SR-35 Columbia River Crossing Study - TS&L

FINAL REPORT - APPENDIX

October 2011

Washington State Department of Transportation

RTC

Oregon Department of Transportation

Table of Contents

Prepared By

PARSONS BRINCKERHOFF
400 SW Sixth Avenue, Suite 802
Portland, Oregon 97204
Telephone: (503) 274-7225

Primary Authors

Mark Hirota, P.E., Project Manager
Laura Amundson, P.E., Bridge Task Lead

Additional Information

For more information about the SR-35 Columbia River Crossing Study, contact:

Dale Robins
Regional Transportation Council
Telephone: (360) 397-6067, x5212
E-mail: sr35@rtc.wa.gov
Project Website: http://www.rtc.wa.gov/studies/sr35

T·Y·LIN INTERNATIONAL
285 Liberty Street NE, Suite 350
Salem, OR 97301

otak
17355 SW Boones Ferry Road
Lake Oswego, OR 97035

Northwest Hydro Inc.
31 Cougar Creek Road
Skamania, WA 98648

Pacific Geotechnical
1419 Washington Street, Suite 101
Oregon City, Oregon 97045

ECONORTHWEST
99 West 10th Avenue, Suite 400
Eugene, Oregon 97401

SWCA ENVIRONMENTAL CONSULTANTS
434 NW 6th Avenue, Suite 304
Portland, OR 97209-3652

APPENDIX A

Final Geotechnical Data Report

Memorandum

To: Mark Hirota, PB

From: John Horne, Evan Garich

Date: May 31, 2011

Subject: Final Geotechnical Foundation Recommendations, TS&L Phase SR-35, Columbia River Crossing Project

This memorandum has been developed to provide preliminary geotechnical recommendations to facilitate the TS&L bridge design efforts for the SR-35 Columbia River Crossing Project. This document supersedes the memorandum "Preliminary Geotechnical Foundation Recommendations" dated December 12, 2010 and February 25, 2011, and incorporates comments received by project team members.

A TS&L geologic profile at the proposed bridge alignment has been developed using historic construction documents, and project specific investigations which included two surveys and three geotechnical borings. The surveys include a bathymetric survey performed on July 14, 2010 and a geophysical survey performed on October 20, 2010. Barge mounted geotechnical drilling occurred from December 20 to 23, 2010.

The investigations were performed in order to develop a better understanding of the elevation of bedrock and thickness of alluvium along the alignment. The historic construction records and geophysical survey are in general agreement at the northerly and southerly margins of the project. However, there is divergence of the data sets from Sta. 33+00 to 51+00. The depth to bedrock is deeper than represented in historic construction records at geotechnical borings B-1 and B-2, however there is good agreement at B-3. The geophysical survey did not produce meaningful results from Sta. 33+00 to 51+00 due to the thickness of the alluvial package over bedrock and the limitations in the ability of the equipment to penetrate 100+ feet of sediment. The TS&L geologic profile is included as Attachment A. Although the bedrock elevation has been determined at the three boring locations and to a high degree of confidence at the southerly and northerly portions of the river crossing, significant uncertainty remains in between the boring locations from Sta. 33+00 to 50+00 and at the south abutment where bedrock may increase in depth again.

Preliminary foundation recommendations have been developed for driven piles and drilled shafts. Driven piles were analyzed for stratigraphies developed at B-1 and B-2, while drilled shafts were analyzed at B-3. It is presumed that driven piles would be more economical at locations of deep bedrock (±50 feet of sediment) while drilled shafts would be more economical in locations of shallow bedrock. Three sizes of open-ended pipe pile were analyzed: 24x0.5, 36x0.5 and 48x0.5. It was assumed all piles would be driven into bedrock and ultimate capacity would be limited by the structural capacity of the piles. In the field, it may not be possible to drive the piles to bedrock, however very high axial capacities will be achievable even if the piles are not tipped in bedrock.

Driven pile tip elevations should be a minimum of 20 feet below the maximum predicted liquefaction depth of 60 feet. Driven pile capacities at B-1 and B-2 are presented in Attachment B.

It is presumed drilled shafts would be socketed into bedrock and behave primarily as end bearing shafts. Shaft sizes of 6, 8, and 10 ft. in diameter were analyzed. Shafts should be socketed at least two diameters into rock. Axial capacity derived from the bedrock will be highly dependent on the overall strength/hardness, jointing characteristics, and degree of weathering at each shaft location. The bedrock at the project location is basalt of the Grande Ronde Formation. Basalt samples obtained from drilling ranged from weathered to fresh, with unconfined compressive strengths ranging from 1,500 to 22,000 psi. Low end strengths were used in the drilled shaft capacity calculations at B-3. Drilled shaft capacities at B-3 are presented in Attachment C.

Soil and rock parameters have been developed for lateral loading and deformation analysis. The recommended parameters are presented in Tables 1 and 2. The lateral parameters for rock were developed based on Unconfined Compressive Strength tests using Mohr-Coulomb failure criteria and accounting for potential jointing in the rock and the stresses acting on the rock.

Table 1. Lateral Analysis Parameters at B-1 and B-2

Unit	1		2		3	4
Description	Loose Alluvial Sand		Med-Dense Alluvial Sand		Dense Alluvial Gravel	Basalt
B-1 Thickness	40 ft		54 ft		26 ft	--
B-2 Thickness	68 ft		22 ft		13 ft	--
Condition	Static	Liquefied	Static	Liquefied	Static/ Liquefied	Static/ Liquefied
Soil Type for LPILE Analysis	"Sand"	"Sand"	"Sand"	"Sand"	"Sand"	"Silt" (c-φ material)
Effective Unit Weight (pcf)	38	38	53	53	68	83
Φ (degrees)	28	8	32	8	35	35
Cohesion (psf)	0	0	0	0	0	144,000
Lateral p-y parameter "k" (pci)[1]	20	4	60	4	125	4000
Strain at 50% Maximum Stress	0	0	0	0	0	0.005

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Table 2. Lateral Analysis Parameters at B-3

Unit	1		2		3	4
Description	Soft Alluvial Silt		Loose Alluvial Sand		Weathered Basalt	Basalt
B-3 Thickness	27 ft		3 ft		15 ft	--
Condition	Static	Liquefied	Static	Liquefied	Static/ Liquefied	Static/ Liquefied
Soil Type for LPILE Analysis	"Clay"	"Sand"	"Sand"	"Sand"	"Sand"	"Silt" (c-φ material)
Effective Unit Weight (pcf)	33	33	53	53	73	83
Φ (degrees)	0	8	28	8	40	35
Cohesion (psf)	100	0	0	0	0	13,000
Lateral p-y parameter "k" (pci)	20	4	20	4	125	4000
Strain at 50% Maximum Stress	0.02	0	0	0	0	0.002

Seismic design parameters have been developed following AASHTO LRFD Bridge Design Specifications, 5th Ed. Currently, ODOT specifies performance requirements for two ground motion events having recurrence intervals of approximately 500-years and 1,000-years based on USGS 2002 PSHA, while WSDOT has performance requirements for one event, the 1,000-year recurrence based on USGS 2008 PSHA. The USGS 2008 ground motions were found to be approximately 5 percent larger than those found using the 2002 data set. For this study, WSDOT seismic criteria were considered to control. Ground motions based on the USGS 2008 data at the rock/alluvium interface have been characterized and are presented in Attachment D.

The site is located within an area of moderate seismicity. No known active faults lie within 6 miles of the project site. A simplified liquefaction assessment of the soil columns at B-1, B-2, and B-3 is presented in Attachment D. The loose alluvium in the upper 60 feet at borings B-1 and B-2 is potentially liquefiable. The elastic silt present in boring B-3 would not be expected to liquefy, however, it may exhibit sensitive behavior which will result in strength loss during a seismic event. Although not directly analyzed, the south approach should be considered susceptible to liquefaction-induced lateral spreading. Mitigation involving ground improvement should be considered to reduce the effects of liquefaction-induced lateral spreading. The limits and type of ground improvement should be developed during subsequent design phases of the project.

Report prepared by:

John Horne

Evan Garich

<u>Attachments</u>

Attachment A: TS&L Geologic Profile
Attachment B: Preliminary Driven Pile Capacities
Attachment C: Preliminary Drilled Shaft Capacities
Attachment D: Seismic Design Criteria

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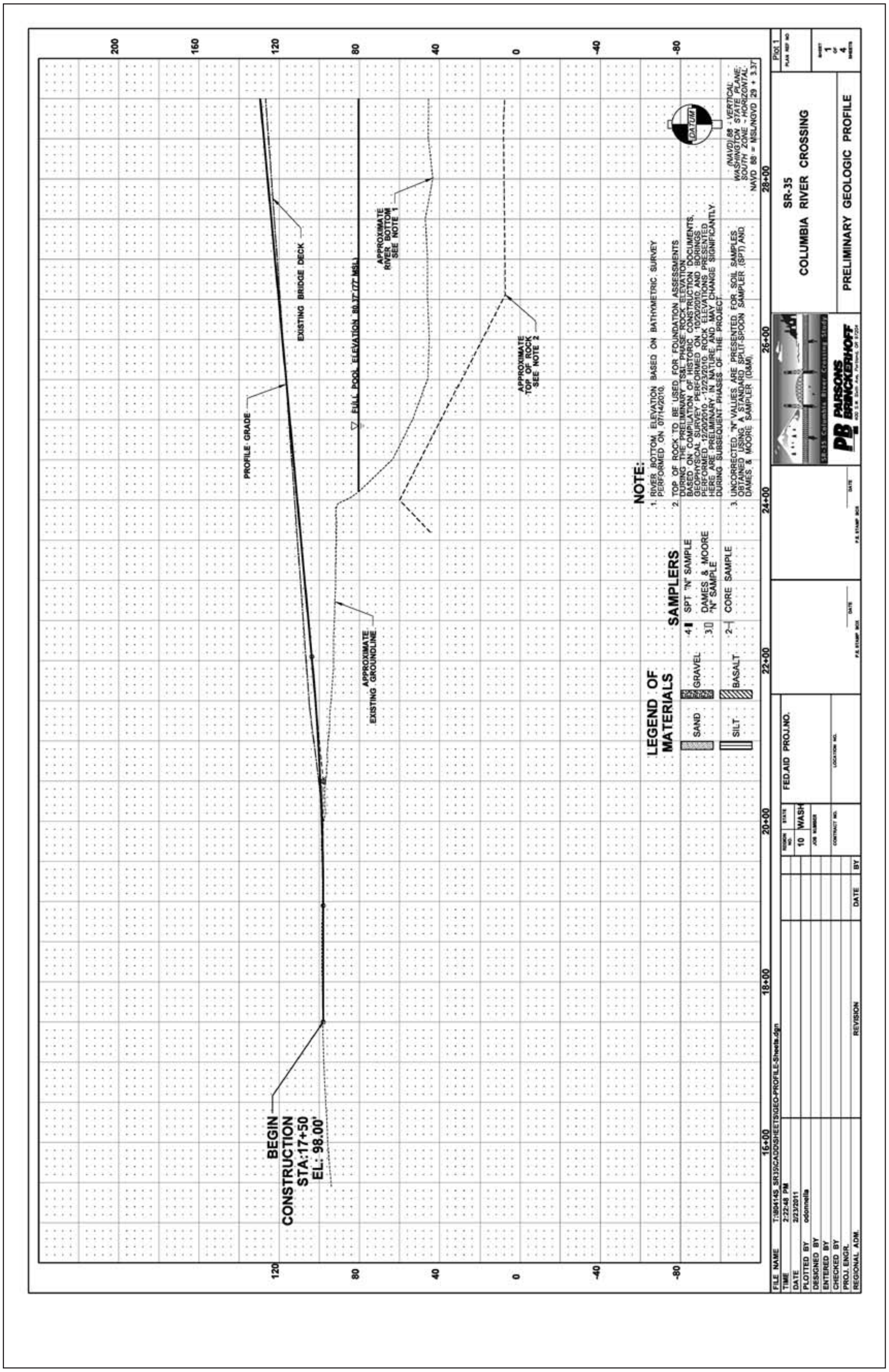
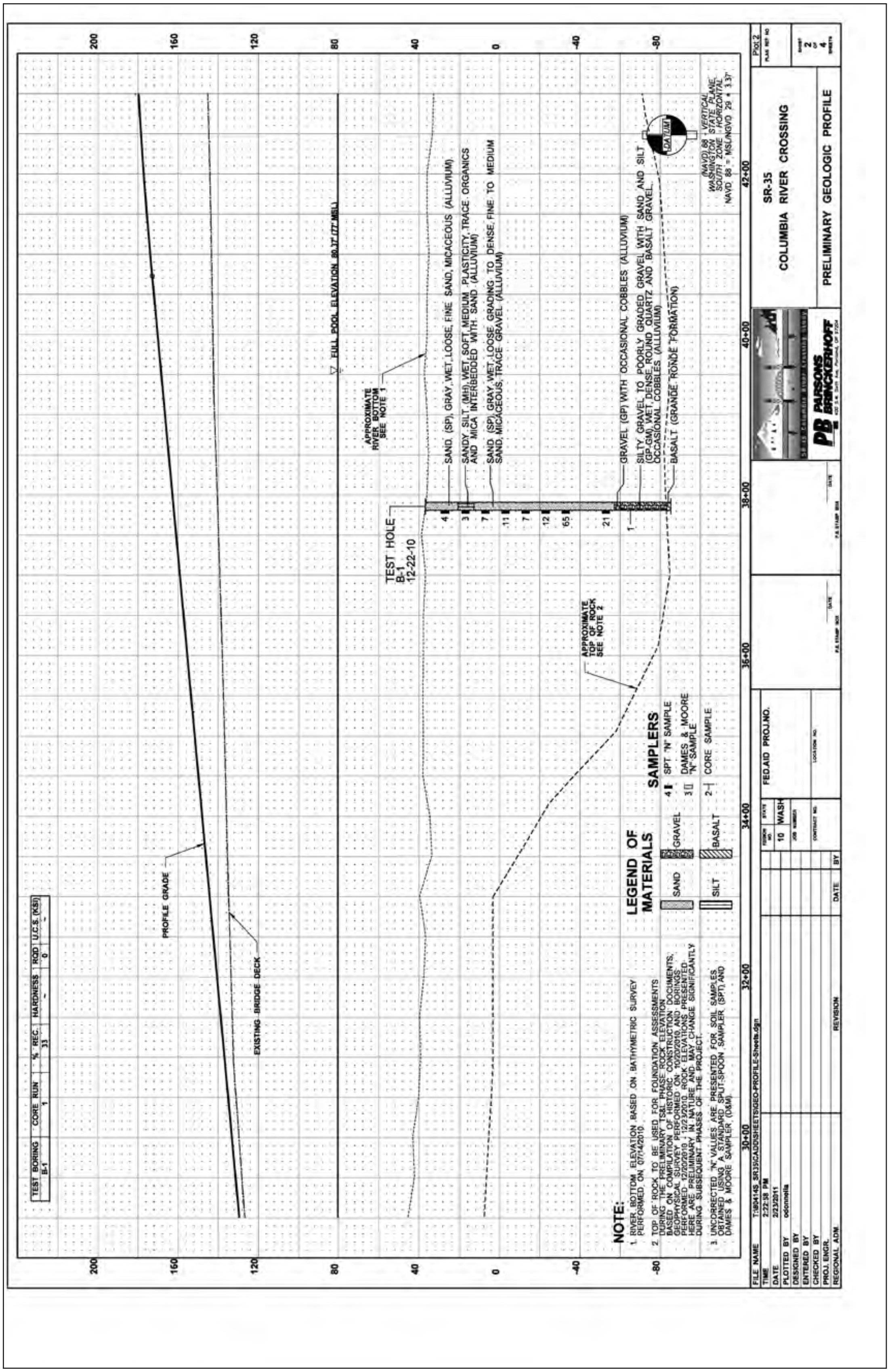
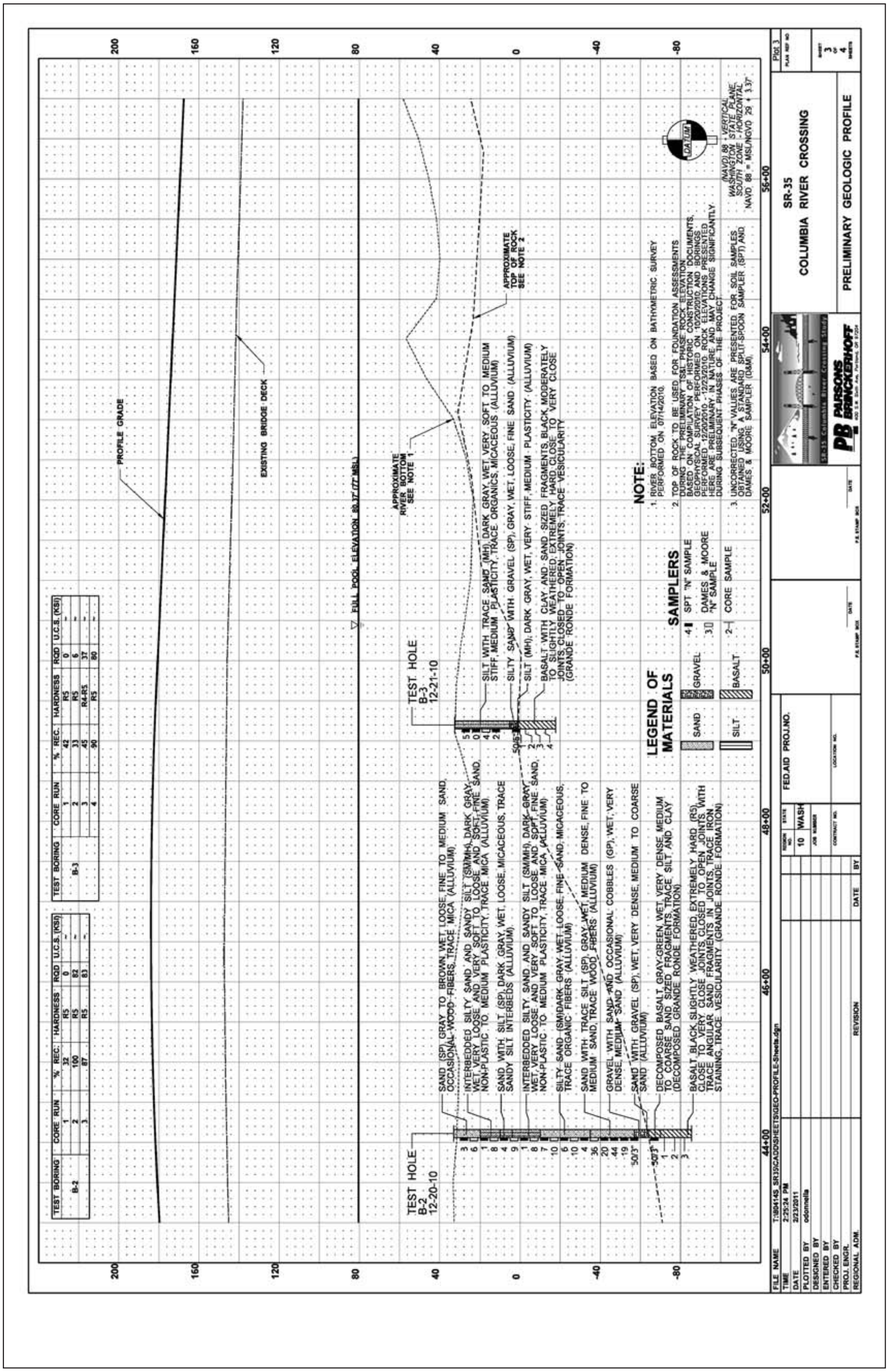
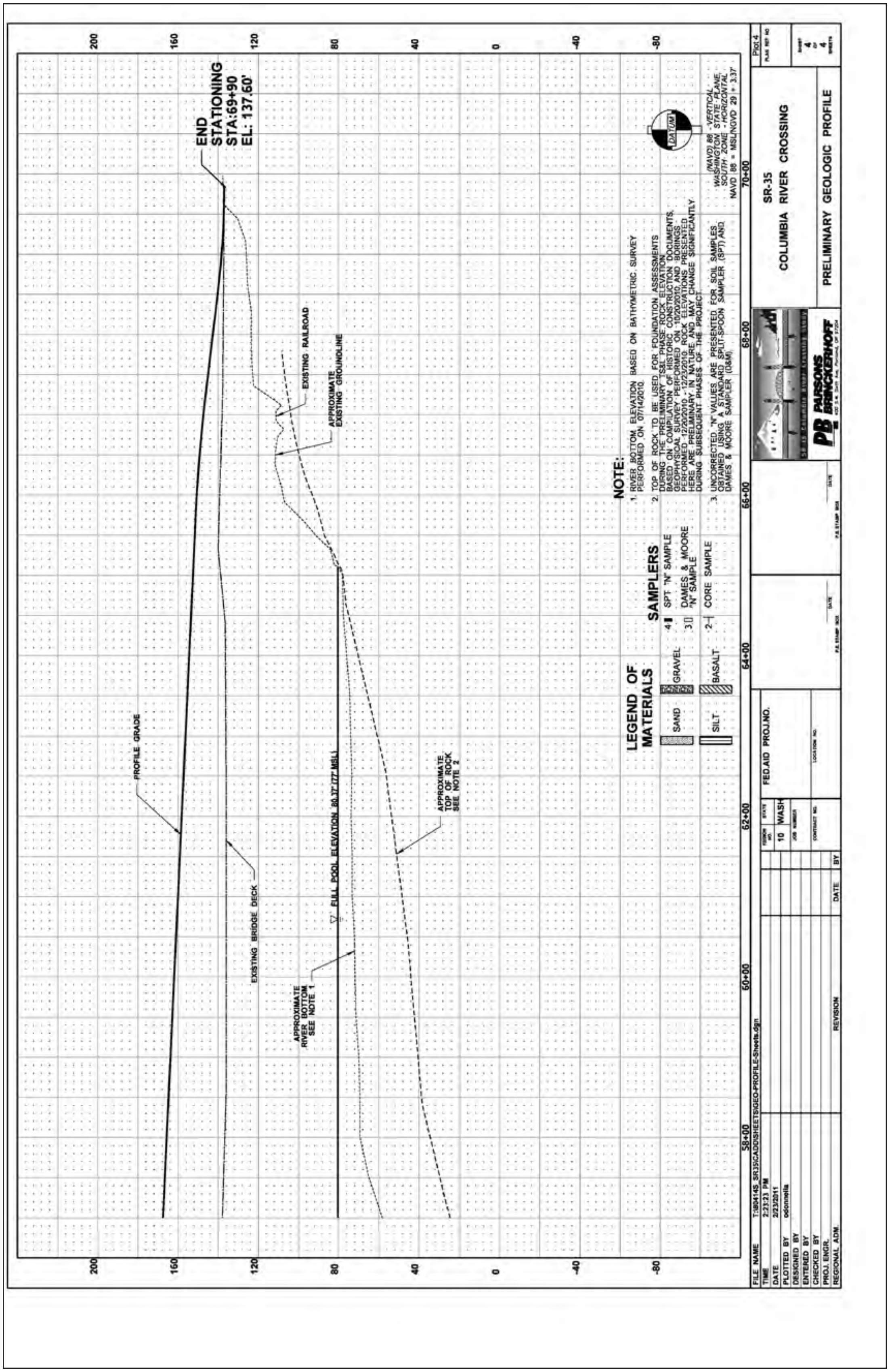
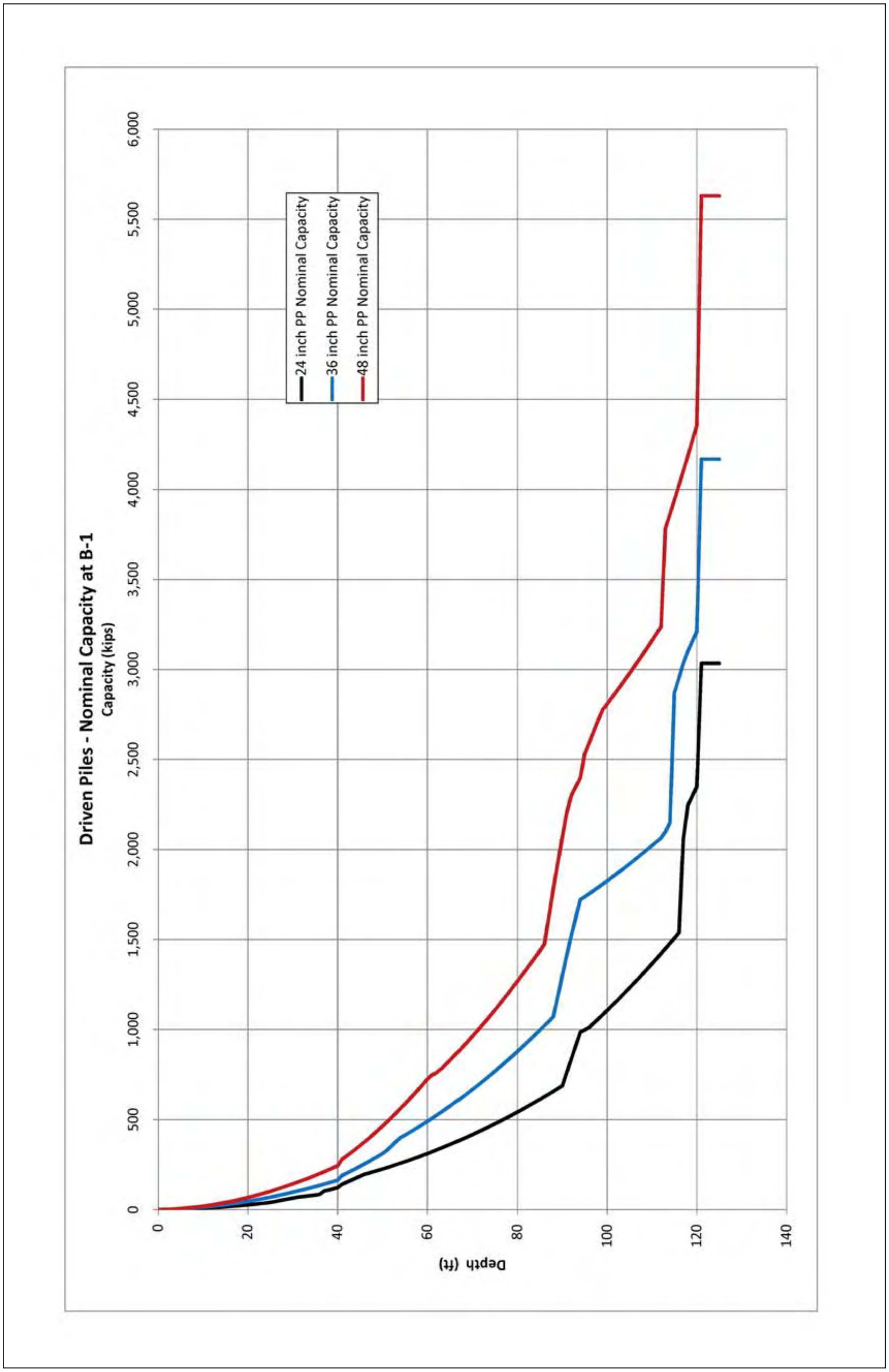

SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
PARSONS BRINCKERHOFF
BEGIN CONSTRUCTION STA:17+50 EL: 98.00'
PROFILE GRADE
EXISTING BRIDGE DECK
APPROXIMATE EXISTING GROUNDLINE
APPROXIMATE RIVER BOTTOM SEE NOTE 1
APPROXIMATE TOP OF ROCK SEE NOTE 2
LEGEND OF MATERIALS
SAND
GRAVEL
SILT
BASALT
SAMPLERS
SPT "N" SAMPLE
DAMES & MOORE "N" SAMPLE
CORE SAMPLE
NOTE:
DATUM

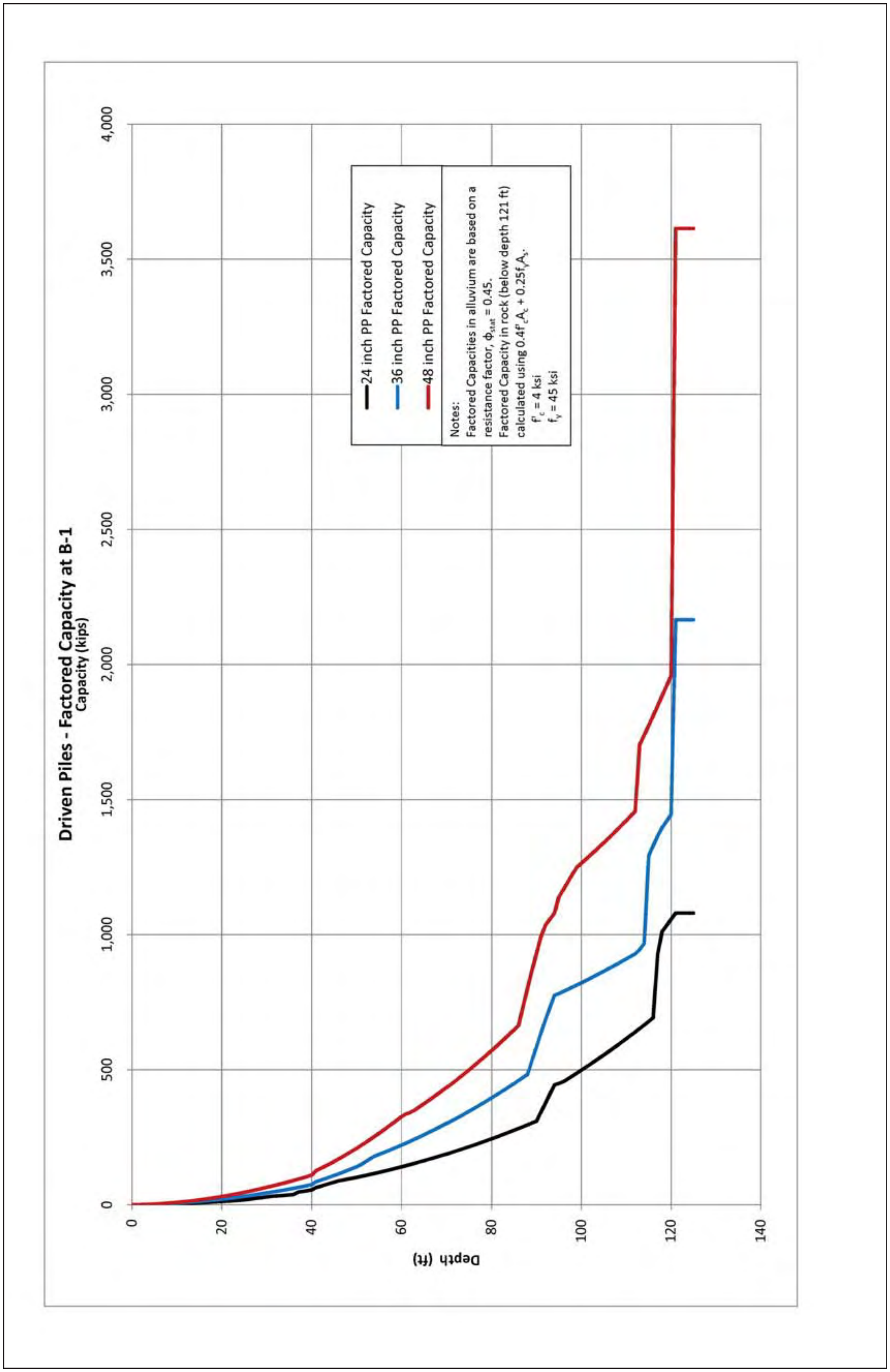

SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE

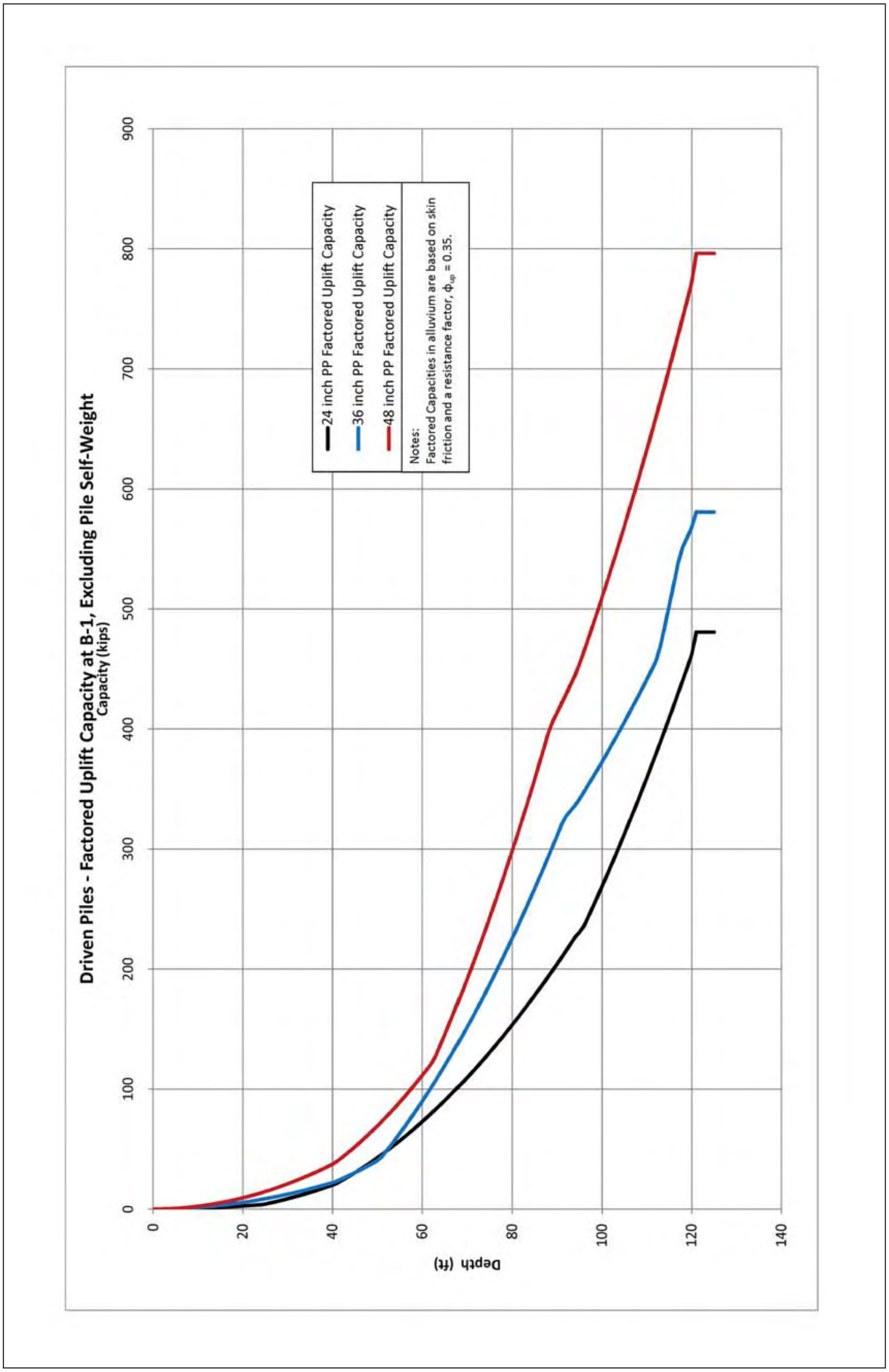

SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
TEST HOLE B-2 12-20-10
TEST HOLE B-3 12-21-10
PROFILE GRADE
EXISTING BRIDGE DECK
APPROXIMATE RIVER BOTTOM SEE NOTE 1
APPROXIMATE TOP OF ROCK SEE NOTE 2
LEGEND OF MATERIALS
SAMPLERS
NOTE:

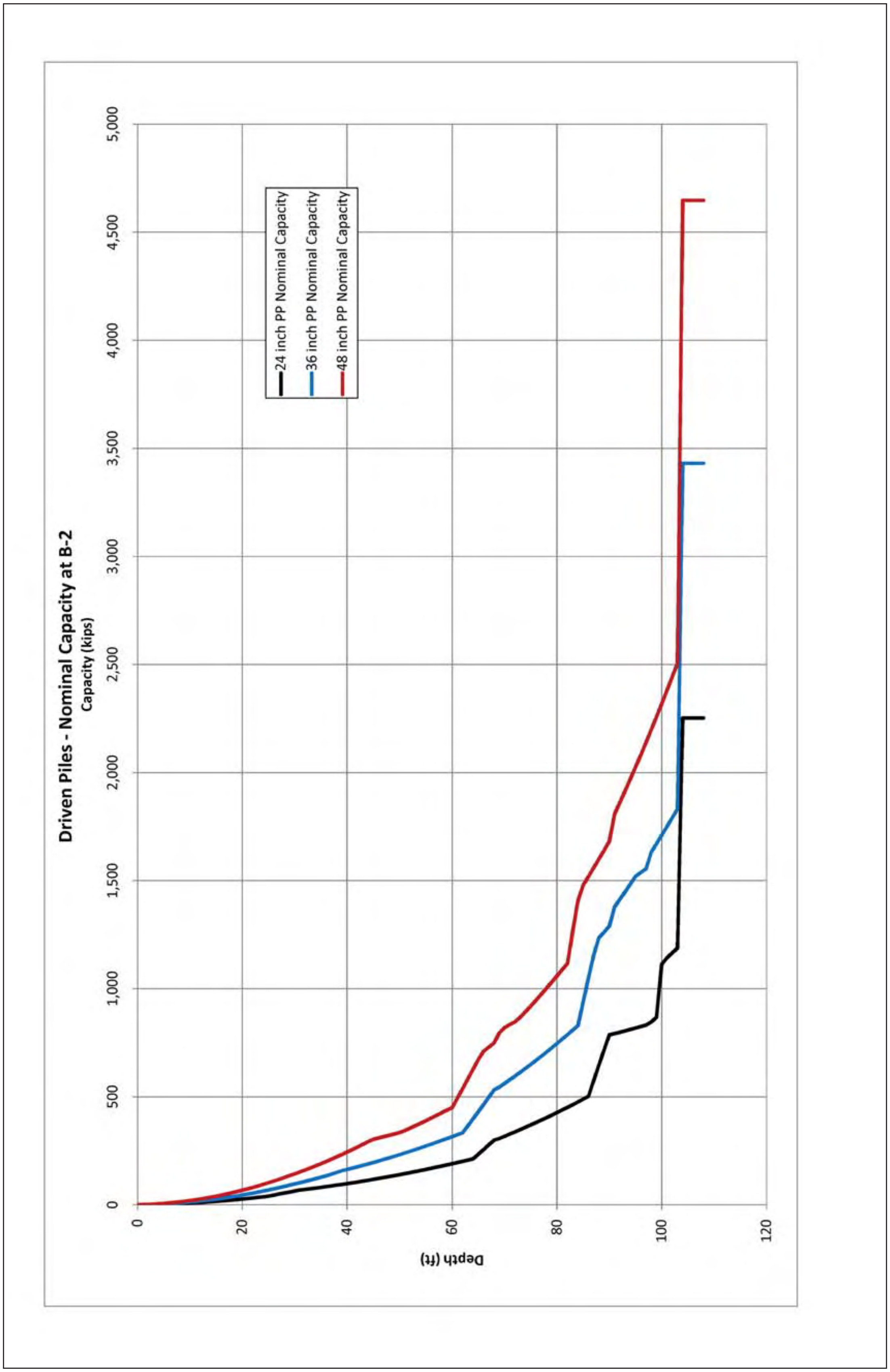

END
STATIONING
STA:69+90
EL: 137.60'
PROFILE GRADE
EXISTING BRIDGE DECK
FULL POOL ELEVATION 80.37 (77' MSL)
APPROXIMATE RIVER BOTTOM SEE NOTE 1
APPROXIMATE TOP OF ROCK SEE NOTE 2
EXISTING RAILROAD
APPROXIMATE EXISTING GROUNDLINE
LEGEND OF MATERIALS
SAND
GRAVEL
SILT
BASALT
SAMPLERS
SPT 'N' SAMPLE
DAMES & MOORE 'N' SAMPLE
CORE SAMPLE
NOTE:
1. RIVER BOTTOM ELEVATION BASED ON BATHYMETRIC SURVEY PERFORMED ON 07/14/2010.
2. TOP OF ROCK TO BE USED FOR FOUNDATION ASSESSMENTS DURING THE PRELIMINARY (SIL) PHASE. ROCK ELEVATION BASED ON COMPILATION OF HISTORIC CONSTRUCTION DOCUMENTS, GEOPHYSICAL SURVEY PERFORMED ON 10/20/2010, AND BORINGS PERFORMED 12/2010 - 1/12/2011. ROCK ELEVATIONS PRESENTED HERE ARE PRELIMINARY IN NATURE AND MAY CHANGE SIGNIFICANTLY DURING SUBSEQUENT PHASES OF THE PROJECT.
3. UNCORRECTED "N" VALUES ARE PRESENTED FOR SOIL SAMPLES OBTAINED USING A STANDARD SPLIT-SPOON SAMPLER (SPT) AND DAMES & MOORE SAMPLER (D&M).
(NAVD) 88 - VERTICAL
WASHINGTON STATE PLANE SOUTH ZONE - HORIZONTAL
NAVD 88 = MSL/NGVD 29 + 3.37'
DATUM
58+00
60+00
62+00
64+00
66+00
68+00
70+00
200
160
120
80
40
0
-40
-80
PARSONS BRINCKERHOFF
SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
FED.AID PROJ.NO.
10
WASH
FILE NAME
TIME
DATE
PLOTTED BY
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.
REVISION
DATE
BY

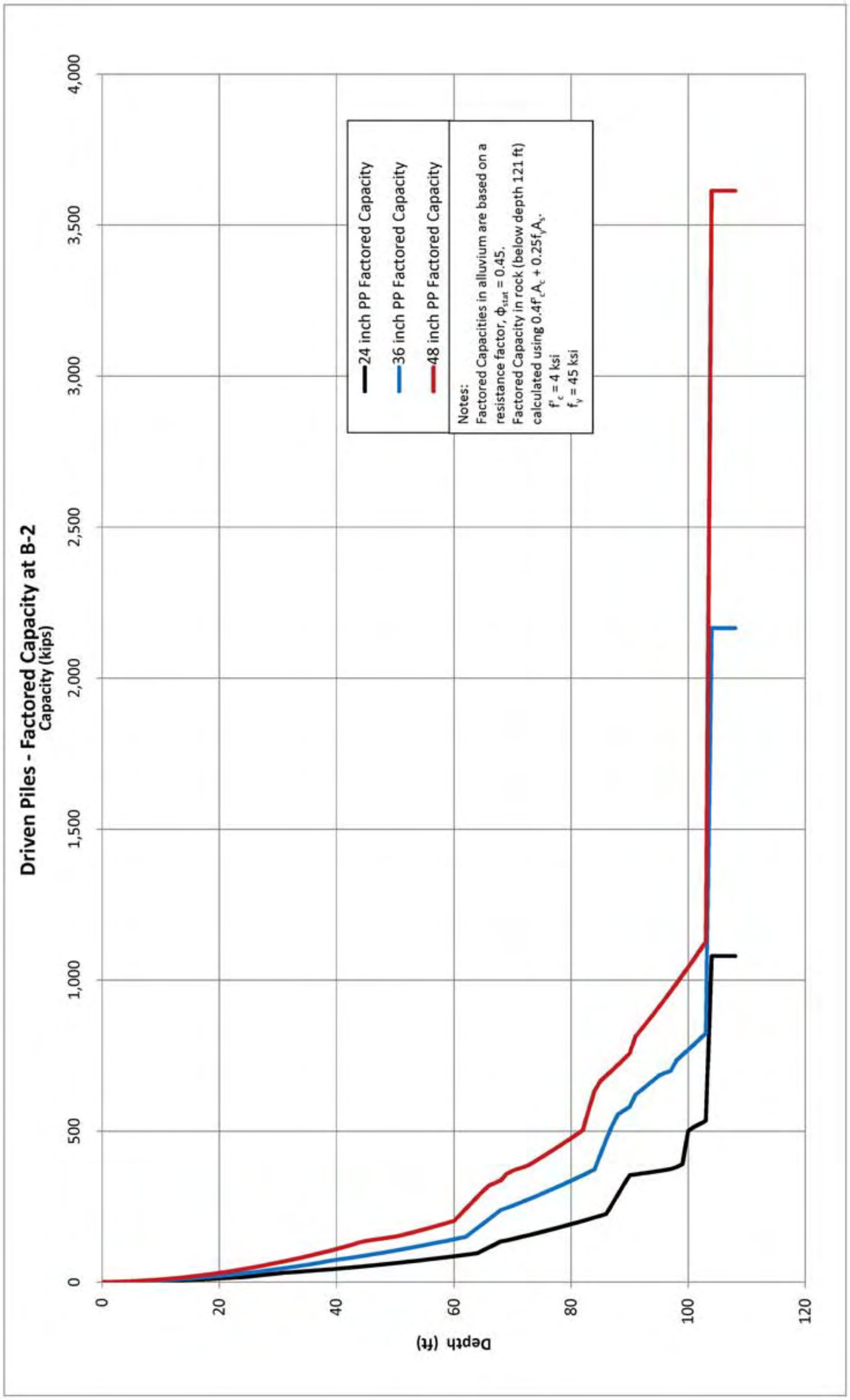


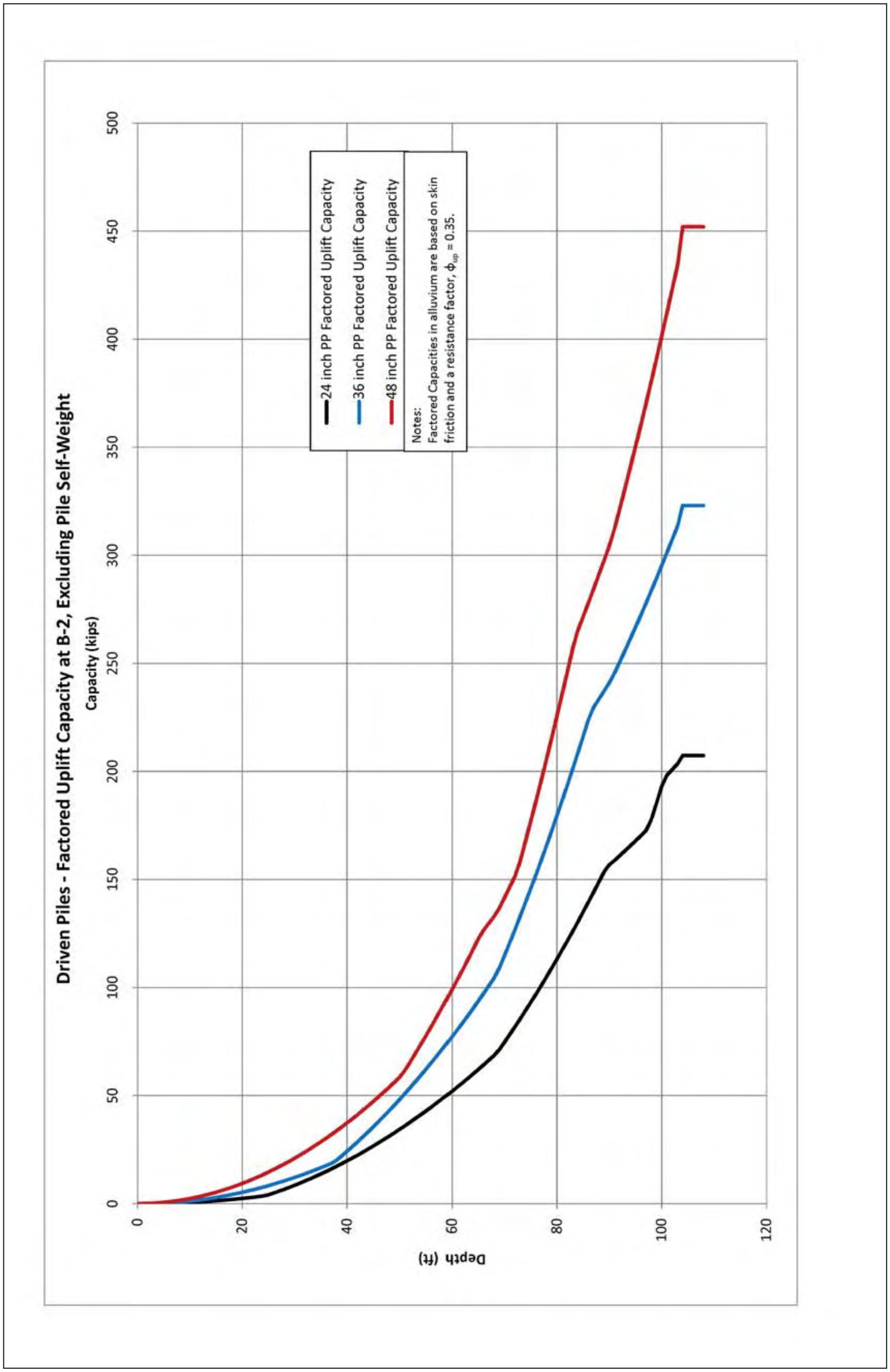
Driven Piles - Nominal Capacity at B-1
Capacity (kips)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
24 inch PP Nominal Capacity
36 inch PP Nominal Capacity
48 inch PP Nominal Capacity
Depth (ft)
0
20
40
60
80
100
120
140

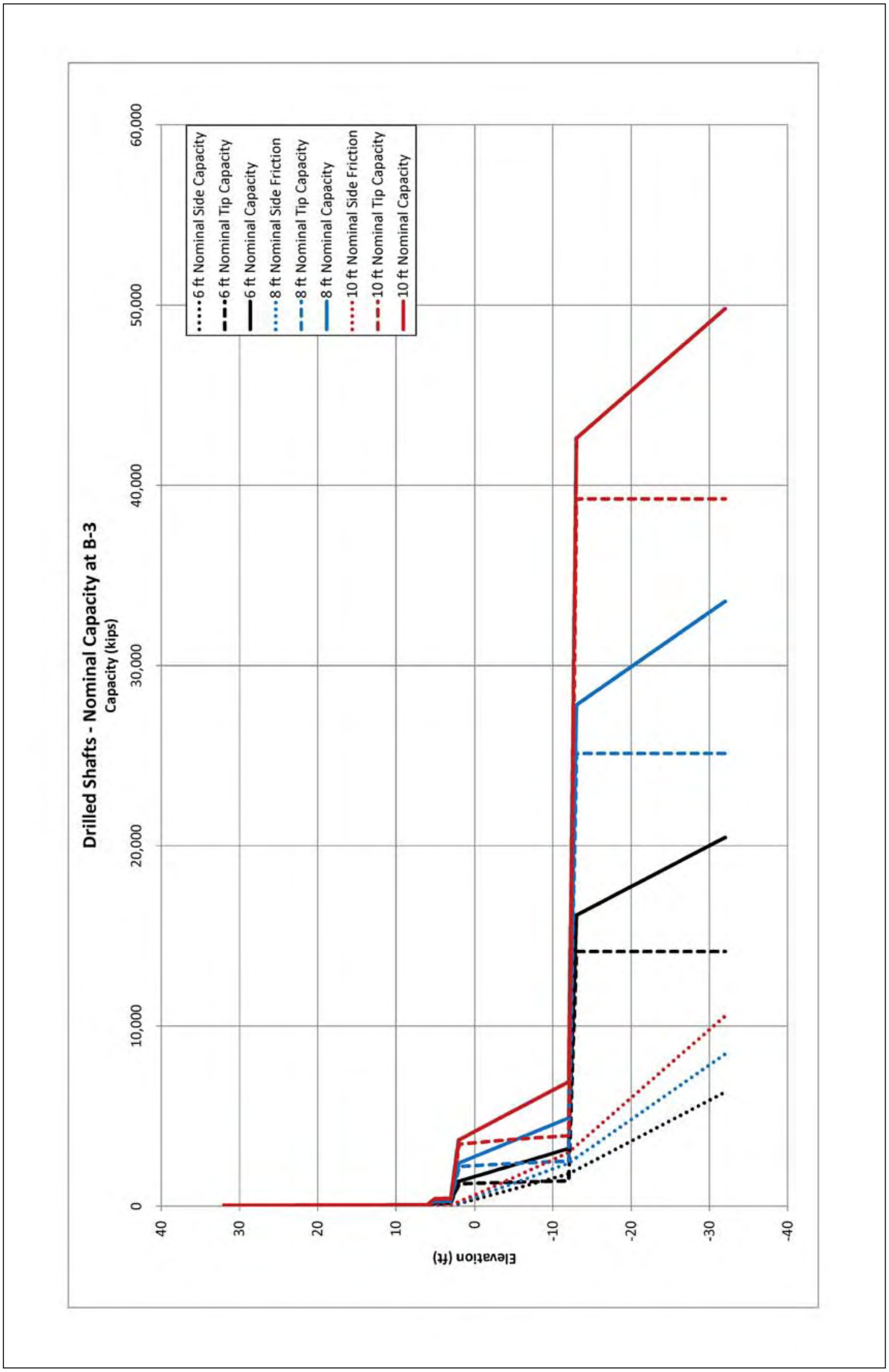

Driven Piles - Factored Capacity at B-1
Capacity (kips)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Depth (ft)
0
20
40
60
80
100
120
140
24 inch PP Factored Capacity
36 inch PP Factored Capacity
48 inch PP Factored Capacity
Notes:
Factored Capacities in alluvium are based on a resistance factor, Φ_{stat} = 0.45.
Factored Capacity in rock (below depth 121 ft) calculated using $0.4f'_cA_c + 0.25f_yA_s$.
f'_c = 4 ksi
f_y = 45 ksi

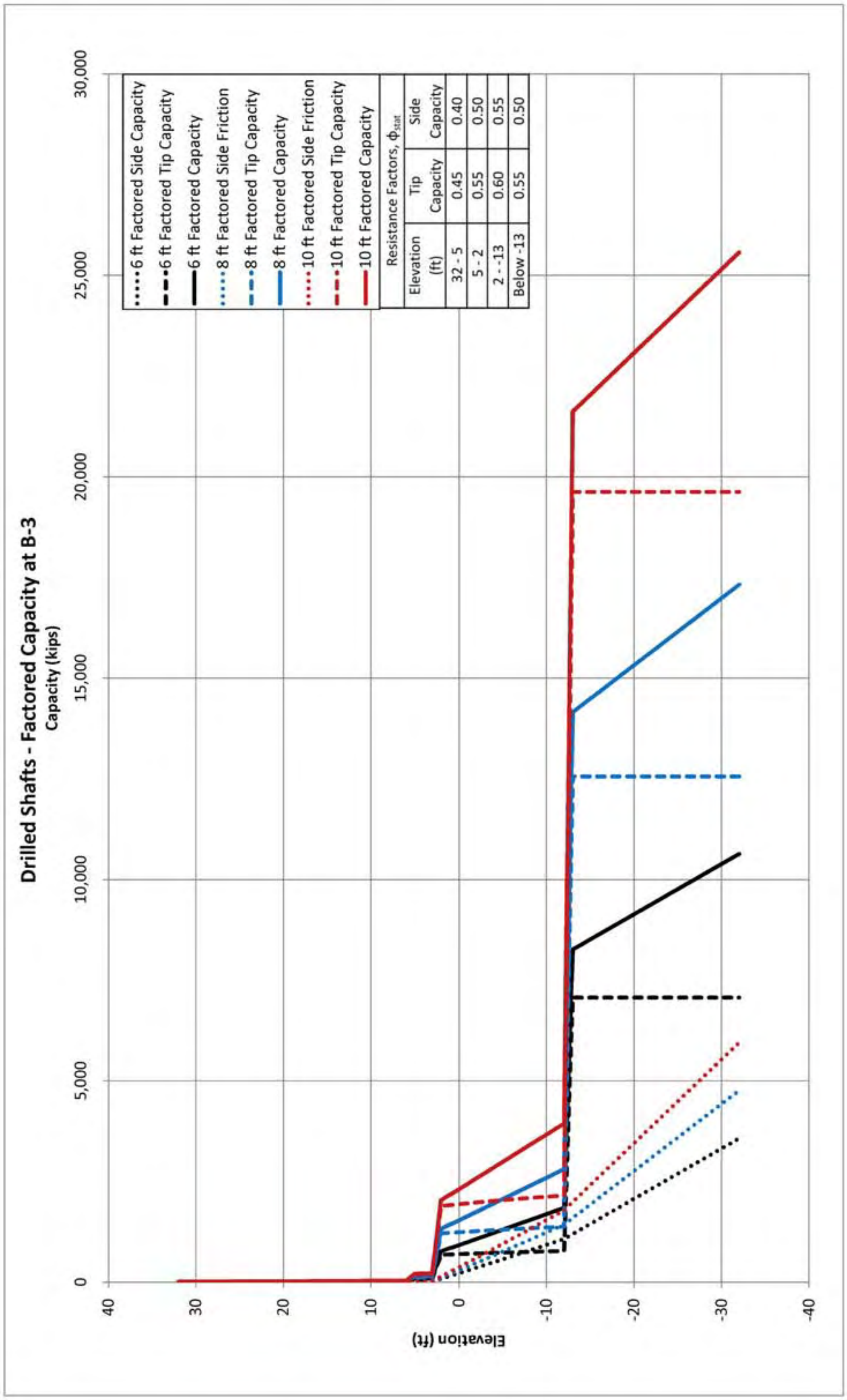

Driven Piles - Factored Uplift Capacity at B-1, Excluding Pile Self-Weight
Capacity (kips)
Depth (ft)
0
100
200
300
400
500
600
700
800
900
0
20
40
60
80
100
120
140
24 inch PP Factored Uplift Capacity
36 inch PP Factored Uplift Capacity
48 inch PP Factored Uplift Capacity
Notes:
Factored Capacities in alluvium are based on skin friction and a resistance factor, ϕ_{up} = 0.35.

