES/BOULDERS (PRIMARILY FILL)
- GRAVEL AND SAND WITH COBBLES/BOULDERS/ ROCK FRAGMENTS (NATIVE SOILS)
- BEDROCK
- PROPOSED RETAINING WALL

ABBREVIATIONS:

RQD	ROCK QUALITY DESIGNATION (°/°)
FF	FRACTURES PER FOOT (F/ft)
UCS	UNCONFINED COMPRESSIVE STRENGTH (KSI)
PLT	POINT LOAD TEST COMPRESSIVE STRENGTH (KSI)
VCS	VERY CLOSELY SPACED DISCONTINUTIES
CS	CLOSELY SPACED DISCONTINUTIES
MS	MEDIUM SPACED DISCONTINUTIES
P	POOR CONDITION
F	FAIR CONDITION
VP	VERY POOR CONDITION
G	GOOD CONDITION

NOTES:

THIS PROFILE WAS DEVELOPED BASED ON PRELIMINARY PLAN DATED JANUARY 2009, OBTAINED FROM WSDOT ON MAY 27, 2009, ALIGNMENT OBTAINED FROM WSDOT IN MAY 7, 2010 AND WORK BENCH AND ROADWAY SURFACE OBTAINED FROM WSDOT ON FEBRUARY 17, 2010.

0 100 200

HORIZONTAL SCALE 1"=100'
VERTICAL EXAGGERATION = 1x

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DATE	10/11/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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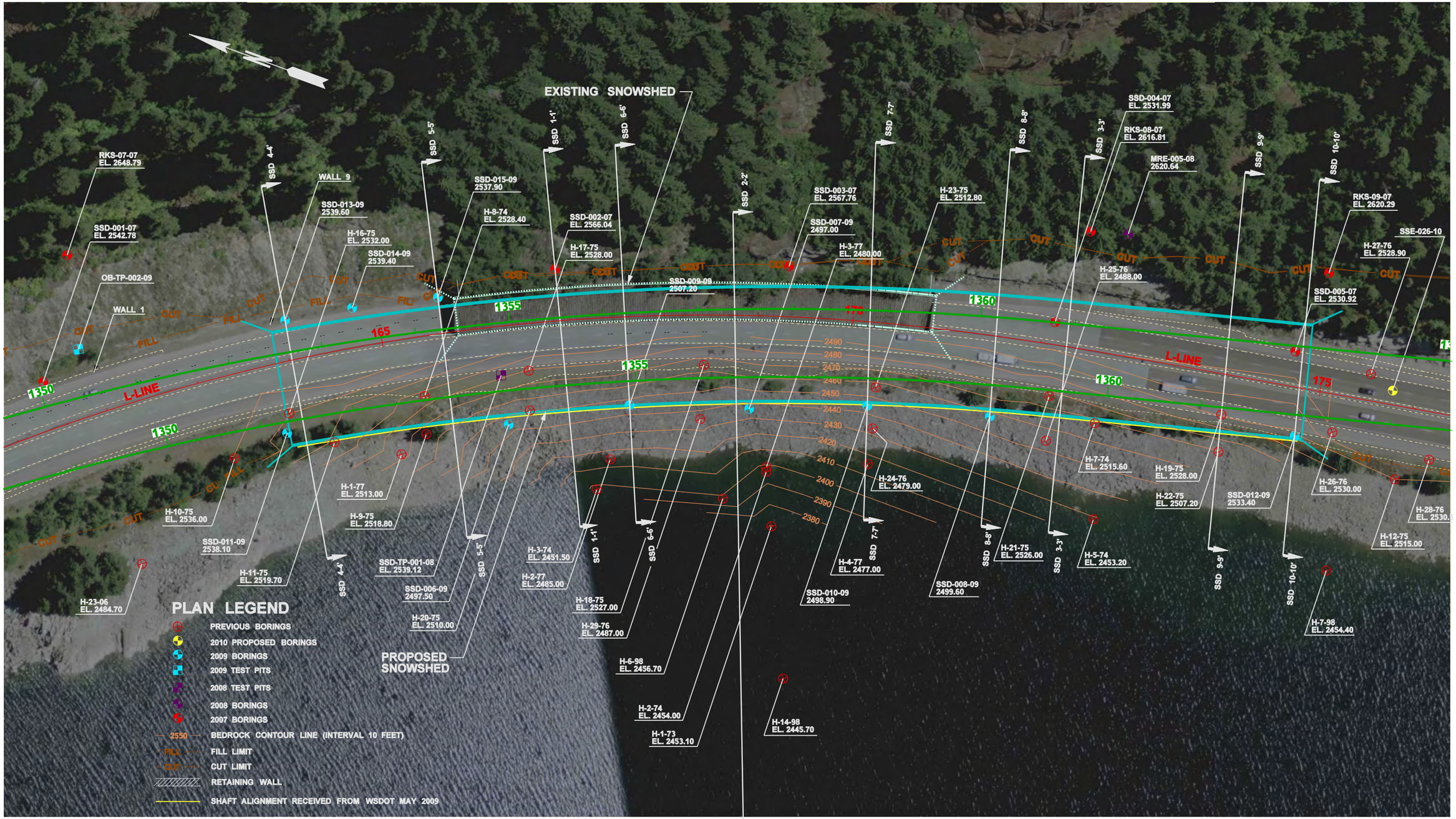
SNOWSHED PIER 2 SUBSURFACE PROFILE

FIGURE 6.14



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DATE	10/11/2010						
DESIGNED BY	Ken Yang				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	KM/DW/MM				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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

SNOWSHED PIER 2 BEDROCK CONTOURS

FIGURE 6.15

Notes

1. Earth pressures in psf may be calculated using the equations and values below.

   $P_1 = K_a\ H$

   $P_2 = P_1 - K_a\ {}_wH_2$

   $P_3 = K_0q$ (for rigid wall)

   $= K_aq$ (for flexible wall)

   $P_4 = {}_wH_2$

   $P_5 = K_0(\ \ -\ \ {}_w)H_3$

Design Parameters for Calculating Lateral Earth Pressures for Strength Limit State

Parameter	Units	Value
Soil Unit Weight,	pounds per cubic foot (pcf)	135
Water Unit Weight, $_w$	pcf	62.4
Soil Friction Angle,	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.22
At-Rest Earth Pressure Coefficient, K_o	unitless	0.36
Avalanche Debris and Snow Surcharge Load, q	psf	1,750
Passive Earth Pressure Coefficient, K_p, for level finish ground line	unitless	use K_0

2. The magnitude of the avalanche debris load will vary over the length of the shed. The maximum load is used in this figure.

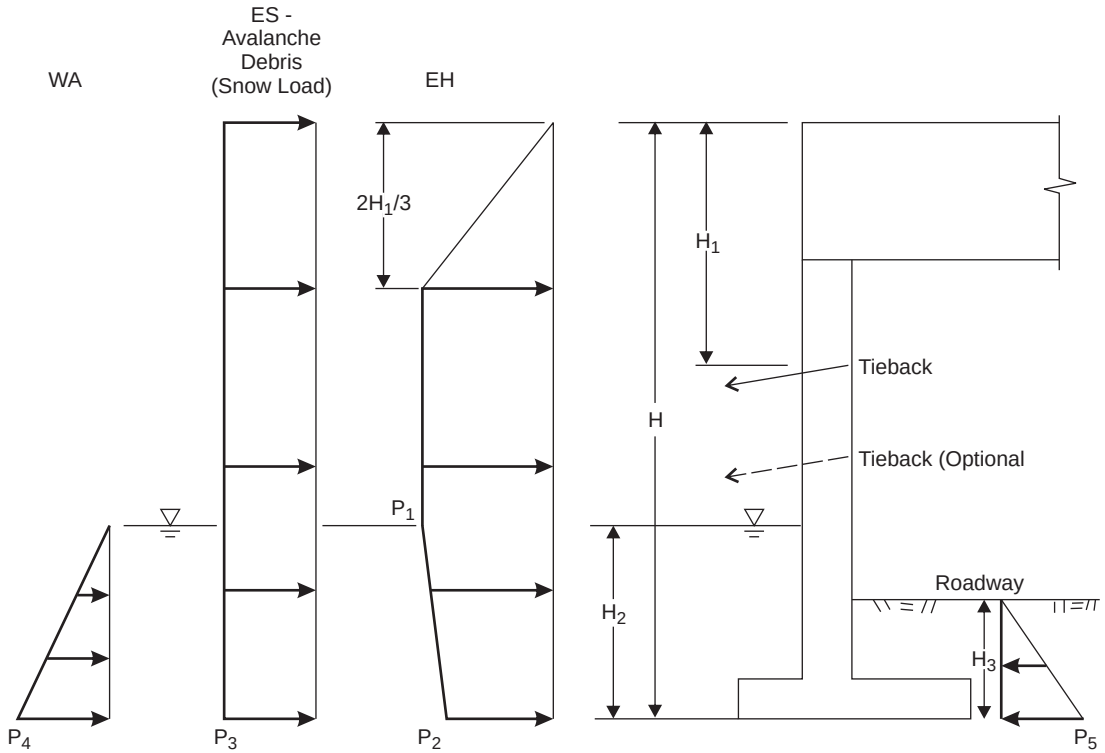

Figure 6.16

Unfactored Lateral Earth Pressure, One or Two Tieback System Strength Limit State - Snowshed Pier 1

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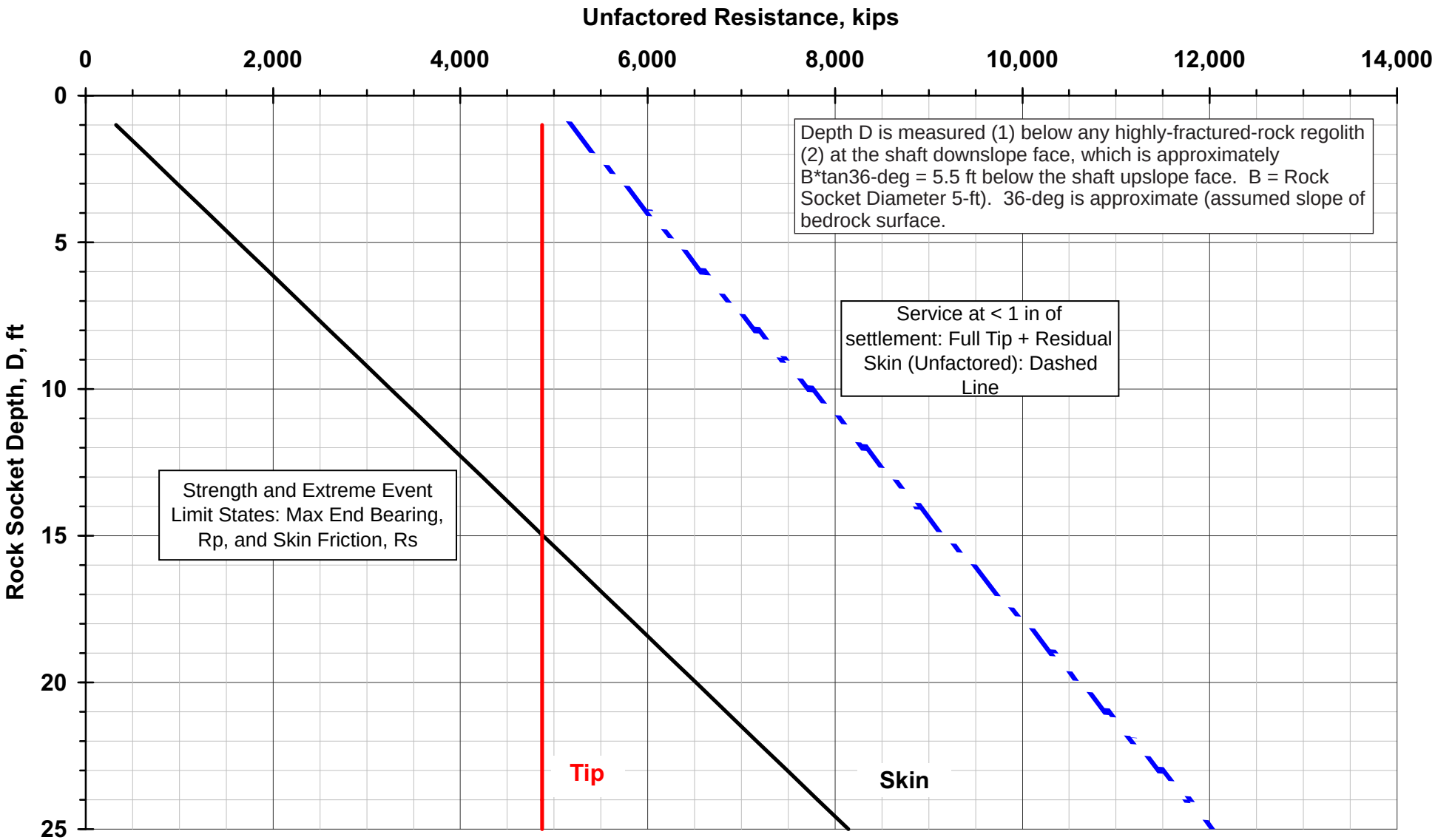

Figure 6.17

Unfactored Bearing Resistance
7-foot Diameter Shaft - Rock

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

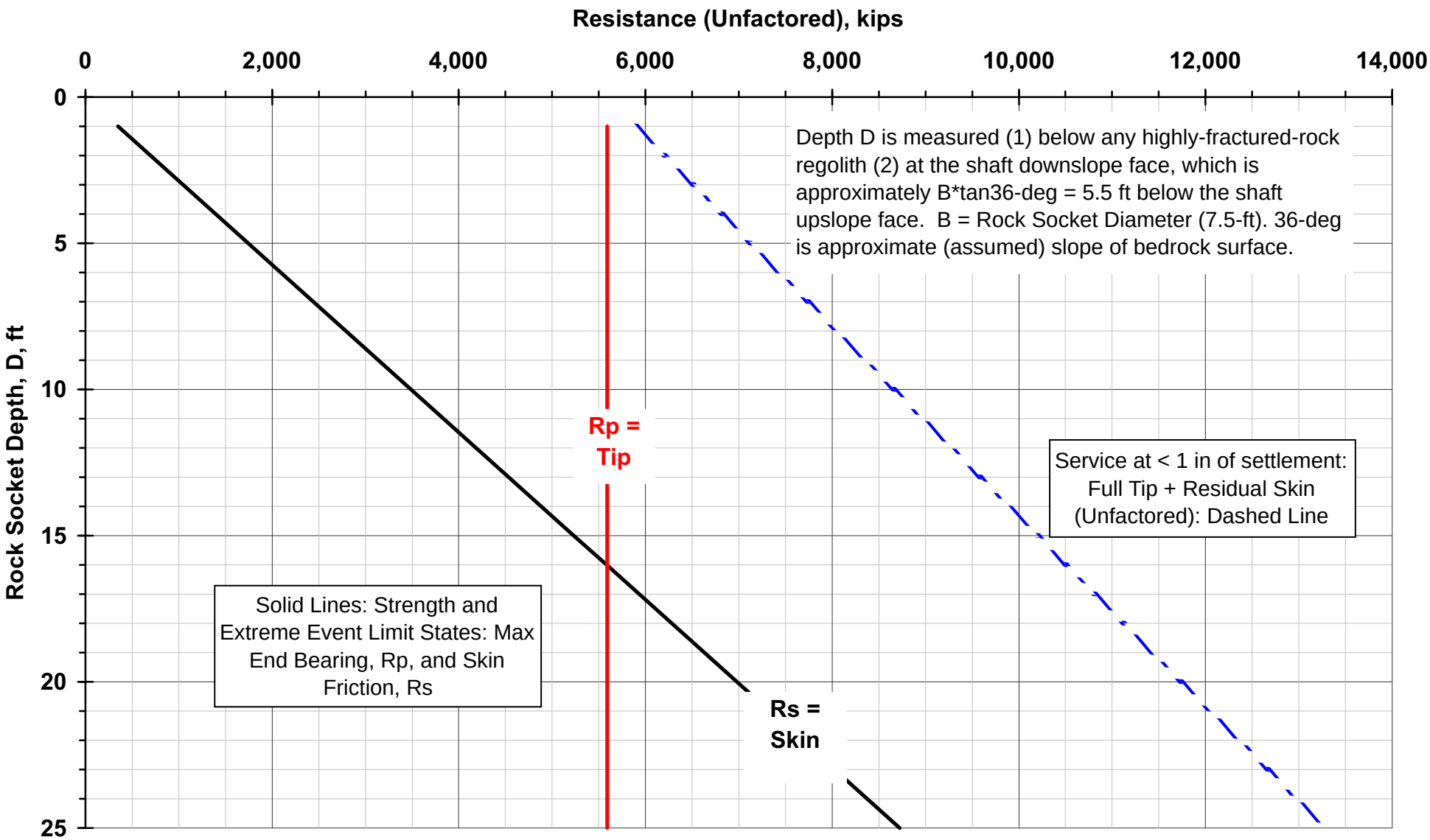

Figure 6.18

Unfactored Bearing Resistance
7.5-foot Diameter Shaft - Rock

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

33758662_25.cdr

WB Sta	Bedrock EL. (feet)	H_w, ft	H, ft	H1, ft	H2, ft	Upslope horizontal load (L), kips/shaft	Downslope resistance (Pae), kips/shaft	P1, kips/ft/shaft (Note 4)	P2, kips/ft/shaft (Note 5)	Vs kips/shaft
1352+50	2500	36	38	26	20	500	0	19	0	270
1353+00	2499	36	38	22	16	500	0	23	0	270
1353+50	2483	51	53	33	27	1000	100	30	7	520
1354+00	2468	65	67	45	39	1700	200	38	10	850
1354+50	2454	78	81	55	49	2400	300	44	12	1230
1355+00	2444	87	90	60	54	3000	400	50	15	1510
1355+50	2449	82	84	52	46	2600	300	50	13	1330
1356+00	2445	85	88	52	46	2900	300	56	13	1440
1356+50	2442	87	90	54	48	3000	300	56	13	1510
1357+00	2440	89	91	56	50	3100	300	55	12	1560
1357+50	2439	89	92	58	52	3100	300	54	12	1580
1358+00	2441	87	90	57	51	3000	300	53	12	1510
1358+50	2443	85	88	55	49	2900	300	52	12	1440
1359+00	2446	82	84	53	47	2600	300	49	13	1330
1359+50	2452	76	78	48	42	2300	200	48	10	1150
1360+00	2458	70	72	46	40	1900	200	42	10	980
1360+50	2463	66	68	45	39	1700	200	38	10	870
1361+00	2466	63	65	44	38	1600	200	36	10	790
1361+50	2470	59	61	44	38	1400	200	32	11	710
1362+00	2476	54	56	41	35	1200	200	29	12	590
1362+50	2482	48	50	36	30	900	100	25	7	470
1363+00	2488	43	44	31	25	700	100	22	8	370
1363+50	2497	34	36	24	18	500	0	21	0	240

Notes

1. Assumes shaft diameter (B) of 8 feet in soil and that soil loads act on shafts over a width of 2B. For other shaft diameters, values of P_1 and P_2 can be calculated by multiplying the value shown by the ratio of the shaft diameters. Shaft spacing should not exceed 3B.
2. Assumes lake side slope edge is 15 feet from shaft centerline.
3. The amount of rock resistance (P_3 and P_4) mobilized, the shaft embedment depth (H_3), and the value of H_4 will vary depending on the magnitude of the unbalanced earth pressure and structure loads and the depth of the rock socket.
4. $P_1 = L/H_1$
5. $P_2 = P_{ae}/(H_2/2)$
6. $P_3 = 18.5 (H_3-H_4) + 26.1$ B (kips/ft/shaft).
7. $P_4 = 6P_3$ (kips/ft/shaft).

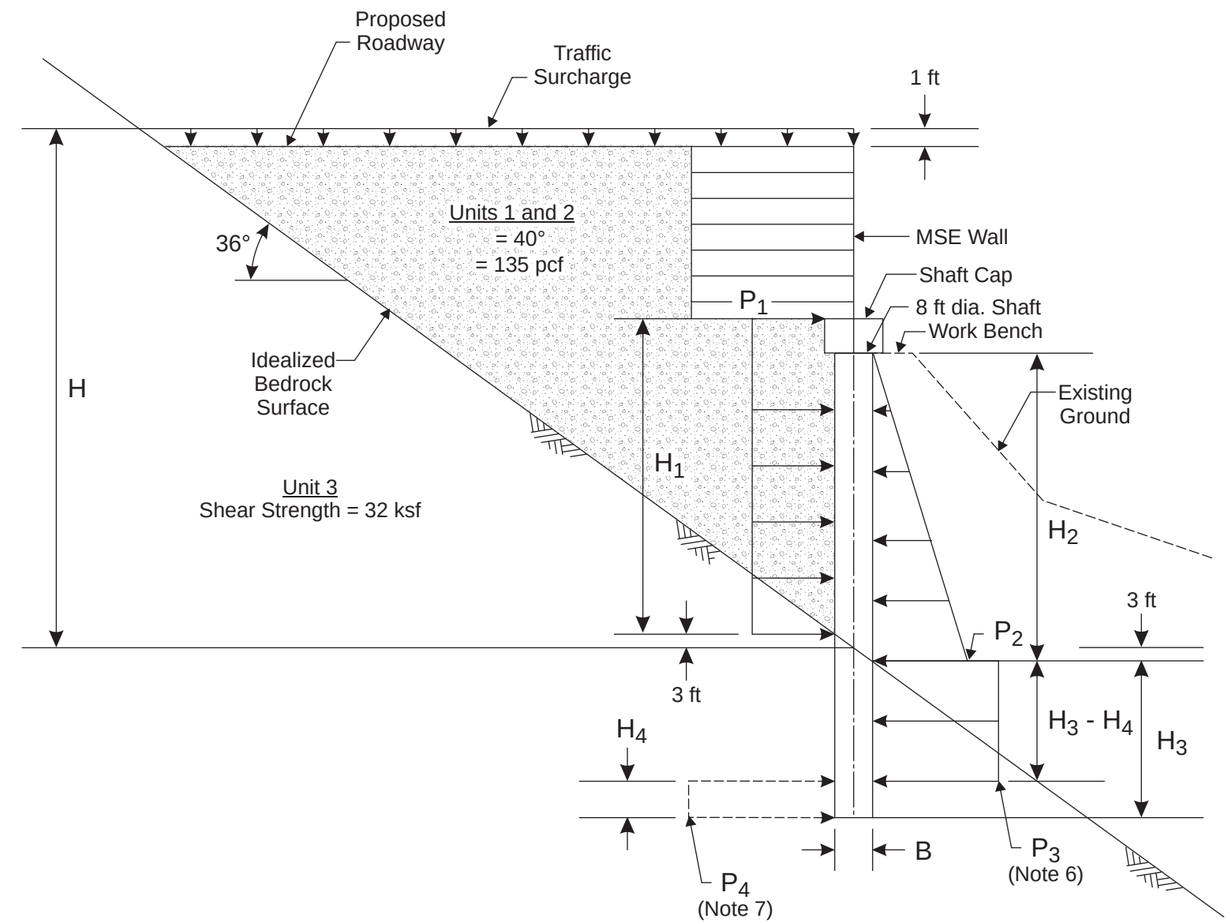
B = Shaft diameter in feet. For P_3 and P_4, use shaft diameter in rock.

V_S = Estimated downdrag load

H_3 = Rock socket depth below downslope shaft face, feet. Minimum H_3 = 10 feet.

H_4 = Height of downslope pressure on shaft in rock, feet (varies as required to provide force and moment equilibrium).

H_W= Height from roadway surface at Pier 2 to bedrock elevation at shaft centerline.



Not to Scale

Figure 6.19

Lateral Earth Pressures

Pier 2 Drilled Shafts – MSE Wall Option – Extreme Event I Limit State

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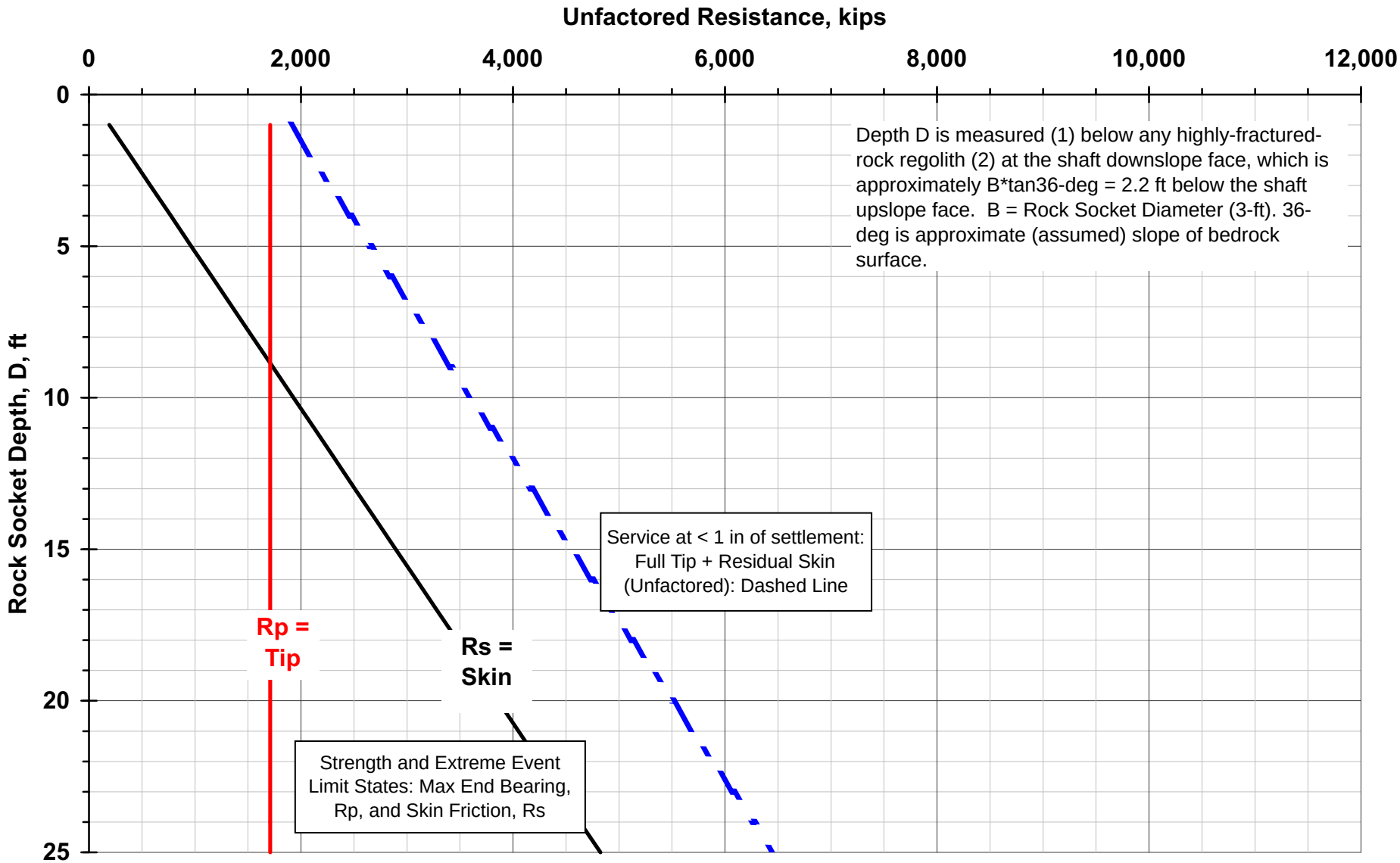

Figure 6.20

Unfactored Bearing Resistance

3-foot Diameter Shaft - West Portal Tower and Generator Room

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

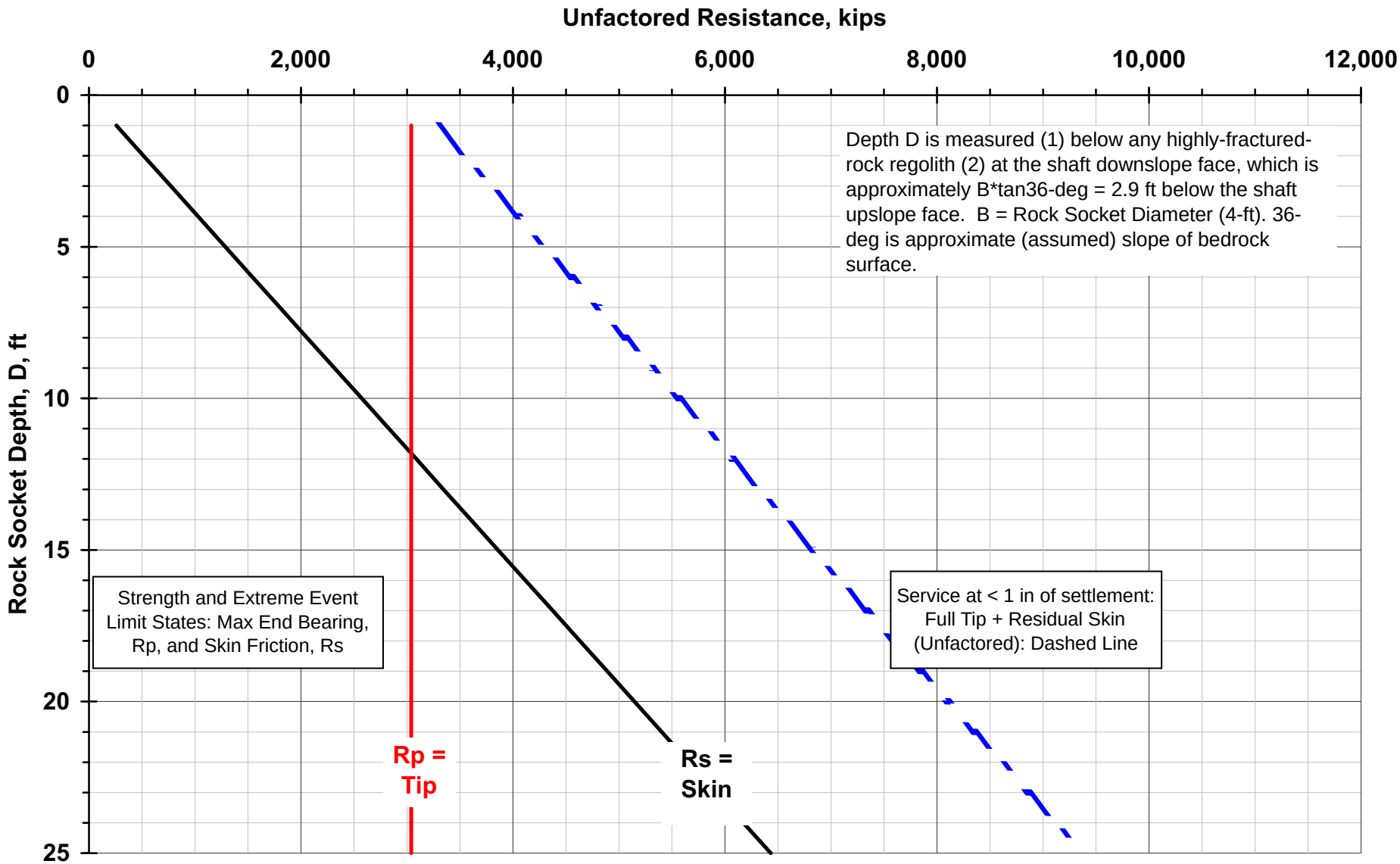

Figure 6.21

Unfactored Bearing Resistance

4-foot Diameter Shaft - West Portal Tower and Generator Room

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

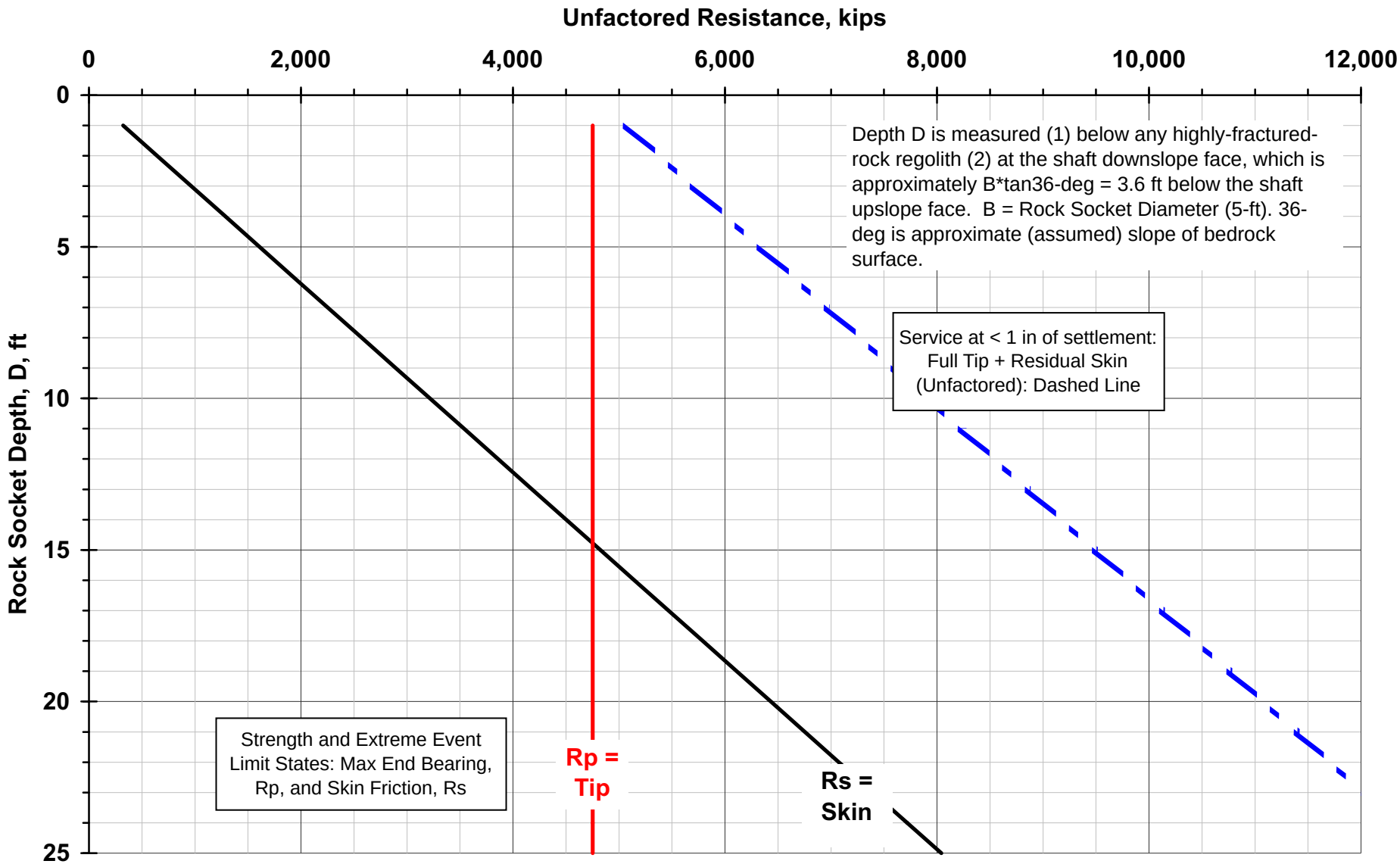

Figure 6.22

Unfactored Bearing Resistance

5-foot Diameter Shaft - West Portal Tower and Generator Room

Job No. 33758662

URS

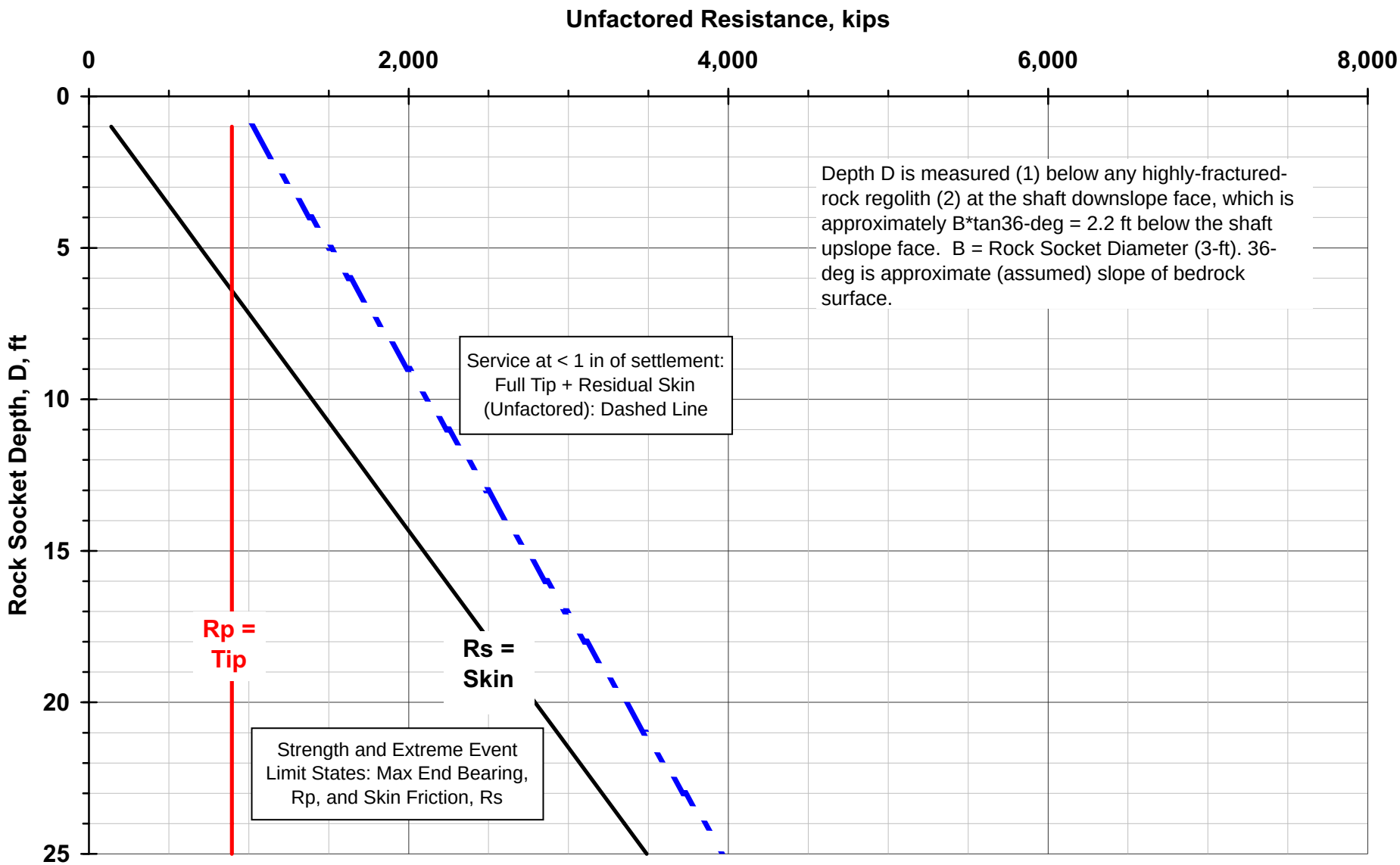

Figure 6.23

Unfactored Bearing Resistance
3-foot Diameter Shaft - East Portal Tower

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

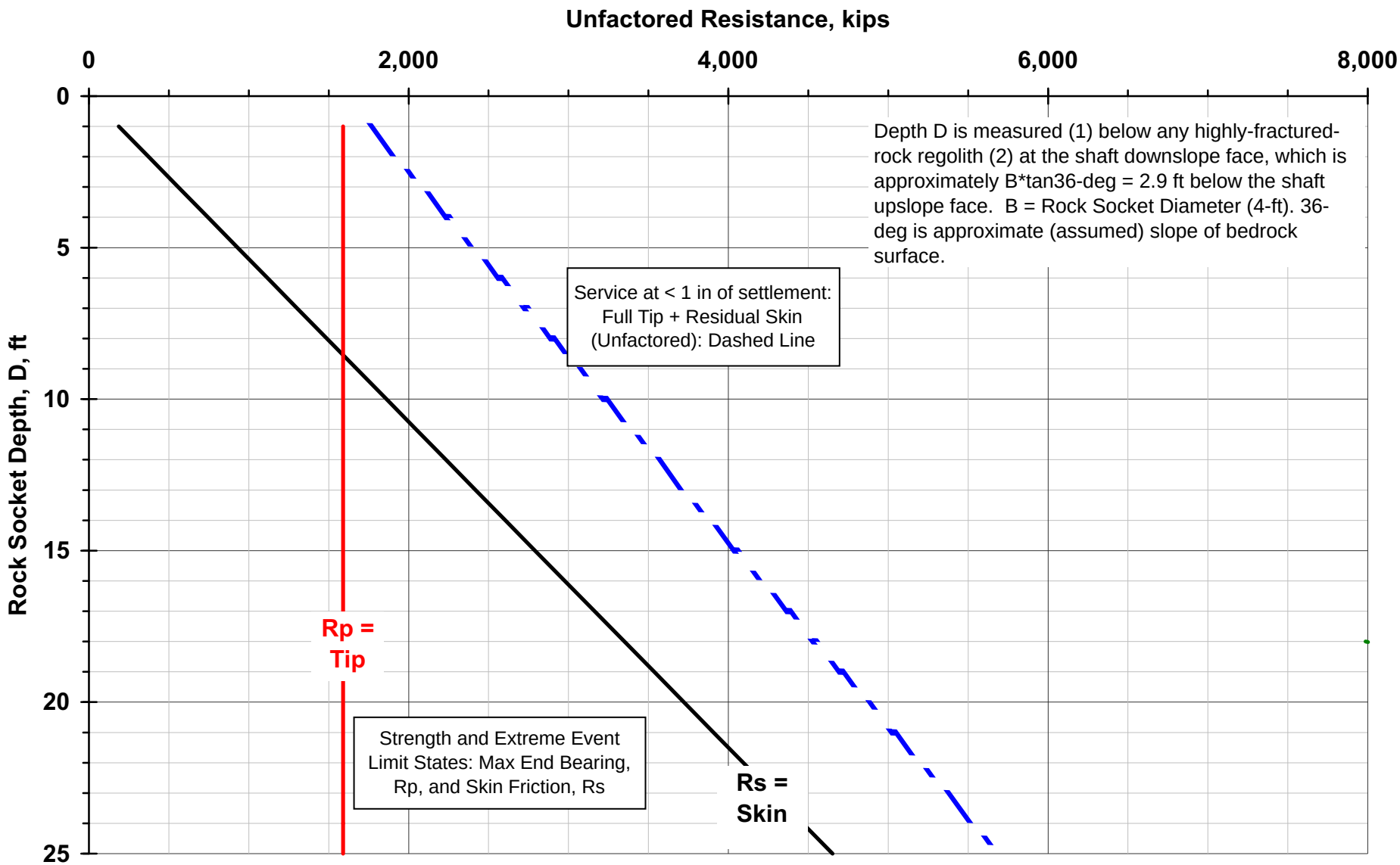

Figure 6.24

Unfactored Bearing Resistance
4-foot Diameter Shaft - East Portal Tower

Job No. 33758662

URS

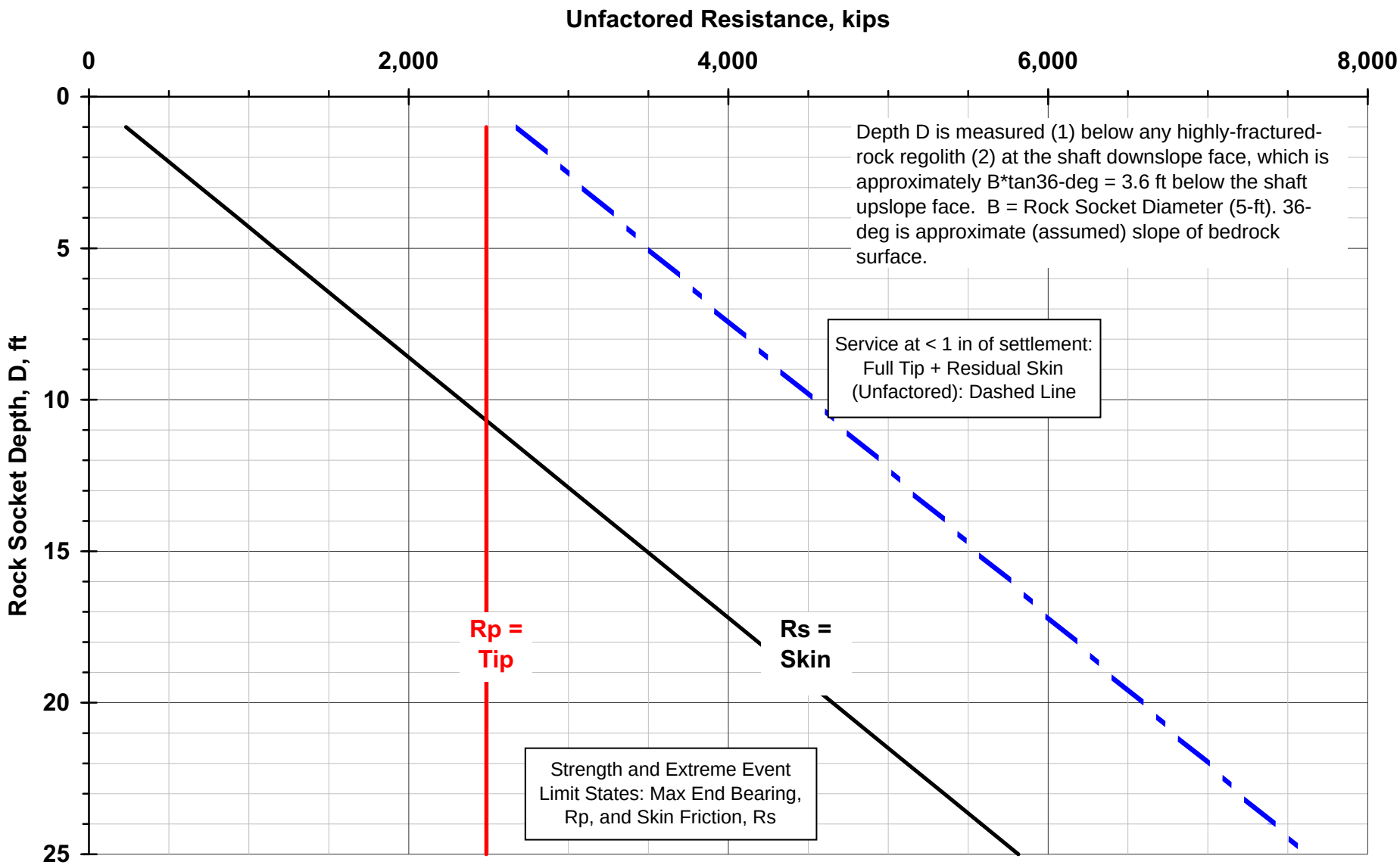

Figure 6.25

Unfactored Bearing Resistance
5-foot Diameter Shaft - East Portal Tower

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

33758662_01.cdr

WB Sta	Bedrock EL. (feet)	H_w, ft	H, ft	H1, ft	Upslope horizontal load (L), kips/shaft	Downslope resistance (Pae), kips/shaft	P_1, kips/ft/shaft	P_2, kips/ft/shaft	Vs kips/shaft
1352+20 Generator Room	2502	34	36	Note 3	300	0	Note 3	0	150
1352+50 W Portal Tower	2495	41	43		430	0		0	210
1363+50 E Portal Tower	2487	44	46		490	0		0	250

Notes

1. Assumes shaft diameter (B) of 5 feet and that soil loads act on shafts over a width of 2B. For other shaft diameters, values of P_1 and P_2 can be calculated by multiplying the value shown by the ratio of the shaft diameters. Shaft spacing should not exceed 3B.

2. The amount of rock resistance (P_3 and P_4) mobilized, the shaft embedment depth (H_3), and the value of H_4 will vary depending on the magnitude of the unbalanced earth pressure and structure loads and the depth of the rock socket.

3. $P_1 = L/H_1$. The value of H_1 can be calculated as the difference between the elevations of the top of shaft cap and the top of bedrock at the upslope face of the shaft.

4. $P_3 = 18.5\ (H_3\text{-}H_4) + 26.1\ B$ (kips/ft/shaft). [East Tower]
   $= 35.8\ (H_3\text{-}H_4) + 50.6\ B$ (kips/ft/shaft). [West Tower and Generator Room]

5. $P_4 = 6P_3$ (kips/ft/shaft).

B = Shaft diameter in feet.

