December 21, 2011 Our Ref: 873.3-11

Mr. Andrew Caneday
Shannon & Wilson, Inc.
400 North 34th Street, Suite 100
PO Box 300303
Seattle, Washington 98103

REPORT: Geophysical Logging Results
Borings B-2L, B-3L and B-9L
Lower Alignment, Index – Galena Road, Mileposts 6.4 to 6.9
Snohomish County, Washington

Dear Mr. Caneday:

This letter report contains the results of the geophysical logging of the three borings along the lower alignment (Borings B-2L, B-3L and B-9L) of the proposed Index-Galena Road alignment. The holes were logged in the first two weeks of September 2011 shortly after the borings had reached their total depth. The boreholes were dry at the time.

The uncased portions of the wells (in rock) were logged using a Mount Sopris MGX II Digital Console with a Mount Sopris / ALT Optical Televiewer tool. A caliper tool was run in Boring B-9L to provide additional information on possible fractures in the rock. A brief description of the logging tools is provided below.

Caliper (CALP) - uses a three-arm caliper to physically trace the diameter of the hole. Caliper is generally used to determine the borehole condition and to locate fracture zones and washouts.

Optical Televiewer – provides an oriented image of the borehole using digital video imaging techniques to delineate bedding and fracture orientation and width. Requires clear water or air-filled boring.

Table 1 is a summary of the interpreted features observed in the optical televiewer data. The features are based on visual inspection. Many of the features are difficult to discern from the surrounding bedrock material due to their similar color and fabric. The features are ranked as Weak, Moderate and Strong depending on how easily the feature is observed. Some of the features may be related to fractures or joints in the rock, while others may be related to a change in composition of the rock material. Please note that in Boring B-9L the caliper log did not indicate any significant changes in borehole diameter.

The table shows the approximate depth (feet below ground surface), strike, dip and the "strength" of how easily the feature is observed. The strike and dip of some of the weak features, and of low-angle dipping features are very approximate. The lack of a strong boundary of many of the features combined with the small-diameter of the borehole (assumed to be approximately 2.42 inches) makes the strike and dip difficult to determine for those features.

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The geophysical logs for each hole are attached. Visible features interpreted from the data are indicated by a black line on the image, and the visual strength of the feature indicated by a "W, "M", or "S" (weak, moderate or strong). The bottom of the surface casing (BOC) is indicated on each log. Depths are from ground surface and are accurate to within about 0.3 feet (due to cable stretch and minor slippage). The raw televiewer data is referenced to Magnetic North, and has been corrected to True North on the logs using a magnetic declination of 16.5° E.

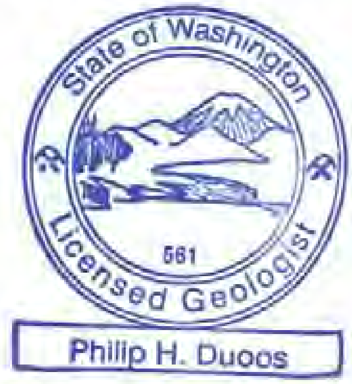
Correlation of the geophysical logs with the coring logs is fair on most of the larger features that show compositional changes in the rock; such as the highly weathered and rubbilized zone in Boring B-2L between about 29.5 to 33.2 feet deep. In Boring B-3L, the zone of weak rock with iron oxide staining at about 50 feet deep is strongly evident in the optical televiewer image. The numerous narrow joints observed in the coring log were typically not observed in the televiewer image. This is probably due to the narrow nature of the joints and perhaps the lack of distinct coloring.

The darker vertical band in the images between about 90° and 180° is due to the probe being off-center in the boring. The probe is just slightly smaller than the borehole so the usual borehole centralizers could not be used. Small-diameter cording was wrapped around the tool and covered with electrical tape at selected locations to help centralize the tool and also to protect the camera lens. The banding in the image is not severe, but may limit the ability to detect very faint and narrow features.

While the geophysical logs do not provide the level of detail that the core provides, they do provide the approximate strike and dip of the interpreted features. The geophysical logs should be reviewed by a geologist familiar with the site conditions at the site. Please feel free to contact me with any questions or comments regarding this information. It was a pleasure to have worked with you on this interesting project.

Sincerely,

Philip H. Duoos
Geophysical Consultant



Attachments:

Table 1: Geophysical Logging Results Summary
Figures B-2L, B-3L, B-9L: Geophysical Logs

Index-Galena, Boring B-2L				
Depth (ft)	Strike	Dip	Width (ft.)	Strength
20.9	26.2	13	0.3	Moderate
21.2	26.2	13		
24.2	162.3	47.9	.05?	Weak
29.5	112.4	15	3.7	Top
31.6	82.7	44.3		Weak
32.4	174.8	57.6		Weak
33.2	320	6.7		Bottom
37.1	284	18.8	0.6	Moderate
37.4	284	16		Moderate
37.7	284.4	19		Moderate
46.8	320.4	1.9	0.1	Weak
46.9	320.4	1.9		
47.4	357.6	4.7	0.1	Weak
47.5	357.6	4.7		
47.9	316.9	5.1	0.1	Weak
48	316.9	5.1		
48.3	79.1	1.2	0.1	Weak
48.4	79.1	1.2		
49.7	193.1	44.3	0.4	Moderate
50.1	193.1	44.3		