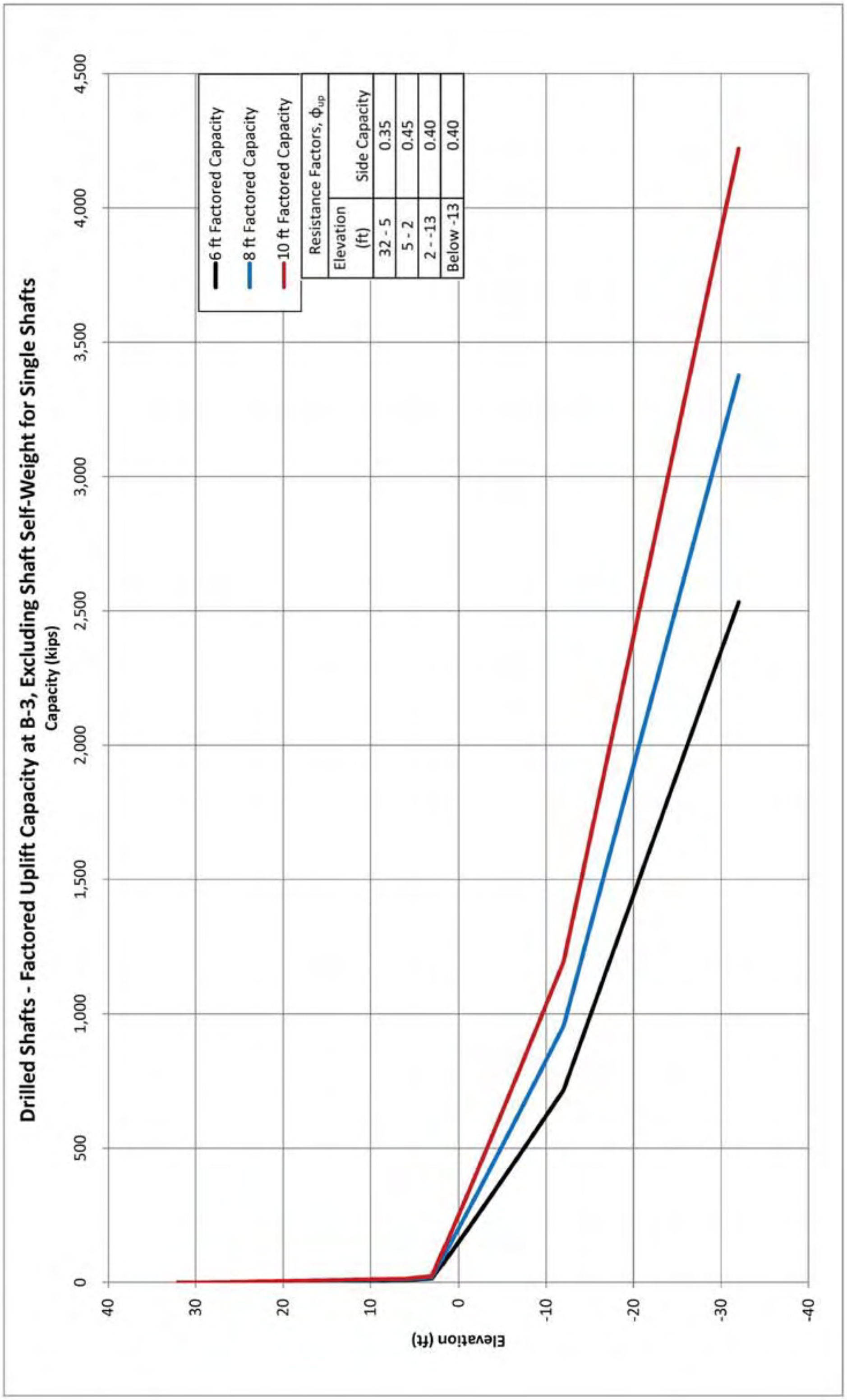

Driven Piles - Nominal Capacity at B-2
Capacity (kips)
Depth (ft)
24 inch PP Nominal Capacity
36 inch PP Nominal Capacity
48 inch PP Nominal Capacity
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
0
20
40
60
80
100
120


Driven Piles - Factored Capacity at B-2
Capacity (kips)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Depth (ft)
0
20
40
60
80
100
120
24 inch PP Factored Capacity
36 inch PP Factored Capacity
48 inch PP Factored Capacity
Notes:
Factored Capacities in alluvium are based on a resistance factor, φstat = 0.45.
Factored Capacity in rock (below depth 121 ft) calculated using 0.4f'cAc + 0.25fyAs.
f'c = 4 ksi
fy = 45 ksi


Driven Piles - Factored Uplift Capacity at B-2, Excluding Pile Self-Weight
Capacity (kips)
0
50
100
150
200
250
300
350
400
450
500
Depth (ft)
0
20
40
60
80
100
120
24 inch PP Factored Uplift Capacity
36 inch PP Factored Uplift Capacity
48 inch PP Factored Uplift Capacity
Notes:
Factored Capacities in alluvium are based on skin friction and a resistance factor, ϕ_{up} = 0.35.


Drilled Shafts - Nominal Capacity at B-3
Capacity (kips)
0
10,000
20,000
30,000
40,000
50,000
60,000
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
6 ft Nominal Side Capacity
6 ft Nominal Tip Capacity
6 ft Nominal Capacity
8 ft Nominal Side Friction
8 ft Nominal Tip Capacity
8 ft Nominal Capacity
10 ft Nominal Side Friction
10 ft Nominal Tip Capacity
10 ft Nominal Capacity


Drilled Shafts - Factored Capacity at B-3
Capacity (kips)
Elevation (ft)
6 ft Factored Side Capacity
6 ft Factored Tip Capacity
6 ft Factored Capacity
8 ft Factored Side Friction
8 ft Factored Tip Capacity
8 ft Factored Capacity
10 ft Factored Side Friction
10 ft Factored Tip Capacity
10 ft Factored Capacity
Resistance Factors, ϕ_{stat}
Elevation (ft) | Tip Capacity | Side Capacity
32 - 5 | 0.45 | 0.40
5 - 2 | 0.55 | 0.50
2 - -13 | 0.60 | 0.55
Below -13 | 0.55 | 0.50
0
5,000
10,000
15,000
20,000
25,000
30,000
40
30
20
10
0
-10
-20
-30
-40



Drilled Shafts - Factored Uplift Capacity at B-3, Excluding Shaft Self-Weight for Single Shafts
Capacity (kips)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
6 ft Factored Capacity
8 ft Factored Capacity
10 ft Factored Capacity
Resistance Factors, ϕ_{up}
Elevation (ft)
Side Capacity
32 - 5
0.35
5 - 2
0.45
2 - -13
0.40
Below -13
0.40

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Page:	1 of 4
Made by:	E. Garich
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Date:	12/9/201

Subject Preliminary Ground Motion Parameters
SR-35, Columbia River Crossing

References
1) United States Geological Survey, 2008, Earthquake Hazards Program
2) AASHTO, 2010, AASHTO LRFD Bridge Design Specifications 5th Edition
3) AASHTO, 2009, Guide Specifications for LRFD Seismic Bridge Design, 1st Edition

Ground motion parameters shall be developed for two recurrence intervals - 500 and 1,000 years

Soil Site Classification at rock/alluvium interface - Site Class B
Seismic Design Category at rock/alluvium interface - SDC A

USGS 2008 accelerations on bedrock:

500 yr	
PGA	0.114
S_s	0.260
S_1	0.096

1000 yr	
PGA	0.158
S_s	0.364
S_1	0.142

AAHSTO 2009 ground motion parameters:

500 yr	
F_{pga}	1.00
F_a	1.00
F_v	1.00
A_s	0.11
S_{DS}	0.26
S_{D1}	0.10
T_0	0.07
T_S	0.37

1000 yr	
F_{pga}	1.00
F_a	1.00
F_v	1.00
A_s	0.16
S_{DS}	0.36
S_{D1}	0.14
T_0	0.08
T_S	0.39

GroundMotions
Ground Motion Parameter

Geotechnical and Tunneling Group

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Page: 2 of 4
Made by: E. Garich
Date: 12/8/201
Checked by: J. Horne
Date: 12/9/201

Subject Preliminary Ground Motion Parameters
SR-35, Columbia River Crossing

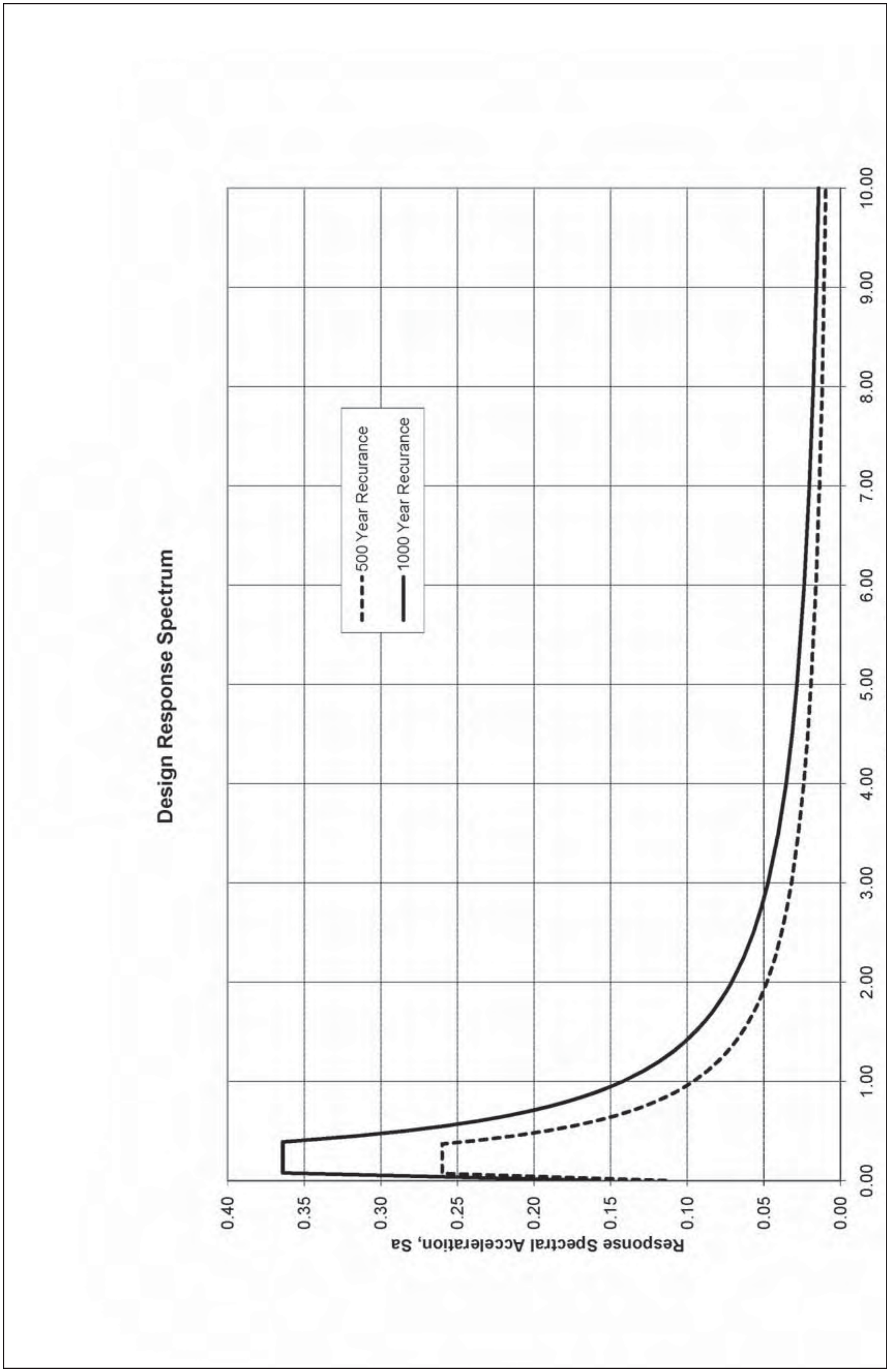
Response Spectrum Values

500 yr	
T (sec)	S_a
0.00	0.11
0.07	0.26
0.37	0.26
0.40	0.24
0.45	0.21
0.50	0.19
0.55	0.17
0.60	0.16
0.65	0.15
0.70	0.14
0.75	0.13
0.80	0.12
0.85	0.11
0.90	0.11
0.95	0.10
1.0	0.10
1.1	0.09
1.2	0.08
1.3	0.07
1.4	0.07
1.5	0.06
1.6	0.06
1.7	0.06
1.8	0.05
1.9	0.05
2.0	0.05
2.3	0.04
2.5	0.04
2.8	0.03
3.0	0.03
3.5	0.03
4.0	0.02
4.5	0.02
5.0	0.02
6.0	0.02
7.0	0.01
8.0	0.01
9.0	0.01
10.0	0.01

1000 yr	
T (sec)	S_a
0.00	0.16
0.08	0.36
0.39	0.36
0.40	0.36
0.45	0.32
0.50	0.28
0.55	0.26
0.60	0.24
0.65	0.22
0.70	0.20
0.75	0.19
0.80	0.18
0.85	0.17
0.90	0.16
0.95	0.15
1.0	0.14
1.1	0.13
1.2	0.12
1.3	0.11
1.4	0.10
1.5	0.09
1.6	0.09
1.7	0.08
1.8	0.08
1.9	0.07
2.0	0.07
2.3	0.06
2.5	0.06
2.8	0.05
3.0	0.05
3.5	0.04
4.0	0.04
4.5	0.03
5.0	0.03
6.0	0.02
7.0	0.02
8.0	0.02
9.0	0.02
10.0	0.01

GroundMotions
Ground Motion Parameter

Geotechnical and Tunneling Group


Design Response Spectrum
500 Year Recurance
1000 Year Recurance
Response Spectral Acceleration, Sa
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

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Page: 4 of
Made by: E. Garich
Date: 2/18/2(
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Date: 2/18/2(

Subject Liquefaction Analysis
SR-35, Columbia River Crossing

A seismic hazard deaggregation was performed to identify the seismic sources that contribute the greatest hazard to the site. The sources were identified: 1) Shallow crustal faults, 2) Intraplate faulting, and 3) Cascadia Subduction Zone (CSZ) faulting. A M-R pair from each source which had the greatest contribution to the mean PGA was choosen to be included in the liquefaction analysis. These pairs are:

1) Shallow crustal - M = 5.40, R = 8.3 km
2) Intraplate - M = 7.01, R = 86.0 km
3) CSZ - M = 9.0, R = 179.7 km

Attenuation relationships were used to determine the PGA from each M-R pair at the site. For the shallow crustal faulting 3 NGA relationships (Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and Youngs (2008)) were equally weighted to evaluate PGA. For CSZ and Intraplate faulting Youngs et al. (1997) was used. Averaged PGA's are as follows:

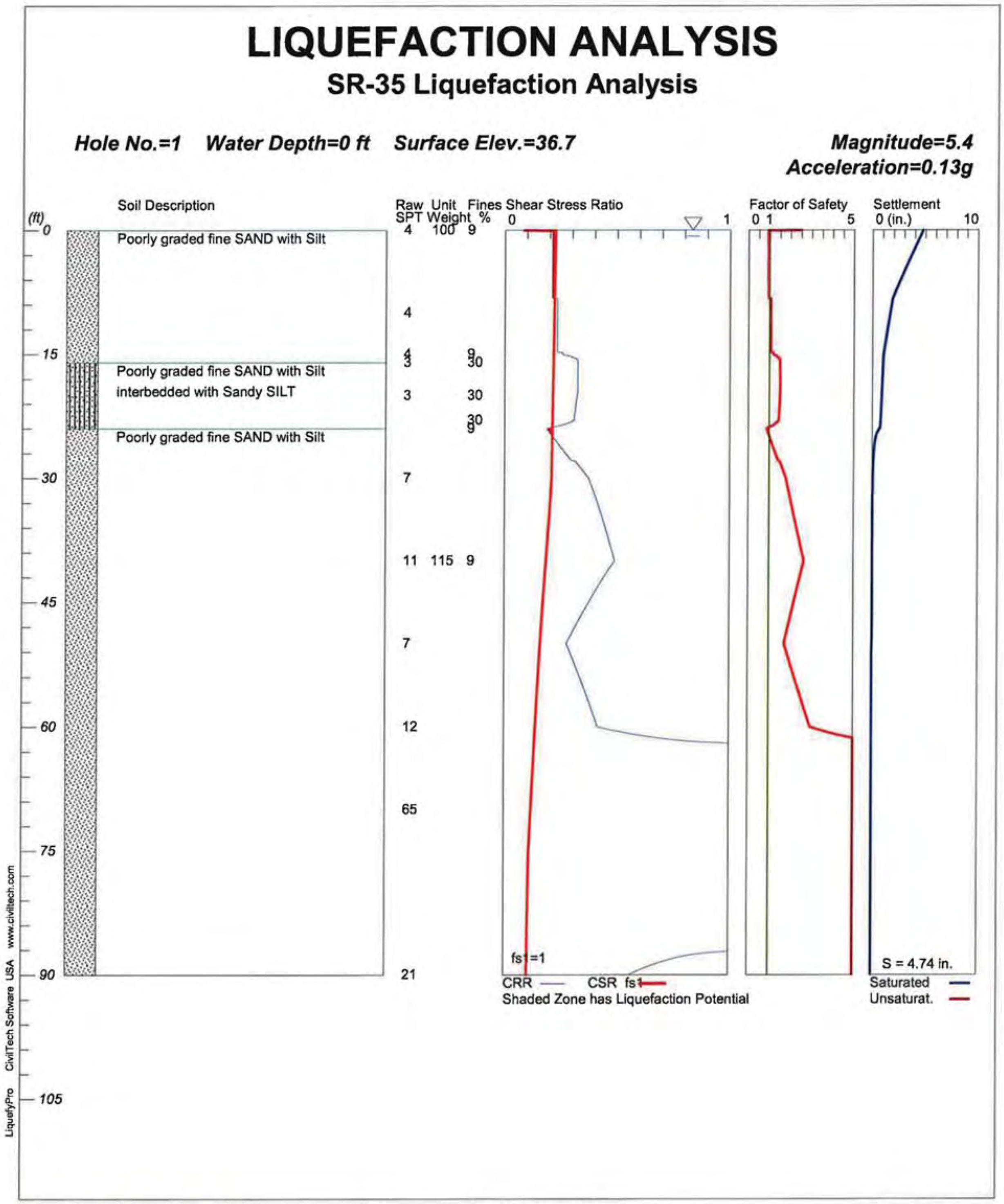
1) Shallow crustal - PGA = 0.13 g
2) Intraplate - PGA = 0.11 g
3) CSZ - PGA = 0.10 g

The liquefaction analysis was performed using the software program LiquefyPro V.5.8f. This program utilizes Seed's Method to calculate the CSR and the CSR is determined from corrected SPT blow count data (Harder and Seed, 1986 and Harder, 1997). Fines content correction formulas developed by Idriss and Seed (1997) were used and the Ishihara/Yoshimine Method was used to calculate settlement. A anlaysis was performed at each boring using insitu and laboratory test data from the field explorations. Three earthquake scenerios were analyzed at each boring. The results of these analyses are presented on Plates B1-1 through B3-3 and summarized below.

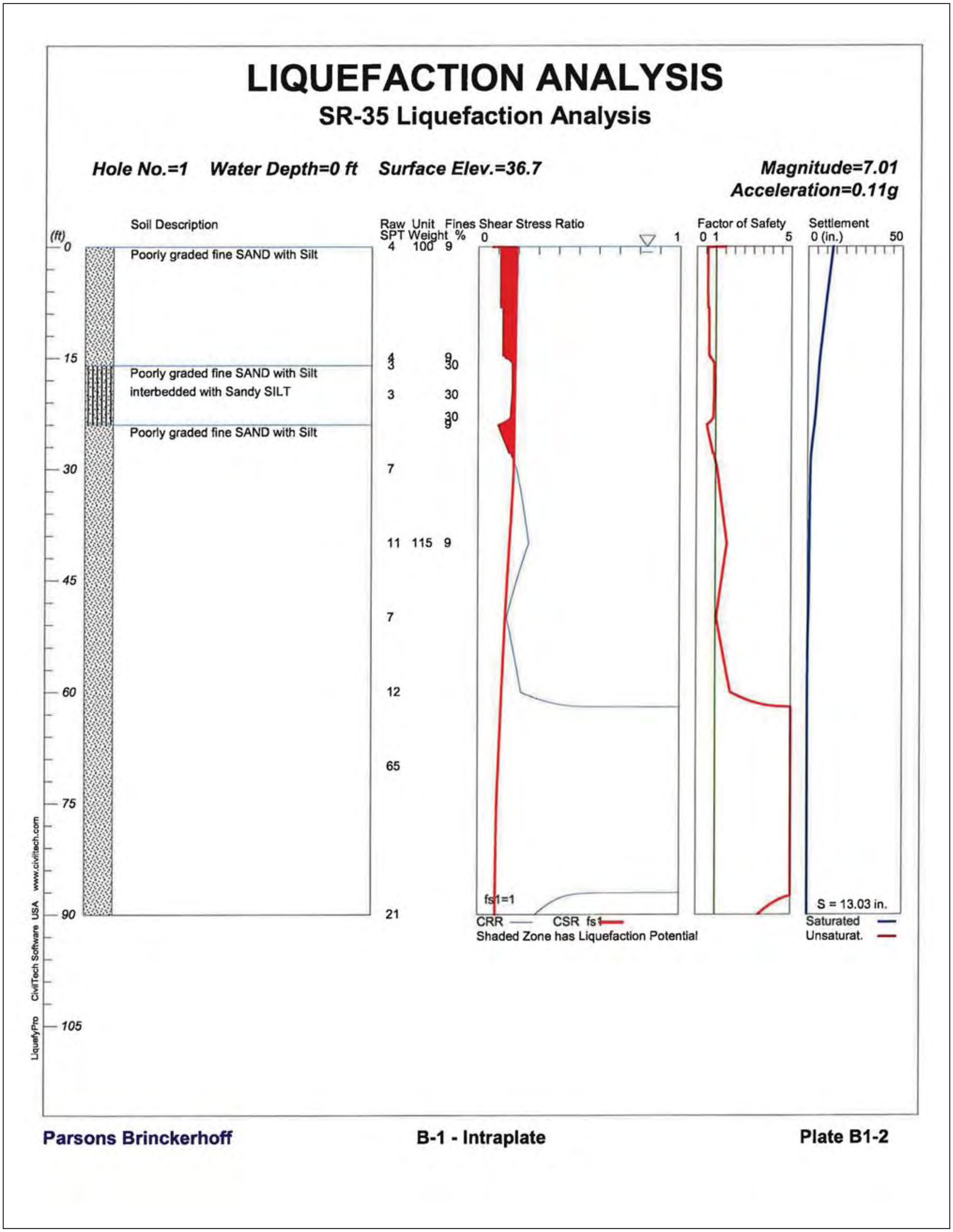
Scenerio	Liquefaction?	Settlement Predicted (inches)
B-1 , Crustal	Yes	5
B-1, Intraplate	Yes	13
B-1, CSZ	Yes	21
B-2 , Crustal	Yes	3
B-2, Intraplate	Yes	14
B-2, CSZ	Yes	24
B-3 , Crustal	Potential	4
B-3, Intraplate	Potential	10
B-3, CSZ	Potential	12

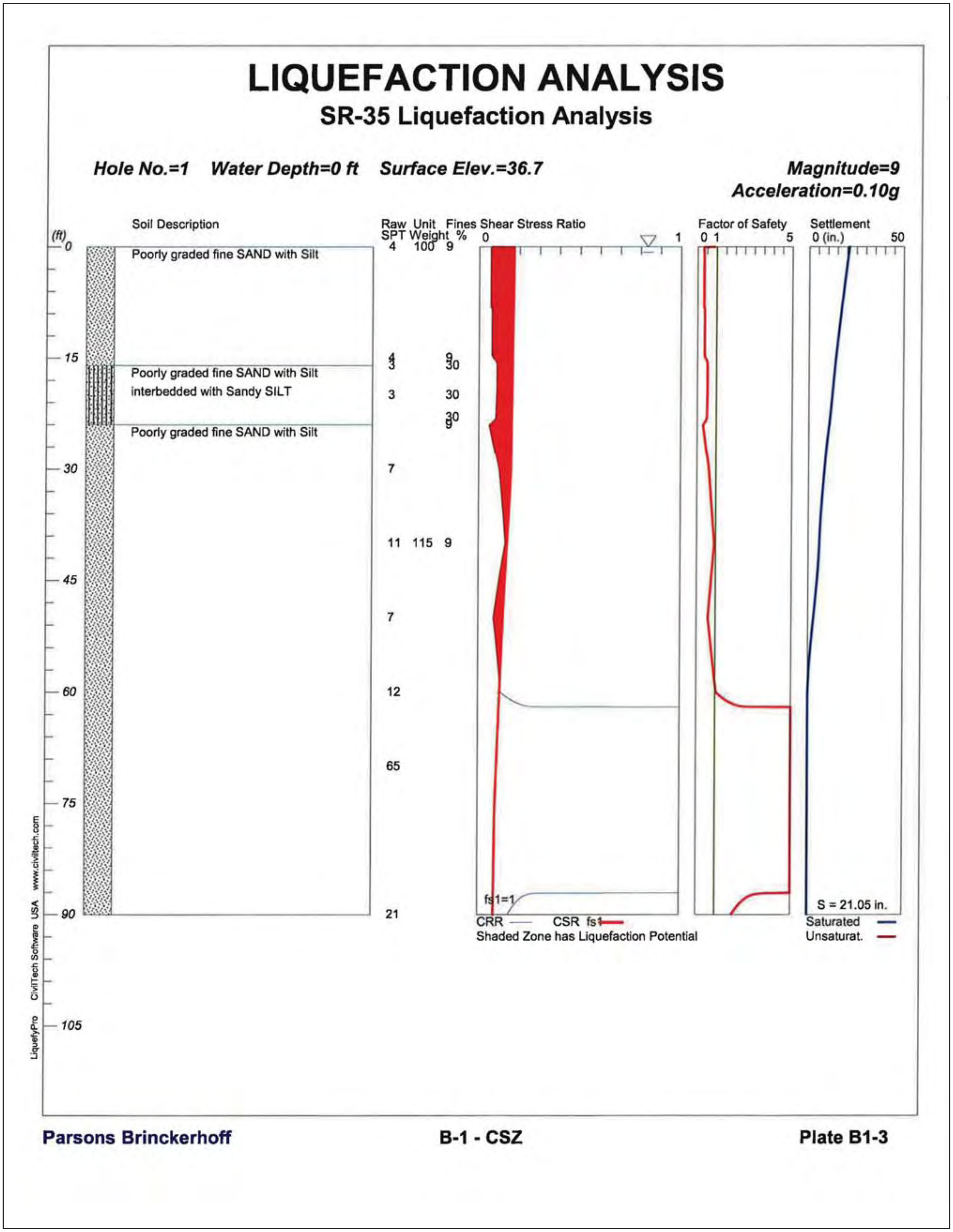
GroundMo
Liquefa

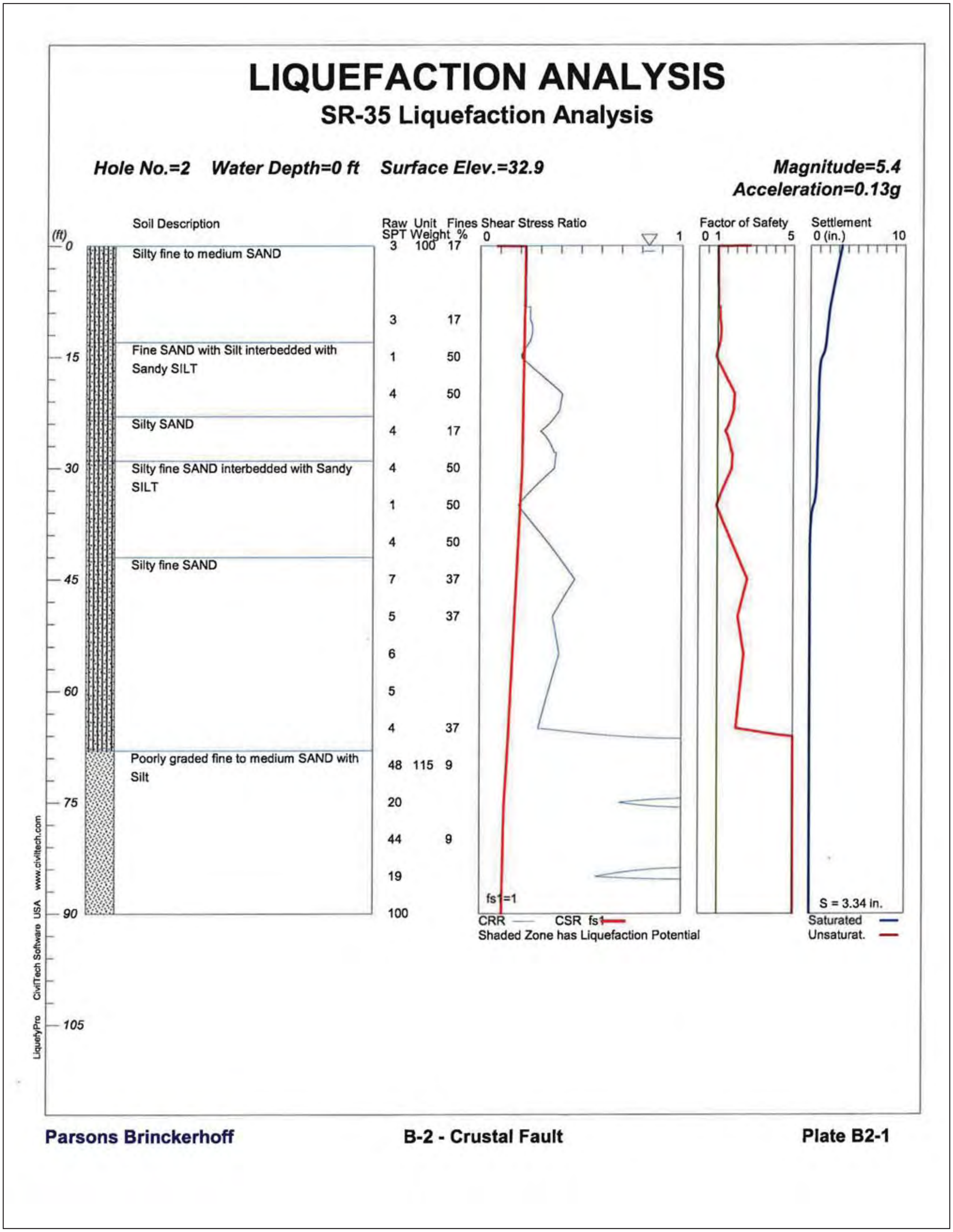
Geotechnical and Tunneling Group

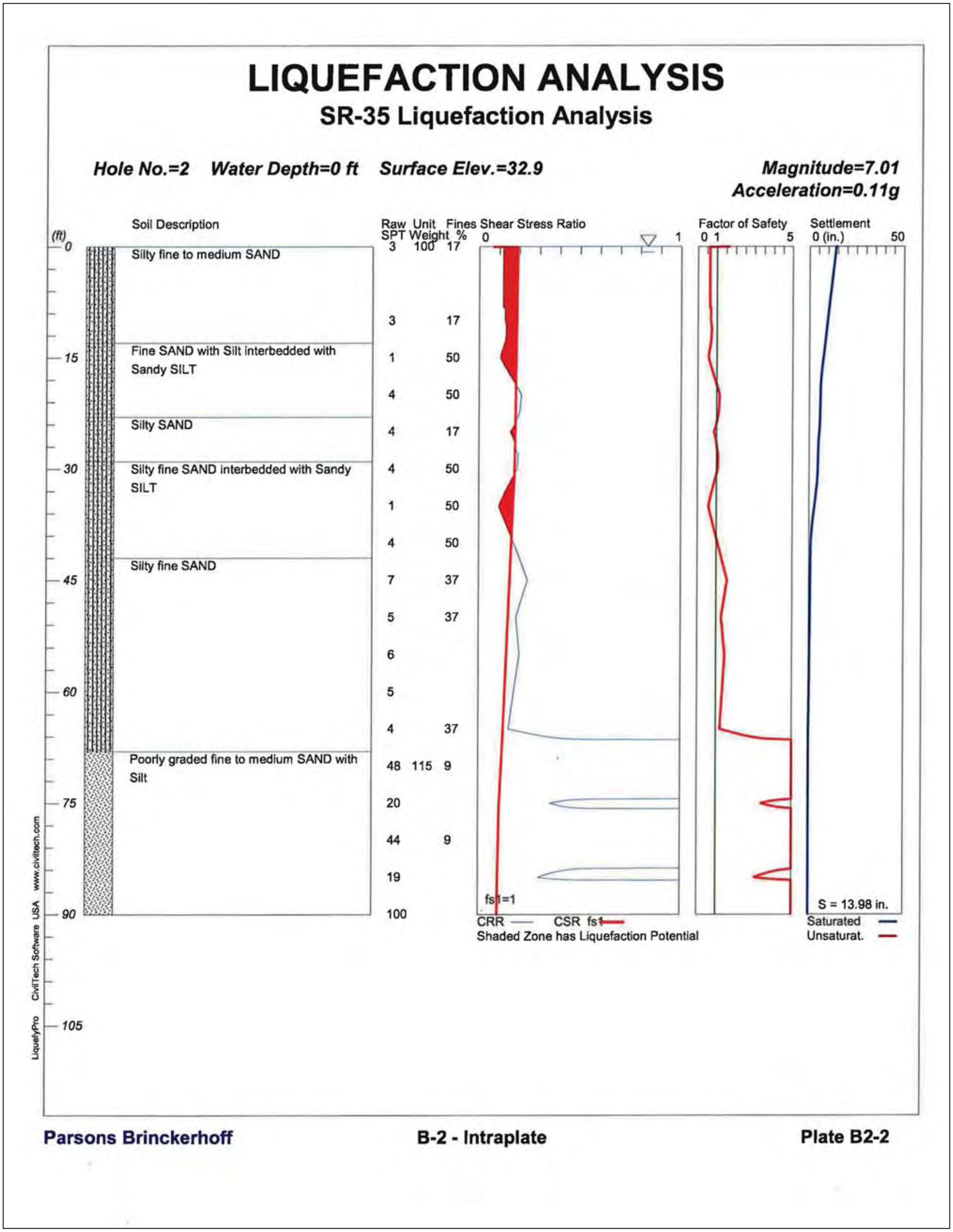


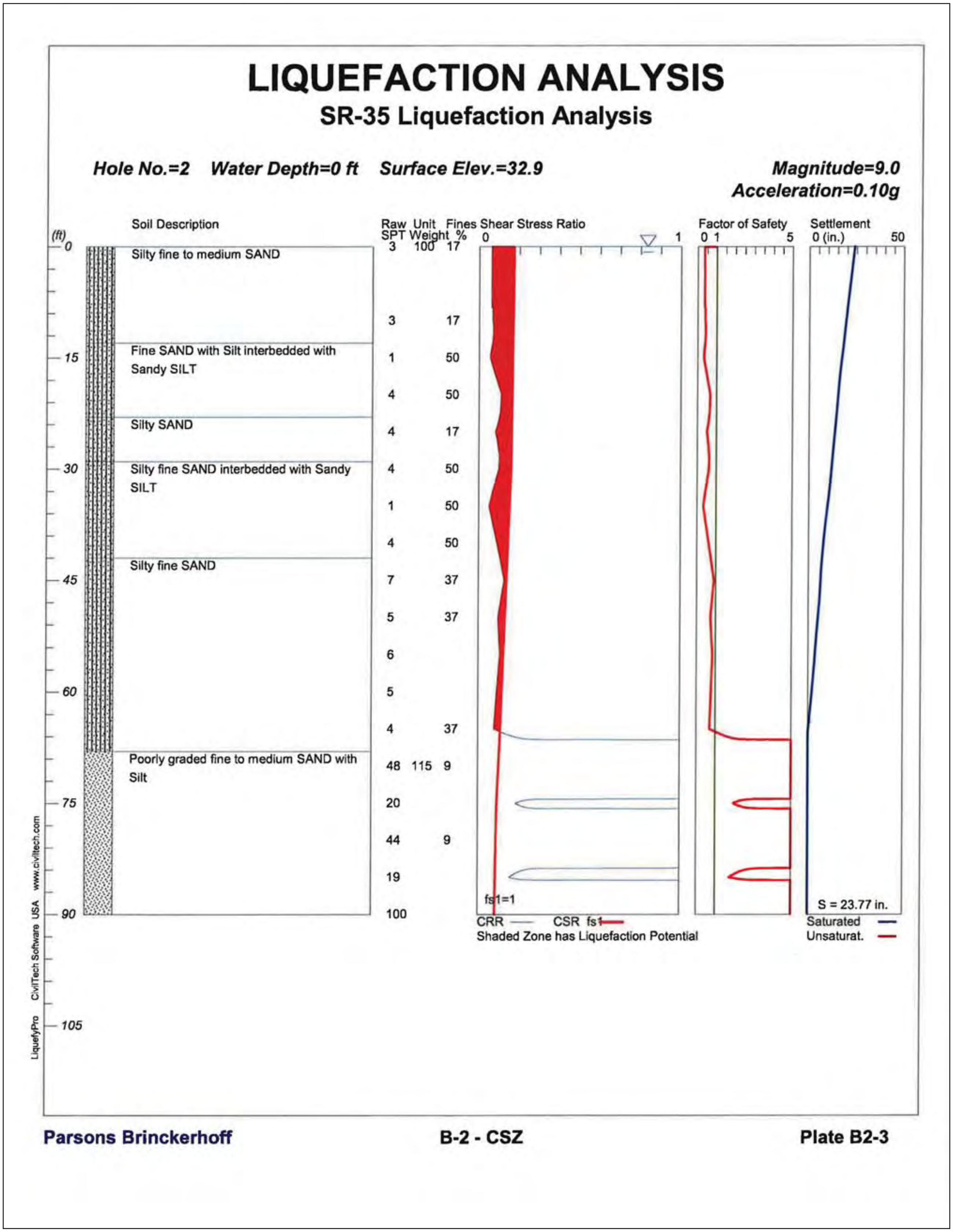
Parsons Brinckerhoff **B-1 - Crustal Fault** **Plate B1-1**

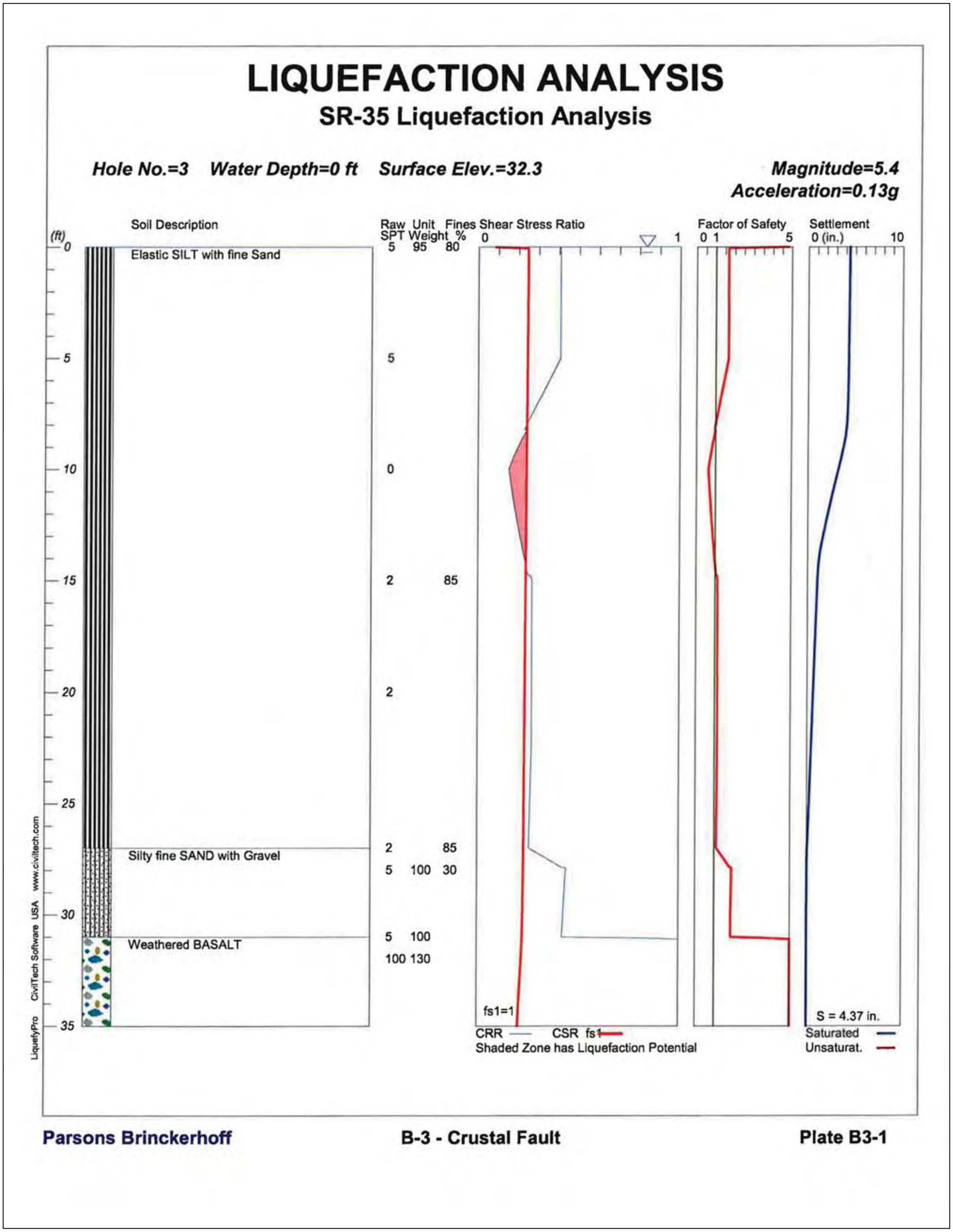

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=1 Water Depth=0 ft Surface Elev.=36.7
Magnitude=7.01
Acceleration=0.11g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
50
(ft)
Poorly graded fine SAND with Silt
Poorly graded fine SAND with Silt interbedded with Sandy SILT
Poorly graded fine SAND with Silt
4 100 9
11 115 9
65
21
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 13.03 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-1 - Intraplate
Plate B1-2

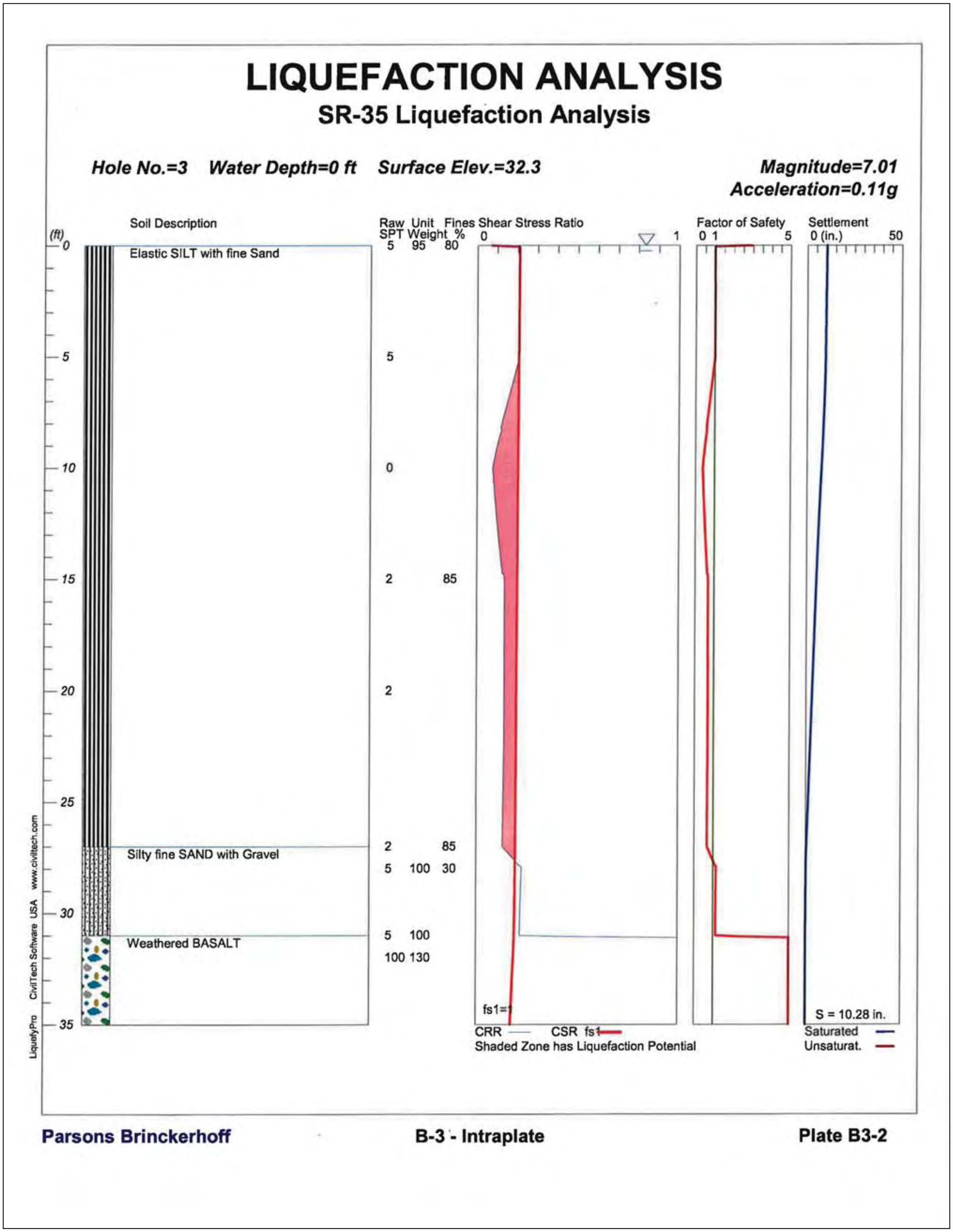

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=1 Water Depth=0 ft Surface Elev.=36.7
Magnitude=9
Acceleration=0.10g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
Poorly graded fine SAND with Silt
Poorly graded fine SAND with Silt interbedded with Sandy SILT
Poorly graded fine SAND with Silt
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 21.05 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-1 - CSZ
Plate B1-3


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=5.4
Acceleration=0.13g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
0
15
30
45
60
75
90
105
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
3 100 17
3 17
1 50
4 50
4 17
4 50
1 50
4 50
7 37
5 37
6
5
4 37
48 115 9
20
44 9
19
100
0 1
0 1 5
0 (in.) 10
fs1=1
S = 3.34 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - Crustal Fault
Plate B2-1

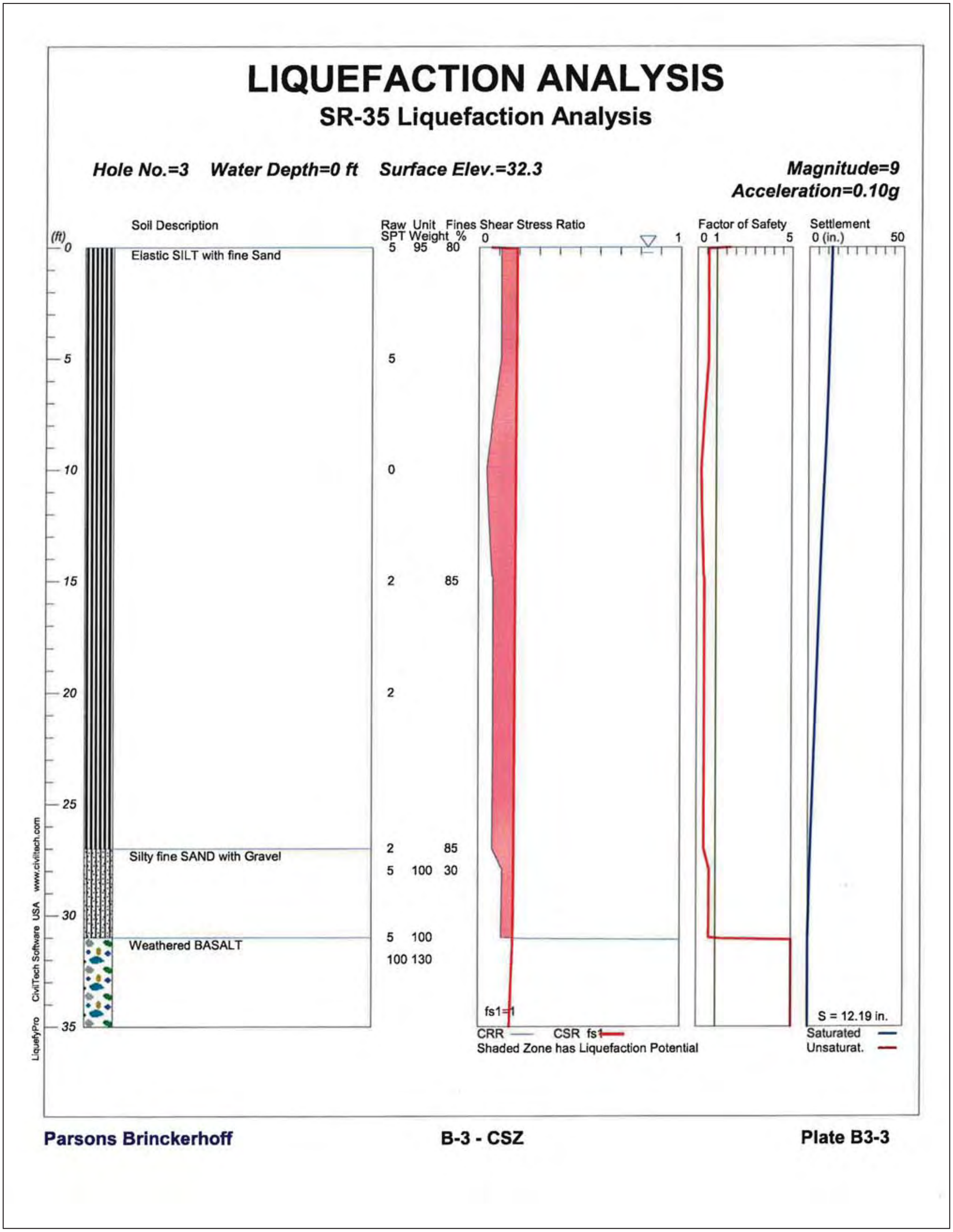

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=7.01
Acceleration=0.11g
Soil Description
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
S = 13.98 in.
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - Intraplate
Plate B2-2


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=9.0
Acceleration=0.10g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
50
(ft)
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
fs1=1
S = 23.77 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - CSZ
Plate B2-3


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=5.4
Acceleration=0.13g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
fs1=1
CRR
CSR
fs1
Shaded Zone has Liquefaction Potential
S = 4.37 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - Crustal Fault
Plate B3-1



LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=7.01
Acceleration=0.11g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 10.28 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - Intraplate
Plate B3-2


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=9
Acceleration=0.10g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
50
(ft)
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
fs1=1
S = 12.19 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - CSZ
Plate B3-3

APPENDIX B

Project Design Criteria

S R - 3 5 C o l u m b i a R i v e r C r o s s i n g S t u d y

RTC

To: Dale Robins,
RTC Project Manager

Date: 9-17-10

From: Mark Hirota,
PB Project Manager

Subject: Design Criteria for the Bridge TSL Study

The SR-35 Columbia River Crossing Study is unique in that the project spans two states and several local jurisdictions. The intent of this document is to define applicable project design criteria based on not only published engineering design standards from both the Oregon and Washington DOTs for the crossing structure but also the context of the end user.