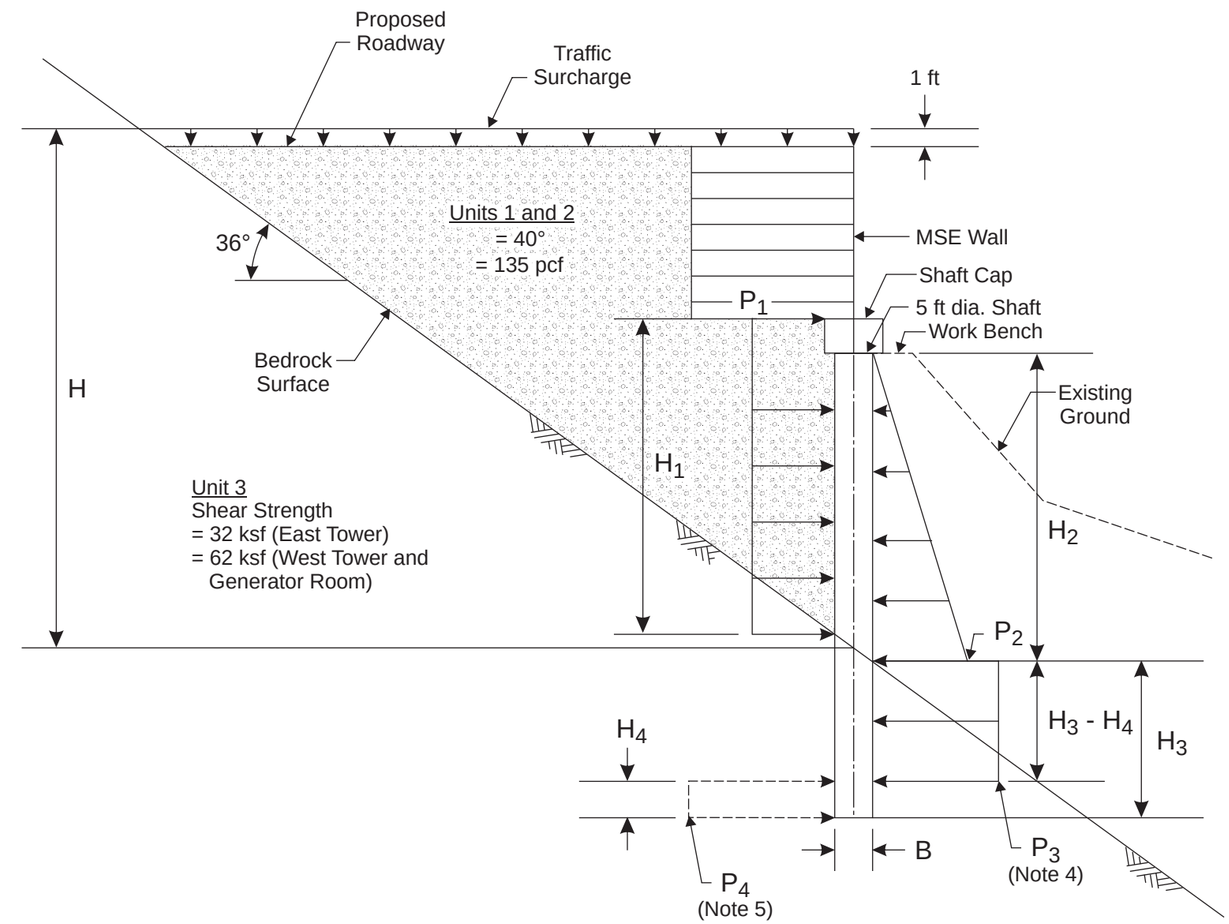
V_S = Estimated downdrag load

H = Height from roadway surface, including superelevation, to bedrock elevation at shaft centerline, plus one foot equivalent traffic surcharge.

H_W= Height from roadway surface at Pier 2 to bedrock elevation at shaft centerline.

H_3 = Rock socket depth below downslope shaft face, feet. Minimum H_3 = 10 feet.

H_4 = Height of downslope pressure on shaft in rock, feet (varies as required to provide force and moment equilibrium).



Not to Scale

Figure 6.26

Lateral Earth Pressures

Pier 2 Tower and Generator Room Shafts – Extreme Event I Limit State

Job No. 33758662

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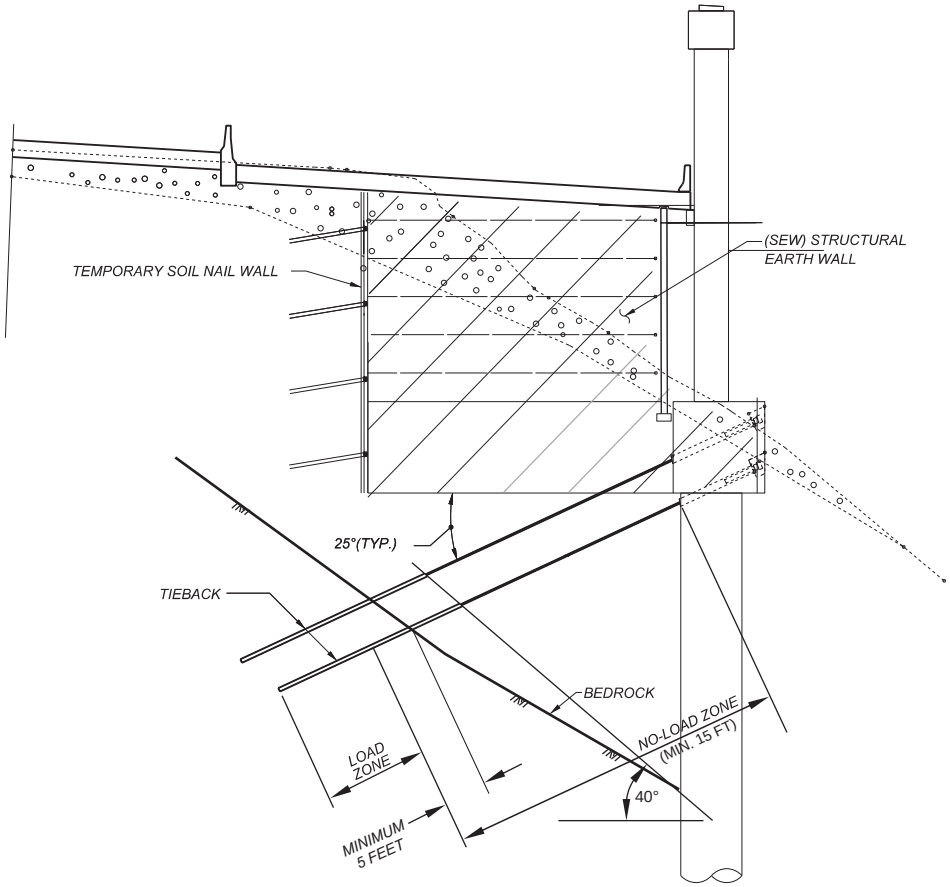
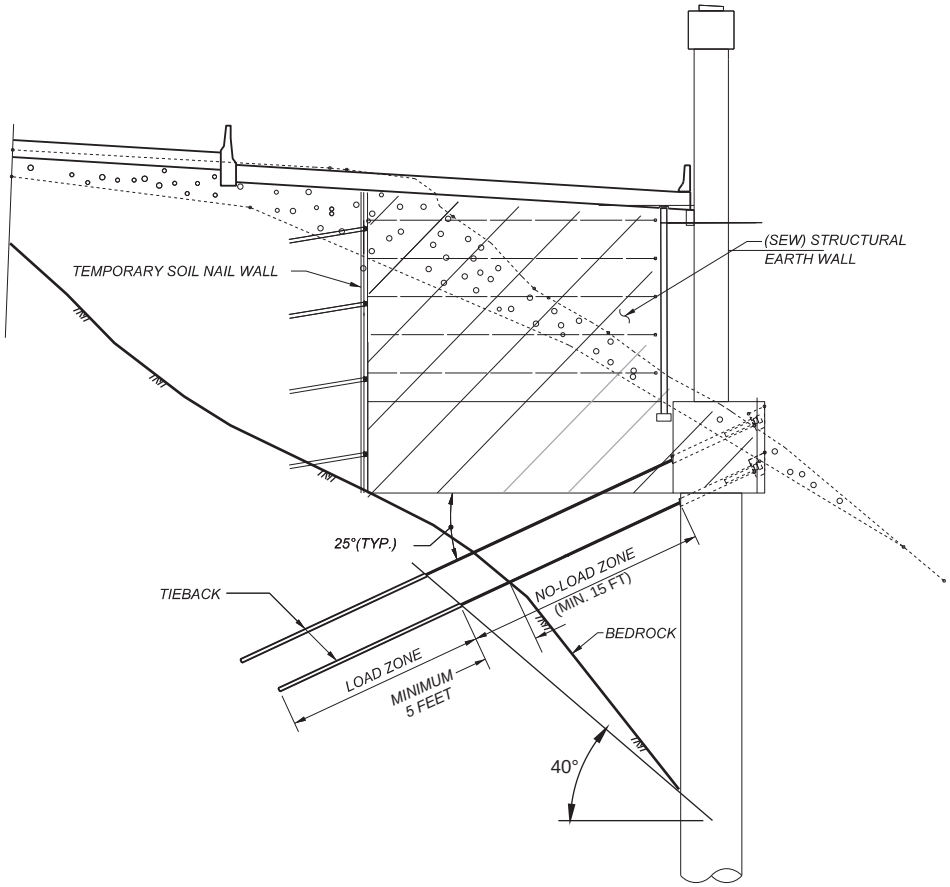
WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting



Case 1. Bedrock Slope Flatter than 40°



Case 2. Bedrock Slope Steeper than 40°

Job No. 33758662

Figure 6.27

No-Load Zone for Pier 2 Permanent Ground Anchors

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2010 Geotechnical Analysis and Reporting

Notes

1. Earth pressures in psf for flexible walls that can deflect may be calculated using the equations and values below.

$P_1 = K_a ã(H_1 + H_2)$
$P_2 = K_a q$
$P_3 = K_p ã(H_2 – 2)$

Design Parameters for Calculating Lateral Earth Pressures for Strength Limit State

Parameter	Units	Value
Soil Unit Weight, ã	pounds per cubic foot (pcf)	135
Soil Friction Angle, ö	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.20
Snow surcharge loading, q	psf	320
Passive Earth Pressure Coefficient for Flexible Retaining Walls, K_p	unitless	use 0.0 (ignored)

2. The backfill behind the wall is assumed to be fully drained.

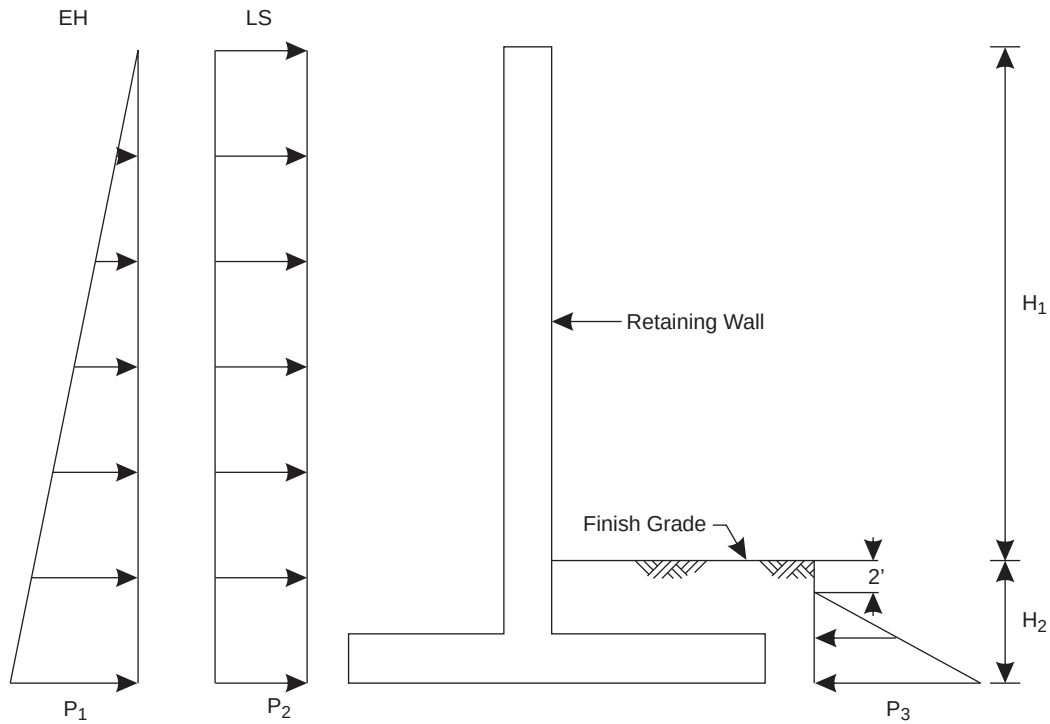


Figure 6.28
Unfactored Strength Limit State Earth Pressures for Wall 1

Job No. 33758662

URS

Notes

1. Earth pressures in psf for flexible walls that can deflect may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(f)}ã(H_1 + H_2)$
$P_2 = K_{ae(f)}ã\ heq$
$P_3 = K_{pe(f)}ã\ (H_2 - 2)$

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

Parameter	Units	Value
Soil Unit Weight, ã	pounds per cubic foot (pcf)	135
Soil Friction Angle, ö	degrees	40
Equivalent Height of Soil for Vehicular Loading, heq	feet	2.0
Seismic Active Earth Pressure Coefficient for Flexible Retaining Walls, $K_{ae(f)}$	unitless	0.31
Seismic Passive Earth Pressure Coefficient for Flexible Retaining Walls, $K_{pe(f)}$	unitless	use 0.0 (ignored)

2. The backfill behind the wall is assumed to be fully drained.

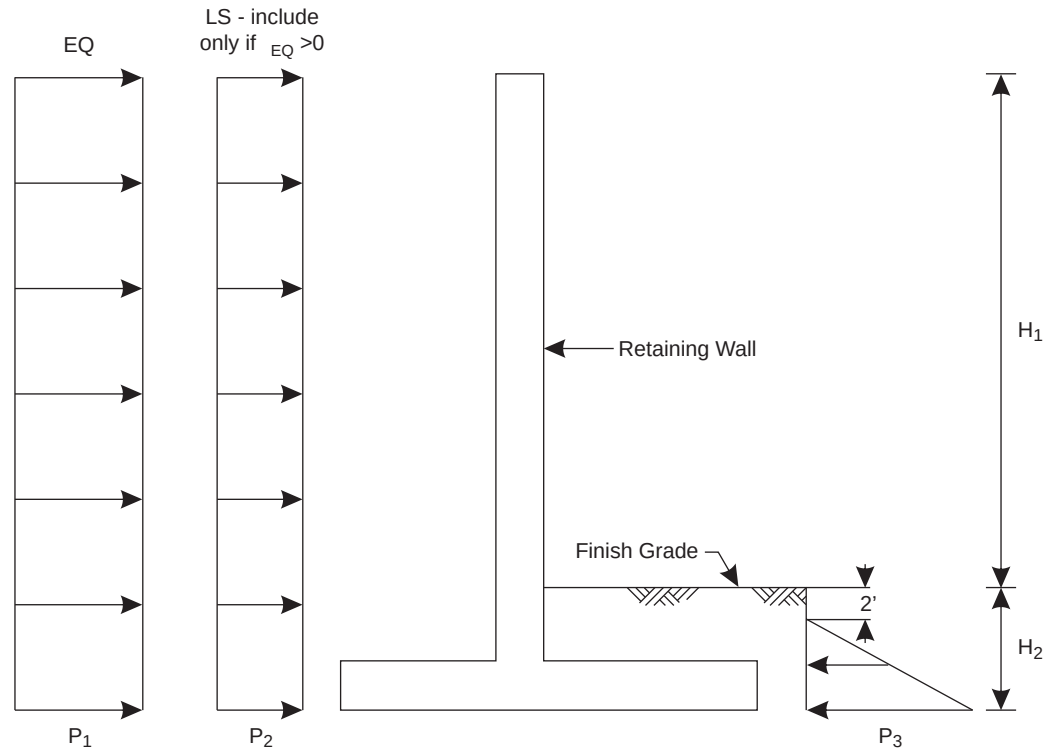
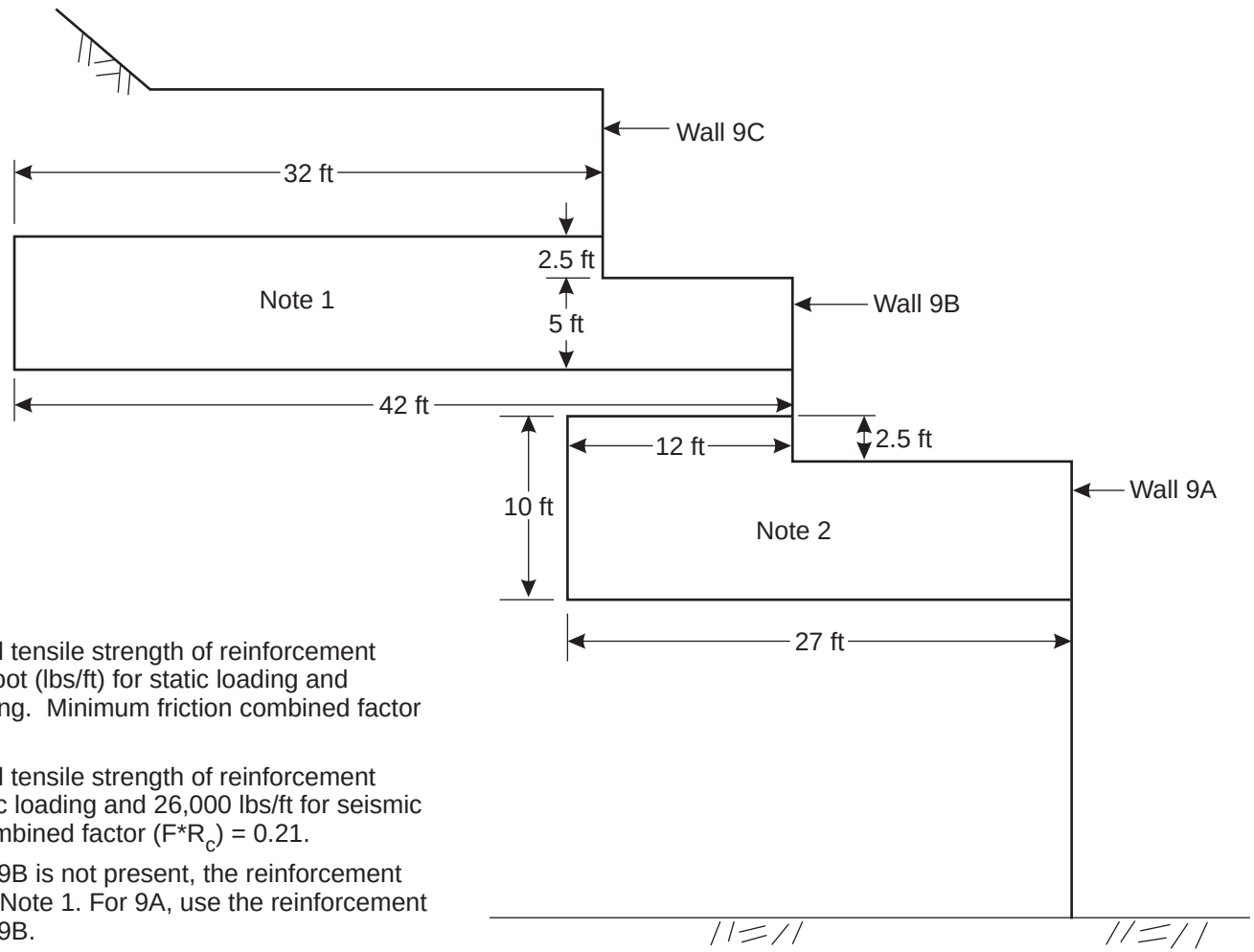


Figure 6.29
Unfactored Extreme Event I Limit State Earth Pressures for Wall 1

Job No. 33758662



Notes

1. Minimum long-term combined tensile strength of reinforcement layers = 60,000 pounds per foot (lbs/ft) for static loading and 75,000 lbs/ft for seismic loading. Minimum friction combined factor (F^*R_c) = 0.42.
2. Minimum long-term combined tensile strength of reinforcement layers = 15,000 lbs/ft for static loading and 26,000 lbs/ft for seismic loading. Minimum friction combined factor (F^*R_c) = 0.21.
3. For wall sections where Wall 9B is not present, the reinforcement requirements are provided in Note 1. For 9A, use the reinforcement requirements shown for Wall 9B.

   F^* = Reinforcement pullout friction factor.

   R_c = Reinforcement coverage ratio.

Figure 6.30

Job No. 33758662

Recommended Reinforcement for Compound Stability - Wall 9

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

Earth Pressures

$P_1 = K_a \gamma H$

$P_2 = K_a q_s$

$P_3 = K_{ae} \gamma H$

$P_4 = K_o \gamma (H-2)$

Parameters

Soil Friction Angle, Ø=38°

Soil Unit Weight, γ=135 pcf

Active Earth Pressure Coefficient, K_a=0.26

Snow Load Surcharge, q_s=Selected by Designer

Seismic Active Earth Pressure Coefficient, K_{ae}=0.41

At-Rest Earth Pressure Coefficient, K_o=0.36

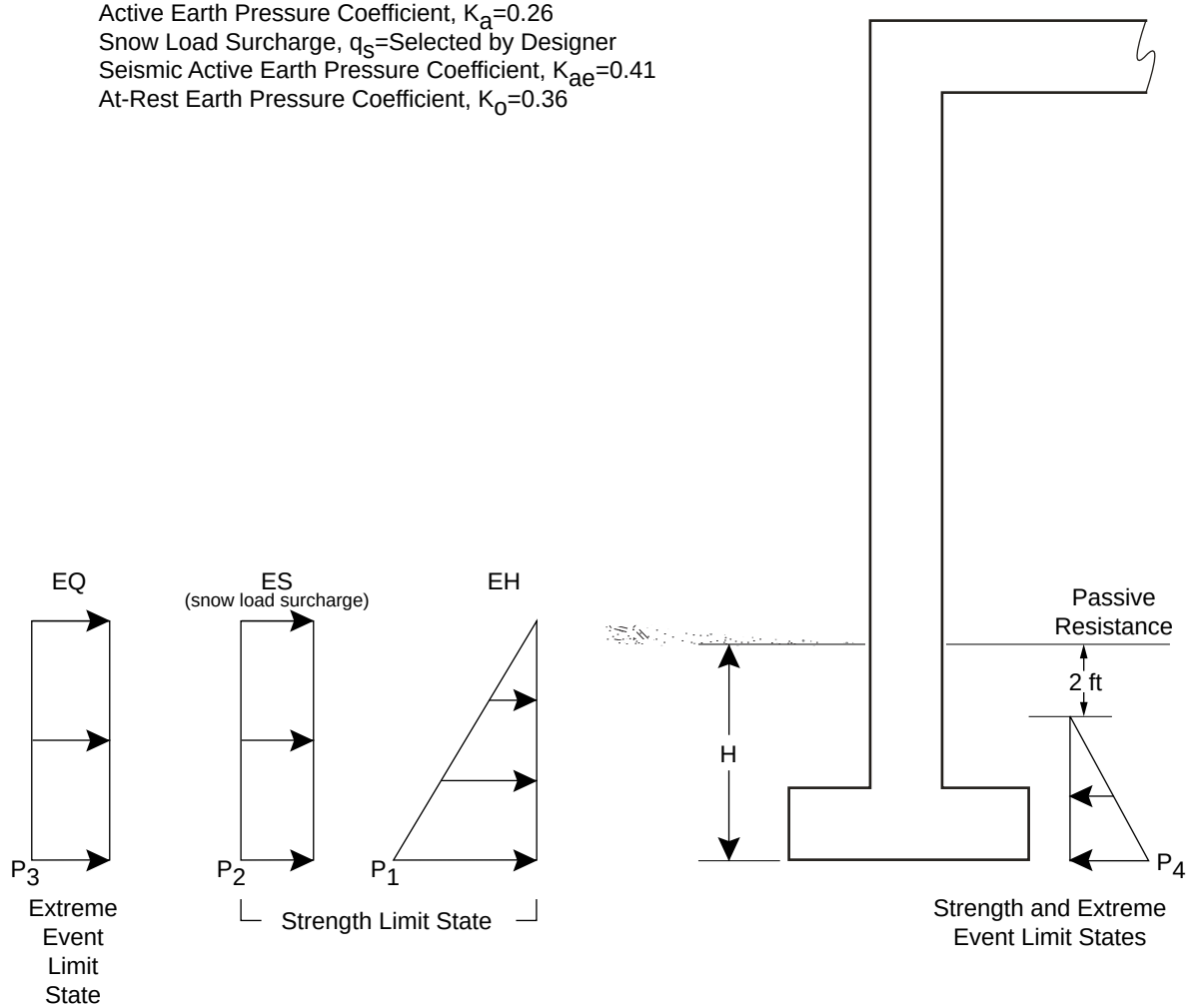

Figure 6.31

Unfactored Lateral Earth Pressures
Snowshed Transformer Building

Job No. 33758662

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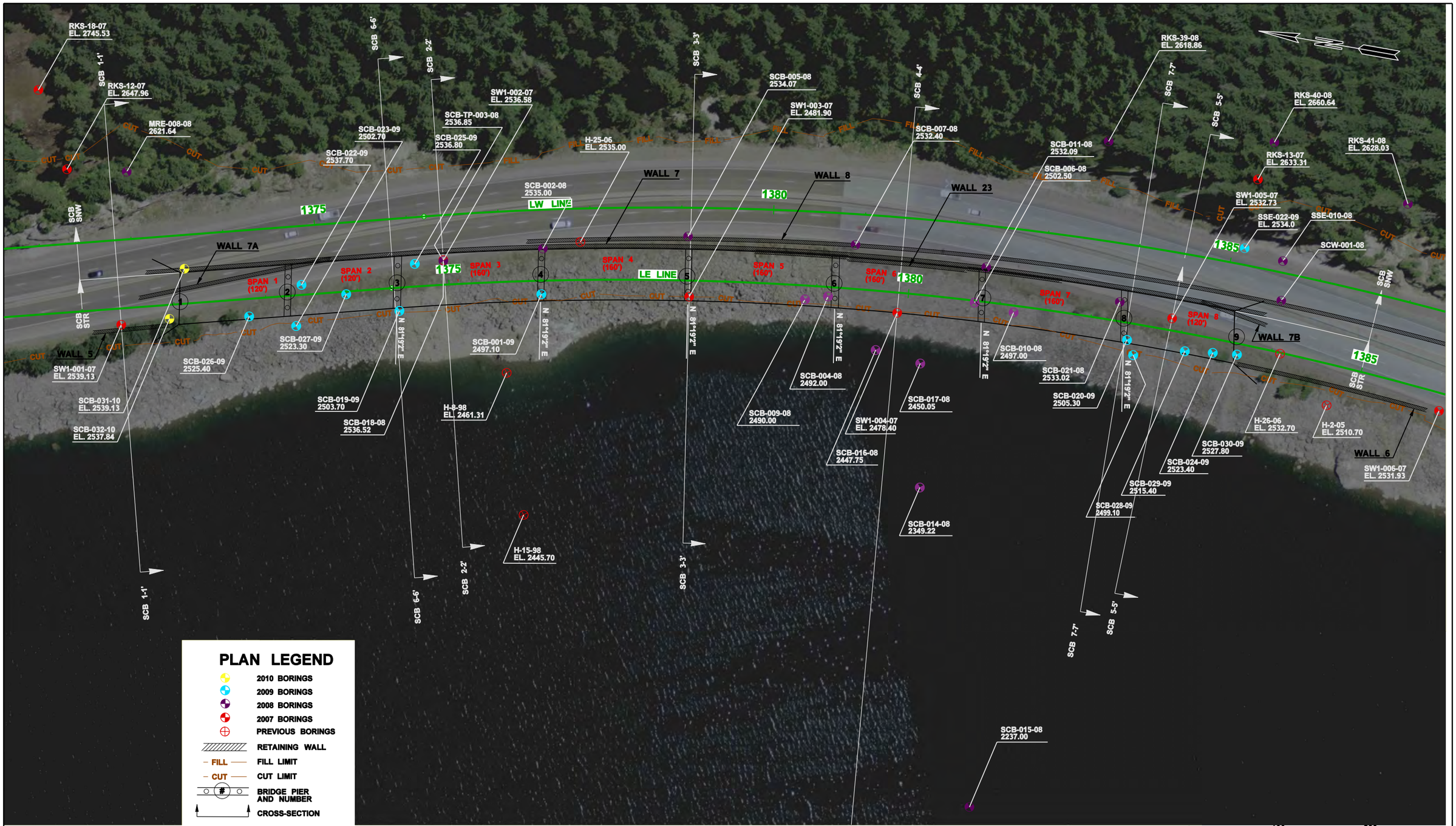
2010 Geotechnical Analysis and Reporting



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DATE	10/7/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
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		

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

SLIDE CURVE BRIDGE BORING LOCATION PLAN

FIGURE 7.1

33758662_27.cdr

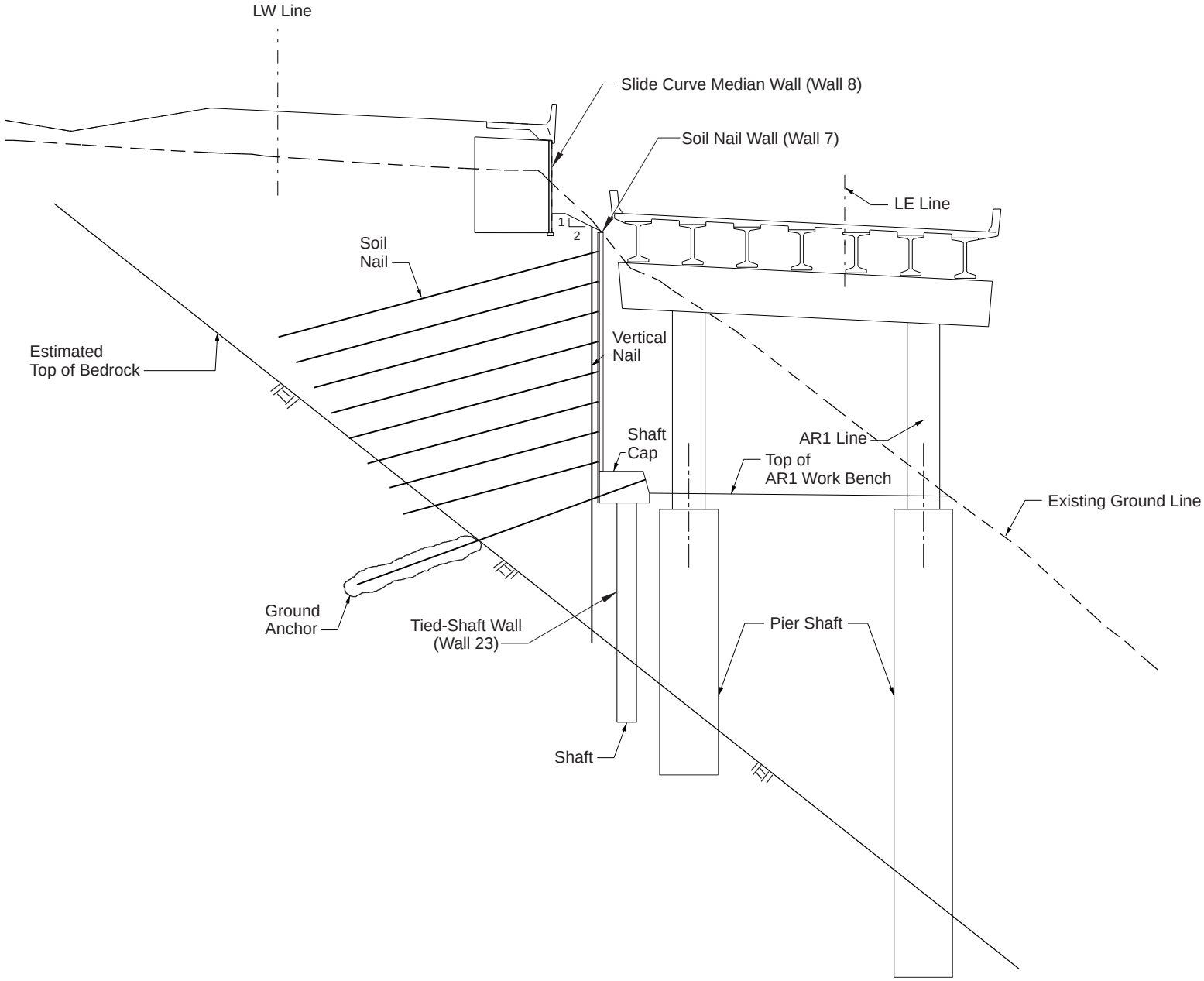

Figure 7.2

Slide Curve Bridge and Walls Typical Section Between EB Stations 1378+32 and 1381+63

Job No. 33758662

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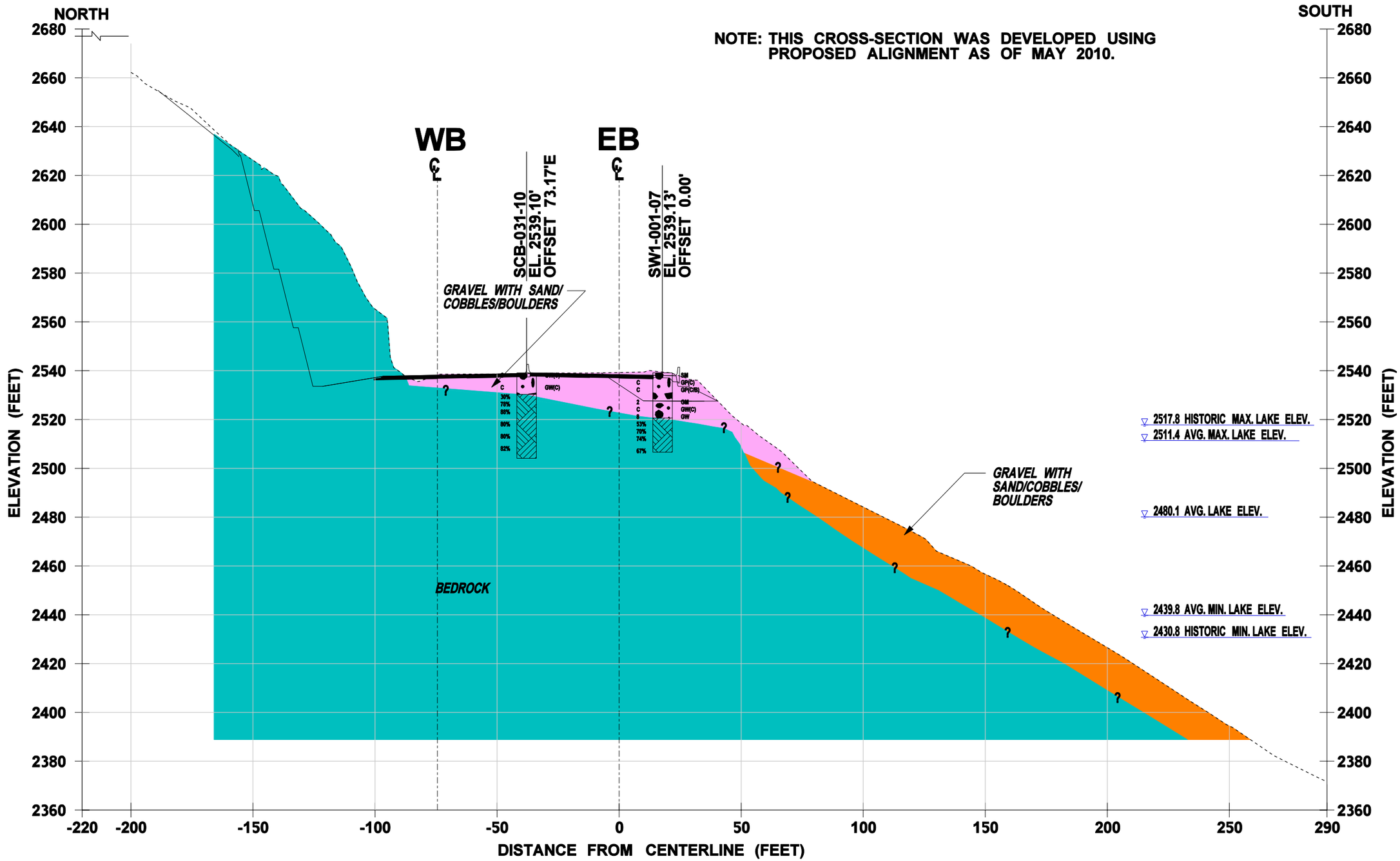

EB STATION 1371+41 SLIDE CURVE BRIDGE

0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	John Zeman
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
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JOB NUMBER 33758623		
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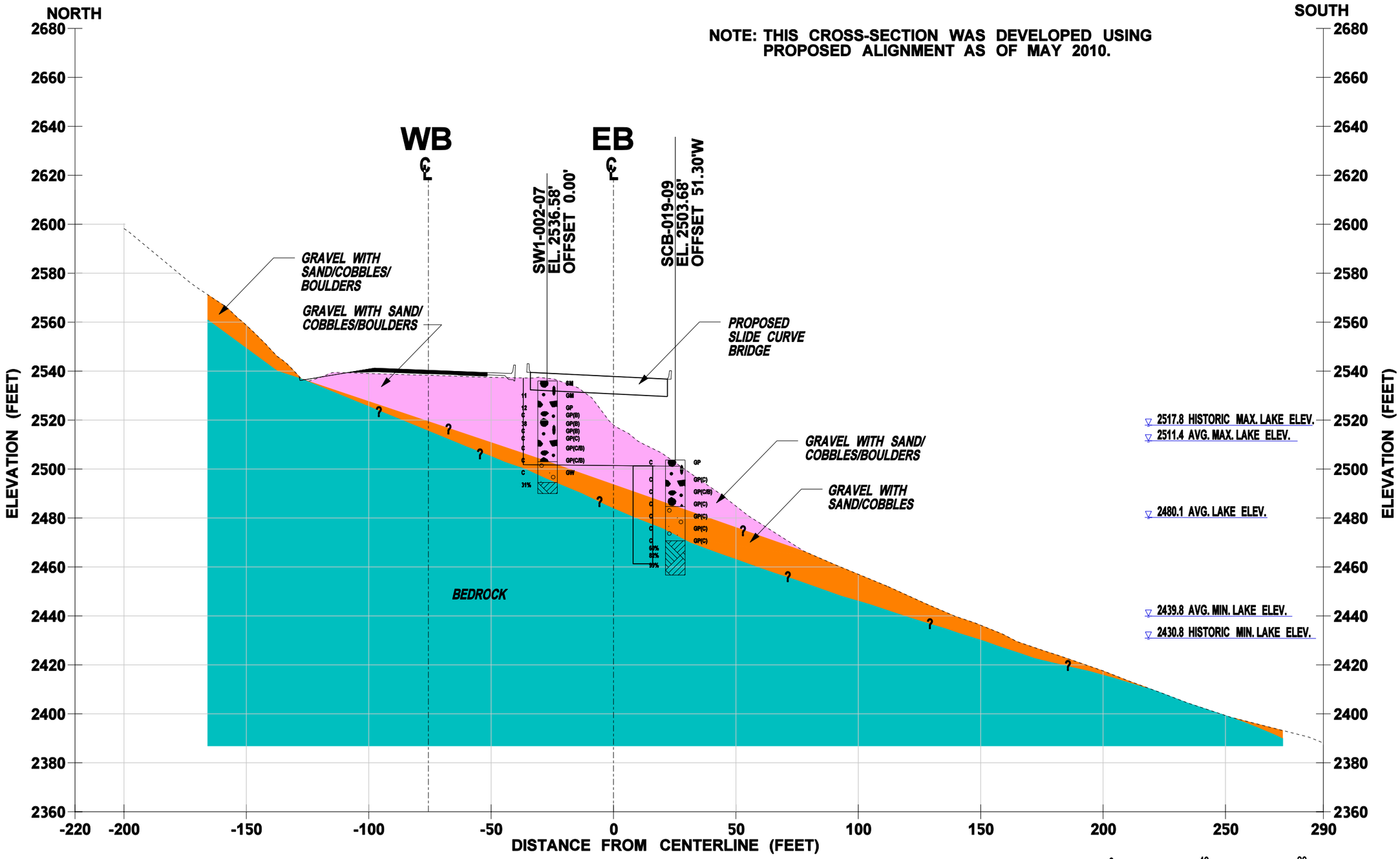
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 1-1'

FIGURE 7.3

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.



EB STATION 1374+95 SLIDE CURVE BRIDGE

0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

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ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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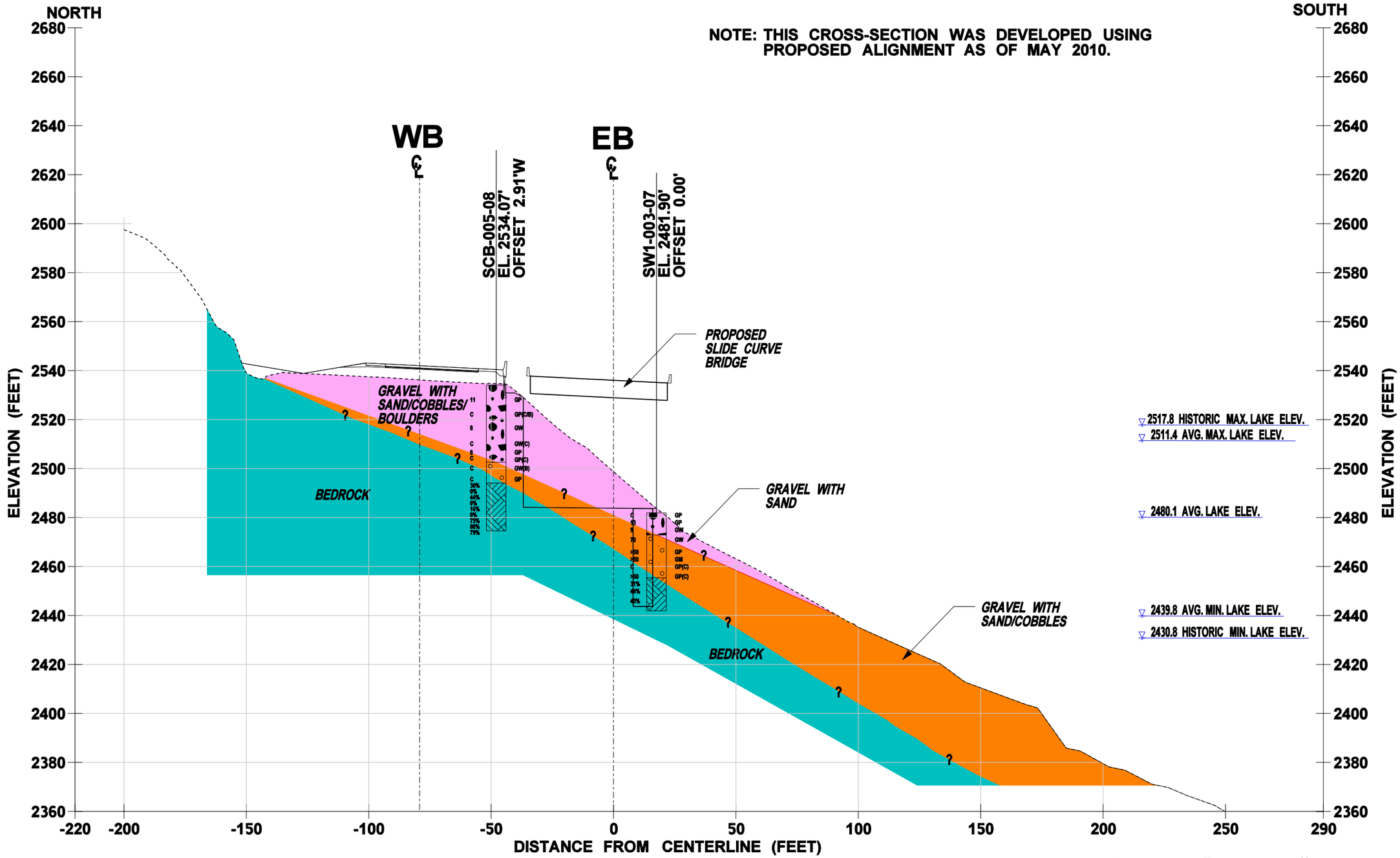
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 2-2'

FIGURE 7.4



EB STATION 1377+62 SLIDE CURVE BRIDGE

0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

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CHECKED BY	Dave Walker/Ken Yang				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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I-90 Snoqualmie Pass East
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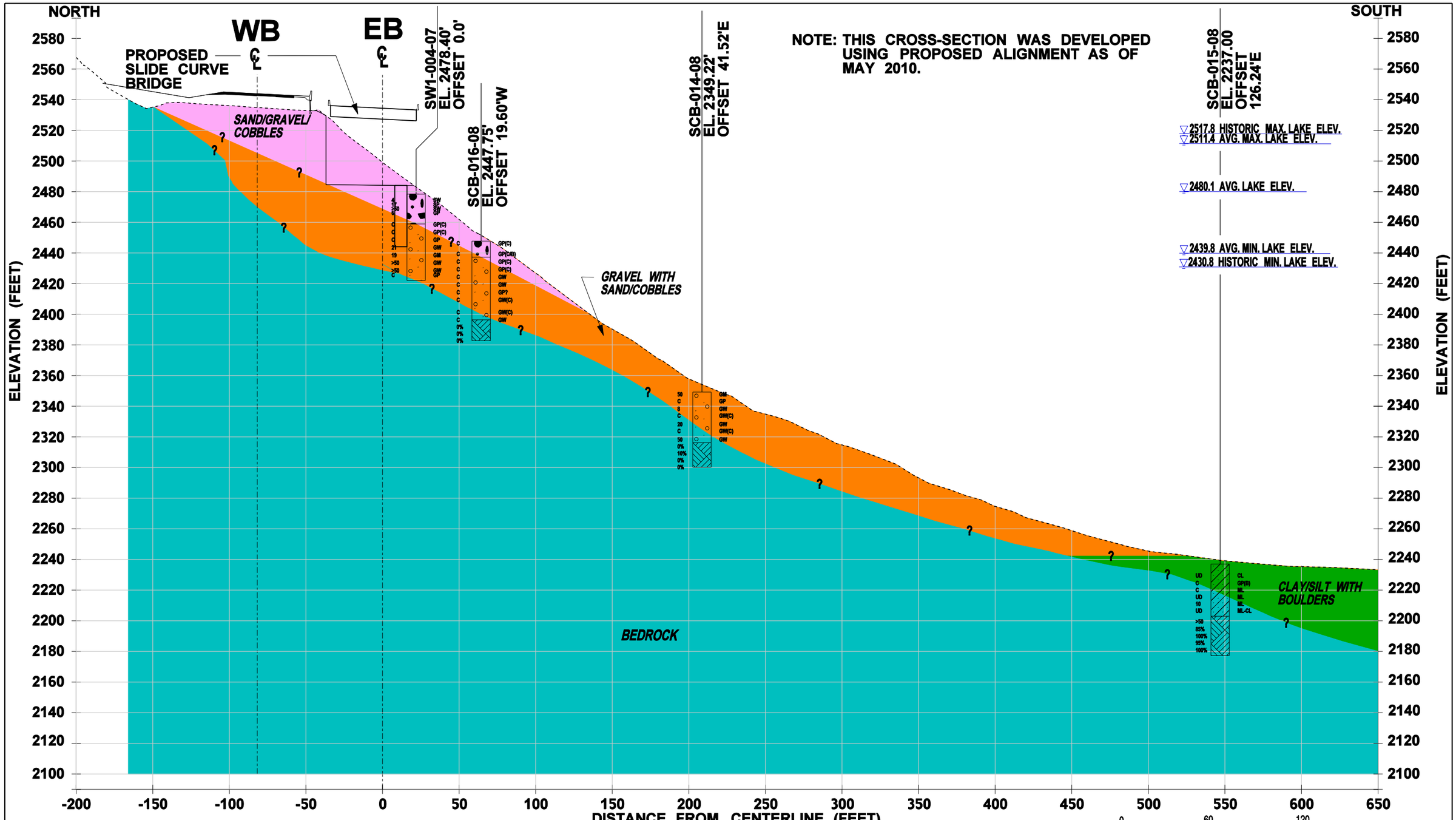
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 3-3'

FIGURE 7.5



EB STATION 1379+90 SLIDE CURVE BRIDGE

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DESIGNED BY	Ken Yang
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	John Zeman
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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CONTRACT NO. Y-9764

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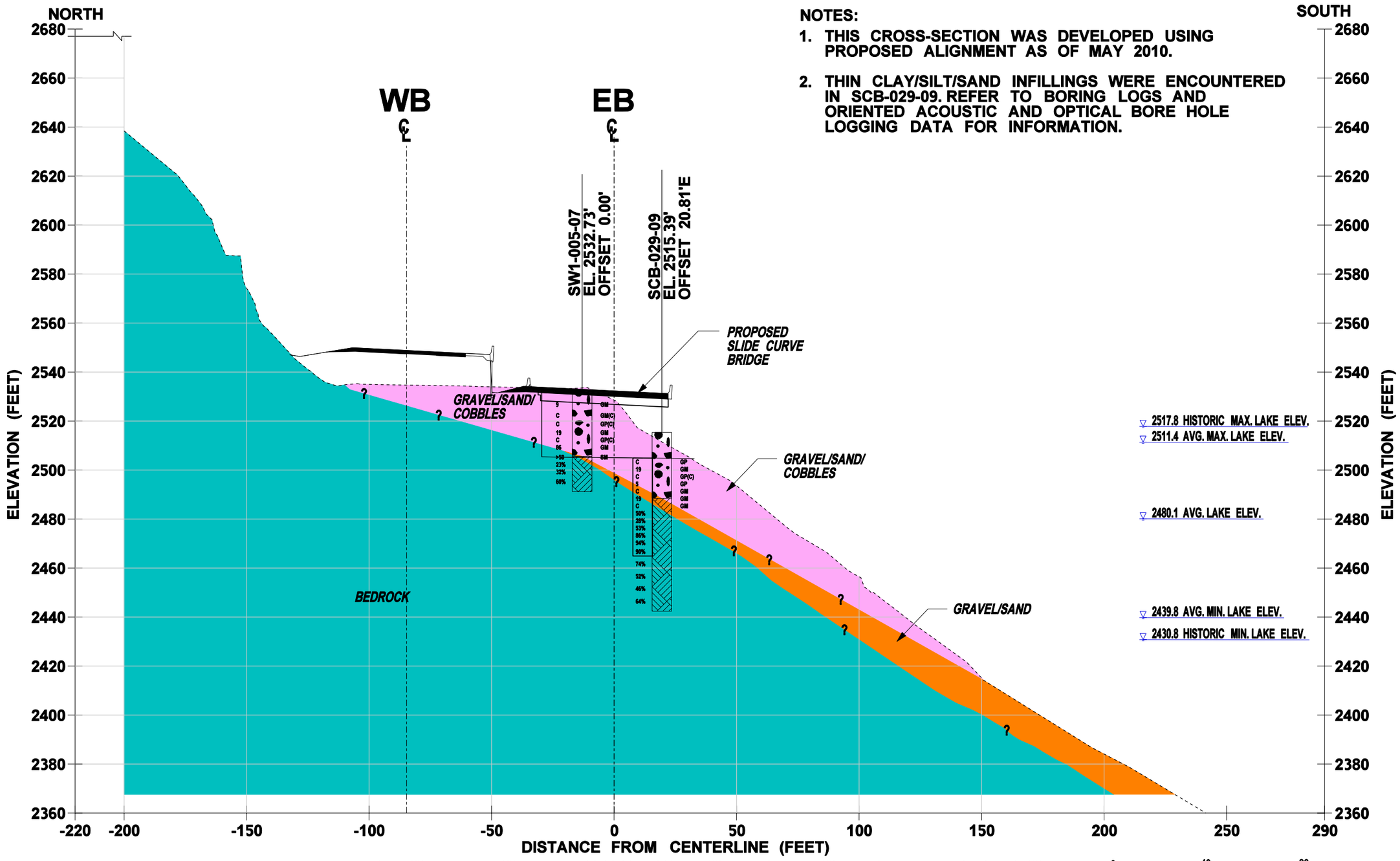
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 4-4'

FIGURE 7.6

NOTES:

1. THIS CROSS-SECTION WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. THIN CLAY/SILT/SAND INFILLINGS WERE ENCOUNTERED IN SCB-029-09. REFER TO BORING LOGS AND ORIENTED ACOUSTIC AND OPTICAL BORE HOLE LOGGING DATA FOR INFORMATION.