Index-Galena, Boring B-3L				
36	116.4	49.6	0.1	Weak
36.1	116.4	49.6		
42.6	328.5	43.3	0.2	Moderate
42.8	328.5	43.3		
47.6	68.3	7.4	0.1	Weak
47.7	68.3	7.4		
50	324	78.4	0.4	Strong
50.4	322	80		

Index-Galena, Boring B-9L				
39.5	207	5.3	0.3	Moderate
39.8	207	5.3		
40.6	217.8	39.1	0.3	Moderate
40.9	217.8	39.1		
42.6	22.1	15.6	0.2	Weak
42.8	22.1	15.6		
43.8	163	18.1	0.1	Weak
43.9	163	18.1		
46.8	82	29.3	0.2	Moderate
47	82	29.3		
48.8	240.7	35.6	0.1	Weak
48.9	240.7	35.6		
54.9	281.1	74.4	0.1	Moderate
55	281.1	74.4		

TABLE 1

Index-Galena Phase III
Geophysical Logging Results

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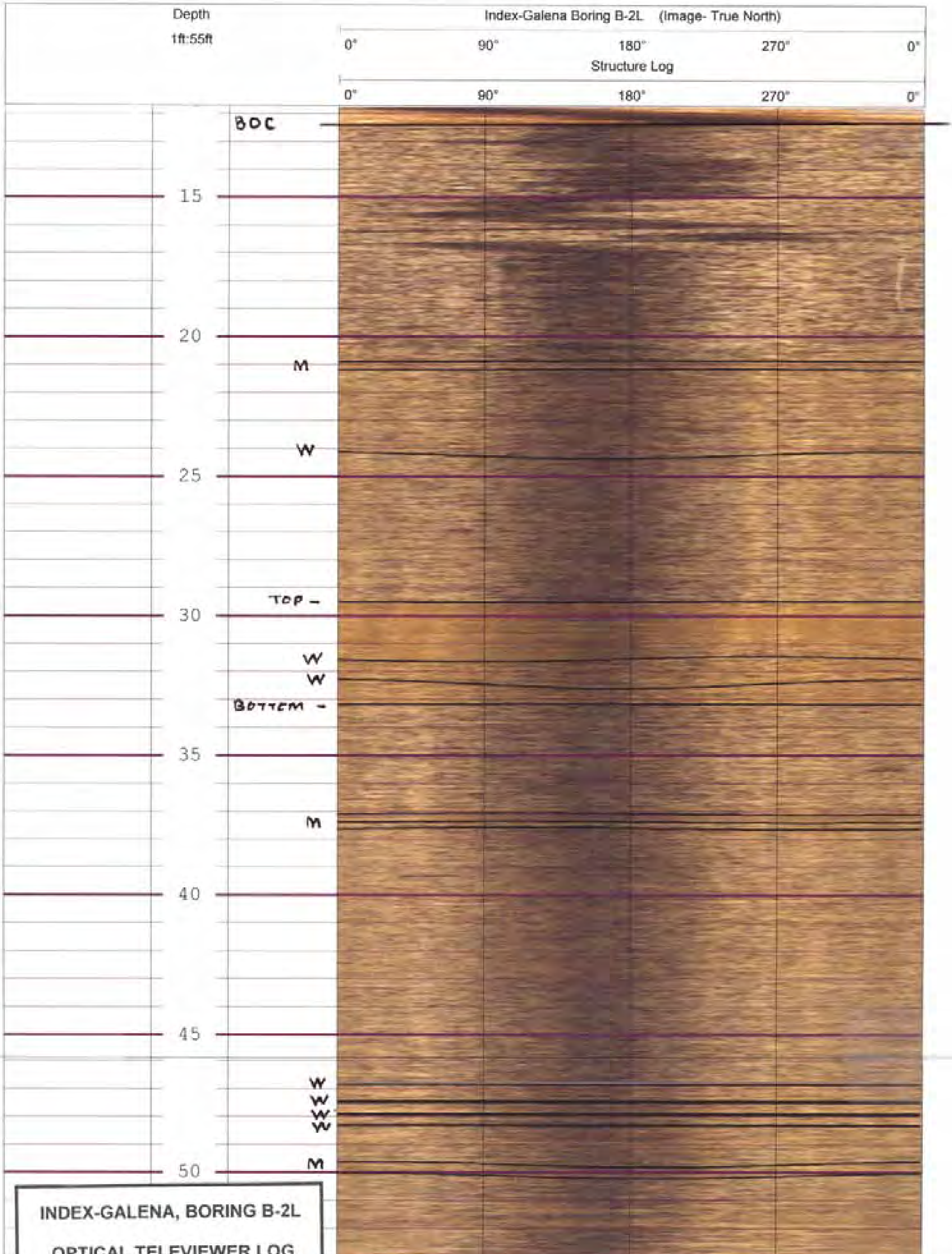
Philip H. Duoos, Geophysical Consultant