At the start of the investigation of design criteria, it became apparent that many of the design criteria are based on a small group of fundamental or foundational criteria. These foundational criteria were discussed at a Project Management Team (PMT) meeting held on 7/13/10 and are noted with footnote #2. The PMT provided direction on these criteria which enabled the remainder of the design criteria to be established.

PROJECT DESIGN CRITERIA

DESIGN ELEMENT	WSDOT (2010)	ODOT (2008)	2003 DEIS	PMT RECOMMENDATION
Units of Measure	English	English	English	English
Functional Class	Minor Arterial[1]	Urban Principal Arterial –State Highway		Principal Arterial[2]
Design Speed (mph)	40-60(or 5 over posted)	40 (5 over posted)	50	40[2]
Shoulder Widths (ft)				
Left	NA	NA	NA	NA
Right	8	8	8	8 min[2]

[1] http://www.wsdot.wa.gov/mapsdata/tdo/FunctionalClassMaps/PDF/bingen.pdf

[2] This design element is considered a foundational design element and was discussed at the 7/13/10 PMT meeting.

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S R - 3 5 Columbia River Crossing Study

DESIGN ELEMENT	WSDOT (2010)	ODOT (2008)	2003 DEIS	PMT RECOMMENDATION	
Nav. Clearance (ft): Horizontal Vertical	Permit with Coast Guard.	Permit with Coast Guard.	450 80	450 H[2] 80 V[2]	
Ability to Widen Bridge or restripe for 3rd lane			yes	Not required[2]	
Pedestrian /Bike lane width (ft)	12 min. (Clear width)	14[3] (incl. 2' shy dist. to rail)	16 (Clear width)	12 foot plus two viewing areas[2]	
Bridge width (out to out)			59'-8"[4]	56'-4"[5]	1
Storm water collection	In shoulders	In shoulders or pipe		In shoulders[2]	
Horizontal Clearance	AASHTO Roadside Design Guide	AASHTO Roadside Design Guide		AASHTO Roadside Design Guide	
Pedestrian /Bike lane location			West side of bridge only	West side of bridge only[2]	
Lane Widths (ft)	12	12		12	
Roadway Cross Slope	2%	2%		2% - Crown	
Maximum Superelevation	10%	4%		4%	
Maximum Tangent Grades	5%[6]	5%	4.5%	5%	
Stopping Sight Distance (ft)	305-570	305		305	
Minimum CL Radius (ft)	540[7]	575		575	
Specific Structural Design Criteria	WSDOT Bridge Design Manual	ODOT Bridge Design and Drafting Manual		Project Specific	
General Bridge Design Criteria	AASHTO LRFD	AASHTO LRFD		AASHTO LRFD	
RR Hor. Clearance (ft)	14 (BNSF)	14 (BNSF)		14 (BNSF)	
Vertical Clearance	16' – 6"	17' – 0"		17' – 0"	
RR Vertical Clearance	23' – 6"	23' - 0"		23' – 6"	
Bridge Railing Height	Br railing-Test level 4 Ped railing- 42"	Br railing-Test level 4 Bike railing- 44"		Br Rail-42" Type S/W Rail-44" Metal	
Seismic Design Criteria	1000 yr No Collapse	500 yr Serviceability 1000 yr No Collapse		500 yr Serviceability 1000 yr No Collapse	2

It is anticipated that additional design criterion may need to be added to this list as the Bridge TSL Study progresses. As those situations arise, decisions on the additional design criterion will be made by the PMT.

[3] Refer to the Oregon Bicycle and Pedestrian Plan for additional combined standards. Shared pedestrian and bicycle paths are not encouraged.
[4] Includes 40' roadway, 16' ped/bike path and allowance for bridge railing and ped railing.
[5] 56'-4" width provides for ped rail, 12' bike, br rail, 8' shldr, 12' lane, 12' lane, 8' shldr, br rail
[6] 7% is allowable, (WSDOT Exhibit 1140-7 urban 40mph), but 5% max for ADA.

[7] Based on WSDOT exhibit 1250-5

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SR-35 Columbia River Crossing Study

Rev #	Revision Date	Revision	Initiator
1	11/30/2010	Changed bridge rail width from 1'-4" to 1'-8"	MEH
2	12/14/2010	Added Seismic Design Criteria	MEH

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APPENDIX C
Navigation Survey Validation Memorandum

S R - 3 5 Columbia River Crossing Study

To: Dale Robins, RTC Project Manager

Date: 9-20-10

From: Mark Hirota, P.E.
PB Project Manager

Subject: SR-35 Columbia River Crossing Navigation Survey

INTRODUCTION

A Navigation Baseline report was prepared in 2003 for SR-35 Columbia River Crossing Feasibility Study. For the TS&L report it was necessary to verify proposed design parameters within the study. Modification, upgrading or replacement of the bridge must consider existing and future vessel traffic and ensure safe navigation. The Columbia River Towboat Association (CRTA), U.S. Army Corps of Engineers, U.S. Coast Guard and other river users were contacted to gather information and to confirm conclusions from the feasibility study.

VESSEL TRAFFIC AND TRENDS

The U.S. Army Corps of Engineers, Waterborne Commerce Statistics, Part 4 cargo tonnage and vessel trips for the Vancouver to The Dalles Reach of the Columbia River were obtained for 2005 and 2008. The data was used to update the following tables summarizing the upbound and downbound cargo movements in addition to commercial vessel trips. Data prior to 2005 was reported in the 2003 Navigation Baseline report.

Total Upbound Cargo Tonnage (million tons): 1980 - 2008						
1980	1985	1990	1995	2000	2005	2008
3.5	2.1	2.1	3.3	3.2	3.0	3.1

Total Downbound Cargo Tonnage (million tons): 1980 - 2008						
1980	1985	1990	1995	2000	2005	2008
7.2	6.2	7.6	8.3	7.4	6.9	5.2

Vessel Trips through the Vancouver-The Dalles Reach: 1980 - 2008							
	1980	1985	1990	1995	2000	2005	2008
Upbound:	7,498	5,754	5,234	2,555	1,980	1,586	1,328
Downbound:	7,307	5,754	5,174	2,556	1,907	1,537	1,328
Avg. Daily:	41	32	28	14	10	9	7

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Compared to available data reported in the 2003 SR-35 Columbia Crossing report, the cargo volumes and vessel traffic have not increased.

VERIFICATION OF PROPOSED BRIDGE CLEARANCE WITH USERS

Existing navigation conditions has not experienced a significant change since 2003. In July 2009, a fuel barge grounded downstream of the bridge on a shoal that has accumulated at the mouth of Hood River, however, it was reported that the vessel was outside of the navigation channel and the incident was attributed to pilot error. According to river users, the existing channel provides enough width for vessel traffic but encroachment of sediment could be a problem in the future. A wider horizontal clearance could introduce the possibility of pilots taking a different approach angle to the bridge opening. According to the Portland District Corps of Engineers there are no current plans for changing the location of the authorized navigation channel.

Vertical Clearance

Existing conditions of SR-35 (Hood River Bridge) indicate a 67 feet vertical clearance when closed relative to the normal Bonneville pool elevation of 73 feet Mean Sea Level (MSL). The proposed vertical clearance for the new bridge is 80 feet above the full pool elevation of 77 feet MSL. This was confirmed with river users as being adequate and it was noted from CRTA that the bridges upstream have a 79 feet vertical clearance. Cranes, sailboats or tour ships with high clearances rarely navigate the channel with the typical traffic users being barges. Lampson International cranes can reach 130 feet but clearances this high would not be practical and an 80 feet vertical clearance was stated as manageable by Lampson because they can ship the cranes in parts.

Horizontal Clearance

The existing bridge at Hood River has a horizontal clearance of 246 feet. A horizontal clearance of 450 feet is proposed for the new bridge. It was noted from CRTA that the existing clearance is inadequate and two tows cannot pass the bridge opening at the same time. The navigation channel and the bridge opening are not lined up with the westerly winds and it is difficult for tows to safely transit with the 246 feet clearance. According to the CRTA, two-way traffic would account for approximately ⅓ to ½ of the traffic, but the existing opening is currently limited to one-way traffic. A horizontal clearance of 450 feet was acceptable to the river users contacted. The wider clearance addresses safety concerns and the possibility of two-way traffic.

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S R - 3 5 C o l u m b i a R i v e r C r o s s i n g S t u d y

CONCLUSION

The CRTA, U.S. Army Corps of Engineers, U.S. Coast Guard and other river users were contacted and verified that information in the 2003 Navigation Baseline Report is still valid. The recommended horizontal clearance is 450 feet and the vertical clearance is 80 feet above the full pool elevation of 77 feet MSL.

REFERENCES

Southwest Washington Regional Transportation Council, *SR-35 Bridge Feasibility Study, Navigation Baseline Report*, prepared by Parsons Brinckerhoff, March 2003.

Telephone discussion and email, Fred Harding (Shaver Transportation) Columbia River Towboat Association, August 18, 2010.

Telephone discussion, Austin Pratt, U.S. Coast Guard, August 18, 2010.

Telephone discussion, Jerry Grossnickle, Columbia River Towboat Association, August 18, 2010.

Telephone discussion, Jon Gornick, U.S. Army Corps of Engineers, Portland District, August 25, 2010.

Telephone discussion, Linda Shames, Port of Hood River, August 24, 2010.

Telephone discussion, Neil Lampson, Lampson International, August 24, 2010.

U.S. Army Corps of Engineers, *Waterborne Commerce of the United States, Part 4 Pacific Coast, Alaska and Hawaii*, 2005, 2008.

Telephone discussion, Paul Godsil and Gary Collin, Ross Island Sand & Gravel, September 7, 2010.

Telephone discussion, Adam Beeman (First Mate of the Spirit of 98'), CruiseWest, September 7, 2010.

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APPENDIX D

Gorge Management Plan Amendment

COLUMBIA RIVER BRIDGE REPLACEMENT

GMA Goal

1. Ensure that a replacement Columbia River Bridge between the Hood River and Bingen/White Salmon Urban Areas provides for regional transportation and public safety needs while being consistent with both purposes of the Scenic Area Act.

GMA Guidelines

Visual Quality

1. A replacement Columbia River Bridge between the Hood River and Bingen/White Salmon Urban Areas shall be visually unobtrusive and harmonious with the surrounding Gorge landscape and the Columbia River. A replacement bridge shall:

   A. Utilize recessive dark natural or earth-tone colors for steel components of the bridge, a thin and open structural design that allows views through it to the extent practicable, and consistent design character and ornamental elements;

   B. Employ lighting that provides a safe and pleasant atmosphere for bicycles and pedestrians while not casting glare directly into the sky or onto the river.

Historic Design Elements

1. A replacement Columbia River Bridge between the Hood River and Bingen/White Salmon Urban Areas shall incorporate elements that reflect historic design features of Scenic Area roadways and bridges. The historic themes should be an integral component of the design of the bridge structure, incorporated from "shore to shore."

2. A replacement bridge should include:

   A. Arches and/or other traditional structural forms in the bridge;

   B. Historic style benches, lighting, other pedestrian furnishings, and signage/graphic materials consistent with the USFS Graphic Signing System for the Scenic Area;

   C. Ornamental concrete or steel railings.

Recreation and Pedestrian/Bicycle Access

1. A replacement Columbia River Bridge between the Hood River and Bingen/White Salmon Urban Areas shall encourage and promote pedestrian and bicycle use, for recreational enjoyment and to enhance multi-modal transportation connections between the Urban Areas it connects.

2. The bridge shall include facilities for pedestrians and bicyclists that:

   A. Are permanent;

   B. Are wide enough to safely accommodate and encourage walking, bicycling, and other uses;

   C. Meet safety standards to prevent conflicts among automobiles, trucks, pedestrians, bicyclists, and other users;

   D. Provide multiple sitting and viewing areas with significant upstream and downstream views;

   E. Are safe to approach from both the north and south ends of the bridge and provide strong multi-modal connections, both east-west and to the nearby Urban Areas.

SPECIAL USES IN HISTORIC BUILDINGS

GMA Guidelines

Additional Review Uses for Historic Buildings

1. Properties in all GMA land use designations except Open Space and Agriculture-Special with buildings included on the National Register of Historic Places shall be permitted to be open for public viewing, interpretive displays, and an associated gift shop that is no larger than 100 square feet and incidental and subordinate to the primary use of the property, subject to compliance with the applicable guidelines to protect scenic, cultural, natural and recreation resources and the following sections of the "Additional Resource Protection Guidelines for Uses in Historic Buildings": Cultural Resources Guidelines (2)(a) and (b), (3), (4) and (5); and all Scenic, Recreation, Agriculture and Forest Lands Guidelines. Voluntary donations and/or fees to support maintenance, preservation and enhancement of the cultural resource may be accepted by the landowner.

2. Properties in all GMA land use designations except Open Space and Agriculture-Special with buildings included on the National Register of Historic Places, and which were former restaurants and/or inns shall be permitted to re-establish these former uses, subject to compliance with the applicable guidelines to protect scenic, cultural, natural and recreation resources and the following sections of the "Additional Resource Protection Guidelines for Uses in Historic Buildings": Cultural Resources Guidelines (2)(a) and (b), (3), (4) and (5); and all Scenic, Recreation, Agriculture and Forest Lands Guidelines. The capacity of restaurant use and overnight accommodations shall be limited to that existing in the former use, and the former use shall be contained within the limits of the building as of January 1, 2006. Banquets, private parties and other special events that take place entirely

SECTION E

Foundations Recommendations Memorandum

Memorandum

To: Mark Hirota, PB

From: John Horne, Evan Garich

Date: February 25, 2011

Subject: Preliminary Geotechnical Foundation Recommendations
SR-35, Columbia River Crossing Project

This memorandum has been developed to provide preliminary geotechnical recommendations to facilitate the TS&L bridge design efforts for the SR-35 Columbia River Crossing Project. This document supersedes the memorandum titled "Preliminary Geotechnical Foundation Recommendations" dated December 12, 2010.

A TS&L geologic profile at the proposed bridge alignment has been developed using historic construction documents, and project specific investigations which included two surveys and three geotechnical borings. The surveys include a bathymetric survey performed on July 14, 2010 and a geophysical survey performed on October 20, 2010. Barge mounted geotechnical drilling occurred from December 20 to 23, 2010.

The investigations were performed in order to develop a better understanding of the elevation of bedrock and thickness of alluvium along the alignment. The historic construction records and geophysical survey are in general agreement at the northerly and southerly margins of the project. However, there is divergence of the data sets from Sta. 33+00 to 51+00. The depth to bedrock is deeper than anticipated from historic construction records at geotechnical borings B-1 and B-2, however there is good agreement at B-3. The geophysical survey did not produce meaningful results from Sta. 33+00 to 51+00 due to the thickness of the alluvial package over bedrock and the limitations in the ability of the equipment to penetrate 100+ feet of sediment. The TS&L geologic profile is included as Attachment A. Although the bedrock elevation has been determined at the three boring locations and to a high degree of confidence at the southerly and northerly portions of the river crossing, significant uncertainty remains in between the boring locations from Sta. 33+00 to 50+00 and at the south abutment where bedrock may increase in depth again.

Preliminary foundation recommendations have been developed for driven piles and drilled shafts. Driven piles were analyzed for stratigraphies developed at B-1 and B-2, while drilled shafts were analyzed at B-3. It is presumed that driven piles would be more economical at locations of deep bedrock (±50 feet of sediment) while drilled shafts would be more economical in locations of shallow bedrock. Three sizes of open-ended pipe pile were analyzed: 24X0.5, 36X0.5 and 48X0.5. It was assumed all piles would be driven into bedrock and ultimate capacity would be limited by the structural capacity of the piles. In the field, it may not be possible to drive the piles to bedrock, however very high axial capacities will be achievable even if the piles are not tipped in bedrock. Driven pile tip elevations should be a minimum of 20 feet below the maximum predicted liquefaction depth of 60 feet. Driven pile capacities at B-1 and B-2 are presented in Attachment B.

It is presumed drilled shafts would be socketed into bedrock and behave primarily as end bearing shafts. Shaft sizes of 6, 8, and 10 ft. in diameter were analyzed. Shafts should be socketed at least two diameters into rock. Axial capacity derived from the bedrock will be highly dependent on the overall strength/hardness, jointing characteristics, and degree of weathering at each shaft location. The bedrock at the project location is basalt of the Grande Ronde Formation. Basalt samples obtained from drilling ranged from weathered to fresh, with unconfined compressive strengths ranging from 1,500 to 22,000 psi. Low end strengths were used in the drilled shaft capacity calculations at B-3. Drilled shaft capacities at B-3 are presented in Attachment C.

Soil and rock parameters have been developed for lateral loading and deformation analysis. The recommended parameters are presented in Tables 1 and 2. The lateral parameters for rock were developed based on Unconfined Compressive Strength tests using Mohr-Coulomb failure criteria and accounting for potential jointing in the rock and the stresses acting on the rock.

Table 1. Lateral Analysis Parameters at B-1 and B-2

Unit	1		2		3	4
Description	Loose Alluvial Sand		Med-Dense Alluvial Sand		Dense Alluvial Gravel	Basalt
B-1 Thickness	40 ft		54 ft		26 ft	--
B-2 Thickness	68 ft		22 ft		13 ft	--
Condition	Static	Liquefied	Static	Liquefied	Static/ Liquefied	Static/ Liquefied
Soil Type for LPILE Analysis	“Sand”	“Sand”	“Sand”	“Sand”	“Sand”	“Silt” (c-φ material)
Effective Unit Weight (pcf)	38	38	53	53	68	83
Φ (degrees)	28	8	32	8	35	35
Cohesion (psf)	0	0	0	0	0	144,000
Initial p-y modulus (ksi)[1]	0.24D	0.04D	0.72D	0.04D	1.5D	450
Strain at 50% Maximum Stress	0	0	0	0	0	0.005

1. The initial p-y modulus in alluvium is presented as a function of depth, D (ft).

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Table 2. Lateral Analysis Parameters at B-3

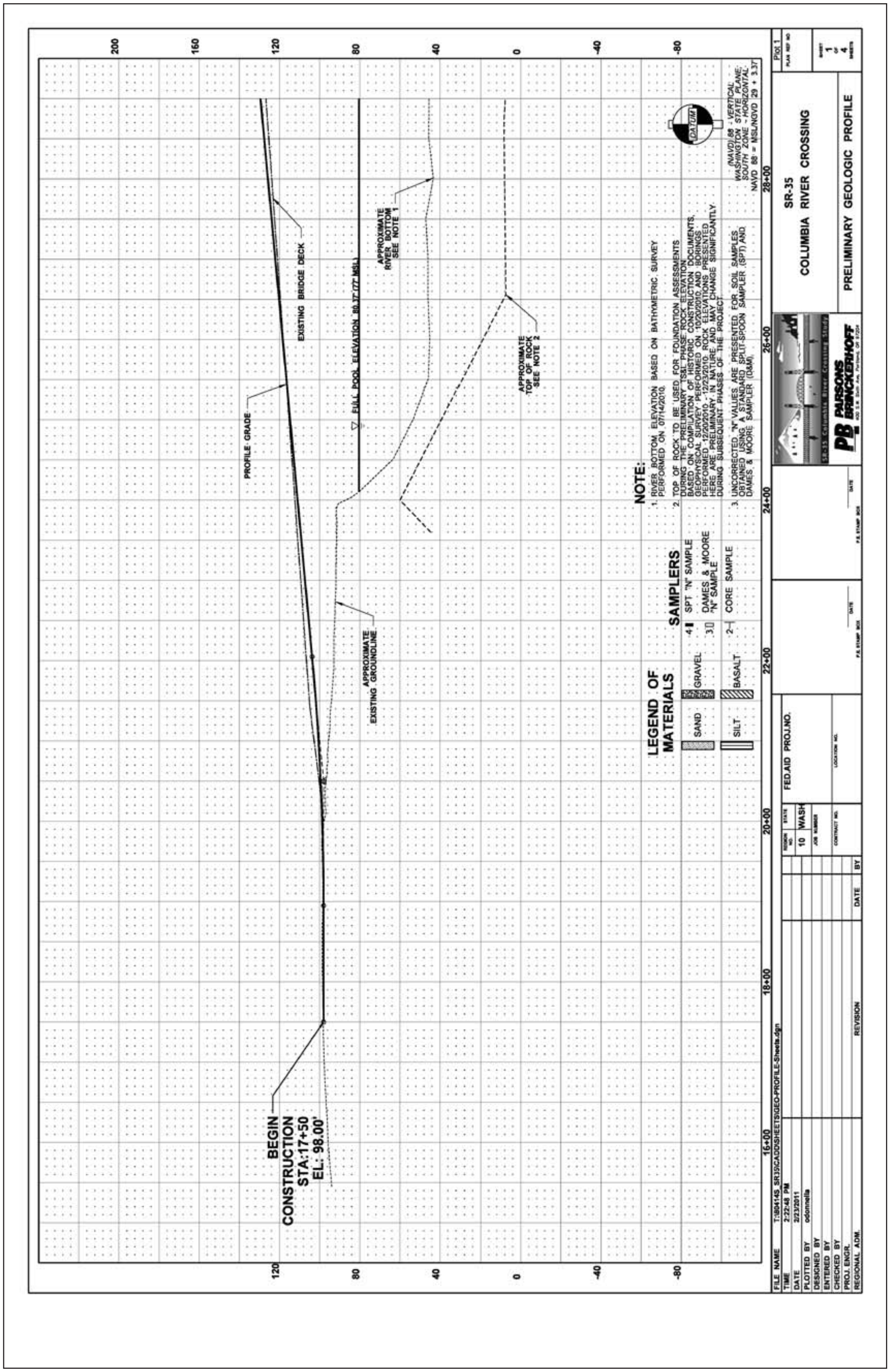
Unit	1		2		3	4
Description	Soft Alluvial Silt		Loose Alluvial Sand		Weathered Basalt	Basalt
B-3 Thickness	27 ft		3 ft		15 ft	--
Condition	Static	Liquefied	Static	Liquefied	Static/ Liquefied	Static/ Liquefied
Soil Type for LPILE Analysis	"Clay"	"Sand"	"Sand"	"Sand"	"Sand"	"Silt" (c-φ material)
Effective Unit Weight (pcf)	33	33	53	53	73	83
Φ (degrees)	0	8	28	8	40	35
Cohesion (psf)	100	0	0	0	0	13,000
Initial p-y modulus (ksi)[1]	0.24D	0.04D	0.24D	0.04D	1.5D	80
Strain at 50% Maximum Stress	0.02	0	0	0	0	0.002

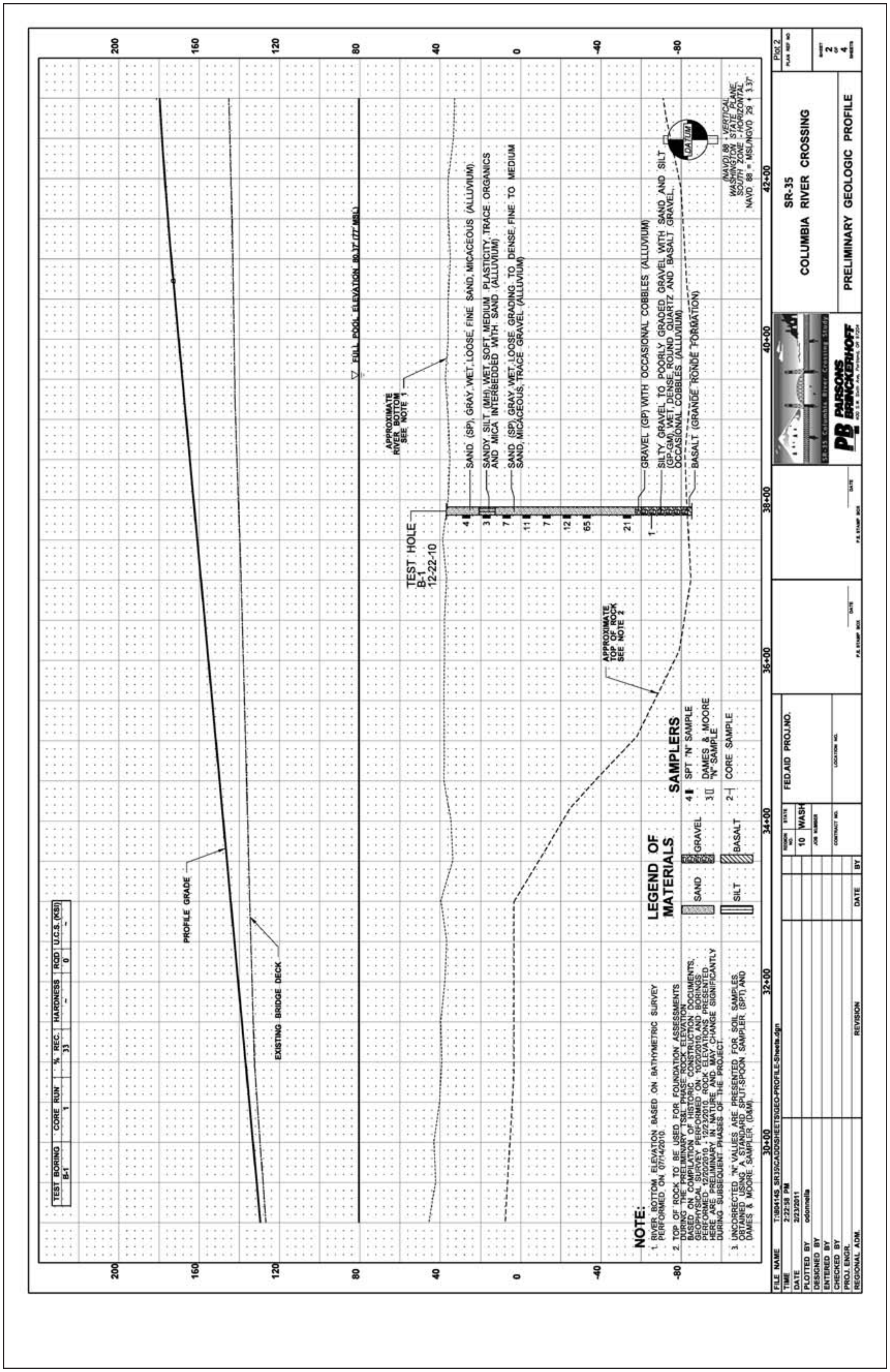
1. The initial p-y modulus in alluvium is presented as a function of depth, D (ft).

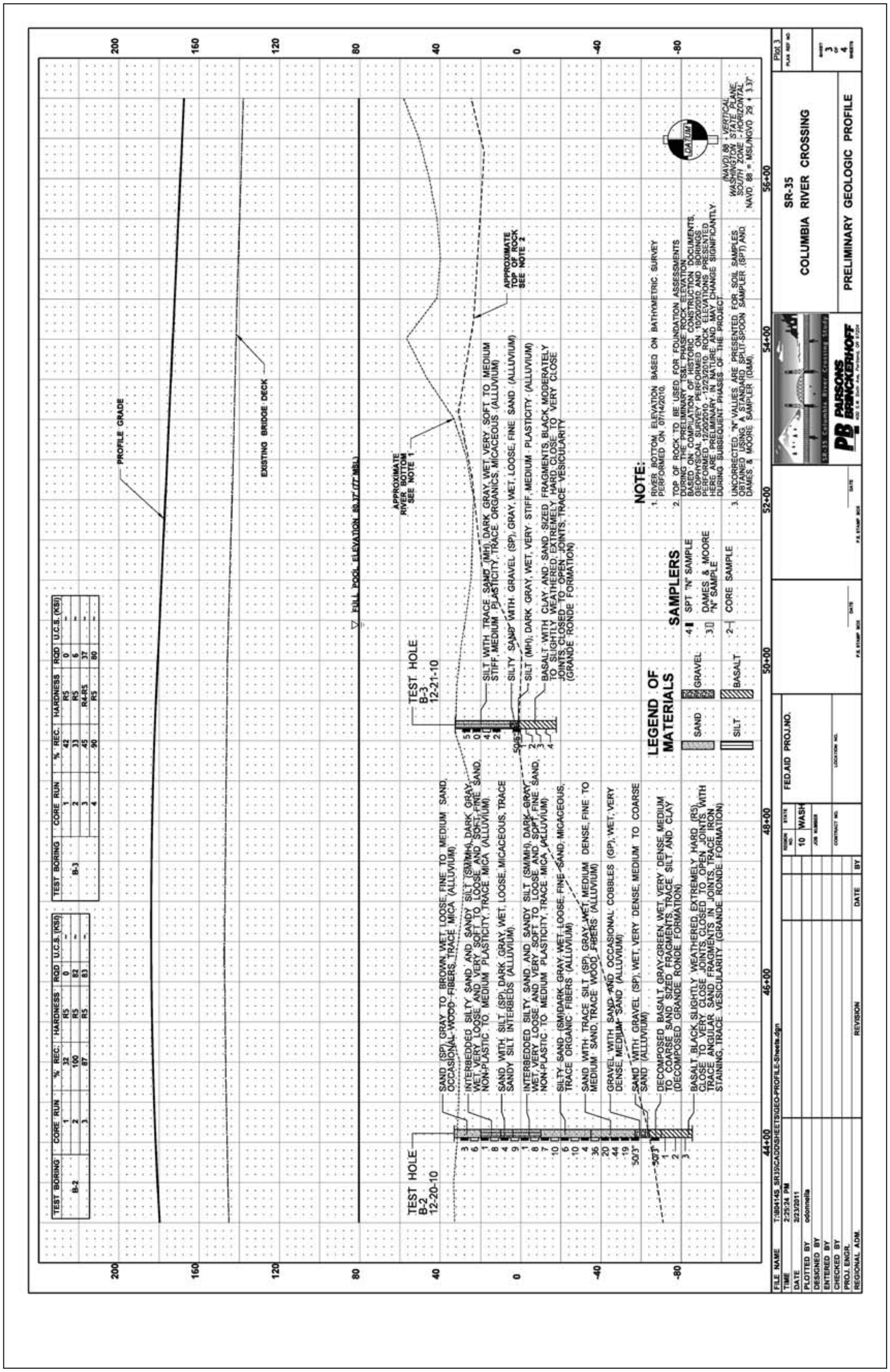
Seismic design parameters have been developed following AASHTO LRFD Bridge Design Specifications, 5th Ed. Currently, ODOT specifies performance requirements for two ground motion events having recurrence intervals of approximately 500-years and 1,000-years based on USGS 2002 PSHA, while WSDOT has performance requirements for one event, the 1,000-year recurrence based on USGS 2008 PSHA. The USGS 2008 ground motions were found to be approximately 5 percent larger than those found using the 2002 data set. Ground motions based on the USGS 2008 data at the rock/alluvium interface have been characterized and are presented in Attachment D.

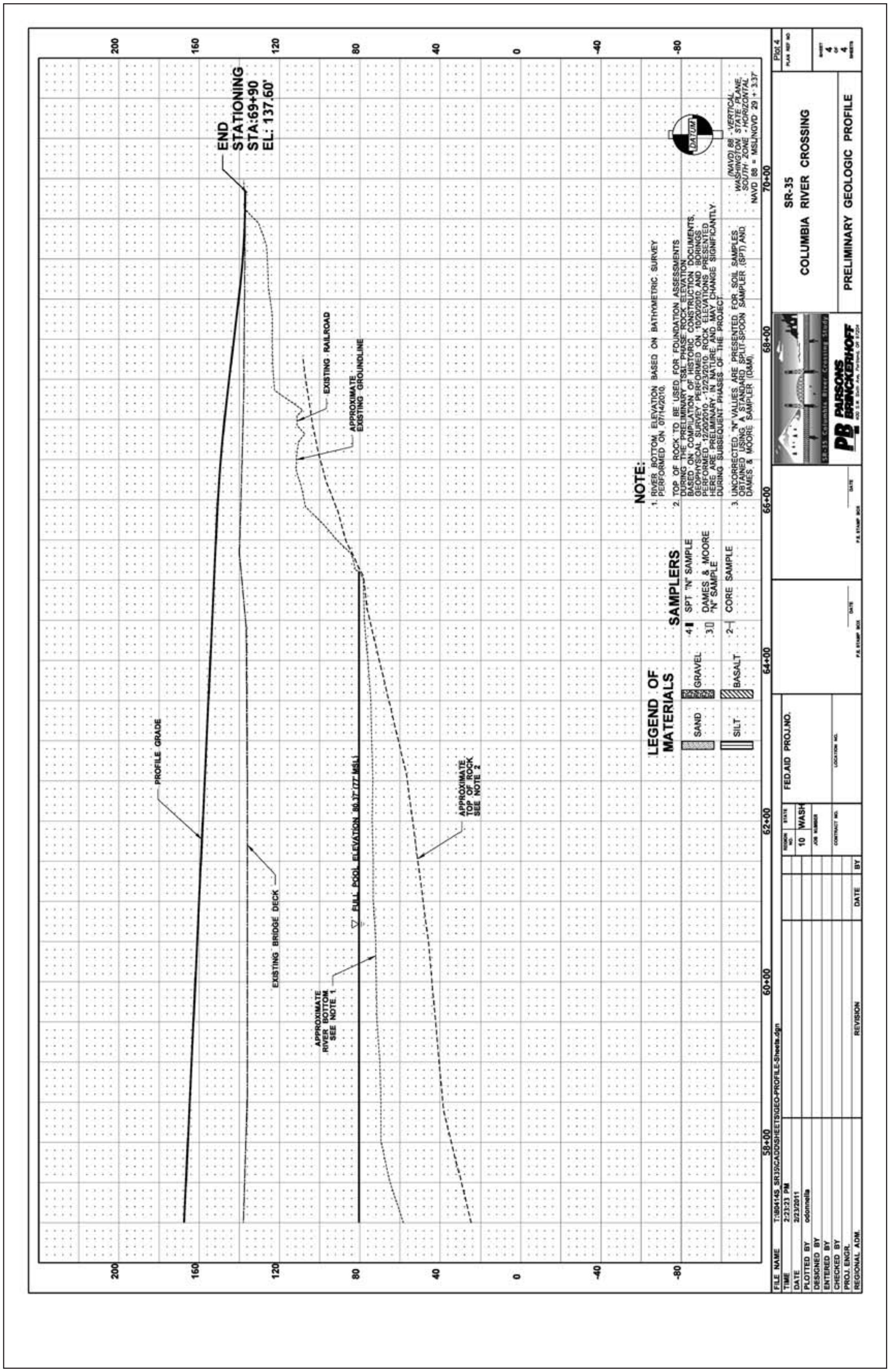
The site is located within an area of moderate seismicity. No known active faults lie within 6 miles of the project site. A simplified liquefaction assessment of the soil columns at B-1, B-2, and B-3 is presented in Attachment D. The loose alluvium in the upper 60 feet at borings B-1 and B-2 is liquefiable. The elastic silt present in boring B-3 should not liquefy, however, it may exhibit sensitive behavior which will result in strength loss during a seismic event. Although not directly analyzed, the south approach should be considered susceptible to liquefaction-induced lateral spreading. Mitigation involving ground improvement should be considered to reduce the effects of liquefaction-induced lateral spreading. The limits and type of ground improvement will be developed during subsequent design phases of the project.

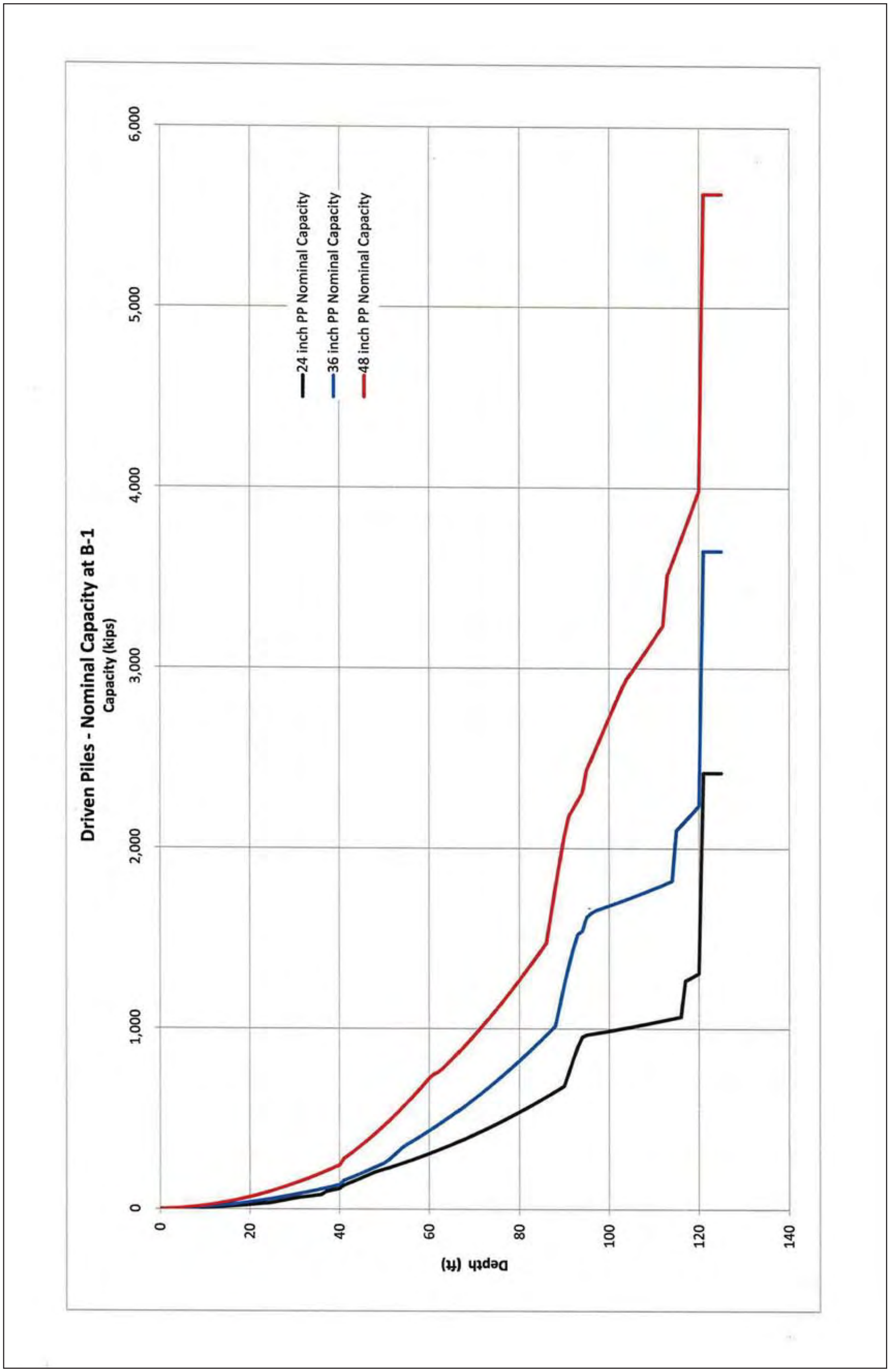
Attachments
Attachment A: TS&L Geologic Profile
Attachment B: Preliminary Driven Pile Capacities
Attachment C: Preliminary Drilled Shaft Capacities
Attachment D: Seismic Design Criteria

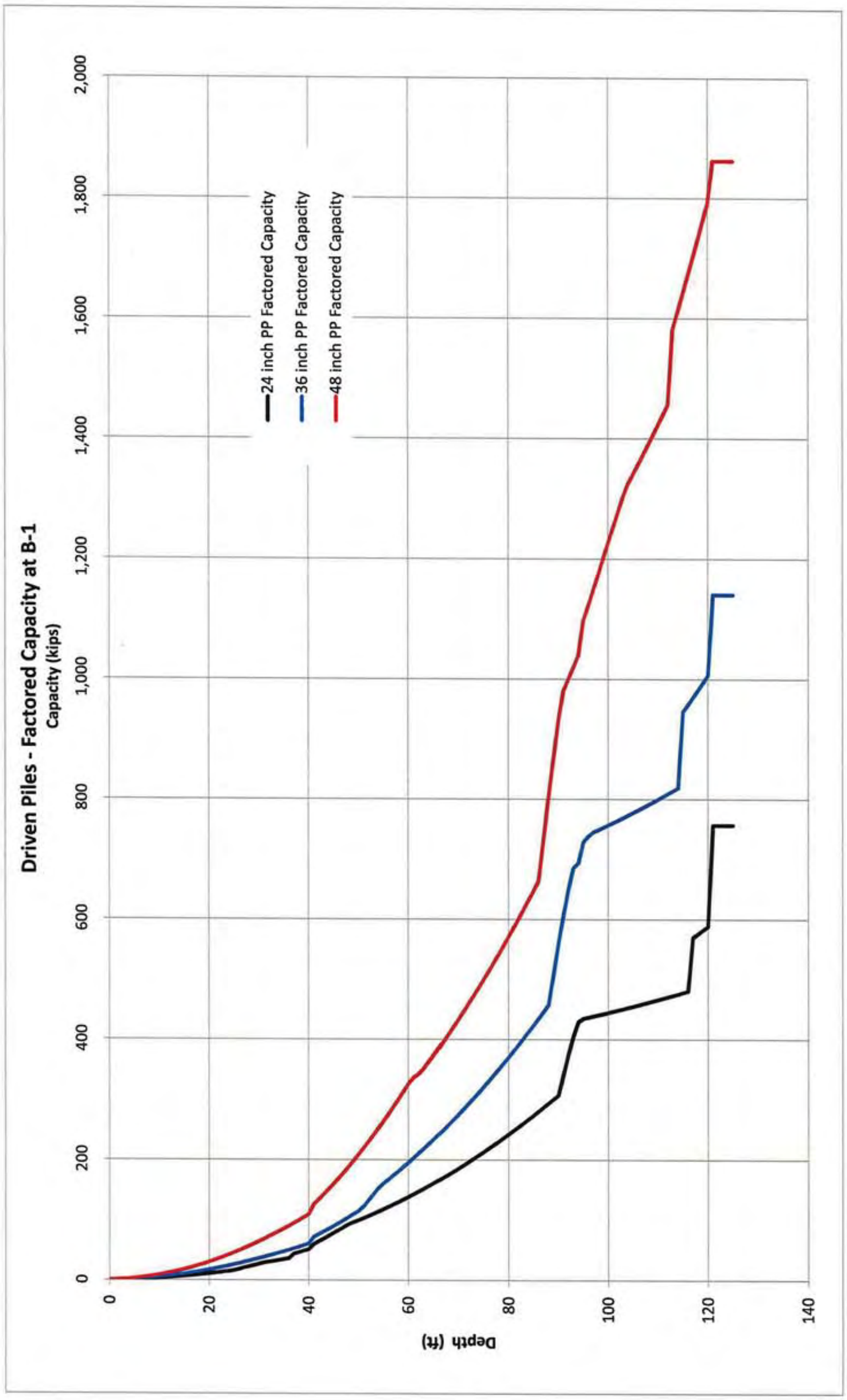

PROFILE GRADE
EXISTING BRIDGE DECK
FULL POOL ELEVATION 80.17'(77' MSL)
APPROXIMATE RIVER BOTTOM SEE NOTE 1
APPROXIMATE TOP OF ROCK SEE NOTE 2
APPROXIMATE EXISTING GROUNDLINE
BEGIN CONSTRUCTION STA:17+50 EL: 98.00'
LEGEND OF MATERIALS
SAND
GRAVEL
SILT
BASALT
SAMPLERS
SPT "N" SAMPLE
DAMES & MOORE "N" SAMPLE
CORE SAMPLE
NOTE:
1. RIVER BOTTOM ELEVATION BASED ON BATHYMETRIC SURVEY PERFORMED ON 07/14/2010.
2. TOP OF ROCK TO BE USED FOR FOUNDATION ASSESSMENTS DURING THE PRELIMINARY TS&L PHASE. ROCK ELEVATION BASED ON COMPILATION OF HISTORIC CONSTRUCTION DOCUMENTS, GEOPHYSICAL SURVEY PERFORMED ON 10/20/2010 AND BORINGS PERFORMED 12/2010 - 1/2011. ROCK ELEVATIONS PRESENTED HERE ARE PRELIMINARY IN NATURE AND MAY CHANGE SIGNIFICANTLY DURING SUBSEQUENT PHASES OF THE PROJECT.
3. UNCORRECTED "N" VALUES ARE PRESENTED FOR SOIL SAMPLES OBTAINED USING A STANDARD SPLIT-SPOON SAMPLER (SPT) AND DAMES & MOORE SAMPLER (D&M).
DATUM
(NAVD) 88 - VERTICAL
WASHINGTON STATE PLANE SOUTH ZONE - HORIZONTAL
NAVD 88 = MSL/NGVD 29 + 3.37'
16+00
18+00
20+00
22+00
24+00
26+00
28+00
200
160
120
80
40
0
-40
-80
FILE NAME T:\804145_SR35\CADD\SHEETS\GEO-PROFILE-Sheets.dgn
TIME 2:22:48 PM
DATE 2/23/2011
PLOTTED BY odonnells
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.
REVISION
DATE
BY
REGION NO. 10
STATE WASH
FED.AID PROJ.NO.
JOB NUMBER
CONTRACT NO.
LOCATION NO.
P.E. STAMP BOX
DATE
PARSONS BRINCKERHOFF
SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
Plot 1
SHEET 1 OF 4 SHEETS

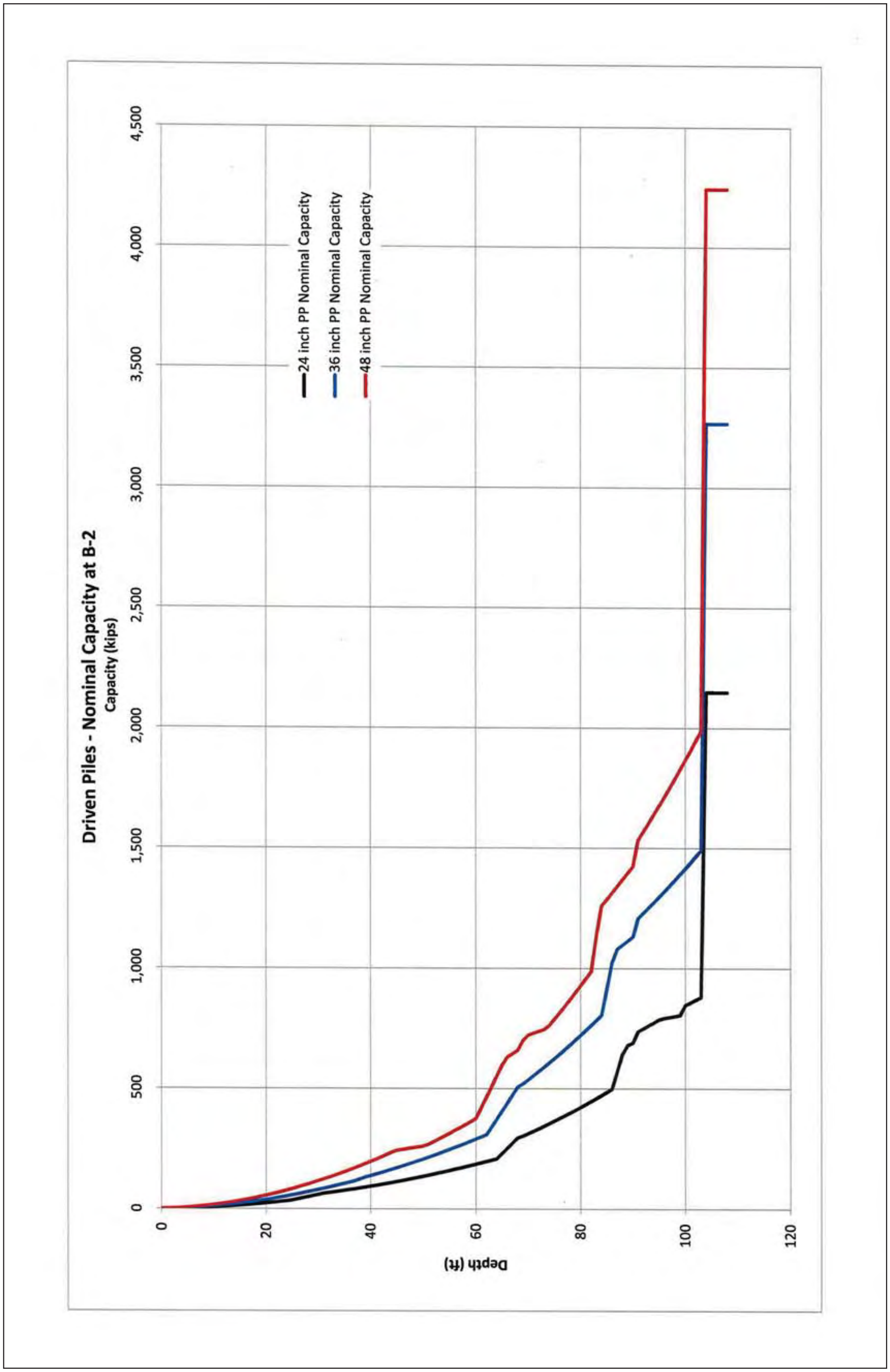

SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
PARSONS BRINCKERHOFF
TEST HOLE B-1 12-22-10
FULL POOL ELEVATION
APPROXIMATE RIVER BOTTOM SEE NOTE 1
APPROXIMATE TOP OF ROCK SEE NOTE 2
PROFILE GRADE
EXISTING BRIDGE DECK
SAND (SP), GRAY, WET, LOOSE, FINE SAND, MICACEOUS (ALLUVIUM)
SANDY SILT (ML), WET, SOFT, MEDIUM PLASTICITY, TRACE ORGANICS AND MICA INTERBEDDED WITH SAND (ALLUVIUM)
SAND (SP), GRAY, WET, LOOSE GRADING TO DENSE, FINE TO MEDIUM SAND, MICACEOUS, TRACE GRAVEL (ALLUVIUM)
GRAVEL (GP) WITH OCCASIONAL COBBLES (ALLUVIUM)
SILTY GRAVEL TO POORLY GRADED GRAVEL WITH SAND AND SILT (GP-GM), WET, DENSE, ROUND QUARTZ AND BASALT GRAVEL, OCCASIONAL COBBLES (ALLUVIUM)
BASALT (GRANDE RONDE FORMATION)
LEGEND OF MATERIALS
SAND
GRAVEL
SILT
BASALT
SAMPLERS
SPT "N" SAMPLE
DAMES & MOORE "N" SAMPLE
CORE SAMPLE
TEST BORING
CORE RUN
% REC.
HARDNESS
RQD
U.C.S. (KSI)
NOTE:
1. RIVER BOTTOM ELEVATION BASED ON BATHYMETRIC SURVEY PERFORMED ON 07/14/2010.
3. UNCORRECTED "N" VALUES ARE PRESENTED FOR SOIL SAMPLES OBTAINED USING A STANDARD SPLIT-SPOON SAMPLER (SPT) AND DAMES & MOORE SAMPLER (D&M).
DATUM
FED.AID PROJ.NO.
WASH
REVISION
DATE
BY