EB STATION 1382+87 SLIDE CURVE BRIDGE

0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

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CHECKED BY	Dave Walker/Ken Yang				CONTRACT NO. Y-9764		LOCATION NO.
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PROJ. MNGR.	Cecil Urlich						
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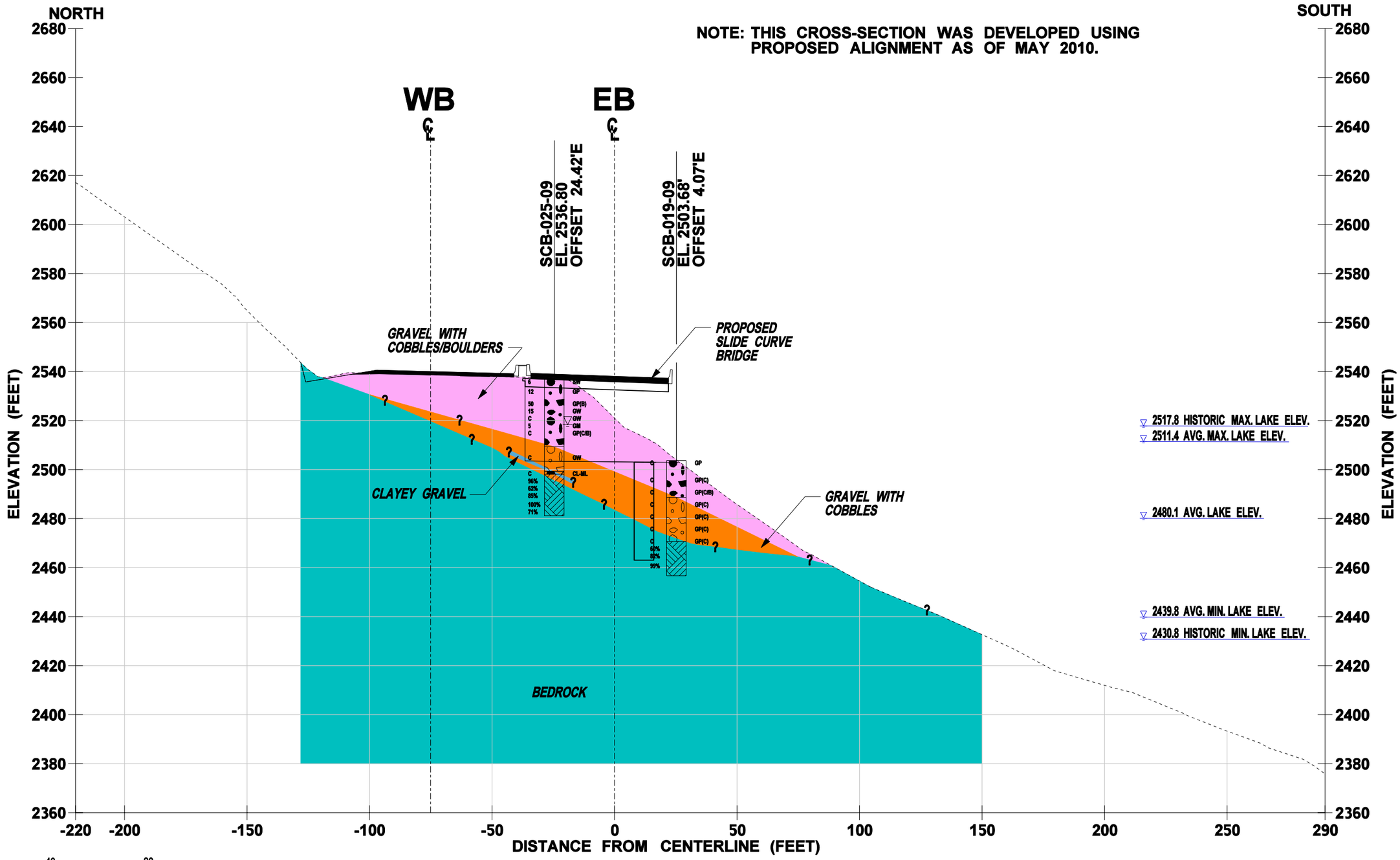
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 5-5'

FIGURE 7.7

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.



0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

EB STATION 1374+40 SLIDE CURVE BRIDGE

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ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
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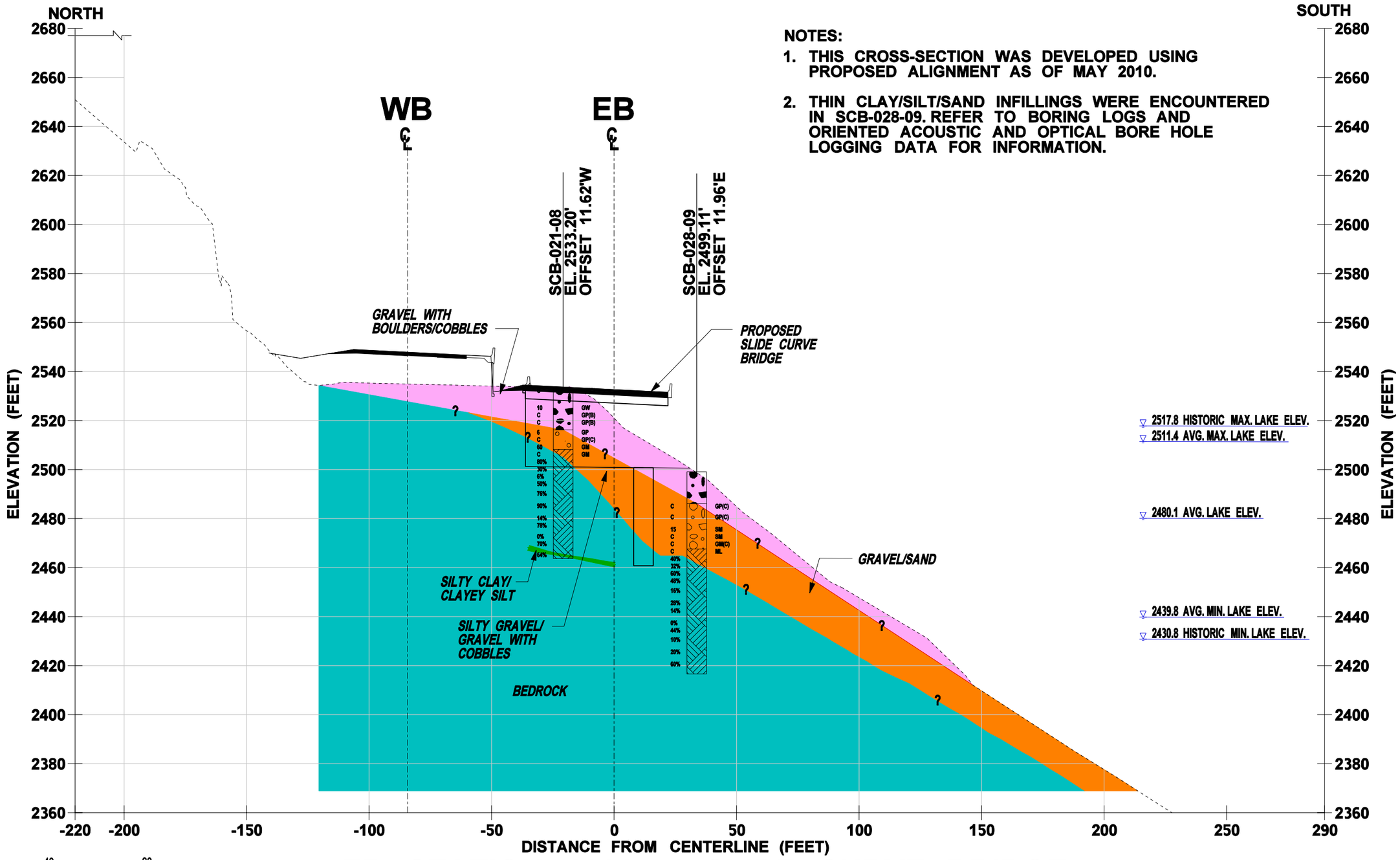
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 6-6'

FIGURE 7.8

NOTES:

1. THIS CROSS-SECTION WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. THIN CLAY/SILT/SAND INFILLINGS WERE ENCOUNTERED IN SCB-028-09. REFER TO BORING LOGS AND ORIENTED ACOUSTIC AND OPTICAL BORE HOLE LOGGING DATA FOR INFORMATION.



0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

EB STATION 1382+40 SLIDE CURVE BRIDGE

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
PROJ. MNGR.	Cecil Urlich

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I-90 Snoqualmie Pass East
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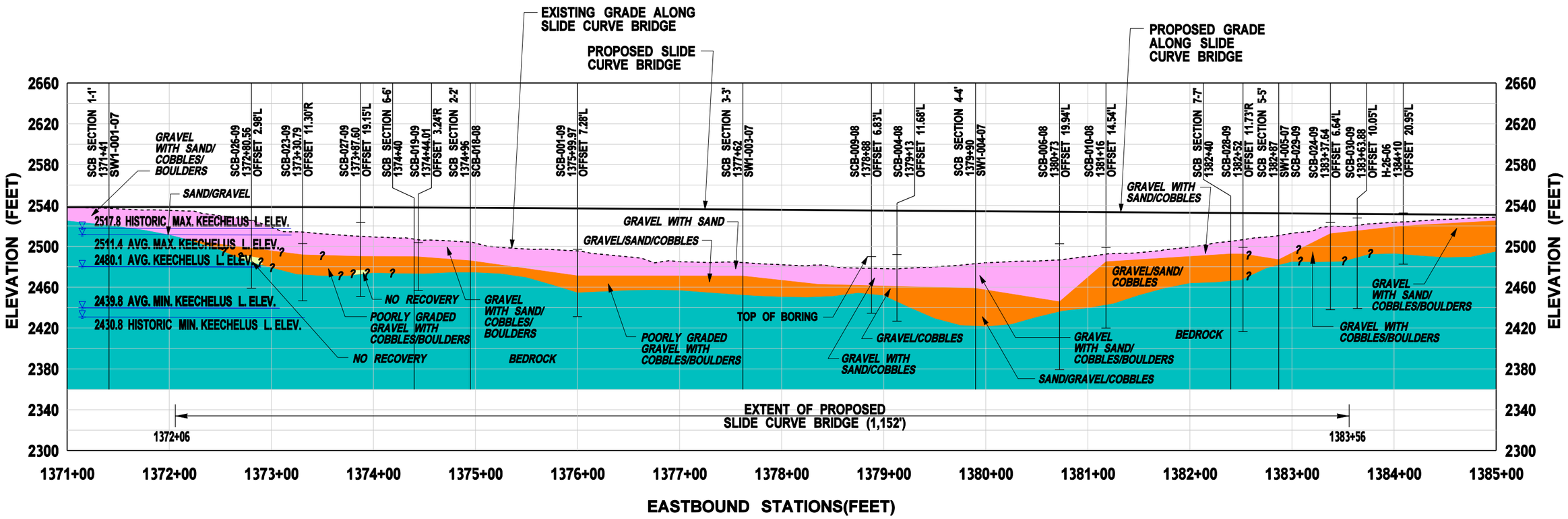
SLIDE CURVE BRIDGE (SCB) - CROSS-SECTION 7-7'

FIGURE 7.9



NOTES:

1. THIS PROFILE WAS DEVELOPED ALONG THE SOUTH EDGE OF SLIDE CURVE BRIDGE USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. CLAY/SILT/SAND INFILLINGS WERE ENCOUNTERED WITHIN BEDROCK IN SEVERAL BORINGS ALONG THE PROFILE. REFER TO BORING LOGS AND ORIENTED OPTICAL AND ACOUSTIC BOREHOLE LOGGING DATA FOR INFORMATION.

0 100 200
HORIZONTAL SCALE 1"=100'
VERTICAL EXAGGERATION = 1x

FILE NAME	\\seaocean\163\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Slide Curve Bridge (SCB)\SLIDE CURVE BRIDGE PROFILE_EB OUTSIDE-BRIDGE.dgn						
TIME	2:12:13 PM						
DATE	10/8/2010						
DESIGNED BY	Kranti Maturi						
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker						
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.
JOB NUMBER 33758623
CONTRACT NO. Y-9764
LOCATION NO.
P.E. STAMP BOX DATE

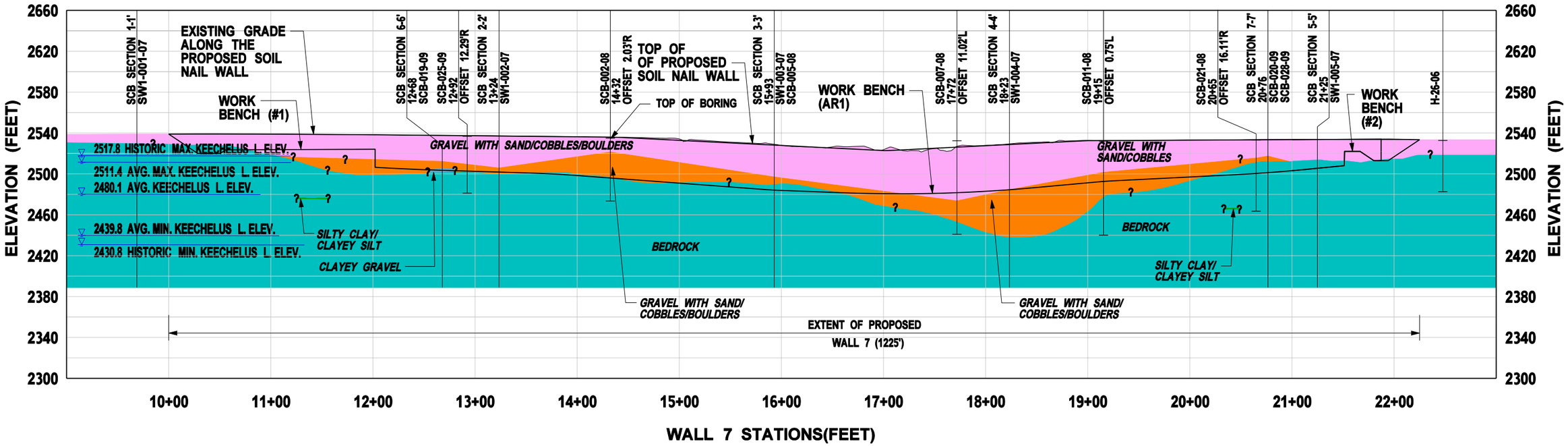
URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State Department of Transportation

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

SLIDE CURVE BRIDGE - STRUCTURE (STR) SUBSURFACE PROFILE

FIGURE 7.10



NOTES:

1. THIS PROFILE WAS DEVELOPED USING PROPOSED WALL 7 ALIGNMENT AS OF AUGUST 2010.
2. CLAY/SILT/SAND INFILLINGS WERE ENCOUNTERED WITHIN BEDROCK IN SEVERAL BORINGS ALONG THE PROFILE. REFER TO BORING LOGS AND ORIENTED OPTICAL AND ACOUSTIC BOREHOLE LOGGING DATA FOR INFORMATION.

0 100 200
HORIZONTAL SCALE 1"=100'
VERTICAL EXAGGERATION = 1x

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DATE	10/8/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

P.E. STAMP BOX | DATE

URS
CENTURY SQUARE
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Washington State Department of Transportation

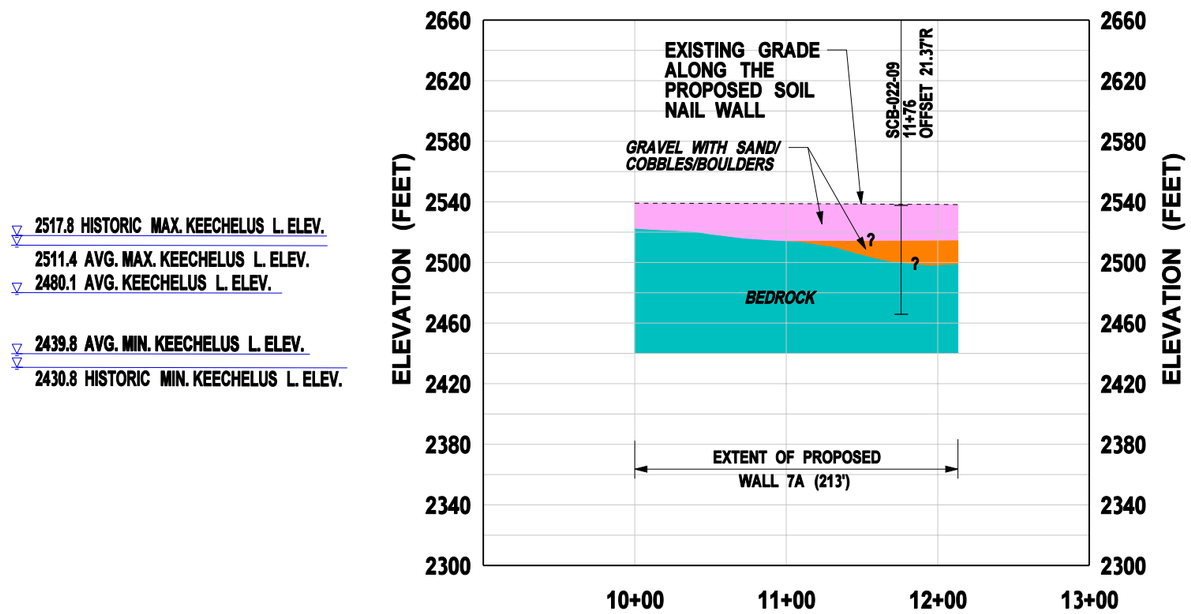
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

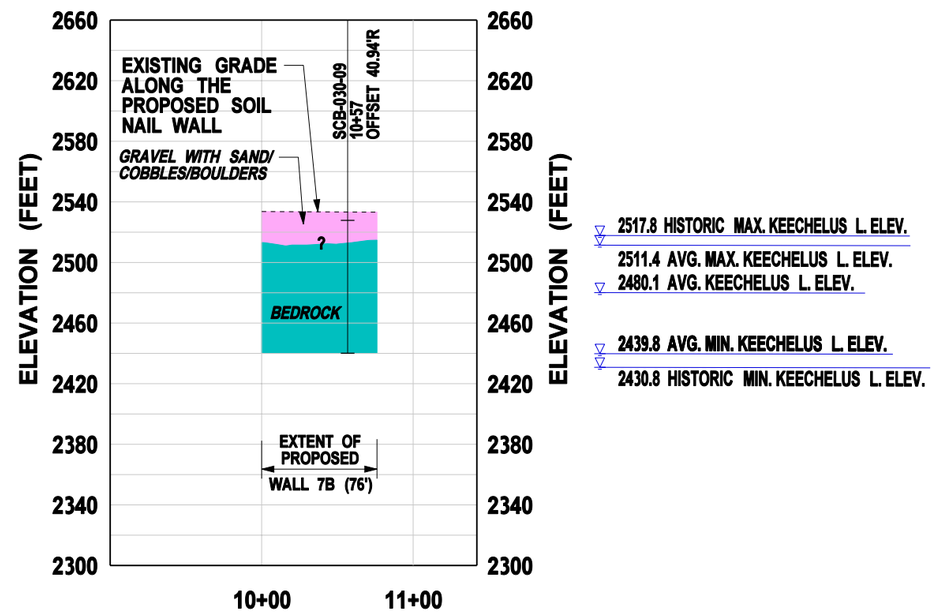
SLIDE CURVE BRIDGE - SOIL NAIL WALL (SNW) 7 SUBSURFACE PROFILE

FIGURE 7.11

NOTES:

1. THESE PROFILES WERE DEVELOPED USING PROPOSED WALL 7A AND WALL 7B ALIGNMENTS AS OF AUGUST 2010.





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DATE	10/8/2010						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker				CONTRACT NO. Y-9764	LOCATION NO.	
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

P.E. STAMP BOX DATE

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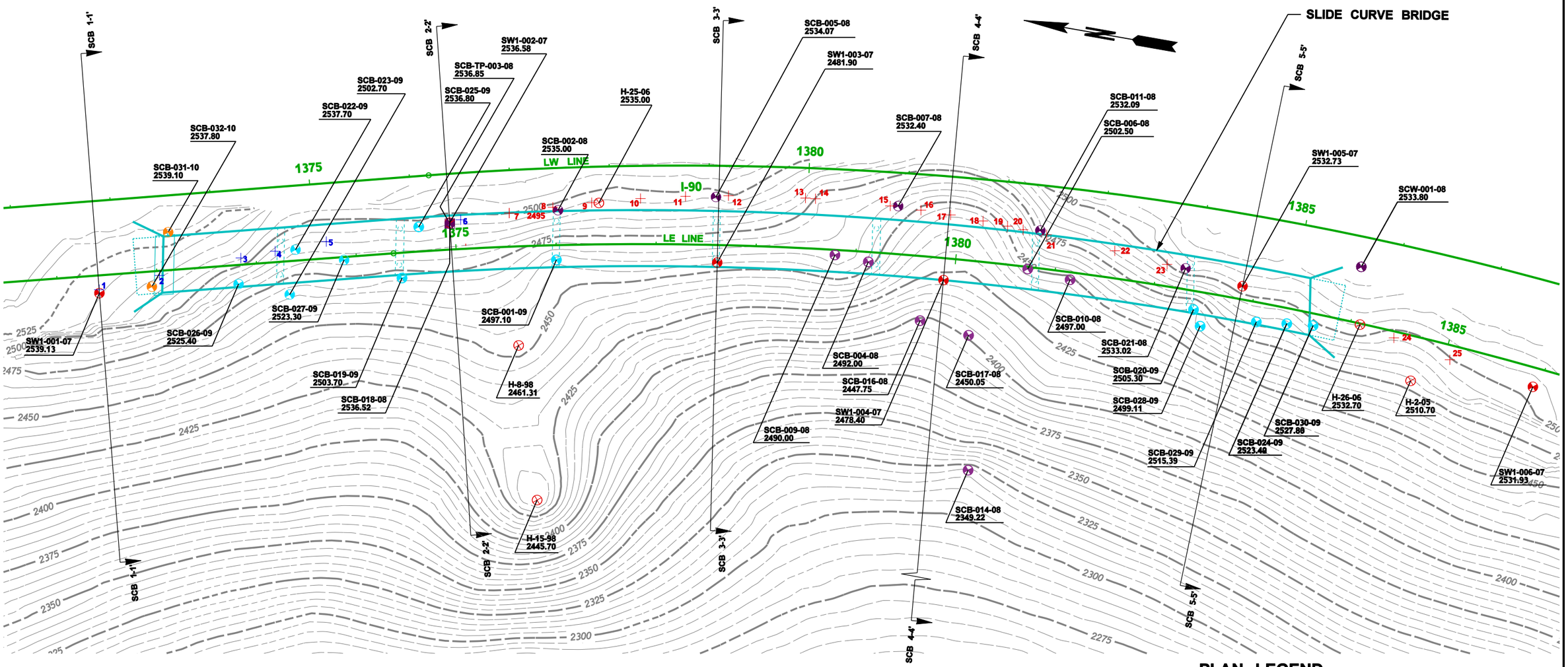
FAX: (206) 438-2699

Washington State Department of Transportation

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

SLIDE CURVE BRIDGE - SOIL NAIL WALLS (SNW) 7A & 7B SUBSURFACE PROFILE

FIGURE 7.12



PLAN LEGEND

- PREVIOUS BORINGS
- 2010 BORINGS
- 2009 BORINGS
- 2009 TEST PITS
- 2008 BORINGS
- 2007 BORINGS
- 2008 TEST PITS
- 10 GEOPHYSICAL SURVEY POINT

SCB-030-09 - BORING DESIGNATION
2527.83 - GROUND SURFACE ELEVATION IN FEET

CONTOUR INTERVAL = 5'

0 50 100
SCALE IN FEET

FILE NAME	K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2011\Sheet Files\Slide Curve Bridge (SCB)\Bedrock Contours\Fig_7.13_Bedrock_Elevations.dgn
TIME	10:04:19 AM
DATE	1/24/2011
DESIGNED BY	
ENTERED BY	brenda_mcintosh
CHECKED BY	
ASST. PROJ. MNGR.	
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER 10Y018		
CONTRACT NO.		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
SNOWSHED TO KEECHELUS DAM PHASE 1C-
REPLACE SNOWSHED AND ADD LANES

SLIDE CURVE BRIDGE BEDROCK CONTOURS

FIGURE 7.13

33758662_28.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.

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

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing walls within a distance H_1 of the abutment wall, may be calculated using the equations and values below.

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

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, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.22
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	4.6

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.

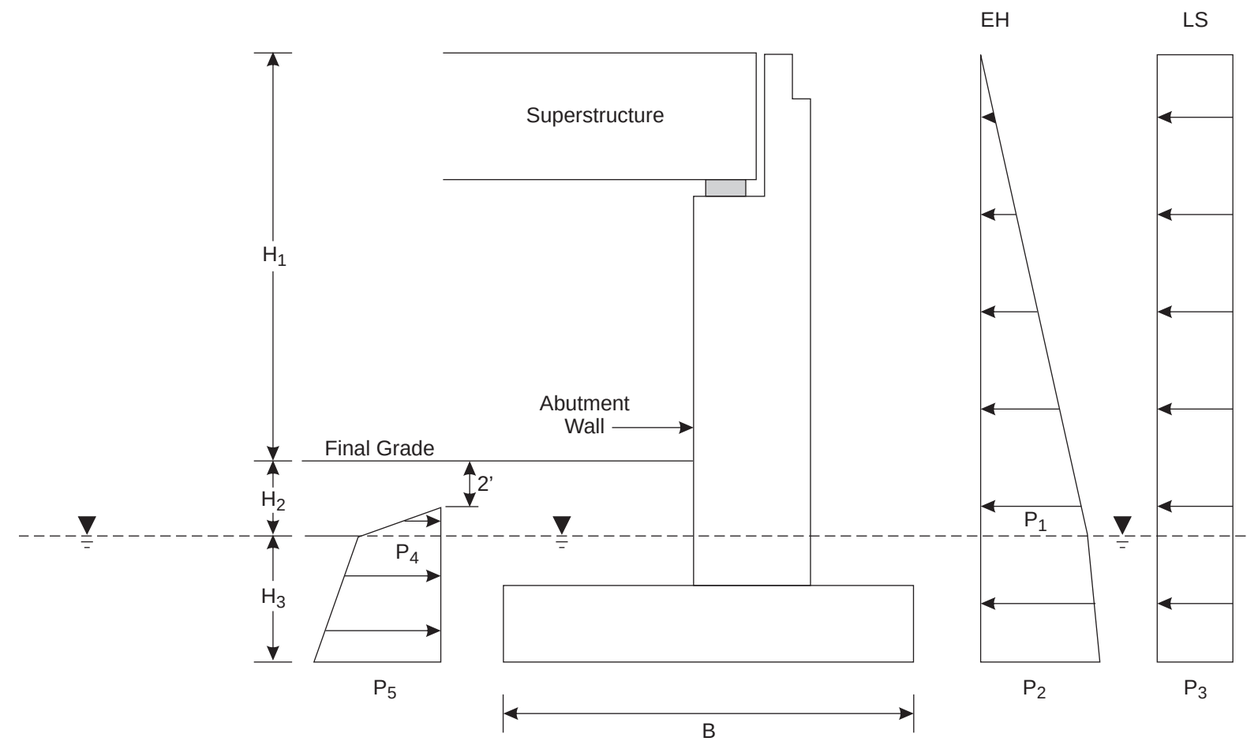


Figure 7.14
Strength Limit State Earth Pressures
Slide Curve Bridge - Pier 1 Abutment

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

33758662_29.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.

$P_1 = 0.5K_{ae(f)}ã(H_1 + H_2 + H_3)$
$P_2 = K_{ae(f)}ã_{EQ}(ãh_{eq})$
$P_3 = K_{pe(f)}ã(H_2 - 2)$
$P_4 = K_{pe(f)}ã(H_2 - 2) + K_{pe(f)}ã'H_3$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing wall within a distance H_1 of the abutment wall, may be calculated using the equations and values below.

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

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, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.22
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 Passive Earth Pressure Coefficient, $K_{pe(f)}$, for Level Finish Ground Line and Flexible Wall	unitless	4.21
Seismic Active Earth Pressure Coefficient for Flexible Retaining Walls, $K_{ae(f)}$	unitless	0.31
Seismic Active Earth Pressure Coefficient for Rigid Retaining Walls, $K_{ae(r)}$	unitless	0.63
Seismic Passive Earth Pressure Coefficient for Level Finish Ground and Rigid Walls, $K_{pe(r)}$	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.

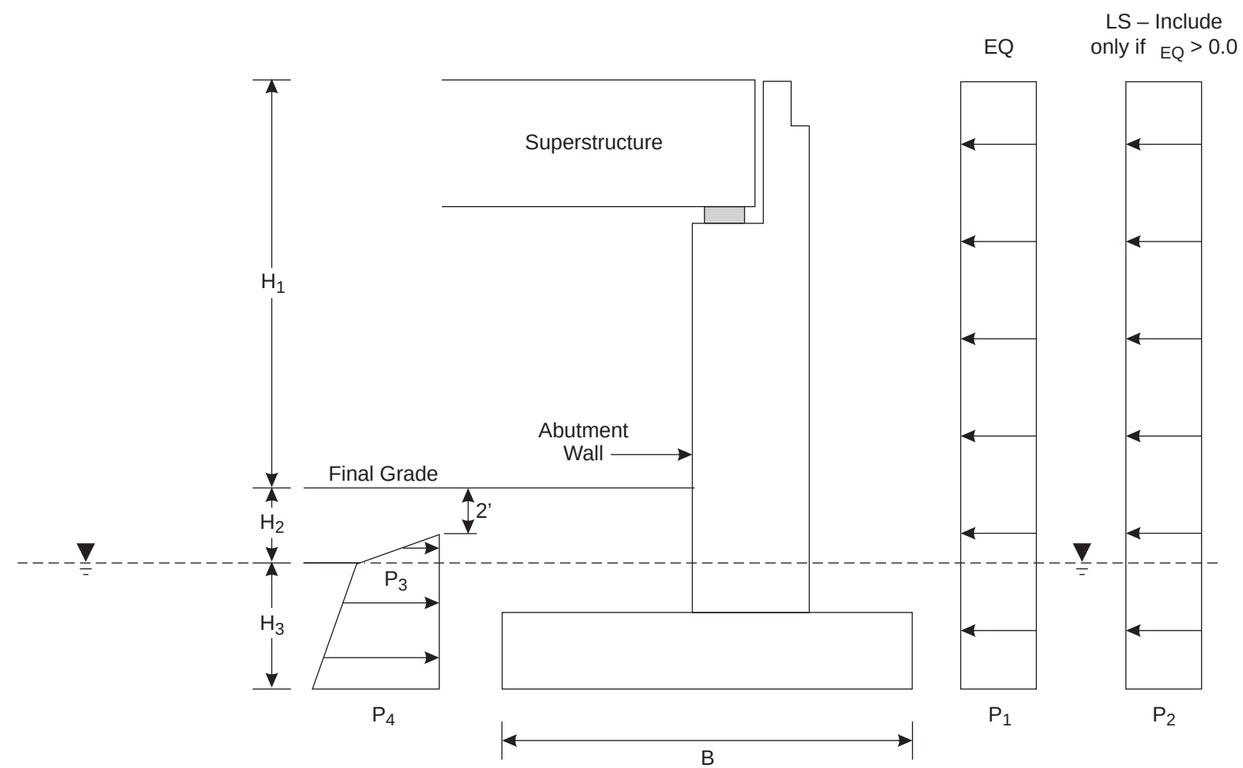

Figure 7.15
Extreme Event I Limit State Earth Pressures
Slide Curve Bridge - Pier 1 Abutment

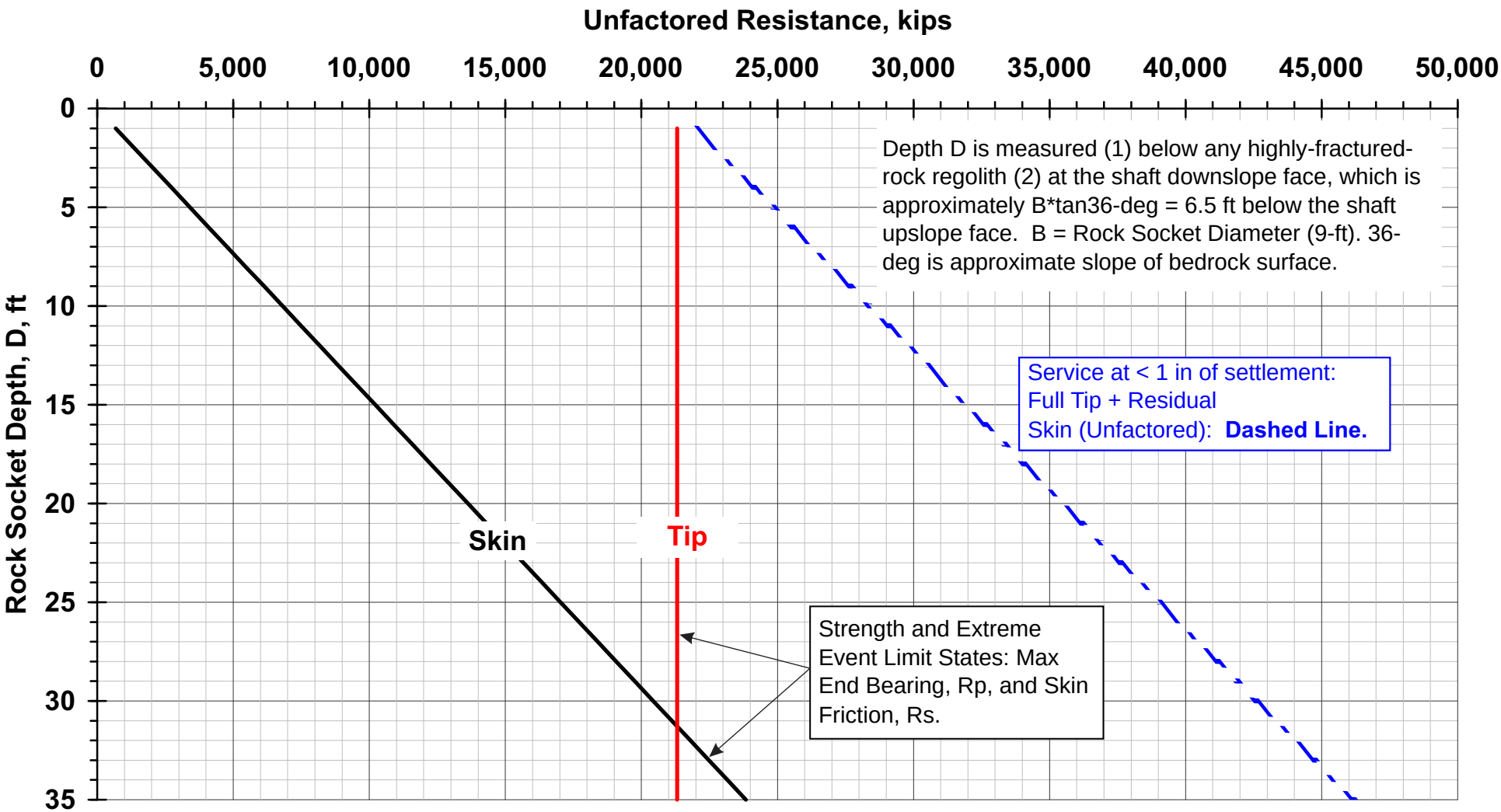

Figure 7.16

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 2

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

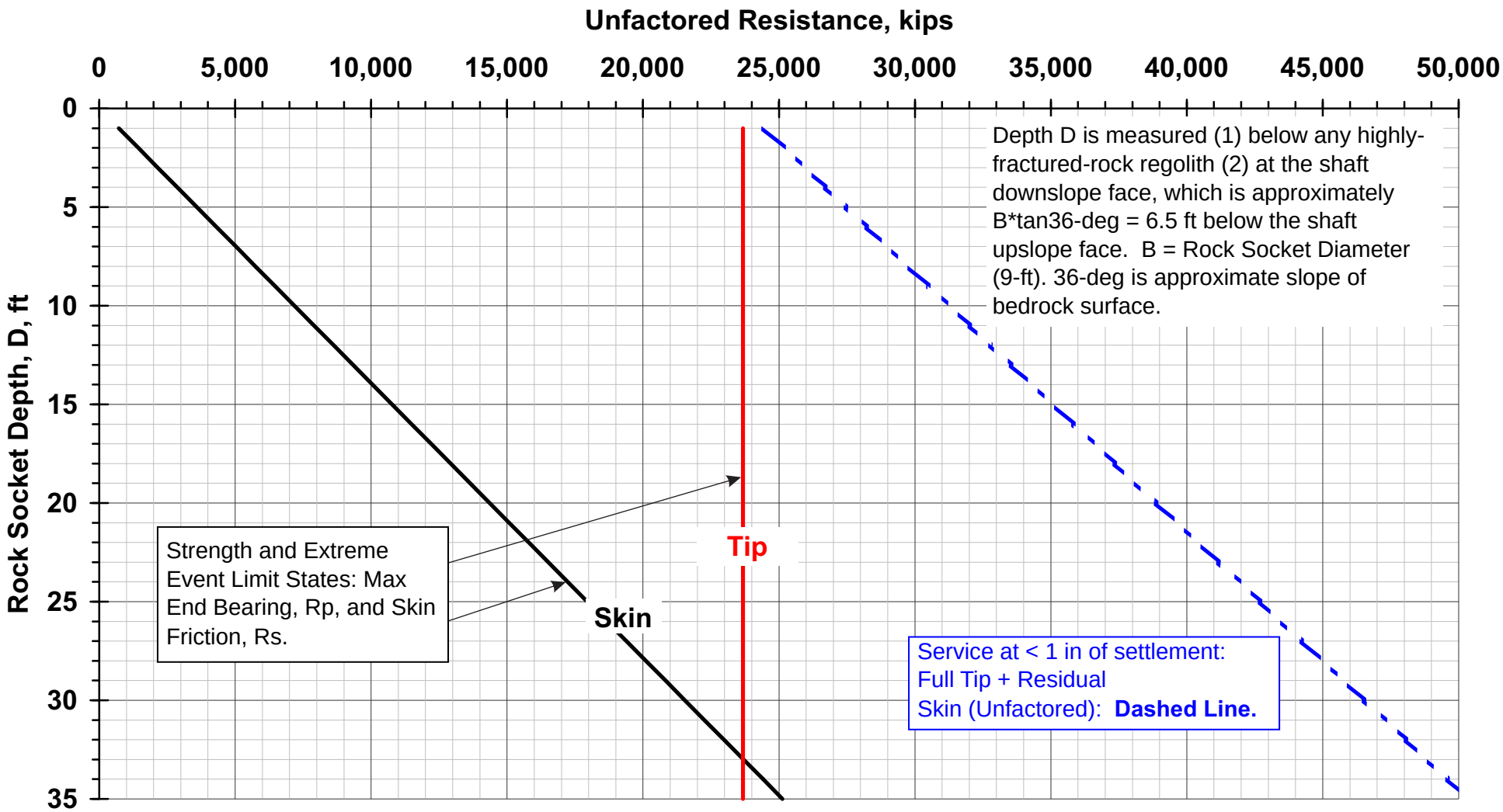

Figure 7.17

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Piers 3 and 4 (Inner)

Job No. 33758662

URS

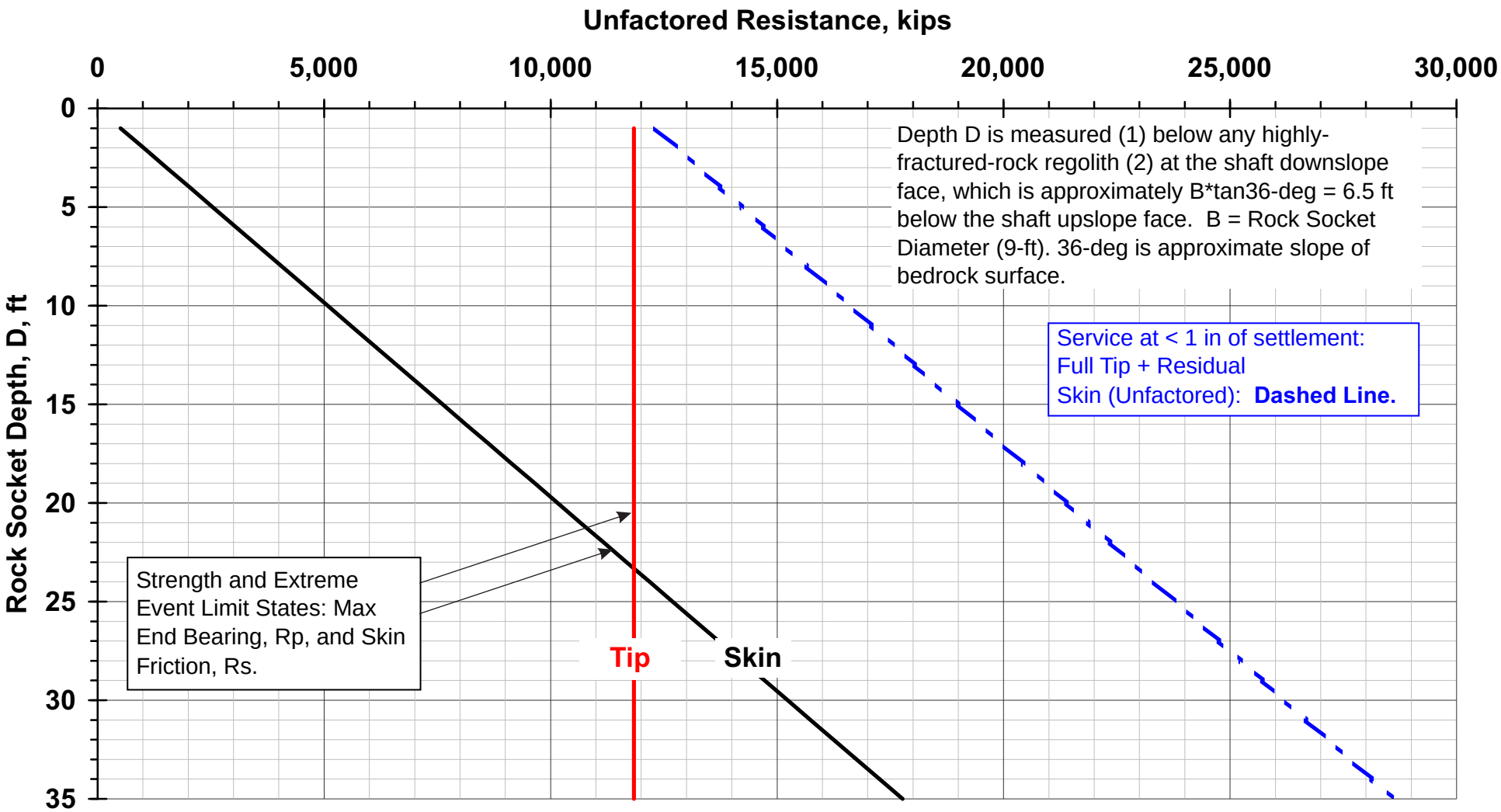

Figure 7.18

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 4 (Outer)

Job No. 33758662

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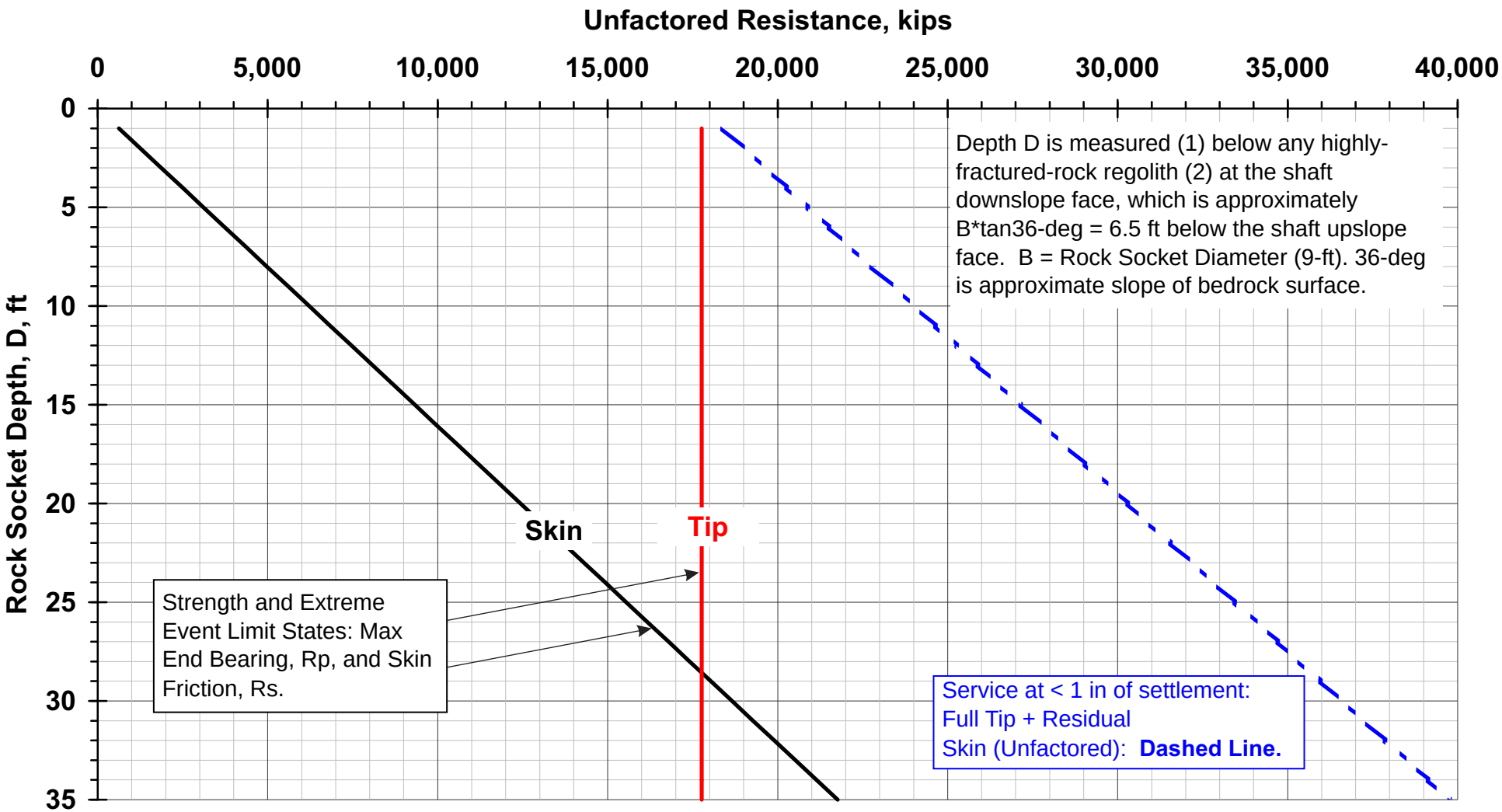