INDEX-GALENA, BORING B-2L

OPTICAL TELEVIEWER LOG

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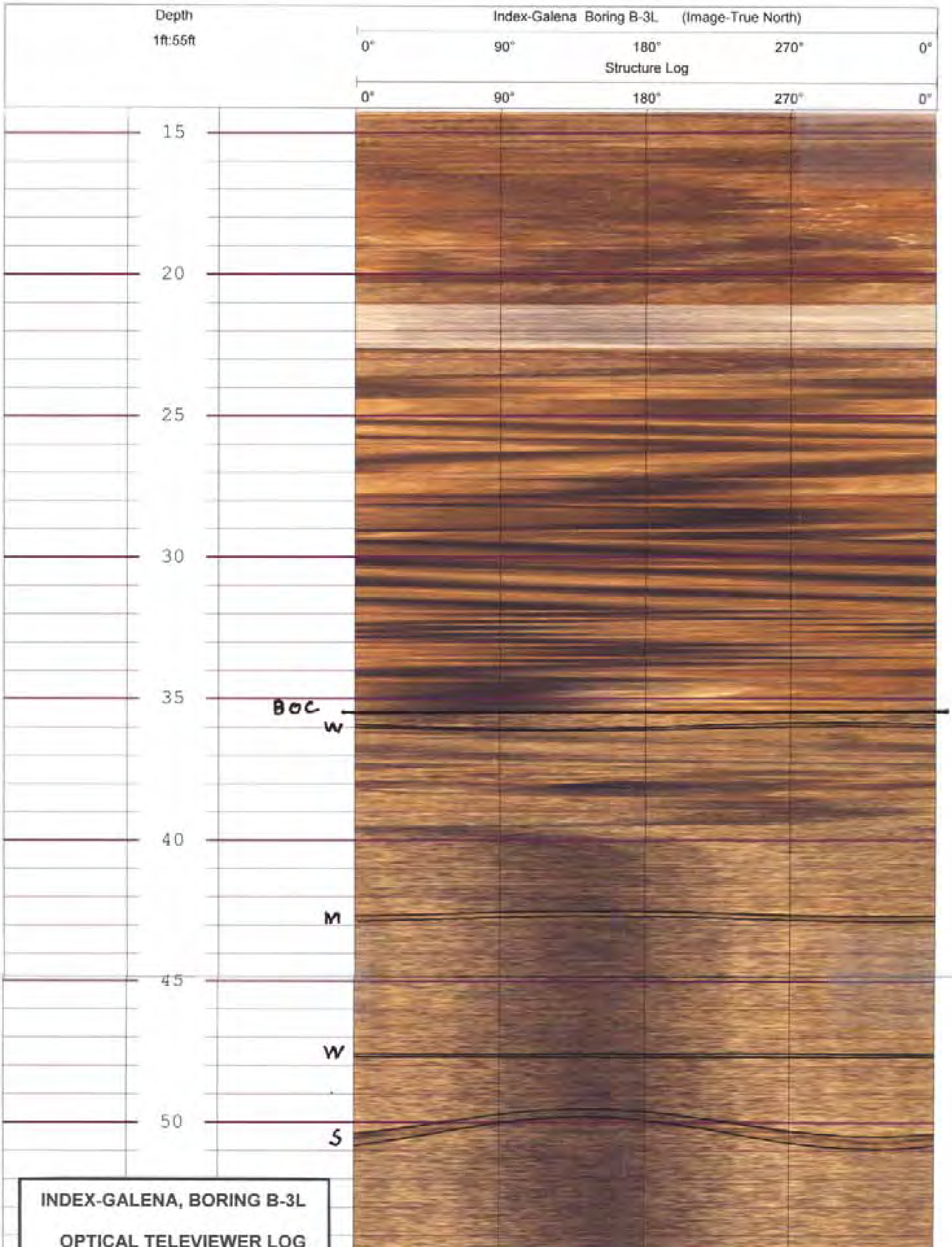
December 21, 2011 Job #873.3-11