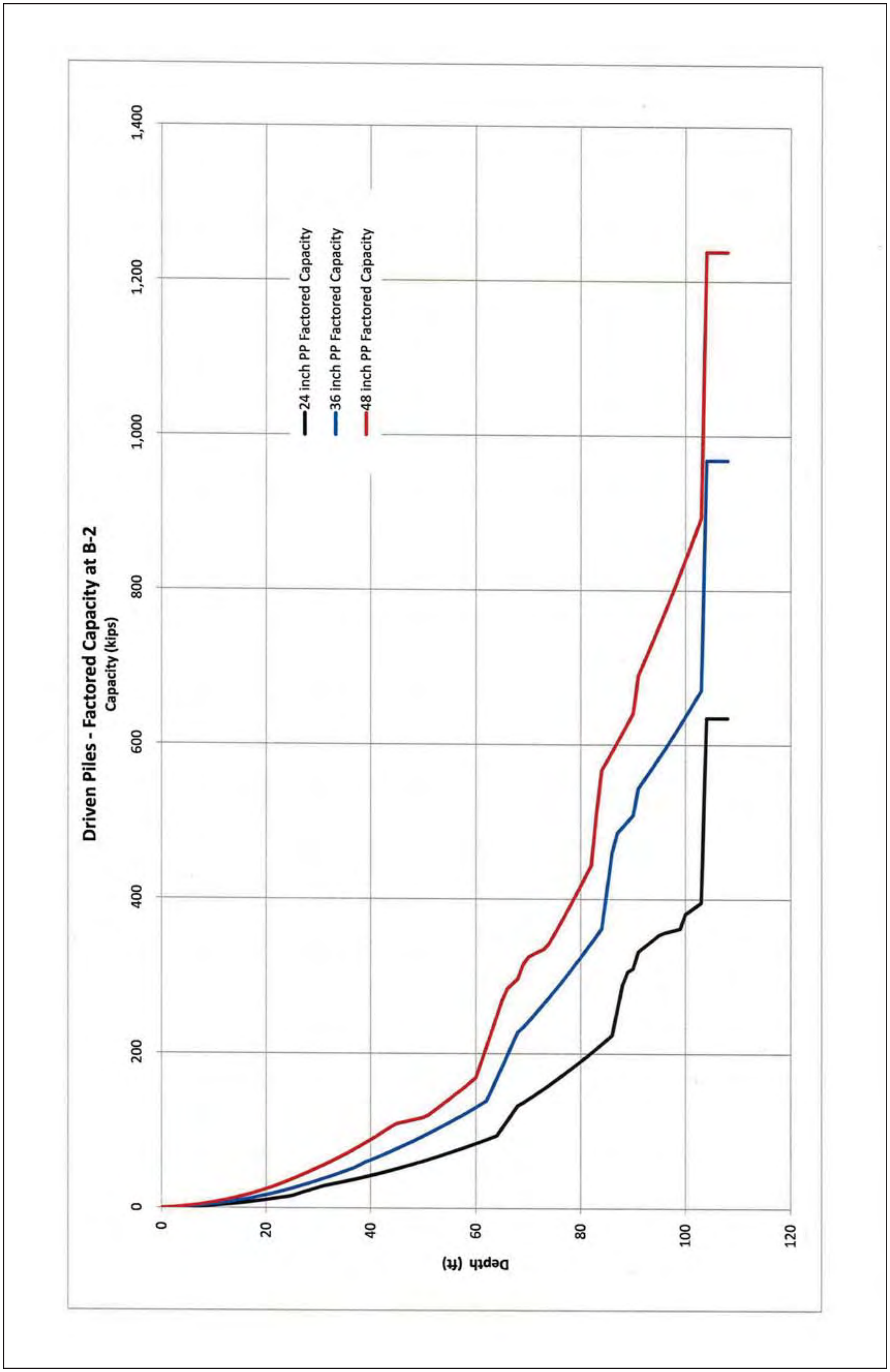

SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
PROFILE GRADE
EXISTING BRIDGE DECK
TEST HOLE B-2 12-20-10
TEST HOLE B-3 12-21-10
LEGEND OF MATERIALS
SAMPLERS
NOTE:
PARSONS BRINCKERHOFF

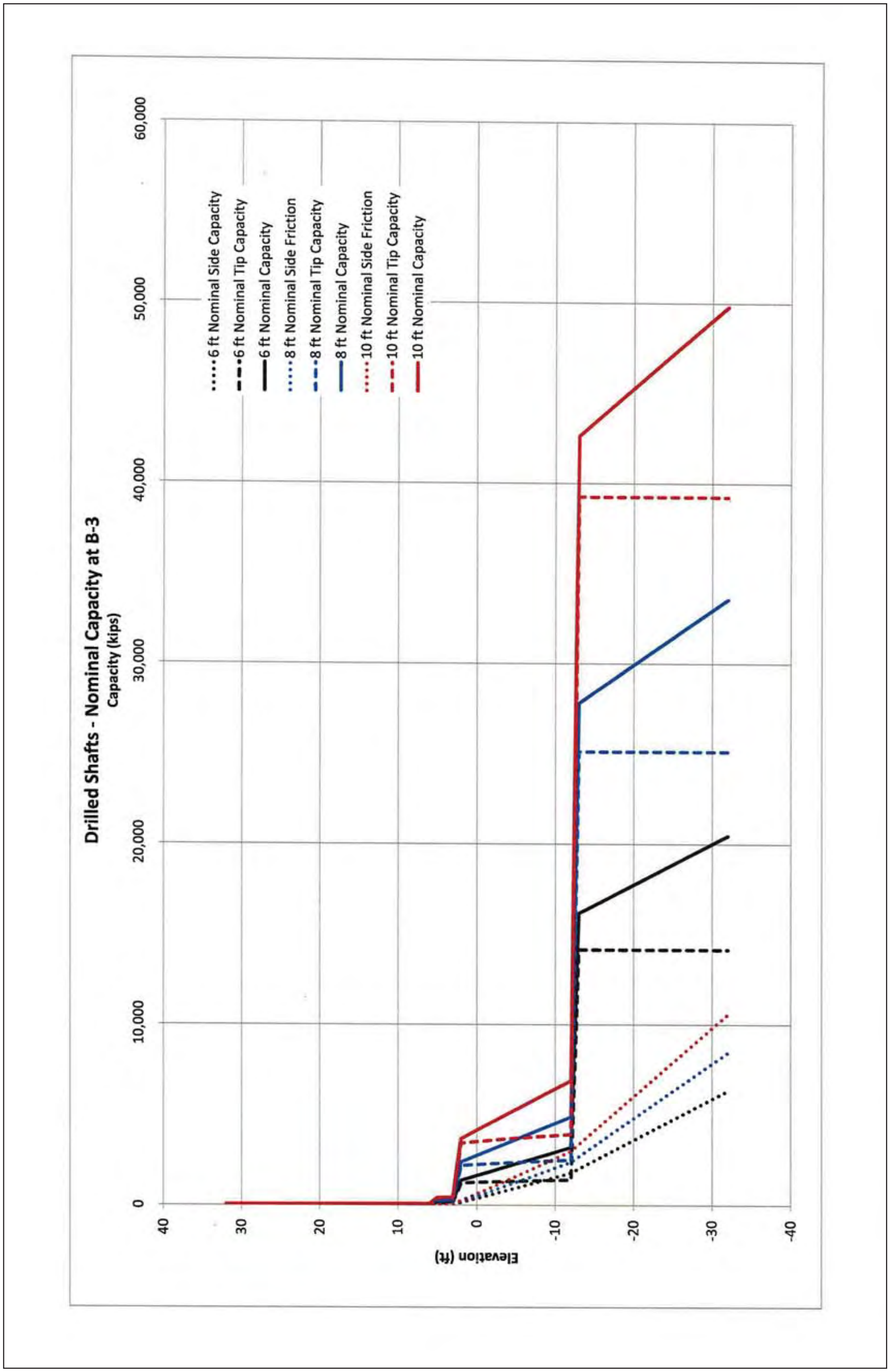

END
STATIONING
STA:69+90
EL: 137.60'
EXISTING RAILROAD
APPROXIMATE
EXISTING GROUNDLINE
PROFILE GRADE
EXISTING BRIDGE DECK
FULL POOL ELEVATION
APPROXIMATE
TOP OF ROCK
SEE NOTE 2
APPROXIMATE
RIVER BOTTOM
SEE NOTE 1
LEGEND OF
MATERIALS
SAND
GRAVEL
SILT
BASALT
SAMPLERS
SPT "N" SAMPLE
DAMES & MOORE
"N" SAMPLE
CORE SAMPLE
NOTE:
SR-35
COLUMBIA RIVER CROSSING
PRELIMINARY GEOLOGIC PROFILE
PARSONS
BRINCKERHOFF

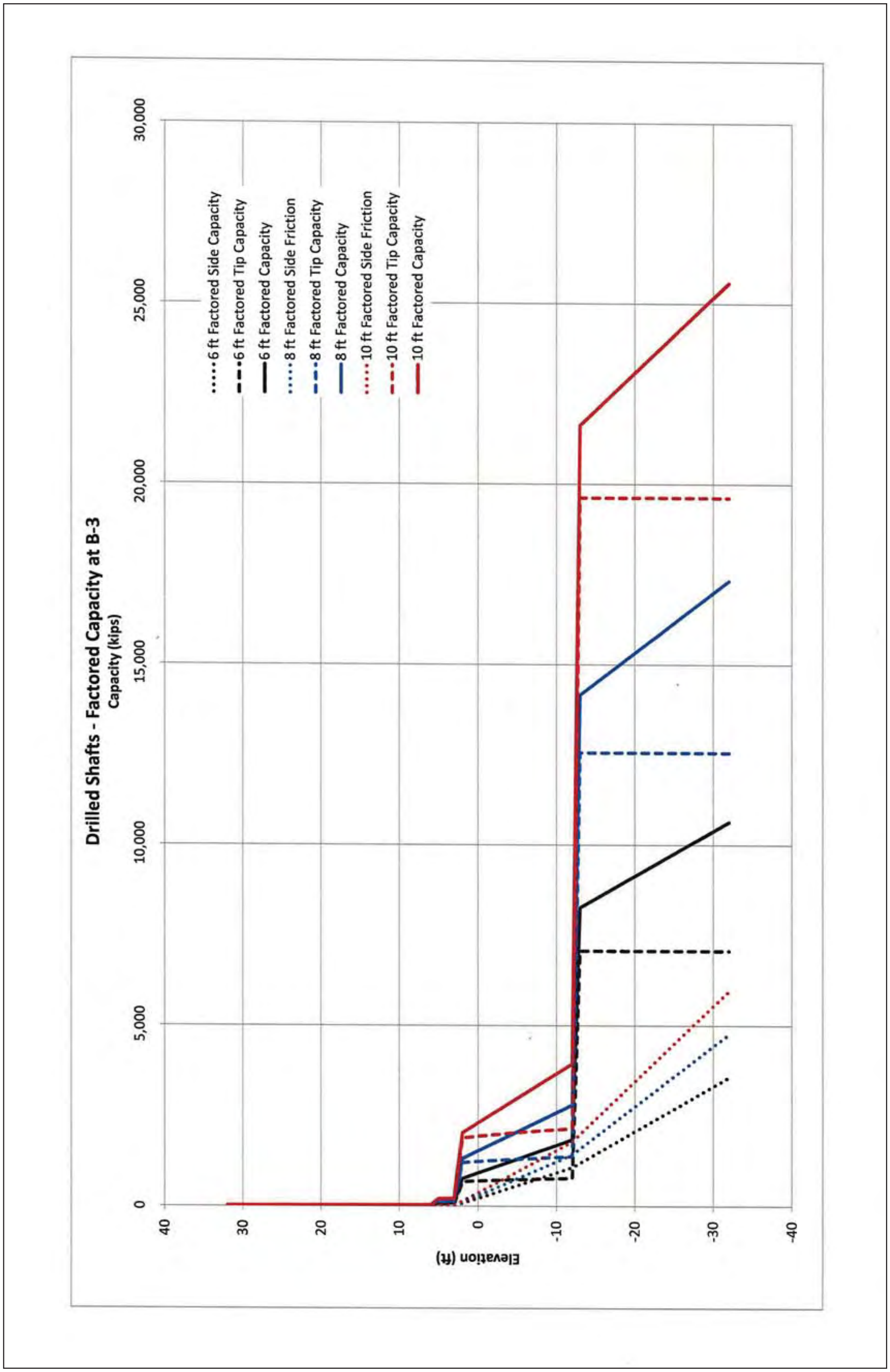

Driven Piles - Nominal Capacity at B-1
Capacity (kips)
Depth (ft)
24 inch PP Nominal Capacity
36 inch PP Nominal Capacity
48 inch PP Nominal Capacity
0
1,000
2,000
3,000
4,000
5,000
6,000
0
20
40
60
80
100
120
140

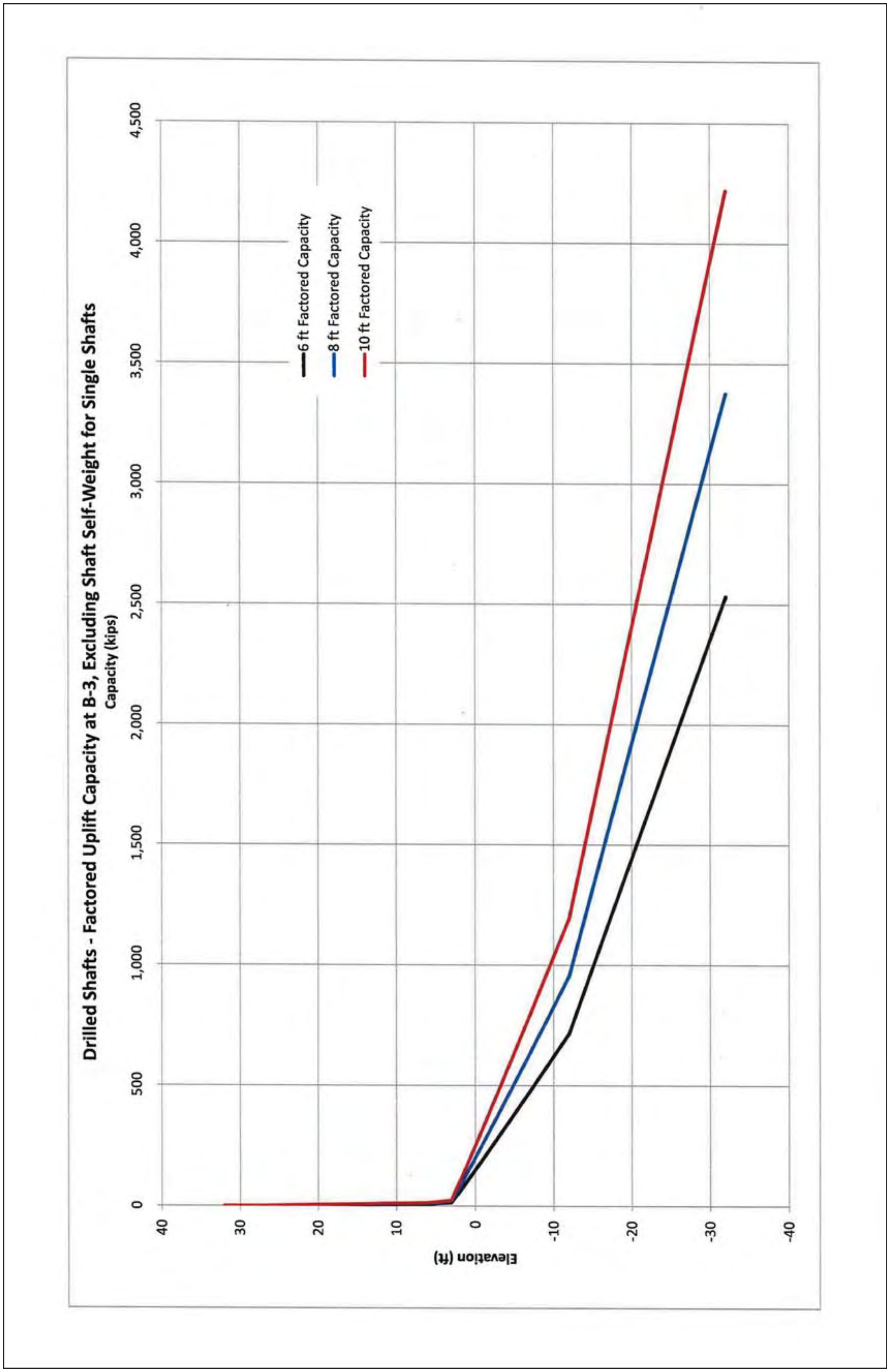

Driven Piles - Factored Capacity at B-1
Capacity (kips)
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
24 inch PP Factored Capacity
36 inch PP Factored Capacity
48 inch PP Factored Capacity
Depth (ft)
0
20
40
60
80
100
120
140


Driven Piles - Nominal Capacity at B-2
Capacity (kips)
Depth (ft)
24 inch PP Nominal Capacity
36 inch PP Nominal Capacity
48 inch PP Nominal Capacity
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
0
20
40
60
80
100
120


Driven Piles - Factored Capacity at B-2
Capacity (kips)
0
200
400
600
800
1,000
1,200
1,400
24 inch PP Factored Capacity
36 inch PP Factored Capacity
48 inch PP Factored Capacity
Depth (ft)
0
20
40
60
80
100
120


Drilled Shafts - Nominal Capacity at B-3
Capacity (kips)
Elevation (ft)
0
10,000
20,000
30,000
40,000
50,000
60,000
40
30
20
10
0
-10
-20
-30
-40
6 ft Nominal Side Capacity
6 ft Nominal Tip Capacity
6 ft Nominal Capacity
8 ft Nominal Side Friction
8 ft Nominal Tip Capacity
8 ft Nominal Capacity
10 ft Nominal Side Friction
10 ft Nominal Tip Capacity
10 ft Nominal Capacity


Drilled Shafts - Factored Capacity at B-3
Capacity (kips)
0
5,000
10,000
15,000
20,000
25,000
30,000
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
6 ft Factored Side Capacity
6 ft Factored Tip Capacity
6 ft Factored Capacity
8 ft Factored Side Friction
8 ft Factored Tip Capacity
8 ft Factored Capacity
10 ft Factored Side Friction
10 ft Factored Tip Capacity
10 ft Factored Capacity


Drilled Shafts - Factored Uplift Capacity at B-3, Excluding Shaft Self-Weight for Single Shafts
Capacity (kips)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
6 ft Factored Capacity
8 ft Factored Capacity
10 ft Factored Capacity

PARSONS BRINCKERHOFF COMPUTATION SHEET	
Page:	1 of 2
Made by:	E. Garich
Date:	12/8/201
Checked by:	J. Horne
Date:	12/9/201

Subject Preliminary Ground Motion Parameters
SR-35, Columbia River Crossing

References
1) United States Geological Survey, 2008, Earthquake Hazards Program
2) AASHTO, 2010, AASHTO LRFD Bridge Design Specifications 5th Edition

Ground motion parameters shall be developed for two recurrence intervals - 500 and 1,000 years

USGS 2008 accelerations on bedrock:

500 yr	
PGA	0.114
S_s	0.260
S_1	0.096

1000 yr	
PGA	0.158
S_s	0.364
S_1	0.142

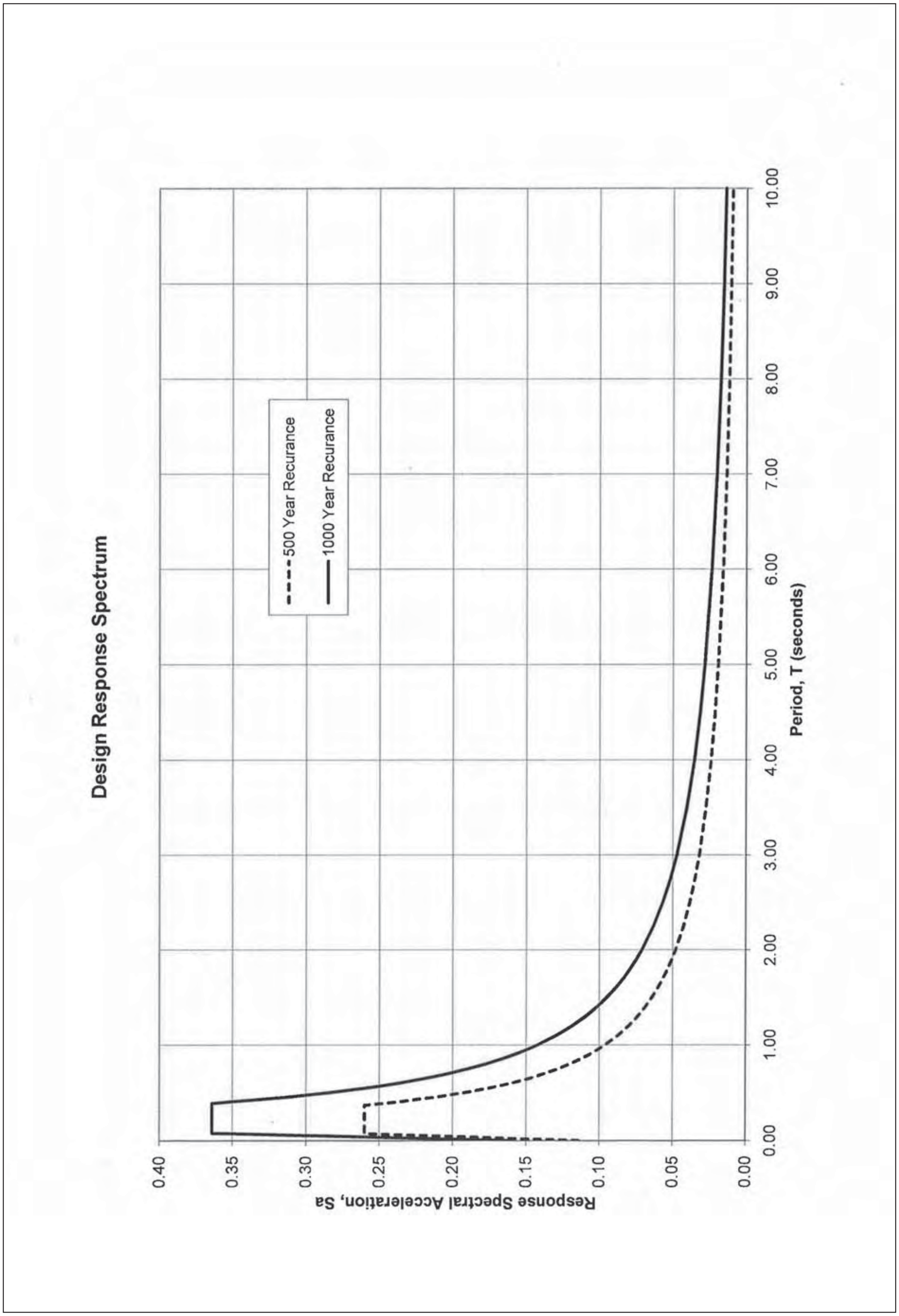
AAHSTO 2009 ground motion parameters:

500 yr	
F_{pga}	1.00
F_a	1.00
F_v	1.00
A_s	0.11
S_{DS}	0.26
S_{D1}	0.10
T_0	0.07
T_S	0.37

1000 yr	
F_{pga}	1.00
F_a	1.00
F_v	1.00
A_s	0.16
S_{DS}	0.36
S_{D1}	0.14
T_0	0.08
T_S	0.39

GroundMotions
Ground Motion Parameter

Geotechnical and Tunneling Group



Design Response Spectrum
500 Year Recurance
1000 Year Recurance
Response Spectral Acceleration, Sa
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Period, T (seconds)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

PARSONS BRINCKERHOFF
COMPUTATION SHEET

Page: 1 of ___
Made by: E. Garich
Date: 2/18/2(
Checked by: J. Horne
Date:

Subject Liquefaction Analysis
SR-35, Columbia River Crossing

A seismic hazard deaggregation was performed to identify the seismic sources that contribute the greatest hazard to the site. The sources were identified: 1) Shallow crustal faults, 2) Intraplate faulting, and 3) Cascadia Subduction Zone (CSZ) faulting. A M-R pair from each source which had the greatest contribution to the mean PGA was choosen to be included in the liquefaction analysis. These pairs are:

1) Shallow crustal - M = 5.40, R = 8.3 km
2) Intraplate - M = 7.01, R = 86.0 km
3) CSZ - M = 9.0, R = 179.7 km

Attenuation relationships were used to determine the PGA from each M-R pair at the site. For the shallow crustal faulting 3 NGA relationships (Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and Youngs (2008)) were equally weighted to evaluate PGA. For CSZ and Intraplate faulting Youngs et al. (1997) was used. Averaged PGA's are as follows:

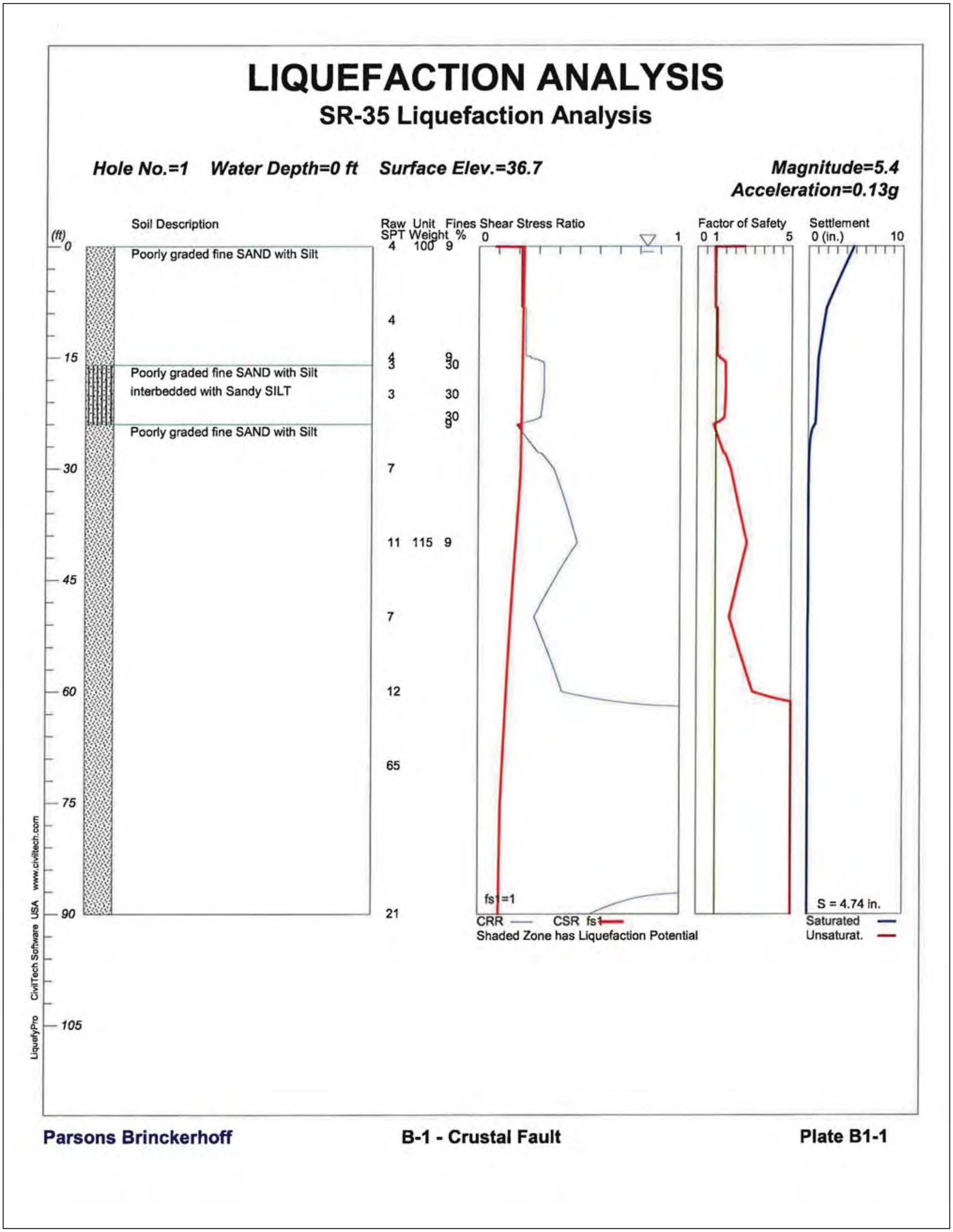
1) Shallow crustal - PGA = 0.13 g
2) Intraplate - PGA = 0.11 g
3) CSZ - PGA = 0.10 g

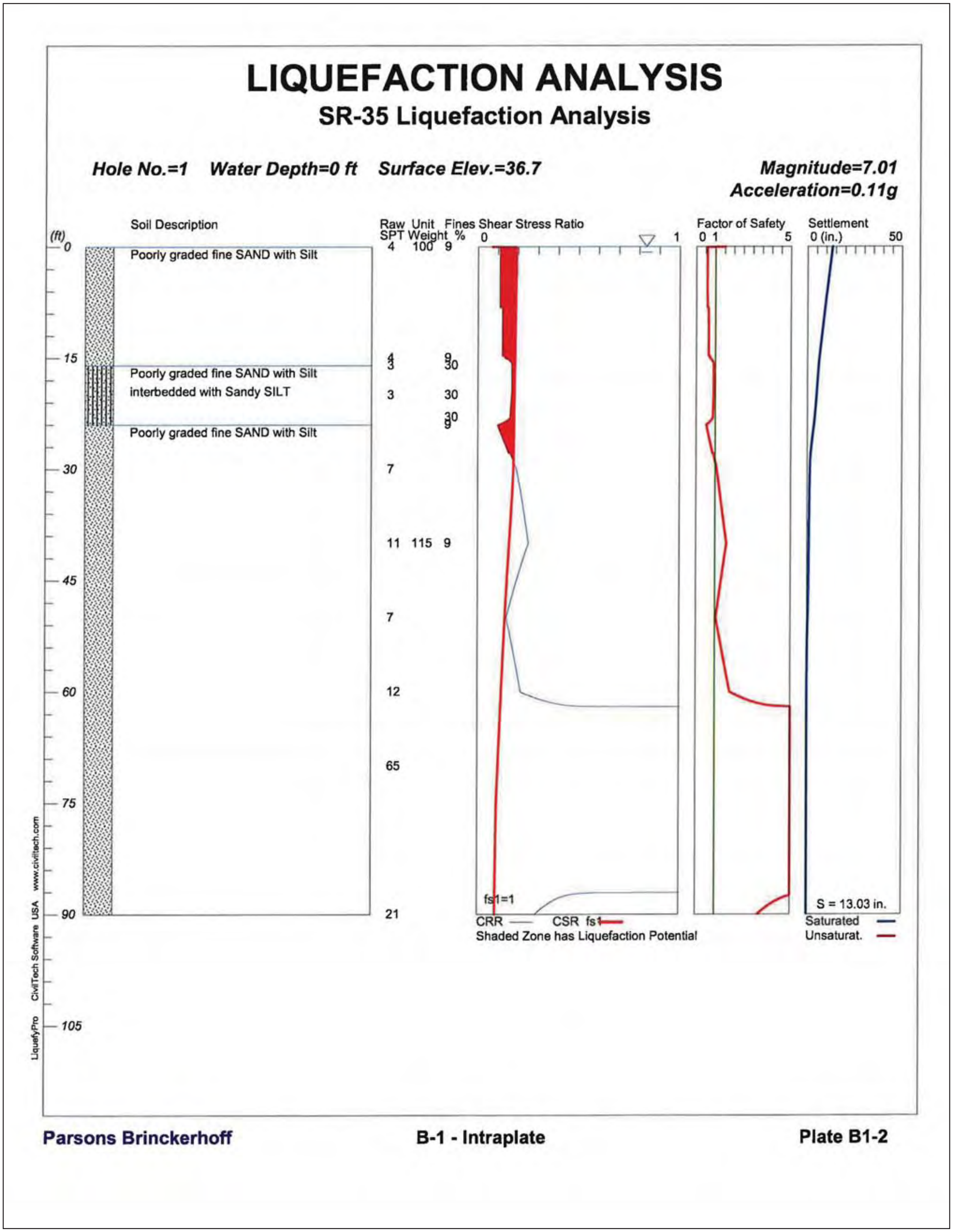
The liquefaction analysis was performed using the software program LiquefyPro V.5.8f. This program utilizes Seed's Method to calculate the CSR and the CSR is determined from corrected SPT blow count data (Harder and Seed, 1986 and Harder, 1997). Fines content correction formulas developed by Idriss and Seed (1997) were used and the Ishihara/Yoshimine Method was used to calculate settlement. A anlaysis was performed at each boring using insitu and laboratory test data from the field explorations. Three earthquake scenerios were analyzed at each boring. The results of these analyses are presented on Plates B1-1 through B3-3 and summarized below.

Scenerio	Liquefaction?	Settlement Predicted (inches)
B-1 , Crustal	Yes	5
B-1, Intraplate	Yes	13
B-1, CSZ	Yes	21
B-2 , Crustal	Yes	3
B-2, Intraplate	Yes	14
B-2, CSZ	Yes	24
B-3 , Crustal	Potential	4
B-3, Intraplate	Potential	10
B-3, CSZ	Potential	12

GroundMo
Liquefa

Geotechnical and Tunneling Group


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=1 Water Depth=0 ft Surface Elev.=36.7
Magnitude=5.4
Acceleration=0.13g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
(ft)
Poorly graded fine SAND with Silt
Poorly graded fine SAND with Silt interbedded with Sandy SILT
Poorly graded fine SAND with Silt
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 4.74 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-1 - Crustal Fault
Plate B1-1



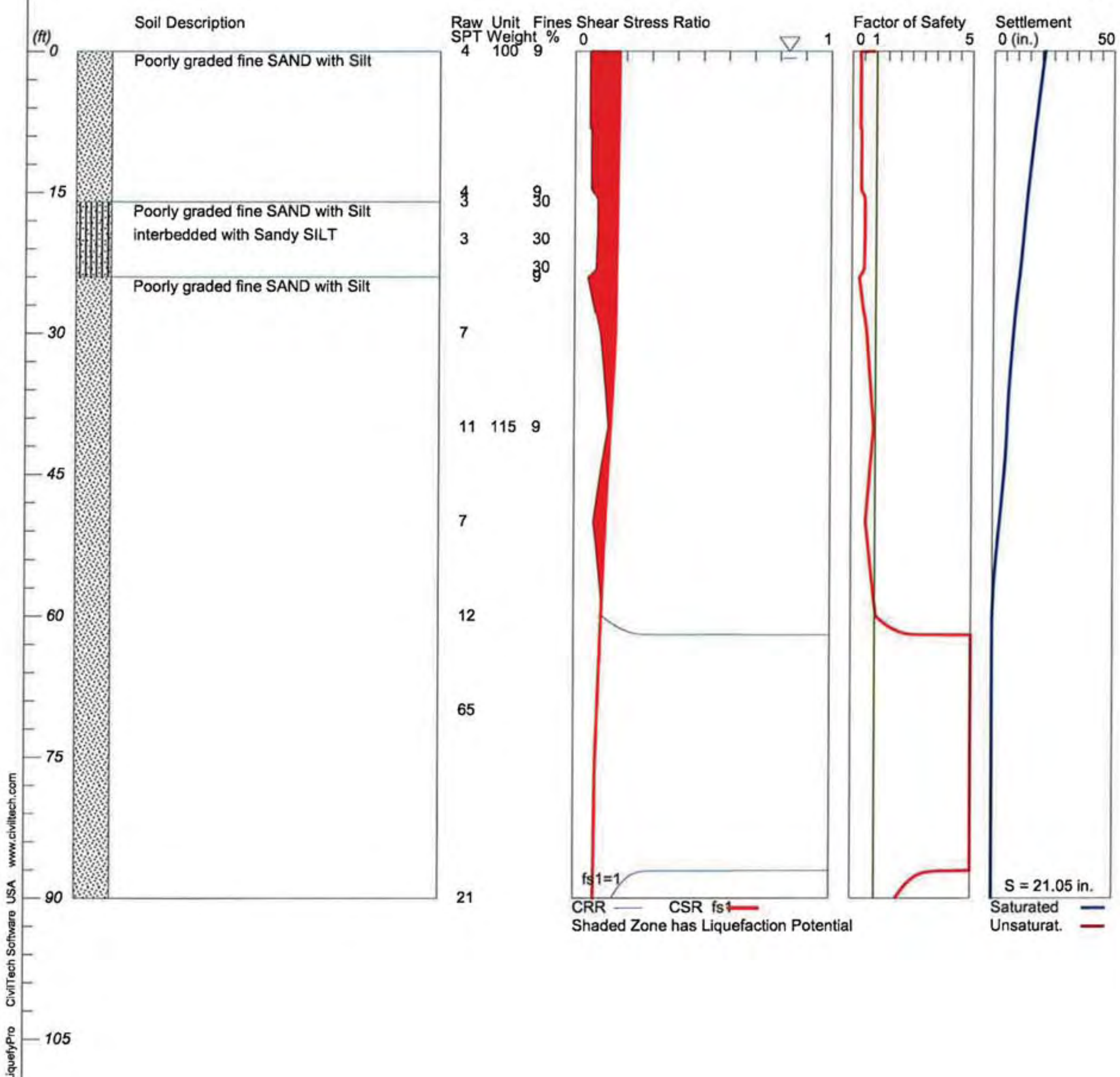
LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=1 Water Depth=0 ft Surface Elev.=36.7
Magnitude=7.01
Acceleration=0.11g
Soil Description
Poorly graded fine SAND with Silt
Poorly graded fine SAND with Silt interbedded with Sandy SILT
Poorly graded fine SAND with Silt
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
50
(ft)
0
15
30
45
60
75
90
105
4 100 9
11 115 9
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 13.03 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-1 - Intraplate
Plate B1-2

LIQUEFACTION ANALYSIS

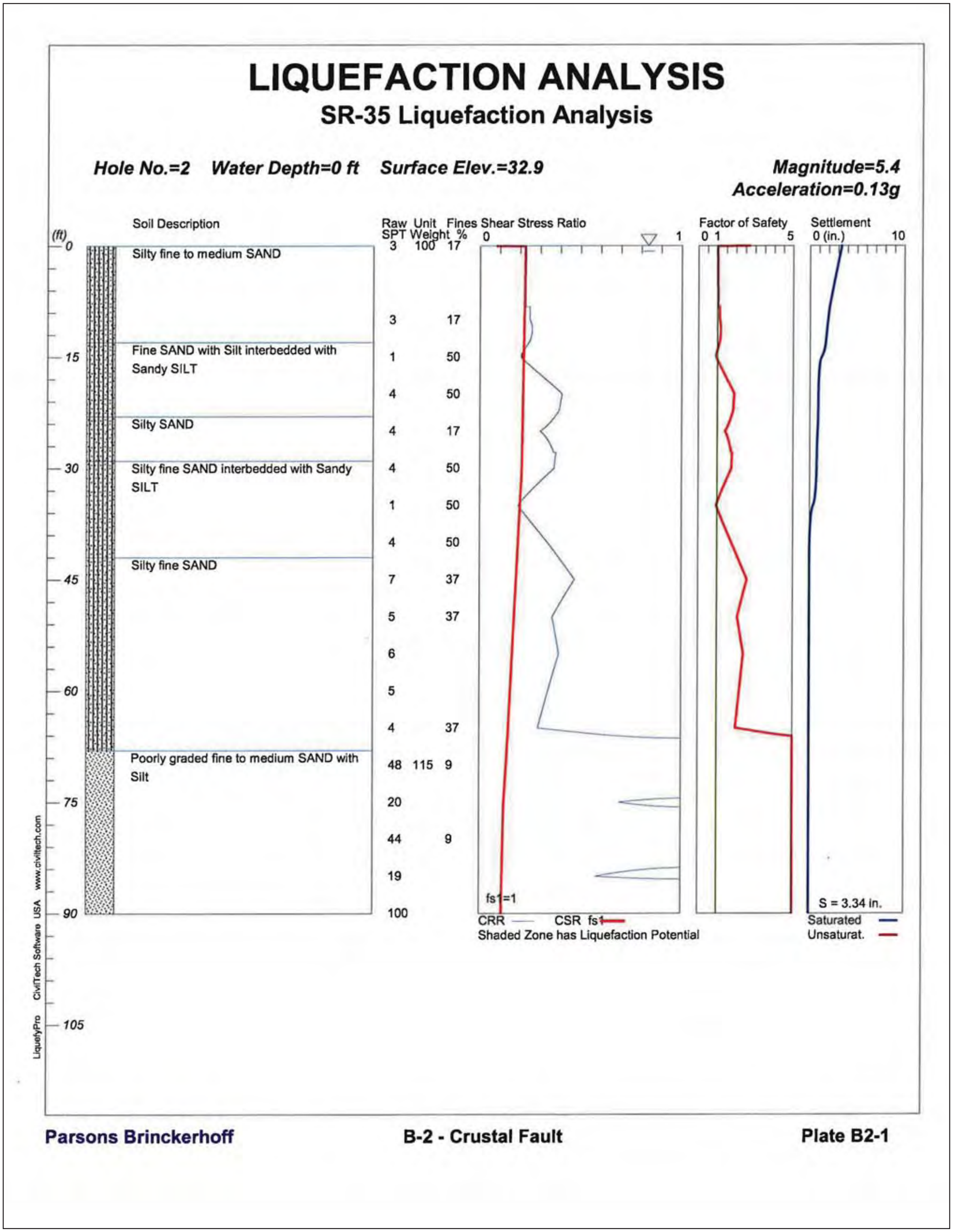
SR-35 Liquefaction Analysis

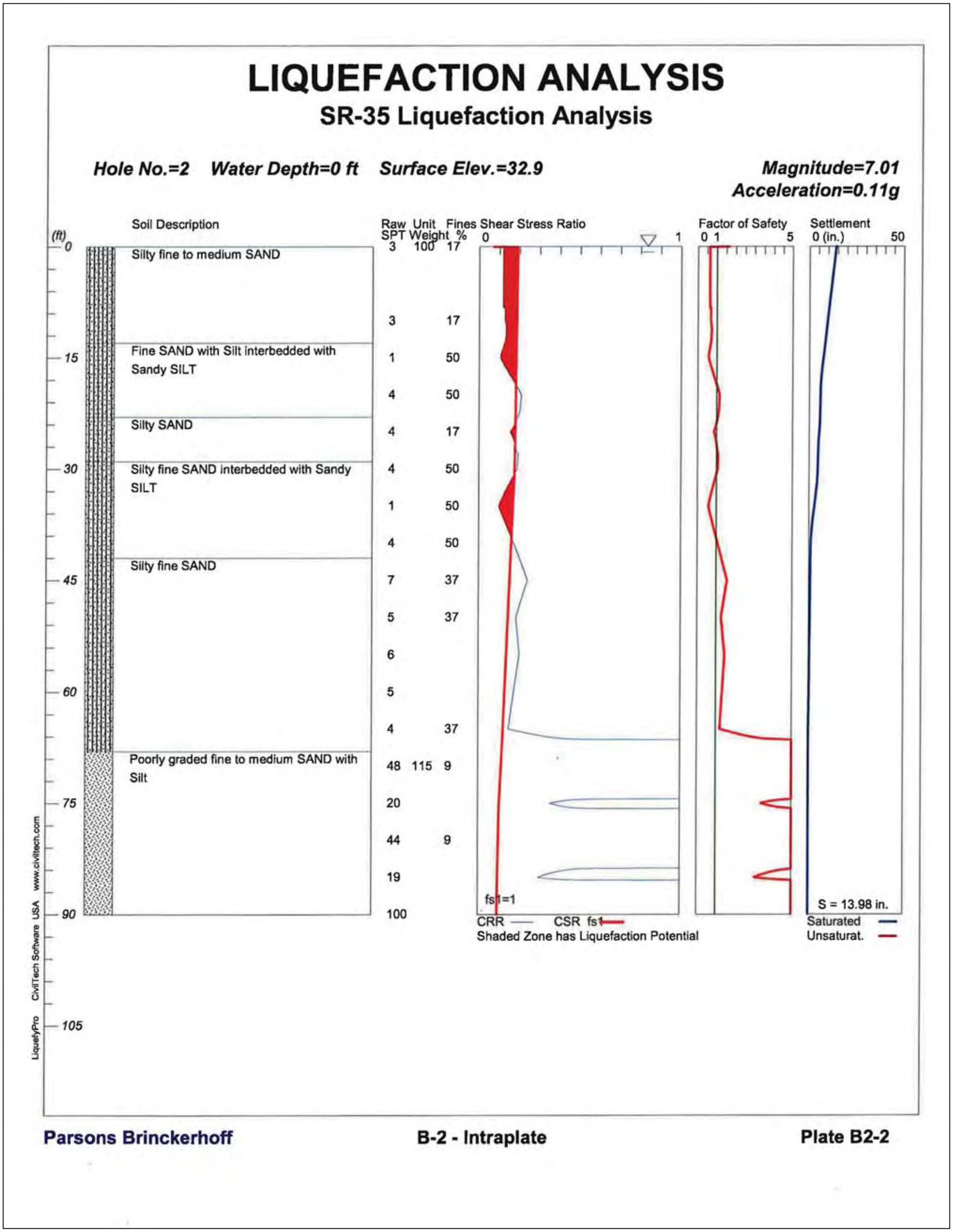
Hole No.=1 Water Depth=0 ft Surface Elev.=36.7

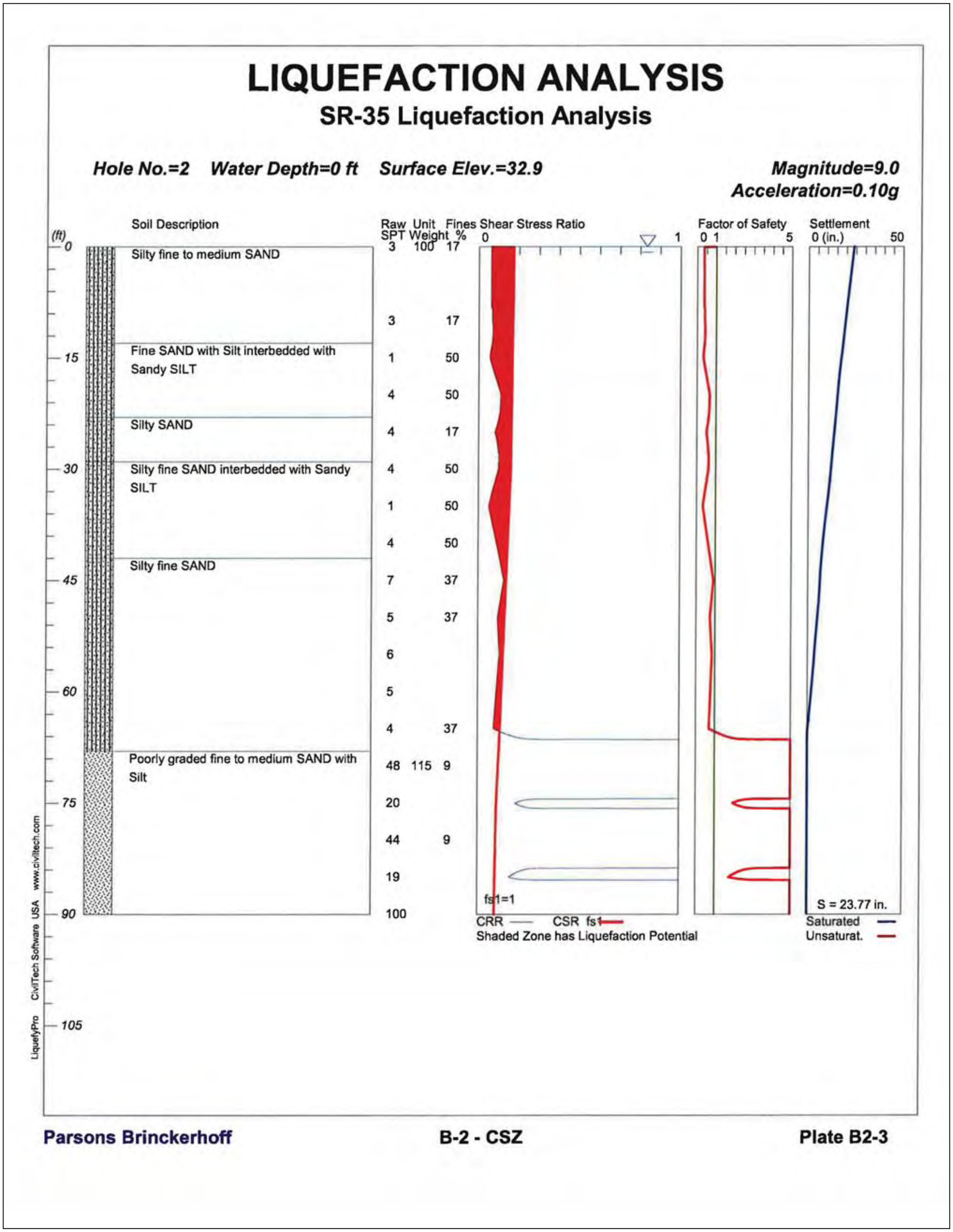
Magnitude=9
Acceleration=0.10g

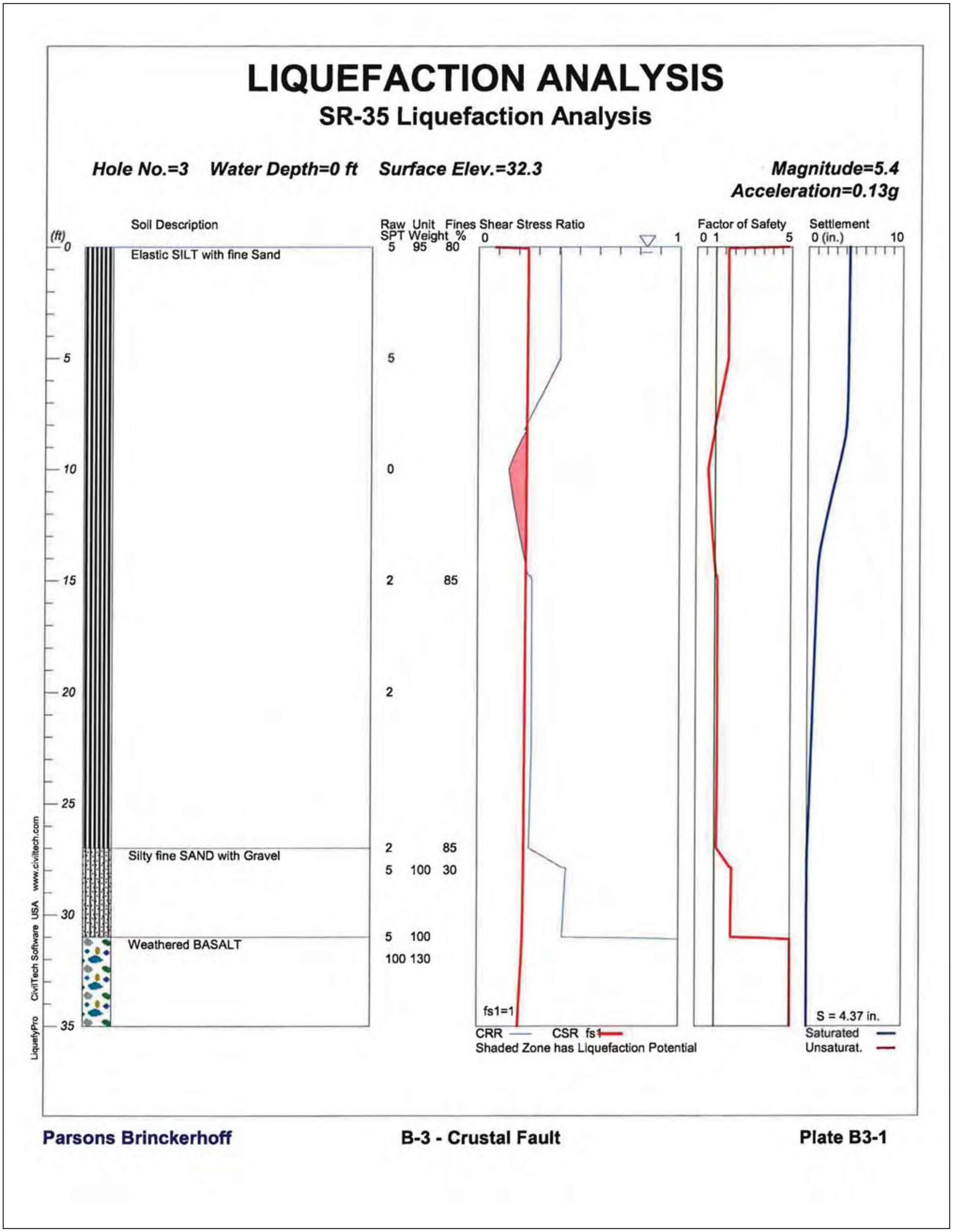


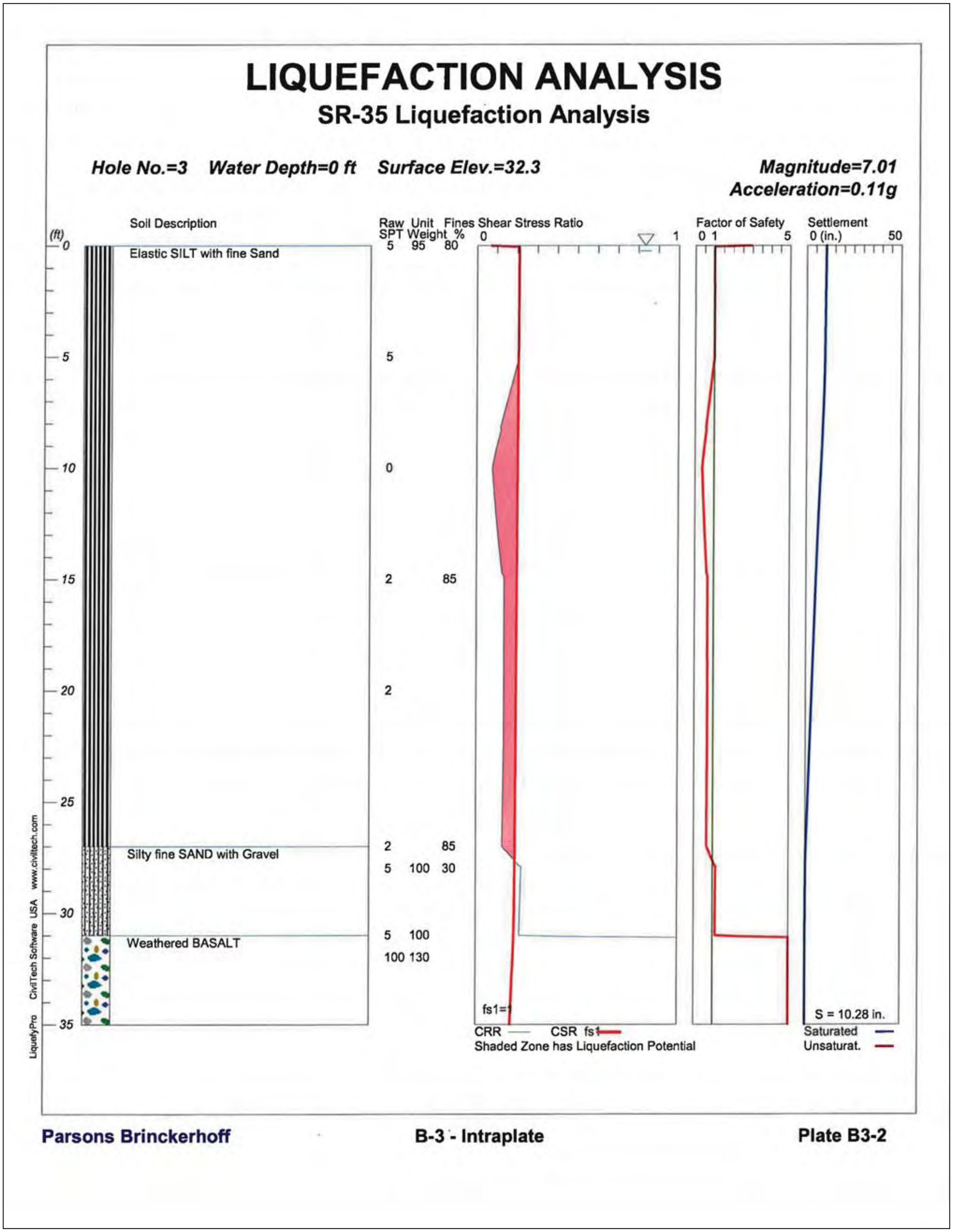
Parsons Brinckerhoff **B-1 - CSZ** **Plate B1-3**