Figure 7.19

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 5

Job No. 33758662

URS

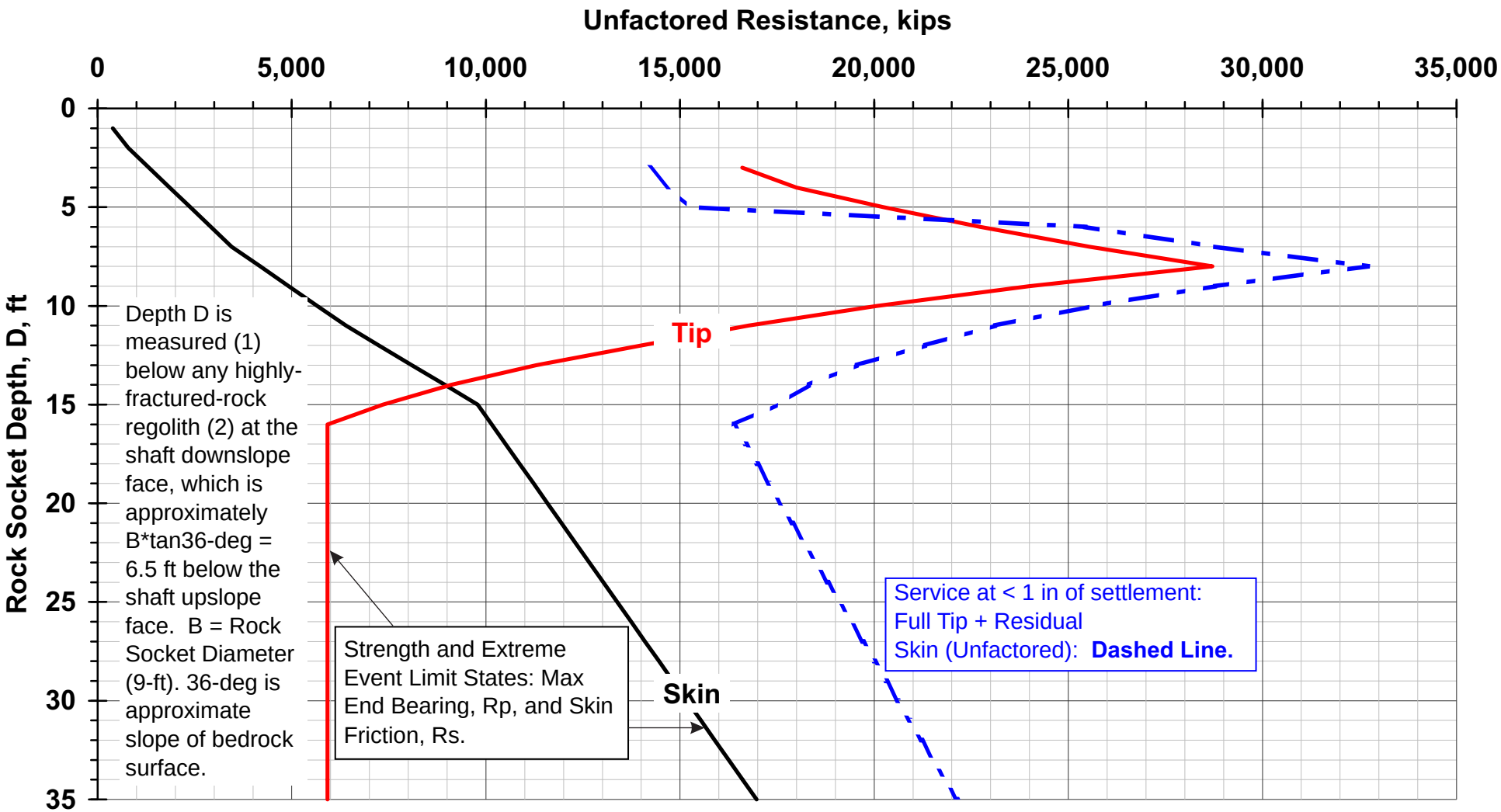

Figure 7.20

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 6

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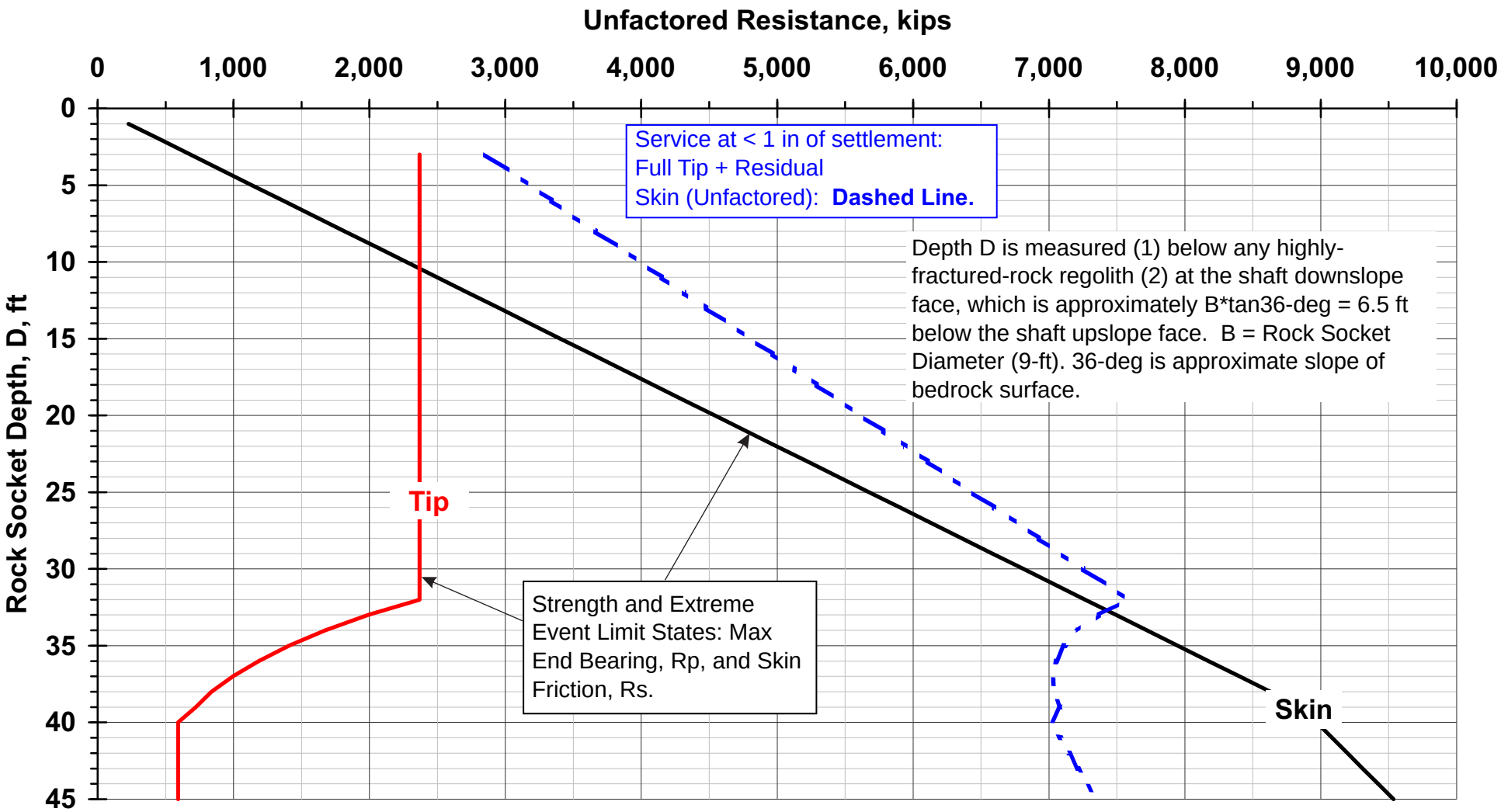

Figure 7.21

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 7

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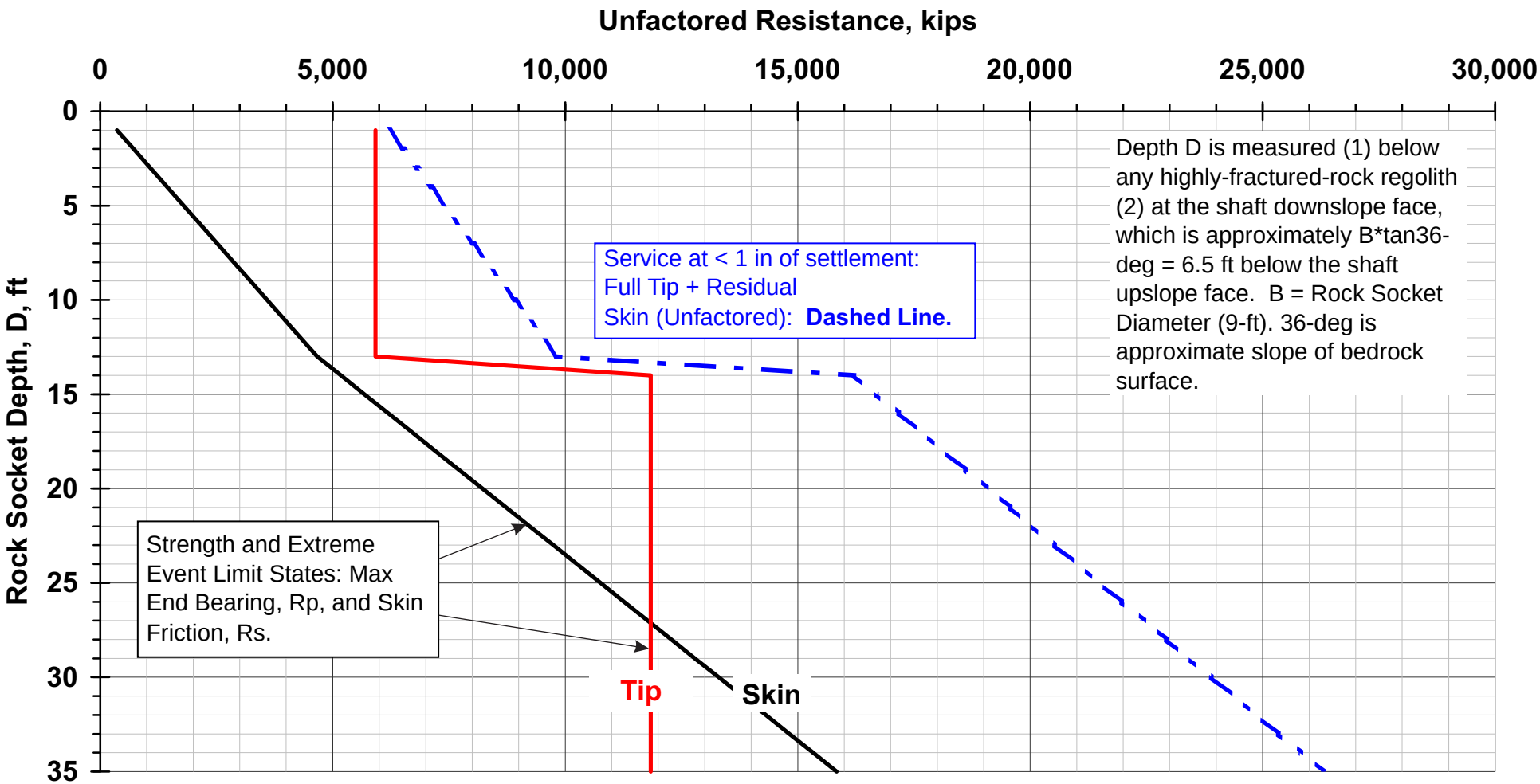

Figure 7.22

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 8

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

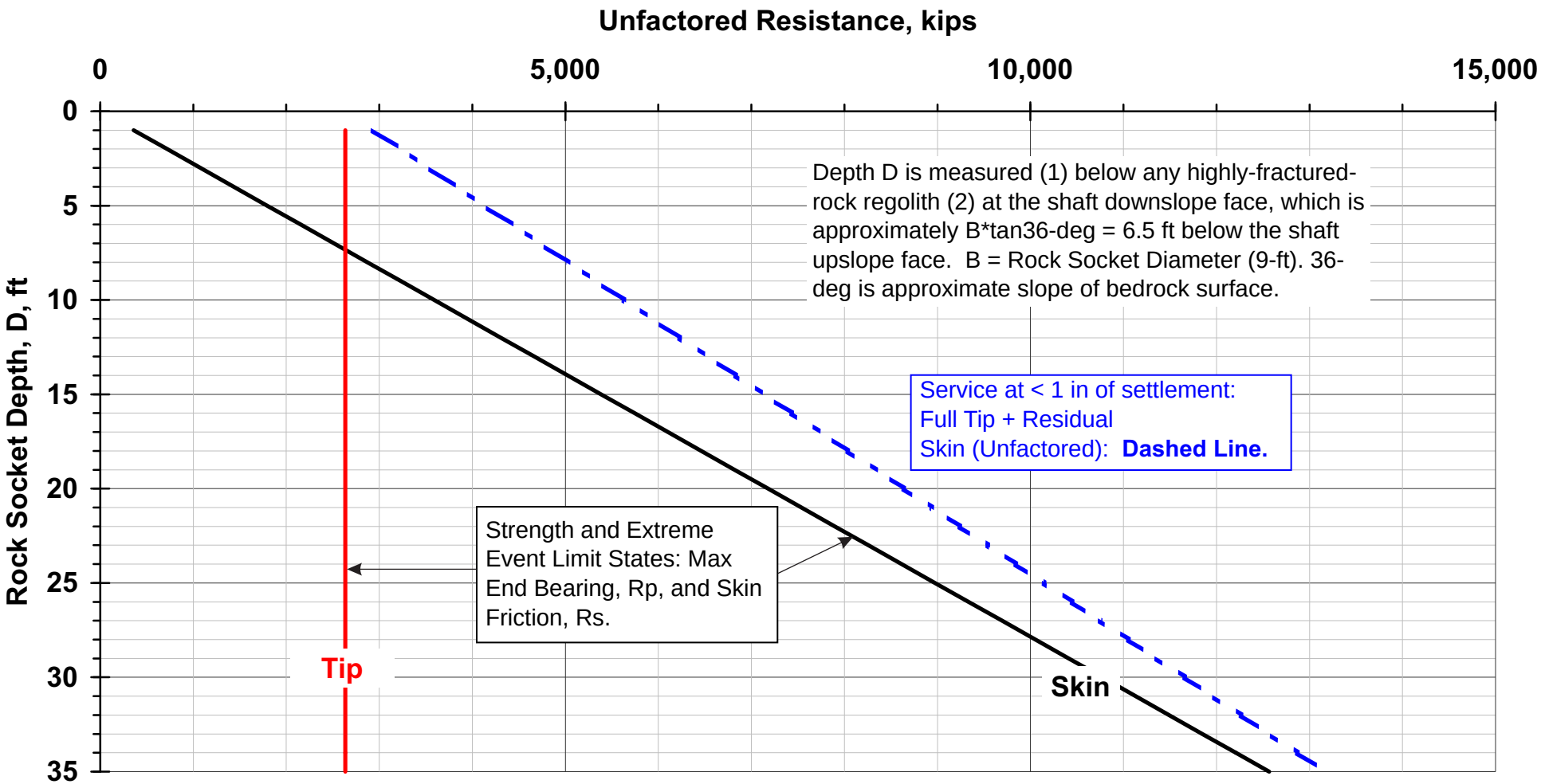


Figure 7.23

Unfactored Bearing Resistance
9-ft Diameter Rock Socket
Slide Curve Bridge Pier 9

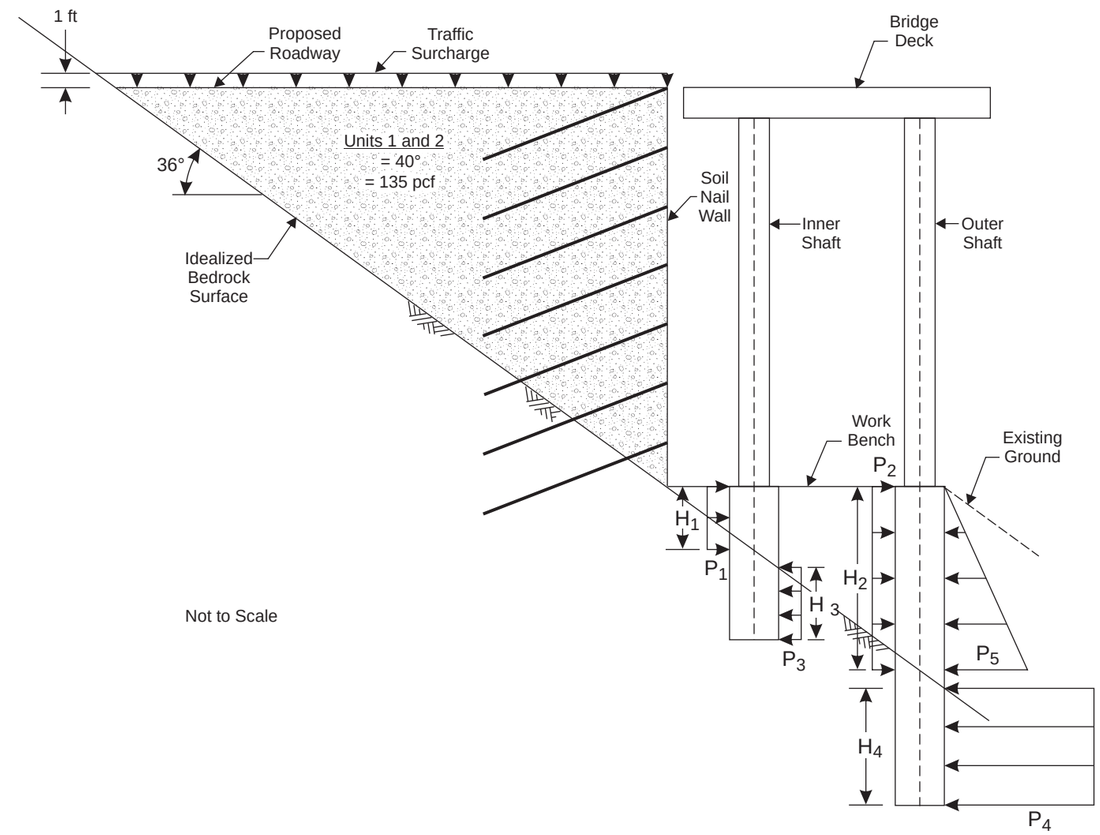
Job No. 33758662

URS

33758662_23.cdr

Lateral Loads on SCB Bridge Pier Shafts

Pier No	EB Station	Workbench El. (ft)	Deck El. (ft)	Recommended Bedrock El. @ Inner Bridge Shaft (ft) (Note 2)	Recommended Bedrock El. @ Outer Bridge Shaft (ft) (Note 2)	Upslope Horizontal Load (L_1) @ Inner Bridge Shaft, kips/ft	Upslope Horizontal Load (L_2) @ Outer Bridge Shaft, kips/ft	Downslope Resistance (P_{ae}) @ Outer Bridge Shaft, kips/ft
2	1373+24	2510	2538	2487	2471	50	91	6.3
3	1374+43.5	2503	2538	2490	2473	3.9	21.6	3.9
4	1376+00	2496	2537	2482	2453	4.4	42.5	7.7
5	1377+60	2484	2536	2477	2454	1.0	20.4	3.7
6	1379+20	2481	2535	2451	2443	17.9	33.1	6.0
7	1380+80	2492	2534	2460	2439	19.8	64.7	11.7
8	1382+36.5	2501	2533	2502	2465	0.6	29.4	5.3
9	1383+58	2512	2532	2500	2488	17	35	2.4



Notes

1. The amount of rock resistance (P_3/P_4) mobilized, the shaft embedment depth (H_3/H_4) will vary depending on the magnitude of the unbalanced earth pressure and structure loads and the depth of the rock socket.

2. Recommended bedrock for design is equal to the estimated bedrock elevation minus 5 feet.

3. $P_1 = L_1 \quad 3B/H_1$, where L_1 can be taken from table above.

4. $P_2 = L_2 \quad 3B/H_2$, where L_2 can be taken from table above.

5. $P_3 = L_R/H_3$, where L_R can be taken from Table 7.10 based on pier number (inner).

6. $P_4 = L_R/H_4$, where L_R can be taken from Table 7.10 based on pier number (outer).

7. $P_5 = P_{ae}/(H_2/2)$.

8. $V_{S1} = 0.64 \quad L_1(\quad B/2)$.

9. $V_{S2} = 0.64 \quad L_2(\quad B/2)$.

B = Shaft diameter in feet.

V_{S1} = Estimated downdrag load at inner bridge shaft.

V_{S2} = Estimated downdrag load at outer bridge shaft.

H_1 = Work bench EL (ft) – estimated bedrock EL at inner bridge shaft (ft)

H_2 = Work bench EL (ft) – estimated bedrock EL at outer bridge shaft (ft)

H_3 = Rock socket depth below downslope shaft face, feet. Minimum H_3 = 10 feet.

H_4 = Rock socket depth below downslope shaft face, feet. Minimum H_4 = 10 feet.

L_R = Lateral resisting force in kips.

Figure 7.24

Lateral Earth Pressures
Slide Curve Bridge Shafts – Extreme Event I Limit State

33758662_30.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.

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

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing walls within a distance H_1 of the abutment wall, may be calculated using the equations and values below.

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

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, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.22
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	4.6

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.

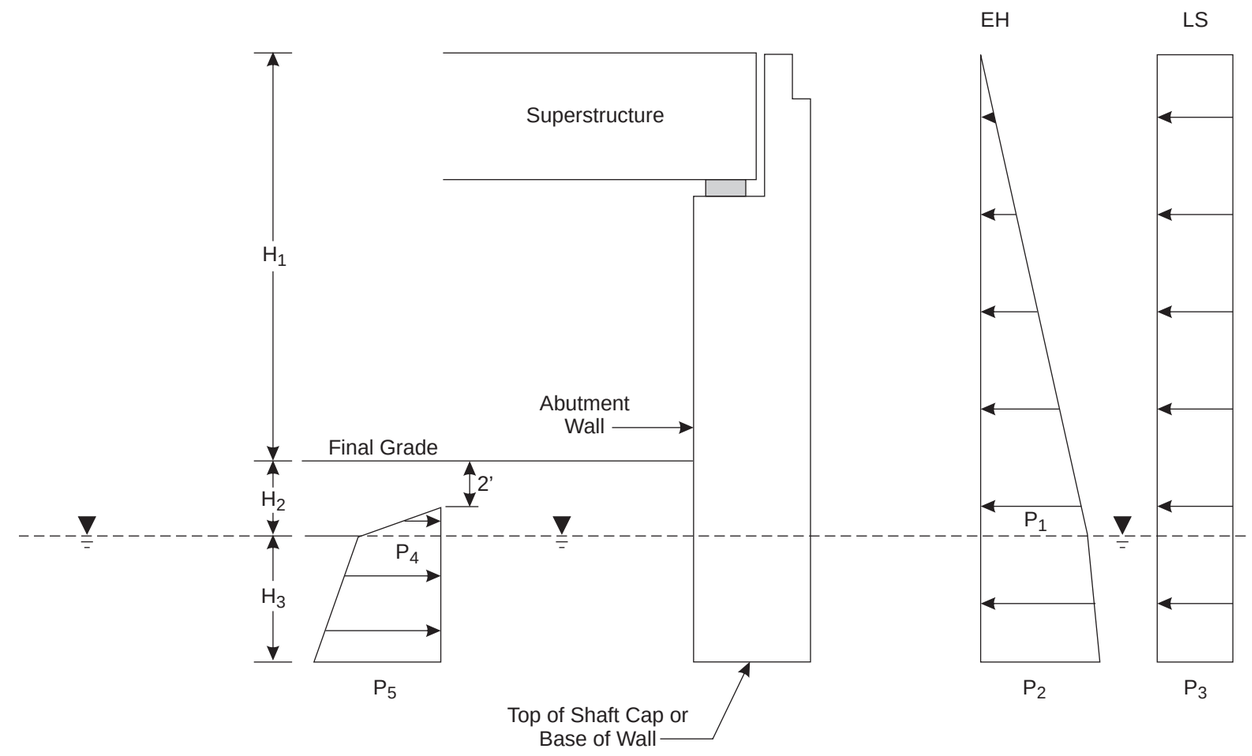


Figure 7.25
Strength Limit State Earth Pressures
Slide Curve Bridge - Pier 9 Abutment

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

33758662_31.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.

$P_1 = 0.5K_{ae(f)}ã(H_1 + H_2 + H_3)$
$P_2 = K_{ae(f)}ã_{EQ}(ãh_{eq})$
$P_3 = K_{pe(f)}ã(H_2 - 2)$
$P_4 = K_{pe(f)}ã(H_2 - 2) + K_{pe(f)}ã'H_3$

Earth pressures in psf for rigid walls that cannot deflect (at-rest pressure conditions), including wing wall within a distance H_1 of the abutment wall, may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(r)}ã(H_1 + H_2 + H_3)$
$P_2 = K_{ae(r)}ã_{EQ}(ãh_{eq})$
$P_3 = K_{pe(r)}ã(H_2 - 2)$
$P_4 = K_{pe(r)}ã(H_2 - 2) + K_{pe(r)}ã'H_3$

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, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	degrees	40
Active Earth Pressure Coefficient, K_a	unitless	0.22
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 Passive Earth Pressure Coefficient, $K_{pe(f)}$, for Level Finish Ground Line and Flexible Wall	unitless	4.21
Seismic Active Earth Pressure Coefficient for Flexible Retaining Walls, $K_{ae(f)}$	unitless	0.31
Seismic Active Earth Pressure Coefficient for Rigid Retaining Walls, $K_{ae(r)}$	unitless	0.63
Seismic Passive Earth Pressure Coefficient for Level Finish Ground and Rigid Walls, $K_{pe(r)}$	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.

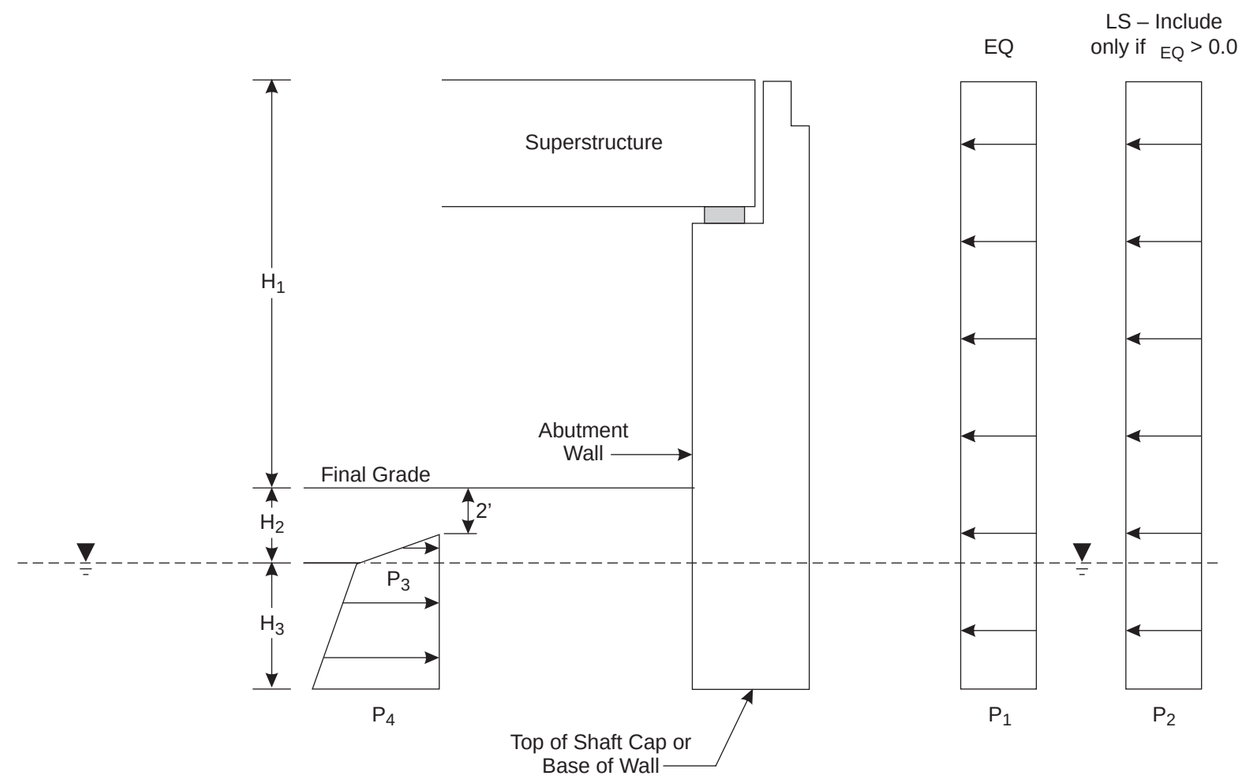

Figure 7.26
Extreme Event I Limit State Earth Pressures
Slide Curve Bridge - Pier 9 Abutment

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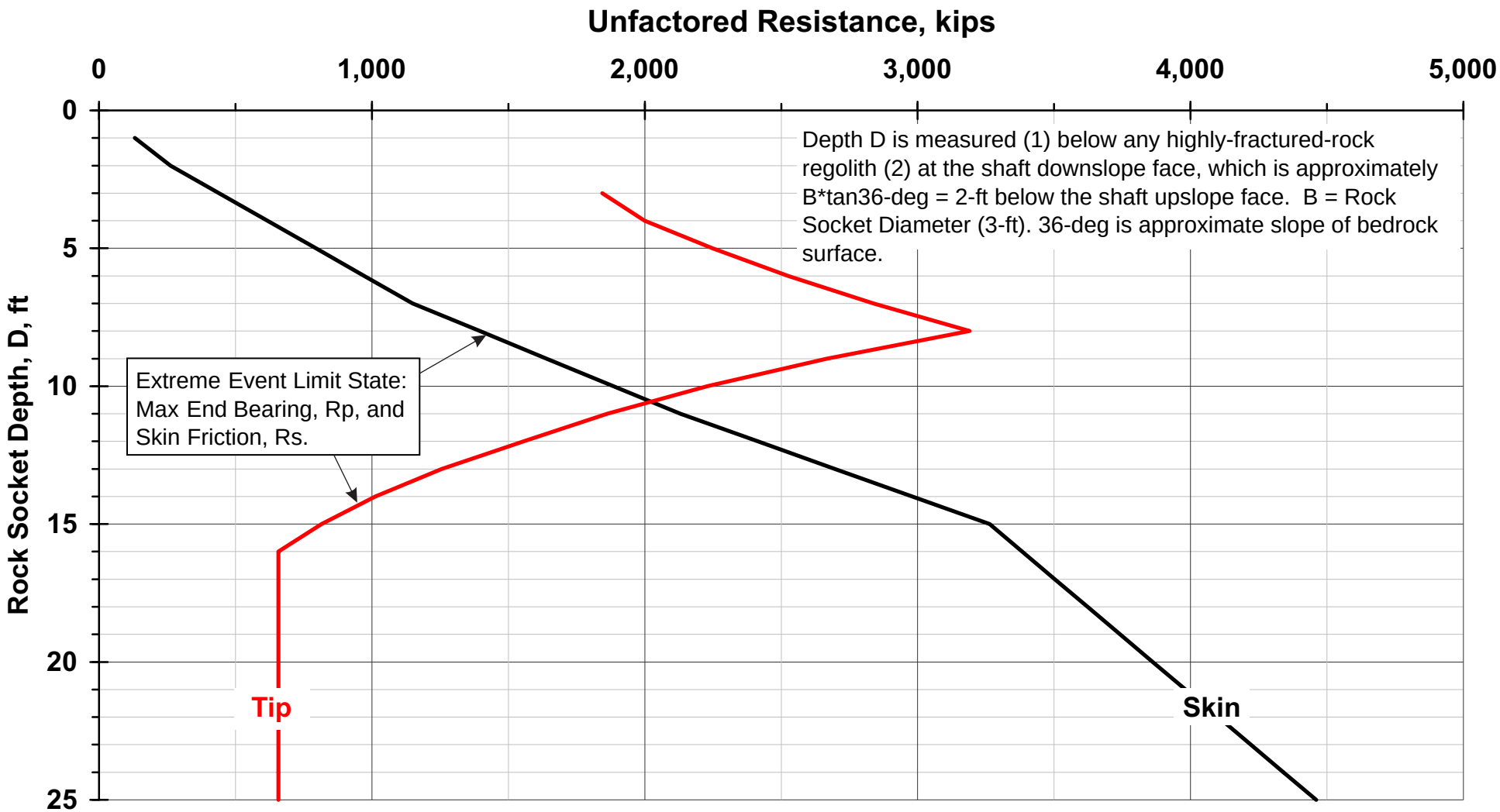

Figure 7.27

Unfactored Bearing Resistance
3-ft Diameter Rock Socket
Slide Curve Bridge Tied-Shaft Wall, West of EB Sta. 1379+20

Job No. 33758662

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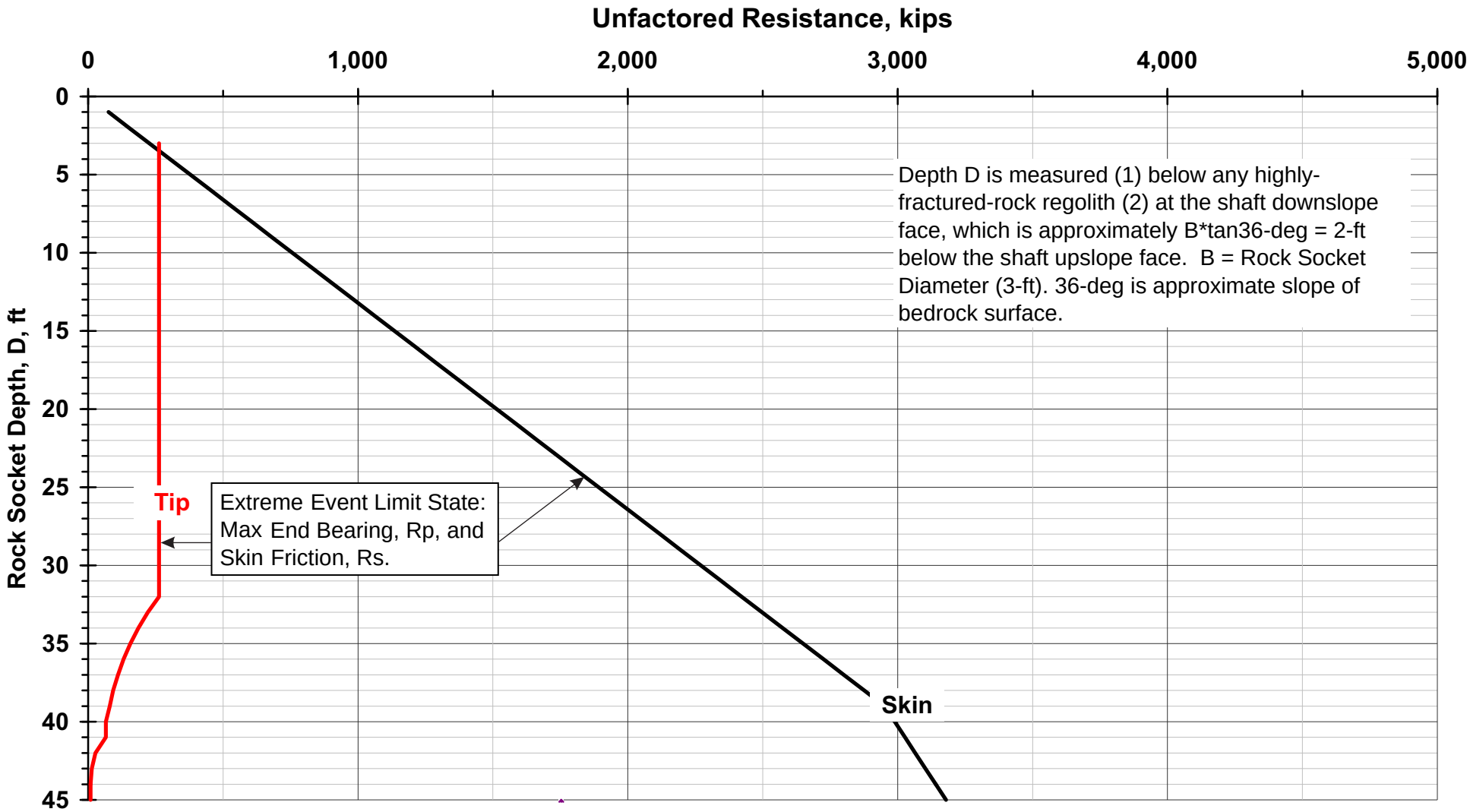

Figure 7.28

Unfactored Bearing Resistance
3-ft Diameter Rock Socket
Slide Curve Bridge Tied-Shaft Wall, East of EB Sta. 1379+20

Job No. 33758662

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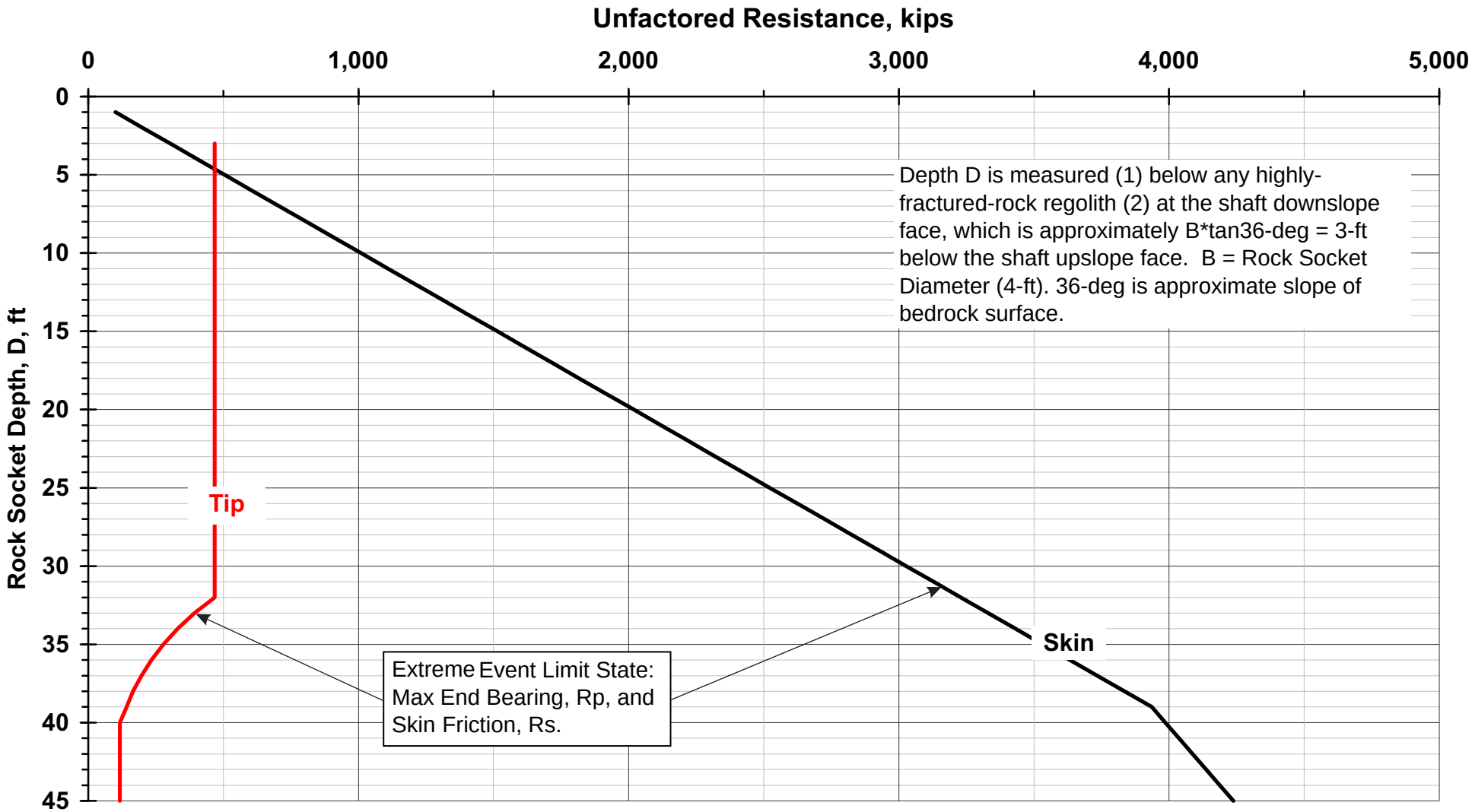

Figure 7.29

Unfactored Bearing Resistance
4-ft Diameter Rock Socket
Slide Curve Bridge Tied-Shaft Wall, East of EB Sta. 1379+20

Job No. 33758662

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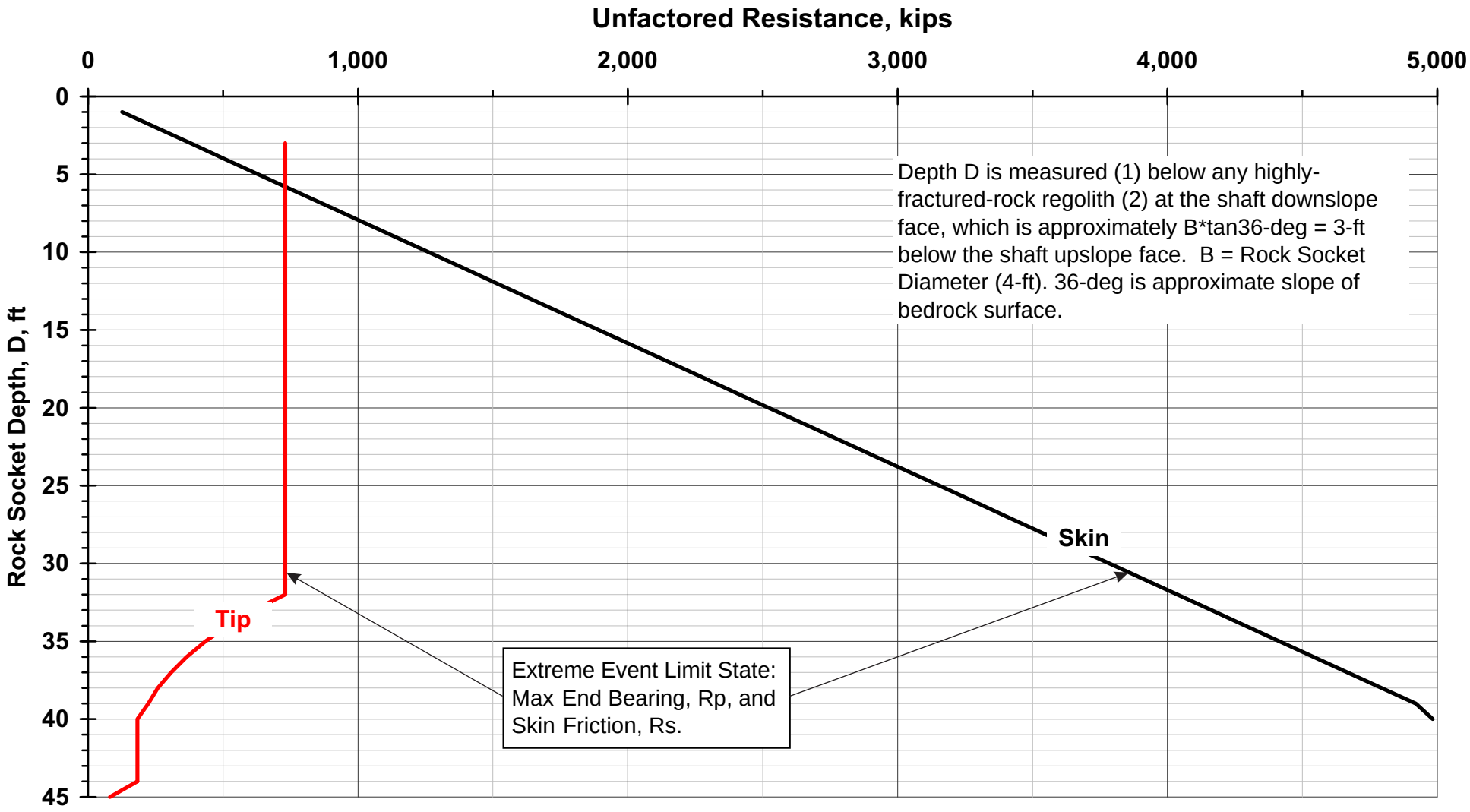

Figure 7.30

Unfactored Bearing Resistance
5-ft Diameter Rock Socket
Slide Curve Bridge Tied-Shaft Wall, East of EB Sta. 1379+20

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33758662_22.cdr

Wall #7 Sta	WB CL EL. (feet)	Workbench EL. (feet)	Bedrock EL. (feet) (Note 2)	H_1, ft	H_2, ft	H_3, ft	H', ft	H, ft
16+69.3	2542.7	2481.7	2476.0	16	45	5.7	62.0	67.7
16+90.6	2542.7	2481.0	2469.6	18.9	42.8	11.3	62.7	74.1
17+18.0	2542.9	2480.6	2465.4	19.9	42.4	15.2	63.3	78.5
17+34.9	2543	2480.6	2462.3	20.7	41.7	18.3	63.4	81.7
17+51.0	2543.2	2481.0	2458.7	18.2	44.0	22.3	63.2	85.5
17+72.9	2543.4	2481.7	2451.2	16.1	45.6	30.5	62.7	93.2
17+98.8	2543.7	2483.0	2441.8	15.8	44.9	41.1	61.7	102.9
18+22.2	2543.9	2484.4	2437.3	14.6	44.9	47.1	60.5	107.6
18+38.5	2544.1	2485.7	2437.0	13.7	44.8	48.7	59.4	108.1
18+54.7	2544.3	2487.1	2439.2	13.3	43.9	48.0	58.2	106.1
18+74.2	2544.6	2488.9	2445.9	12.0	43.7	43.1	56.7	99.7
18+88.3	2544.8	2490.3	2453.1	12.3	42.3	37.1	55.5	92.7
19+01.6	2545	2491.6	2463.1	12.0	41.3	28.5	54.4	82.9
19+16.5	2545.2	2492.7	2475.0	12.6	39.9	17.7	53.5	71.2
19+40.8	2545.5	2494.0	2478.1	13.1	38.4	15.9	52.5	68.4
19+58.6	2545.8	2494.9	2480.5	13.2	37.7	14.4	51.9	66.3
19+72.7	2546	2495.6	2483.7	13.3	37.1	11.9	51.4	63.3
19+86.7	2546.2	2496.3	2487.5	13.3	36.7	8.8	50.9	59.7
20+00.6	2546.5	2497.0	2491.4	13.4	36.1	5.6	50.5	56.1

Notes

1. Linear interpolation can be used for H' and H_3 for shafts located between stations. Do not interpolate values of H. Shaft spacing should not exceed 3B.
2. Estimated bedrock elevation 4 feet in front of wall 7 face.
3. The amount of rock resistance (P_2) mobilized, and the shaft embedment depth (H_4), will vary depending on the magnitude of the unbalanced earth pressure and the depth of the rock socket.
4. $P_1 = L \quad S/H_3$.
5. $P_2 = L_R/H_4$, where L_R can be taken from Table 7.10 based on shaft location and diameter.

   B = Shaft diameter in feet.

   H_4 = Rock socket depth below downslope shaft face, feet. Minimum H_3 = 10 feet.

   L = Lateral force in kips/ft.