INDEX-GALENA, BORING B-2L

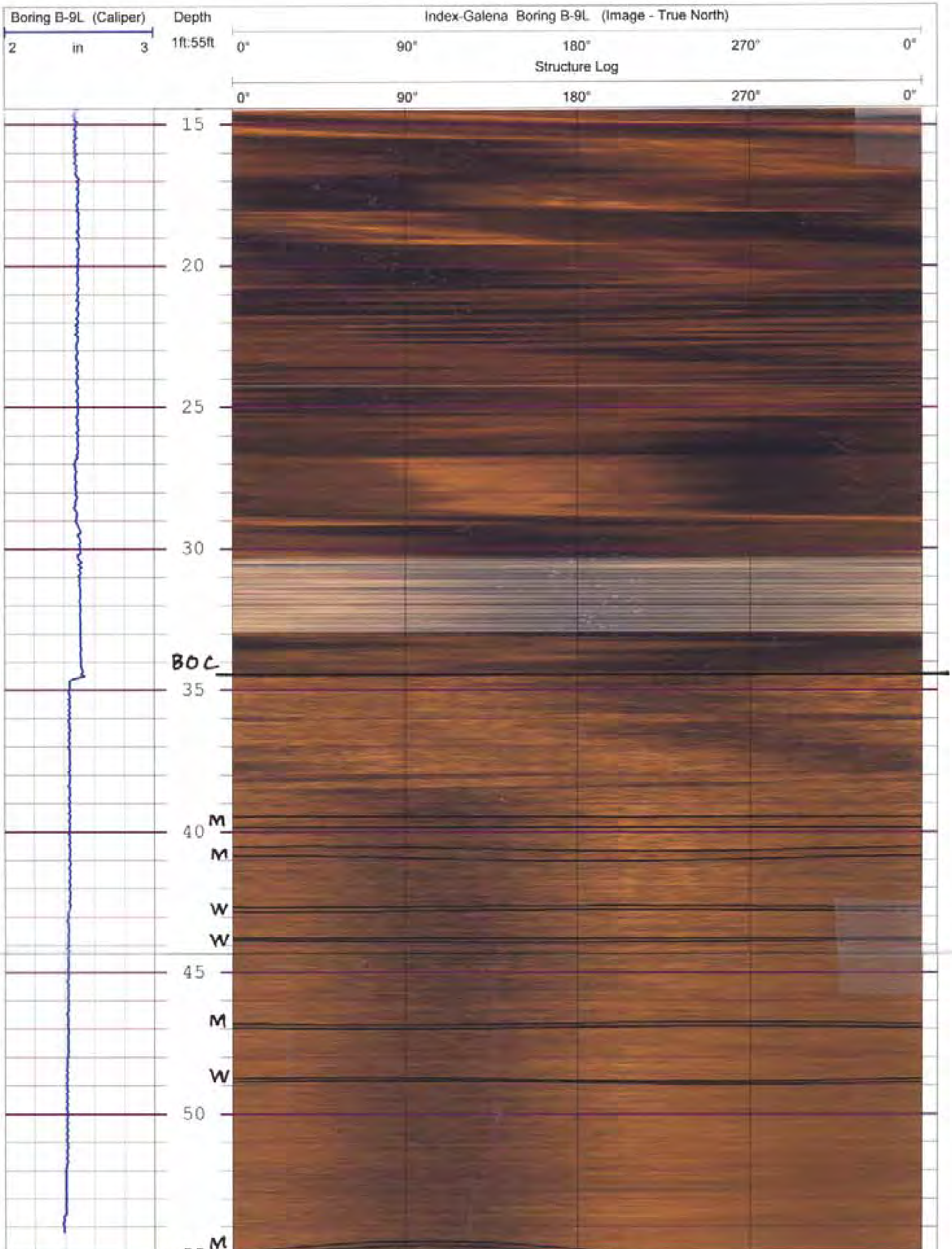


INDEX-GALENA, BORING B-3L

OPTICAL TELEVIEWER LOG

Phil Duoos, Geophysical Consultant
December 21, 2011 Job #873.3-11

INDEX-GALENA, BORING B-3L



INDEX-GALENA, BORING B-9L

OPTICAL TELEVIEWER LOG
CALIPER LOG

Phil Duoos, Geophysical Consultant
December 21, 2011 Job #873.3-11

INDEX-GALENA, BORING B-9L

APPENDIX F

SLOPE STABILITY ANALYSES

APPENDIX F

SLOPE STABILITY ANALYSES

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F.3 REFERENCES F-2

TABLE

F-1 Summary of Global Slope Stability Analyses Results

FIGURES

F-1 STA 26+75 Global Stability, 0.5H:1V RSS, Flood Level Conditions
F-2 STA 40+50 Global Stability, MSE Wall, Static Conditions
F-3 STA 40+50 Global Stability, MSE Wall, Flood Level Conditions
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F-11 STA 52+25 Global Stability, 1.5H:1V Rockfill Slope, Static Conditions
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F-13 STA 52+75 Global Stability, 0.5H:1V RSS, Static Conditions
F-14 STA 52+75 Global Stability, 0.5H:1V RSS, Flood Level Conditions

APPENDIX F

SLOPE STABILITY ANALYSES

F.1 GENERAL

We performed global slope stability analyses for representative sections at Stations 26+75, 40+50, 44+00, 46+25, 48+00, 52+25, and 52+75 of the proposed alignment. Our analyses included calculating factors of safety (FSs) against global instability for the existing slopes and for proposed constructed geometries. Figures F-1 through F-14 present the results of these analyses, the assumed soil layer thicknesses and material parameters, and the calculated critical failures surfaces. The global stability analysis results are summarized in Table F-1.

F.1.1 Soil Parameters and Generalized Subsurface Profiles

Soil layer thicknesses and geometries used for the global stability models were interpreted using soil boring logs in conjunction with the seismic refraction surveys (see Section 6.3). Proposed geometries were developed based on cross sections provided by Snohomish County.

The engineering parameters used in our global stability analyses are presented in Figures F-1 through F-14. These parameters are based on published correlations with Standard Penetration Test N-values and our experience with the soil units present at the site.

F.1.2 Analysis Method

We used the computer program SLOPE/W Version 7.17 (GeoSlope International, 2007) to perform slope stability analyses. The computer program SLOPE/W uses a number of methods to calculate the FS against slope instability by analyzing the shear and normal forces acting on a series of vertical “slices” that comprise a failure surface. Each vertical slice is treated as a rigid body; therefore, the forces and/or moments acting on each slice are assumed to satisfy static equilibrium (i.e., a limit equilibrium analysis). The FS is defined as the ratio of the forces available to resist movement to the forces of the driving mass. An FS of 1.0 means that the driving and resisting forces are equal; an FS less than 1.0 indicates that the driving forces are greater than the resisting forces (indicating failure). For each potential failure surface, we used the general limit equilibrium method (Fredlund and Krahn, 1977), which satisfies both force and moment equilibrium, to calculate an FS against slope failure.