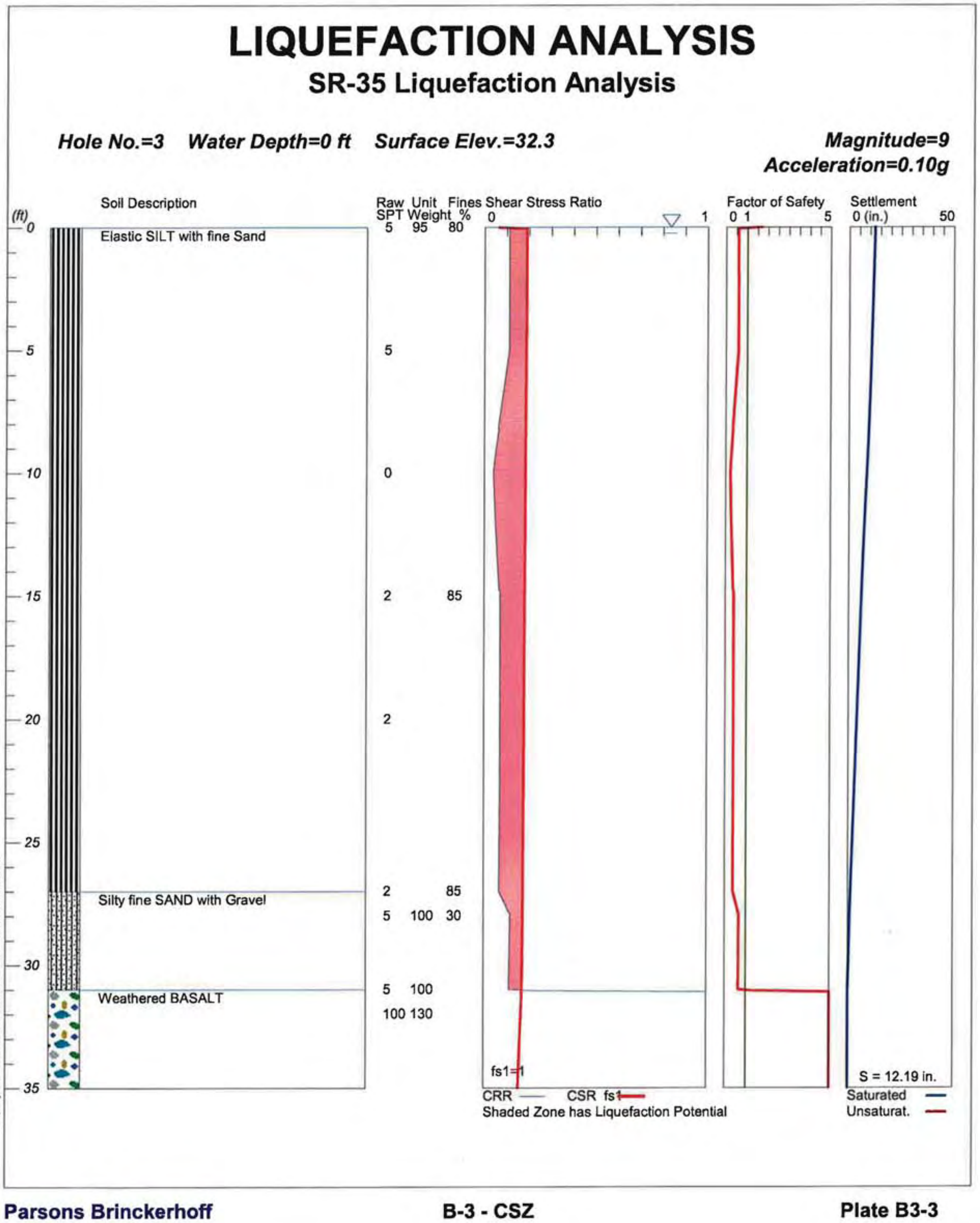

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=5.4
Acceleration=0.13g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
fs1=1
S = 3.34 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - Crustal Fault
Plate B2-1


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=7.01
Acceleration=0.11g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
(ft)
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
fs1=1
S = 13.98 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - Intraplate
Plate B2-2


LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=2 Water Depth=0 ft Surface Elev.=32.9
Magnitude=9.0
Acceleration=0.10g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
0
15
30
45
60
75
90
105
Silty fine to medium SAND
Fine SAND with Silt interbedded with Sandy SILT
Silty SAND
Silty fine SAND interbedded with Sandy SILT
Silty fine SAND
Poorly graded fine to medium SAND with Silt
3 100 17
3 17
1 50
4 50
4 17
4 50
1 50
4 50
7 37
5 37
6
5
4 37
48 115 9
20
44 9
19
100
0
1
0 1
5
0 (in.)
50
fs1=1
S = 23.77 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-2 - CSZ
Plate B2-3

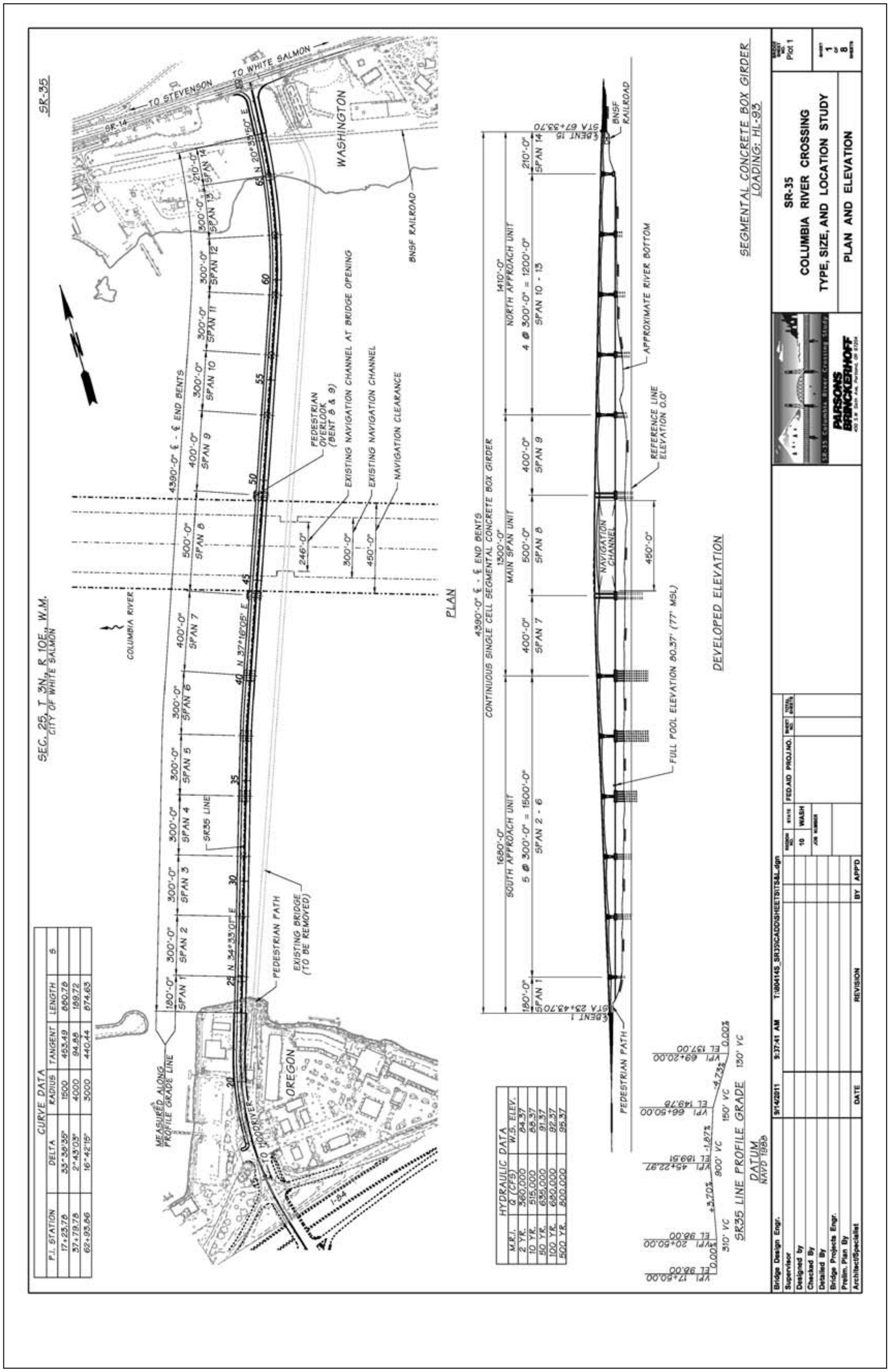

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=5.4
Acceleration=0.13g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
5 95 80
5
0
2 85
2
2 85
5 100 30
5 100
100 130
fs1=1
S = 4.37 in.
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - Crustal Fault
Plate B3-1

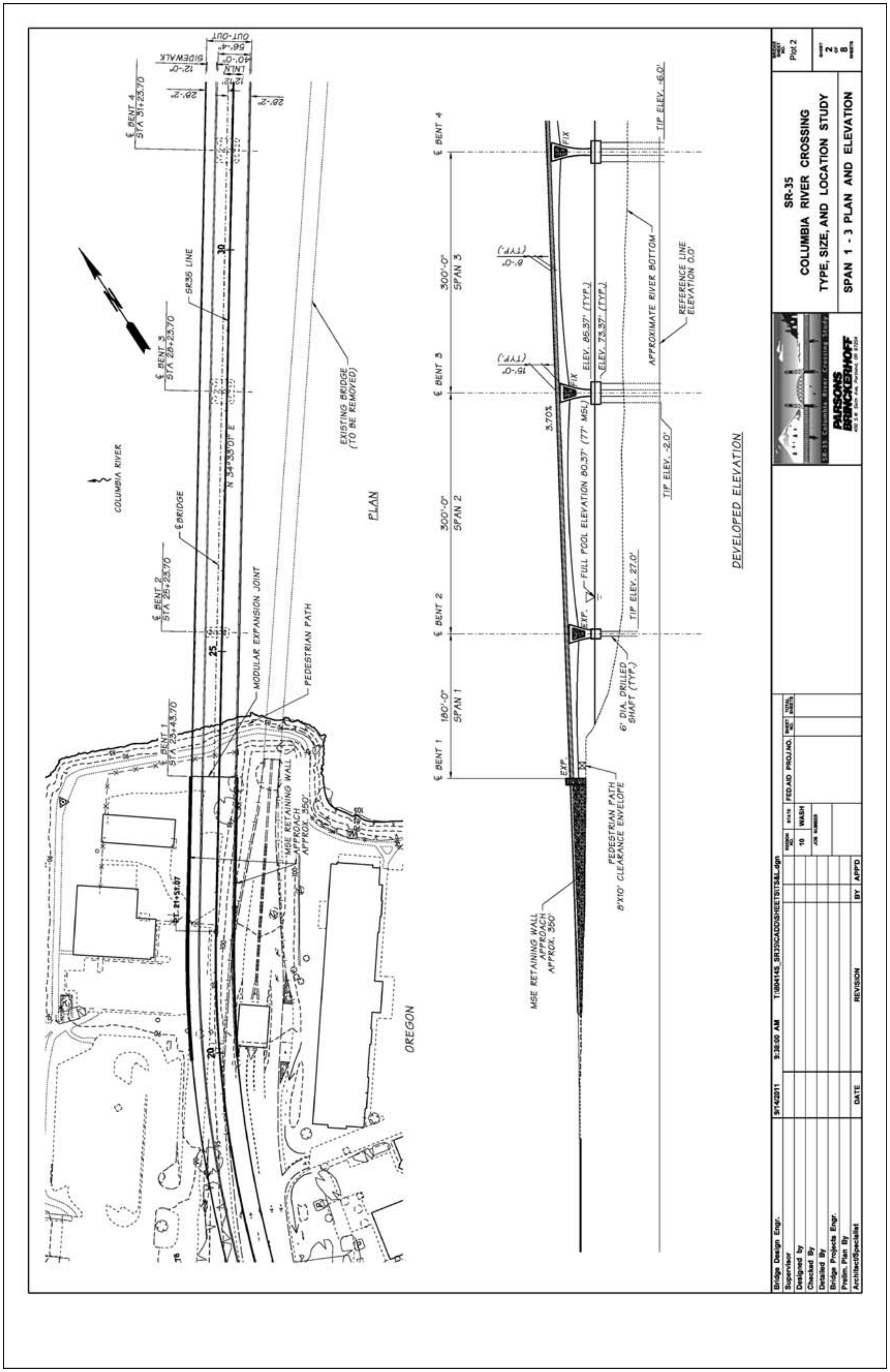

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=7.01
Acceleration=0.11g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
0 (in.)
50
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 10.28 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - Intraplate
Plate B3-2

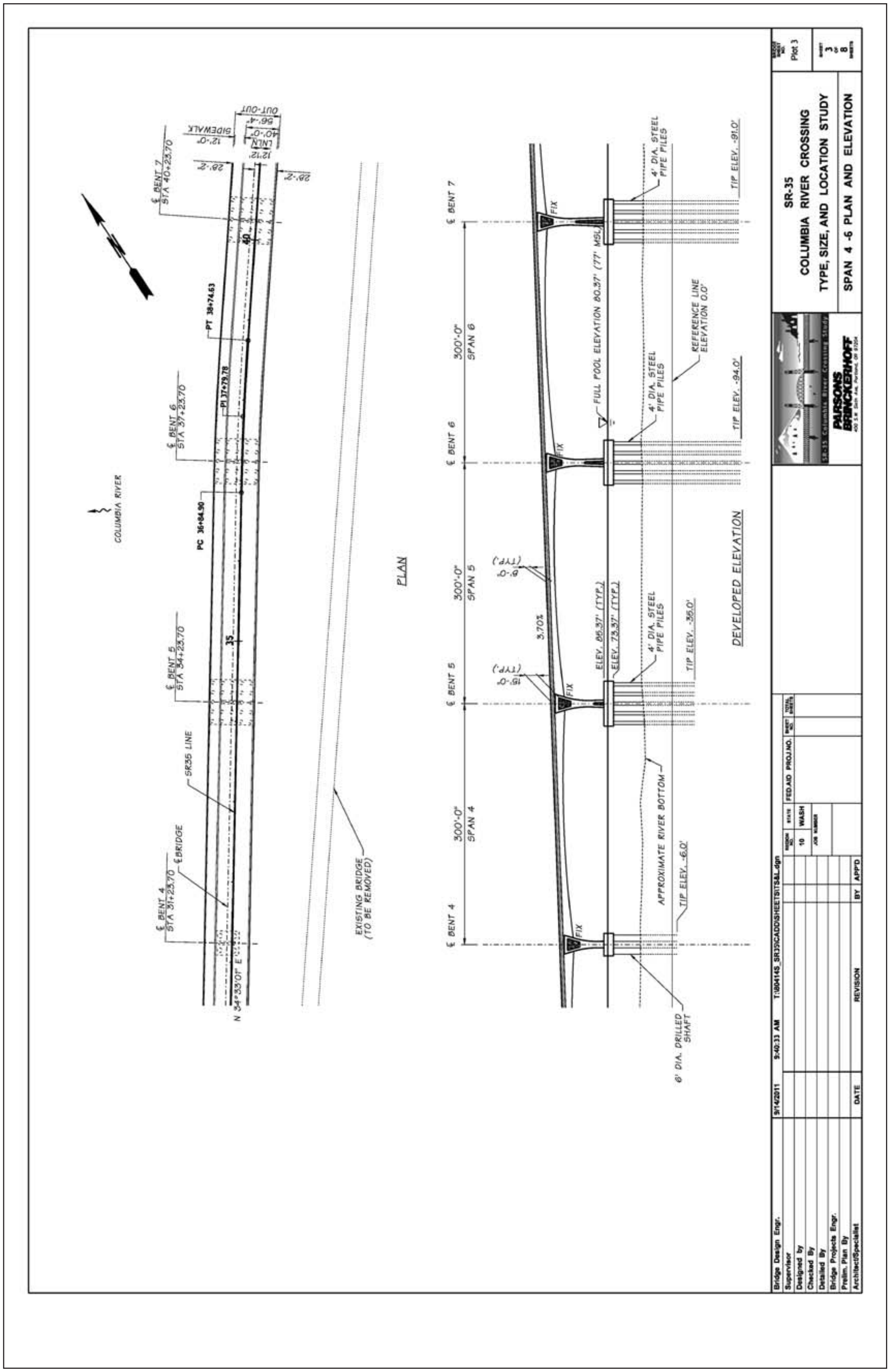

LIQUEFACTION ANALYSIS
SR-35 Liquefaction Analysis
Hole No.=3 Water Depth=0 ft Surface Elev.=32.3
Magnitude=9
Acceleration=0.10g
Soil Description
Raw SPT
Unit Weight
Fines %
Shear Stress Ratio
Factor of Safety
Settlement
(ft)
0 (in.)
50
Elastic SILT with fine Sand
Silty fine SAND with Gravel
Weathered BASALT
5 95 80
5
0
2 85
2
2 85
5 100 30
5 100
100 130
fs1=1
CRR
CSR fs1
Shaded Zone has Liquefaction Potential
S = 12.19 in.
Saturated
Unsaturat.
LiquefyPro CivilTech Software USA www.civiltech.com
Parsons Brinckerhoff
B-3 - CSZ
Plate B3-3

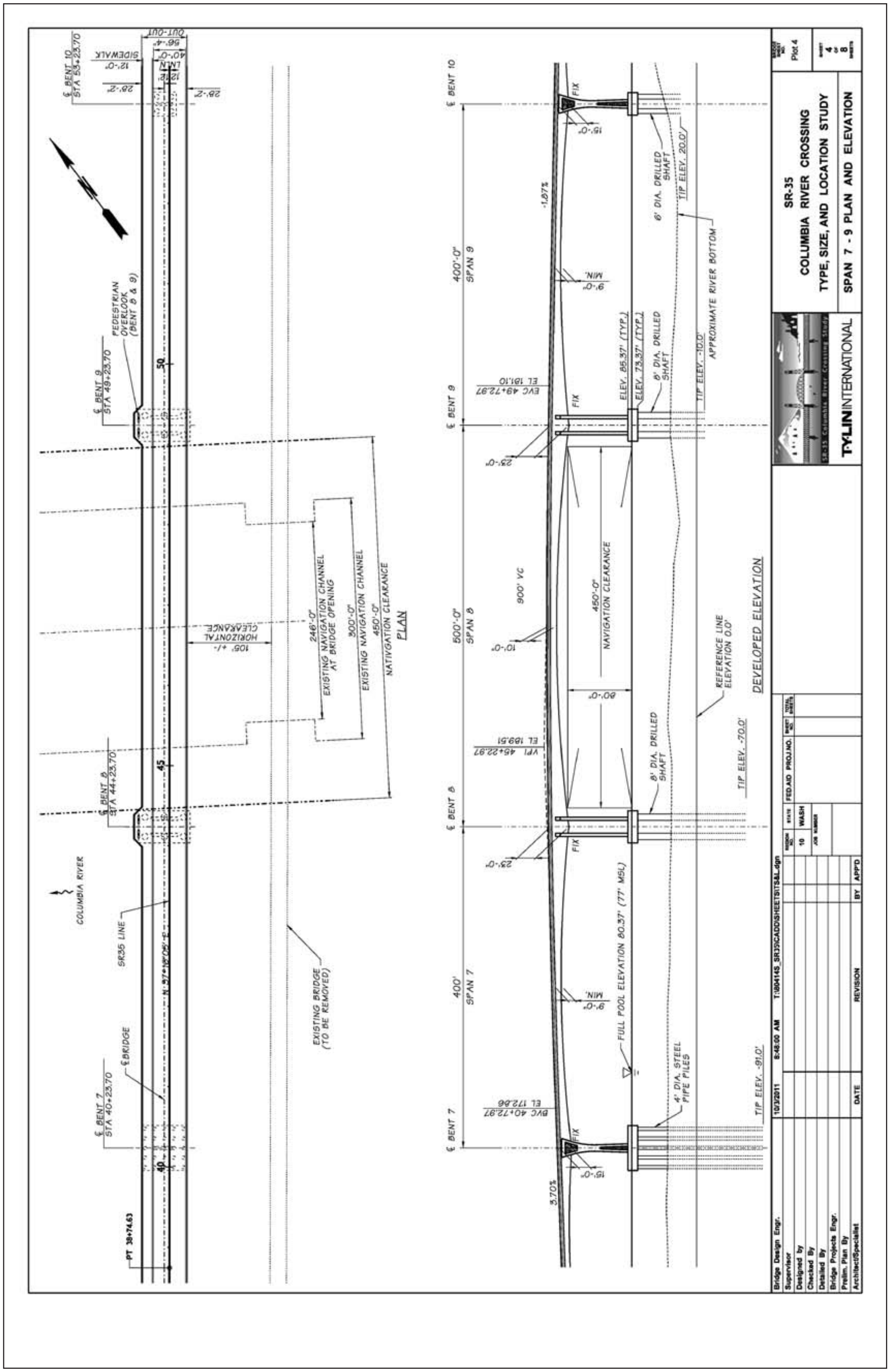
APPENDIX F

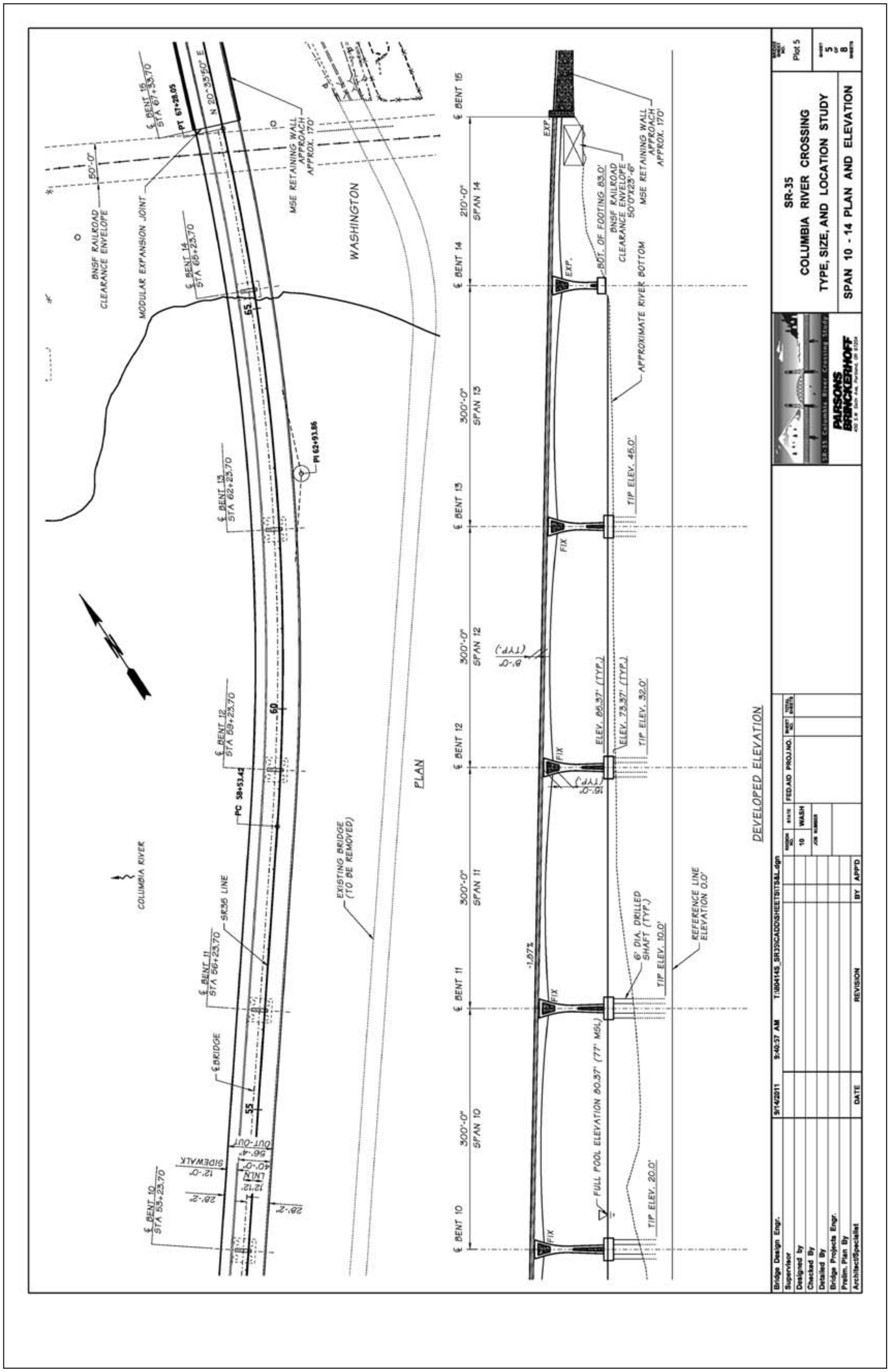
Bridge TS&L Drawings

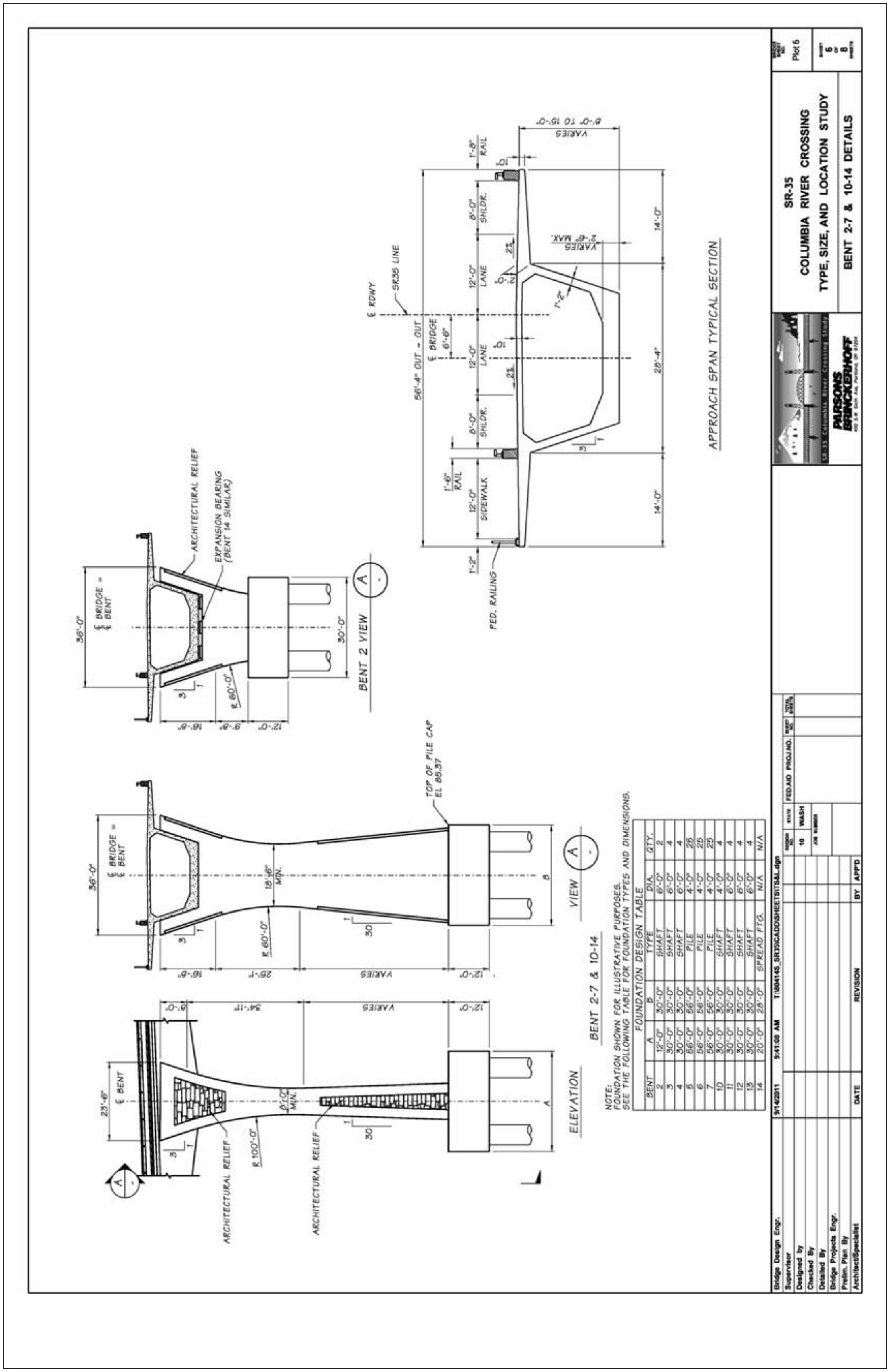

PLAN
DEVELOPED ELEVATION
SEGMENTAL CONCRETE BOX GIRDER
LOADING: HL-93
SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
PLAN AND ELEVATION
PARSONS BRINCKERHOFF
WASHINGTON
OREGON
COLUMBIA RIVER
BNSF RAILROAD

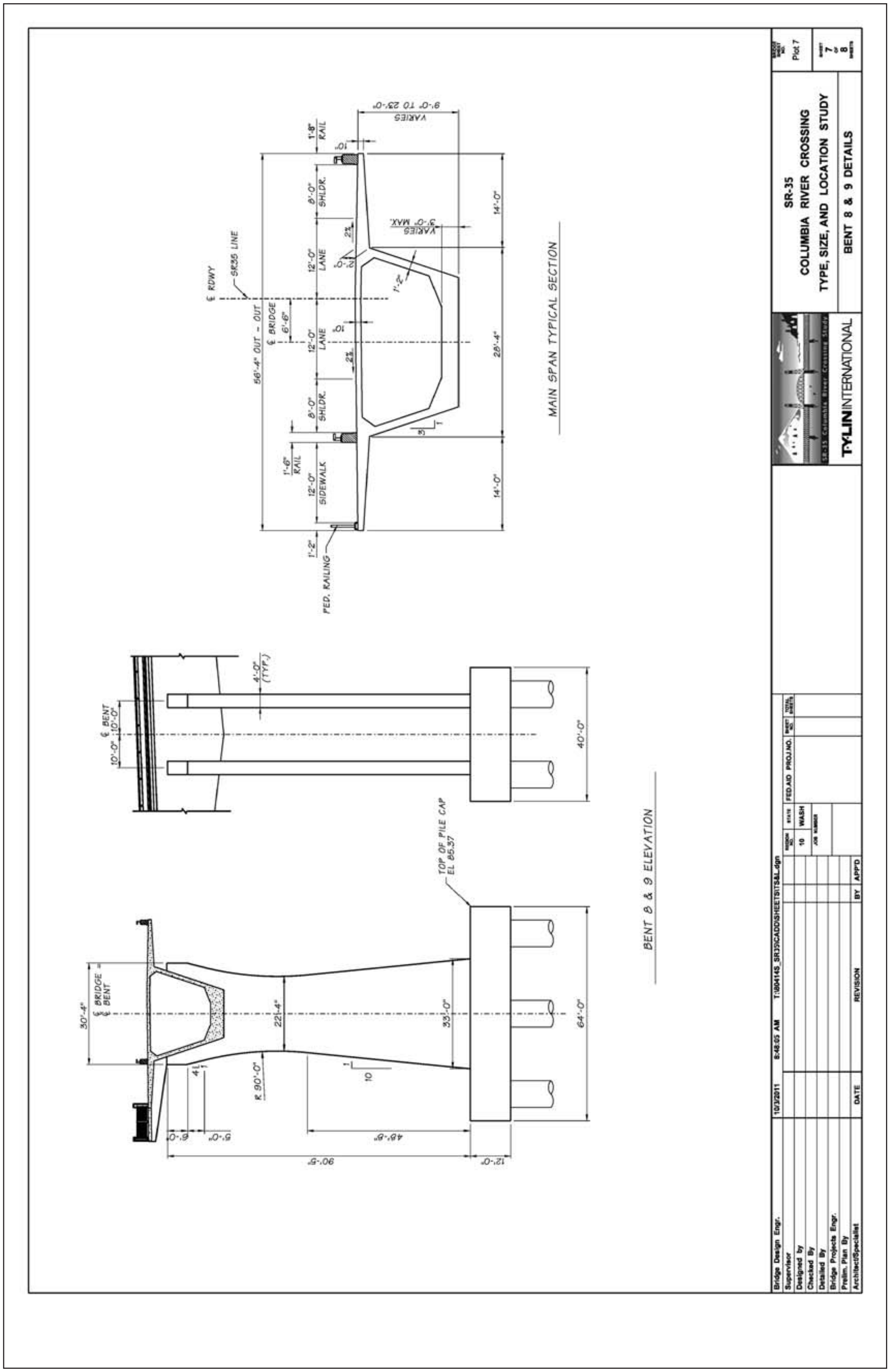

SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
SPAN 1 - 3 PLAN AND ELEVATION
PARSONS BRINCKERHOFF
PLAN
DEVELOPED ELEVATION
COLUMBIA RIVER
OREGON
EXISTING BRIDGE (TO BE REMOVED)
PEDESTRIAN PATH
MODULAR EXPANSION JOINT
SR35 LINE
N 34°35'01" E
180'-0" SPAN 1
300'-0" SPAN 2
300'-0" SPAN 3
FULL POOL ELEVATION 80.37' (77' MSL)
APPROXIMATE RIVER BOTTOM
REFERENCE LINE ELEVATION 0.0'
6' DIA. DRILLED SHAFT (TYP.)
PEDESTRIAN PATH 8'X10' CLEARANCE ENVELOPE
MSE RETAINING WALL APPROACH APPROX. 350'
TIP ELEV. 27.0'
TIP ELEV. -2.0'
TIP ELEV. -6.0'
ELEV. 85.37' (TYP.)
ELEV. 73.37' (TYP.)
3.70%

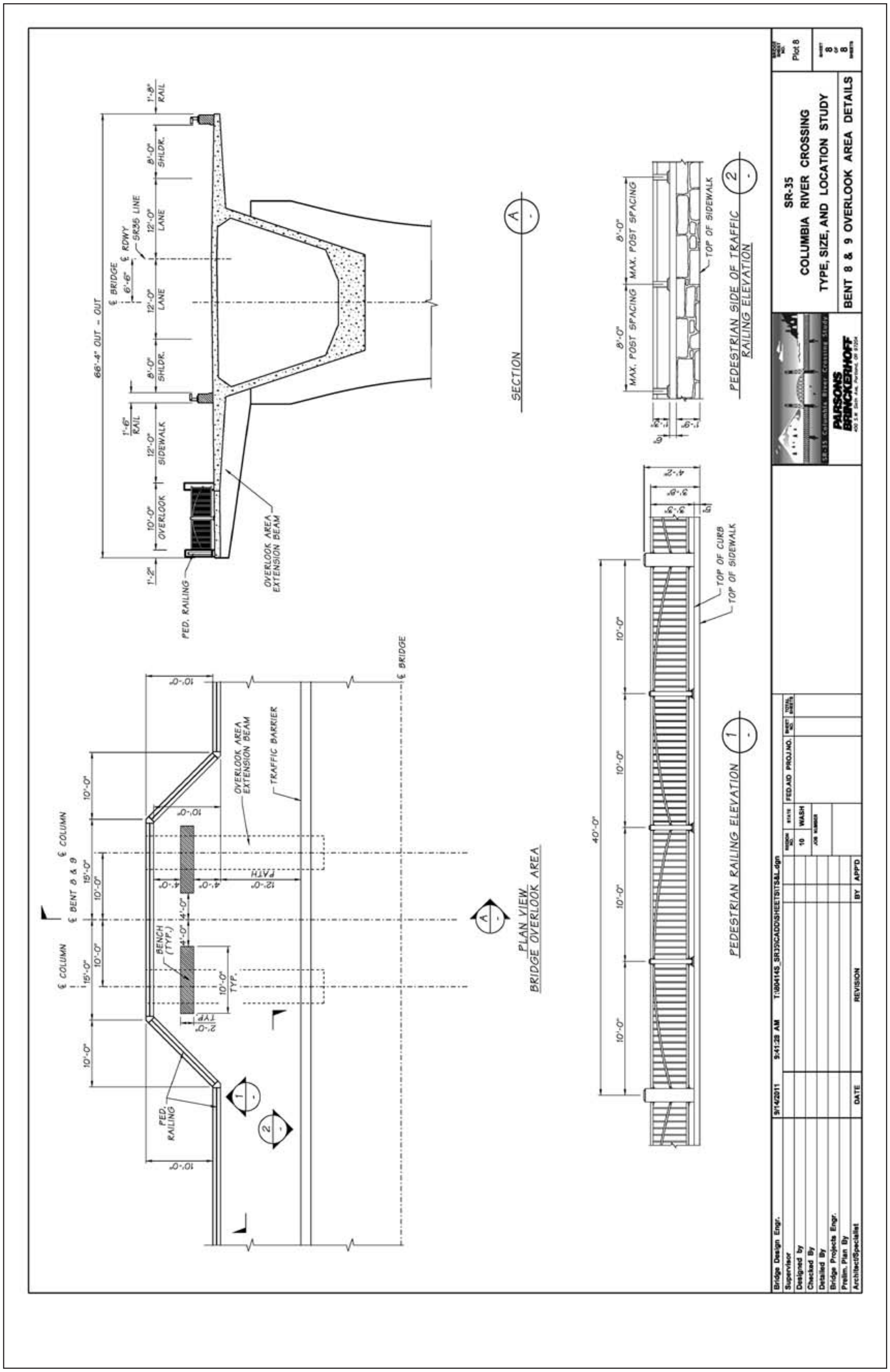

PLAN
DEVELOPED ELEVATION
COLUMBIA RIVER
SR35 LINE
℄ BRIDGE
℄ BENT 4 STA 31+23.70
℄ BENT 5 STA 34+23.70
℄ BENT 6 STA 37+23.70
℄ BENT 7 STA 40+23.70
PC 36+84.90
PI 37+79.78
PT 38+74.63
N 34°33'01" E
EXISTING BRIDGE (TO BE REMOVED)
SPAN 4 300'-0"
SPAN 5 300'-0"
SPAN 6 300'-0"
FULL POOL ELEVATION 80.37' (77' MSL)
ELEV. 86.37' (TYP.)
ELEV. 73.37' (TYP.)
3.70%
4' DIA. STEEL PIPE PILES
6' DIA. DRILLED SHAFT
APPROXIMATE RIVER BOTTOM
REFERENCE LINE ELEVATION 0.0'
TIP ELEV. -6.0'
TIP ELEV. -36.0'
TIP ELEV. -94.0'
TIP ELEV. -91.0'
FIX
SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
SPAN 4 -6 PLAN AND ELEVATION
PARSONS BRINCKERHOFF
Plot 3
9/14/2011 9:40:33 AM


SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
SPAN 7 - 9 PLAN AND ELEVATION
T.Y.LIN INTERNATIONAL
PLAN
DEVELOPED ELEVATION
SPAN 7
SPAN 8
SPAN 9
400'
500'-0"
400'-0"
900' VC
450'-0" NAVIGATION CLEARANCE
FULL POOL ELEVATION 80.37' (77' MSL)
REFERENCE LINE ELEVATION 0.0'
APPROXIMATE RIVER BOTTOM
EXISTING BRIDGE (TO BE REMOVED)
COLUMBIA RIVER
SR35 LINE
PEDESTRIAN OVERLOOK (BENT 8 & 9)
EXISTING NAVIGATION CHANNEL AT BRIDGE OPENING
EXISTING NAVIGATION CHANNEL
NAVIGATION CLEARANCE
TIP ELEV. -91.0'
TIP ELEV. -70.0'
TIP ELEV. -10.0'
TIP ELEV. 20.0'
8' DIA. DRILLED SHAFT
6' DIA. DRILLED SHAFT
4' DIA. STEEL PIPE PILES


SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
SPAN 10 - 14 PLAN AND ELEVATION
PLAN
DEVELOPED ELEVATION
WASHINGTON
COLUMBIA RIVER
EXISTING BRIDGE (TO BE REMOVED)
BNSF RAILROAD CLEARANCE ENVELOPE
MODULAR EXPANSION JOINT
MSE RETAINING WALL APPROACH APPROX. 170'
APPROXIMATE RIVER BOTTOM
FULL POOL ELEVATION 80.37' (77' MSL)
6' DIA. DRILLED SHAFT (TYP.)
REFERENCE LINE ELEVATION 0.0'
PARSONS BRINCKERHOFF


SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
BENT 2-7 & 10-14 DETAILS
Plot 6
PARSONS BRINCKERHOFF
APPROACH SPAN TYPICAL SECTION
56'-4" OUT - OUT
SR35 LINE
PED. RAILING
SIDEWALK
SHLDR.
LANE
VARIES 8'-0" TO 15'-0"
BENT 2 VIEW
ARCHITECTURAL RELIEF
EXPANSION BEARING (BENT 14 SIMILAR)
TOP OF PILE CAP EL 86.37
ELEVATION
VIEW A
BENT 2-7 & 10-14
NOTE:
FOUNDATION SHOWN FOR ILLUSTRATIVE PURPOSES.
SEE THE FOLLOWING TABLE FOR FOUNDATION TYPES AND DIMENSIONS.
FOUNDATION DESIGN TABLE
BENT | A | B | TYPE | DIA. | QTY.
2 | 12'-0" | 30'-0" | SHAFT | 6'-0" | 2
3 | 30'-0" | 30'-0" | SHAFT | 6'-0" | 4
4 | 30'-0" | 30'-0" | SHAFT | 6'-0" | 4
5 | 56'-0" | 56'-0" | PILE | 4'-0" | 25
6 | 56'-0" | 56'-0" | PILE | 4'-0" | 25
7 | 56'-0" | 56'-0" | PILE | 4'-0" | 25
10 | 30'-0" | 30'-0" | SHAFT | 4'-0" | 4
11 | 30'-0" | 30'-0" | SHAFT | 6'-0" | 4
12 | 30'-0" | 30'-0" | SHAFT | 6'-0" | 4
13 | 30'-0" | 30'-0" | SHAFT | 6'-0" | 4
14 | 20'-0" | 28'-0" | SPREAD FTG. | N/A | N/A
9/14/2011 9:41:08 AM T:\804145_SR35\CADD\SHEETS\ITS&L.dgn
Bridge Design Engr.
Supervisor
Designed by
Checked By
Detailed By
Bridge Projects Engr.
Prelim. Plan By
Architect/Specialist
DATE
REVISION
BY
APP'D
10
WASH


MAIN SPAN TYPICAL SECTION
BENT 8 & 9 ELEVATION
SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
BENT 8 & 9 DETAILS
T.Y.LIN INTERNATIONAL
WASH


PLAN VIEW
BRIDGE OVERLOOK AREA
SECTION
PEDESTRIAN RAILING ELEVATION
PEDESTRIAN SIDE OF TRAFFIC RAILING ELEVATION
PARSONS BRINCKERHOFF
SR-35
COLUMBIA RIVER CROSSING
TYPE, SIZE, AND LOCATION STUDY
BENT 8 & 9 OVERLOOK AREA DETAILS

APPENDIX G

Preliminary Storm Water Analysis Memorandum

Memorandum

To: Mark Hirota, P.E.

From: Ron Horres, P.E.

Date: 09/12/2011

Subject: SR-35 Preliminary Storm Water Analysis

Storm Water Analysis

The preliminary analysis was completed using the rational formula and gutter flow formulas as found in ODOT's Hydraulics Manual. Assumptions made in the storm water analysis were as follows:

- Bridge cross-section includes two 12-foot vehicle travel lanes, two 8-foot vehicle shoulders, a single 12-foot pedestrian/bikeway, and associated walls on the outside edges of the bridge deck and between the vehicle/pedestrian travel ways.
- Crown of the bridge is located between the 12-foot vehicle travel lanes.
- Surface runoff can move from the vehicle travel lane/shoulder to the pedestrian/bikeway sections through holes at the base of the wall separating the two sections.
- Rainfall intensity for the bridge site is considered Zone 5 (same as Hood River) per the ODOT Hydraulics Manual.

Collection

It is preferred that storm water collection on the bridge surface occur via surface flow along the outside gutter line to catch basins located at the ends of the bridge on both the Oregon and Washington sides. The placement of catch basins on the bridge surface itself, or the use of storm water conveyance pipes supported by the bridge structure should not be used as a means of storm water collection.

Preliminary calculations were made to determine whether collection and conveyance of the 10-year design storm could be handled in this manner without the storm water flows encroaching on the vehicle travel lane. In other words, for the 10-year design storm, surface runoff to the ends of the bridge must be confined to the pedestrian/bikeway and the vehicle shoulder. The calculation confirmed that this was the case with storm water flows extending approximately 8 feet from the bridge edge on the pedestrian/bikeway side of the bridge and 6.5 feet from the

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Memorandum

bridge edge on the vehicle travel side of the bridge (being confined to the roadway shoulder).

At the ends of the bridge collection would occur via catch basins and below ground piping to the storm water treatment facilities. It is estimated that pipes ranging from 12 to 18 inches in diameter will be required for the conveyance piping from the bridge to the treatment facilities. Estimated pipe flows for the water quality and 10-year design storm are as follows:

- Water Quality Storm, Washington side – 1.4 cfs
- Water Quality Storm, Oregon side – 1.7 cfs
- 10-Year Design Storm, Washington side – 3.4 cfs
- 10-Year Design Storm, Oregon side – 4.3 cfs

Treatment

Two methods of storm water treatment were reviewed for the SR-35 Bridge, storm water bioswales and a vault system with filter cartridges.

The cross section of the bio-swale was assumed to have a 4-foot bottom width, 3 to 1 horizontal to vertical side slopes, and a maximum depth of 2 feet. Channel longitudinal slope was assumed to be 0.003 feet per foot. For a desired hydraulic residence time of nine minutes for the Water Quality Storm the estimated swale lengths were:

- 630 feet on the Washington side
- 680 feet on the Oregon side

From reviewing aerial photography and surveyed topography, it has been determined that finding locations for these long of swales may be difficult on both sides of the river. Therefore, the less land-intensive storm water vault with filter cartridges alternative was considered.

Assuming a cartridge capacity of 0.033 cfs per cartridge the estimated requirements would be:

- 40 cartridges on the Washington side, 20-foot by 30-foot vault
- 52 cartridges on the Oregon side, 20-foot by 40-foot vault

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PB 100 YEARS

Memorandum

System Costs

A budget level capital cost for the system is estimated at approximately $610,000. Annual operations and maintenance costs are estimated at approximately $5600 per year, assuming a cartridge life of approximately 2 years average.

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APPENDIX H
HECRAS Scour Memorandum

Memorandum

100 YEARS

To: Mark Hirota

From: Karl Krcma and Choncy Jones

Date: 7/13/2011

Subject: SR-35 HECRAS modeling and scour analysis

Introduction

Choncy Jones and I have completed the HEC-RAS modeling and scour analysis for the proposed SR-35 bridge at Hood River over the Columbia River. The following is a summary of the methodology and results.

HECRAS Modeling

HECRAS and HEC-2 models were obtained from the Portland District Corps of Engineers. The HEC-2 model was developed in 1997 and the HECRAS model was developed in 2008. The HECRAS model was used in 2008 by the Corps to analyze sedimentation impacts from recent Hood River floods. Geometry data from these models was composited into one HECRAS model. This model was then supplemented with hydrographic survey data from NWHydro collected in 2010. NWHydro's data consisted of seven cross sections in the vicinity of the existing and proposed bridges. The new cross section data also reflected the downstream delta from the Hood River confluence. Two geometry files were created, 1) the existing bridge geometry was input using as-built information and 2) the existing bridge is replaced by the proposed bridge geometry using information supplied by Matthew Miller. The proposed bridge consists of 13 inwater piers (Bents #2 through #14). The model was run with an assumed starting water surface elevation at Bonneville Dam of 80.37 NAVD (77 ft. NGVD + 3.37 ft conversion to NAVD). This is in accordance with Corps of Engineers Bonneville Dam Reservoir Hydrologic and Hydraulic Analysis dated 20 October 1990. Recurrence interval discharges were modeled for the 2, 10, 50, 100, and 500 year events. The HECRAS model results comparing the existing condition and proposed condition results are listed in Table 1. for the approach cross section 170.2 located just upstream of the proposed and existing bridges.

Table 1. HECRAS Model Results

Recurrence Interval (years)	Discharge (cubic feet/second)	Existing Water Surface Elev. (Ft. NAVD)	Proposed Water Surface Elev. (Ft. NAVD
2	360,000	84.309	84.312
10	515,000	87.622	87.628
50	635,000	90.525	90.534
100	680,000	91.629	91.639
500	800,000	94.628	94.641

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Memorandum

Comparison of the 100 year existing versus proposed conditions indicates a water surface elevation increase of 0.010 feet.