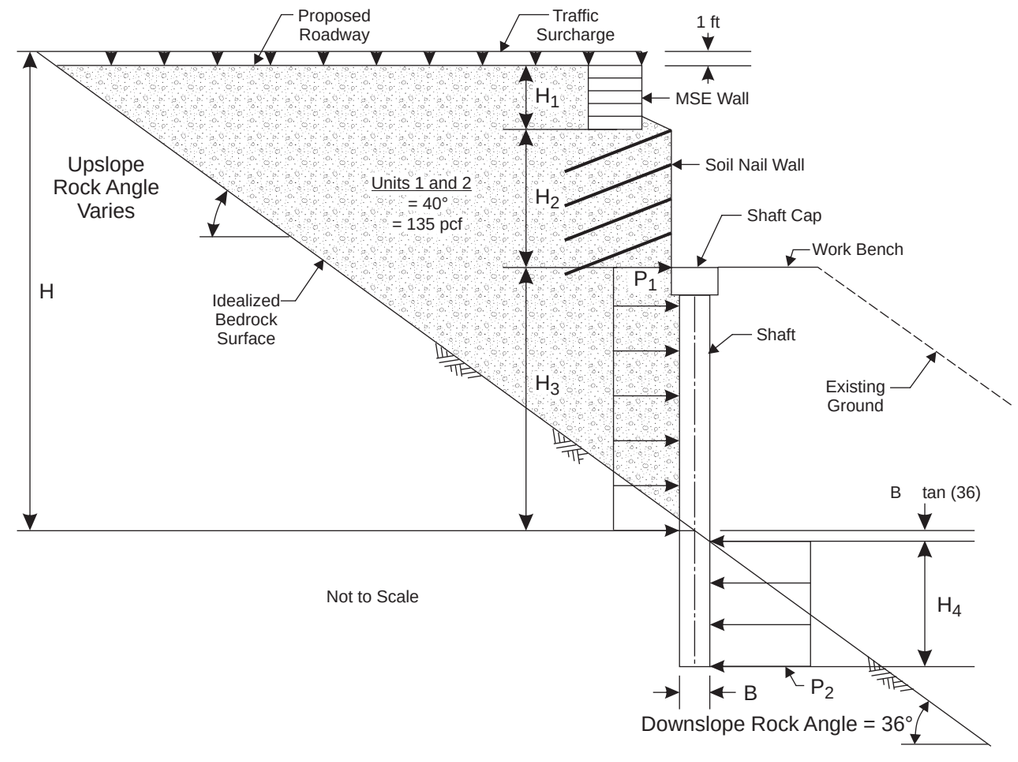
   S = Shaft spacing in feet.

   L_R = Lateral resisting force in kips.

   CL: Centerline.

   H' = $H_1 + H_2 + 1$.

   H = $H' + H_3$.
6. Downdrag loads, V_S, can be calculated as $V_S = 0.64\ L \quad (B/2)$



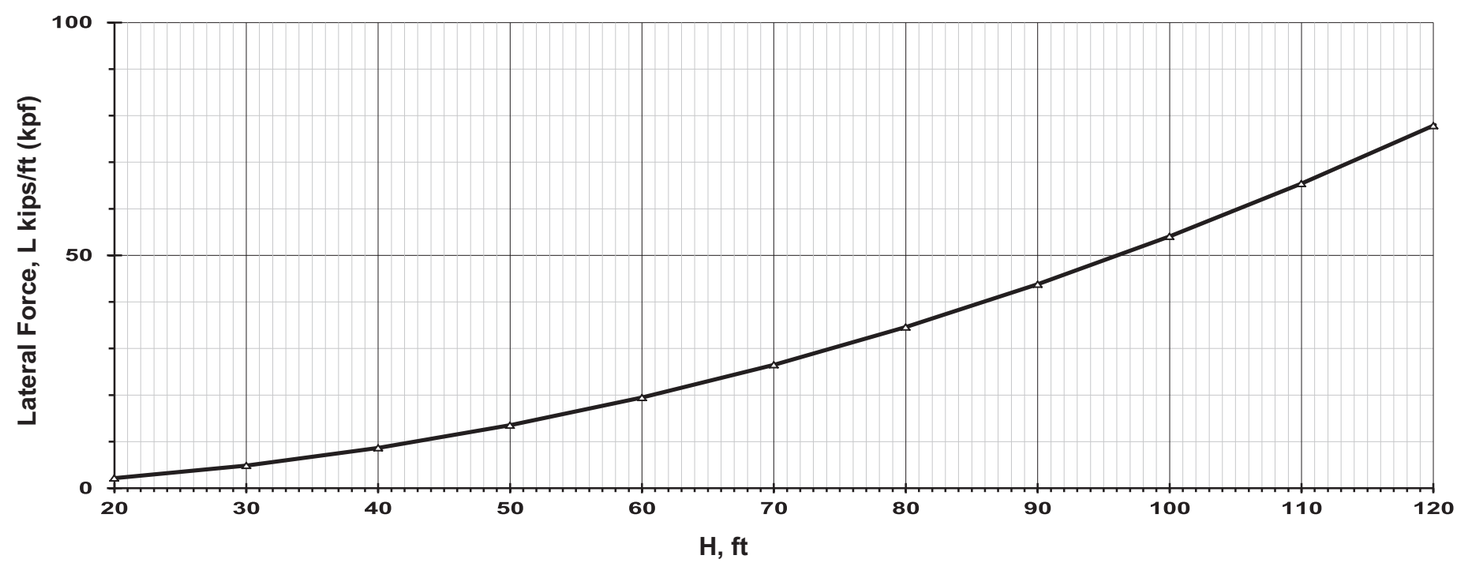
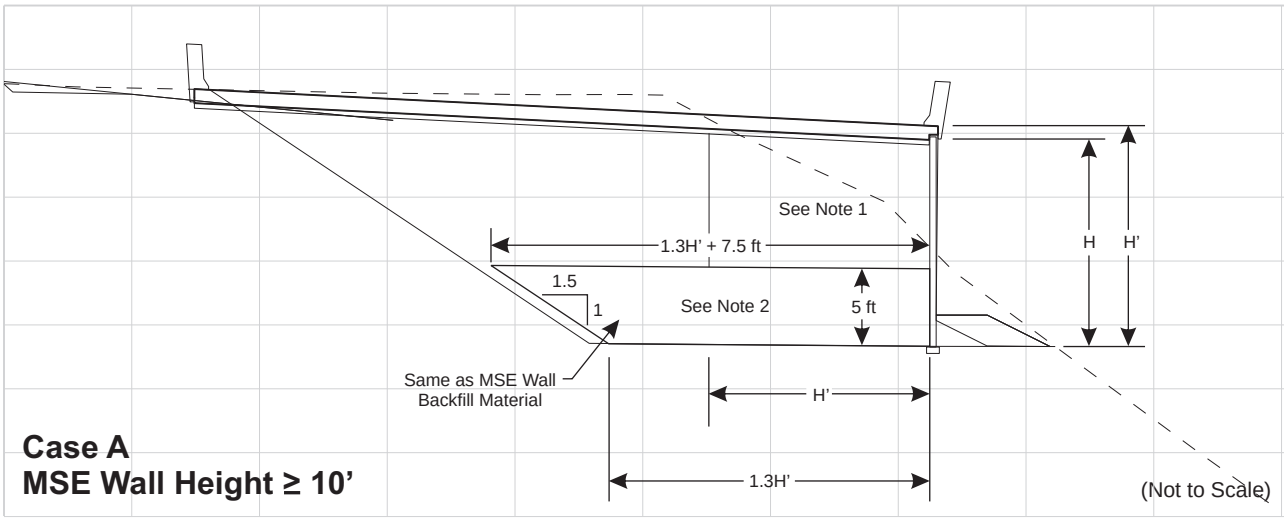


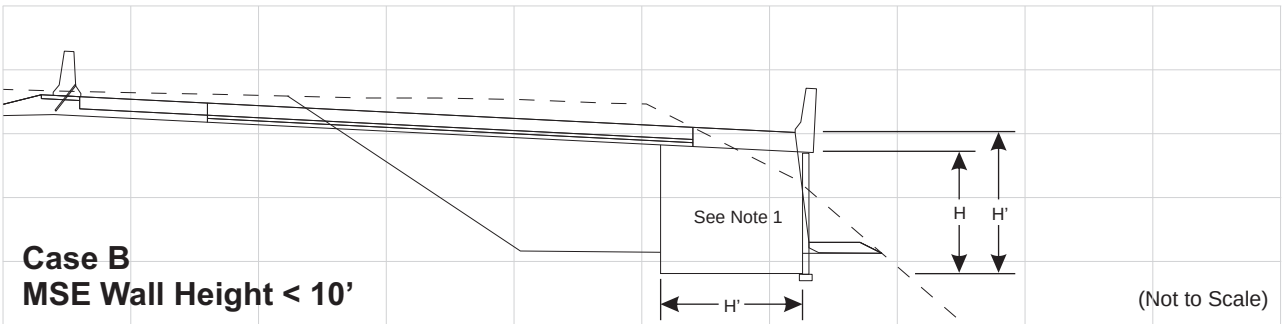
Figure 7.31

Lateral Earth Pressures

Slide Curve Bridge Tied Shafts – Extreme Event I Limit State

33758662_06.cdr





NOTES

(1) MSE wall designer must design reinforcement in remaining wall area and internal stability for full wall area.

(2) Long-term combined tensile strength of reinforcement layers ≥ 15,000 lbs/ft. Minimum of 6 reinforcement layers. Minimum height of extended reinforcement zone = 5 ft. Uppermost reinforcement layer must be no less than 5 feet above bottom reinforcement layer. Each reinforcement wrap must be designed to provide ≥ 2,500 lbs/ft of pullout resistance.

Figure 7.32

Slide Curve Bridge Approach Fills
MSE Wall Recommendations

Job No. 33758662

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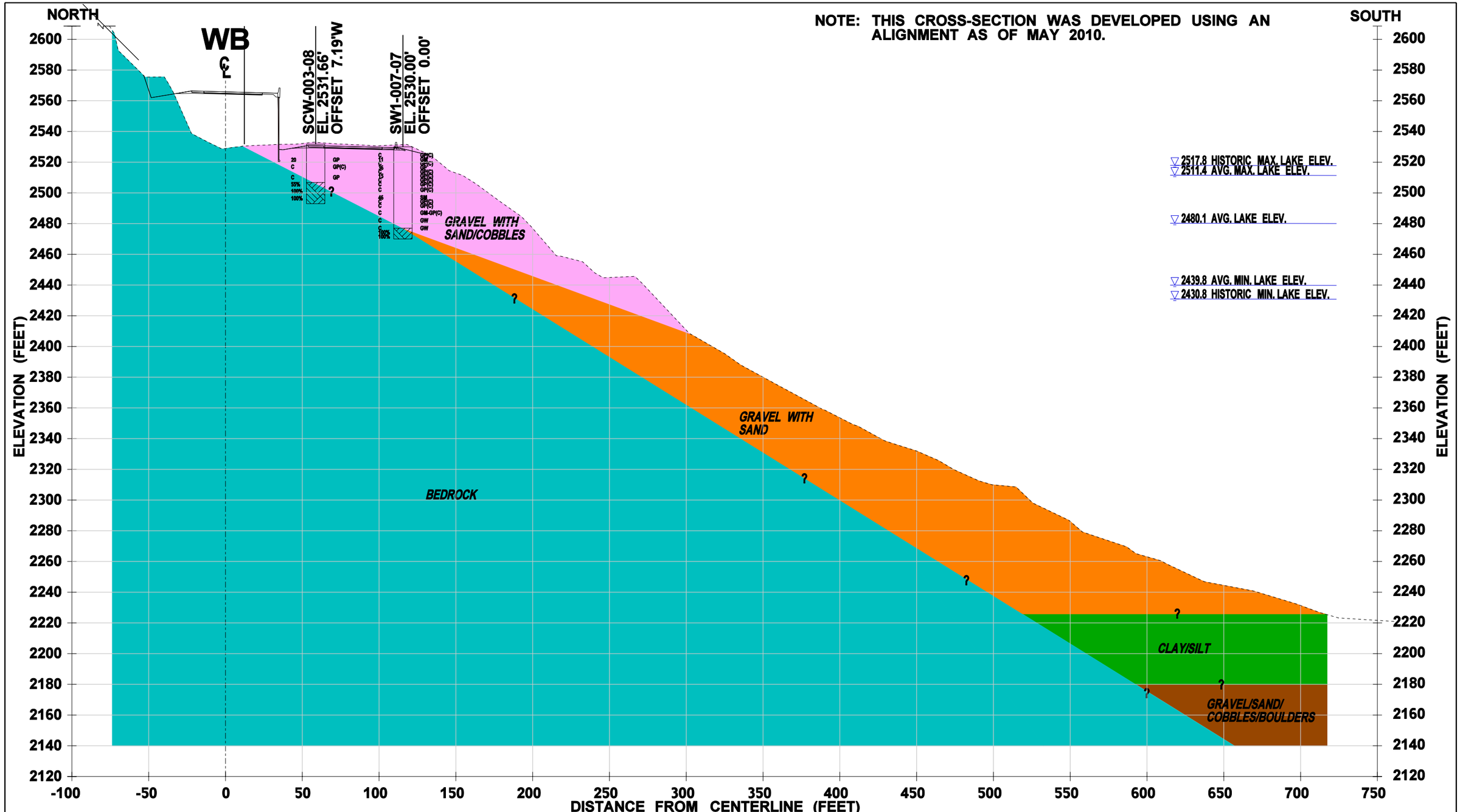
2010 Geotechnical Analysis and Reporting



WB STATION 1390+75 SLIDE CURVE MEDIAN WALL

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DATE	11/29/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
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CONTRACT NO.		LOCATION NO.
Y-9764		

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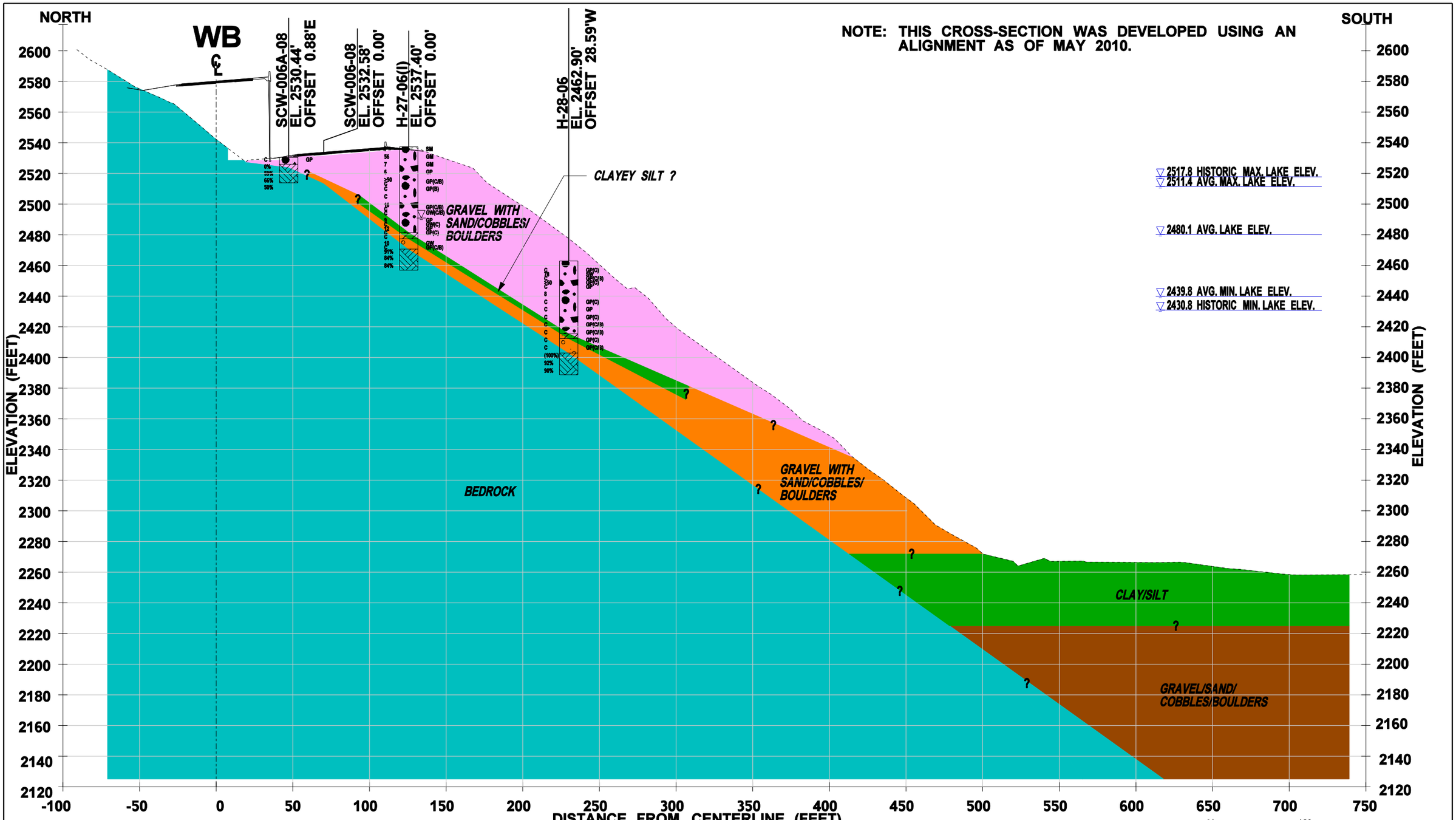
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SLIDE CURVE MEDIAN WALL (SCW) - CROSS-SECTION 1-1'

FIGURE 8.1



WB STATION 1399+00 SLIDE CURVE MEDIAN WALL

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
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PROJ. MNGR.	Cecil Urlich

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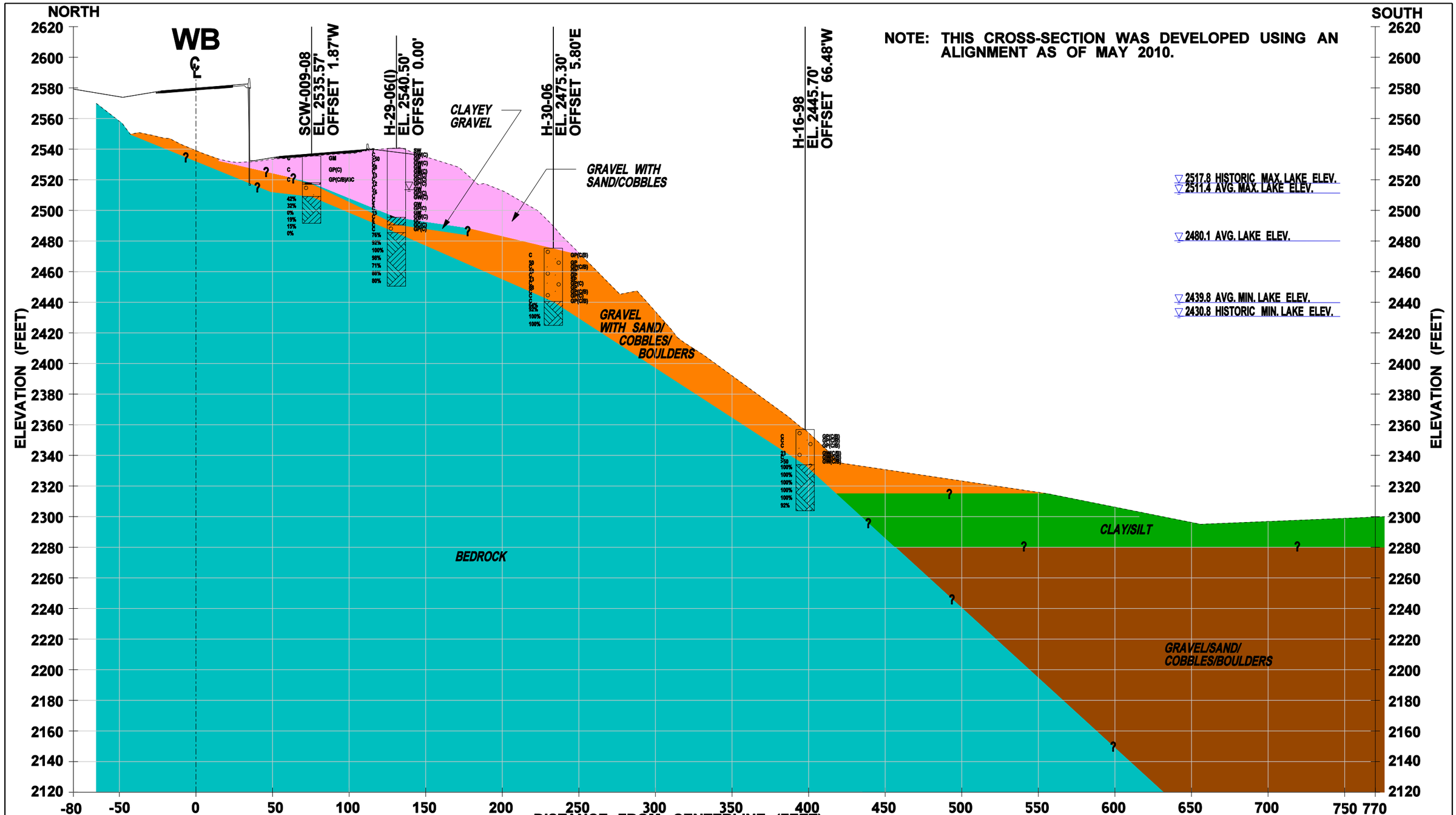
SLIDE CURVE MEDIAN WALL (SCW) - CROSS-SECTION 2-2'

FIGURE 8.2



WB STATION 1404+17 SLIDE CURVE MEDIAN WALL

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DATE	11/29/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

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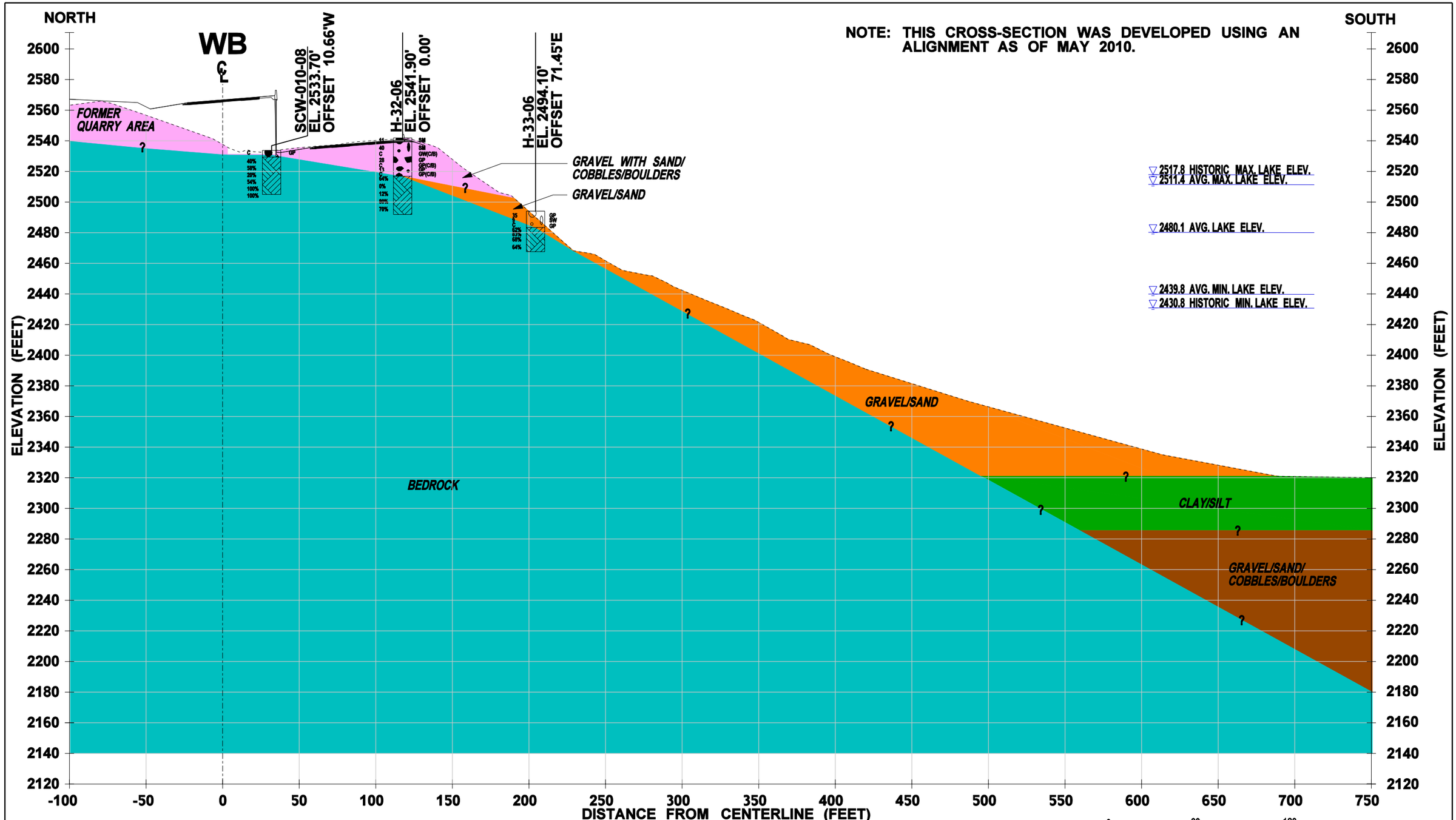
SLIDE CURVE MEDIAN WALL (SCW) - CROSS-SECTION 3-3'

FIGURE 8.3



WB STATION 1411+66 SLIDE CURVE MEDIAN WALL

0 60 120
HORIZONTAL SCALE 1"=60'
VERTICAL EXAGGERATION = 1x

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

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JOB NUMBER		
33758623		
CONTRACT NO.		LOCATION NO.
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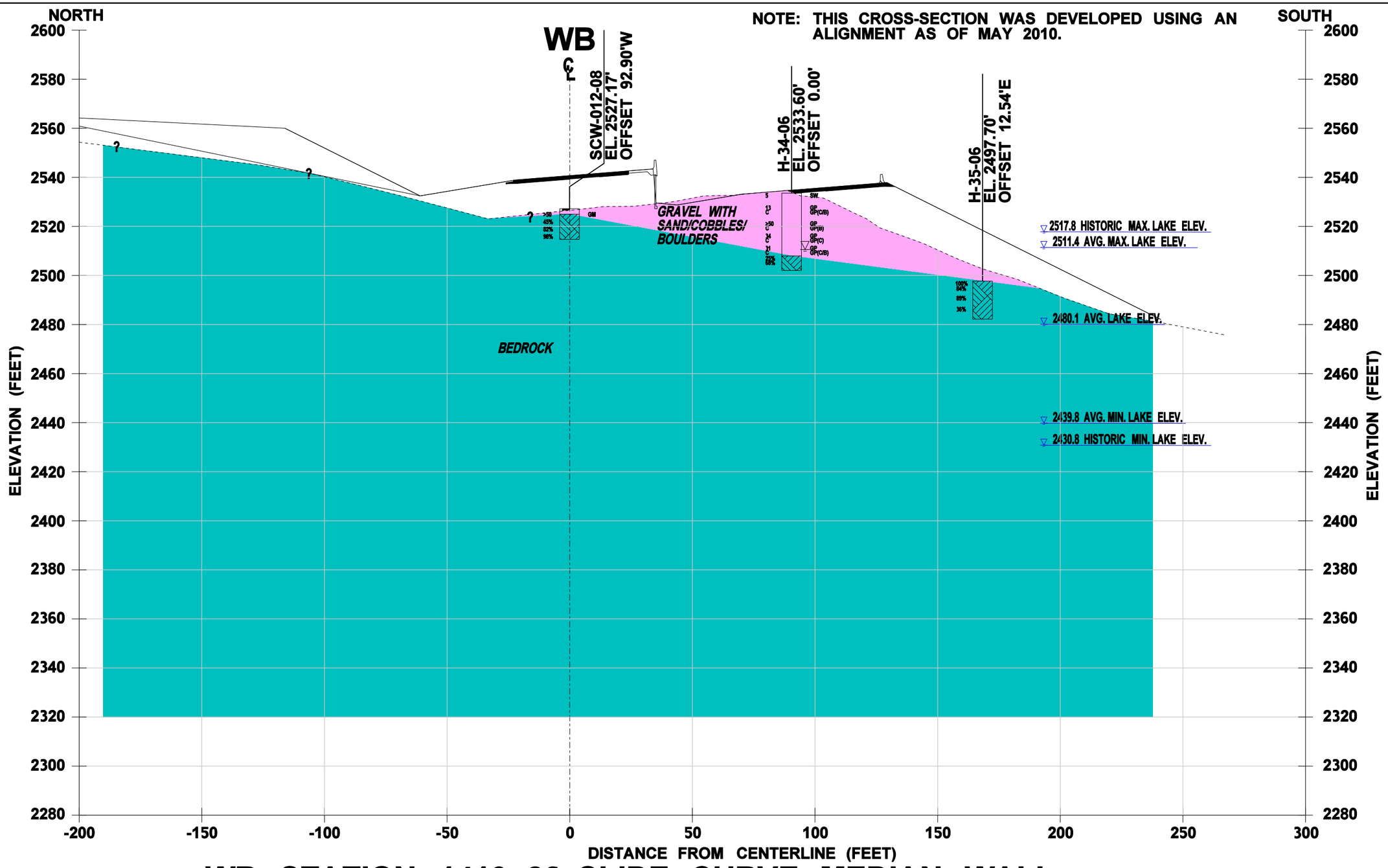
SLIDE CURVE MEDIAN WALL (SCW) - CROSS-SECTION 4-4'

FIGURE 8.4



WB STATION 1419+26 SLIDE CURVE MEDIAN WALL

0 40 80

HORIZONTAL SCALE 1"=40'
VERTICAL EXAGGERATION = 1x

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ENTERED BY	brenda_mcintosh						
CHECKED BY	Dave Walker				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Dave Walker						
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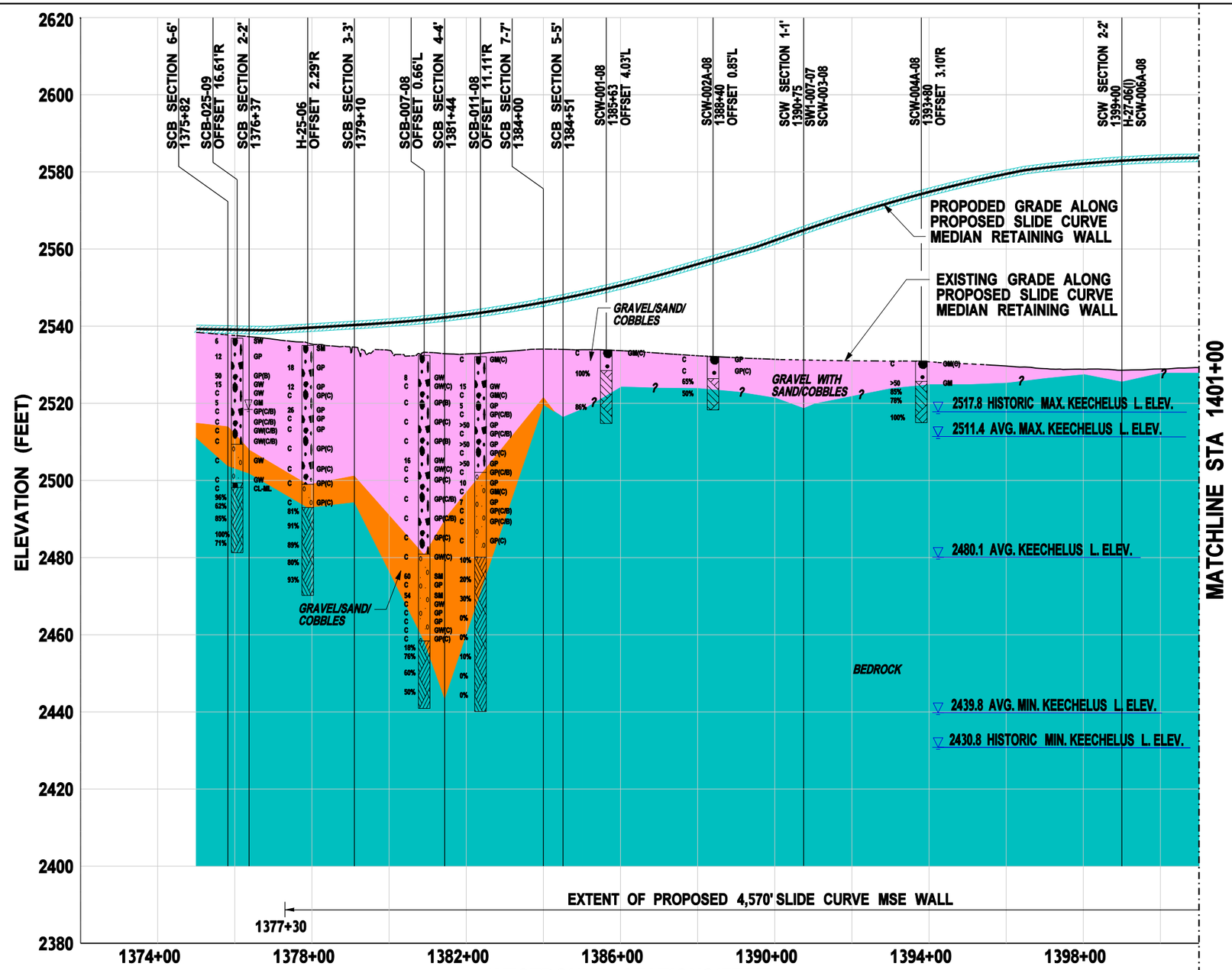
SLIDE CURVE MEDIAN WALL (SCW) - CROSS-SECTION 5-5'

FIGURE 8.5



NOTES:

1. THIS PROFILE WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. BEDROCK SURFACE BETWEEN APPROX. WB STA. 1403+00 AND 1409+00 IS BASED ON THE GEOPHYSICAL SURVEY THAT WAS CONDUCTED BY NORTHWEST GEOPHYSICAL ASSOCIATES. BEDROCK ELEVATION AT WALL ALIGNMENT WAS ESTIMATED USING GEOPHYSICAL SURVEY LINE ROCK ELEVATION AND OFFSET WITH ASSUMED BEDROCK SLOPE OF 2H:1V.

0 300 600

HORIZONTAL SCALE 1"=300'
VERTICAL EXAGGERATION = 10x

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CHECKED BY	Dave Walker				CONTRACT NO. Y-9764	LOCATION NO.	
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PROJ. MNGR.	Cecil Urlich						
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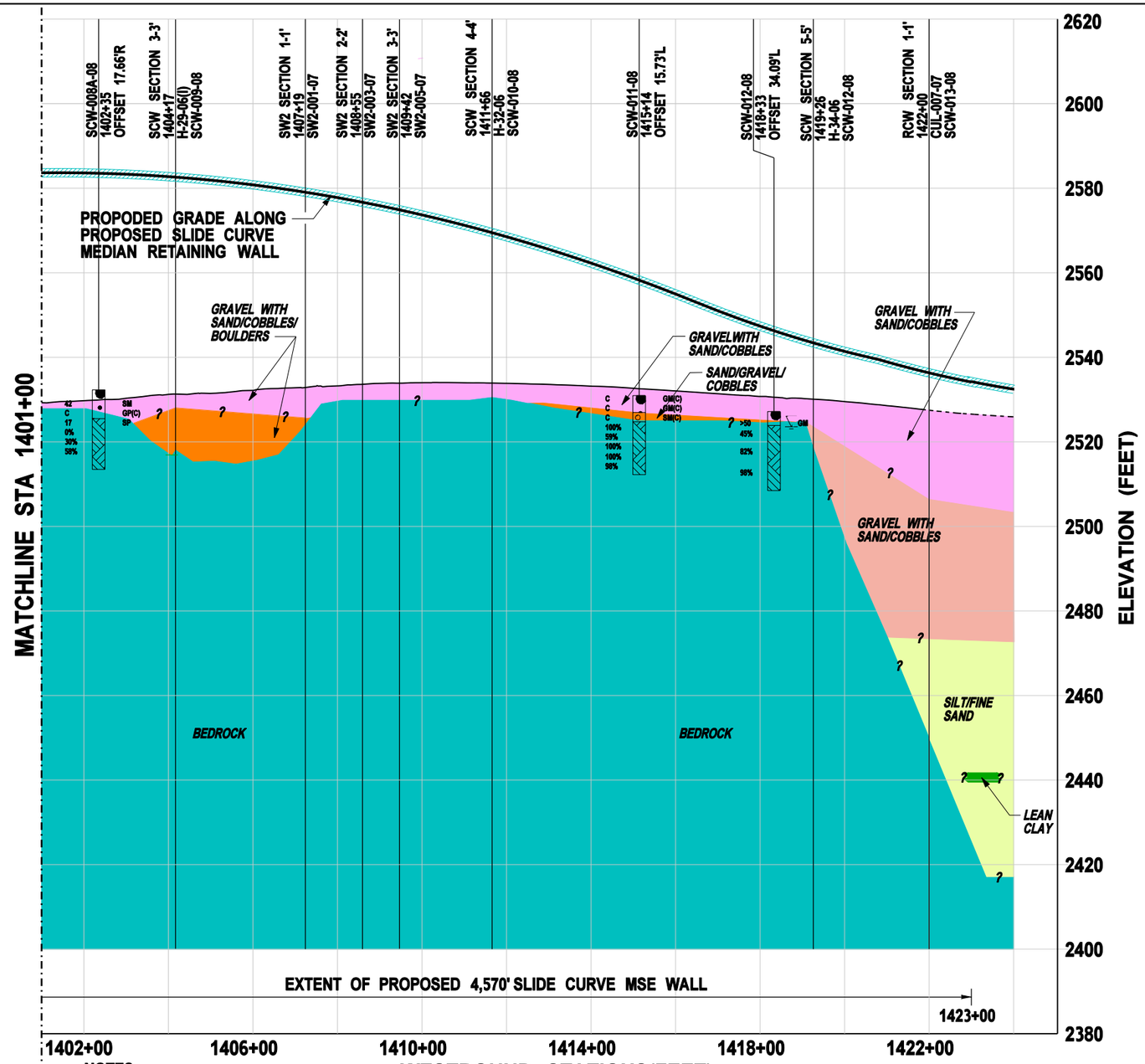
SLIDE CURVE MEDIAN WALL - SUBSURFACE PROFILE

FIGURE 8.6A



NOTES:

1. THIS PROFILE WAS DEVELOPED USING PROPOSED ALIGNMENT AS OF MAY 2010.
2. BEDROCK SURFACE BETWEEN APPROX. WB STA. 1403+00 AND 1409+00 IS BASED ON THE GEOPHYSICAL SURVEY THAT WAS CONDUCTED BY NORTHWEST GEOPHYSICAL ASSOCIATES. BEDROCK ELEVATION AT WALL ALIGNMENT WAS ESTIMATED USING GEOPHYSICAL SURVEY LINE ROCK ELEVATION AND OFFSET WITH ASSUMED BEDROCK SLOPE OF 2H:1V.

0 300 600

HORIZONTAL SCALE 1"=300'
VERTICAL EXAGGERATION = 10x

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
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SLIDE CURVE MEDIAN WALL - SUBSURFACE PROFILE

FIGURE 8.6B

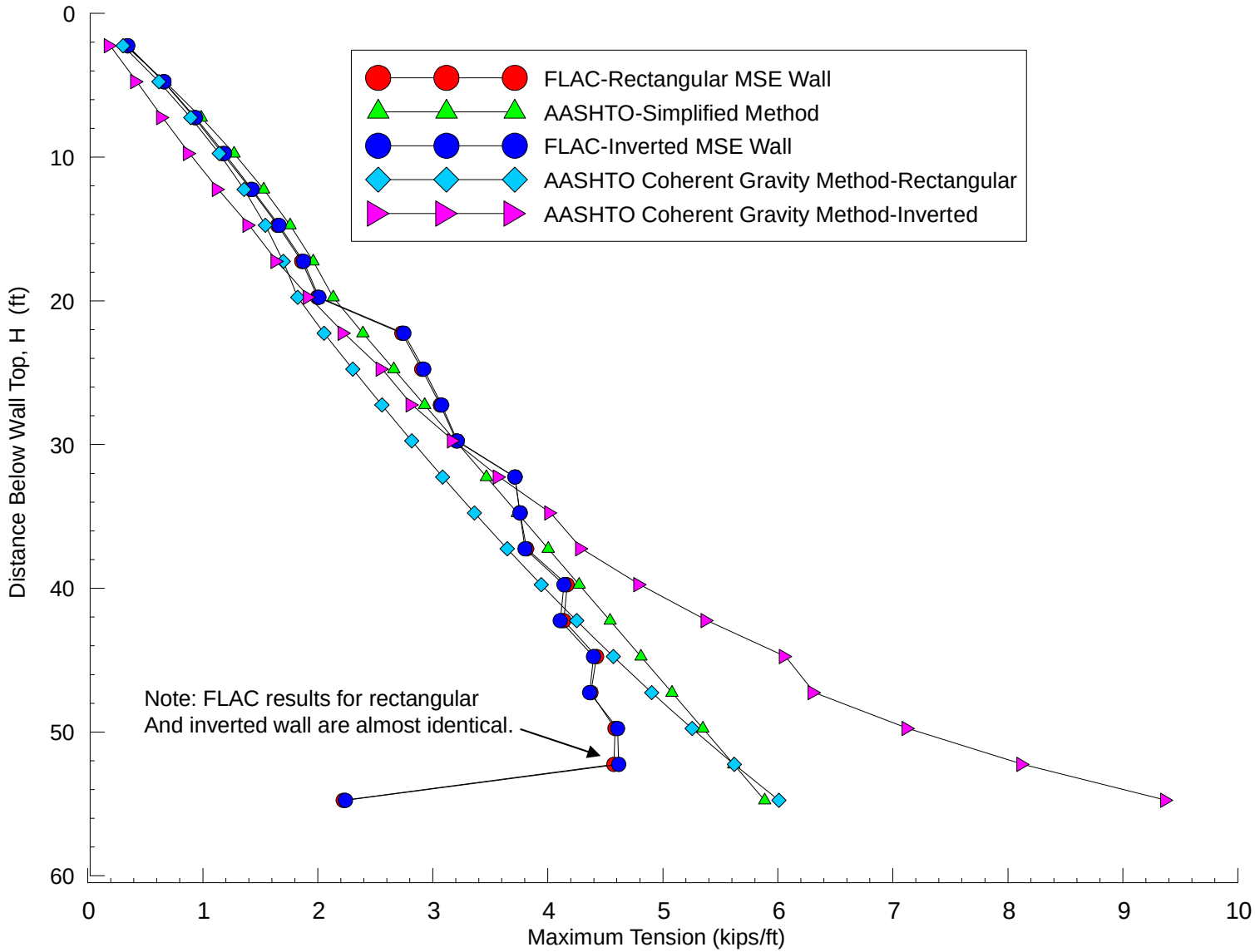


Figure 8.7

Maximum Predicted Unfactored Reinforcement Forces, Slide Curve Median Wall at WB Station 1399+00 - Static Loading

Job No. 33758662

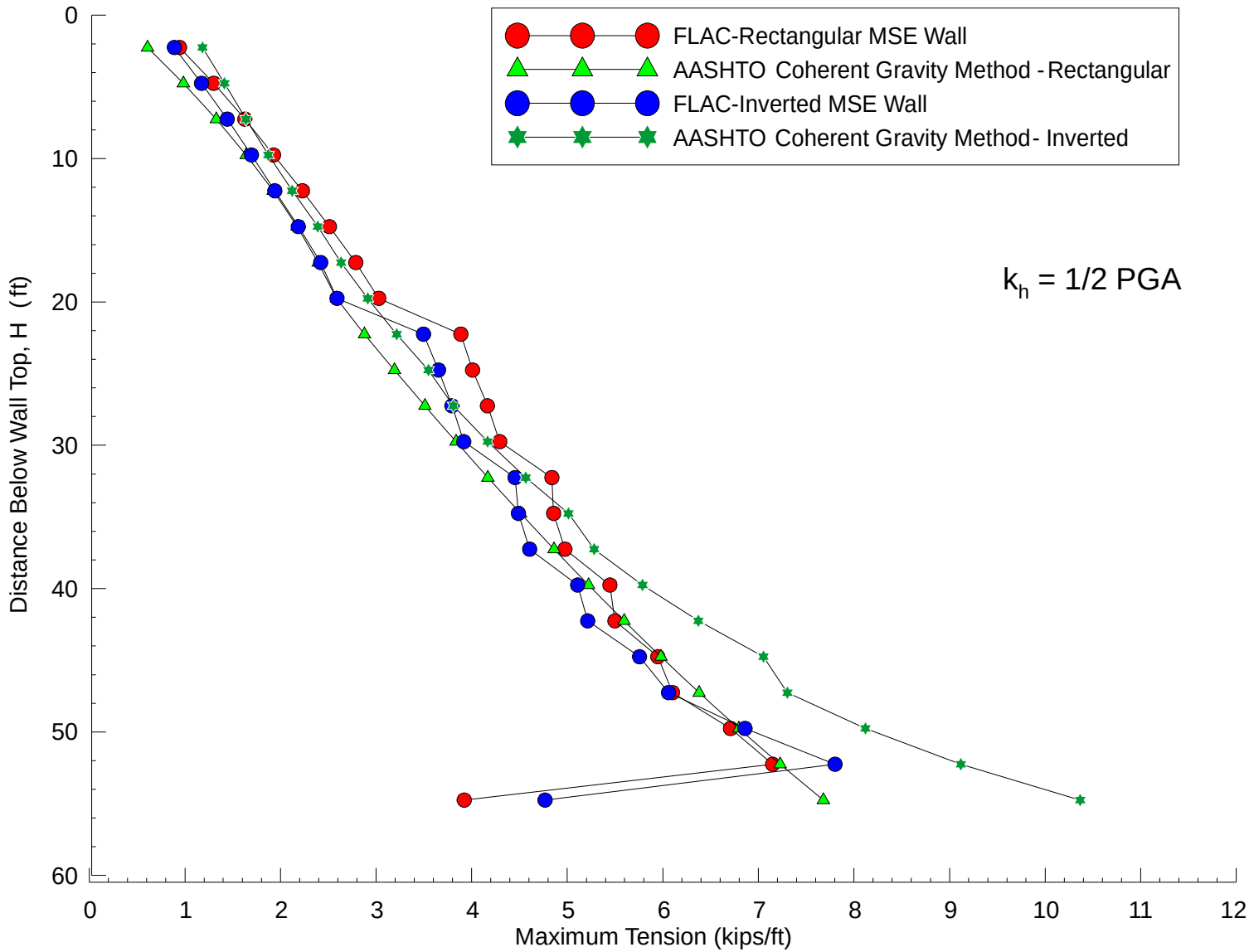
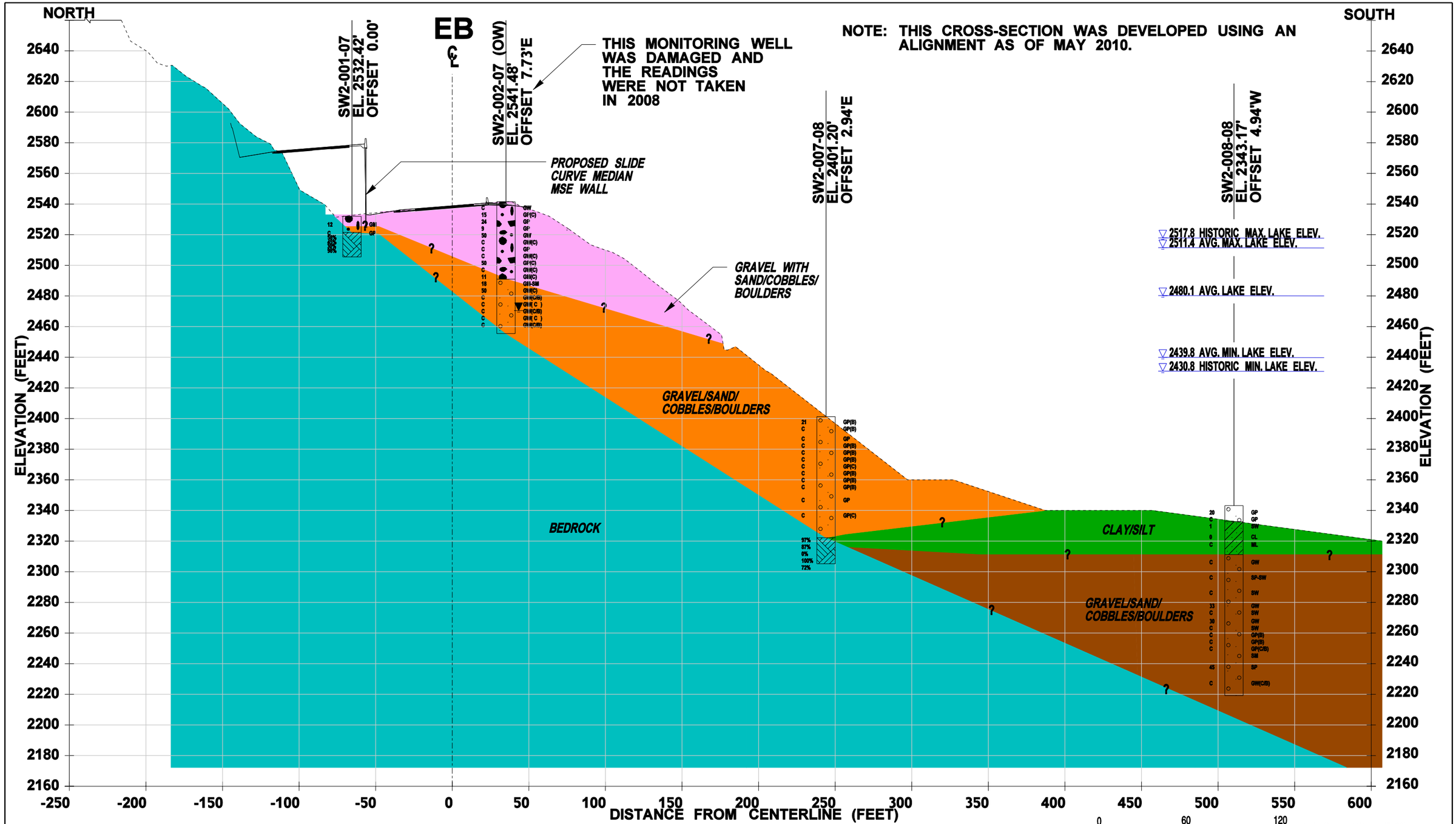


Figure 8.8

Maximum Predicted Unfactored Reinforcement Forces, Slide Curve Median Wall at WB Station 1399+00 - Seismic Loading

Job No. 33758662

URS



EB STATION 1406+07 STRUCTURAL WALL 2

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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
PROJ. MNGR.	Cecil Urlich

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JOB NUMBER 33758623		
CONTRACT NO. Y-9764		LOCATION NO.