We selected analysis cross sections that represent the tallest walls or slopes and the walls and slopes bearing on sloping ground in colluvium (Qc) and alluvium (Qal). For each analysis section, circular and non-circular failure surfaces were evaluated using entry and exit ranges. Cross sections were evaluated for the static loading condition and the 100-year flood condition. Seismic loading conditions were not considered in these analyses.

Proposed geometries were modified in an iterative manner until the target static FSs were reached. The Washington State Department of Transportation [WSDOT] Geotechnical Design Manual [GDM] specifies target minimum FSs of 1.25 for unreinforced soil slopes and 1.3 for mechanically stabilized earth walls (MSEWs) and reinforced soil slopes (RSSs). For extreme event conditions (i.e., earthquake or flood), the WSDOT GDM specifies target FSs of 1.05 for unreinforced soil slopes and 1.1 for MSEWs and RSSs. We assumed a reinforcement length of 0.7 times the total height of the MSEW or RSS and an embedment depth of 2 feet below the elevation at which there is a 4-foot horizontal distance from the wall face to the slope face in front of the wall.

We used slope stability analyses to calculate earth pressures for the soldier pile wall at Station 44+00. Conventional earth pressure analyses are not applicable at this location because of the presence of a sloping groundwater surface. We modeled the wall as an open cut and iteratively applied a force to the cut that achieves a factor of safety of 1.0. This procedure is described in the WSDOT GDM. Figure F-5 presents the results of our earth pressure analysis.

F.2 ANALYSIS RESULTS

The results of our global stability analyses are presented in Figures F-1 through F-14 and are summarized in Table F-1. Target static and 100-year flood condition FSs were achieved for the various proposed geometries analyzed.

F.3 REFERENCES

Geo-Slope International, 2007, SLOPE/W v 7.13: Calgary, Alberta, Geo-Slope International.

Fredlund, D.G. and Krahn, J, 1977, Comparison of slope stability methods of analysis. Canadian Geotechnique 14(3): 429-439.

Washington State Department of Transportation (WSDOT), 2010, Geotechnical design manual: Olympia, Wash., WSDOT Manual M 46-30, 1 v., January.

TABLE F-1
SUMMARY OF GLOBAL SLOPE STABILITY ANALYSES RESULTS

Station Analyzed	Feature Analyzed	Approximate Wall, RSS, or Embankment Height	Foundation Soil	Static Factor of Safety	Flood Level Factor of Safety
26+75	0.5H:1V RSS	27 feet	~2H:1V Qc Slope	1.6 (not shown)	1.6 (Fig. F-1)
40+50	MSE Wall	29 feet	Qc/Qal	2.1 (Fig. F-2)	1.9 (Fig. F-3)
44+00	Soldier Pile Wall	11.5	~30° Qvrl/Qc/Qal Slope	1.3 (Fig. F-4, Earth Pressure Analysis - Fig. F-5)	1.2 (Fig. F-6)
46+25	Existing Slope	--	~30° Qvrl/Qc/Qal Slope	Without Drains: 0.9 With Drains: 1.3 (not shown)	Without Drains: 0.9 (Fig. F-7) With Drains: 1.3 (Fig. F-8)
48+00	MSE Wall	13 feet	~1.2H:1V Qc Slope	1.5 (Fig. F-9)	1.4 (Fig. F-10)
52+25	1.5H:1V Rock Fill Slope	19 feet	~1.5H:1V Qal Slope	1.3 (Fig. F-11)	1.2 (Fig. F-12)
52+75	0.5H:1V RSS	24 feet	~2H:1V Qal Slope	1.3 (Fig. F-13)	1.1 (Fig. F-14)