Scour Analysis

Data from the HECRAS proposed condition model was utilized to perform scour calculations using HEC-18 methodology. Since the proposed piers consist of columns of piles, a pile cap and a pier stem the analysis required the methodology for complex pier shapes. The 100 year and 500 year events were used in the analysis. The D_{50} and D_{95} grain sizes for the various pier locations were obtained from the Pacific Geotechncial Data Report SR-35 Columbia River Study. The grain sizes ranged from very fine silt at Bent #9 to sand with a D_{50} of 0.15 mm for bents #2 through 7. Table 2 lists the grain sizes for the various bents used in the analysis. Scour was computed for both contraction and local scour. Channel degradation was assumed to be an insignificant factor due to the anthropomorphic conditions induced by the Bonneville dam and due to the sediment load contributed by Hood River. Contraction scour was calculated using the HEC-18 methodology resulting in 1.03 feet for the 100 year event and 1.21 feet for the 500 year event. Table 3 lists the total scour (contraction and local) for the various bents for both the 100 year and 500 year events.

Table 2. Sediment Grain Size for Proposed Bents

Bent #	D_{50} (mm)	D_{95} (mm)
2	0.15	0.28
3	0.15	0.28
4	0.15	0.28
5	0.15	0.28
6	0.15	0.28
7	0.15	0.28
8	0.13	0.30
9	0.05	0.10
10	0.09	0.15
11	0.09	0.15
12	0.09	0.15
13	0.09	0.15
14	0.09	0.15

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Table 3. Estimated Total Scour for the Proposed Bridge		
Bent #	**100 Year Total Scour (feet)**	**500 Year Total Scour (feet)**
2	10.6	11.2
3	20.2	21.9
4	19.9	21.9
5	21.9	23.6
6	22.4	24.1
7	23.0	24.7
8	25.1	26.8
9	20.9	22.3
10	16.8	16.8
11	15.9	16.1
12	15.9	16.1
13	16.1	16.2
14	26.6	27.1

As a conservative approach, in areas where the HECRAS proportioned flow lane velocities were low with respect to the average channel velocity, the channel velocity was used in the scour calculation. Note that the predicted scour depths assumes that erodible material is available to the ultimate depth. The presence of bedrock is not accounted for in the calculations. For instance, Bent#14 predicts over 26 feet of scour due to a foundation width of 20 feet, however, bedrock is located near the mudline for the proposed bent location. Also note that scour calculations assumed no significant accumulation of debris on the piers.

Memorandum

References

NOAA Multibeam hydrographic Survey, 26 January 2010

NW Hydro, Hydrographic Survey, 19 July 2010

Pacific Geotechnical, Geotechnical Data Report SR-35 Columbia River Crossing Study, 3 February 2011

U.S. Army Corps of Engineers, Portland District, "Bonneville Dam Reservoir Hydrologic & Hydraulic Analysis", 20 October 1990

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 4.1.0, January 2010

U.S. Army Corps of Engineers, Portland District, Hydrographic Survey of Hood River, 20 March 2008

U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 18, "Evaluating Scour at Bridges", May 2001

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APPENDIX I
Preliminary Cost Estimate Data

PRELIMINARY - COST ESTIMATE - LOW RANGE

				COUNTY	
	SR-35 COLUMBIA RIVER CROSSING TS&L STUDY				
KEY NUMBER	BRIDGE NAME	BR #	DATE	ROADWAY DESIGNER	
	Hood River Bridge	–	10/5/11	PB	
ITEM NUMBER	**ITEM DESCRIPTION**	**UNIT**	**AMOUNT**	**UNIT COST**	**TOTAL**
ROADWORK					
	CLEARING AND GRUBBING	ACRE	1.5	$4,000	$6,000
	EMBANKMENT IN PLACE	CUYD	8,339	$18.00	$150,107
DRAINAGE AND SEWERS					
	CONCRETE INLETS	EACH	8	$1,200.00	$9,600
	DIVERSION MANHOLES	EACH	2	$8,600.00	$17,200
	RETURN FLOW MANHOLES	EACH	2	$2,800.00	$5,600
	VAULT WITH INTERNALS	EACH	2	$183,610.00	$367,220
	PIPE, 12 INCH DIAMETER	FOOT	140	$40.00	$5,600
	PIPE, 15 INCH DIAMETER	FOOT	400	$50.00	$20,000
	PIPE, 18 INCH DIAMETER	FOOT	700	$60.00	$42,000
BRIDGES					
	BRIDGE REMOVAL	SQFT	101,650	$158.50	$16,111,525
	SHORING, CRIBBING AND COFFERDAMS	LS	1	$130,000.00	$130,000
	STRUCTURE EXCAVATION	CUYD	303	$100.00	$30,341
	GRANULAR STRUCTURE BACKFILL	CUYD	96	$55.00	$5,256
	FURNISH DRILLING EQUIPMENT	EACH	1	$35,000.00	$35,000
	DRILLED SHAFT CONCRETE	CUYD	4,172	$340.00	$1,418,620
	DRILLED SHAFT REINFORCEMENT	LBS	625,862	$1.30	$813,620
	CSL TEST ACCESS TUBES	FOOT	20,247	$4.00	$80,989
	CSL TESTS	EACH	9	$700.00	$6,300
	DRILLED SHAFT EXCAVATION, 72 INCH DIAMETER	FOOT	1,539	$700.00	$1,077,314
	DRILLED SHAFT EXCAVATION, 96 INCH DIAMETER	FOOT	1,377	$1,240.00	$1,707,034
	FURNISH PILE DRIVING EQUIPMENT	FOOT	1	$25,000.00	$25,000
	FURNISH PP 48 X 0.5 STEEL PILES	FOOT	10,490	$155.00	$1,625,989
	FURNISH PP 48 X 0.5 STEEL TEST PILES	FOOT	899	$155.00	$139,379
	DRIVE PP 48 X 0.5 STEEL PILES	EACH	75	$200.00	$15,000
	DRIVE TEST PILES	EACH	6	$200.00	$1,200
	PILE LOAD TEST (DYNAMIC)	EACH	6	$25,000.00	$150,000
	PP 48 X 0.5 STEEL PILE SPLICES	EACH	22	$4,500.00	$99,000
	REINFORCEMENT	LBS	9,813,785	$1.50	$14,720,677
	COATED REINFORCEMENT	LBS	858,349	$1.65	$1,416,275
	FOUNDATION CONCRETE, CLASS 4000	CUYD	9,399	$308.00	$2,894,744
	GENERAL STRUCTURAL CONCRETE, CLASS 4000	CUYD	33,444	$615.00	$20,567,983
	REINFORCED CONCRETE END PANELS	SQYD	190	$250.00	$47,466
	POST-TENSIONING	LBS	2,405,082	$6.50	$15,633,033
	BEARING DEVICES, ABUTMENTS	EACH	4	$22,500.00	$90,000
	BEARING DEVICES, BENT 2 & 14	EACH	6	$52,500.00	$315,000
	2 INCH ELECTRICAL CONDUIT	FOOT	8,780	$130.00	$1,141,400
	MODULAR EXPANSION JOINT SEALS	FOOT	113	$2,400.00	$270,400
	COMBINATION BRIDGE RAIL	FOOT	8,780	$185.00	$1,624,300
	HANDRAIL PEDESTRIAN ORNAMENTAL	FOOT	4,390	$175.00	$768,250
	RETAINING WALLS, MSE	SQFT	12,940	$41.00	$530,540
	MARINE SUPPORT	LS	1	$17,225,000.00	$17,225,000
BASES					
	AGGREGATE BASE	TON	2,110	$45.00	$94,950
WEARING SURFACES					
	HMAC	TON	2,050	$95.00	$194,750
	CONCRETE WALKS	SQFT	10,152	$4.50	$45,684
	CONCRETE SIDEWALK RAMPS	EACH	4	$4,000.00	$16,000

	CONCRETE CURBS, CURB AND GUTTER	FOOT	464	$35.00	$16,240
PERMANENT TRAFFIC SAFETY AND GUIDANCE DEVICES					
	CONCRETE BARRIER	FOOT	1,330	$400.00	$532,000
	LONGITUDINAL PAVEMENT MARKINGS	FOOT	22,000	$2.00	$44,000
PERMANENT TRAFFIC CONTROL AND ILLUMINATION SYSTEMS					
	SIGNAGE	SQFT	300	$45.00	$13,500
RIGHT-OF-WAY DEVELOPMENT AND CONTROL					
		LS	1	$1,000,000.00	$1,000,000
FUTURE LIFE CYCLE COSTS					
					$0
SUBTOTAL, Construction Items					**$103,298,000**
	MOBILIZATION	LS	1	10%	$10,330,000
SUBTOTAL, All Items					**$113,628,000**
	CONTINGENCIES, for all work listed	LS	1	30%	$34,089,000
SUBTOTAL, All Items + Contingencies					**$147,717,000**
	SALES TAX, 7.0% for WA portion only (apply to 1/2 previous subtotal)	LS	1	3.50%	$5,171,000
	FINAL DESIGN	LS	1	12%	$17,727,000
	CONSTRUCTION ENGINEERING SUPPORT	LS	1	12%	$17,727,000
TOTAL COST	**2011$**				**$190,000,000**
	ESCALATION (2011-2020), COMPOUNDED ANNUALLY	YR	9	4%	$80,430,000
TOTAL COST	**2020$**				**$270,000,000**

PRELIMINARY - COST ESTIMATE - HIGH RANGE

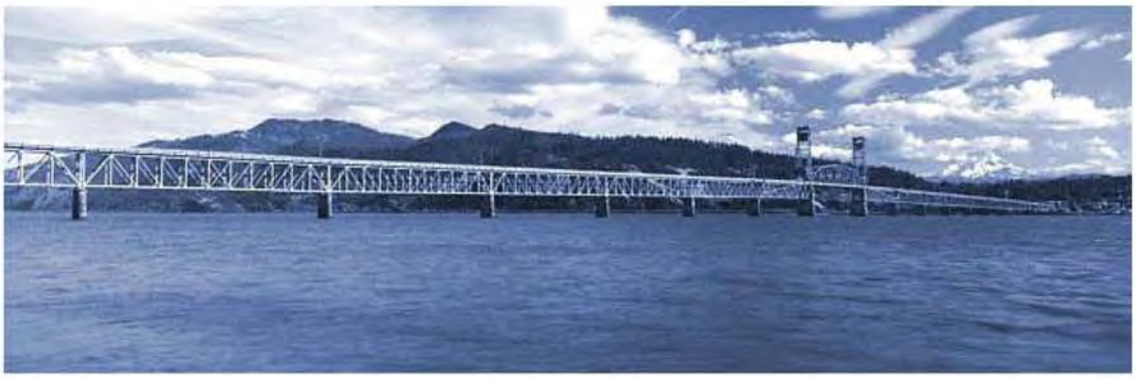
				COUNTY	
	SR-35 COLUMBIA RIVER CROSSING TS&L STUDY				
KEY NUMBER	BRIDGE NAME	BR #	DATE	ROADWAY DESIGNER	
	Hood River Bridge	–	10/5/11	PB	
ITEM NUMBER	**ITEM DESCRIPTION**	**UNIT**	**AMOUNT**	**UNIT COST**	**TOTAL**
ROADWORK					
	CLEARING AND GRUBBING	ACRE	1.5	$4,000	$6,000
	EMBANKMENT IN PLACE	CUYD	8,339	$18.00	$150,107
DRAINAGE AND SEWERS					
	CONCRETE INLETS	EACH	8	$1,200.00	$9,600
	DIVERSION MANHOLES	EACH	2	$8,600.00	$17,200
	RETURN FLOW MANHOLES	EACH	2	$2,800.00	$5,600
	VAULT WITH INTERNALS	EACH	2	$183,610.00	$367,220
	PIPE, 12 INCH DIAMETER	FOOT	140	$40.00	$5,600
	PIPE, 15 INCH DIAMETER	FOOT	400	$50.00	$20,000
	PIPE, 18 INCH DIAMETER	FOOT	700	$60.00	$42,000
BRIDGES					
	BRIDGE REMOVAL	SQFT	101,650	$158.50	$16,111,525
	SHORING, CRIBBING AND COFFERDAMS	LS	1	$130,000.00	$130,000
	STRUCTURE EXCAVATION	CUYD	303	$100.00	$30,341
	GRANULAR STRUCTURE BACKFILL	CUYD	96	$55.00	$5,256
	FURNISH DRILLING EQUIPMENT	EACH	1	$35,000.00	$35,000
	DRILLED SHAFT CONCRETE	CUYD	4,172	$340.00	$1,418,620
	DRILLED SHAFT REINFORCEMENT	LBS	625,862	$1.30	$813,620
	CSL TEST ACCESS TUBES	FOOT	20,247	$4.00	$80,989
	CSL TESTS	EACH	9	$700.00	$6,300
	DRILLED SHAFT EXCAVATION, 72 INCH DIAMETER	FOOT	1,539	$700.00	$1,077,314
	DRILLED SHAFT EXCAVATION, 96 INCH DIAMETER	FOOT	1,377	$1,240.00	$1,707,034
	FURNISH PILE DRIVING EQUIPMENT	FOOT	1	$25,000.00	$25,000
	FURNISH PP 48 X 0.5 STEEL PILES	FOOT	10,490	$155.00	$1,625,989
	FURNISH PP 48 X 0.5 STEEL TEST PILES	FOOT	899	$155.00	$139,379
	DRIVE PP 48 X 0.5 STEEL PILES	EACH	75	$200.00	$15,000
	DRIVE TEST PILES	EACH	6	$200.00	$1,200
	PILE LOAD TEST (DYNAMIC)	EACH	6	$25,000.00	$150,000
	PP 48 X 0.5 STEEL PILE SPLICES	EACH	22	$4,500.00	$99,000
	REINFORCEMENT	LBS	9,813,785	$1.50	$14,720,677
	COATED REINFORCEMENT	LBS	858,349	$1.65	$1,416,275
	FOUNDATION CONCRETE, CLASS 4000	CUYD	9,399	$308.00	$2,894,744
	GENERAL STRUCTURAL CONCRETE, CLASS 4000	CUYD	33,444	$615.00	$20,567,983
	REINFORCED CONCRETE END PANELS	SQYD	190	$250.00	$47,466
	POST-TENSIONING	LBS	2,405,082	$6.50	$15,633,033
	BEARING DEVICES, ABUTMENTS	EACH	4	$22,500.00	$90,000
	BEARING DEVICES, BENT 2 & 14	EACH	6	$52,500.00	$315,000
	2 INCH ELECTRICAL CONDUIT	FOOT	8,780	$130.00	$1,141,400
	MODULAR EXPANSION JOINT SEALS	FOOT	113	$2,400.00	$270,400
	COMBINATION BRIDGE RAIL	FOOT	8,780	$185.00	$1,624,300
	HANDRAIL PEDESTRIAN ORNAMENTAL	FOOT	4,390	$175.00	$768,250
	RETAINING WALLS, MSE	SQFT	12,940	$41.00	$530,540
	MARINE SUPPORT	LS	1	$17,225,000.00	$17,225,000
BASES					
	AGGREGATE BASE	TON	2,110	$45.00	$94,950
WEARING SURFACES					
	HMAC	TON	2,050	$95.00	$194,750
	CONCRETE WALKS	SQFT	10,152	$4.50	$45,684
	CONCRETE SIDEWALK RAMPS	EACH	4	$4,000.00	$16,000

	CONCRETE CURBS, CURB AND GUTTER	FOOT	464	$35.00	$16,240
PERMANENT TRAFFIC SAFETY AND GUIDANCE DEVICES					
	CONCRETE BARRIER	FOOT	1,330	$400.00	$532,000
	LONGITUDINAL PAVEMENT MARKINGS	FOOT	22,000	$2.00	$44,000
PERMANENT TRAFFIC CONTROL AND ILLUMINATION SYSTEMS					
	SIGNAGE	SQFT	300	$45.00	$13,500
RIGHT-OF-WAY DEVELOPMENT AND CONTROL					
		LS	1	$1,000,000.00	$1,000,000
FUTURE LIFE CYCLE COSTS					
					$0
SUBTOTAL, Construction Items					**$103,298,000**
	MOBILIZATION	LS	1	10%	$10,330,000
SUBTOTAL, All Items					**$113,628,000**
	CONTINGENCIES, for all work listed	LS	1	35%	$39,770,000
SUBTOTAL, All Items + Contingencies					**$153,398,000**
	SALES TAX, 7.0% for WA portion only (apply to 1/2 previous subtotal)	LS	1	3.50%	$5,369,000
	FINAL DESIGN	LS	1	15%	$23,010,000
	CONSTRUCTION ENGINEERING SUPPORT	LS	1	15%	$23,010,000
TOTAL COST	**2011$**				**$205,000,000**
	ESCALATION (2011-2020), COMPOUNDED ANNUALLY	YR	9	4%	$86,779,000
TOTAL COST	**2020$**				**$290,000,000**

APPENDIX J

SR-35 Economic Analysis

SR-35 Hood River Bridge: Economic Effects



Prepared for
The Southwest Washington Regional Transportation Council

October 2010

Prepared by ECONorthwest

99 W 10th Avenue
Suite 400
Eugene, Oregon 97401
541 687-0051
www.econw.com

Primary authors:

Terry Moore, Principal and Planning Director

Beth Goodman, Planner

Disclaimer

ECONorthwest completed this report as a subcontractor to Parsons Brinckerhoff, who was working for the Washington Regional Transportation Council. The report is an economic analysis evaluating the benefits to the Hood River region on the Hood River bridge (SR 35) and the economic benefits to the region of a new bridge.

Throughout the report we have identified the sources of information and assumptions used in the analysis. Within the limitations imposed by uncertainty and the project budget, ECONorthwest and Parsons Brinckerhoff have made every effort to check the reasonableness of the data and assumptions, and to test the sensitivity of the results of our analysis to changes in key assumptions. ECO acknowledges that any forecast of the future is uncertain. The fact that we evaluate assumptions as reasonable does not guarantee that those assumptions will prevail.

Additional Information

For more information about the SR-35 Columbia River Crossing Study, contact:

Dale Robins
Regional Transportation Council
Telephone 360-397-6067 x5212
E-MAIL: sr35@rtc.wa.gov

Project website:
http://www.rtc.wa.gov/studies/sr35/

Table of Contents

Executive Summary

The Hood River Bridge is one of the three highway bridges crossing the Columbia River in the Columbia River Gorge National Scenic Area. The nearest highway bridges to the west and east are both about 20 miles away. The bridge connects the communities of White Salmon/Bingen, Washington with Hood River, Oregon.

The Hood River-White Salmon Interstate Bridge was built in 1924 and rebuilt in 1938 when the Bonneville Dam was built. Residents, businesses, and the bridge users on both sides of the Columbia River are concerned about the safety and service life of the bridge. Previous studies from transportation agencies in Washington and Oregon have evaluated the need to reconstruct or replace the bridge. Two studies completed in 2004 (*SR-35 Columbia River Crossing Feasibility Study* and *Draft Environmental Impact Statement*) identified a preferred alternative: building a replacement bridge to the west of the existing Hood River bridge.

The current phase of the bridge evaluation builds on previous work and focuses on completing engineering elements that will provide information for the completion of a future Final Environmental Impact Statement (FEIS). It will address current deficiencies associated with the current Hood River bridge. As part of this phase of the evaluation, ECONorthwest, a consultant on economic and planning issues related to transportation, prepared this report.

This report summarizes the evaluation of *economic effects* of a replacement for the Hood River bridge. Its purpose is to identify and document the arguments in support of the larger benefits of a replacement bridge.

Evaluation Methods

Evaluation of transportation benefits typically consider factors such as access, mobility, travel time reliability, safety, convenience, comfort, cost effectiveness, and equitable distribution of impacts. This evaluation considers these transportation benefits and also non-transportation benefits on economic development, the environment, and land use. The evaluation has these steps:

1. **Evaluation framework**. Evaluation of transportation options, and how economic effects (benefits and costs) are typically specified and measured for transportation projects. Section 2.1 provides that framework.
2. **Review of existing studies.** Past study results were reviewed and used in this analysis. We incorporate the results of that review into Section 3.
3. **Setting a context.** The review of existing studies and standard data sources sets a context for this evaluation by describing the past, current, and likely future amounts of population, employment, and traffic in the study area.
4. **Stakeholder focus groups.** Focus groups give qualitative and anecdotal input about replacing the existing bridge. We held four 90- minute small-

group discussions with stakeholders. We invited 51 attendees from a range of interests and had 27 participants in the discussions, who represented a range of interests, including public agencies, private companies, freight-dependent businesses, and recreational and environmental interests. The discussions covered topics such as the use of the existing bridge, need for a replacement bridge, and benefits of a replacement bridge. See Section 2.2.2

EVALUATION OF ECONOMIC EFFECTS OF A REPLACEMENT BRIDGE

The evaluation of economic effects of replacement of the Hood River bridge addresses these questions:

1. What is the role of the existing bridge in the regional economy?
2. How do current conditions affect the use of the bridge?
3. What are the potential benefits of a replacement bridge?

The last question is the main focus of the evaluation. Consistent with the framework described in Section 2, it discusses potential transportation benefits and non-transportation benefits. For transportation benefits it discusses not only benefits to travel and shipping via cars and trucks, but also travel by alternative modes (transit, bicycle, and walking).

1. Roles of the existing Hood River bridge

The fundamental role of the bridge is to connect the communities of White Salmon/Bingen with Hood River, allowing the communities to share a common workforce, retail services, and public services. It is not one of several transportation links making that connection: it is the *only* link making that connection for 20 miles in either direction. More specifically, the bridge:

- **Provides residents and businesses with cross-river access to Washington and Oregon.** Businesses are dependent on access to workers on both sides of the bridge. On average, about 10% to 15% of daily trips on the bridge are made by people commuting to work. The majority of regional employment is located in Oregon. About 9% of workers living in Klickitat County commuted to work in Wasco or Hood River Counties in Oregon, while about 6% of workers living in Hood River County commuted to work in Klickitat County. Not all of these workers commute via the Hood River bridge: some cross-river commutes to The Dalles (OR) or Stevenson (WA) use adjacent bridges. Several Oregon-based business people indicated that as many as 20% to 30% of their employees commute from Washington.
- **Supports the regional economy. Hood River is the economic center of the region.** Residents of Washington depend on the bridge to be able to shop and conduct business in Hood River. Many businesses in Hood River depend on residents of Washington for customers. The majority of retail and services are located in Hood River County. If the economies of

Klickitat and Hood River Counties were similar, one would expect retail sales to be similar in each county, certainly on a per capita basis, and even on an absolute basis since the two counties have similar numbers of people. But (1) per capita retail sales in Klickitat County are only about ¼ of those in Hood River County, and (2) the City of Hood River accounts for 90% of the approximately $260 million in retail sales that occur in White Salmon, Bingen and Hood River combined (2007).

- **Supports the movement of goods and services between Washington and Oregon.** The bridge allows relatively easy freight movement across the river, which thus allows manufacturers and producers some choice in where to have materials processed. The majority of freight goods that cross the bridge are wood products and fruit: for processing, use within the region, or for export outside of the region. While direct counts are not available, interviews with businesses suggest that it is reasonable to assume that on the order of 10% to 20% of manufactured products and fruit grown in the region crosses the bridge, which would have a value of the value of freight crossing the bridge is between about $35 million to $75 in 2007.

- **Provides access to recreational attractions and improves tourism within this region.** Visitors to the region use the bridge to access attractions or recreational opportunities on both sides of the river, as well as the retail and accommodations services available primarily in Hood River. These trips include those traveling to the growing wine industry on both sides of the river. The bridge provides visitors with a direct connection between the main tourism centers, rather than traveling 20 miles to the next-nearest river crossing.

- **Provides access for emergency services between Washington and Oregon.** The bridge also allows local emergency-service providers with the opportunity to combine resources and support each other. Currently, inter-local agreements exist between fire services in the region, allowing mutual aide on 911 emergencies and combining department resources (e.g. fire personnel, funding, and fire equipment). Additionally, the Hood River bridge provides the Washington-side emergency-service providers access to Interstate 84 in Oregon, allowing for a quicker emergency response time to Portland area hospitals and trauma centers.

2. Effects of current conditions on bridge usage

The current conditions on the bridge primarily affect bridge usage as a result of safety concerns (e.g., the narrowness of the bridge) and freight limitations (e.g., weight limitations on the bridge):

- Safety problems do not manifest themselves in reported crashes or severe accidents involving fatalities, or injuries: there is a good argument that the substandard lanes on the bridge actually reduce severe accidents because (1) speeds are slow and (2) pedestrians and bicyclists are not allowed to use the bridge. Most collisions, based on anecdotal evidence, are unreported and tend to be mirror-to-mirror collisions. Participants in the small-group discussions identified the following safety concerns:

- The narrowness of the bridge frightens people crossing the bridge: local resident and visitors alike.
- The narrowness of the bridge causes problems for schools and transit agencies: minor damage to vehicles (such as scrapes or broken side-view mirrors) and worries about passenger safety.
- Motorcycles have a hard time riding on the grating of the bridge.
- The bridge's narrow width between supports, the strong cross winds in the Gorge, and the barge lineup for the span when approaching from the downstream side makes the Hood River bridge one of the most challenging bridge on the Columbia River system for barge operators.
- The weight limit for vehicles crossing the bridge is 80,000 pounds, which is the same weight limit on the Bridge of the Gods. This weight limit and the narrowness of the bridge impedes efficient freight movement. Small-group discussion participants suggested that increase in weight limitation or a wider bridge would allow for more efficient and fewer bridge crossings.

  In addition, very heavy equipment and construction trucks (for road construction and logging) are overweight for the bridge. The Port allows this type of heavy equipment to cross under very controlled situations, rather than requiring them to detour to a different bridge crossing.

3. Benefits of a replacement bridge

The research and public outreach in this project suggest a replacement Hood River bridge would provide or improve:

- **Access between Hood River, OR and White Salmon/Bingen, WA beyond the existing bridge's estimated remaining useful life of 25 years**. A new bridge would have a design lifetime in excess of 75 years.
- **Travel time within the region.** Increases in the speed of bridge crossings, from 25 to 35 miles per hour, would reduce the time it takes to cross the bridge. Based on projected bridge crossings by 2030, the annual savings would be $350,000 (in 2010 dollars). In addition, if congestion is relieved and speed flow is improved, the reduction in fuel consumption could result in savings on the order of $90,000 per year (in 2010 dollars).
- **Freight mobility within the region.** A new bridge with an increase in the maximum freight load allowed (e.g. increasing from 80,000 pounds per truck to 105,500 pounds) could attract more freight users to the region and also provide a savings of around $125,000 (in 2010 dollars) per year.
- **Safety for bridge users.** Improving safety on the bridge would help people in the region feel more comfortable when crossing the bridge. The focus group discussions suggest that accidents that result in minor damage (e.g.,

damaged side mirrors) are common on the bridge. In addition, large vehicles occasionally scrape or ride-up on guardrails. The replacement would allow drivers to feel more comfortable crossing the bridge and provide an annual savings, from fewer broken mirrors, between $40,000 and $80,000 (in 2010 dollars). The savings from more severe incidents is on the order of $100,000 to $300,000 per year (in 2010 dollars).

- **Safety for river traffic.** This bridge is the most challenging on the Columbia River system for barge operators. Barges carry a range of commodities, ranging from garbage and waste to fuel. While there have been relatively few barge strikes on the bridge, with a cost of less than $100,000, there is potential for a serious barge incident that could involve loss of life, negative environmental impacts (fuel leaks and spillage of goods), and could significantly damage the bridge.
- **Multimodal transportation options to cross the bridge.** A replacement bridge would accommodate transit buses, pedestrian and bicycle facilities, resulting in a decrease in vehicle miles travelled (VMT) and providing alternative means of commuting for the region.
- **Economic opportunities within the region and reduce river barriers within the region.** The economic development benefits of a new bridge that provide: (1) opportunities to increase bicycle tourism, as part of the development of the Columbia River Gorge Scenic Area into a world-class tourism destination, especially for bicyclists, (2) a landmark that attracts visitors and (3) a reduction in barriers to river traffic.
- **Environmental quality.** The replacement bridge would contain storm water catchment facilities that would channel all runoff to detention areas on either side of the River, reducing or eliminating storm water runoff which, because of the open deck grating, runs directly into the Columbia River. There are environmental benefits from preventing water pollution via runoff from the bridge but the monetary benefits are very small per vehicle mile traveled.

Section 1 Introduction

1.1 Background

The Hood River Bridge is one of the three highway bridges crossing the Columbia River in the Columbia River Gorge National Scenic Area. The nearest highway bridges to the west and east are both about 20 miles away. The bridge connects the communities of White Salmon/Bingen, Washington with Hood River, Oregon.

In 1923 Congress approved the construction of the Hood River bridge by the Oregon-Washington Bridge Company. In December 1924, the bridge was completed and opened to traffic. The completion of the Bonneville Dam in 1938 caused the river's water level to rise and created the need to rebuild the Hood River bridge. At the same time a lift span and toll booth were added to the bridge. The Port of Hood River purchased the bridge in 1950 and continues to operate and maintain it.

Recent studies of the bridge began in 1999. Their purpose, broadly, is "to improve the movement of people and goods across the Columbia River between communities of White Salmon/Bingen, Washington with Hood River, Oregon." Two studies completed in 2004 (*SR-35 Columbia River Crossing Feasibility Study* and *Draft Environmental Impact Statement*) identified a preferred alternative: building a replacement bridge to the west of the existing Hood River bridge. The next phase of analysis is a Type, Size, and Location Study as well as this economic analysis report.

The current phase of the bridge evaluation builds on previous work and focuses on completing engineering elements that will provide information for the completion of a future Final Environmental Impact Statement (FEIS). It will address current deficiencies associated with the current Hood River Bridge and propose ways to:

- Alleviate current and future congestion at the bridge termini, on the bridge itself, and on the access road to and from the bridge (SR-35).
- Alleviate congestion related to diverted traffic due to severe weather conditions or incidents on Mount Hood, I-84, or SR-14.
- Accommodate increases in cross-river demand while also providing multimodal travel across the Columbia River.
- Comply with funding and legislative requirements regarding the SR-35 Columbia River Crossing.
- Satisfy social demands and economic needs for cross-river flow of goods and people.

- Accommodate river navigation by providing horizontal and vertical clearances that meet current standards while also providing intermodal and multimodal connections across the river.
- Improve safety and the current substandard design of the current bridge.

To achieve these objectives, several types of evaluation will be required. This report summarizes the evaluation of *economic effects*. It was prepared by ECONorthwest, a subcontractor to Parsons Brinckerhoff, the lead consultant working for the Southwest Washington Regional Transportation Council (RTC). Technical guidance for the project was provided by the Project Management Team (PMT), which consisted of staff from the RTC, Washington State Department of Transportation (WSDOT), and Oregon Department of Transportation (ODOT). In addition, the PMT and consultants worked with local governments and ports.

This study considers the economic effects of the Hood River Bridge at several levels of geography: (1) the cities of Hood River, White Salmon, and Bingen, as well as the immediately surrounding areas, (2) Hood River, Klickitat, and (eastern) Skamania Counties, and (3) the Columbia River Gorge. The focus of the study are the cities of Hood River/White Salmon/Bingen and the immediately surrounding areas, referred to as the Hood River/White Salmon/Bingen region. The broader region is Hood River, Klickitat, and (eastern) Skamania Counties.

1.2 PURPOSE OF THIS ECONOMIC ANALYSIS

Large public infrastructure projects are complicated and expensive. It often takes a long time to go from the first discussion of a proposed project to project construction. This is particularly true for projects like the replacement Hood River bridge. The feasibility of replacing the current bridge will depend in large part on the cost to build the replacement bridge, the economic benefits of replacement, and the ability to finance a replacement bridge. A new bridge is the smallest investment increment and it is expensive, and the amount of population and economic activity in the Gorge is small relative to that in the metropolitan areas (thus, both use and ability to pay for a major bridge is much smaller).

These difficulties were identified before the evaluation of a replacement bridge began over 10 years ago. But the evaluation proceeded because a replacement bridge will eventually be needed, and substantial planning and discussion have to occur before it can become a reality.

Additionally, users of a replacement bridge would most likely be willing to pay tolls that would cover about one-third of the amortized cost of the replacement bridge. In other words, the personal value that travelers crossing a replacement bridge would gain would not be great enough to make them willing to increase tolls to a level where they would fully pay for a replacement bridge. This Study and the recent focus group meeting finding, strongly suggest that a replacement bridge will not be built in the near term, if (1) the old bridge continues to function (albeit inadequately) and (2) no outside state or federal funding gets allocated to the project.

Attracting such funding is supported by reasonable arguments about benefits that go beyond those to local users of the bridge, residents, and businesses. And reasonable arguments do exist. *The purpose of this report is to assemble and document the arguments about the larger benefits of a replacement bridge.*

1.3 ORGANIZATION OF THE REPORT

This report contains the following chapters:

- **Framework for Evaluating Economic Effects** presents the framework for evaluating the economic effects of transportation projects, as well as the key assumptions for this project.
- **Analysis of Economic Effects** answers questions about users of the existing bridge and benefits of a replacement bridge.
- **Synthesis** restates the key findings of the analysis of the economic effects of the replacement bridge.

It also includes two appendices:

- **Summary of Focus Group Discussions**
- **Review of Existing Studies**

Section 2 Framework for Evaluating Economic Effects

This section describes the approach used in this report for evaluating the economic effects of a replacement bridge. It describes a typical evaluation of transportation options, and how economic effects (benefits and costs) are typically specified and measured for transportation projects. It uses that information as a context for specifying the evaluation techniques used in this report.

2.1 Evaluating the Economic Effects of Transportation Projects

At the broadest level, the purpose of government action is to make all the people under its jurisdiction better off.

Government action can be planning, funding, public investment (either directly or through incentives to the private sector), regulation, and coordination.

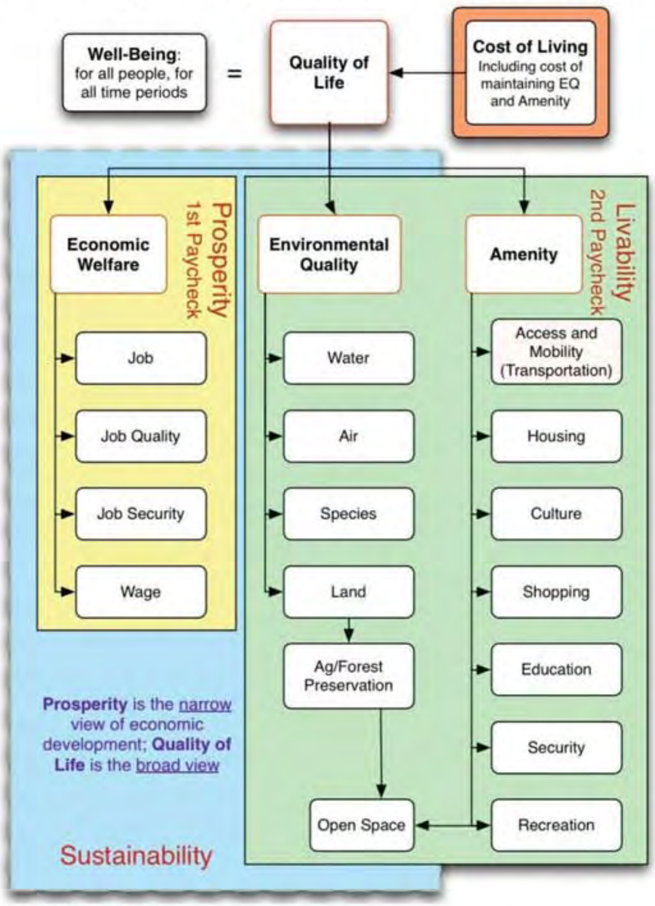
Defining *better-off* is more difficult. Any individual can make a judgment about whether some action would improve his or her condition, but many public actions affect millions of people, in many different ways, immediately and into the future. Economists use the term *social welfare* to refer to some aggregate, average outcome of some government action. Planners often use the term *public good*, or *quality of life*, or, more recently, *sustainability*. Whatever the term used to capture the broad idea of making good policy choices, it is clear that the term is composed of many components that contribute to satisfaction: those components include ones that are economic, environmental, and social, and each of these has many sub-components.

No policy or program can simultaneously maximize net benefits on all the components of quality of life. Instead, it must find a combination of measures to enhance quality of life to some *optimal* level: one that balances benefits and costs by type and across affected parties (i.e., across classes of people, subareas of the affected area, and existing and future residents).

It is common for economists to sub-categorize benefits and costs in terms of *efficiency* (when all the benefits and costs are listed, described, and somehow measured, is a proposed action likely to lead to net benefits in the aggregate?) and *fairness* (independent of whether society in the aggregate would enjoy net benefits, how are the benefits and costs distributed over different areas and groups?). They are usually careful to note that fairness is a normative judgment made by elected and appointed decisionmakers: analysts can describe how benefits and costs *are* distributed, but fairness (or equity) requires a judgment about how they *should be* distributed.

But regional transportation and land use planning exercises are much more likely to categorize benefits and costs in terms of what people most often think makes a region livable: economic opportunity and security, environmental quality, urban amenity and services (including, significantly, the pattern and quality of built space and transportation), and the cost of living. Exhibit 1 shows a typical set of categories that could be applied in any land use, transportation, economic development, environmental, or social planning process.

Exhibit 1. Typical objectives for municipal and regional planning



Source: ECONorthwest

In summary, Exhibit 1 illustrates that:

- The purpose of public action is to increase the quality of life of a public entity's constituents.
- Quality of life has many components. They can be grouped into broad categories, but the number of sub-categories, and the number of possible measurements within those sub-categories, is large.

- Public actions to improve quality of life are subject to a fiscal constraint: the spending and the effects of the policies cannot make "cost of living" too high.

Depending on the area of policy being evaluated, some of the categories would get much more attention and sub-categories of evaluation than others. This bridge project is a transportation evaluation. Thus, the box in Exhibit 1 about transportation is going to get more attention than others: it will have a lot more discussion and measurement of transportation-related benefits and costs. Exhibit 2 shows typical categories of transportation benefits: things that people want a transportation system to give them.

Exhibit 2. Typical transportation benefits of transportation investments

Benefit	Comment
Access	The ability to get somewhere that was previous inaccessible. This relates to "speed" because very few places in urban areas are truly inaccessible: but some of them take a long time to reach
Speed (mobility)	Typically one of the main, measurable benefits. Transportation models can report changes in travel time (by route, time of day, mode of travel) with and without a proposed transportation project or policy
Travel-time reliability	A high probability of arriving at a predicted and relatively constant time has value to travelers. Transportation analysis and models are just starting to quantify that value.
Safety	A necessary condition for arriving quickly is to arrive at all.
Convenience	This may be a largely or partially covered by speed (more convenient may mean more frequent) but it can also be separate: yes, I can get there relatively quickly, but I can only do that three times a day or under certain restrictive conditions.
Comfort	Studies show this consideration to be less important than speed or cost, but, other things being equal, different people perceive some modes are more comfortable than others, and the quality of the trip can certainly vary within a mode.
Cost: Effectiveness, Fiscal Constraint	Yes: quick, reliable, safe—but how much is that going to cost me. Travelers look not for maximum benefits or minimum cost, but the best value—the optimum mix of benefits and costs.
Distribution of impacts (equity)	What might be true on average is not true for every individual, or even every sub-group. A benefit of a transportation project could be that it makes a targeted group better off, even if its costs overall exceed its total benefits

Source: ECONorthwest

In addition to transportation benefits (often referred to as *user benefits* because they accrue to users of the transportation systems: travelers and shippers), transportation investments can have *non-transportation benefits.* The possible benefits are many: in fact, they exist in every other box in Exhibit 1 besides transportation. But most of them fit into four categories: economic development, the environment, land use, and other.

- *Economic development*, the benefits of transportation investment now derive not only from the first-order effects on transportation (in metropolitan areas, primarily the reduction in congestion and travel time, and the increase in travel-time reliability), but also from the second-order effects on land use (allowing concentration of economic activities and what economists refer to as "agglomeration economies," and providing other positive "amenity" effects). Ultimately that may lead to better products, more consumer satisfaction, more jobs, higher wages, more spending—in general, to more economic activity. Here again are the problems of specification (what are all the possible effects?), measurement, and double counting.
- *Environment*, the economic theory that is the foundation of benefit-cost analysis acknowledges that some of the benefits and costs of human activity (including the construction and use of transportation facilities) are not incorporated into market prices. The current and much-debated example is the potential costs of climate change, to which the carbon emissions of motor vehicles contribute. Economists have developed techniques to try to estimate the benefits of reducing these "external" costs.
- *Land use*, there are at least two main sub-categories of purported benefits. First, transportation improvements may raise property values, so measurements and estimations of change in property value have been used as a measure of benefit. But, transportation economists generally agree on the proper theory here: those changes in property value will be largely a capitalization and double-count of the transportation user benefits. Second, advocates of smart growth believe that high-density, mixed-use land use patterns are inherently superior to low-density, segregated-use land use patterns and have supported that belief with research showing that such land-use patterns might reduce the cost of public services (including, notably but not only, transportation) and greenhouse gas emissions.
- *Other* benefits not covered in the three categories above are found mainly on the right side of Exhibit 1 under the heading "Amenity." In the context of a transportation investment, the subcategories are mainly goods, services, or activities that people desire and the transportation allows them better access to: things like shopping, recreation, security (e.g., faster police, fire, and EMS response), and so on. Also in this category would be any socially defined distributional benefits: ones that accrue from the fact that a transportation investment is providing benefits to groups that public policy or sentiment has agreed merit special attention.[1]

[1] In transportation planning, this category of benefit is often labeled "social justice."

To achieve more of these transportation and non-transportation benefits for its citizens, governments make decisions about transportation policy: about investments, programs, and regulations. Implementing these policies is a big part (but not the only part) of the costs of getting the desired transportation benefits. There are many types of costs, and many ways they can be categorized:

- Construction vs. operation, maintenance, preservation
- Short run vs. long run
- Facility vs. vehicle
- Project vs. program
- Marginal vs. average
- Highway vs. alternative mode
- Public vs. private
- Direct vs. external
- Monetized vs. non-monetized

All of these dimensions are important in a comprehensive evaluation of large transportation investments, and there is no simple formula for incorporating them all.

Ideally, an evaluation of the economic effects of a transportation project would consider all costs and benefits of the project. It would provide details for each policy option or scenario[2] for *all types of economic impacts*, on *all types of businesses and organizations* (disaggregated by industry type and size), for *all subareas*, for *all time periods* (e.g., every year for the next 20 – 40 years).

It is not hard to imagine a matrix whose column headings are the many *scenarios* (e.g., no bridge, existing bridge, new bridges of different types and in different locations); whose row headings are the many different *measures* (the categories of impacts described in the previous paragraph) of "economic vitality" that are the *criteria* by which the scenarios get evaluated; and whose cells are populated with information about how each scenario performs on each measure.

That neat theoretical matrix, however, always proves messy in practice. The number of potential impacts (i.e., benefits and costs) is large, they overlap (double counting), data are not available, and the number of variations on any measurement can get very large. For example, decision-makers might agree that a good measure of economic impact would be the relative change in employment in the Hood River and White Salmon/Bingen region, based on the build and no-build scenarios. But it would be typical to find much more detail requested later: changes in employment by type of industry, by size of business, by geographic sub-area, by year for 20

[2] The scenarios examined in this report are building a new Columbia River bridge between Hood River and White Salmon/Bingen or not building a new bridge. The *Columbia River Feasibility Study* (2004) examined other scenarios for the bridge.

years, and for several more bridge options. One measure morphs into dozens, and complexity, perplexity, and cost grow exponentially.

This assertion may sound unscientific and self-serving, but it is nonetheless true: no project that relies heavily on such a technically based mega-matrix to make the decision has much chance of success. But if the development of the ideal mega-matrix is not an achievable objective, why talk about it? Because the theory, logic, and assumptions on which such a matrix would be built suggest ideas that a more practical evaluative framework might strive to achieve. The matrix concept serves best as an organizing framework (for thinking about choices, their performance, and the relative differences and tradeoffs among the choices on things that matter—i.e., the impacts / performance criteria).

We think it is essential to describe such a framework at the beginning of a project so that all parties agree on how the technical analysis will be conducted and interpreted. Having done that, we now discuss the implications of that framework for the specific methods used in the evaluation in this report.

2.2 Evaluating the Economic Impacts of the SR 35 Columbia River Crossing Project

2.2.1 Evaluation Principles

The framework of evaluating the economic impacts of the SR 35 Columbia River Crossing project is shaped by some broad principles and assumptions derived from ECONorthwest's experiences with evaluating projects of this type and complexity. They include:

1. Acknowledge complexity, but then simplify
2. Start with clear definitions of what economic effects are, how they should and can be measured, and how they will be handled in this project
3. Focus on assembling relevant economic information that can then be used in various ways to address questions about economic impacts (rather than on trying to create a big database of predetermined measures of impacts)
4. Convey the analysis and findings as an understandable story about economic effects that is consistent with the theory and experience of economic and urban development, and then embellish that story to address specific issues that stakeholders see as important to this project.

Other principles and assumptions specific to this evaluation of the economic impacts of a replacement bridge are following:

- Section 1.2 clarifies the purpose to focus on the potential economic *benefits* of a replacement bridge, not on its full impacts. The analysis will not include a benefit-cost analysis.

- Given that this study does not include a full benefit-cost analysis, we are less concerned about having measurements, and in dollars, of every economic impact. We include descriptive, qualitative analysis of benefits, as we can show good reasons to believe that these benefits are real and not a double-count of other impacts.

2.2.2 SPECIFIC METHODS

The steps below are a reasonable and consistent implementation of the principles in the previous section:

1. **Evaluation framework**. Section 2.1 provides that framework.
2. **Review of existing studies.** Past study results were reviewed and used in this analysis. We incorporate the results of that review into Section 3, following.
3. **Setting a context.** The review of existing studies and standard data sources sets a context for this evaluation by describing the past, current, and likely future amounts of population, employment, and traffic in the study area.
4. **Stakeholder focus groups.** Focus groups give qualitative and anecdotal input about replacing the existing bridge. We held four 90- minute small-group discussions with stakeholders. We invited 51 attendees from a range of interests and had 27 participants in the discussions. Participants represented a range of interests, including public agencies, private companies, freight-dependent businesses, and recreational and environmental interests. The discussions covered topics such as the use of the existing bridge, need for a replacement bridge, and benefits of a replacement bridge.

The public outreach, analysis, and steps described above, provide the foundation for drawing conclusions about the potential benefits of a replacement bridge. Additionally, those conclusions are influenced by professional judgment. One person's benefit is another person's cost: benefits depend on perspective and assumptions.

As an illustration, consider two hypothetical futures: the more likely one in which the existing bridge is maintained in good repair and continues to serve existing traffic; and one in which some natural or human-caused catastrophe closes the bridge over night. These two cases suggest a very different conclusion about the benefits of a replacement bridge.

First consider the actual case. A bridge has existed for over 80 years and development has oriented around that access. Users of the bridge know it has always been there and presume it always will be there. They would prefer not to pay any tolls, but if they could get better service (especially wider or more lanes) they might be willing to double what they pay now (which is $0.75) or maybe even stretch to $2. At the margin, a replacement bridge is worth to them in the range of an extra $1 per crossing. Shippers (trucks) are probably willing to pay more per trip; bicyclists and pedestrians would like expect to pay a lower toll than motor vehicles or to cross for free. But as a rough approximation, there are on the order of 350,000 to 400,000 automotive and truck crossings per year now, so if the surveys and anecdotal evidence is to be believed, bridge users are willing to pay around $800,000 a year for the benefits they would receive from a replacement bridge. But automotive and freight bridge users benefit from the existing bridge. We do not have any simple way to separate out the benefits of the existing and the proposed replacement bridge, but it is clear that the major benefit is just being able to make the crossing at all, which is what the existing bridge provides. For the sake of this illustration, we assume that the capacity enhancements of a replacement bridge accounts for 10 – 15% of the total value of the replacement bridge: that is about $100,000 per year now, and increases over time as the number of crossings increase.

Now consider the hypothetical case where the current bridge disappears over night. The regional economy on both sides of the River has already developed around the fact that the two sides are connected, and the presumption that the connection will always be there. The *loss* of access benefits is now felt acutely: people cannot get to jobs, shopping, business activities, recreation, and social engagements. Were one able to somehow immediately create a much smaller temporary bridge and then ration its use with tolls, one would find a very different willingness to pay than what one observes today on the current bridge. Some travelers would skip the trip altogether, and some might do the 40 mile loop through The Dalles. But even after trips were eliminated and consolidated, there would still be many former bridge users will to pay more to get across.

A large and wide variety of studies have been undertaken by economists regarding "value of time", or how to quantify, in dollars, how much travelers value their time under a variety of conditions and trip purposes. The consensus of these studies is that *on average* people value travel time at about ½ their wage rate.

To help put a dollar value on benefits of a new SR 35 Columbia River Crossing, the following assumptions are made:

- The average wage for bridge crossers is $16/hour[3]
- Without the current Hood River bridge in place, getting between Hood River and White Salmon / Bingen would add 40 minutes to the travel time for each crossing.
- Using information from the Automobile Association of America, the cost per mile to operate a motor vehicle ranges from 50¢ (passenger car) to 75¢ (truck), including insurance and taxes; if only the cost of fuel is counted, the average number is on the order 15¢ per mile

The value of that time for the average person is $6. If a person's wage rate is higher (which will be the case for many people), so is the value of travel time. If people were to car pool (as they would) now each vehicle crossing has 2 to 4 times

[3] Based on information from the Oregon Housing and Community Services Department and Washington Office of Financial Management, which estimates median income in the region at approximately $30-35,000 per year.

more value. For operating costs, an additional 40 miles is the equivalent an additional $6. Trucks (with high operating and inventory costs) would likely pay more to save 40 minutes of travel time. Thus, it would not be surprising if the limited capacity of this hypothetical, a low-capacity temporary bridge could capture an average of $10 or more per crossing during peak periods, at least in the short run. In the longer run travelers would change activity and travel patterns.

The point is that the benefits of the existing or a replacement bridge depend on perspective and assumptions. Here are the ones we make as a basis for our analysis in the next section:

- There is no current discussion about letting the maintenance on the current bridge decrease, which could increase the risk of some catastrophic failure. Absent some unpredicted and very unlikely natural disaster, everyone expects the current bridge to be there until a new one is built.
- Given the previous assumption, the most appropriate way to think about the benefits of a replacement bridge is in comparison to the benefits that the existing bridge is already delivering. The benefits of the existing bridge are substantial, especially if measured as the avoided disbenefits that would occur if the existing land use patterns continued but the existing bridge disappeared. But the additional benefits of a replacement bridge—one that only improves on the essential access that the existing bridge is already providing—will be much smaller.

Section 3 Analysis of Economic Effects

The analysis of economic effects of the Hood River bridge is based on: (1) findings from previous studies about the Hood River bridge project, (2) small-group discussions held in Hood River in June 2010, and (3) analysis of existing data. This section addresses the following questions that were specified in setting up the economic effects study:

- How is the bridge used now?
- What is the role of the bridge in the regional economy?
- How do current conditions affect the use of the bridge?
- What are the potential benefits of a replacement bridge?

The last question is the main focus of the study. Consistent with the framework above, we discuss potential transportation (user) benefits and non-transportation benefits. For transportation benefits we discuss not only benefits to travel and shipping via cars and trucks, but also travel by alternative modes (transit, bicycle, and walking).

Before addressing these questions we provide as context a brief discussion of population and employment trends in the Hood River/White Salmon/Bingen region.

3.1 Population and employment trends

Exhibit 3 shows population growth from 1990 to 2009 in Klickitat County, White Salmon, Bingen, Skamania County, Hood River County, and Hood River. Population in the three incorporated cities in the region has grown from about 7,100 people in 1990 to nearly 9,900 people in 2009, an increase of more than 2,700 people or 38%.

In 1990, nearly two-thirds of the residents of the incorporated cities lived in the City of Hood River. By 2009, the share of population living in the City of Hood River increased slightly to 70% of the broader regional population total.