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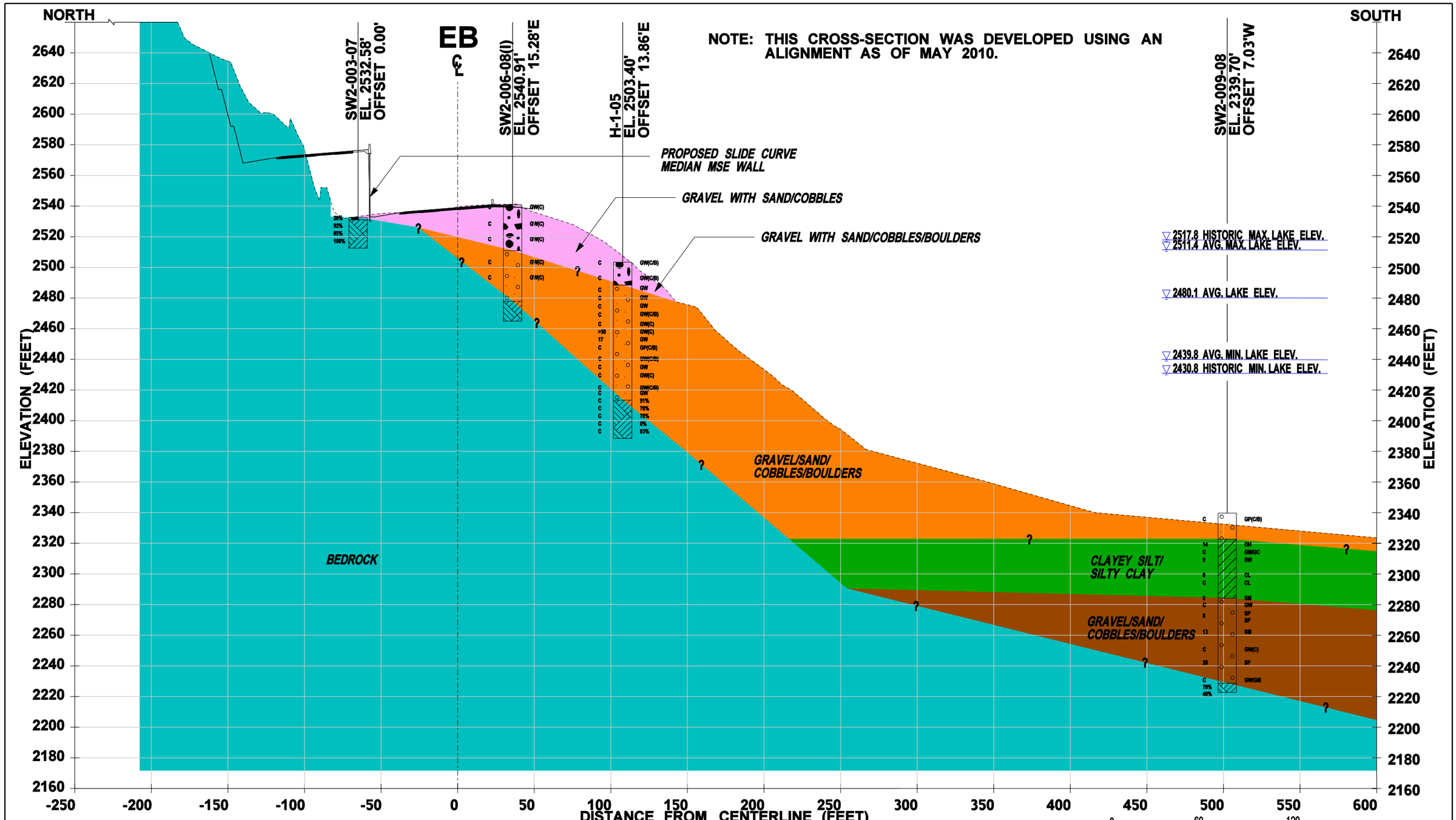
Washington State Department of Transportation

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

SLIDE CURVE EMBANKMENT STABILIZATION (SW2) - CROSS-SECTION 1-1'

FIGURE 9.1



EB STATION 1407+49 STRUCTURAL WALL 2

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DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
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

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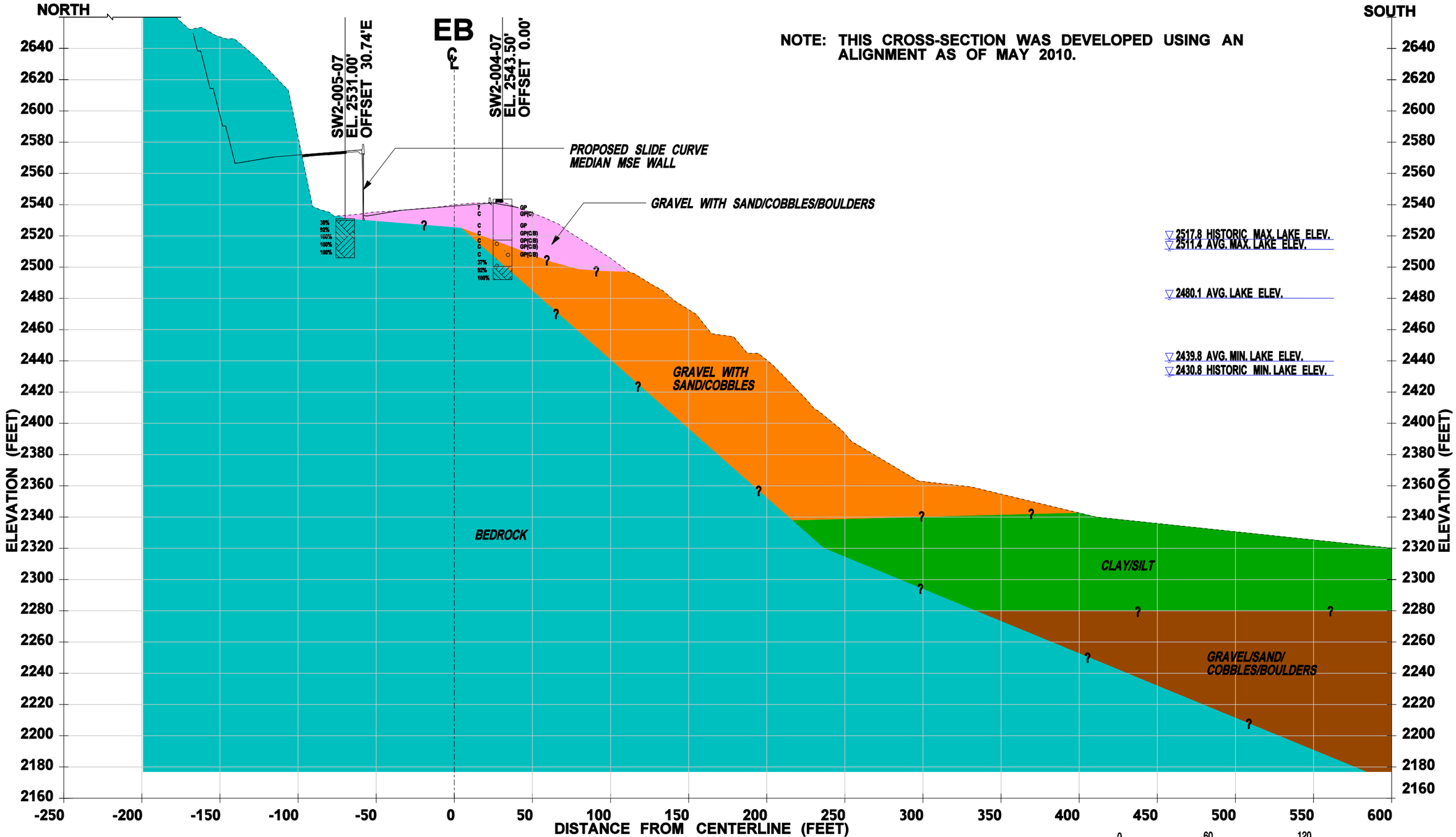
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Washington State
Department of Transportation

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

SLIDE CURVE EMBANKMENT STABILIZATION (SW2) - CROSS-SECTION 2-2'

FIGURE
9.2



EB STATION 1408+42 STRUCTURAL WALL 2

0 60 120

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

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DATE	11/30/2010
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ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	John Zeman
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		

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Washington State
Department of Transportation

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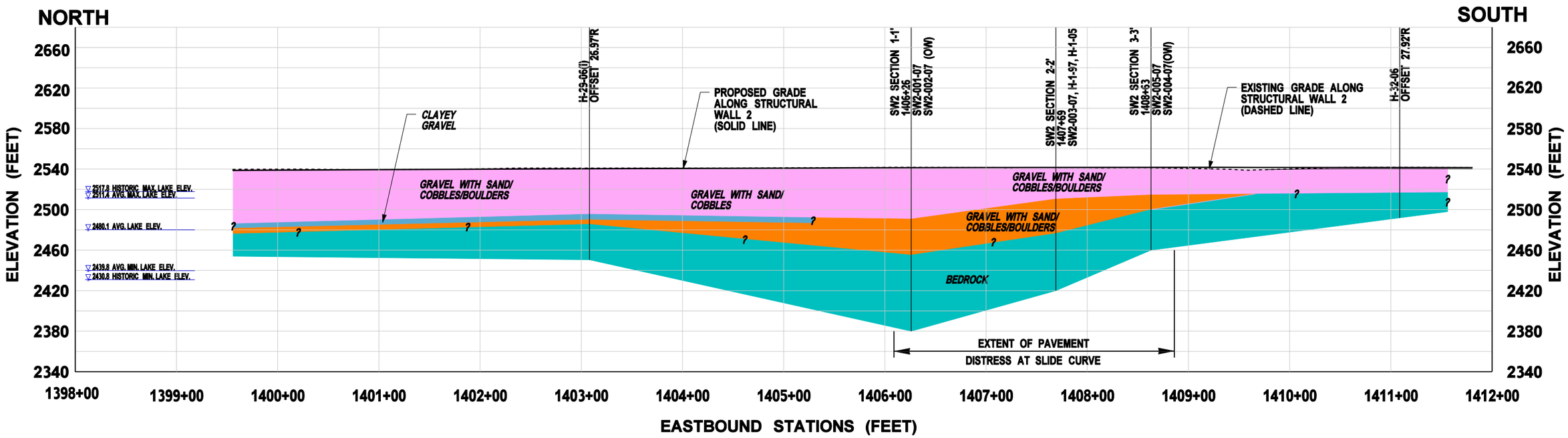
SLIDE CURVE EMBANKMENT STABILIZATION (SW2) - CROSS-SECTION 3-3'

FIGURE
9.3



0 100 200

HORIZONTAL SCALE 1"=100'
VERTICAL EXAGGERATION = 1x

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DATE	11/30/2010						
DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	brenda_mcintosh						
CHECKED BY	Xiangdong Han				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	John Zeman						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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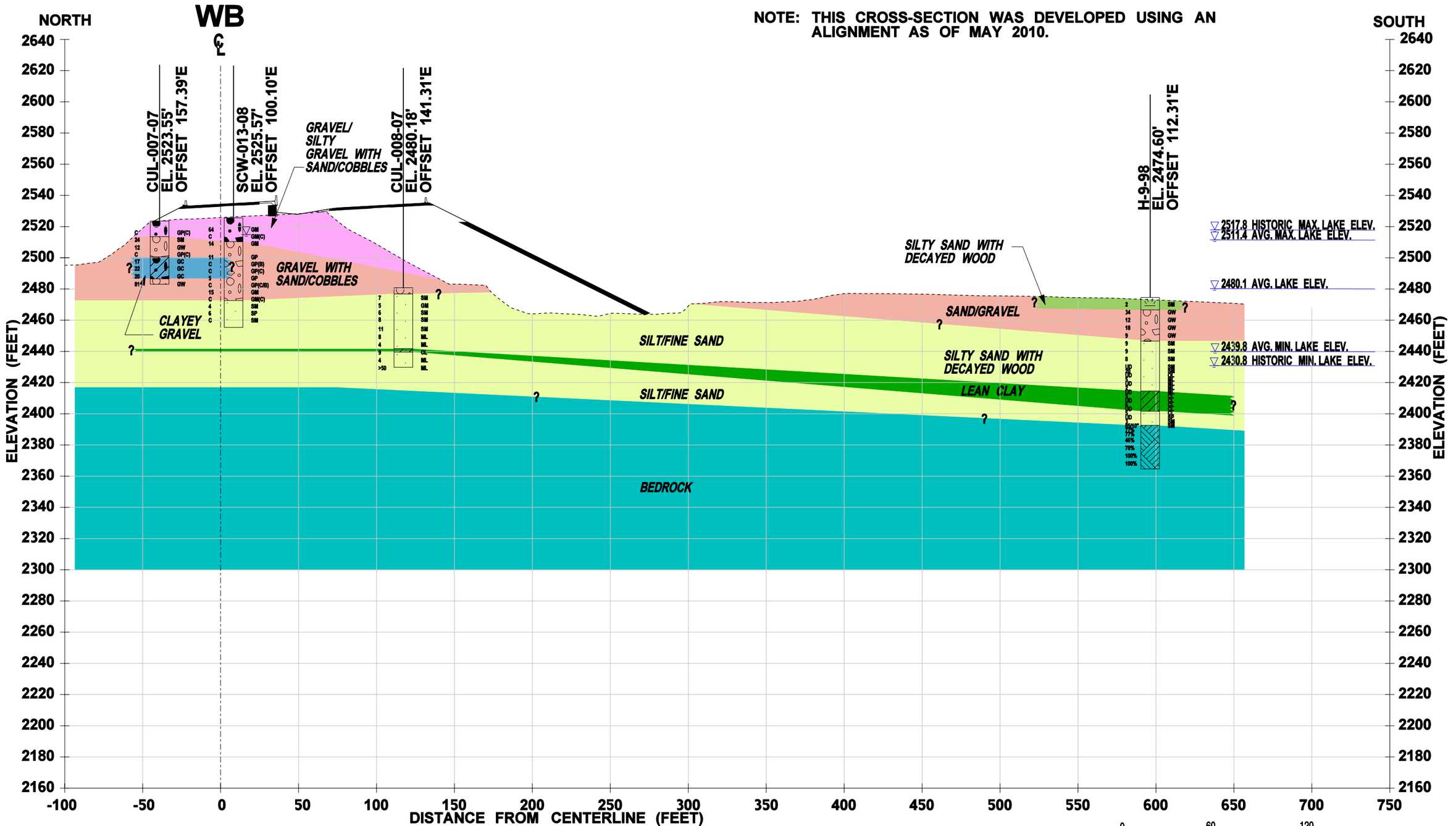
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

SLIDE CURVE EMBANKMENT STABILIZATION (SW2) - EDGE OF THE EB LANE SUBSURFACE PROFILE

FIGURE 9.4



WB STATION 1421+99 RESORT CREEK EMBANKMENT

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DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
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		

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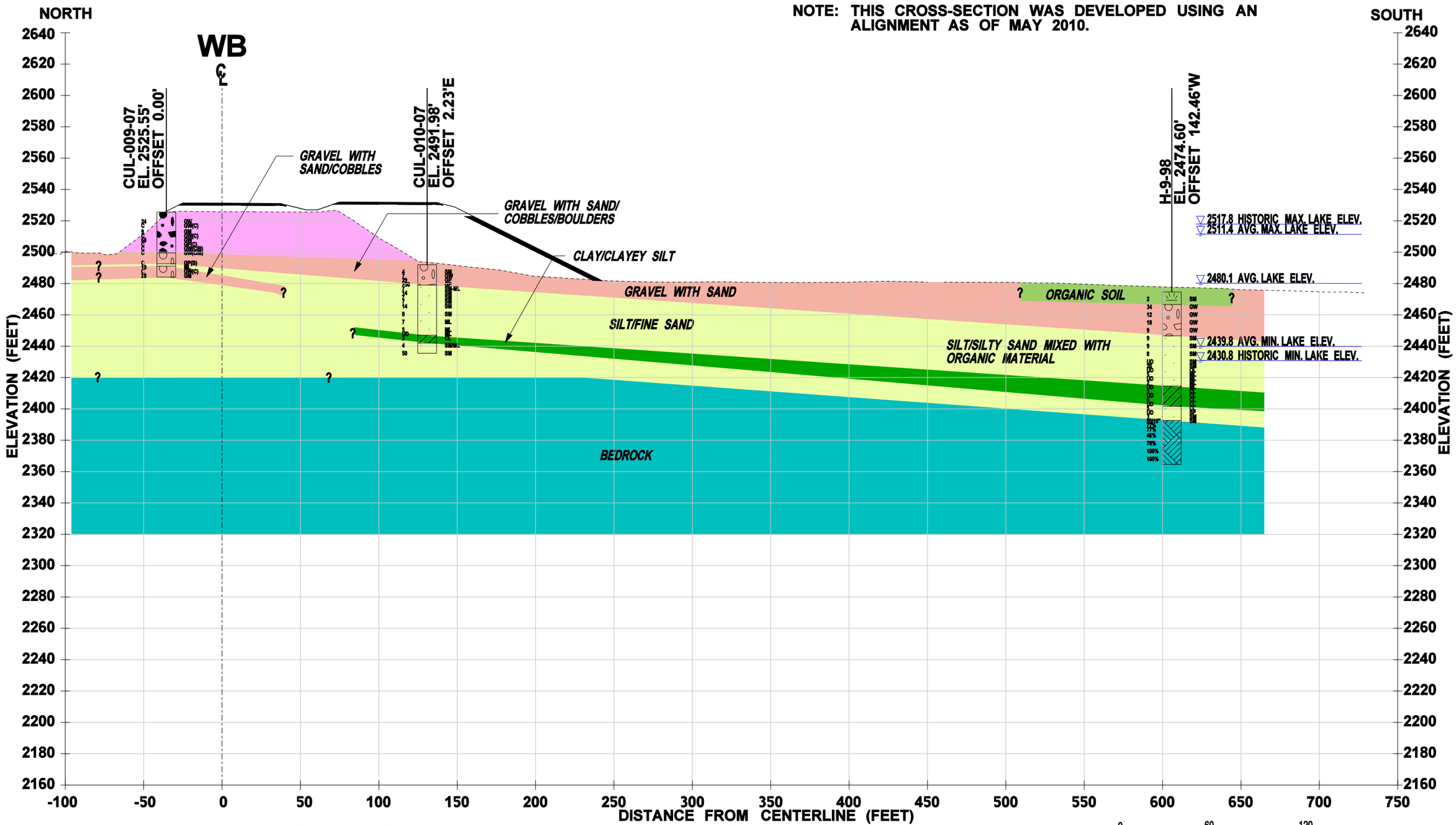
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

RESORT CREEK WALL - CROSS-SECTION 1-1'

FIGURE 10.1



WB STATION 1424+97 RESORT CREEK EMBANKMENT

0 60 120
HORIZONTAL SCALE 1"=60'
VERTICAL EXAGGERATION = 1x

FILE NAME	\\seaocean\163\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Resort Creek Wall (RCW)\RCW CROSSECTION 2-2.dgn
TIME	8:08:12 AM
DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Xiangdong Han
ASST. PROJ. MNGR.	Dave Walker
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		

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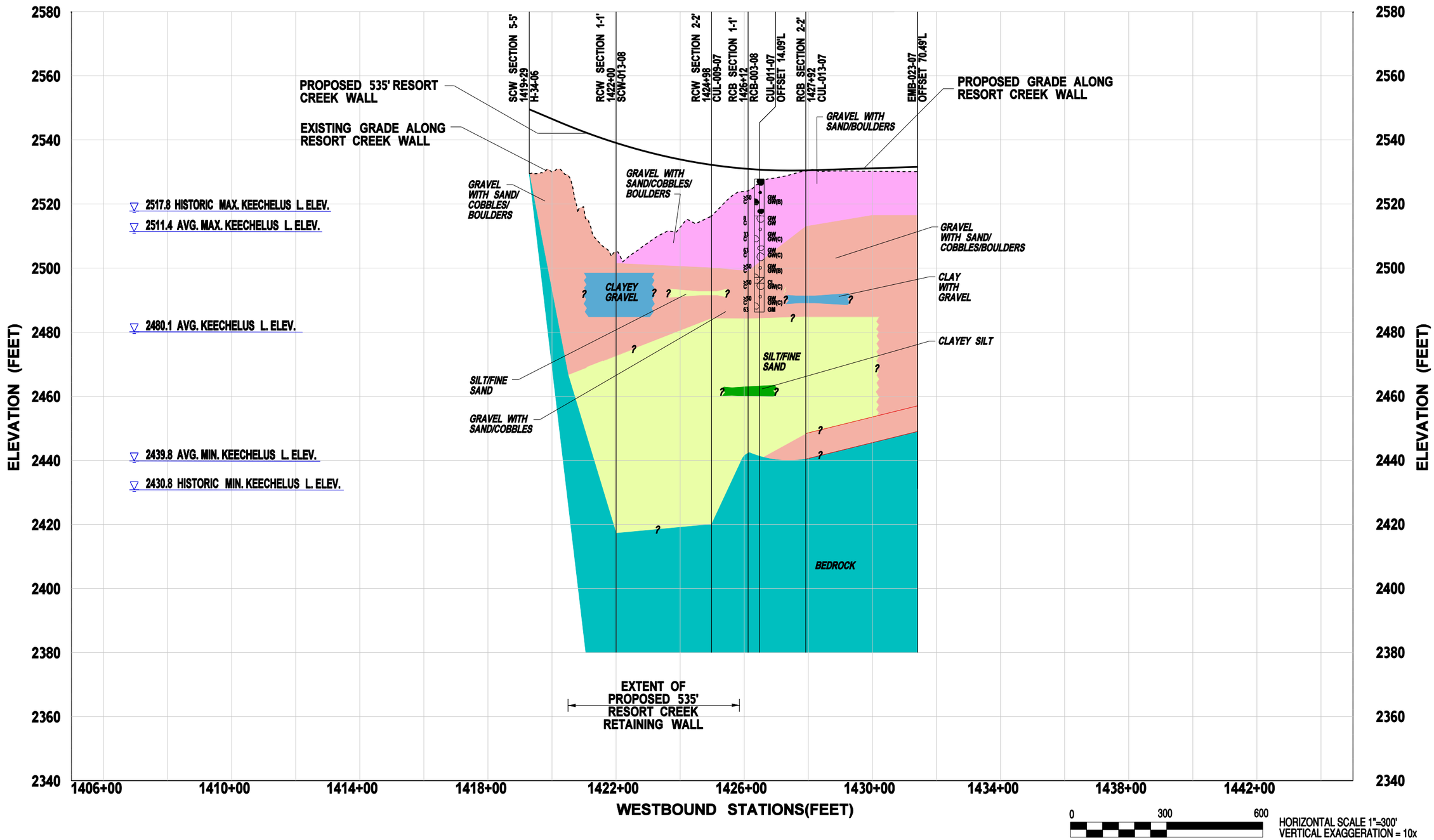
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

RESORT CREEK WALL - CROSS-SECTION 2-2'

FIGURE 10.2



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TIME	11:43:05 AM
DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Xiangdong Han
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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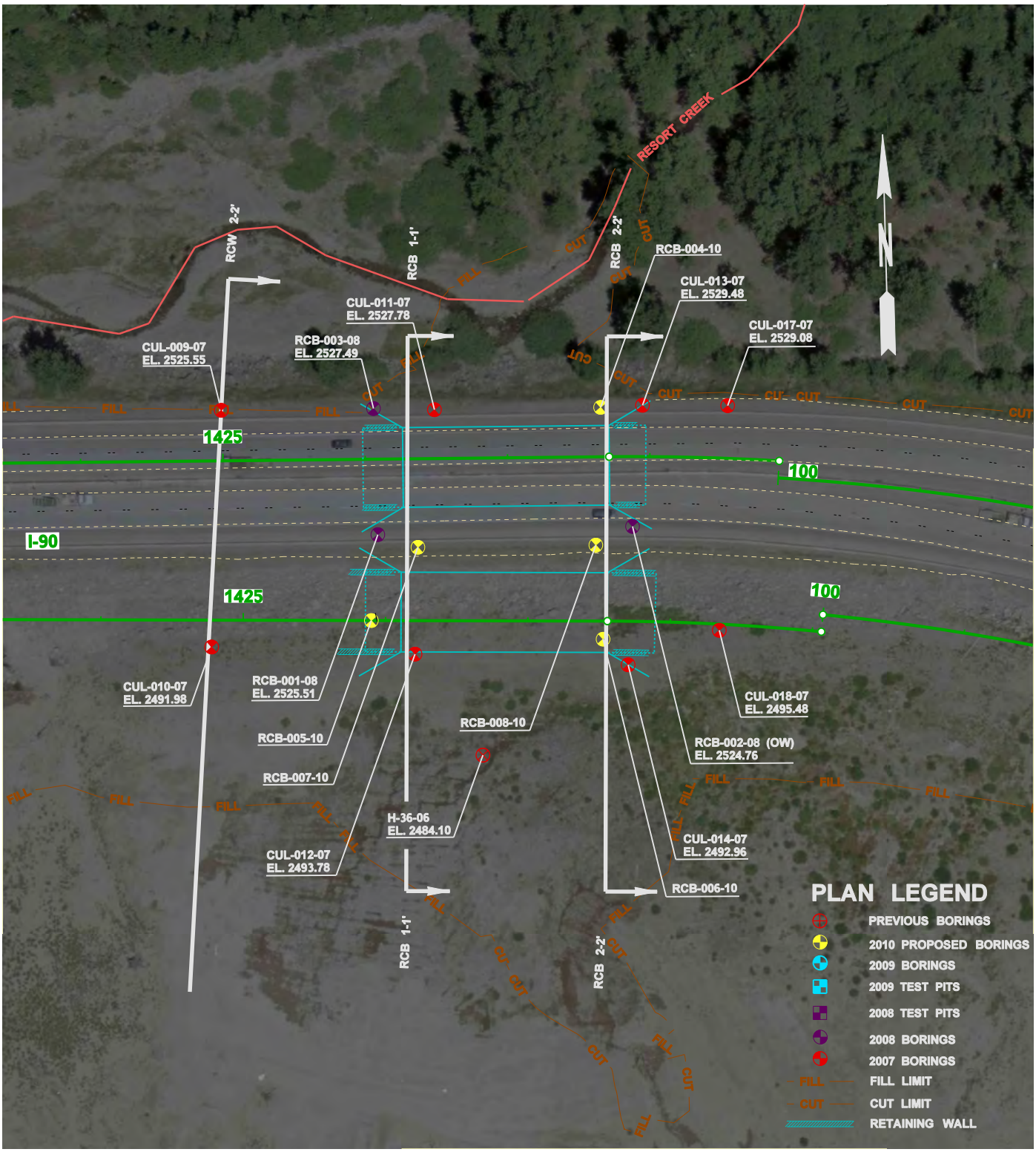
Hyak to Keechelus Dam, Washington

RESORT CREEK WALL - SUBSURFACE PROFILE

FIGURE 10.3



0 100 200

SCALE 1" = 100'

$$$$$$$$DESIGNFILENAME$$$$$$

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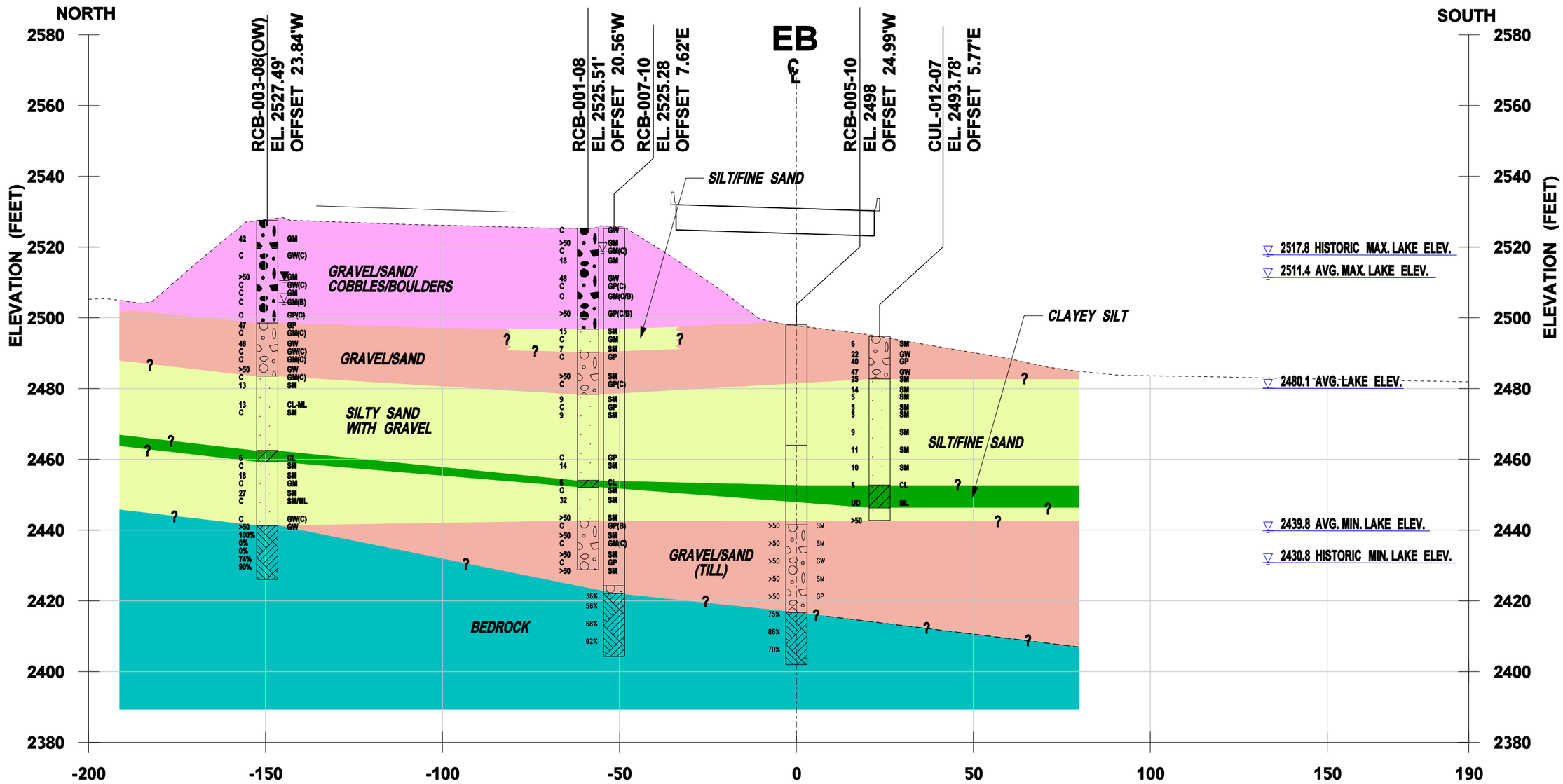
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

BORING LOCATION PLAN
RESORT CREEK BRIDGES

FIGURE
11.1

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.



EB STATION 1426+15 RESORT CREEK BRIDGES WEST ABUTMENT (PIER 1)

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

FILE NAME	\\seaocean\163\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Resort Creek Bridge (RCB)\P1234_RS_RCB_Section_1.dgn
TIME	8:16:32 AM
DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION	DATE	BY

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10	WASH	
JOB NUMBER		
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CONTRACT NO.		LOCATION NO.
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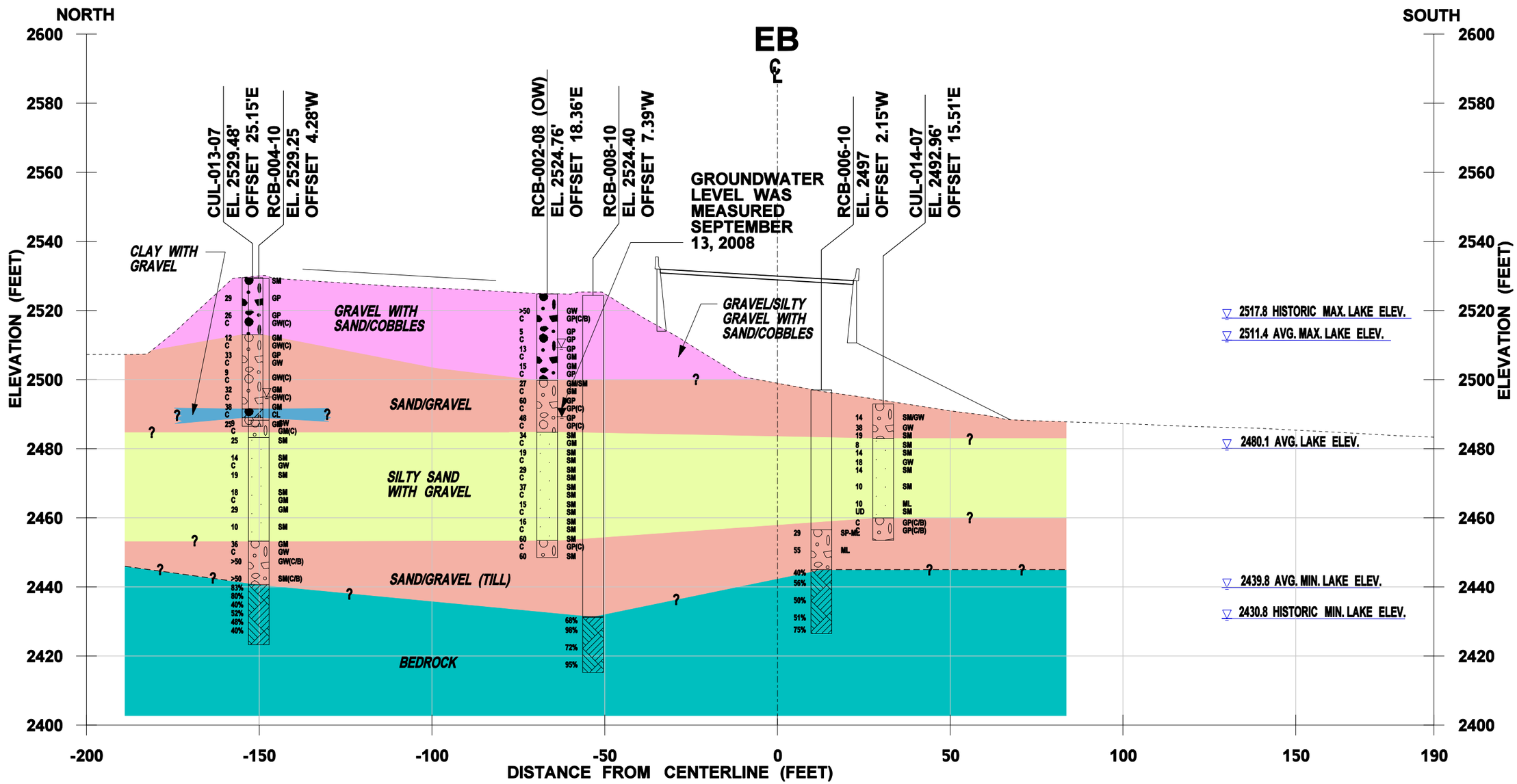
Washington State Department of Transportation

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

RESORT CREEK BRIDGE (RCB) - CROSS-SECTION 1-1'

FIGURE 11.2

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.



EB STATION 1427+55 RESORT CREEK BRIDGES EAST ABUTMENT (PIER 2)

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

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DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker/Ken Yang
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

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

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

RESORT CREEK BRIDGE (RCB) - CROSS-SECTION 2-2'