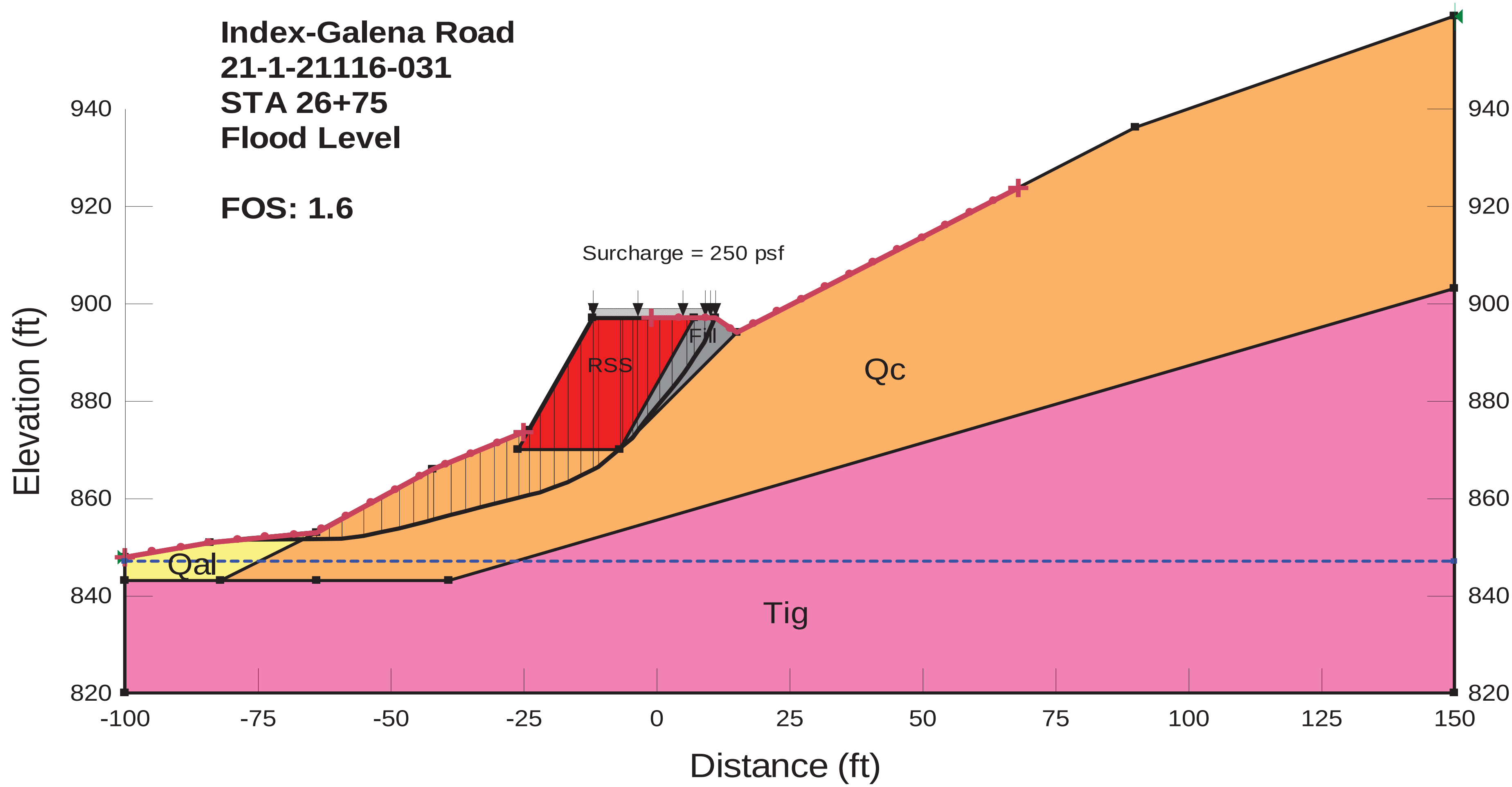
Notes:

MSE = Mechanically Stabilized Earth

RSS = Reinforced Soil Slope

Qc = Quaternary age colluvium

Qal = Quaternary age alluvium



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

FIG. F-1

Index Galena Flood Repair Project Mileposts 6.4 to 6.9 Snohomish County, Washington	
STA 26+75 GLOBAL STABILITY **0.5H:1V RSS** **FLOOD LEVEL CONDITIONS**	
December 2012	21-1-21116-031
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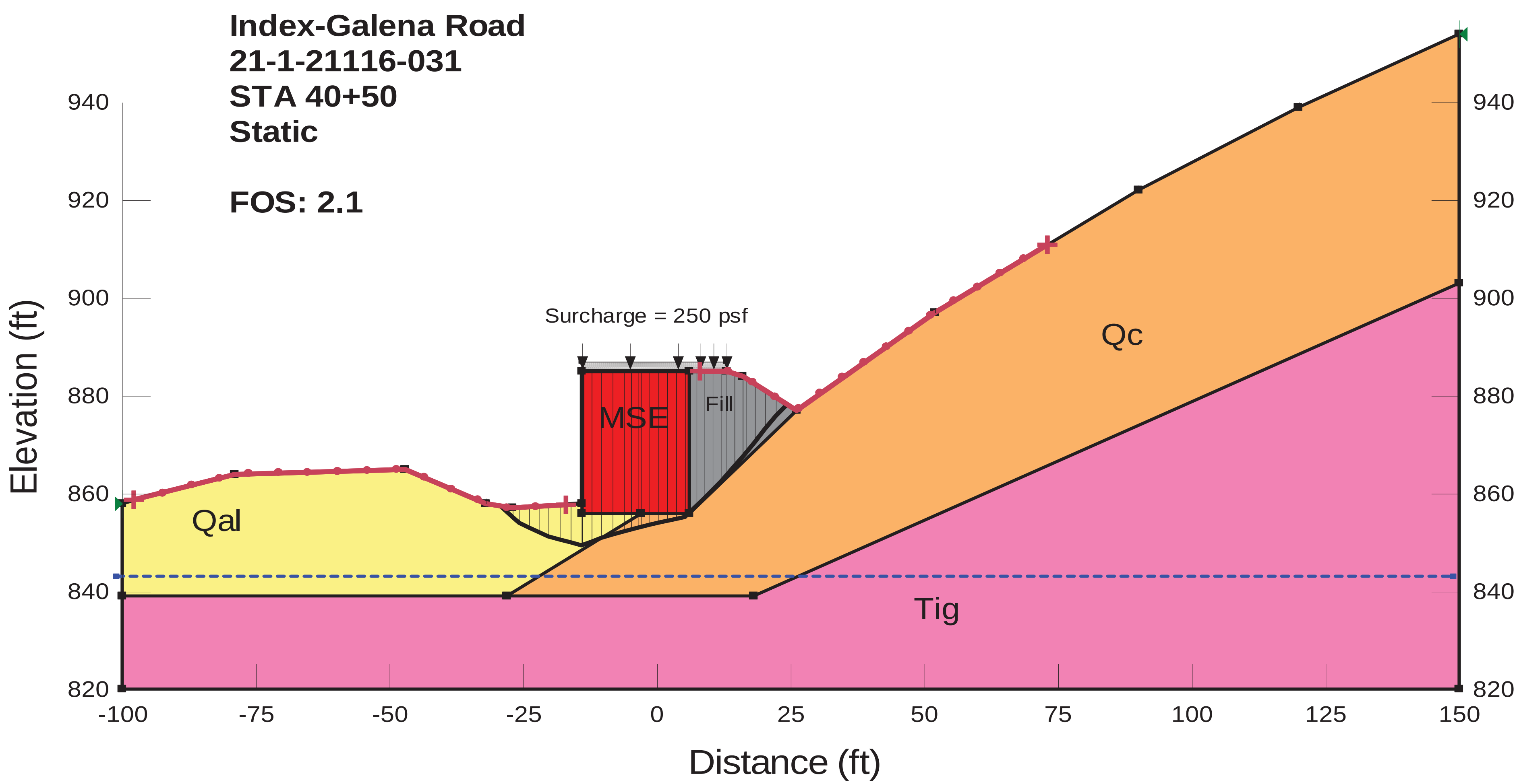
40+50.xlsm 12/13/2012