Exhibit 3. Population, Washington State, Klickitat County, White Salmon, Bingen, Skamania County, Oregon, Hood River County, and Hood River, 1990 to 2009

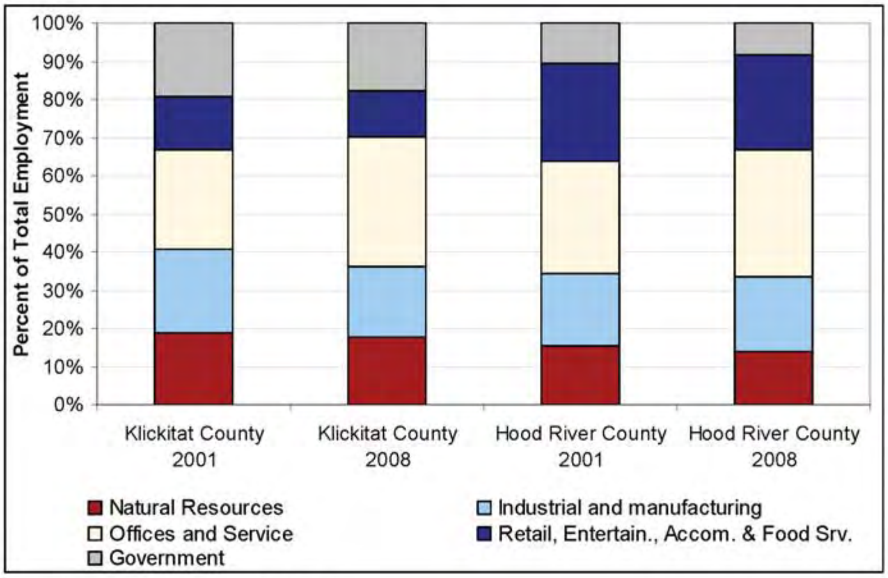
	Population			Change 1990 to 2009		
Area	**1990**	**2000**	**2009**	**Number**	**Percent**	**AAGR**
Washington	4,866,692	5,894,121	6,733,250	1,866,558	38%	1.7%
Klickitat County	16,616	19,161	20,500	3,884	23%	1.1%
White Salmon	1,861	2,193	2,255	394	21%	1.0%
Bingen	645	672	690	45	7%	0.4%
Skamania County	8,289	9,872	10,800	2,511	30%	1.4%
Oregon	2,842,321	3,421,399	3,823,465	981,144	35%	1.6%
Hood River County	16,903	20,411	21,725	4,822	29%	1.3%
Hood River City	4,632	5,831	6,925	2,293	50%	2.1%
Incorporated Cities	7,138	8,696	9,870	2,732	38%	1.7%

Source: U.S. Decennial Census for 1990 and 2000
Washington State office of Financial Management and the Population Research Center at Portland State University for 2009

In 2008, Klickitat County had about 10,300 employees, Skamania County had about 3,200 employees, and Hood River County had nearly 16,000 employees. Between 2001 and 2008, employment in Klickitat County grew by an average annual growth rate of 2.0% (adding about 1,300 employees) and employment in Skamania County grew by an average annual rate of 2.4% (adding 500 employees), compared to Washington State's annual employment growth rate of 1.3%. Employment in Hood River County grew by an average annual growth rate of 2.7% (adding nearly 2,700 employees), compared to Oregon's annual employment growth rate of 1.0%.

Exhibit 4 shows the distribution of employment in Klickitat and Hood River Counties by broad category of employment in 2001 and 2008. Hood River County's employment was concentrated in Office and Services (33%) and Retail, Entertainment, and Accommodation and Food Services (25%) in 2008. In comparison, Klickitat County's employment was more evenly distributed across sectors, with the most employment in Office and Services (34%) and the least employment in Retail, Entertainment, and Accommodation and Food Services (12%) in 2008.

Exhibit 4. Total Employment, Klickitat County and Hood River County, 2001 to 2008



Source: U.S. Bureau of Economic Analysis

Skamania County's employment base is small enough that the Bureau of Economic Analysis does not disclose employment in many sectors because of confidentiality issues. The available information shows that, in 2008, employment in Skamania County was concentrated in Government and Retail/ Entertainment/Accommodations and Food Services. The jobs in Skamania County that are dependent on the Hood River bridge are the agricultural jobs in eastern Skamania County, which use the Hood River bridge to access food processors in Oregon and to access I-84.

Exhibit 5 shows employment and sales or revenue for selected sectors based on information from the U.S. Census Bureau's 2007 Economic Census. Exhibit 5 shows that the economy of Hood River is larger than Klickitat County despite the fact that the counties have a similar number of residents. This supports anecdotal evidence that people living in Washington work, shop, and do personal business in Oregon. Exhibit 5 shows that:

- Hood River County had more establishments, employment, and revenue in the selected sectors shown in Exhibit 5.
- The revenue of firms in Klickitat County from office and service sectors ($116.3 million) was less than two-thirds of the revenue of firms in Hood River County ($202.4 million).
- The value of sales of firms in Klickitat County from retail and related sectors ($85.7 million) was about one-quarter of the sales in Hood River County ($375.1 million).

Exhibit 5. Employment and sales or revenue for selected sectors, Klickitat County and Hood River County, 2007

	Hood River County			Klickitat County		
	Establish-ments	Emp.	Sales or Revenue	Establish-ments	Emp.	Sales or Revenue
Manufacturing	58	1,200	$245,734,000	31	740	D
Offices and Service	325	2,434	$202,413,000	174	1,161	$ 116,299,000
Retail, Entertainment, and Accomodation & Food Service	251	4,010	$375,124,000	118	738	$ 85,689,000
Total	**634**	**7,644**	**$823,271,000**	**323**	**2,639**	**$ 201,988,000**

Source: Source: U.S. Census Bureau, Economic Census, 2007
Note: Manufacturing revenue data for Klickitat County was not available because of disclosure and confidentiality issues. Klickitat County's total sales or revenue does not include manufacturing revenue.
Note: The information for sales or revenue also includes information about the value of shipments and receipts

The most important implications of the population, employment, and revenue data for a discussion of the potential benefits of a replacement bridge are that:

- The population and employment base of the Hood River/White Salmon region is small in comparison to other urban areas in Washington and Oregon. Although the benefit of the bridge in the local economy may be substantial for the region, when compared to these other, larger urban areas in Oregon and Washington, the total benefit is likely to be small.
- Broader regional economic activity is concentrated in Hood River County relative to Klickitat County.
- The population and employees have grown and will continue to grow. Thus, the benefits of a replacement bridge are likely to increase over time.

3.2 How is the bridge used now?

The Hood River bridge is used by residents and businesses located within the Hood River/White Salmon/Bingen region, and by visitors to the broader region. The bridge is critical to connecting Hood River with White Salmon / Bingen to create one community rather than two (or three) separate communities. Residents and businesses throughout the larger community access shared public and private services on either side of the Columbia River with relative ease.

In 2001, two surveys were conducted to understand bridge use: one was an intercept survey of motorists crossing the bridge; the other was a telephone survey of households in the region. The motorists (by definition, bridge users) averaged 9.1 one-way trips across the bridge per week. The survey of local households showed an average of 8.5 one-way trips across the bridge per week for respondents who traveled across the bridge in the week prior to the survey.[4]

[4] The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

Exhibit 6 shows the purpose of trips across the bridge. Respondents were allowed to choose multiple purposes for the trips. In both surveys, the most common trip purpose was shopping or personal business (e.g., groceries, banking, or medical appointment), followed by recreation or leisure activities.

Exhibit 6: Purposes of trips across the Hood River bridge, 2001

Trip purpose	Motorists (intercept survey)	Local households (telephone survey)
Shopping or personal business	37%	69%
Recreation or leisure activities	20%	38%
Commute to work or school	18%	25%
Business travel as a part of job	13%	25%
Visiting friends or relatives	10%	28%
Other purposes	3%	3%

Source: The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

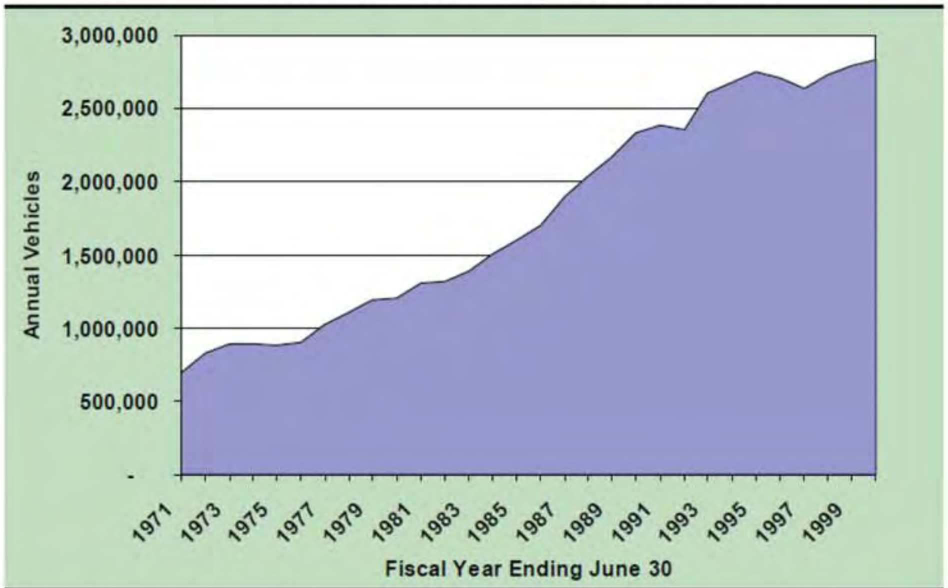
Although residents and businesses on both the Washington and Oregon sides of the bridge are dependent on the bridge for crossing the River, residents on the Washington side use the bridge more frequently than residents of Oregon. The survey of motorists using the bridge showed that more than half of motorists originated from Washington and the most common destinations were: Hood River (32%), White Salmon (21%), Bingen (8%), other Washington destinations (26%), and other Oregon destinations (13%).[5] These results are consistent with a 1990 Origin-Destination Survey that was conducted for the Washington State Legislative Transportation Committee, which showed that the majority of trips on the bridge originated from Washington.[6]

Exhibit 7 shows change in annual traffic volumes from 1971 to 2000. Traffic volumes grew most consistently and fastest during the 1970's and 1980's. Since 2000, annual bridge crossings increased from 2.9 million in fiscal year 2000-2001 to 3.5 million crossings in fiscal year 2009-2010, an increase of 25% or more than 725,000 crossings over the nine year period. Growth in bridge crossings in the 2000s slowed compared to the 1970s and 1980s, from an average annual growth rate of nearly 6% in the 1970's and 1980's to an average annual growth rate of nearly 3% since 2000.

[5] The Gilmore Research Group, *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

[6] Parsons Brinckerhoff, *SR-35 Columbia River Crossing Feasibility Study Tier I Report*, July 16, 2001.

Exhibit 7. Annual traffic volumes, Hood River bridge, 1971 to 2000



Source: Port of Hood River from the *Baseline Conditions Report*, Parsons Brinckerhoff, January 8, 2001

Exhibit 8 shows average daily traffic (ADT) in both directions across the bridge in fiscal years 2000-2001 and 2009-2010. ADT has increased from about 8,000 to about 10,000 over the nine-year period, a 25% increase in trips. ADT increased each year, with the possible exception of 2004-2005, when the bridge was closed during the night for maintenance.

Exhibit 8. Average Daily Traffic, Hood River Bridge, Fiscal Years 2000-2001 and 2009-2010

			Change 00-01 to 09-10	
	2000-01	2009-10	ADT	Percent
July	9,969	11,932	1,963	20%
August	9,792	11,744	1,952	20%
September	8,877	10,890	2,013	23%
October	7,814	10,085	2,271	29%
November	7,143	9,126	1,983	28%
December	6,449	8,507	2,057	32%
January	6,463	8,327	1,864	29%
February	6,843	9,151	2,309	34%
March	7,413	9,508	2,095	28%
April	8,123	9,888	1,766	22%
May	8,439	10,225	1,787	21%
June	9,024	10,896	1,872	21%
Fiscal Year Average	8,036	10,029	1,993	25%

Source: Port of Hood River

Exhibit 8 shows that traffic on the Hood River Bridge is seasonal, with the largest amount of traffic during May through October, with a peak in June through August. Trips were lower during November through April, with the fewest trips in December and January. The traffic peak corresponds with activity in the fruit growing industry and with summer tourism.

Exhibit 9 shows ADT by vehicle type between July 2009 and June 2010. The annual ADT for all vehicles was 10,028 crossings, nearly all of which (9,819) were two-axle vehicles. An average of 2% (164) of daily trips were made by vehicles with three or more axles (i.e., mainly trucks). Crossings by three-axle vehicles peaked in the summer and early fall, with an average of about 200 daily crossings. For comparison, truck travel on interstate highways is typically in the range of 10-20% of total vehicle traffic, while truck travel on urban arterials tends to be on the order of 2%. In other words, the bridge exhibits truck volumes more like that of an urban arterial than an interstate highway.

Exhibit 9. Average daily trips by month by vehicle type, Hood River bridge, July 2009 to June 2010

	2 Axle Vehicles	3+ Axle Vehicles	Motorcycle	Total
July	11,614	204	114	11,932
August	11,397	244	103	11,744
September	10,529	280	81	10,890
October	9,862	199	24	10,085
November	8,980	136	10	9,126
December	8,391	111	5	8,507
January	8,213	107	7	8,327
February	9,018	117	17	9,152
March	9,338	147	22	9,507
April	9,727	131	31	9,889
May	10,049	131	44	10,224
June	10,654	162	80	10,896
Annual Average	**9,819**	**164**	**45**	**10,028**

Source: Port of Hood River

Participants in the small-group discussions said that the economies on the Washington and Oregon sides of the River had become more intertwined over time, especially during the last decade. The increase in bridge crossings over time supports this idea. The following sections describe the importance of the bridge, in support of both local economic activity and livability of the region.

3.2.1 Commuting

One of the uses of the bridge is commuting to work. According to the Census, in 2008 about 430 workers commuted from Klickitat County to Hood River County and 252 workers commuted from Skamania County to Hood River County. The majority of whom live in western Klickitat County and eastern Skamania County. About 140 workers commuted from Hood River County to Klickitat County.[7] This suggests that about 10-15% of the 10,000 ADT are commuting traffic, which is confirmed by the respondents to the 2001 bridge user surveys, which indicated that between 16% to 18% of trips across the bridge were for commuting to work or school. By comparison, 20% of trips are commute trips in a typical urban area. Given that workers have to cross the bridge to commute and that a large percentage of daily trips are for personal business or recreation, the bridge exhibits commute characteristics similar in nature to an urban arterial.

Participants in the small-group discussions agreed that commuting across the Hood River bridge is relatively easy and allows residents of the region to choose on which side of the River to reside. The majority of the jobs have historically been (and still are) located on the Oregon side of the River. Businesses located in Oregon depend on employees who live in Washington and, to a lesser degree, businesses in Washington depend on Oregon for employees. Several Oregon-based business people indicated that about 20% to 30% of their employees commute from Washington.

A negative effect of the cross-river commuting is congestion on the bridge during peak commuting hours: in the morning from 7 AM to 9 AM, at noon, and from 4 PM to 6 PM in the evening.

3.2.2 Retail and services

The economies of the three communities within the region are inter-dependent. Participants in the small-group discussions and the 2001 surveys indicated that some people drive across the bridge during the day to engage in shopping, children's activities, and recreation. Businesses located in Oregon are dependent on customers from Washington. Additionally, businesses in Washington are also dependent on Oregon customers, to a lesser degree. Several Oregon-based business people indicated that about 20% to 40% of their customers were from Washington.

Exhibit 10 shows retail sales in Klickitat and Hood River Counties in 1997 and 2007. The incorporated cities had $150.9 million in retail sales in 1997 and $257.9 million in retail sales in 2007, an increase of about $107 million. More than 90% of retail sales were in the City of Hood River, which had about $237 million in retail sales in 2007.

[7] U.S. Census Bureau Local Employment Dynamics OnTheMap, http://lehd.did.census.gov/led/datatools/onthemap4.html

Exhibit 10. Retail sales, Klickitat County, White Salmon, Bingen, Hood River County, and Hood River, 1997 to 2007

	1997		2007	
	Retail Sales	Per Capita Retail Sales	Retail Sales	Per Capita Retail Sales
Klickitat County	$ 47,399,000	$ 2,545	$ 65,712,000	$ 3,302
White Salmon*	$ 9,942,000	$ 15,064	$ 12,234,711	$ 17,992
Bingen*	$ 5,405,000	$ 2,656	$ 8,695,235	$ 3,961
Hood River County	$ 170,254,000	$ 8,735	$ 293,665,000	$ 13,678
Hood River City	$ 135,547,000	$ 26,762	$ 236,965,000	$ 35,315
Incorporated Cities	**$ 150,894,000**		**$ 257,894,945**	

Source: Source: U.S. Census Bureau 1997 and 2007 Economic Census and Washington State Department of Revenue
*Note: for White Salmon and Bingen, the 1997 Estimate was based on County Sales Tax Distribution and 2007 estimate based on each city's portion of taxable retail sales in the county

Exhibit 11 shows household buying power in Klickitat and Hood River Counties: an estimate of the potential for household expenditures such as retail expenditures. The number of households was in relatively similar in each county, with about 400 households more in Klickitat than Hood River County. The median household income is about $10,000 greater in Hood River County, giving households in Hood River County greater buying power than in Klickitat County.

Exhibit 11. Household buying power, Klickitat County and Hood River County, 2008

	Number of Households	Median Household Income	Buying Power
Klikitat County	8,215	$ 40,015	$ 328,723,225
Hood River County	7,777	$ 50,301	$ 391,190,877

Source: Source: U.S. Census Bureau American Community Survey, Data set 2006-2008 3-Year Estimates
Note: Buying power was calculated by multiplying the number of households with median household income.

The total buying power of households in Klickitat County ($328.7 million) is about 84% of the total buying power of households in Hood River County ($391.2 million). Thus, if the economies on both sides of the river are similar, one would expect that retail sales would be similar in both counties. Exhibit 10, however, shows that per capita retail sales in Klickitat County were 24% of per capita sales in Hood River County, which supports the point that retail sales are concentrated in Hood River County.

This pattern of retail sales and household buying power is consistent with the fact that Hood River County has a larger share of employment in retail and related sectors (25%) than Klickitat County (12%). The pattern of retail sales within the region shows that the bridge provides an important retail connection within the region. This conclusion is supported by: (1) the 2001 surveys that showed shopping and personal business as the most common reasons for bridge crossings and (2) a key finding in the small-group discussions was that the three communities function as a region, for both local and visiting consumers.

An important segment of consumers not directly represented in the small-group discussions is visitors to the broader region. Direct travel spending[8] in 2008 in Klickitat County was $31.8 million and $64.8 million in Hood River County. Between 2001 and 2008, direct travel spending grew faster in Klickitat County, increasing by $8.5 million (36%), compared with a $5.3 million (9%) increase in Hood River County over the same period.[9] Not all of this spending occurs in the Hood River/White Salmon/Bingen region, but it is reasonable to assume that a large share of travel spending in the broader region currently occurs in Hood River or White Salmon/Bingen. The bridge is an important link to allow tourists to visit attractions on both sides of the river.

3.2.3 Manufacturing and freight

The majority of freight in the region passes through on I-84, without crossing the Hood River Bridge. Exhibit 9 shows the average monthly number of vehicles with three or more axles to cross the bridge was 164 over the July 2009 to June 2010 period. Most freight that crosses the bridge is from local lumber and wood product manufacturers, fruit growers and processors, and businesses with suppliers on one side and the business on the other. In 2007, the value of manufactured goods in Hood River County was $245.7 million.[10] The market value of agricultural products in 2007 from Hood River County was $100.4 million, $95.9 million of which was from fruits, tree nuts, and berries, which includes cherries, apples, and pears. The market value of agricultural products in 2007 from Klickitat County was $57.3 million, $29.5 million of which was from fruits, tree nuts, and berries and $13.4 million was from livestock and poultry.[11]

The small-group discussions and follow-up discussions with individual businesses found:

- **Wood product** businesses frequently use the bridge for moving freight (e.g. lumber, wood chips, or sawdust) across the River. For example, Allen Brown Wood hauls multiple loads of wood chips and sawdust across the bridge daily. Being able to move freight across the Hood River bridge, rather than making a detour to a more distant bridge, is key to the success of this business.
- **Fruit growers and processors** are major users of the bridge. Their use of the bridge occurs mainly during the summer and early autumn: June to July for cherries and August through October for apples and pears. Fruit growers process fruit either in White Salmon (Washington) at Underwood Fruit and

[8] Direct travel spending includes spending on accommodations, transportation, food, retail sales, and entertainment and recreation.

[9] Dean Runyan Associates, *Washington Travel Impacts 1991-2008* and *Oregon Travel Impacts 1991-2009*

[10] U.S. Census Bureau 2007 Economic Census. No about the value of manufactured goods in Klickitat because of data confidentiality requirements.

[11] USDA National Agricultural Statistics Service, 2007 Census of Agriculture

Warehouse Company or in Odell (Oregon) at either Diamond Fruit Growers or Duckwall-Pooley Fruit Company. Processing fruit may require crossing the bridge for processing and crossing the bridge for shipping fruit out of the region. Moving fruit across the bridge is time sensitive because the unprocessed fruit, especially cherries, will spoil with prolonged exposure to the sun.

- **Other manufacture and freight businesses** depend on the bridge to connect their operations on either side of the River or to move goods across the River. Examples of large industries located in the region, are Insitu Inc. (manufacture of aircraft systems), Hood River Sand and Gravel, and Cardinal Glass.

3.2.4 Emergency services

The Hood River Bridge provides an important connection between Washington and Oregon in the event of an emergency, such as a natural disaster (e.g., flood or wild fire), weather emergency (e.g., the closure of I-84 as a result of winter storms or a landslide), or for emergency management. The bridge also provides local emergency service providers the opportunity to combine resources and support each other. Currently, inter-local agreements exist between fire services in the region, allowing for mutual aide response on 911 emergencies and the ability to combine department resources (e.g. fire personnel, funding, and fire equipment).Without the bridge, emergency services would have difficulty coordinating and crossing the River in a timely fashion. In addition, SR 14 has recurring rock slides, which could close SR 14, making I-84 an important transportation route.

The bridge provides quicker access to hospitals from the Washington side. According to small-group discussion participants, transportation from the Washington side to Portland hospitals saves 5 to 15 minutes using the existing bridge, which may be significant for critical patients, rather than traveling to Portland via SR 14 and crossing the river at the Bridge of the Gods or on I-205.

3.2.5 Education

The White Salmon Valley School District and Hood River County School District use the bridge to take students across the River for field trips and extracurricular activities. On the Washington side, school buses traveling east-west through the Gorge cross the bridge to travel on I-84 or Highway 30. The school district risk managers advise against allowing buses to travel on SR-14 in Washington because of the narrowness and height of the tunnels, which requires large vehicles to travel in the middle of the tunnel by using both traffic lanes, and the potential for rock slides along SR-14 during the rainy season.

3.2.6 Winter travel

Interstate 84 can be closed several times per year because of inclement weather, and SR-14, which is on the south-facing side of the River, is more likely to be open. The bridge allows people on the Oregon side to cross to Washington and travel to Portland during winter storms. Without the bridge, travelers would need to cross the river at The Dalles and drive back to White Salmon, adding 40 miles of travel. Being able to travel during winter storms is important for people who need to get to essential services in Portland, such as a hospital or the airport.

3.3 What role does the bridge play in the regional economy?

This section seeks to answer the question: What role does the bridge play in the economy of the White Salmon/Bingen/Hood River region? It considers the anecdotal information provided from the small group discussions and the data presented in the preceding section.

The fundamental role of the bridge is clear: it connects the communities of White Salmon/Bingen with Hood River, allowing the communities to share a common workforce, retail, commercial services, and public services. Moreover, it is not one of several transportation links making that connection: it is the *only* link making that connection. The way to understand the importance of the bridge to the region's present and future economy is (as we noted in Section 2) to imagine how that economy would function without it. The answer is that there would be substantial inefficiency and dislocation in the short run. Infrastructure and development have oriented around the existence of the connection: remove it, and many economic activities are, quite literally, located in the wrong place. In the longer run, adaptations would be made, but the economy would always function at a lower level than it would if the bridge existed. Consider some of the evidence in support of this conclusion that we provided in earlier sections:

- **Use of the bridge.** The amount of traffic crossing the bridge has increased steadily since the early 1970s. Between 2000 and 2009, average annual bridge crossings increased by more than 25%. Peak usage of the bridge occurs in May through October, corresponding with activity in the fruit growing industry and with summer tourism. The increased usage of the bridge supports the conclusion of the small group participants that the communities on either side of the bridge have become more economically interdependent over time.
- **Commuting.** Businesses are dependent on access to workers on both sides of the bridge. On average, about 10% to 15% of daily trips on the bridge are made by people commuting to work. The majority of regional employment is located in Oregon, making Oregon businesses potentially more dependent on access to workers in Washington. About 9% of workers living in Klickitat County commuted to work in Wasco or Hood River Counties in

Oregon. About 6% of workers living in Hood River County commuted to work in Klickitat or Skamania Counties. Not all of these workers commute via the Hood River Bridge because some workers commute to The Dalles (OR) or Stevenson (WA) by way of the Bridge of the Gods or The Dalles Bridge. Several Oregon-based business people indicated that about 20% to 30% of their employees commute from Washington.

- **Retail and services.** The economy of Hood River County is larger than Klickitat County, despite the fact that the counties have a similar number of residents. The total buying power of households in Klickitat County is about 84% of that of households in Hood River County. If the economies on both sides of the river were similar, one would expect that retail sales would be similar in both counties. But per capita retail sales in Klickitat County are 24% of per capita sales in Hood River County: retail sales are concentrated in Hood River County.

  These statistics and others support a point that is obvious from simple observation: that the City of Hood River is the economic center of the broader region; residents on the Washington side of the river cross the bridge to shop and conduct business in Hood River. Many businesses in Hood River are dependent on residents of Washington for customers; some would grow slower, reduce in size, or go out of business in the absence of the bridge. Several Oregon-based business people indicated that about 20% to 40% of their customers were from Washington.

- **Manufacturing and freight.** The majority of freight goods that cross the bridge are wood products and fruit: for processing, use within the region, or for export outside of the region. The raw lumber and agricultural products are processed on both sides of the bridge. For example, fruit processors are located in White Salmon (Washington) at Underwood Fruit and Warehouse Company or in Odell (Oregon) at either Diamond Fruit Growers or Duckwall-Pooley Fruit Company. Information about the value of manufacturing and agricultural products that cross the bridge for shipping and/or processing is not available. Assuming that 10% to 20% of manufactured products and fruit grown in the region crosses the bridge, the value of freight crossing the bridge is between about $35 million to $75 annually.[12] The bridge allows for relatively easy freight movement across the river, allowing manufacturers and producers some choice in where to have materials processed.

- **Tourists.** Visitors to the region use the bridge to access attractions or recreational opportunities on both sides of the river, as well as the retail and accommodations services available primarily in Hood River. The bridge plays an important role in allowing visitors to easily cross the river, rather

[12] This assumption is based on the following information: (1) in 2007 the value of manufactured goods in Hood River County was $245.7 million and (2) in 2007 the value of fruits, tree nuts, and berries grown in Hood River County was $95.9 million and $29.5 million in Klickitat County.

than traveling 20 miles to the nearest river crossing. The attractiveness of the region as an outdoor recreation destination decreases if the bridge is not available, and evidence from the Focus Group process indicates that the lack of bicycle and pedestrian facilities on the Hood River Bridge may be constraining recreational-based economic growth as well. The attractiveness of the area is so strong, however, that the lack of a bridge or the inability to cross on bike or as a pedestrian does not cause a collapse of the region's tourism industry but does constrain its growth.

It is hard to answer the question about the importance of the bridge without talking about an unlikely situation in which the bridge is no longer available. The likely broad effects in that hypothetical situation are: (1) the short-run effects are worse than the long-run ones; (2) over the long-run, the economy still grows, but only after a period of readjustment (one to five years), and it may grow at a slightly lower rate; and (3) that change in growth rate would not be uniformly experienced: there will be some big losers (households in Washington; certain retail businesses in Oregon), but also some gainers (certain retail businesses in Washington).

Thinking about the impacts of the loss of the bridge is useful for making the case that it is worth doing some planning and, ultimately, investment to make sure that the access and mobility that the bridge now provides is never lost or even significantly reduced. But, realistically, no one is talking about closing the bridge. Its importance to the economy is generally recognized and, even if that were to be discounted, the politics of closing a functioning bridge would be horrendous. So the bridge is very likely to continue to function into the indefinite future and to continue supplying a transportation linkage that is very important to the economy. The key question then becomes: is it worth improving the functionality of the existing bridge (its capacity, its safety, the speed of crossing, its availability to bicyclist and pedestrians) by building a new one? Sections 3.4 and 3.5 begin to address that question.

3.4 HOW DO CURRENT CONDITIONS AFFECT THE USE OF THE BRIDGE?

This section seeks to answer the question: Do the current bridge conditions affect decisions about how and when to travel? It considers the following types of bridge conditions: bridge width, weight limitations on the bridge, and congestion during peak commuting times.

3.4.1 Safety issues

The main safety issue on the bridge is the narrowness of the bridge, which leads to minor crashes. The most common type of minor crash is side-view mirrors being damaged while crossing the bridge, either by making contact with the bridge or vehicles traveling in the opposite direction. In addition, some vehicles may get too close to the outer edge of the bridge and have their tires ride-up on the guard rail, risking a potential for overturning the vehicle. As a result, many bridge users, including businesses, residents, and tourists, perceive the bridge as unsafe. Participants in the small-group discussions said:

- The narrowness of the bridge frightens people crossing the bridge, both local resident and visitors alike. Some local residents refuse to cross the bridge or will only cross the bridge with someone else driving.
- Some bridge users consolidate their trips across the bridge because of concerns about safety crossing the bridge or the cost of the toll. For example, the Wal-Mart on the Oregon side is a large draw, but due to safety concerns with the bridge and the cost of crossing (tolls and gas), many consumers consolidate their trips across the River. A focus group participant estimated that as many as 2 in 10 customers consolidate trips across the bridge because they do not feel safe crossing the bridge.
- Some RV drivers ask for advice to find an alternative way to cross from the Washington to Oregon side of the River.
- Children on school buses are required to keep windows up out of fear that metal and glass from a clipped mirror will harm them.
- Traffic congestion on both sides of the bridge, at the interchanges of SR 14 and I-84, creates safety issues. Traffic queuing on I-84 is especially hazardous.

Other bridge safety issues include:

- Motorcyclists have a hard time riding on the grating of the bridge.
- The bridge's narrow span, strong cross winds in the Gorge, and the lineup for the span when approaching from the downstream side makes the Hood River bridge one of the most challenging bridge on the Columbia River system for barge operators. Barges from the most frequent barge operator, Tidewater Barge Lines, have struck the bridge twice in the last decade, resulting in no physical damage to the bridge and small damage to the barges. The cost of the incidents was low (less than $100,000) but there is potential for a serious incident that could involve loss of life, negative environmental impacts (depending on what goods the barge is carrying), and could significantly damage the bridge.[13]

Despite these safety concerns, crossing via the Hood River bridge is obviously a better alternative to its users than crossing at the Bridge of the Gods or The Dalles Bridge. Aside from the fact that both of these bridges require a 40-mile round trip detour, conditions on SR-14 (e.g., the narrow tunnel or danger of rock slides) make crossing the Hood River bridge a better alternative than crossing elsewhere. This is especially true for school buses and heavy or tall trucks.

[13] Based on a discussion with Brian Fletcher Port Capitan for Tidewater Barge Lines.

3.4.2 Freight limitations

The weight limit for vehicles crossing the bridge is 80,000 pounds, which is the same weight limit on the Bridge of the Gods. This weight limit impedes efficient freight movement. Participants in the small-group discussions said:

- Some freight haulers would make fewer trips across the bridge if the weight limitation were higher. The weight limit forces some wood products businesses to make more cross-bridge trips than they would with a higher weight limit.
- Fruit growers and processors are major users of the bridge and the limitation for them is the width of the bridge. The movement of fruit (especially cherries) is time sensitive because fruit cannot stay in the sun for long periods; delays caused by the bridge hurt these users.
- Very heavy equipment and construction trucks (for road construction and logging) are overweight for the bridge. The Port allows this type of heavy equipment to cross under very controlled situations, rather than requiring them to detour to a different bridge crossing.

3.4.3 Commuting constraints

Commuting creates traffic congestion during peak periods at the intersections at either end of the bridge. The capacity problem is with the intersections and not the bridge itself. The construction work being performed on the I-84 interchange exacerbates this issue in the short-term but should help address the issue in the long-term.

A 1990 study of bridge use showed that the peak hour of travel on the bridge is 4:00 PM to 5:00 PM.[14] Participants in the small-group discussions said that there is a morning commute peak, from 7:00 AM to 9:00 AM. Traffic is fairly steady throughout the day until the evening commute peak, which ends around 6:00 PM, after which traffic decreases for the rest of the day.

3.5 What are the potential new benefits of a replacement bridge?

This is the fundamental question that this report is to address. Consistent with the discussion in Section 2, we describe the new benefits of a replacement bridge. The existing bridge already delivers substantial benefits. Standard practice for the evaluation of public policy and investment decisions (actually, for the evaluation of any choices—public sector, private sector, or personal—that are complicated and important enough to merit critical thinking) is to compare what is likely to happen

[14] "SR-35 Columbia River Crossing Draft Environmental Impact Statement and Section 4(f) Evaluation," December 2003.

without new action to what is likely to happen with new action. In this case, without new action the existing bridge is likely to be maintained and (for all its inadequacies) to continue to allow traffic to move between Washington and Oregon. The current bridge has an estimated remaining useful life of 25 years.[15]

A replacement bridge would make the travel safer, faster, more reliable, and available to alternative modes. Those improvements would, in turn, have effects on the economy and development, the environment, and other things people in the region care about. It is the additional direct and indirect benefits of a replacement bridge that this study and this section are addressing.

This section divides benefits of a replacement bridge into (1) transportation benefits for automotive and alternative modes of travel, and (2) non-transportation benefits for economic development, the environment, land use, and other benefits.

3.5.1 Transportation benefits

Section 2 discusses transportation benefits, which are things that people want a transportation system to give them, such as improvements in mobility or in safety. Exhibit 2 (in Section 2) summarizes the typical transportation benefits of transportation investments. This section discusses how these transportation benefits are likely to increase with a replacement bridge relative to the existing bridge.

3.5.1.1 Automobile travel and shipping

The automotive benefits of a replacement bridge are described the following section, based on the framework described in Section 2.

- **Access.** The existing bridge provides a connection between Hood River and White Salmon/Bingen. While a replacement bridge would not provide additional access (as opposed to speed), a replacement bridge will provide access over a longer period of time. The replacement bridge would have a design lifetime in excess of 75 years and would be designed to better withstand earthquakes.

  In addition, a replacement bridge would provide access to oversized weight trucks, which are either not allowed to cross the existing Hood River bridge or do so on a very controlled basis. Allowing large trucks to cross the bridge has an economic benefit to the region. Haulers of wood products said they would like to be able to cross with larger trucks, which would result in fewer crossings to move the same amount of freight. As an order-of-magnitude estimate of value, going from a limit of 80,000 pounds per truck to 105,500 pounds trucks and subtracting out the unloaded weight means that larger trucks could carry the same total freight weight in 2/3 the number of trips. If, for example, 30 truck-trips a day might take advantage of this

[15] "SR-35 Columbia River Crossing Draft Environmental Impact Statement and Section 4(f) Evaluation," December 2003.

lowered restriction, then there would 20 loads instead of 30; if each trip were 50 miles, the savings is around $500 per day and $125,000 in a 250-day work year.[16]

The majority of access benefits for the replacement bridge are preventative: in other words, a replacement bridge reduces the probability of losing or decreasing the access provided by the existing bridge. The rest of this section discusses what those negative effects on access might be. A proper consideration of those effects must, however, consider the probability that the existing bridge would be unavailable permanently because of a catastrophe, or temporarily because of the need for increasing maintenance as it ages. We do not have any information about those probabilities, but believe that:

- Catastrophic failures of major infrastructure do occur, but they are rare given all the infrastructure in the U.S. (tens of thousands of bridges, highway miles, dams and levees, electric towers and lines, sewer treatment plants, and so on). We do not have any engineering evidence from structural inspections on the Hood River bridge that would allow the quantification of risk which in turn would allow for a value-of-risk calculation. Our point is that though the effects of a failure are large, the chances of such failure occurring are very small, and the effects must be discounted appropriately.

- Increases in temporary closures are likely when equipment and facilities approach the end of their design life. Such closures can be scheduled to reduce negative impacts (e.g., at night, on and off peak days and seasons), but they do have some effect (the existing bridge had lower travel when it closed at nights for major maintenance in 2004).

The existing bridge has an estimated remaining useful life of 25 years. As the end of the useful life of the existing bridge approaches, safety concerns may lead to additional restrictions on bridge use, such as limiting or prohibiting use by trucks, buses or emergency vehicles. If a replacement bridge is not built by the end of the useful life of the existing bridge or if the bridge is damaged or destroyed by a natural or human-caused event, Hood River and White Salmon/Bingen will be much less accessible to each other. Without a bridge, the trip between White Salmon/Bingen and Hood River would require an additional 40 miles of travel, to either The Dalles or Cascade Locks.

The small-group discussions and 2001 survey results make it clear that a scenario without the bridge or with significant restrictions on bridge usage would have significant negative effects on the regional economy. Residents living on the Washington side of the bridge are dependent on businesses on

[16] As no truck data were available for this study, we assumed average truck trip length of 50 miles; savings would vary in proportion to the different truck trip lengths.

the Oregon side of the bridge for employment, and for goods and services. Businesses on the Oregon side of the bridge are dependent on the Washington side of the bridge as a source of employees and customers.

Businesses dependent on the bridge crossing might choose to relocate or may close if there were an extended bridge closure, especially freight-dependent businesses. For example, the wood products' industry is highly dependent on the ability to cross the bridge, with milling operations on both sides of the bridge and production that uses materials from both sides of the bridge. During extended maintenance on the bridge in 2004, which closed the bridge during the night, some businesses in Hood River were negatively impacted by the closure, with decreases in customers, and at least one business closed as a result.

The effects of bridge closure or significant restrictions on bridge usage would be felt throughout the Columbia River Gorge region by restricting transportation and increasing usage of the adjacent two bridges within the Gorge. Tourism and other businesses in the Gorge depend on the River crossings for the functioning of the regional economy.

Another consideration is access for emergency vehicles such as ambulances. In the absence of the Hood River Bridge, ambulances on the Washington side of the River would have to cross the River at the Bridge of the Gods, which can add 5 to 15 minutes on trips to Portland.

- **Speed (mobility).** Recent traffic modeling shows that the replacement bridge would save the average user 30 seconds for each cross-river trip in peak hour traffic. In 2030, with an average of about 16,700 daily crossings,[17] the replacement bridge would save about 51,000 hours of travel time per year or a time cost of nearly $350,000[18] (in 2010 dollars). Under the same assumptions, in 2040 there would be 18,000 daily crossings, with a savings of nearly 55,000 hours of travel time per year or a time cost of nearly $370,000 (in 2010 dollars).
- **Travel-time reliability.** The main sources of problems for travel-time reliability are: (1) recurrent congestion at the intersections at the ends of the bridge, (2) congestion at the toll booths, (3) delay from raising the drawbridge, (4) bridge closures to allow very wide or over-weight vehicles to cross, and (5) occasional traffic incidents. The on-going construction at the intersection with I-84 should address the first congestion problem. Congestion at the toll booths can be reduced independent of bridge

[17] The estimate of 16,700 ADT in 2030 was extrapolated is based on Parsons Brinckerhoff's forecast of 16,000 ADT by 2025 and 18,000 ADT by 2040.

[18] The time cost estimate uses the following assumptions: (1) 2009 average wage of about $13.50 in Hood River County, (2) the standard assumption in transportation economics that, on average, drivers value delay time at about half their wage rate (sometimes higher ratios are used) for both work and non-work trips, and (3) business and truck travel value travel time at twice the rate of passenger vehicles. A more detailed analysis would disaggregate the estimate by type of trip (especially freight trips, which have much higher time values), driver income, and number of passengers.

replacement, through tolling in one direction (with the toll doubled in one direction and free in the other.)

Replacing the existing bridge would reduce all these impediments to reliability (though congestion at bridge toll booths and intersections could be reduced without having to replace the entire bridge, and projects to reduce intersection delay are underway already at the Oregon bridgehead and I-84). According to the Port of Hood River, the draw bridge is lifted between 12 to 15 times per year and the bridge is closed to allow large vehicles to pass about 10 to 12 times per year. When possible, the Port tries to time bridge closures at low-use times of day. If bridge closures last 30 to 45 minutes each, then this causes the bridge to be closed for 10 to 20 hours per year.

- **Safety.** There are no formal data about crashes on the Hood River bridge. Anecdotal evidence suggests that minor incidents, mostly involving damage to side-view mirrors and the sides of the car, are very common. To get a sense of the problem, we assume that there are about 200 minor incidents per year and that 80% of them would be avoided with a replacement bridge, and that it costs $250 to $500 to fix the damages (inclusive of damages to the vehicle and the time cost to owners of getting repairs made), the annual savings from decreasing these minor incidents by replacing the bridge would be between $40,000 and $80,000 (in 2010 dollars).

  Although drivers would have savings from a reduction in minor incidents on the bridge, the net benefit to the region would be less because some of the cost of fixing broken mirrors goes to local businesses. A replacement bridge would decrease revenues for businesses such as auto body shops.

  Beyond the costs of broken mirrors and scrapes, a replacement bridge, with wider lanes and a shoulder, may have fewer major incidents that result in time loss, automotive damage, and injuries.[19] Assuming a major incident occurred at peak travel time, the cost of the incident might be between $20,000 and $50,000 in lost time, property damages, and injuries. If a replacement bridge were to eliminate six major incidents per year, the benefit would be on the order of $100,000 to $300,000 per year (in 2010 dollars).

- **Comfort.** A replacement to the existing bridge would be more comfortable to cross. Small-discussion participants said that crossing the existing bridge frightens a lot of residents and visitors, primarily because of the narrowness of the bridge and the bridge surface (which is a grid). A replacement bridge would be wider, have a shoulder, and have a solid deck surface.

  Anecdotal information suggests that some potential bridge users avoid using the bridge and some bridge users consolidate trips across the bridge. The design of the replacement bridge should make people feel safer and more

[19] We are not aware of any crash-related fatalities on the bridge in many years.

comfortable crossing the bridge. On this basis alone, it seems reasonable to assume that a replacement bridge would have more trips per day. Without further analysis than we are doing in this report, however, we cannot tell whether an increased willingness to cross the bridge would be off-set by users' willingness and ability to pay an increased toll.

- **Operating cost.** If congestion is relieved and speeds and flow are improved, vehicles would be running less and running more efficiently. We suggested above that average travel speed might change from 25 mph to 35 mph, which would reduce fuel consumption for the average car by about 0.005 gallons per mile. At 16,700 ADT (in 2030) and $3/gallon, the fuel cost savings for the one-mile crossing is on the order of $90,000/year (in 2010 dollars).

- **Distribution of impacts (equity).** The current toll to cross the bridge is $0.75. Based on results from the 2001 survey, previous studies concluded that bridge users would accept a toll of $1.75 (in 2010 dollars) per crossing.[20] The estimated cost of the replacement bridge is $200 million (2010 dollars). The 2001 survey showed little support for using local taxes (e.g., property or sales tax) as a source of funding the cost of the replacement bridge.[21]

  Participants in the small-group discussions said that some residents and businesses in the area recognize that increasing the toll may be necessary. Increasing the toll from $0.75 to $2 each way may be supportable. ($2 was the hypothesized increase in the prior toll study based on optimizing toll revenues). If the toll were much higher some people may choose to shop in The Dalles rather than Hood River. A long-term consequence of a higher toll may be that people change trip behavior, especially for casual trips for shopping. Increases in tolls may have modest negative impacts on freight use and could even be positive if a replacement bridge has fewer weight, width, and safety limitations.

  Some participants were concerned that a replacement bridge might not be a benefit to the region if it would result in an unaffordable toll. There is clearly a tension here: (1) it is critical to the economy and well-being of the region to have a replacement for the existing bridge when that bridge ultimately is deemed unusable, but (2) funding that bridge will almost certainly mean paying higher tolls. Participants had the general desire that the bridge tolls be "affordable" to support the regional economy and allow easy interchange across the River, for businesses, private individuals, and transit crossing.

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[20] *SR-35 Columbia River Crossing Feasibility Study*, September 2004

[21] The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

3.5.1.2 Alternative modes

A replacement bridge would allow for alternative modes of crossing the bridge bicycle or on foot, which is a benefit of a replacement bridge. In addition, crossing a replacement bridge would be easier for transit vehicles, which might open possibilities for establishing regular transit service across the bridge.

Pedestrian and bicycle

The design and regulations of the bridge do not allow pedestrians and bicyclists to cross. Residents and businesses generally agree that the bridge's lack of pedestrian and bicycle facilities is a deficiency. The feedback from the small-group discussions provides some context for the importance of replacing the bridge with one that has pedestrian and bicycle access:

- Residents and employees within the region want to be able to commute across the bridge by bicycle. At a recent bicycle summit, people in the region supported providing a way for bicyclists and pedestrians to cross the bridge. Even if pedestrians and bicycles were allowed to use the bridge, the narrowness and bridge's gridded surface and narrowness would be a barrier to crossing the bridge because of safety concerns.
- Some bicyclists, visitors and residents alike, wait on the Washington side of the bridge until a driver stops to pick them up to cross the bridge and offer to pay the toll in exchange for the ride across the bridge.
- Even if the bridge is replaced, a replacement bridge is unlikely to be completed for at least 10 years. Local efforts are underway to address the lack of bicycle facilities on the bridge until the bridge is reconstructed or replaced. The Mid-Columbia Economic Development District (MCEDD) is working to develop a demonstration project that would offer shuttle service to cross the bridge for bicyclists.

While it is clear that residents want to have the option to cross the River as pedestrians or on bicycle, it is not clear how many people would actually do so. The demand for pedestrian and bicycle facilities can be estimated through use of the Bridge of the Gods in Cascade Locks, about 20 miles west of the Hood River bridge. While the Port of Cascade Locks does not keep detailed records of pedestrian or bicycle counts, the Port estimated that 2,100 pedestrians and 3,000 bicycles crossed the Bridge of the Gods in 2003, accounting for about 0.5% the annual crossings.

The 2001 survey of the Hood River bridge asked about potential bicycle and pedestrian usage. Bridge users were asked whether they would have made the current trip or recent trips by bicycle or foot if facilities were available and the toll were either reduced or free. Responses to the motor intercept survey suggest that between 14% to 27% of the trips made by automobile might be made by foot or on bike. Responses by bridge uses on the phone survey suggest that between 11% to

20% of the trips made by automobile might be made by foot or on bike.[22] Our experience with contingent valuations like this one (i.e., "what would you do if…?" rather than observation of actual behavior) is that people tend to overestimate the degree to which they would shift modes. A reasonable estimate for the SR 35 Columbia River Crossing might be a little higher than that experienced by the Bridge of the Gods (0.5% bike/pedestrian mode share per year) that 1% to 10% of total person crossings would be by foot or by bicycle.[23]

There are multiple benefits to allowing pedestrian and bicycle access across the bridge, including:

- **Reduced VMT and greenhouse gas emissions.** Allowing pedestrians and bicycles to cross the bridge would reduce vehicle miles traveled (VMT) and greenhouse gas emissions for the people crossing the bridge. Using the Bridge of the Gods as a model, about 5,000 people might choose to cross the bridge on foot or bicycle annually, rather than by car. The number of people crossing the bridge by bicycle would probably increase with growth in bicycle tourism.[24]
- **Alternative means of commuting.** Building a replacement bridge with bicycle facilities gives workers an alternative means of commuting. Providing multimodal transportation options could be important for people who cannot afford an automobile, giving them an opportunity to find work on either side of the bridge. In addition, some people prefer to commute by bicycle or by foot as a means of living a healthier lifestyle.

Transit

There are two transit agencies within the region: Klickitat County Mt. Adams Transportation in Washington and the Hood River County Transportation District in Oregon. Both transit agencies make on-demand trips across the bridge. Mt. Adams Transportation crosses the bridge more frequently than the Hood River County Transportation District, most frequently for passengers to conduct personal business in Hood River, such as medical appointments. The Hood River County Transportation District occasionally takes passengers across the bridge, most frequently to the hospital in White Salmon, Washington.

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[22] The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

[23] The foot traffic count might be higher if one counts all tourist trips that just go to mid-span and back for the view. Those might contribute modestly the region's ability to attract tourist business, but they do not relieve congestion on the bridge by replacing automobile trips.

[24] Standard calculations are about 20 pounds of CO_2 per gallon of fuel (gasoline or diesel) burned, and a value of CO_2 in the range of $5 to $50 per metric ton (today, but probably increasing in the future at a rate faster than inflation). Further assuming that each of the 5000 trips saved is an average of 5 miles long, and 20 miles per gallon of fuel, the value of the GHG reduction is on the order of a few hundred dollars per year. It may be more important as a policy objective, but its current benefits are small using standard economic estimation techniques.

There is no fixed transit route that crosses the bridge. The barriers to a fixed transit route are: (1) both agencies' service districts are limited to one state (either Oregon or Washington) because the agencies are separated by state bureaucracies and funding sources and (2) the agencies are reluctant to cross the bridge more frequently because the narrowness of the bridge occasionally results in damage to the transit buses, such as broken mirrors or vehicle body damage.

While a replacement bridge would not resolve the barrier to providing service between states, it would address the safety issues with bus crossings on the bridge because a new, wider bridge could better accommodate transit buses. The option of taking transit across the bridge would be most important for people who cannot afford an automobile, giving them an opportunity to find work on either side of the bridge. In addition, transit crossings on the bridge would reduce total VMT, all else being equal. The demand for transit crossing on the bridge could increase if the toll is increased substantially.

3.5.2 Non-transportation benefits

3.5.2.1 Economic development

The most tangible economic benefits of a replacement bridge are largely captured in the additional user benefits (particularly savings in travel time and reliability). But there are other likely or possible benefits that are harder to measure.

- **Commitment to a long-run, reliable connection.** The construction of a replacement bridge is a major infrastructure project that will have to occur in the next 10 to 50 years. Over time, business and development decisions will be affected (though probably in a small way) by that uncertainty. More specifically, but also impossible to measure and probably small, is the economic-development message large infrastructure projects send about economic development.

- **Regional landmark.** A replacement bridge could make modest contributions to the region's tourism, especially if it were done as a landmark infrastructure project that fits within the Gorge Management Plan design requirements. An observation deck mid-river would offer stunning views of Mt. Hood unavailable to most visitors to Hood River.[25] For example, some visitors walk across the Bridge of the Gods to enjoy a different view of the Columbia River and the Gorge.
- **Bicycle tourism.** The lack of bicycle facilities on the bridge is an economic constraint for bicycle tourism. Bicyclists visiting the area want to be able to safely cross the River and explore areas on both sides of the River. For example, the Centennial Celebration of the Columbia River Highway will

[25] Sydney, Australia, offers a three-hour bridge-walk tour that climbs through an interior stairway to the top of the bridge. It runs tours 24 hours a day. The price: over $2000 per person.

occur in 2016 and will attract bicyclists from across the nation to ride along the newly restored Columbia River Highway. If bicyclists are unable to cross to the Washington side, tourism opportunities will be missed both by visitors and businesses. In addition, some bicycle supporters hope that allowing bicycling across the bridge would decrease parking pressure in Hood River during the summer.

Furthermore, the Columbia River Gorge National Scenic Area is becoming a national and international bicycling destination. A bridge that accommodates bicycles and pedestrian traffic could support the transformation of the Columbia River Gorge Scenic Area into a world-class tourism destination.

- **River traffic.** A replacement bridge may reduce barriers to river traffic on the Columbia River. The design of the replacement bridge would include a widened navigation clearance that is wide enough and better aligned with the navigation channel to safely accommodate barges, reducing the potential for barge collisions with the bridge.

3.5.2.2 Land use

The policies that regulate growth within the Columbia River Gorge Scenic Area are intended to limit development to urban areas. The characteristics of the Gorge itself (e.g., the beauty of the area and the proximity to Portland) make it a desirable area to live in. Growth pressures in the Gorge region are likely to continue into the future.

The land use pattern in the region has developed for over 80 years with the bridge connecting the two sides of the River. The unspoken presumption has been that the access provided by the bridge will always be available. That access allows land use specialization. All three communities have some capacity to accommodate growth. The connection provided by the bridge has allowed the communities to develop specializations for accommodating specific types of growth. For example, the Washington side of the bridge has specialized in affordable housing and Hood River is the economic center of the region. The result of this development pattern is that people living in Washington commute to Oregon for work or for services, such as retail or medical services. A replacement bridge would continue to support the existing land use development pattern over the next 75 years or longer, allowing for residential growth in areas best able to provide affordable housing and employment growth around existing businesses.

Replacing the bridge also provides an opportunity for increasing natural hazard preparedness, by building a more seismically designed bridge.

3.5.2.3 Environment

The existing bridge deck is an open steel grate allowing all storm water runoff (and vehicle fluids) to drain directly into the Columbia River. A replacement bridge would contain storm water in catchment facilities that would channel all runoff to detention areas on either side of the River.

A few studies have quantified the economic cost of oil spills, but there is essentially no systematic research on the costs of the other impacts of water pollution, such as runoff from traffic.There are environmental benefits from preventing water pollution via runoff from the bridge but the monetary benefits are very small per vehicle mile traveled. Research suggests that the cost of runoff is about $0.0001 per mile.[26] With a replacement bridge that collects storm water, the benefit of eliminating storm water runoff would be about $600 per year in 2030, assuming 16,700 ADT.

The river is home to several federally-listed protected species. Replacing the existing bridge may affect these species in multiple ways, including through a decrease in water pollution from runoff with a replacement bridge. Estimating the economic benefits of potential impact of a replacement bridge on protected species is challenging (and beyond the scope of this project), especially in the context of the whole river system.

[26] External Costs of Transport in the U.S., by Mark Delucchi and Don McCubbin, Institute of Transportation Studies University of California, Davis, Forthcoming in Handbook of Transport Economics, ed. by A. de Palma, R. Lindsey, E. Quinet, and R. Vickerman, Edward Elgar Publishing Ltd. (2010).