FIGURE 11.3

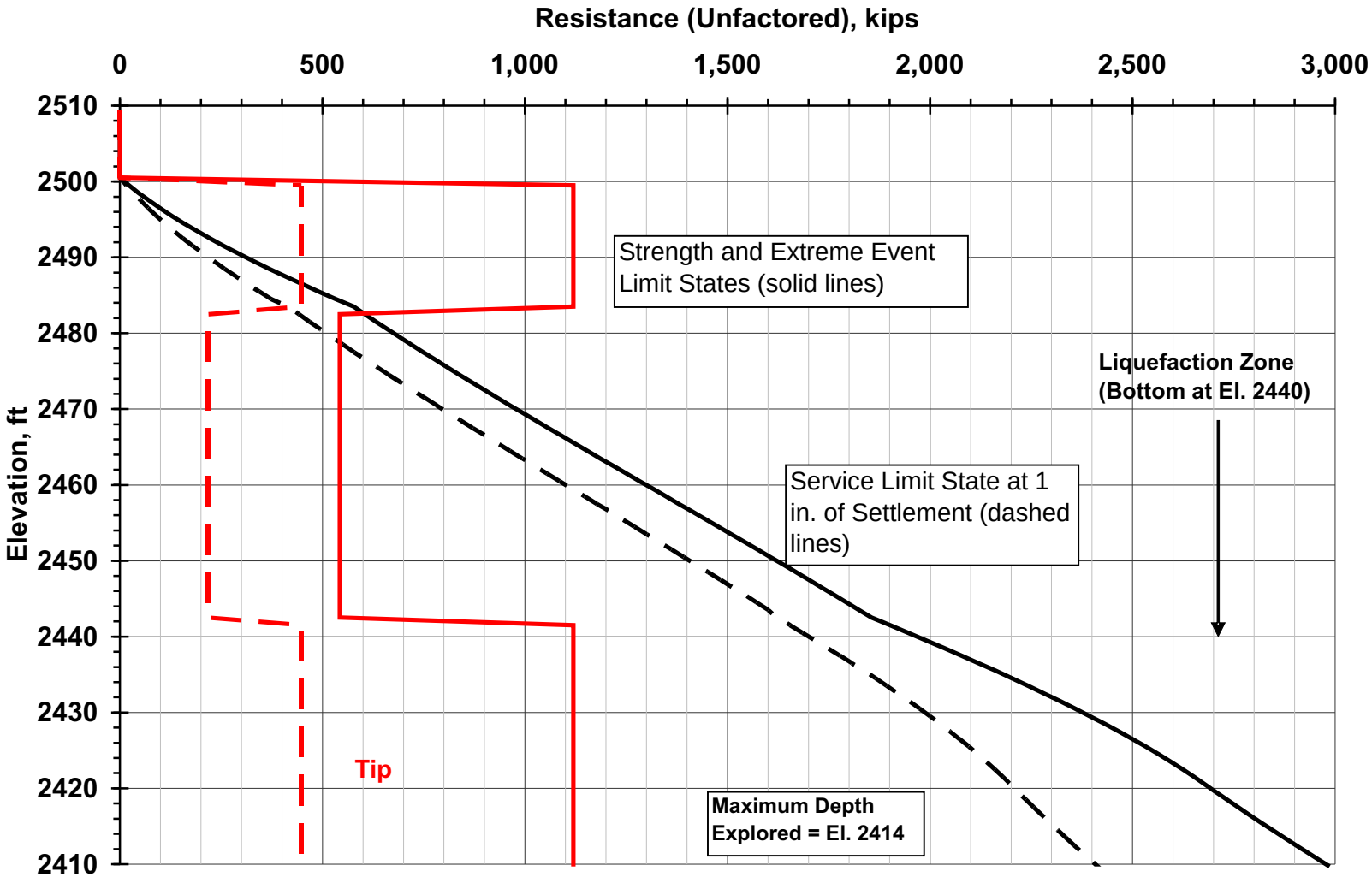

Figure 11.4

Unfactored Bearing Resistance

6-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 1) - Soil

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

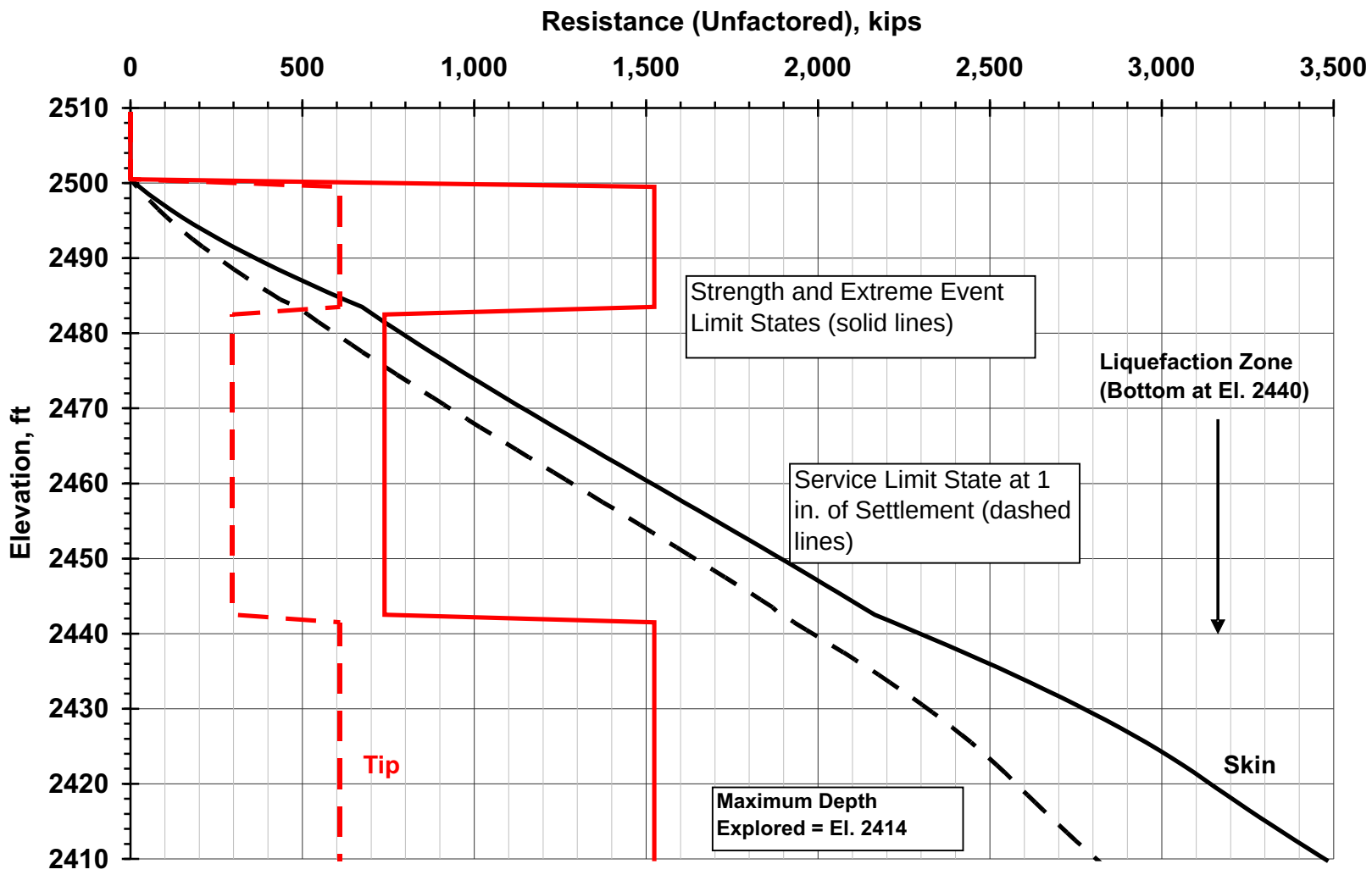

Figure 11.5

Unfactored Bearing Resistance

7-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 1) - Soil

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

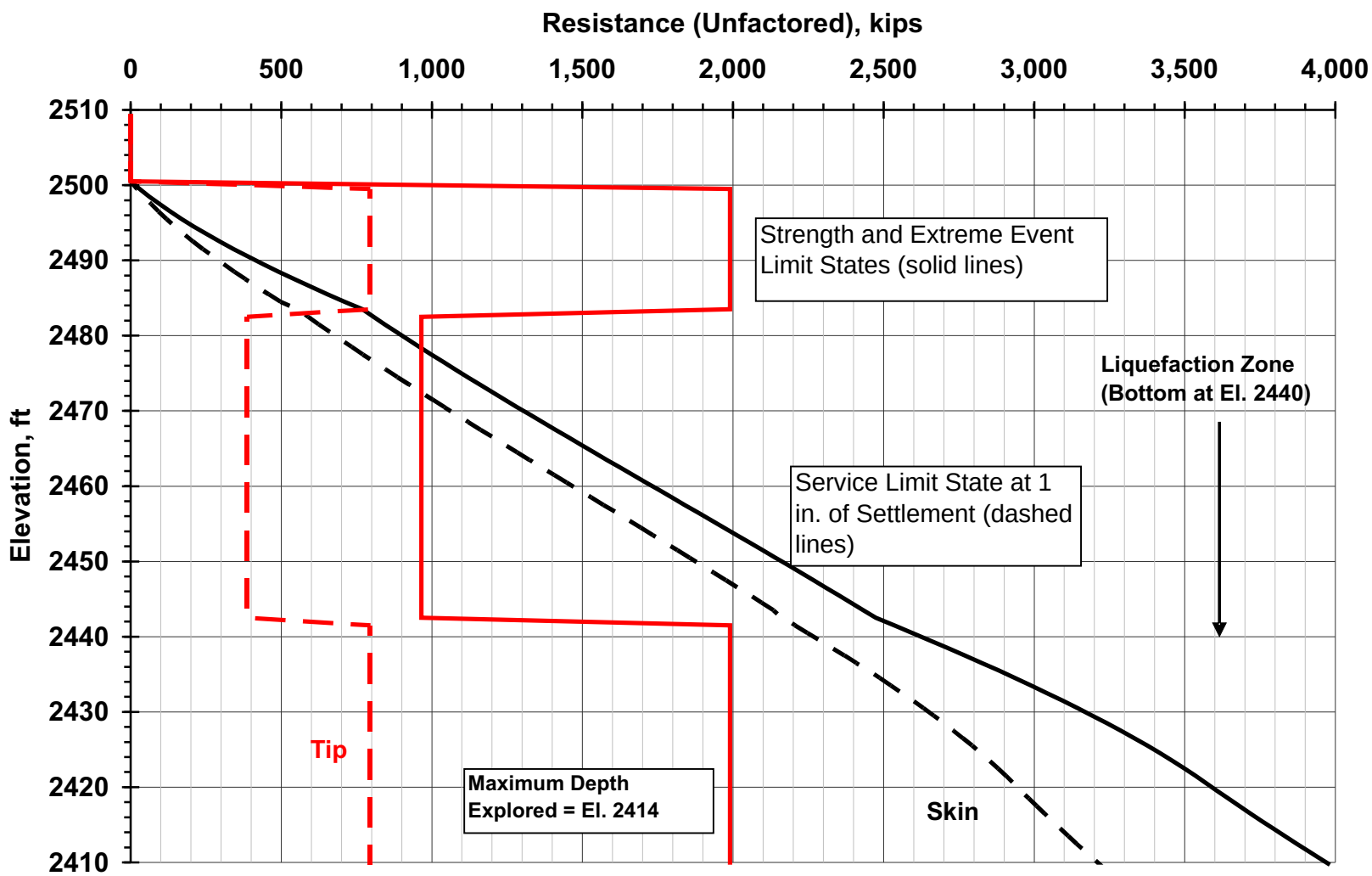

Figure 11.6

Unfactored Bearing Resistance

8-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 1) - Soil

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

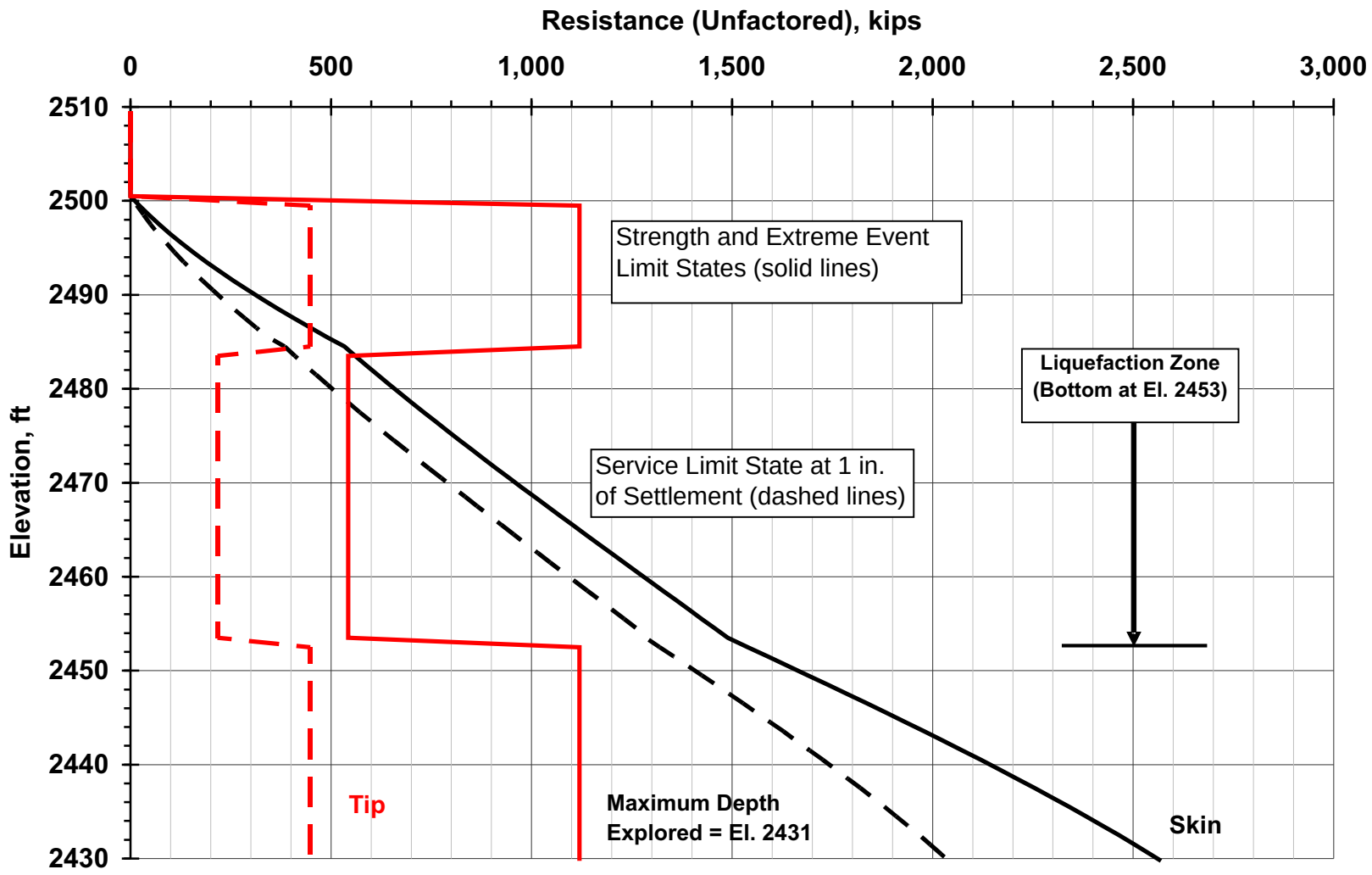

Figure 11.7

Unfactored Bearing Resistance

6-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 2) - Soil

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

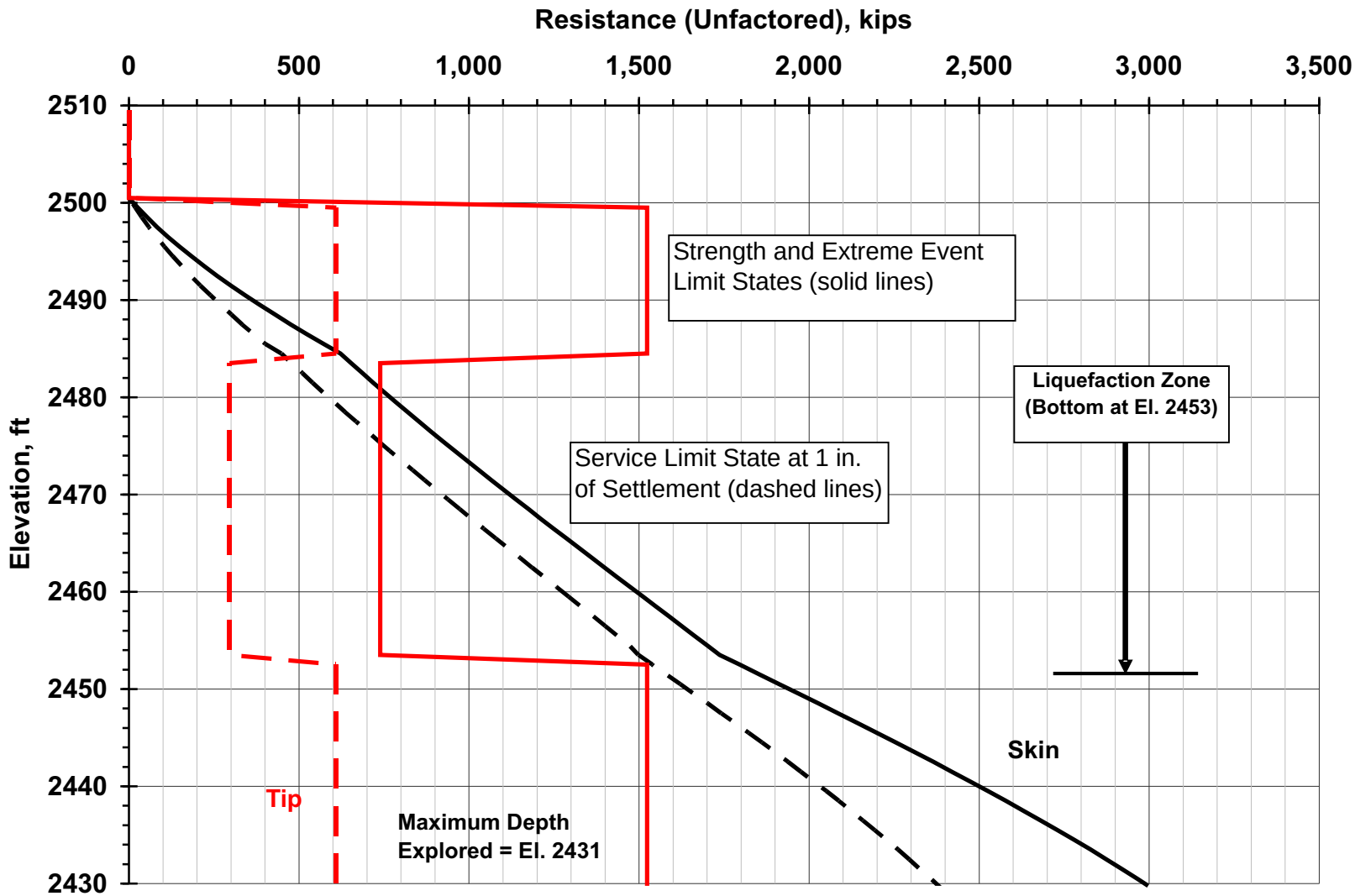

Figure 11.8

Unfactored Bearing Resistance

7-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 2) - Soil

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

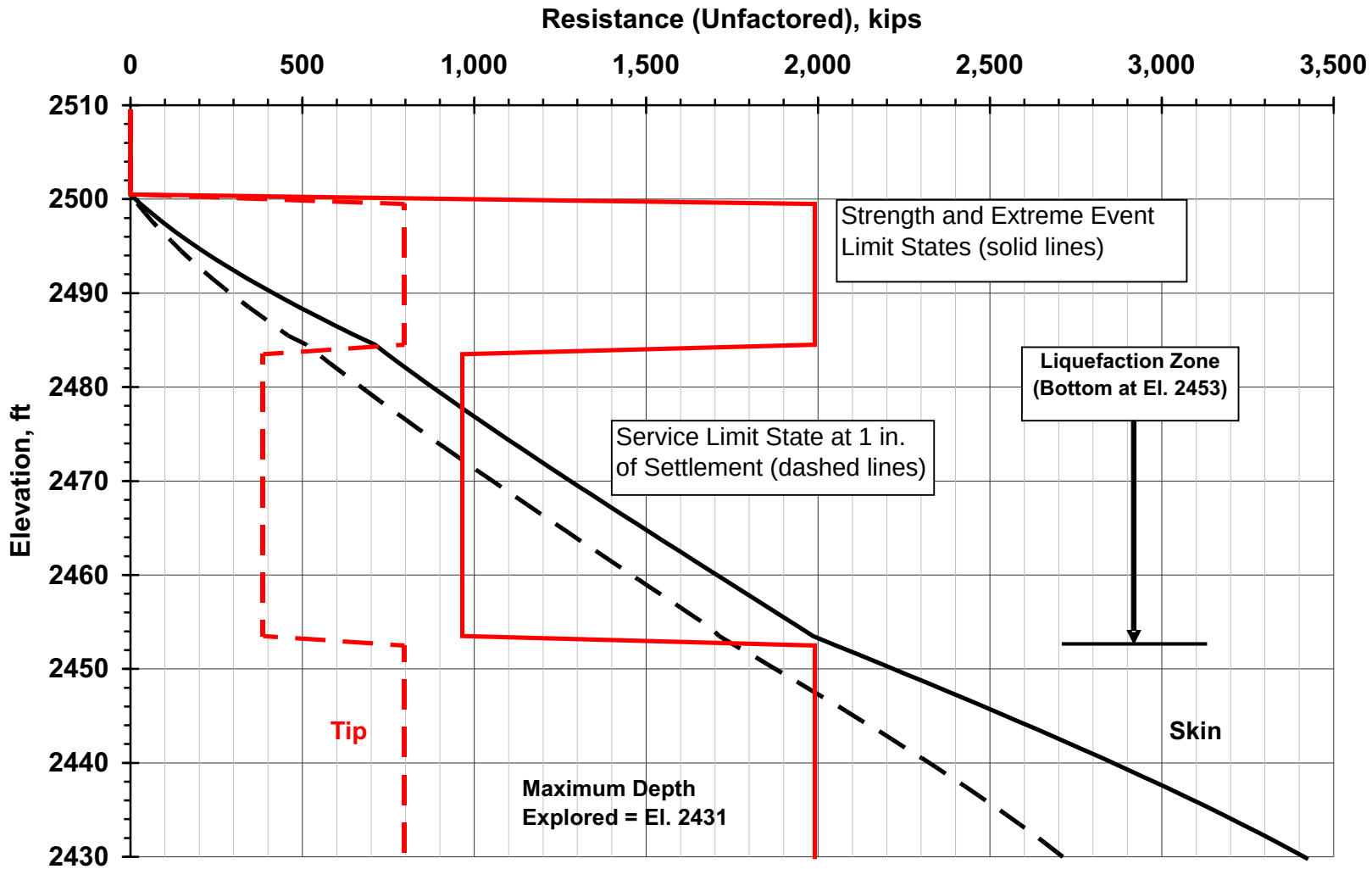

Figure 11.9

Unfactored Bearing Resistance

8-ft Diameter Shaft, Resort Creek Bridges West Abutment (Pier 2) - Soil

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

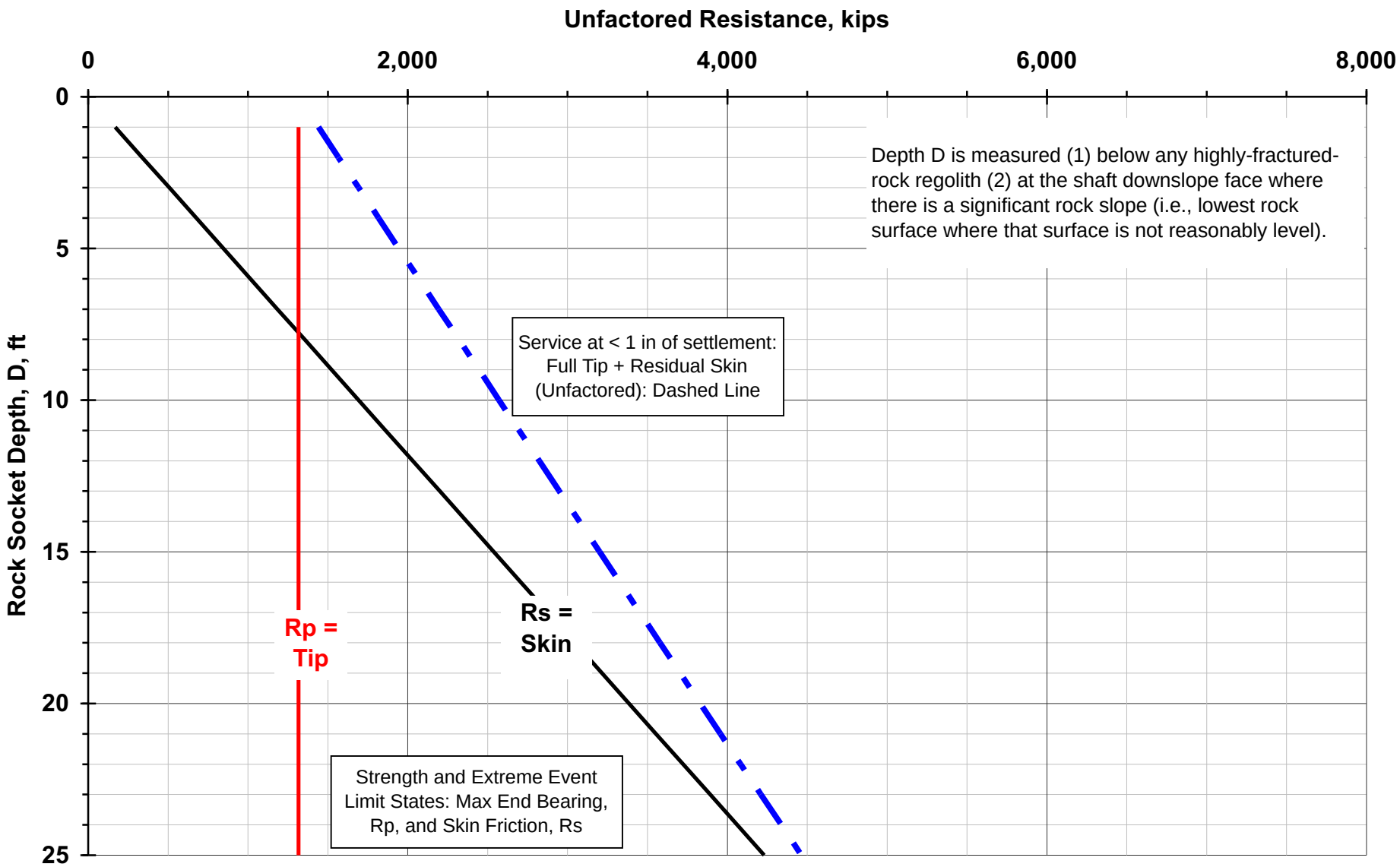

Figure 11.10

Unfactored Bearing Resistance

6-ft Diameter Shaft, Resort Creek Bridges West and East Abutments (Piers 1 and 2) - Rock

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

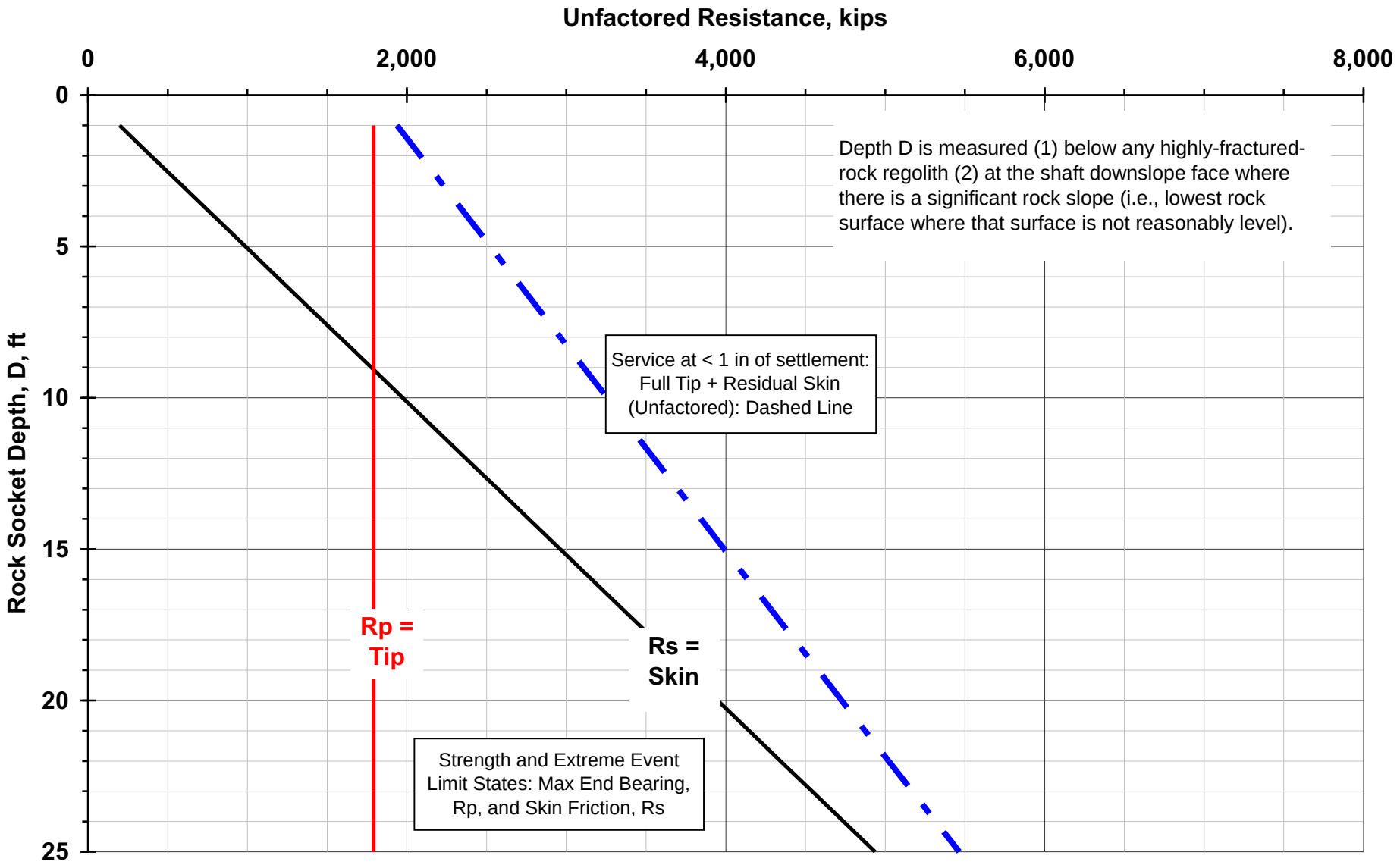

Figure 11.11

Unfactored Bearing Resistance

7-ft Diameter Shaft, Resort Creek Bridges West and East Abutments (Piers 1 and 2) - Rock

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2010 Geotechnical Analysis and Reporting

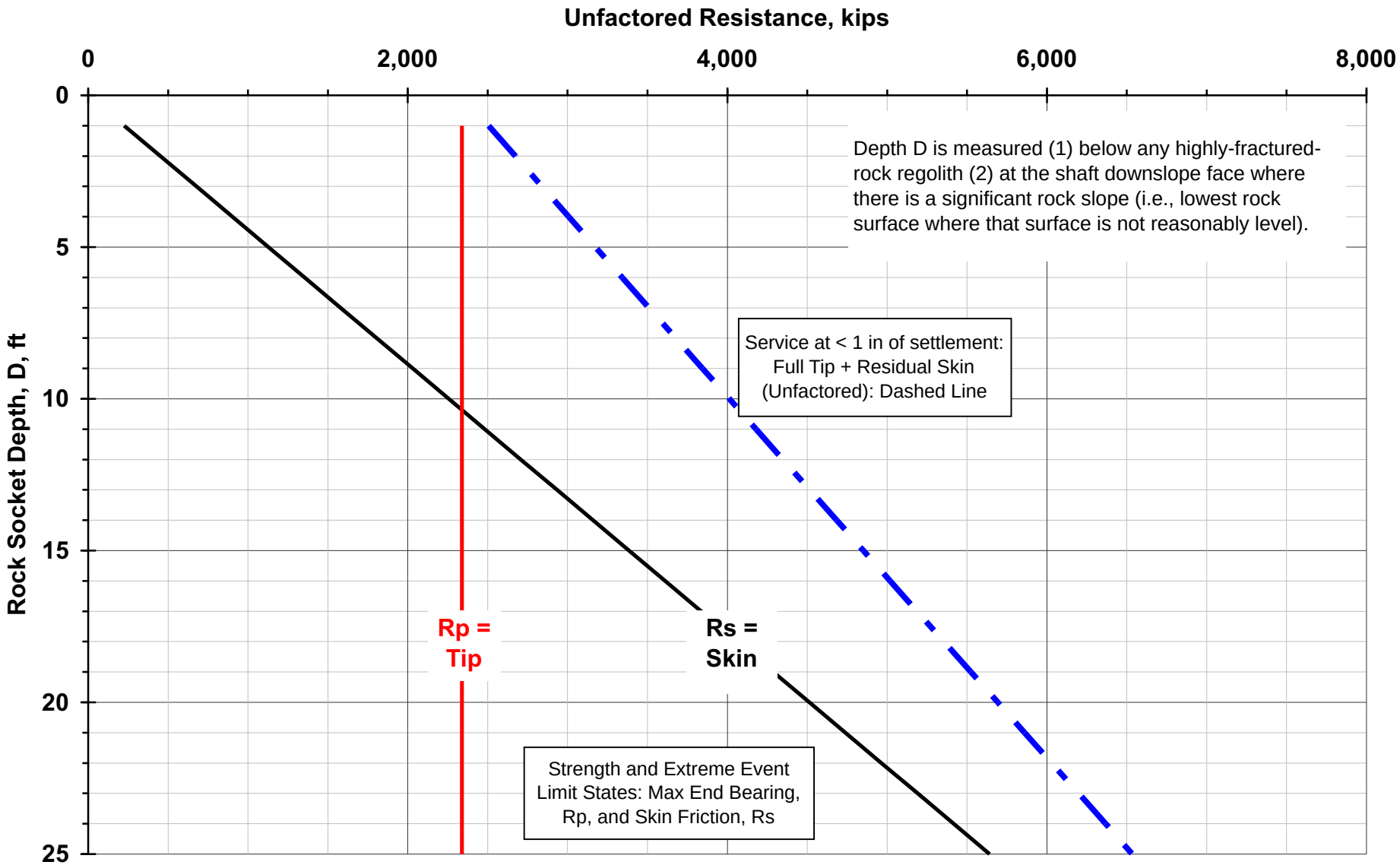

Figure 11.12

Unfactored Bearing Resistance

8-ft Diameter Shaft, Resort Creek Bridges West and East Abutments (Piers 1 and 2) - Rock

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

33758662_40.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.

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

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.

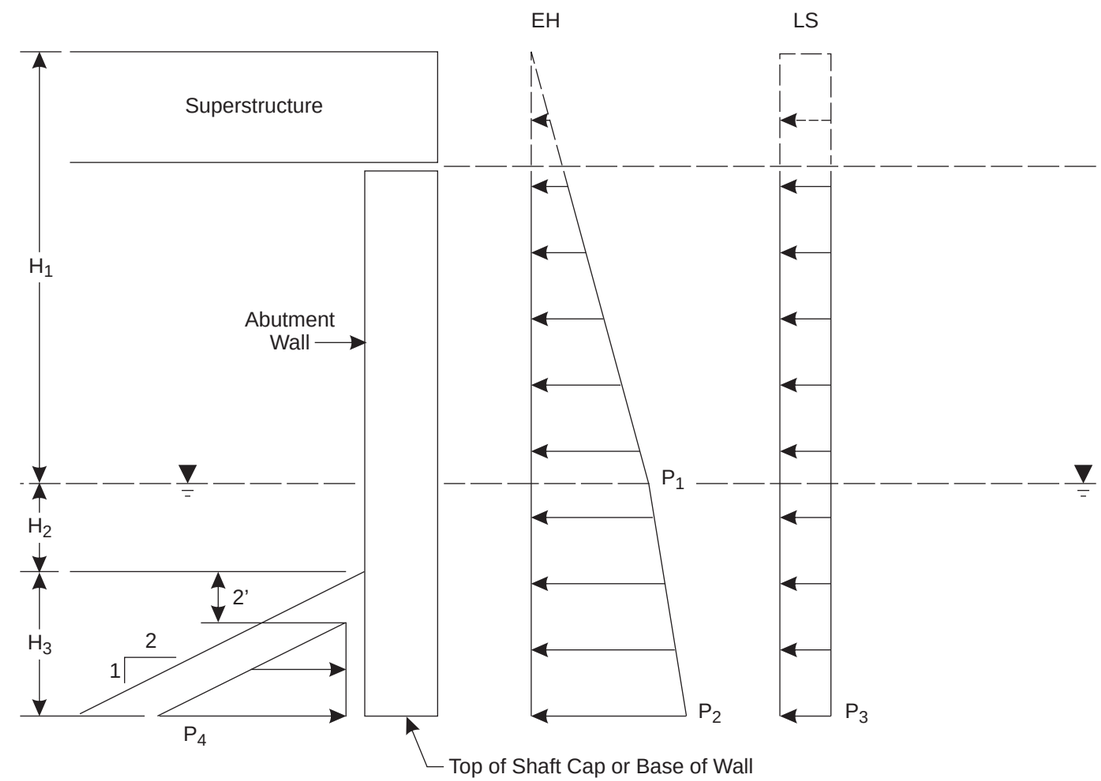
$P_1 = K_0 ã H_1$
$P_2 = K_0 ã H_1 + K_0 ã' (H_2 + H_3)$
$P_3 = K_0 ã h_{eq}$
$P_4 = K_0 ã' (H_3 - 2)$

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 Strength Limit State

Parameter	Units	Value
Soil Unit Weight, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	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	2.07

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



Job No. 33758662

Figure 11.13
Strength Limit State Earth Pressures – Resort Creek Bridges Abutments

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2010 Geotechnical Analysis and Reporting

33758662_41.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.

$P_1 = 0.5K_{ae(f)}ã(H_1 + H_2)$
$P_2 = K_aãH_1 + K_aã'H_2$
$P_3 = K_aãH_1 + K_aã'(H_2 + H_3)$
$P_4 = K_aãh_{eq}$
$P_5 = K_{pe}ã'(H_3 – 2)$

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.

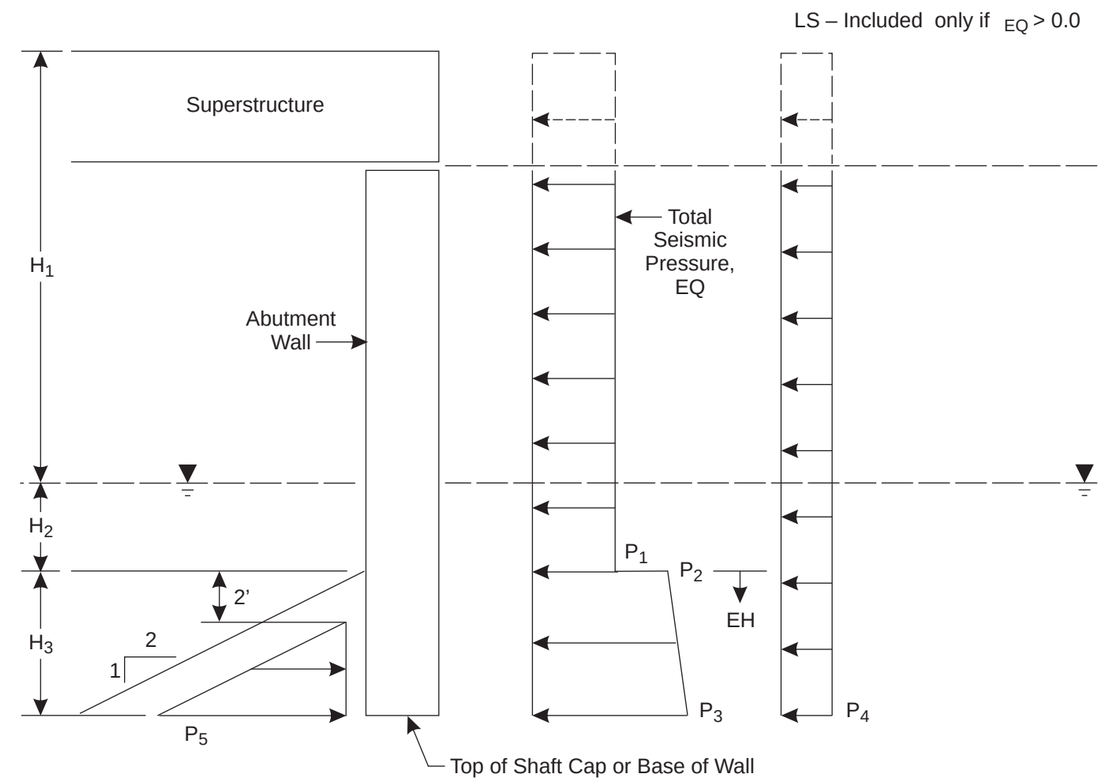
$P_1 = 0.5K_{ae(r)}ã(H_1 + H_2)$
$P_2 = K_0ãH_1 + K_oã'H_2$
$P_3 = K_0ãH_1 + K_oã'(H_2 + H_3)$
$P_4 = K_0ãh_{eq}$
$P_5 = K_oã'(H_3 – 2)$

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, ã	pounds per cubic foot (pcf)	135
Soil Effective Unit Weight, ã'	pcf	73
Soil Friction Angle, ö	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	0.30
Seismic Earth Pressure Coefficient for Shafts and Rigid Retaining Walls, $K_{ae(r)}$	unitless	0.69
Seismic Passive Earth Pressure Coefficient for Flexible Walls, K_{pe} for level finish ground line	unitless	10
Seismic Passive Earth Pressure Coefficient for Flexible Walls, K_{pe} for finish ground line sloped at 2H:1V	unitless	1.61

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



Job No. 33758662

Figure 11.14
Extreme Event Limit State Earth Pressures – Resort Creek Bridges Abutments

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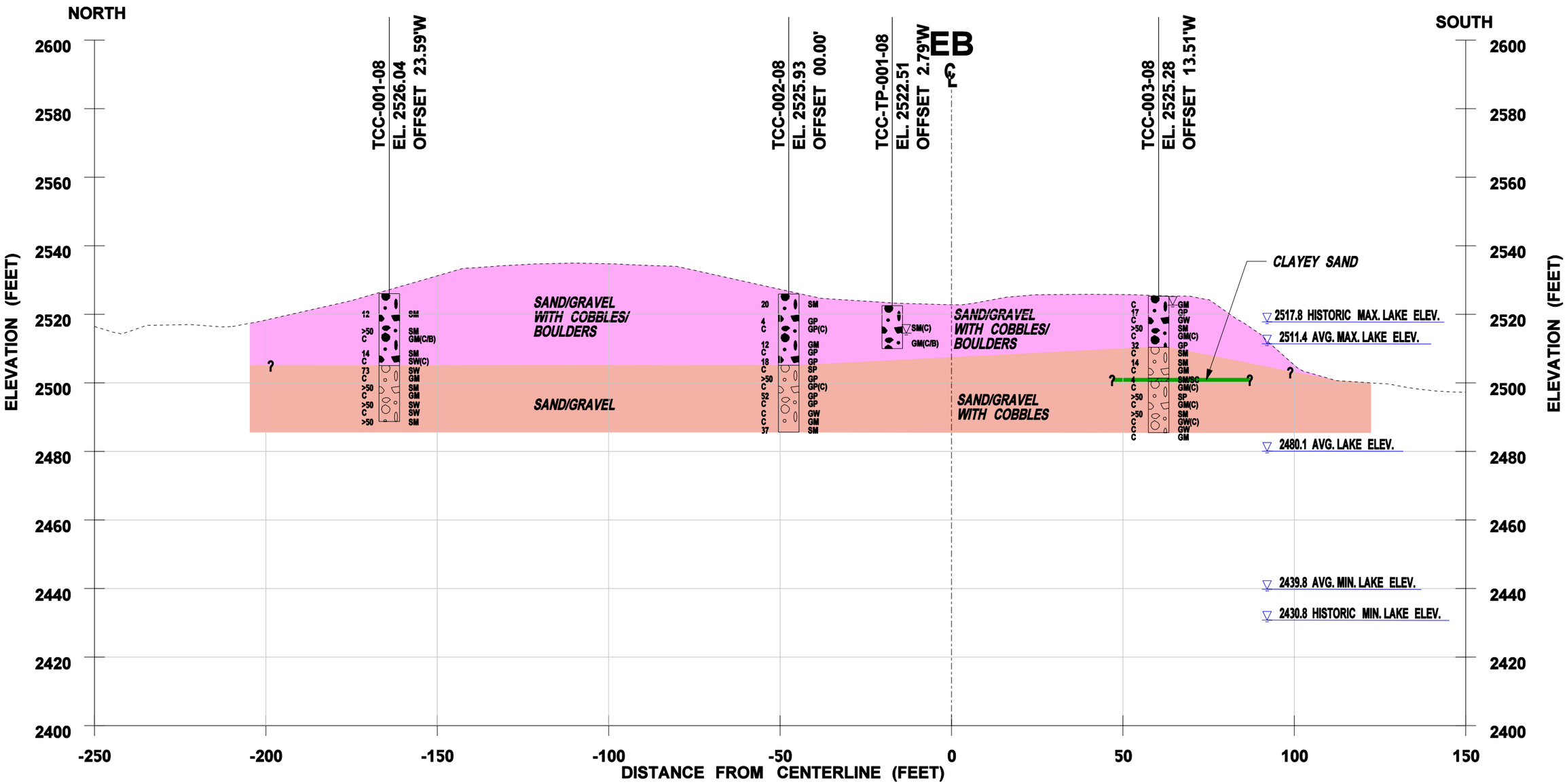
2010 Geotechnical Analysis and Reporting

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.



EB STATION 1484+23 TOWNSEND CREEK

0 30 60

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

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TIME	8:20:06 AM
DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 33758623

CONTRACT NO. Y-9764 | LOCATION NO.

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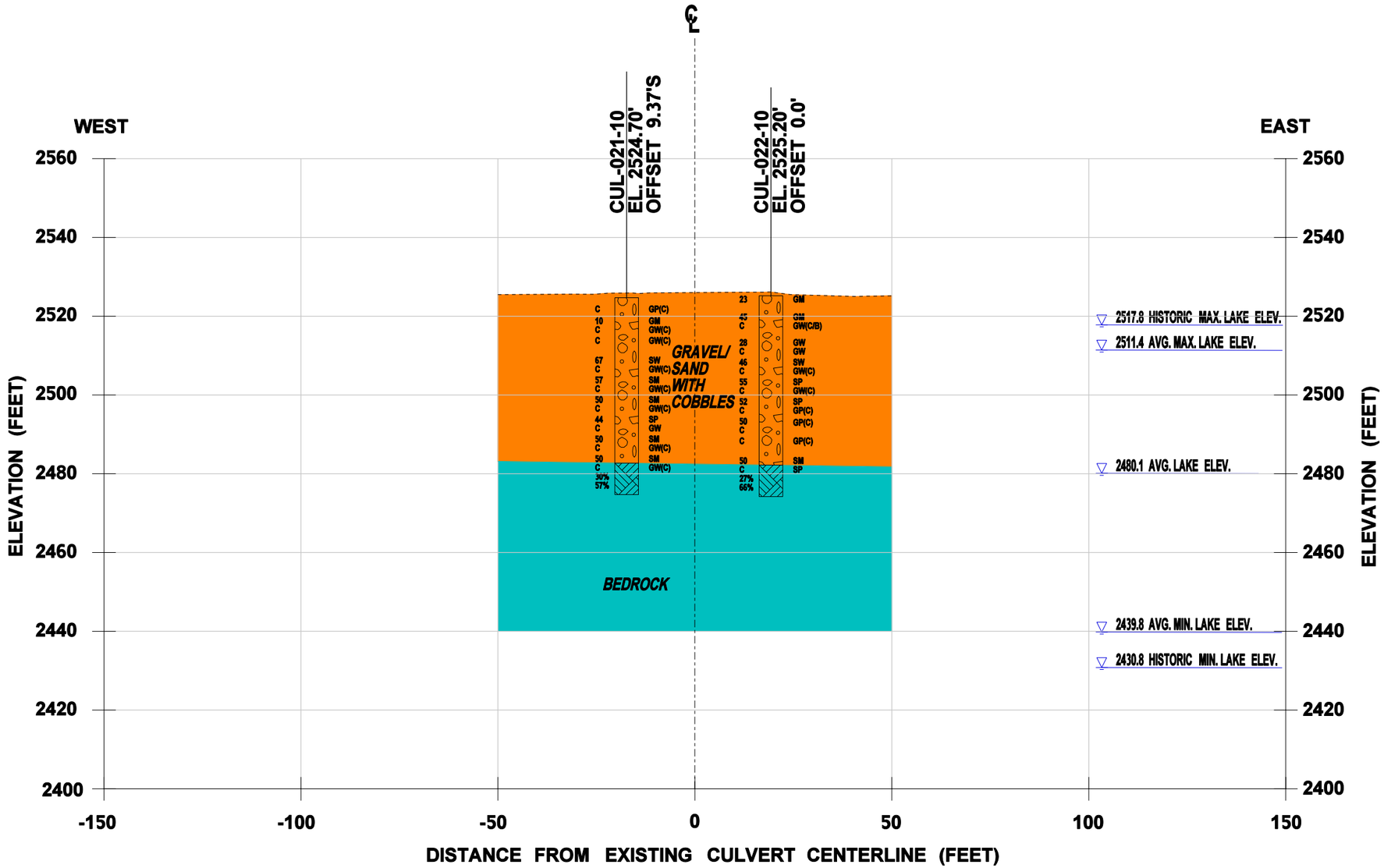
Washington State Department of Transportation

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

TOWNSEND CREEK - CROSS-SECTION 1-1'

FIGURE 12.1



RESORT CREEK CULVERT

0 30 60

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

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DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
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.

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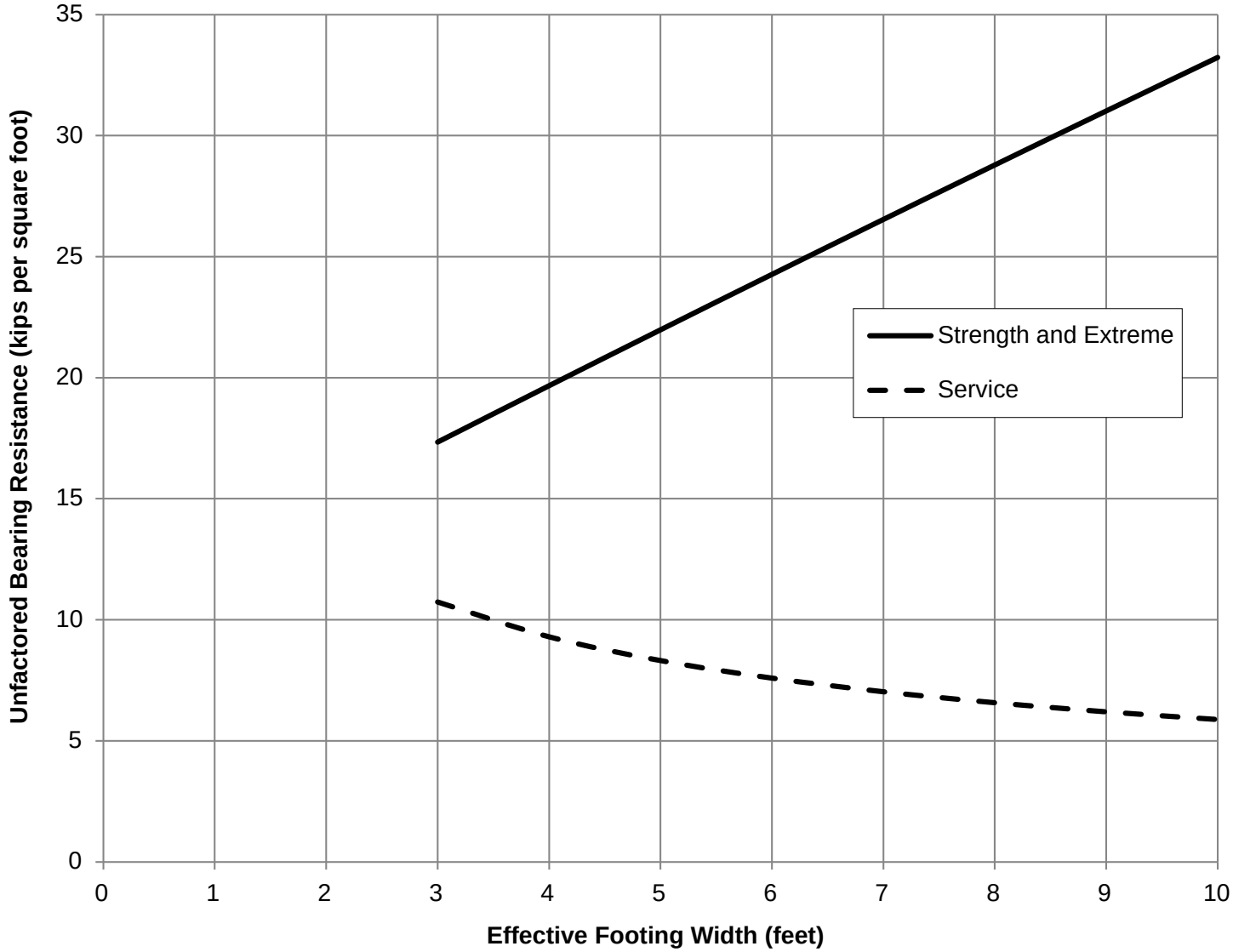
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

RESORT CREEK CULVERT PROFILE

FIGURE 12.2

33758662_30.ai



NOTES

1. Effective footing length (L')=100 feet
2. Assumed groundwater elevation equal to footing elevation
3. Bearing resistance for the service limit state calculated assuming 1.0 inch settlement

Figure 12.3

Unfactored Bearing Resistance vs. Effective Footing Width
Townsend Creek and Resort Creek Culverts

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

33758662_35.cdr

Notes

1. Part of a rigid concrete box culvert is shown. The water table is assumed at the bottom of footing level. For the surcharge load, q, on the roadway, use the larger of the vehicular load or snow load.

2. Earth pressures in psf for rigid culvert walls that cannot deflect (at-rest pressure conditions) may be calculated using the equations and values below.

$P_1 = K_0 \tilde{a} H_1$
$P_2 = K_0 \tilde{a} (H - H_3)$
$P_3 = P_2 + K_0 (\tilde{a} - \tilde{a}_w) H_3$
$P_4 = K_0 q$
$P_5 = K_0 (\tilde{a} - \tilde{a}_w)(H_2 - 2)$

Design Parameters for Calculating Lateral Earth Pressures for Strength Limit State

Parameter	Units	Value
Soil Unit Weight, $\tilde{a}$	pounds per cubic foot (pcf)	135
Water Unit Weight, $\tilde{a}_w$	pcf	62.4
Soil Friction Angle, ö	degrees	40
At-Rest Earth Pressure Coefficient, K_0	unitless	0.36
Surcharge Load, q (Vehicular Live Load or Snow Load)	pounds per square foot (psf)	selected by the designer

3. Any fine-grained or organic soil encountered in the culvert construction must be removed and replaced with compacted select fill. The backfill should be free of draining.

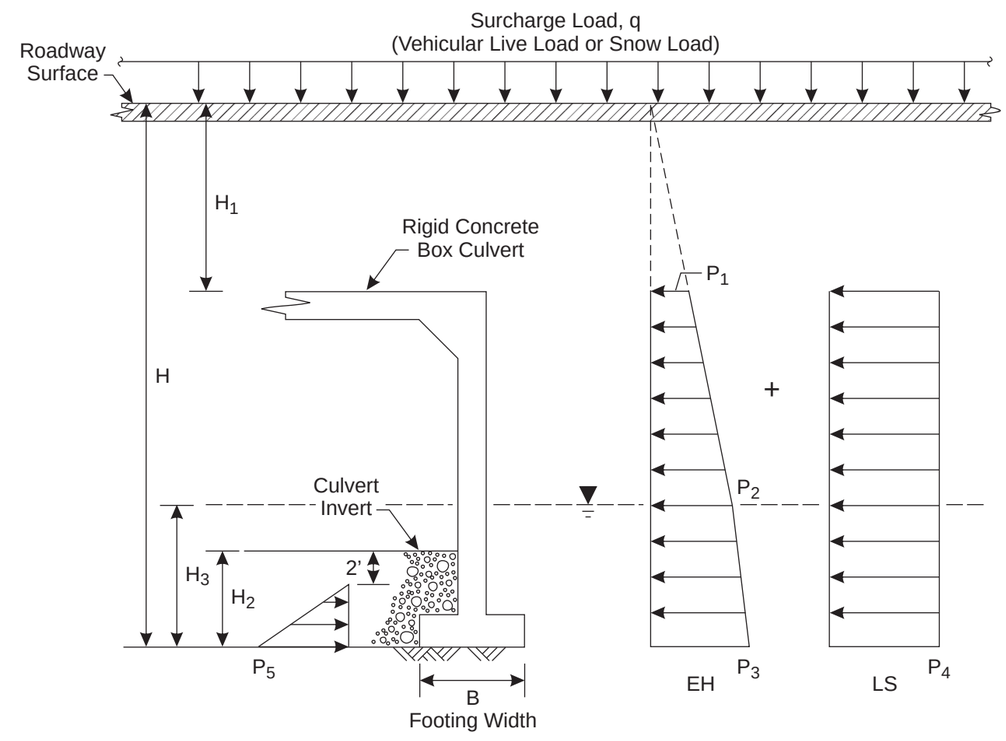

Figure 12.4
Strength Limit State Earth Pressures
Townsend Creek and Resort Creek Culverts

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

33758662_36.cdr

Notes

1. Part of a rigid concrete box culvert is shown. The water table is assumed at the bottom of footing level. For the surcharge load, q, on the roadway, use the larger of the vehicular load or snow load.

2. Earth pressures in psf for rigid culvert walls that cannot deflect (at-rest pressure conditions) may be calculated using the equations and values below.

$P_1 = 0.5K_{ae(r)}\ H$
$P_2 = K_{ae(r)\ eq}\ q$
$P_3 = K_{pe(r)}\ H_2 - 2)$

Design Parameters for Calculating Lateral Earth Pressures for Extreme Limit State

Parameter	Units	Value
Soil Unit Weight, ã	pounds per cubic foot (pcf)	135
Soil Friction Angle, ö	degrees	40
Seismic Active Earth Pressure Coefficient for Rigid Wall, $K_{ae(r)}$	unitless	0.63
Surcharge Load, q (Vehicular Live Load)	pounds per square foot (psf)	selected by the designer
Seismic Passive Earth Pressure Coefficient for Rigid Wall, $K_{pe(r)}$	unitless	0.36
Load Factor for Surcharge Load, LS, $_{eq}$	unitless	0.5

3. Any fine-grained or organic soil encountered in the culvert construction must be removed and replaced with compacted select fill. The backfill should be free draining.