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

FIG. F-2

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 40+50 GLOBAL STABILITY
MSE WALL
STATIC CONDITIONS

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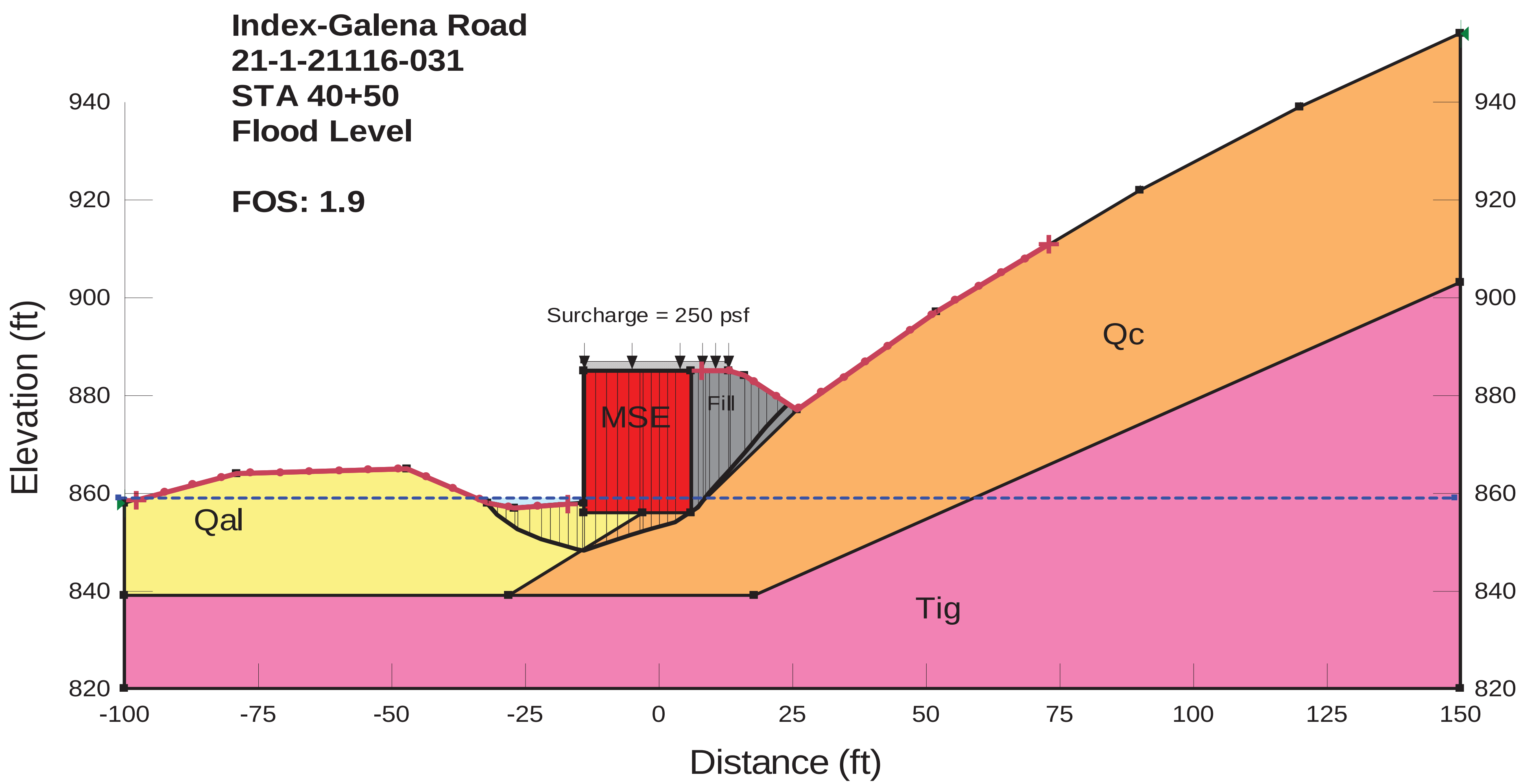
FIG. F-2