Section 4 Synthesis

Section 3 provides a full discussion of the role of the current bridge in and benefits of a replacement bridge. This section summarizes the role of the bridge and the key benefits of a replacement bridge.

4.1 Roles of the existing bridge

The fundamental role of the bridge is to connect the communities of White Salmon/Bingen with Hood River, allowing the communities to share a common workforce, retail services, and public services. It is not one of several transportation links making that connection: it is the *only* link making that connection for 20 miles in either direction. More specifically, the bridge:

- The amount of traffic crossing the bridge has increased steadily since the early 1970s. Between 2000 and 2009, average annual bridge crossings increased by more than 25%. This usage trend supports the conclusion that the three communities have become more economically interdependent over time.
- Businesses are dependent on access to workers on both sides of the bridge. On average, about 10% to 15% of daily trips on the bridge are made by people commuting to work. The majority of regional employment is located in Oregon, making Oregon businesses potentially more dependent on access to workers in Washington. About 9% of workers living in Klickitat County commuted to work in Wasco or Hood River Counties in Oregon, while about 6% of workers living in Hood River County commuted to work in Klickitat County. Not all of these workers commute via the Hood River bridge: some commute to The Dalles (OR) or Stevens (WA). Several Oregon-based business people indicated that about 20% to 30% of their employees commute from Washington.
- Hood River is the economic center of the broader region. Residents of Washington depend on the bridge to be able to shop and conduct business in Hood River. Many businesses in Hood River depend on residents of Washington for customers. The majority of retail and services are located in Hood River County. If the economies of Klickitat and Hood River Counties were similar, one would expect retail sales to be similar in each county, certainly on a per capita basis, and even on an absolute basis since the two counties have similar numbers of people. But (1) per capita retail sales in Klickitat County are only about ¼ of those in Hood River County, and (2) the City of Hood River accounts for 90% of the approximately $260 million in retail sales that occur in White Salmon, Bingen and Hood River combined (2007).
- The majority of freight goods that cross the bridge are wood products and fruit: for processing, use within the region, or for export outside of the

region. The bridge allows for relatively easy freight movement across the river, allowing manufacturers and producers some choice in where to have materials processed. While direct counts are not available, interviews with businesses suggest that it is reasonable to assume that on the order of 10% to 20% of manufactured products and fruit grown in the region crosses the bridge, which would have a value of the value of freight crossing the bridge is between about $35 million to $75 million in 2007.

- Visitors to the region use the bridge to access attractions or recreational opportunities on both sides of the river, including the growing wine industry on both sides of the River, as well as the retail and accommodations services available primarily in Hood River. The bridge provides visitors with a direct connection between the main tourism centers, rather than traveling 20 miles to the next-nearest river crossing.
- The bridge also allows local emergency-service providers with the opportunity to combine resources and support each other. Currently, inter-local agreements exist between fire services in the region, allowing mutual aide on 911 emergencies and combining department resources (e.g. fire personnel, funding, and fire equipment). Additionally, the Hood River bridge provides the Washington-side emergency-service providers access to Interstate 84 in Oregon, allowing for a quicker emergency response time to Portland area hospitals.

In summary, the existing bridge allows workers, customers, freight, and visitors to cross relatively freely across the river. The economy in the region depends on this level of access to continue functioning as a region with public and private services and employers located on both sides of the bridge.

4.2 Benefits of a replacement bridge

The analysis assumes the current bridge will continue to function until a replacement bridge is built and, thus, tries to estimate the additional benefits a replacement bridge would provide:

- A replacement bridge would provide access between Hood River and White Salmon/Bingen beyond the existing bridge's estimated remaining useful life of 25 years. A replacement bridge would have a design lifetime in excess of 75 years.
- A replacement bridge would provide access to wide or over-weight trucks, which would allow for movement of more freight per truck, reducing the number of River crossings to move the same amount of freight.
- Increases in the maximum freight load allowed on the bridge, from a limit of 80,000 pounds per truck to 105,500 pounds, would have a savings of around $125,000 (in 2010 dollars) per year.
- Increases in the speed of bridge crossings, from 25 to 35 miles per hour, would reduce the time it takes to cross the bridge. Based on projected bridge crossings by 2030, the annual savings would be on the order of $350,000 (in 2010 dollars).
- If congestion is relieved and speeds and flow are improved, vehicles are running less and running more efficiently. Average travel speed might change from 25 mph to 35 mph, which would reduce fuel consumption for the average car, resulting in savings on the order of $90,000 per year (in 2010 dollars).
- Replacing the existing bridge would eliminate delays from raising the draw bridge or from closures to allow wide or over-sized vehicles to pass. These savings are relatively minor, generally averaging 10 to 20 hours per year.
- Safety improvements on a replacement bridge would result in fewer minor incidents (scrapes and broken mirrors): a savings on the order of $40,000 and $80,000 per year. Though we lack information about current or future major incident rates, the savings from fewer major incidents is on the order of $100,000 to $300,000 per year (in 2010 dollars).
- The bridge is the most challenging on the Columbia River system for barge operators. While there have been relatively few barge strikes on the bridge, with a cost of less than $100,000, there is potential for a serious barge incident that could involve loss of life, negative environmental impacts (depending on what goods the barge is carrying), and could significantly damage the bridge.
- Pedestrian and bicycle facility accommodations on a replacement bridge would result in a decrease in Vehicle Miles Traveled (VMT) and greenhouse gas emissions, and would provide an alternative means of

commuting, which is important for people who cannot afford an automobile.

- A replacement bridge could better accommodate transit buses and would open the possibility of establishing a fixed-route across the bridge. The option of crossing the bridge via transit would result in a decrease in VMT and provide an alternative means of commuting, which is important for people who cannot afford an automobile.
- The economic development benefits of a replacement bridge are: (1) a long-term, reliable connection between Hood River and White Salmon/Bingen, (2) contribution to tourism as an attraction, and (3) increasing bicycle tourism with development of the Columbia River Gorge Scenic Area as a world-class tourism destination for bicyclists.
- A replacement bridge would continue to support the existing land use development pattern, allowing for residential growth in areas best able to provide affordable housing and employment growth around existing businesses.
- The replacement bridge would contain storm water catchment facilities that would channel all runoff to detention areas on either side of the River, reducing or eliminating storm water runoff. There are environmental benefits from preventing water pollution via runoff from the bridge but the monetary benefits are very small per vehicle mile traveled.
- Replacing the bridge provides an opportunity for increasing natural hazard preparedness, by building a seismically safer bridge.

In summary, a replacement bridge would add to typical user benefits, but would provide non-traditional user benefits (especially for bicyclists) and benefits to non users as well. Non-user benefits could be in terms of economic development, tourism development, and environmental quality.

The benefits notwithstanding, a fundamental reason to be evaluating options for a replacement bridge is that the existing bridge, while functional, is old and fails to meet the design and multi-modal standards of a modern bridge.

Appendix A

Summary of Focus Group Discussions

A key part of this project is assessing the economic role the Hood River bridge plays within the Hood River, White Salmon, and Bingen region and within the larger Columbia River Gorge region. The economic analysis evaluates the dependence of the region on the existing bridge and the economic benefits to the region of a replacement bridge.

One part of the evaluation of the role of the bridge within the region is talking with local business and residents who use the bridge regularly. ECONorthwest conducted several focus group meetings to discuss with local agencies, residents and business the role of the bridge in the regional economy, with substantial assistance from Parsons Brinckerhoff (the prime contractor on the study), the Southwest Washington Regional Transportation Council (RTC), and staff from Washington State Department of Transportation (WSDOT), Oregon Department of Transportation (ODOT).

This appendix summarizes the methodology used to conduct the focus group meetings and the results from these focus group discussions

Methodology

The focus group meetings were held on June 3, 2010 in the Port of Hood River's conference room, with four focus groups meeting for 90 minutes each. The following section describes the methodology used to organize and facilitate the focus group meetings.

- **Select and invite participants.** The RTC developed a list of participants to invite to these four focus group meetings based on input from the Project Management Team (which includes staff from RTC, WSDOT, and ODOT) and the consulting staff. Participants represented a broad range of interests, such as commuters to businesses, freight operators, recreational traffic and those with environmental interests. The RTC first tried to invite people by telephone and then by mail. The RTC sent out letters confirming focus group attendance for invitees that said they would participate and made reminder phone calls the day before these focus group meetings to confirm attendance. A complete list of focus group attendees is found in at the end of this appendix.
- **Separate participants into groups.** The optimal size of a focus group is between 6 and 10 participants. The consultants and RTC worked together to separate participants into groups based on common interests among participants. The groups were: (1) public agencies and transportation providers; (2) business, retail, and commute interests; (3) private companies and freight-dependent businesses; and (4) recreational economy interests. Scheduling conflicts resulted in some mixing of the groups (e.g., people from the recreational economy group participating in the focus group with

business, retail, and commute interests) but did not create issues for the focus groups.

- **Agree on discussion topics.** ECONorthwest worked with the consulting team and the Project Management Team to develop broad topics to discuss during the focus groups. The topics were covered to varying degrees in each group, with some groups choosing to focus more or less on certain topics:
  - Use of the bridge by business customers, employees, shippers, and others and ways that use of the bridge differs by business type, such as manufacturers, retailers, offices, or tourism.
  - Whether the current bridge conditions (width, weight limits, congestion, tolls) affect decisions about how and when to travel.
  - Use of the bridge by bicyclists and pedestrians (who are currently prohibited), and transit.
  - Measuring benefits of the project beyond transportation, such as growth in businesses that may not use the bridge much, but that provide goods or services to businesses that do use the bridge.
- **Hold the focus groups.** The four focus groups met for 90 minutes each, beginning in the morning and ending in the early evening. Terry Moore facilitated the focus groups, ensuring that each participant had an opportunity to talk and that all the topics of discussion were covered to some degree in each group. The discussions were relatively conversational and free flowing. Terry recorded key ideas on notes that he arranged on the wall. while the consultant staff took formal meeting notes.

Focus Group Discussion Results

The consulting team conducted four focus group sessions to discuss the role of the bridge in the regional economy. Forty-eight people were invited to participate and 27 people attended and participated in the in the focus groups. Participants represented a broad range of interests, from commuters to business and freight operators to recreational and environmental interests.

The following section summarizes the discussions and key ideas from all four of the focus groups. The results are organized by the four broad topics of discussion described in the section above. Within those topics, the results are organized by themes that emerged from the discussions.

Use of the bridge by business and ways that use of the bridge differs by business

Interdependence of communities within the region

- The bridge allows the cities of Hood River, Bingen, and White Salmon to operate as one community rather than two (or three) separate communities. Residents and businesses throughout the larger community access shared public and private services on either side of the River. For example, the Veterans' Service Office in Hood River has clients from both sides of the River.
- The economies of the three communities within the region are closely inter-dependent on each other. Businesses located in Oregon are dependent on employees and customers from Washington. Businesses in Washington are also dependent on Oregon for employees and customers, although perhaps to a lesser degree. Several Oregon-based business people indicated that about 20% to 30% of their employees and roughly 20% to 40% of their customers were from Washington. The cities have grown more economically intertwined over the last 10 years.
- The affect of a prolonged closure of the bridge, such as a bridge failure caused by a natural disaster, would cause an economic catastrophe within the region because the economies are so intertwined. Past closures of the Hood River Bridge resulted in business closures on the Oregon side of the River. A prolonged closure of the bridge would have a large negative effect on Hood River, which is the regional economic center, but it would have a larger negative effect on White Salmon and Bingen, which might "dry up" if the bridge was closed for long. In addition, closure of the bridge would have a negative effect on the larger Columbia River Gorge region by restricting transportation and increasing usage of the other two bridges within the Gorge. A bridge failure will also

result in a disruption of utility service between both sides of the river: gas, phone, and cable utilities, supplied out of Hood River, cross the river on the bridge.

Commuting across the bridge

- Workers in both Oregon and Washington are dependent on the bridge for their daily commute. It is not uncommon for people to live and work on different sides of the bridge. The majority of the jobs have historically been located on the Oregon side of the River. Workers need the ability to easily get across the river via the bridge. The level of commuting results in difficulty crossing the bridge in the morning from 7am to 9am, at noon, and during the evening 4pm or 5pm period.
- Non-workers also create a large demand for bridge travel. A lot of people drive across the bridge during the day to engage in shopping, children's activities, and recreational opportunities. These people usually leave by 6 pm at which point traffic levels drop. It is important that these people have access to both sides of the river because they promote tourism and business.
- Peak commuting times create traffic congestion at the intersections at either end of the bridge. The capacity issue lies with the intersections and not the bridge itself. The construction work being performed on the I-84 interchange during 2010 and 2011 exacerbates this issue.

Retail and service customers use of the bridge

- Washington residents must cross the bridge to access shopping and services in Oregon. For example, shopping options on the Washington side do not include clothing retailers and the Washington side of the river also lacks nursing homes. Small retailers such as restaurants and recreation-related rentals in Hood River rely on patrons from White Salmon/Bingen and the reverse is true.
- Visitors view the communities as a united region and cross the bridge freely to access retail and services on either side of the bridge. The natural attractions and recreational opportunities are attractive to visitors on both sides of the bridge. The connection the bridge provides is important in the future development of the Columbia Gorge National Scenic Area as a national and international tourist attraction.

Manufacturer and freight business use of the bridge

- Most freight that crosses the bridge is from local lumber and wood products' manufacturers, fruit growers and processors. Much of the freight that goes through the region does so on I-84, without crossing the Hood River bridge.

- Local businesses rely on the bridge to connect them with suppliers and customers. For example, there is a juice factory that buys fruit on the Washington side but will soon be located at the Port of Hood River. Specific manufacturing and freight businesses that rely on the bridge: lumber, fruit growers, juice factory, businesses with suppliers on one side and the business on the other.
- Fruit growers and processors are major users of the bridge. Their major use of the bridge occurs in the fall: August through October (apples/pears) and June to July (cherries). There are a lot of bins that go out of the Valley across the bridge.
- Wood products businesses frequently use the bridge for moving freight across the River. The lumber industry would be hurt badly if there was no bridge. For example, Allen Brown Wood hauls 20 to 30 loads of wood chips and sawdust across the bridge daily for local businesses. Being able to move freight across the Hood River bridge, rather than making a detour to a more distant bridge, is key to the success of this business.
- Truck freight originating on the Washington side of the River will need to cross the River to access I-84. Trucks prefer to travel west via I-84 because of height limitations in the tunnels on SR 14. Trucks traveling east have a choice of using the Hood River bridge or the bridge at SR 197, at the Dalles.
- Trucks have other incentives to use the Hood River bridge. There is some attempt by businesses and truck drivers to avoid being weighed in Oregon. Truckers might cross to the Washington side and cross back to Oregon at Hood River to avoid the truck scales.

Emergency uses of the bridge

- The bridge provides an important connection in the event of an emergency, such as a natural disaster (e.g., flood or wild fire) or weather emergency (e.g., the closure of I-84 as a result of winter storms). The bridge provides an important connection between both sides of the River for emergency management. Without the bridge, emergency personnel or equipment would have difficulty crossing the River in a timely fashion. In addition, SR 14 is has a danger of rock slides, which could close SR 14, making I-84 an important transportation route on the Oregon side of the River.
- The bridge provides quicker access to hospitals from the Washington side. Transportation from the Washington side to Portland hospitals saves 5 to 15 minutes using the existing bridge, which may be significant for some patients.

Affect of current bridge conditions on how and when to travel

Safety issues with the bridge

- Many users, including businesses, residents, and tourists perceive the bridge as unsafe. The participants reported that the bridge is very frightening to some people crossing the bridge. Some people refuse to use the bridge because they do not feel safe. This is true for some residents and visitors alike. Some RV users seek local advice to find an alternative way to cross from the Washington to Oregon side of the River. Motorcyclists have a hard time riding on the grating of the bridge.
- Users report that the bridge is narrow to the point that it causes safety issues. There are many instances of mirrors getting hit by either making contact with the bridge or vehicles traveling in the opposite direction. Children on school buses are required to keep windows up out of fear that metal and glass from a clipped mirror will harm them.
- For large vehicles, crossing the bridge is a better option than traveling on SR 14. The school district busses use the bridge for safety issues, as opposed to tunnels which are too narrow for many trucks. School district risk managers advise against allowing buses to travel through the tunnels. The narrowness of the tunnels and their arches forces large trucks to travel down the center of the tunnel in both lanes. Additionally, SR 14 suffers from dangerous rock slides during the rainy season.
- Some bridge users consolidate their trips across the bridge because of concerns about safety crossing the bridge or the cost of the toll. For example, the Wal-mart on the Oregon side is a large draw, but due to safety concerns with the bridge and the cost of crossing (tolls and gas), many consumers consolidate their trips across the river.
- Traffic congestion on both sides of the bridge, at the interchanges of SR 14 and I-84, creates safety issues. Traffic queuing on I-84 is especially hazardous.
- The bridge has the narrowest passages for Barges along the River, creating safety concerns for barges.

Commuting constraints on the bridge

- Peak commuting times create traffic congestion at the intersections at either end of the bridge, with the majority of people originating from the Washington side to destinations on the Oregon side. The capacity issue lies with the intersections and not the bridge itself. The construction work being performed on the I-84 interchange exacerbates this issue.

Freight limitations on the bridge

- Weight limits on the bridge impede freight movement. One of the limiting effects of the bridge is the weight limitation of about 80,000 pounds. The bridge would facilitate more efficient freight movement if it allowed more weight. The Bridge of the Gods has the same weight limitation as the Hood River Bridge.
- Very heavy equipment and construction trucks (for road construction and logging) are overweight for the bridge. The Port of Hood River allows this type of heavy equipment to cross under controlled situations, rather than requiring them to detour to a different bridge crossing.
- On the Washington side, SR 14 was not built to accommodate high weight trucks and has tunnels that are too small for large trucks. Therefore, trucks need to cross the river at Hood River to use I-84.
- Wood products businesses have issues using the bridge, the biggest of which are the weight limitation and the width problems. The weight limit forces some wood products businesses to make more cross-bridge trips than they would with a higher weight limit. The width of the bridge is also a constraint. Some trucks have had near accidents on the bridge: some have nearly tipped up on to the rails and some lose their mirrors against the bridge or other large vehicles.
- Fruit growers and processors are major users of the bridge and the limitation for them is the width of the bridge. The movement of fruit (especially cherries) is time sensitive because fruit cannot stay in the sun for long periods; delays caused by the bridge hurt these users.
- Underwood is a fruit packing plant that uses semi-trucks to haul the fruit out of Hood River via the Hood River Bridge. These are some of the heavier trucks that use the bridge and they operate from September through May.

Tolling on the bridge

- There are multiple ways that toll collection could be improved. Tolls could be collected in one direction to minimize queuing on SR 35 or I-84. Toll collection could be dynamic: fees could vary throughout the day and a enhanced fast-pass method (e.g., a pass that allows bridge users to pre-purchase a pass or transponder on-line) could be implemented. Further, fees should be reduced during non-peak hours to encourage shoppers and day users to cross the bridge.
- If the method of collecting tolls is changed (e.g. collecting tolls one-way), the new method should consider actual and perceived safety issues. Some bridge-users would strongly prefer not to queue on the bridge while waiting to pay the toll. Analysis shows that converting

to one-way tolls will not change the traffic queues in the tolled direction.

Use of the bridge by bicyclists and pedestrians and transit

Desire for bicycle and pedestrian facilities

- There is desire to allow pedestrians and bicyclists a safe way to cross using the Hood River bridge. There is no safe way for pedestrians and bicyclists to cross the existing bridge, except by automobile. Some bicyclists, visitors and residents alike, will wait on the Washington side of the bridge until a driver stops to pick them up to cross the bridge and offer to pay the toll in exchange for the ride across the bridge.
- Residents and employees within the region have expressed a desire to be able to commute across the bridge by bicycle. At a recent bicycle summit, people in the region expressed strong support for providing a way for bicyclists and pedestrians to cross the bridge. As things currently stand, even if bicycles were allowed to use the bridge, the narrowness and the bridge's gridded surface would be a barrier to bicycling because of safety concerns.
- Housing on the Washington side of the River has historically been less expensive than on the Oregon side. And the majority of the jobs have historically been (and still are) located on the Oregon side of the River. The lack of a pedestrian and bicycle crossing limits lower-income residents, who may not be able to afford an automobile, from living in Washington and working in Oregon.
- The lack of bicycle facilities on the bridge is an economic constraint for bicycle tourism. Bicyclists visiting the area want to be able to safely cross the River and explore areas on both sides of the River. Some bicycle supporters hope that allowing bicycling across the bridge would decrease parking pressure in Hood River during the summer.
- The Columbia River Gorge National Scenic Area is becoming a national and international bicycling destination. In order to support this development, the Gorge's infrastructure, including the Hood River bridge, should accommodate bicyclists.
- Local efforts are underway to try to address the lack of bicycle facilities on the bridge and the fact that, even if the bridge is replaced, a replacement bridge is unlikely to be completed for at least 10 to 20 years. The Mid-Columbia Economic Development District (MCEDD) is working to develop a demonstration project, which would offer shuttle service to cross the bridge for bicyclists.

Lack of regular transit service to cross the bridge

- There are two transit agencies within the region, the Klickitat County Mt. Adams Transportation in Washington and the Hood River County Transportation District in Oregon. The two transit agencies do not have fixed routes that cross the bridge, for several reasons: (1) the two agencies are separated by state bureaucracies and funding sources and (2) the narrowness of the bridge results in damage to the transit buses, such as broken mirrors or vehicle body damage.
- Washington residents, desiring to access services in Oregon, have a greater demand for transit to cross the bridge than Oregon residents. The Klickitat County Mt. Adams Transportation crosses the bridge several times per day, generally to take residents to medical appointments in Hood River. The demand for transit crossing on the bridge could increase if the toll is increased substantially.
- Oregon residents need to cross the bridge to the Washington side, but to a lesser degree, than Washington residents need to cross in the opposite direction. The Hood River County Transportation District occasionally takes residents across the bridge, most frequently to the hospital in White Salmon. Another source of demand for transit from the Oregon side include the fact that the Amtrak stop is on the Washington side of the River, making it difficult for Amtrak riders in Oregon to get to the train station.

Benefits of a replacement bridge beyond transportation

- A bridge that accommodates bicycles and pedestrian could support the transformation of the Columbia River Gorge Scenic Area into a world-class tourism destination. The Centennial Celebration of the Columbia River Highway will occur in 2016 and will attract bicyclists from across the nation to ride along the newly restored Columbia River Highway. If bicyclists are unable to cross to the Washington side, tourism opportunities will be missed both by visitors and businesses.
- The construction of a replacement bridge opens the opportunity for an added attraction to the area. A replacement bridge could be an attraction in and of itself, both as a man-made feature in the Gorge and as a pedestrian destination and observation point.
- Replacing the bridge potentially provides ecosystem benefits, through promoting "clean" commuting solutions (e.g., bicycling or transit) or decreasing air and water pollution. In addition, the design of a replacement bridge could incorporate "clean" energy features, such as wind turbines.
- Replacing the bridge provides opportunities for increasing regional linkages and economic opportunities. It also provides an opportunity

for increasing natural hazard preparedness, by building a seismically safer bridge.

Supporting the regional connections and development patterns

- The policies that regulate growth within the Columbia River Gorge Scenic Area are intended to limit development to urban areas. The characteristics of the Gorge itself (e.g., the beauty of the area and the proximity to Portland) make it a desirable area in which to live. Growth pressures in the Gorge region are likely to continue into the future.
- The development pattern in the local region was developed around the bridge and provides opportunities with more housing opportunities, on either side of the River, regardless of where an individual's job is located. All three communities have some capacity to accommodate growth but there may be more capacity for residential growth on the Washington side of the bridge. Hood River is likely to continue to be the economic center of the region, meaning that people will need to be able to commute from Washington to Oregon for work.
- One way to support the continued growth and prosperity of the region is to replace the bridge with one that better accommodates automotive, freight, bicycle, pedestrian, and transit users.

Other considerations of replacing the bridge

Potential effect of increasing the tolls

- Increasing the bridge toll may have negative economic consequences for area businesses, depending on the amount of the increase. Currently the difference in sales tax brings retail customers from Washington to Oregon.
- Some residents and businesses in the area recognize that increasing the toll may be necessary and acceptable. There is a desire, however, for positive and tangible use of toll money that improves the existing bridge or that there is a concrete plan to use toll increase to build a replacement bridge.
- The cost of the toll will affect willingness to travel. Increasing the toll from $0.75 to $2 each way may be supportable. If the toll is $5, for instance, some people may choose to use a different bridge and shop in Cascade Locks or The Dalles, rather than in Hood River. The long-term consequence of a higher toll may is that it may cause people to change trip behavior, especially for casual trips for shopping.
- Business and residents on the Washington side of the River are generally aware of their dependence on the bridge. But those in Oregon may not be aware that a change in travel behavior could hurt

businesses in Oregon because 20% to 40% of their customers and a substantial amount of employees come from Washington.

- Increases in tolls may be tolerable for freight businesses that depend on the bridge, especially if a replacement bridge has fewer weight, width, and safety limitations.

Cost of replacing the bridge

- The current bridge is marginally functional, even with the current deficiencies. Is there a very strong economic need to replace the current bridge, considering the cost of replacement? A replacement bridge might not be a benefit to the region if it would result in an unaffordable toll. It is important to have a replacement for the existing bridge, when it ultimately fails (possibly in 20 or more years) but using the bridge should be affordable in order to support the regional economy and allow easy interchange across the River, for businesses, private individuals, and transit crossing.
- Is it financially and politically feasible to replace the bridge, given the costs of replacement and other bridge replacement projects across Oregon and Washington states? If the bridge replacement project goes forward soon, it may compete for funding with the Columbia River Crossing project in Portland/Vancouver. In addition, while there is some political support for a replacement bridge, thus far neither WSDOT nor ODOT has placed a replacement bridge on its Statewide Transportation Improvement Program nor is it shown as a priority project in either state's Highway System Plan.

Focus Group Participants

The following people participated in the June 3, 2010 focus groups about the Hood River bridge:

Alina Aaron, Mid-Columbia Economic Development District
Betty Barnes, City of Bingen
Mike Benedict, Hood River County
Allen Brown, Allen Brown Woodwaste, Inc
Andrew Bryden, DaKine
Ken Burgsthaler, Washington State Department of Transportation
Michael Cannon, Klickitat County Economic Development
Sharon Carter, Klickitat County Mt Adams Transportation
Mike Doke, Port of Hood River
Ty Erickson, Providence Hood River Memorial Hospital
Jean Godfrey, Columbia Gorge Fruitgrowers' Association
Jonathan Graca, Hood River Valley Residents Committee
Dugan Harris, Wal-Mart
Chuck Hinman, Hood River Inn
Marsha Holliston, Mount Adams Chamber of Commerce
Jim Kacena, Mt. Adams Chamber of Commerce
Michael Lang, Friends of the Gorge
Jerry Lewis, White Salmon Valley School District
Kevin Liburdy, Hood River City Planning
Brian Litt, Columbia River Gorge Commission Director
Michael Madden, Skyline Hospital
Dan Schwanz, Columbia Area Transit
Linda Shames, Port of Hood River
Tom Stevenson, Stevenson Ranch
Marc Thornsbury, Port of Klickitat
Susan Tibke, White Salmon Valley School District
Johanna Wyers, In Situ Company

Appendix B Review of Existing Studies

The SR-35 Columbia River Crossing Feasibility Study was conducted over a five year period (1999 to 2004) and resulted in more than one dozen reports, culminating a Draft Environmental Impact Statement (DEIS) in 2004. The results of the Study are summarized in the report SR-35 Columbia River Crossing Feasibility Study, September 2004. This section presents key points for the analysis of the economic effects of the Hood River bridge based on these and other related studies.

Bridge users

- In 2001, two surveys were conducted to understand bridge use: one was an intercept survey of motorists crossing the bridge; the other was a telephone survey of households in the region. The motorists (by definition, bridge users) averaged 9.1 trips per week. The survey of local households showed an average of 8.5 trips per week for respondents who traveled across the bridge in the week prior to the survey.[27]
- A 2001 survey of motorists using the bridge showed that 60% of bridge users lived in the Hood River/White Salmon/Bingen region and 40% were from outside the region. [28]
- The majority of bridge users have historically been from Washington. More than half of motorists were traveling to Washington and the most common destinations were: Hood River (32%), White Salmon (21%), Bingen (8%), other Washington destinations (26%), and other Oregon destinations (13%).[29] These results are consistent with a 1990 Origin Destination Survey that was conducted by WSDOT, which showed that local Washington residents are the primary users of the Hood River bridge.[30]

Bridge replacement

- The need for replacing the existing Bridge is: (1) to alleviate current and future congestion at the bridge termini and on the bridge itself, (2) accommodate the increase in demand for automotive crossing of the River; (3) provide crossing opportunities for bicycle and pedestrians; (4) accommodate river navigation by providing wider horizontal clearances for river-based shipping; and (5) address

[27] The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

[28] The Gilmore Research Group, *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

[29] The Gilmore Research Group, *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

[30] Parsons Brinckerhoff, *SR-35 Columbia River Crossing Feasibility Study Tier I Report*, July 16, 2001.

and improve on safety and current substandard design elements of the existing Bridge.[31]

- The preliminary preferred alternative for bridge replacement is the EC-2 West Alignment. This alternative would be located directly adjacent to the west side of the existing bridge. The alternative was found to be the most desirable and best balanced functional efficiency with environmental, social, and economic effects.[32]
- The cost estimate of a replacement bridge in the existing bridge corridor was between $110 million and $121 million in 2002 dollars. [33]

Financial feasibility

- Surveys were conducted of motorists crossing the bridge and local residents. More than 80% of those surveyed thought there is a need for a new bridge crossing. Survey respondents were generally willing to pay a higher toll for crossing the bridge, with the majority of respondents willing to pay a toll ranging from $1.50 to $2.00. [34]
- The SR-35 Columbia River Crossing Financial Feasibility Study proposed the following toll structure for financing the replacement bridge: (1) increasing the toll to $1.00 in 2004 (with $0.50 set aside for capital costs of replacing the bridge between 2004 and 2010), (2) increasing the toll to $1.75 when the new bridge opens in 2010, and (3) periodically increasing the toll by $0.25 to account for inflation. Based on this structure, to toll cost finance approximately $50 million in projected costs. It should be noted that the toll has remained $0.75, rather than increasing to $1.00 in 2004.[35]
- An analysis of the funding capacity of the toll revenue stream indicated that there is not a toll level which would pay for 100 percent of the bridge replacement project costs.[36]
- The recommended funding sources are as follows: 37% from tolls; 36% from the Federal government; 26% from Washington and Oregon states; and 1% from other local sources.[37]

[31] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, page ES-2

[32] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, pages ES-11 to ES-12

[33] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, page 13

[34] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, pages 11 to 12

[35] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, pages 13 to 14

[36] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, pages 26 to 27

[37] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, page 34

Benefits of a replacement bridge

- The environmental benefits of the preferred alternative in comparison to the no-build alternative include: alleviation of significant traffic congestion (including improved fuel efficiency and reduced air pollution; widening the navigation channel to meet current standards; providing facilities for bicycle and pedestrian crossing; removal of weight restrictions and improvement of freight efficiency; improvement of water quality and treatment of storm water runoff; and potentially decreased habitat for predatory fish resulting from fewer bridge piers.[38]
- The 2001 survey asked about potential bicycle and pedestrian usage. Bridge users were asked whether they would have made the current trip or recent trips by bicycle or foot if facilities were available and the toll were either reduced or free. Responses to the motor intercept survey suggest that between 14 to 27% of the trips made by automobile might be made by foot or on bike. Responses by bridge uses on the phone survey suggest that between 11 to 20% of the trips made by automobile might be made by foot or on bike. [39]

[38] *SR-35 Columbia River Crossing Feasibility Study*, September 2004, page 25

[39] The Gilmore Research Group *SR-35 Bridge Motorist Intercept and Telephone Survey: Narrative Report of Research Findings*, December 2001

SECTION K

Final EIS Scope of Services

Scope of Work
Final Environmental Impact Statement and Preliminary Engineering

Task 1. Project Management and Coordination

1.1 Project Management and Quality Assurance

Assumptions:
- Project duration will be 24 months

1.2 Project Invoices and Progress Reports

Assumptions:
- Project invoices and progress reports will be prepared monthly

1.3 Monthly Project Management Team Coordination Meetings

Assumptions:
- Monthly design coordination meetings will be held between RTC, WSDOT, ODOT, and the consultant with three (3) consultant staff attending each meeting
- Coordination meetings will be used to manage current tasks, plan for future tasks, and provide technical and project management coordination opportunities
- Consultant shall prepare and distribute meeting agenda prior to each meeting

Task 2. Environmental

2.1 Discipline Reports: Update discipline reports with new information and regulatory changes

a. Soils and Geology

b. Fish
   i. Address any changes to threatened and endangered species listings and critical habitat designations

c. Wildlife
   i. Address any changes to threatened and endangered species listings and critical habitat designations

d. Vegetation
   i. Conduct additional plant surveys for sensitive species, species habitat, and invasive species during appropriate seasons particularly on the Washington shore area disturbed during construction
   ii. Address project impacts on invasive species, including prevention and control of outbreaks

e. Wetlands
   i. Conduct survey to identify any wetlands that may be present along north end of new alignment

f. Waterways/Water Quality
   i. Coordinate with design team to address specifications of bridge drainage capacity, treatment facilities, spill prevention and containment plans
   ii. Disclose detailed construction impacts on water quality
   iii. Address snow and ice management in water quality section
   iv. Identify any monitoring wells, wells that would be abandoned, water rights, or water licenses that would be affected; comply with Oregon Water Resources Department guidance

g. Land Use
   i. Coordinate with Columbia Gorge Commission on any any changes to policies that address project compliance with the Columbia River Gorge National Scenic Area management plan
   ii. Reevaluate project consistency with the Port of Hood River marina master plan and the river walk conceptual plan

h. Social and Economic Elements
   i. Perform further outreach to nearby census blocks and block groups that contain higher proportions of minority and low-income populations compared to local, county and state distributions
   ii. Include more discussion on the financial feasibility study: update data and analysis to disclose the need for tolls
   iii. Consider interpretive signs on proposed bridge
   iv. Update census data

i. Relocations

j. Visual Resources

k. Noise

l. Air Quality
   i. Address toxics and particulate matter on sensitive receptors, including treaty access fishing sites

m. Energy

n. Hazardous Materials

Assumptions:

- Studies involving collection of fish samples or wildlife specimen will not be required
- Assumes one (1) field visit for plant surveys
- Revisions to discipline reports assume the preferred alternative is consistent with the preferred alternative identified in the project Type, Size and Location (TS&L) Study

2.2 Final Environmental Impact Statement (FEIS)

a. Prepare FEIS document, which shall:
    i. Include updated technical information from revised discipline reports
    ii. Incorporate changes as needed to respond to comments received on the Draft EIS (DEIS)
    iii. Expand the secondary and cumulative impacts discussion on
        1. Air quality
        2. Noise
        3. Hazardous materials transport
        4. Induced growth
    iv. Updated traffic modeling results
    v. Be prepared in a reader-friendly format using plain language and graphics to the extent possible per WSDOT's Reader-Friendly Toolkit
    vi. The Final EIS shall provide evidence and detailed explanation on why all alternatives that preserved the Hood River Bridge were eliminated from further study in the EIS (e.g., bridge structural evaluations, barge accidents)

b. Prepare for and participate in pre-signatory and signatory briefings with Washington State Department of Transportation (WSDOT) and coordinate with the Oregon Department of Transportation (ODOT) and Federal Highway Administration (FHWA) to obtain signatures

c. Prepare Record of Comments, which shall include point-by-point responses to each comment received on the DEIS

d. Prepare Record of Decision (ROD), which shall include the following elements
    i. Decision
    ii. Purpose and Need
    iii. Alternatives Considered
    iv. Determinations and Findings
    v. Measures to Minimize Harm
    vi. Project Commitments
    vii. Monitoring and Enforcement

viii. Responses to Comments Received on the FEIS

e. Prepare legal ads announcing availability of FEIS and ROD; prepare statute of limitations

f. Update Administrative Record through the signature of the ROD

Assumptions:

- A total of four (4) versions of the FEIS shall be prepared:
    - Draft 1 FEIS will be reviewed by RTC, WSDOT SW Region, WSDOT Headquarters, ODOT Region 1, and ODOT Geo-Environmental Section
    - Draft 2 FEIS will be reviewed by FHWA Washington Division
    - FEIS for WSDOT, ODOT and FHWA signatures
    - Final FEIS for public distribution
- No major revisions to the DEIS are anticipated as technical experts have previously reviewed the document
- The FEIS shall analyze the same alternatives examined in the DEIS; the preferred alternative is assumed to be the same as the preferred alternative identified in the project TS&L Study
- Two (2) versions of the Record of Comments shall be prepared:
    - Draft Record of Comments
    - Final Record of Comments
- A total of 12 comments were received on DEIS and will be addressed in Record of Comments and FEIS
- A total of three (3) versions of the ROD shall be prepared:
    - Draft 1 ROD will be reviewed by RTC, WSDOT SW Region, WSDOT Headquarters, ODOT Region 1, and ODOT Geo-Environmental Section
    - Draft 2 ROD will be reviewed by FHWA Washington Division
    - Final ROD for FHWA's signature
- Publication costs of legal ads included

2.3 Mitigation Plan

a. Prepare detailed mitigation plan that addresses project impacts to shoreline habitat, instream habitats, wetlands, and water quality

2.4 Section 106 of the National Historic Preservation Act

a. Determine the Area of Potential Effects (APE)

b. Conduct archaeological surveys in areas that will have ground disturbance within the preferred alternative footprint and all staging areas including the extant Hood River Bridge; these areas may involve underwater exploration

c. Make a finding of effect for any historic properties and archaeological resources that are eligible for listing on the National Register of Historic Places

d. If any resources are found to be adversely affected, develop mitigation measures and prepare a Memorandum of Agreement (MOA)

e. Coordinate with Oregon and Washington State Historic Preservation Officers, Port of Hood River, and other local historic preservation groups

Assumptions:

- Hood River Bridge is eligible for listing on the National Register of Historic Places
- APE will be reviewed by Washington Department of Archaeology and History Preservation (DAHP) and the Oregon State Historic Preservation Officer (SHPO) and revised up to two (2) times to address comments
- Archaeological surveys will include a pedestrian survey augmented by shovel probes due to poor surface visibility, vegetation, and overburden
- A permit for surveying public lands will be required from SHPO and possibly from DAHP
- Assumes one (1) newly discovered site will be identified; an excavation permit would be required prior to additional field evaluation to make a finding of effect
- MOA will be reviewed by Washington Department of Archaeology and History Preservation (DAHP) and the Oregon State Historic Preservation Officer (SHPO) and revised up to two (2) times to address comments
- Historic American Engineering Record (HAER) documentation of the Hood River Bridge would be reviewed by DAHP, SHPO, and the National Park Service one (1) time.

2.5 Tribal Coordination

a. Coordinate and consult with the following Native American tribes: Yakama Nation, Confederated Tribes of the Warm Springs, Confederated Tribes of the Umatilla Reservation, and Nez Perce

b. Engage tribes in face-to-face meetings

c. Comply with the WSDOT Centennial Accord

d. Coordinate with tribes on potential project impacts to treaty access fishing sites and Section 106 resources

e. Disclose construction impacts and operational impacts on treaty access fishing sites

f. Review compliance with treaty rights in the land use plan consistency section

Assumptions:

- RTC, WSDOT, and ODOT will have significant involvement in tribal coordination
- Official correspondence will take place on WSDOT and/or ODOT letterhead
- Mailing lists will be provided by RTC, WSDOT, and ODOT
- Two (2) group tribal meetings will be held with two (2) consultant staff attending each meeting

2.6 Biological Assessment

a. Prepare a Biological Assessment (BA)

b. Coordinate and consult with NOAA Fisheries and USFWS to obtain updated species lists and other relevant information

c. Address the NOAA Fisheries Stormwater Guidance

d. Determine effect of project on applicable ESA species

e. Develop acceptable conceptual mitigation measures and construction BMPs

Assumptions:

- Mitigation will be required to compensate for aquatic project impacts
- A total of two (2) versions of the BA shall be prepared:
  - Draft BA will be reviewed by RTC, WSDOT SW Region, WSDOT Headquarters, ODOT Region 1, and ODOT Geo-Environmental Section
  - Final BA for submittal to USFWS and NOAA
- Additional revisions to the Final BA (if requested by USFWS and NOAA Fisheries) are not included in this scope
- Includes attendance at three (3) agency meetings as well as two (2) site visits

2.7 Section 4(f) of the US Department of Transportation Act

a. Prepare Final Section 4(f) Evaluation to include:
   i. Updated technical information from revised discipline reports if applicable
   ii. Incorporate changes as needed to respond to comments received on the Draft EIS and Draft Section 4(f) Evaluation

b. Coordinate with both State Historic Preservation Officers, Port of Hood River, and other local historic preservation groups

Assumptions:

- Hood River Bridge is applicable to Section 4(f); no other resources need to be included in the Section 4(f) Evaluation
- Programmatic Section 4(f) Evaluation can be used for the Hood River Bridge

2.8 Environmental Streamlining

a. Prepare SAFETEA-LU Coordination Plan
   i. Work with RTC to identify and invite Cooperating and Participating Agencies

b. Restart coordination with Washington State's Statewide Advisory Group for Environmental Stewardship (SAGES) and Oregon's Collaborative Environmental and Transportation Agreement for Streamlining (CETAS) groups

c. Concurrence on criteria for selecting the preferred alternative

d. Concurrence on selection of a preferred alternative

Assumptions:

- Two (2) coordination meetings with Washington State SAGES group to coordinate on criteria for selecting the preferred alternative and selection of the preferred alternative with two (2) consultant staff attending each meeting
- Two (2) coordination meetings with Oregon CETAS group to coordinate on criteria for selecting the preferred alternative and selection of the preferred alternative with two (2) consultant staff attending each meeting

Task 3. Preliminary Engineering

3.1 Preliminary Engineering Validation

a. Validate design requirements listed in the Final TS&L Study

b. Update cost estimate to support financing and grant applications

c. Achieve an updated design acceptance by ODOT, WSDOT, and other key agencies

d. Update the design to a level to support the FEIS and biological assessment, if needed

3.2 Drainage

a. Validate bridge deck drainage capacity calculations and the amount of potential runoff, including snow removal

b. Determine the location, preliminary sizing and specifications for storm water conveyance and treatment facilities

c. Specify how proposed treated discharges into the Columbia River would comply with water quality standards and how accidental spills would be managed

Assumptions:

- There will be two (2) stormwater treatment facilities, one located on each side of the river
- Stormwater conveyance and treatment facility design will be based on a single set of criteria for both the Washington and Oregon sides of the bridge; the more restrictive of the Washington and Oregon stormwater design criteria will be used
- A separate draft/final Stormwater Hydraulics/Management Report is not included in this phase of the work; these will be included in the 60% (Draft Stormwater Report) and 90% (Final Stormwater Report) phases of final design
- Coordination with WSDOT and ODOT will occur regarding management of accidental spills
- Assumes 10 Drainage Drawings for 30% Level

3.3 Survey

a. Determine specific right-of-way acquisition of private property and/or transfer of public ownership of property

3.4 ODOT Coordination

a. Coordinate with ODOT should occur regarding the connection of bridge approach road and nearby I-84 ramps

3.5 Perform Geotechnical Studies

a. Develop a geotechnical work plan to support the preliminary engineering effort

b. Prepare exhibits that will accompany in-water drilling permit applications and right-of-entry permit applications, and traffic control plans
c. Conduct geotechnical subsurface exploration, including geotechnical borings at each pier location and at each abutment
d. Execute laboratory testing to determine geotechnical properties of soil and rock samples
e. Perform geotechnical analyses to confirm foundation type(s) and size(s) at each pier
f. Perform geotechnical analyses to determine geometry and foundation performance of approach fills
g. Performed geotechnical analyses to quantify the seismic effects at piers and approaches and develop mitigation concepts
h. Develop preliminary pavement design
i. Summarize findings and recommendations in a draft geotechnical report
j. Participate in design review workshops with geotechnical counterparts of ODOT and WSDOT
k. Issue final geotechnical report that incorporates agency comments

Assumptions:

- Work will be governed jointly by Geotechnical Design Manuals of ODOT and WSDOT; where conflicts exist, the more conservative design manual will take precedence
- In-water drilling permit applications will be prepared, submitted by others
- Traffic control plans will be prepared, submitted by others

3.6 Conduct wind load analysis to support the finalization of bridge type, size, and location

a. The wind load analysis will also determine impacts of the bridge on windsurfing and kiteboarding
b. A wind model will be developed based on wind rose readings collected as part of this task

3.7 Utility coordination

a. Establish a utility coordination matrix by identifying utilities and contact names for utilities within the project limits

i. Request utility as-built information

ii. Review available information about existing utilities, prior rights of utility owners

b. Potential Utility Conflict Technical Memo and Utility Concurrence Letters: provide a technical memorandum to identify potential conflicts (type of utility, size, and location (horizontal and vertical)) based on 30% design package

3.8 Validate design requirements listed in the TS&L Study

a. Determine the bridge and structural member size applicability based on wind load studies

Assumptions:

- Design of foundation piers and other proposed in-water structures will remain substantially the same as what was modeled in the TS&L Study, so no additional hydraulic and scour analysis is needed

3.9 Right of way acquisition plans for bridge, access road, stormwater facilities, and environmental impact mitigation

Task 4. Transportation

4.1 Update traffic modeling results for the design year; the design year would be twenty years beyond the expected year of opening

4.2 Re-examine previously used traffic volume growth factors to check if they would still be applicable and recalculate if necessary

4.3 Prepare traffic forecasts for analysis of potential tolling policies and other financing strategies

Assumptions:

- T-design intersection shown in TS&L Study would move forward as the preferred alternative
- Synchro/SimTraffic software would be used to perform traffic analysis to determine delay, LOS and queue lengths

Task 5. Tolling Financial Feasibility Study

5.1 Update Financial Feasibility Technical Memorandum

a. Research current population and employment projections for the study area and identify changes and new trends since the previous work. Identify recent and planned commercial and residential developments and estimate their potential impacts on official projections. Review and analyze 2010 census data for demographic changes since 2000 that would affect journey to work and other travel patterns across the river.

b. Revisit survey data and determine if the results are still valid to inform a feasibility level toll traffic and revenue study, making potential adjustments for the effects of inflation, changing demographics, and other factors noted in 5.1.a above. In the event that additional survey work is undertaken for public involvement or traffic planning purposes, coordinate with those efforts to identify additional information that can be collected to further inform the feasibility level toll traffic and revenue study.

c. Working closely with the transportation analysis in Task 4, prepare feasibility level, annual toll traffic and revenue projections for a 30 year forecast horizon based on an agreed upon toll rate schedule and escalation policy. This may rely on updating the econometric regression model developed for the previous work to assess changes in traffic under higher than today's toll rate and/or applying elasticity diversion factors and daily-to-annual expansion factors to traffic projections prepared in Task 4.

d. Prepare operations and maintenance cost estimates for toll collection functions, bridge operation and maintenance, and related operating costs necessary to arrive at the net revenue stream that could support financing. Several of the inputs and/or estimates involved would be provided by one or both of the two states assuming that the new bridge would not be owned by the Port of Hood River.

e. Prepare a simple financial model to estimate the toll funding contribution possible from leveraging the forecasted net toll revenue stream from the sale of municipal bonds. This work would be done in close coordination with the state that would likely issue the debt to agree upon the debt structure, any additional backing by the state, applicable financing assumptions including future interest rates, credit ratings and debt service coverage.

f. In close coordination with both states, identify the set of candidate local tax and fee revenue sources, including existing statutory options and those that would require new legislation, by which to augment toll funding. Prepare updated revenue estimates and projections for the identified candidate local tax and fee revenue sources in both states.

Task 6. Public Involvement

6.1 Public activities

a. Determine whether to use an advisory committee (recommended); assuming a committee is used, undertake the following activities:

   i. Conduct up to three meetings with the committee to review, comment and advise on bridge design issues, results of additional environmental analysis, and other public outreach activities

   ii. Publicize meetings via media releases

   iii. Summarize meeting results

b. Prepare up to three (3) newsletters or fact sheets about the project; distribute to interested parties and via community gathering places, including public offices and local businesses; newsletters would describe the status of the project

c. Conduct up to two (2) public workshops or open houses to review the preliminary design and environmental impacts associated with the preferred alternative; one (1) meeting would be a design workshop and one (1) meeting would be an open house

   Specific activities would include:

   i. Publicize meetings via media releases, public notices, meeting flyers, newsletter/fact sheets, direct e-mail notices and advisory committee member assistance (assuming an advisory committee is used)

   ii. Prepare for and conduct meetings, including assisting with meeting materials, logistics and facilitation

   iii. Summarize meeting results

d. Prepare additional media releases, as needed to publicize project results or activities

e. Assist with presentations to local groups, if requested

f. Summarize public involvement activities and results in a concise report for incorporation in the FEIS

6.2 Coordinate funding strategies with the Port of Hood River

a. Meet with Port officials at the outset of the project to identify shared objectives, process and schedule for coordination, and responsibilities of project team and Port representatives

b. Meet periodically with Port to implement process agreed upon in (a)

c. Summarize meetings and agreements with Port

SR-35 Columbia River Crossing 12 October 2011

6.3 Agency activities

a. Determine whether to use a steering committee composed of state and local agency representatives at the outset of the project

b. Assist in informing and soliciting comments from state, federal and local agency representatives, as needed, pursuant to NEPA and state environmental review requirements

c. Meet or communicate with agency representatives regarding specific issues of concern; identify and clarify such issues for presentation in the FEIS

Task 7. Final Design and Permitting Statement of Work

7.1 Prepare Statement of Work for final design and permitting

Assumptions:

- Statement of work will cover plans, specifications, and construction cost estimate
- ODOT, WSDOT, RTC would review the Statement of Work

Final EIS and Preliminary Engineering Estimated Budget: $1,840,000 - $2,240,000

The total estimated cost for the Final EIS and Preliminary Engineering Phase of work is $1,840,000 to $2,240,000 depending on when the work is performed. This cost estimate assumes the work begins during the 2011-2016 timeframe. The cost is expected to increase over time due to inflation.

The HAER documentation of the Hood River Bridge, included in Task 2.4, could be deferred to the next phase of work (Final Design and Permitting). In addition, there are a number of tasks that could be led or supported by WSDOT and/or ODOT for potential project savings. These tasks include:

- Task 2.5 Tribal Coordination
- Task 3.2 Drainage
- Task 3.3 Survey
- Task 3.5 Geotechnical Studies
- Task 3.7 Utility Coordination
- Task 3.9 Right of Way Acquisition Plans
- Task 6 Public Involvement.

The attached breakdown of costs provides an estimate for each task.

SR 35 Columbia River Crossing

Estimated Budget

Final Environmental Impact Statement and Preliminary Engineering

October 4, 2011

Task	Estimated Cost	Potential Savings from Agency Lead or Support of Task
Task 1 Project Management and Coordination		
1.1 Project Management and Quality Assurance	$150,000	
1.2 Project Invoices and Progress Reports	$25,000	
1.3 Monthly Project Management Team Coordination Meetings	$75,000	
TOTAL Task 1	*$250,000*	
Task 2 Environmental		
2.1 Discipline Reports	$180,000	
2.2 Final Environmental Impact Statement	$175,000	
2.3 Mitigation Plan	$20,000	
2.4 Section 106	$150,000	
2.5 Tribal Coordination	$15,000	X
2.6 Biological Assessment	$100,000	
2.7 Section 4(f)	$15,000	
2.8 Environmental Streamlining	$10,000	
TOTAL Task 2	*$665,000*	
Task 3 Preliminary Engineering		
3.1 Preliminary Engineering Validation	$10,000	
3.2 Drainage	$60,000	X
3.3 Survey	$20,000	X
3.4 ODOT Coordination	$10,000	
3.5 Perform Geotechnical Studies	$440,000	X
3.6 Conduct wind load analysis	$150,000	
3.7 Utility coordination	$10,000	X
3.8 Validate design requirements listed in the TS&L Study	$5,000	
3.9 Right of way acquisition plans	$15,000	X
TOTAL Task 3	*$720,000*	
Task 4 Transportation		
4.1 Update traffic modeling results for the design year	$9,000	
4.2 Re-examine previously used traffic volume growth factors	$3,000	
4.3 Prepare traffic forecasts	$3,000	
TOTAL Task 4	*$15,000*	
Task 5 Financial Feasibility Study		
5.1 Update data and analysis in tech memo	$80,000	
TOTAL Task 5	*$80,000*	
Task 6 Public Involvement		
6.1 Public activities	$80,000	X
6.2 Coordinate funding strategies with the Port of Hood River	$10,000	X
6.3 Agency activities	$15,000	X
TOTAL Task 6	*$105,000*	
Task 7 Final Design and Permitting Statement of Work		
7.1 Prepare Statement of Work for final design and permitting	$5,000	
TOTAL Task 7	*$5,000*	
2011 TOTAL Cost	**$1,840,000**	
2016 TOTAL Cost (Assumes 4% inflation per year)	**$2,240,000**	