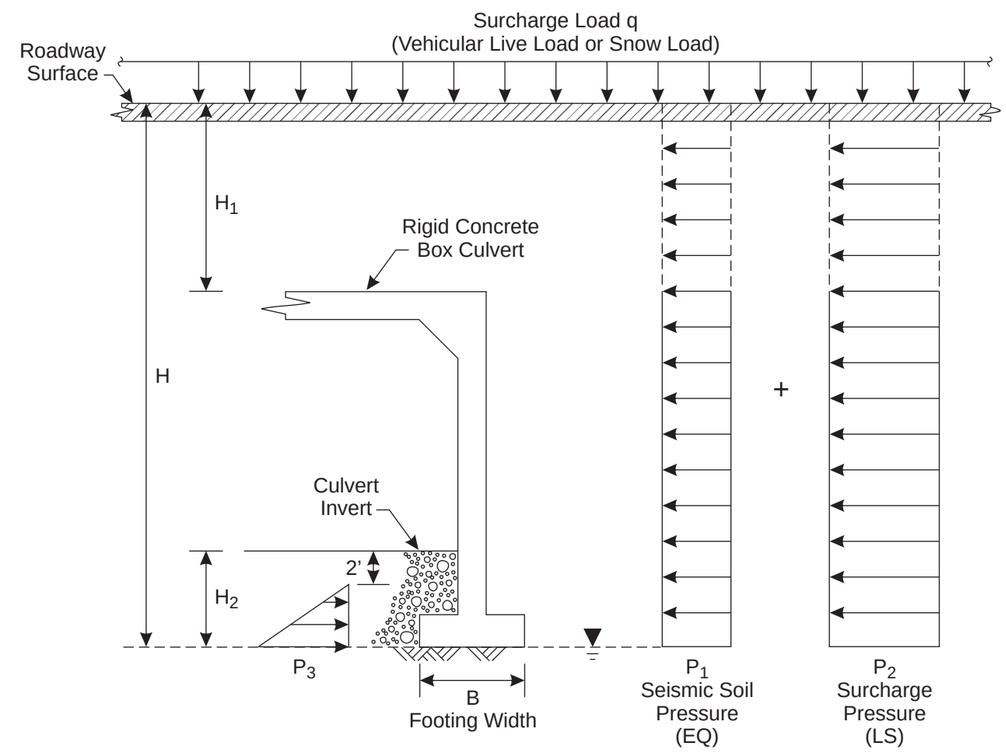

Figure 12.5

Extreme Event I Limit State Earth Pressures
Townsend Creek and Resort Creek Culverts

Job No. 33758662

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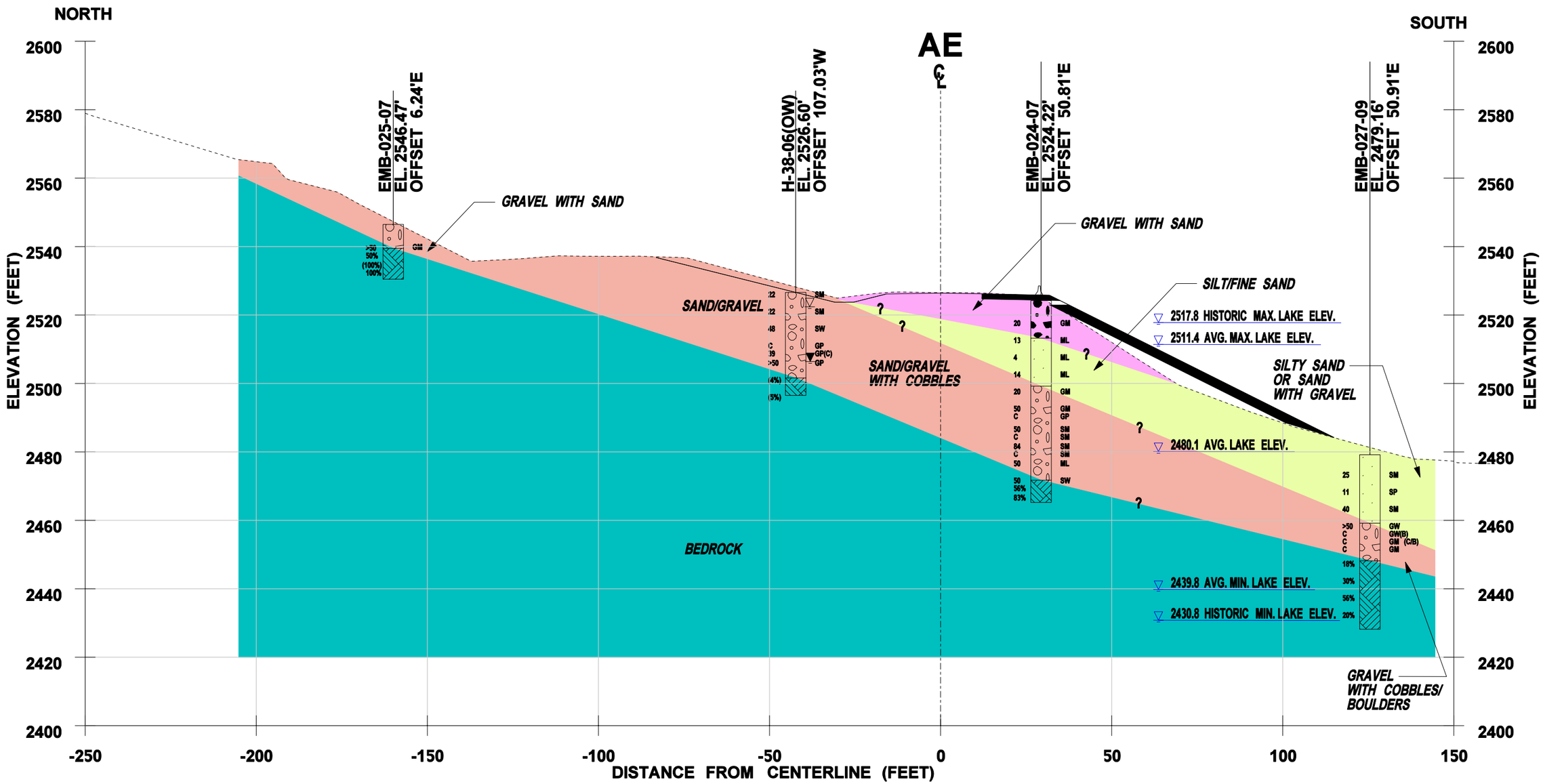
2010 Geotechnical Analysis and Reporting

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.



AE STATION 121+03 EMBANKMENT

0 30 60

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

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DATE	11/30/2010
DESIGNED BY	Kranti Maturi
ENTERED BY	brenda_mcintosh
CHECKED BY	Dave Walker
ASST. PROJ. MNGR.	Dave Walker
PROJ. MNGR.	Cecil Urlich

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JOB NUMBER 33758623

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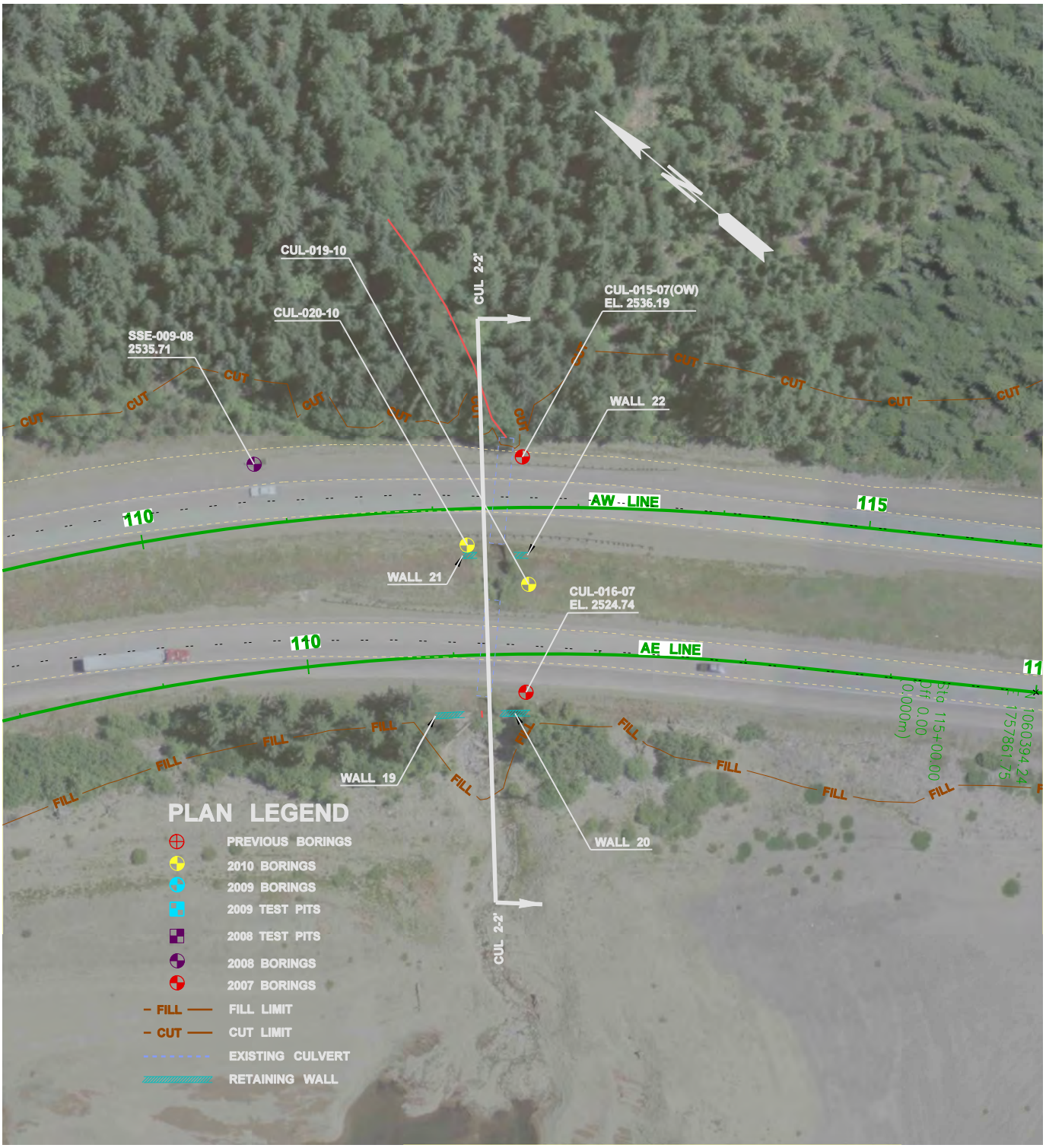
I-90 Snoqualmie Pass East
Hyak to Keechelus Dam, Washington

EMBANKMENT - CROSS-SECTION 3-3'

FIGURE 13.1



0 100 200 SCALE 1" = 100'

K:\WSDOT I-90 Snoqualmie Pass\07000 CADD\070100 CADD 2010\Sheet Files\Exploration Plans\Plan Sheet 003 Boring & Test Pit Locations 100 SCALE.dgn

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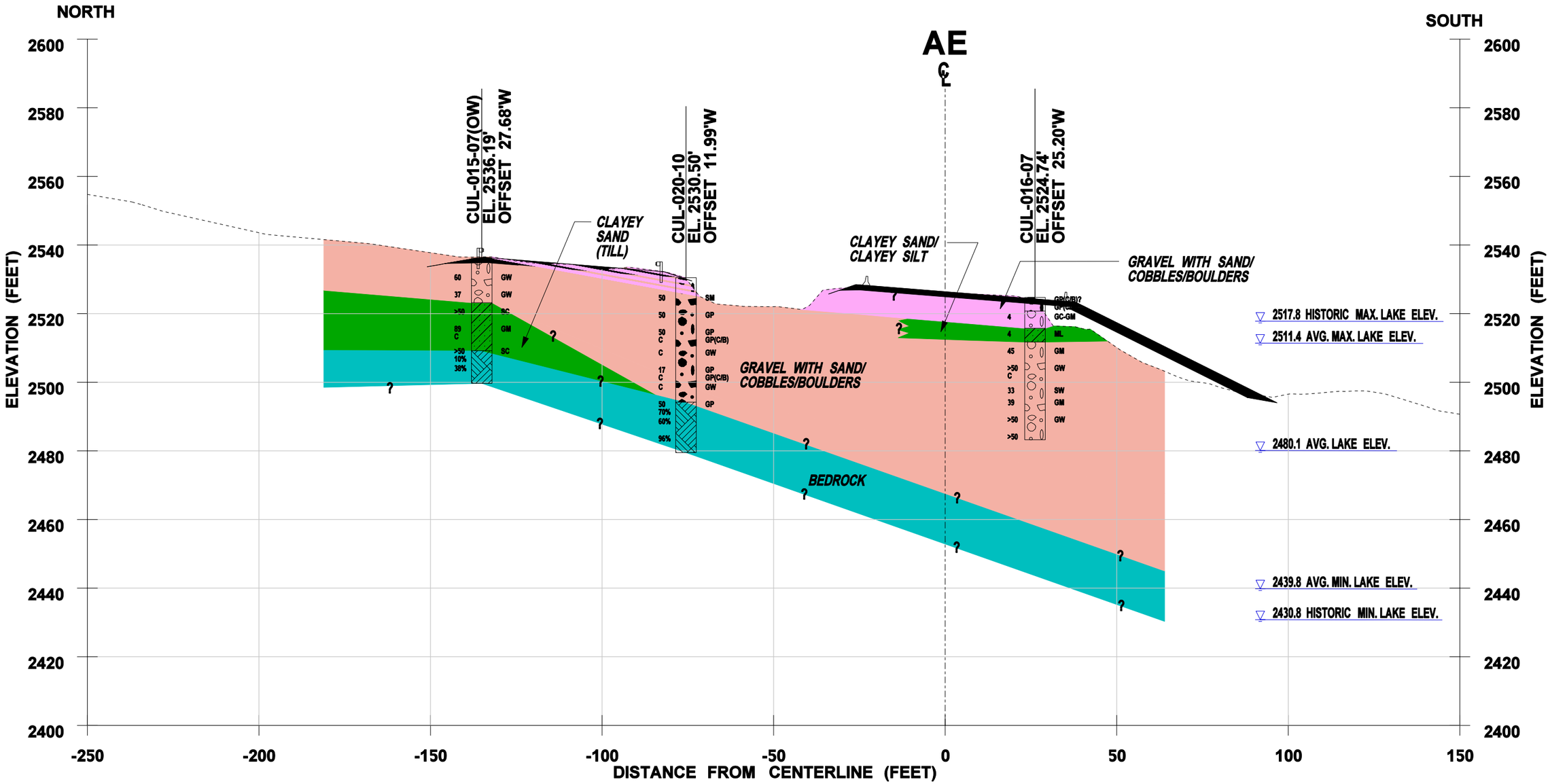
Department of Transportation

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

BORING LOCATION PLAN
MP 59.7 UNNAMED CREEK CROSSING

FIGURE
16.1

NOTE: THIS CROSS-SECTION WAS DEVELOPED USING AN ALIGNMENT AS OF MAY 2010.



AE STATION 111+24 MP 59.7 CROSSING

0 30 60

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

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DESIGNED BY	Kranti Maturi				JOB NUMBER 33758623		
ENTERED BY	Larry Jiles						
CHECKED BY	Dave Walker				CONTRACT NO. Y-9764		LOCATION NO.
ASST. PROJ. MNGR.	Dave Walker						
PROJ. MNGR.	Cecil Urlich						
		REVISION	DATE	BY			

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Hyak to Keechelus Dam, Washington

MP 59.7 CROSSING - CROSS-SECTION 1-1'

FIGURE 16.2

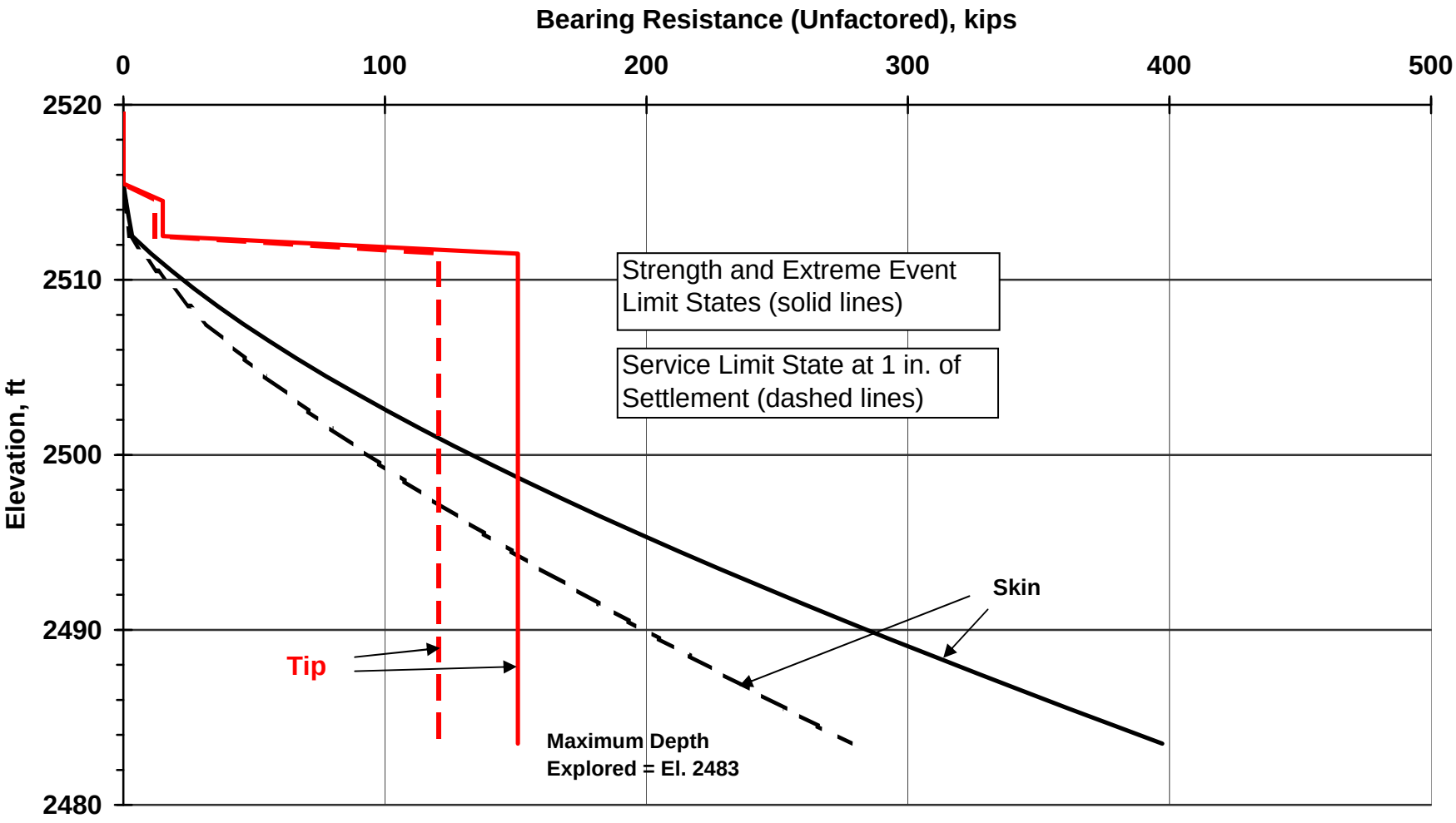

Figure 16.3

Unfactored Bearing Resistance
24-inch Diameter Shaft, MP 59.7 EB Crossing

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2010 Geotechnical Analysis and Reporting

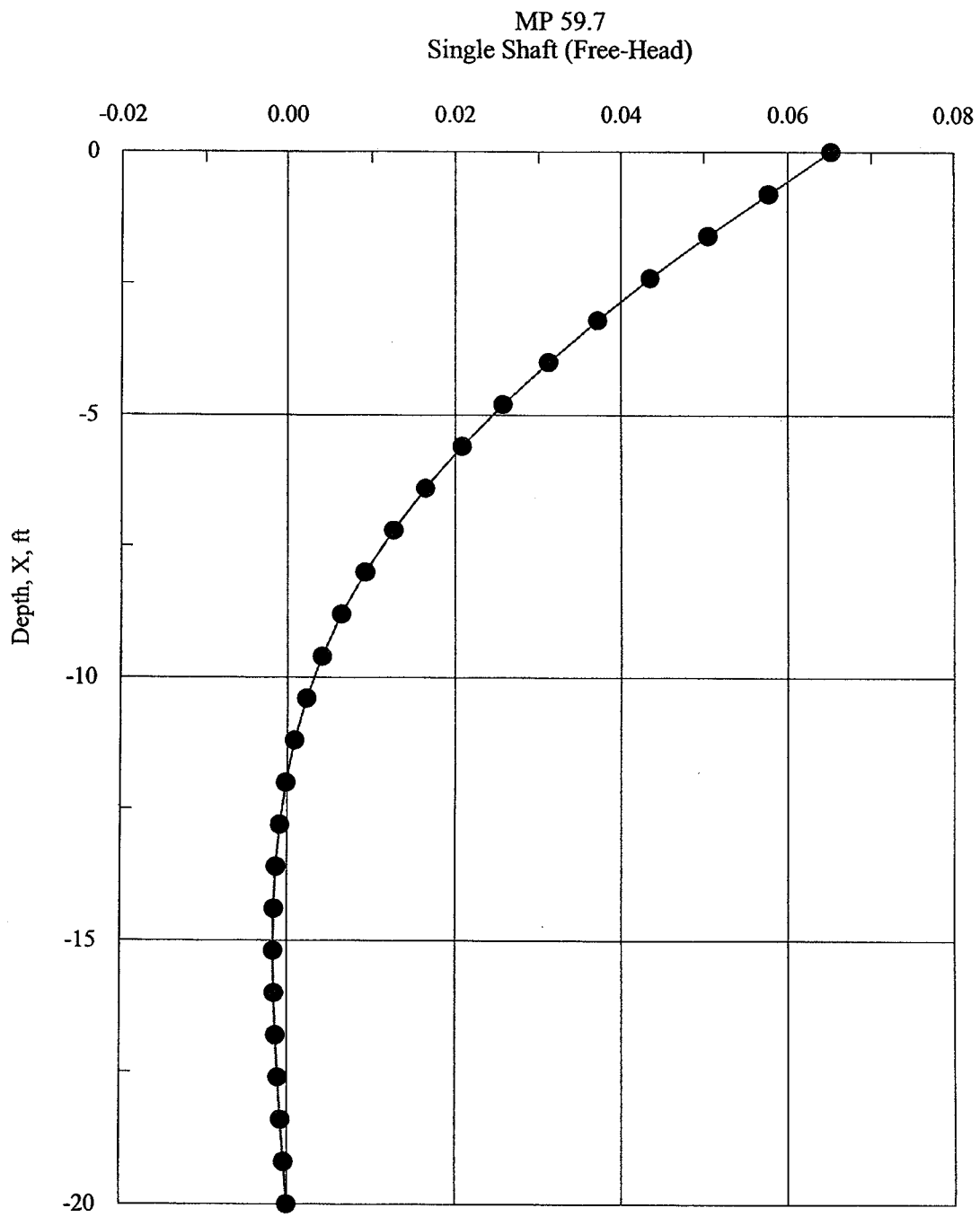

Figure 16.4

Calculated Deflection, 24-inch Diameter Shaft - Longitudinal Loading
MP 59.7 EB Crossing

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

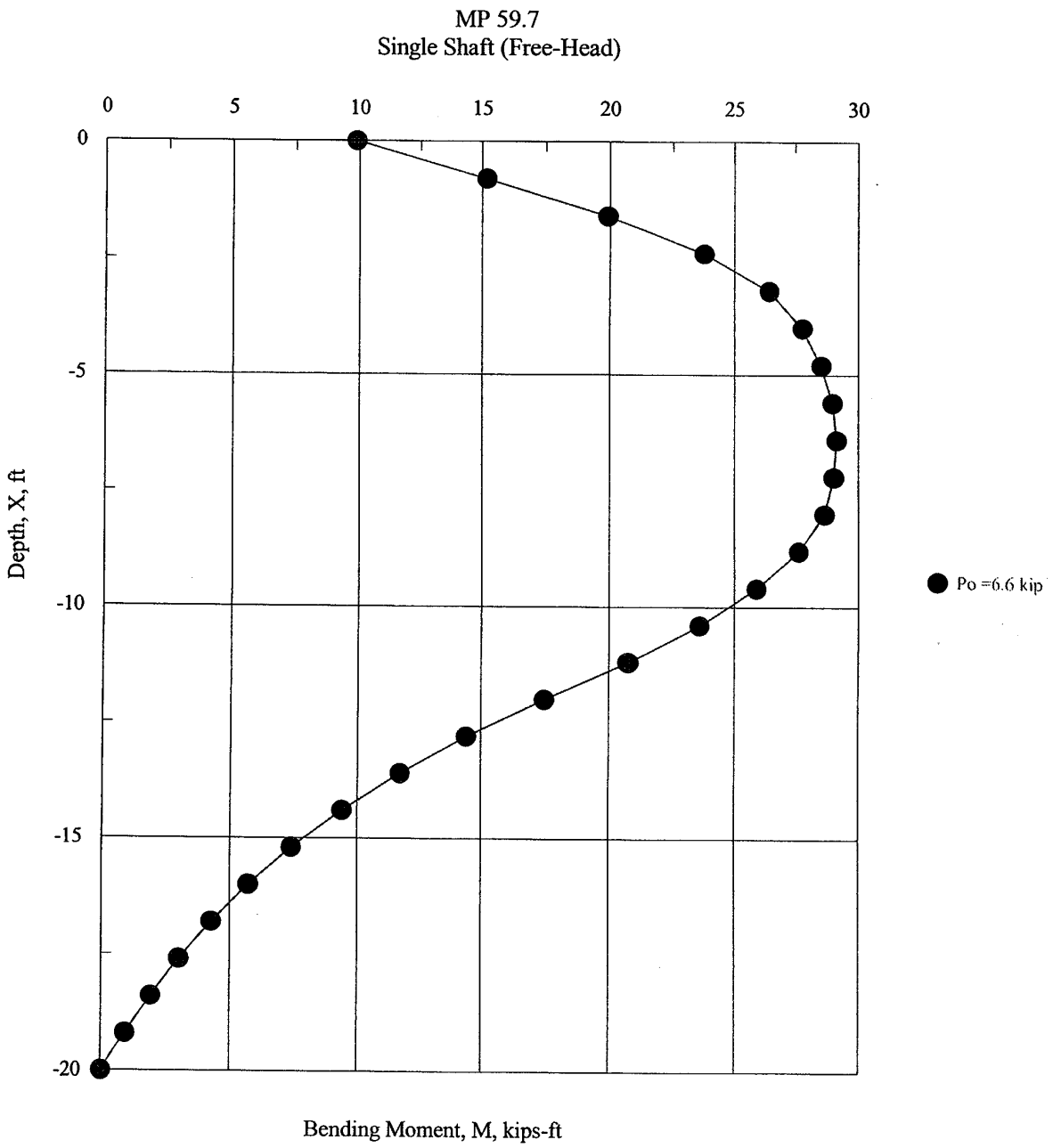

Figure 16.5

Calculated Moment, 24-inch Diameter Shaft - Longitudinal Loading
MP 59.7 EB Crossing

Job No. 33758662

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2010 Geotechnical Analysis and Reporting

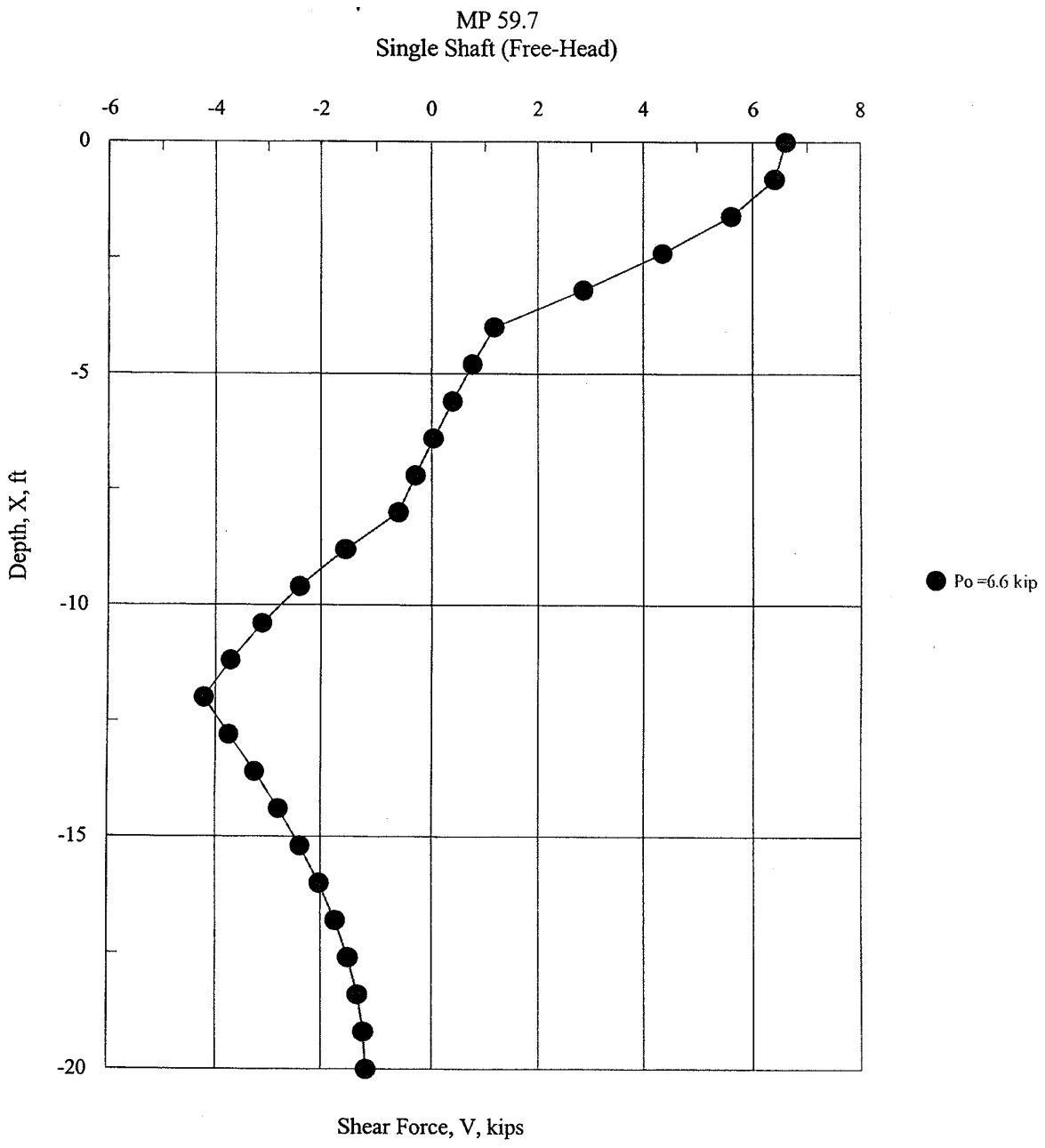

Figure 16.6

Calculated Shear, 24-inch Diameter Shaft - Longitudinal Loading
MP 59.7 EB Crossing

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

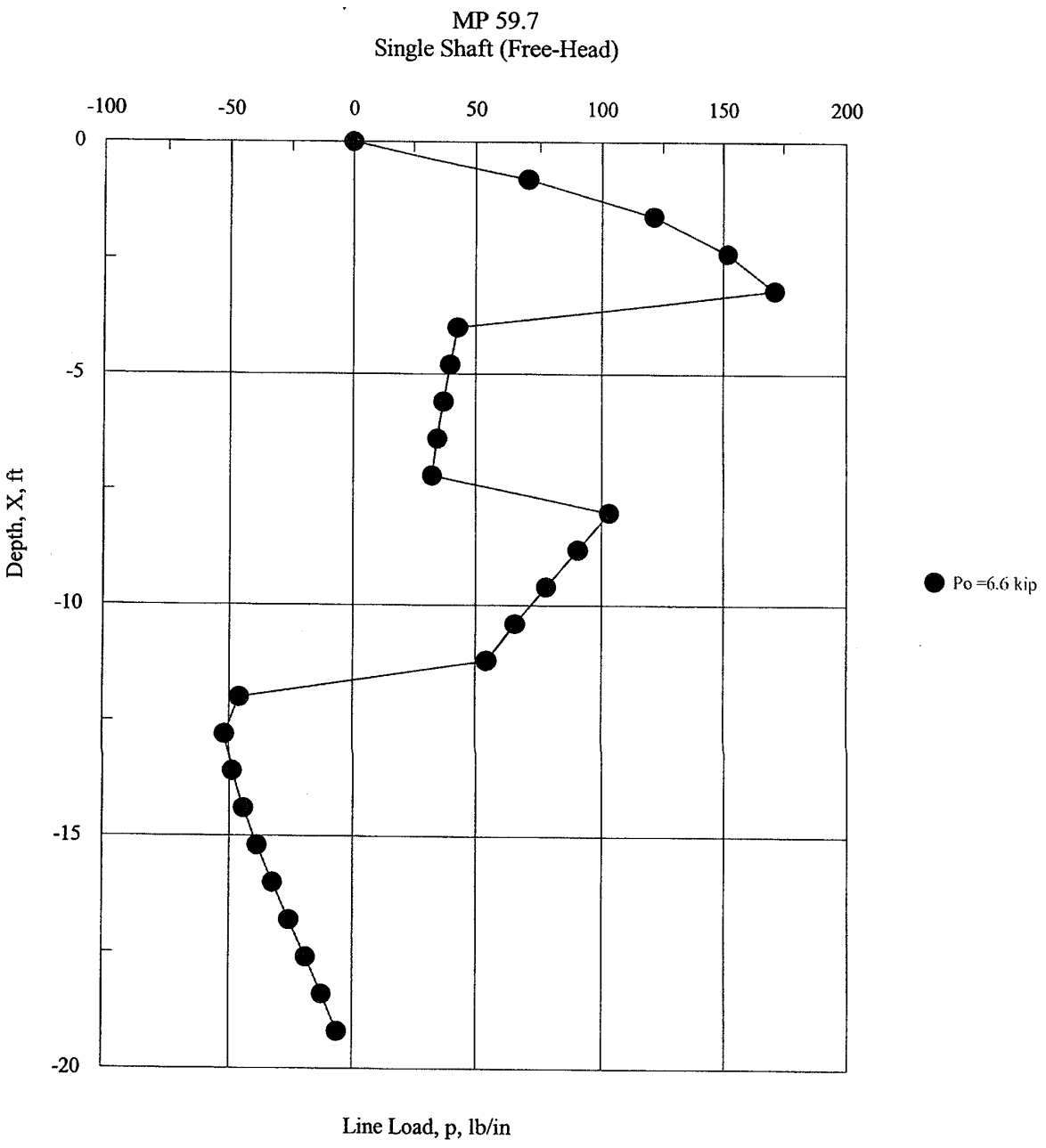

Figure 16.7

Calculated Line Load, 24-inch Diameter Shaft - Longitudinal Loading
MP 59.7 EB Crossing

Job No. 33758662

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WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

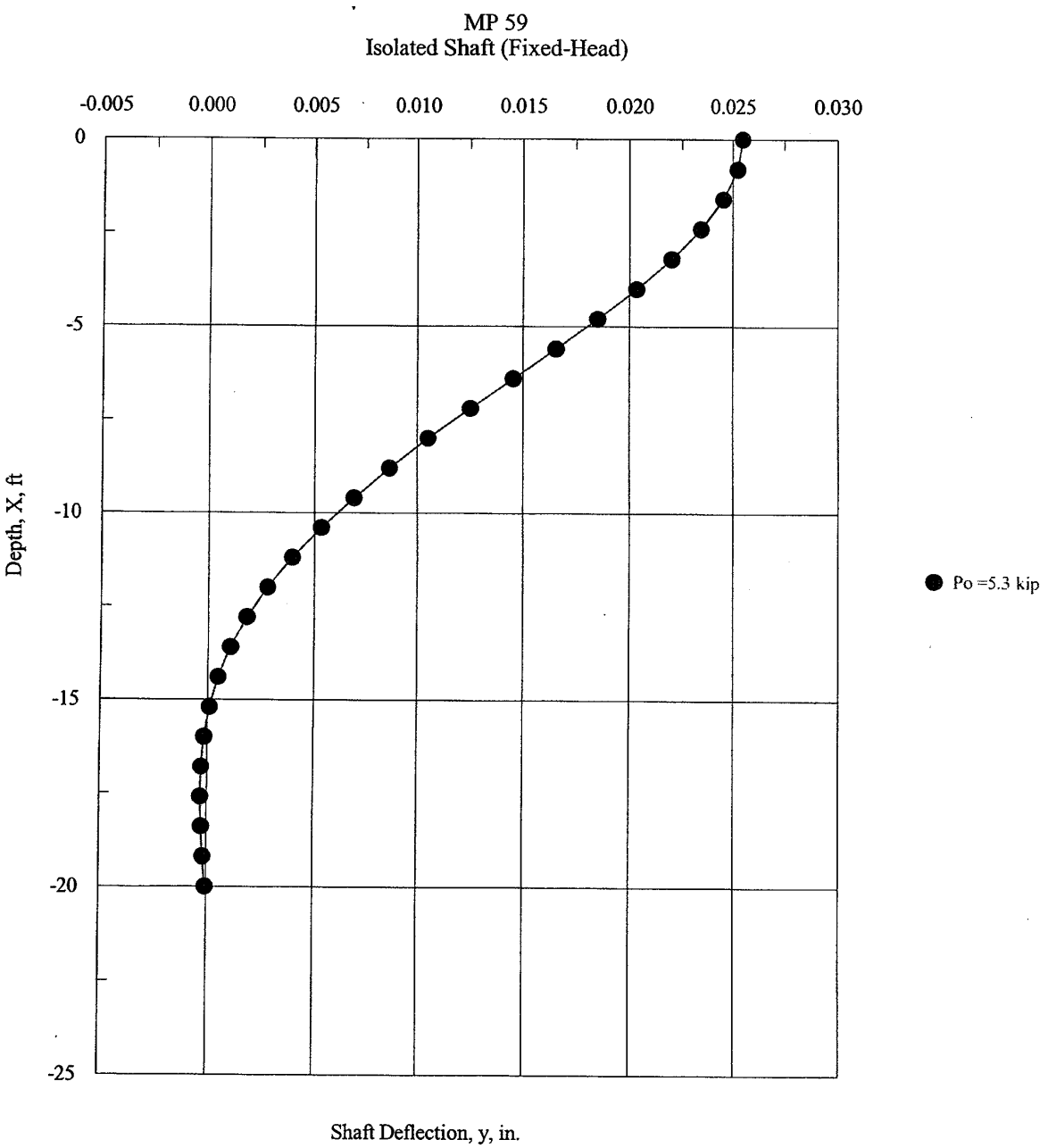

Figure 16.8

Calculated Deflection, 24-inch Diameter Shaft - Transverse Loading
MP 59.7 EB Crossing

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

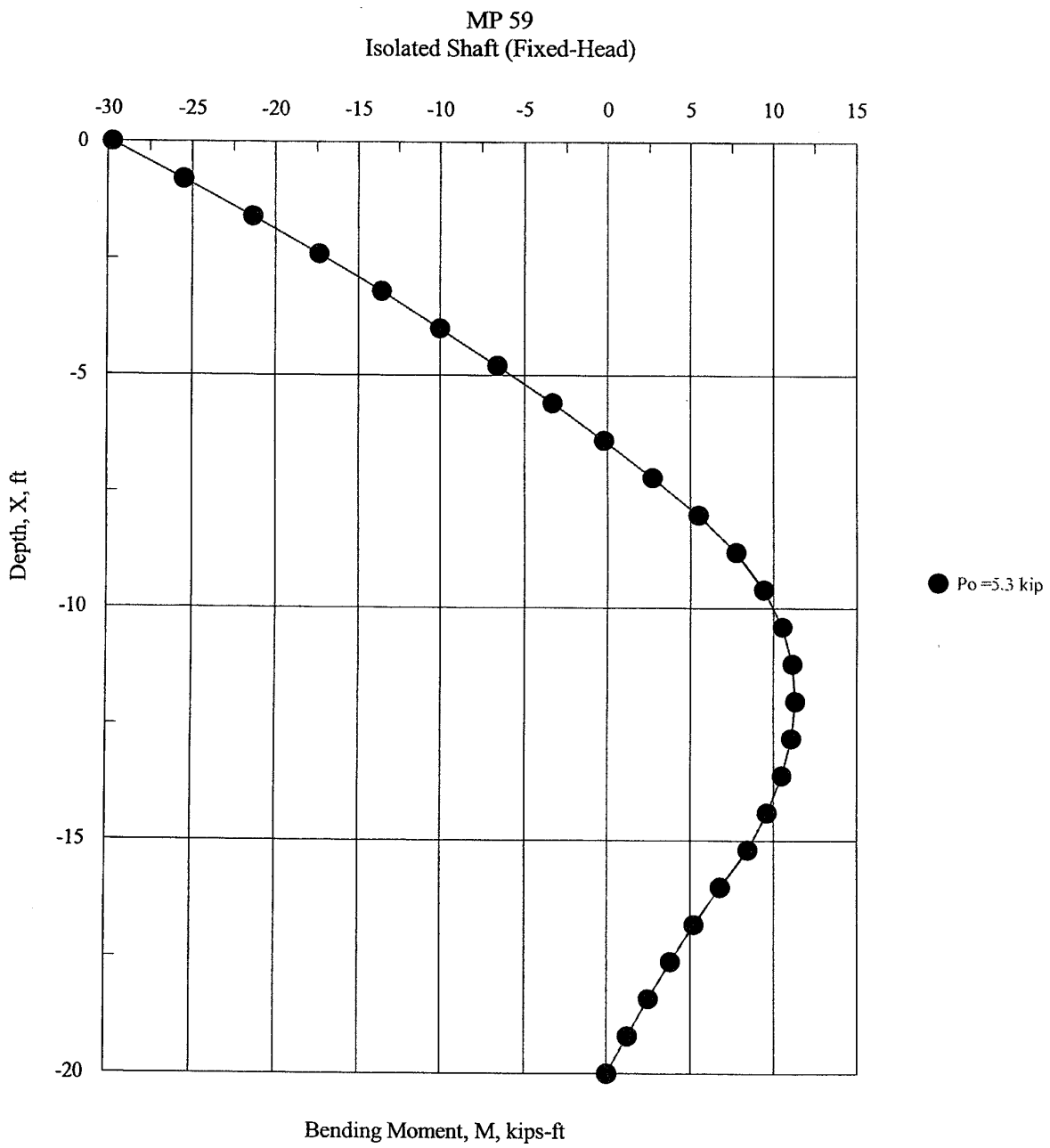

Figure 16.9

Calculated Moment, 24-inch Diameter Shaft - Transverse Loading
MP 59.7 EB Crossing

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

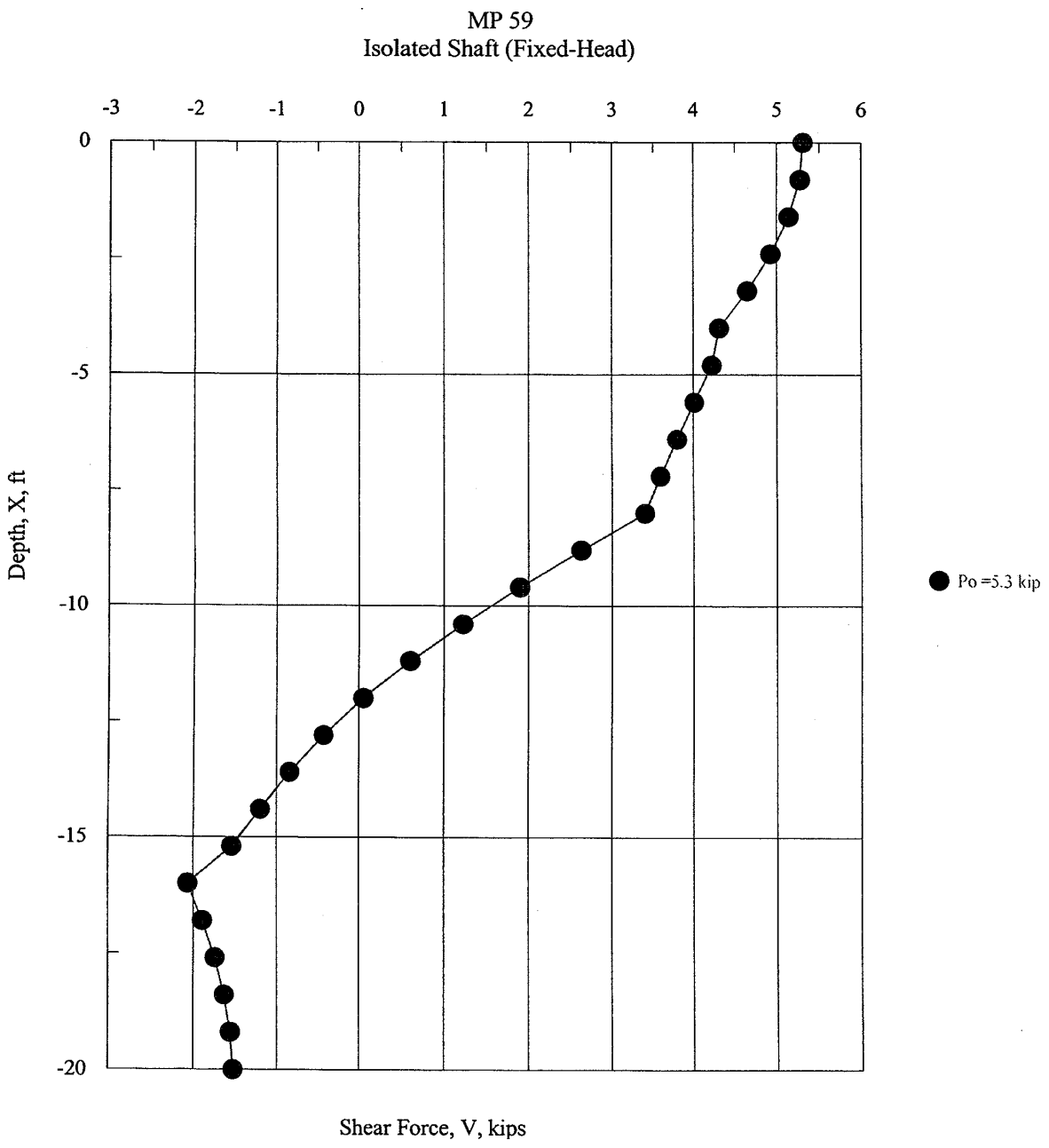

Figure 16.10

Calculated Shear, 24-inch Diameter Shaft - Transverse Loading
MP 59.7 EB Crossing

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting

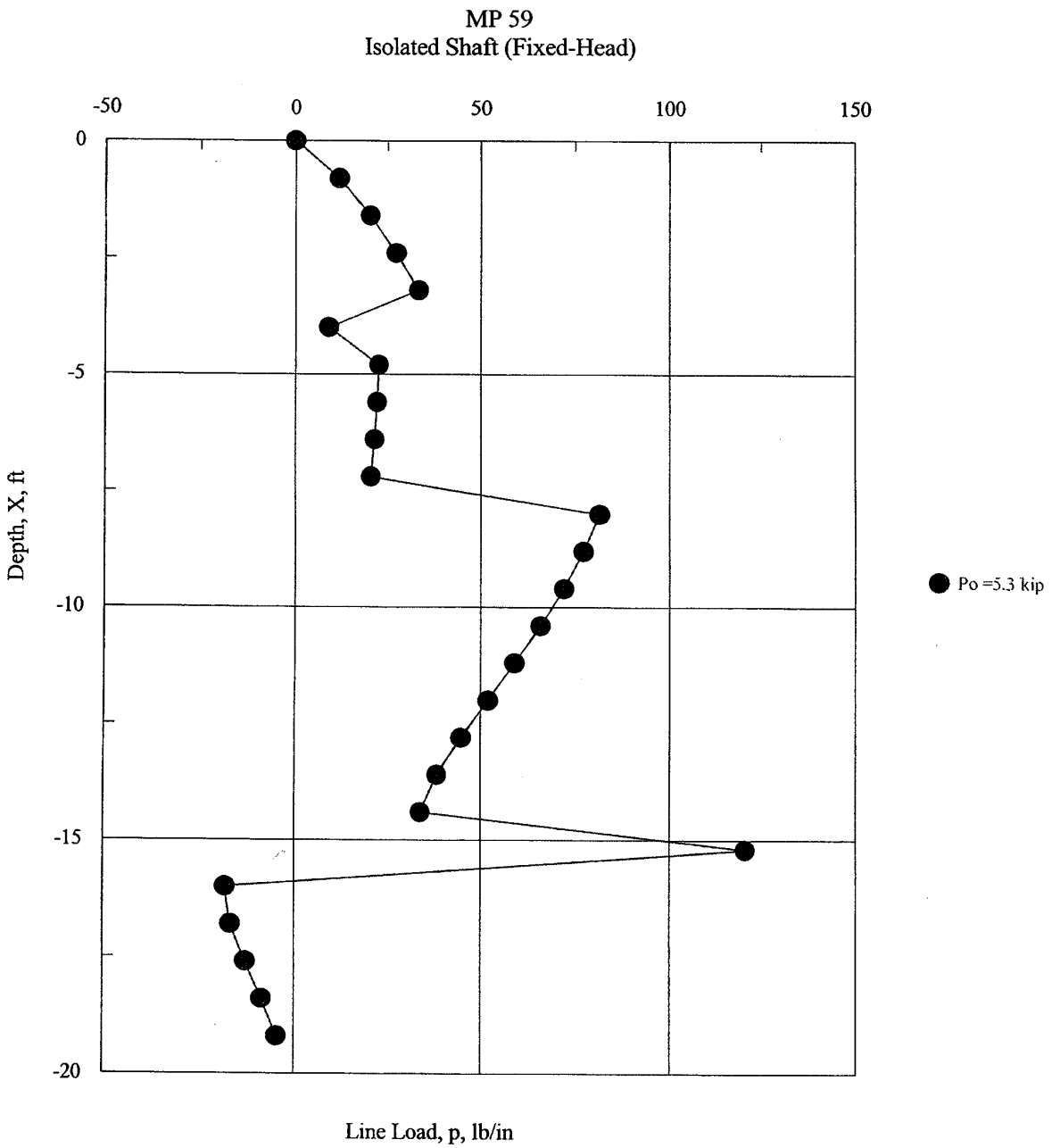

Figure 16.11

Calculated Line Load, 24-inch Diameter Shaft - Transverse Loading
MP 59.7 EB Crossing

Job No. 33758662

URS

WSDOT I-90 Snoqualmie Pass East
2010 Geotechnical Analysis and Reporting