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

FIG. F-3

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 40+50 GLOBAL STABILITY
MSE WALL
FLOOD LEVEL CONDITIONS

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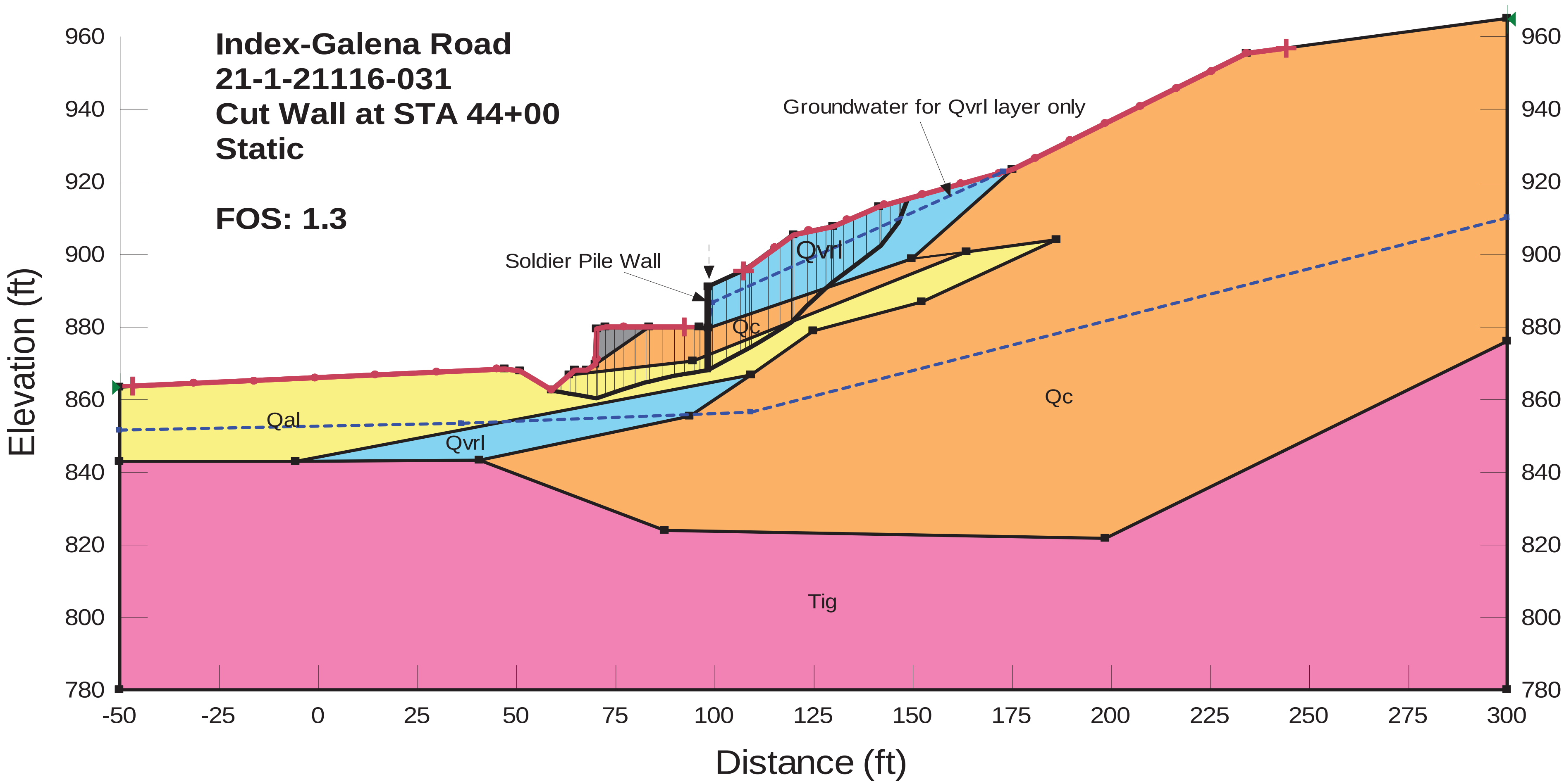
FIG. F-3



<u>Soil Parameters:</u>

Qc: Unit Weight - 135 pcf, Friction Angle - 42°

Qal: Unit Weight - 125 pcf, Friction Angle - 32°

Qvrl: Unit Weight - 120 pcf, Friction Angle - 28°, Cohesion - 100 psf

<u>NOTES</u>

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).
2. Analysis assumes soldier pile wall embedment is equal to the exposed height.

FIG. F-4

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 44+00 GLOBAL STABILITY
SOLDIER PILE WALL
STATIC CONDITIONS

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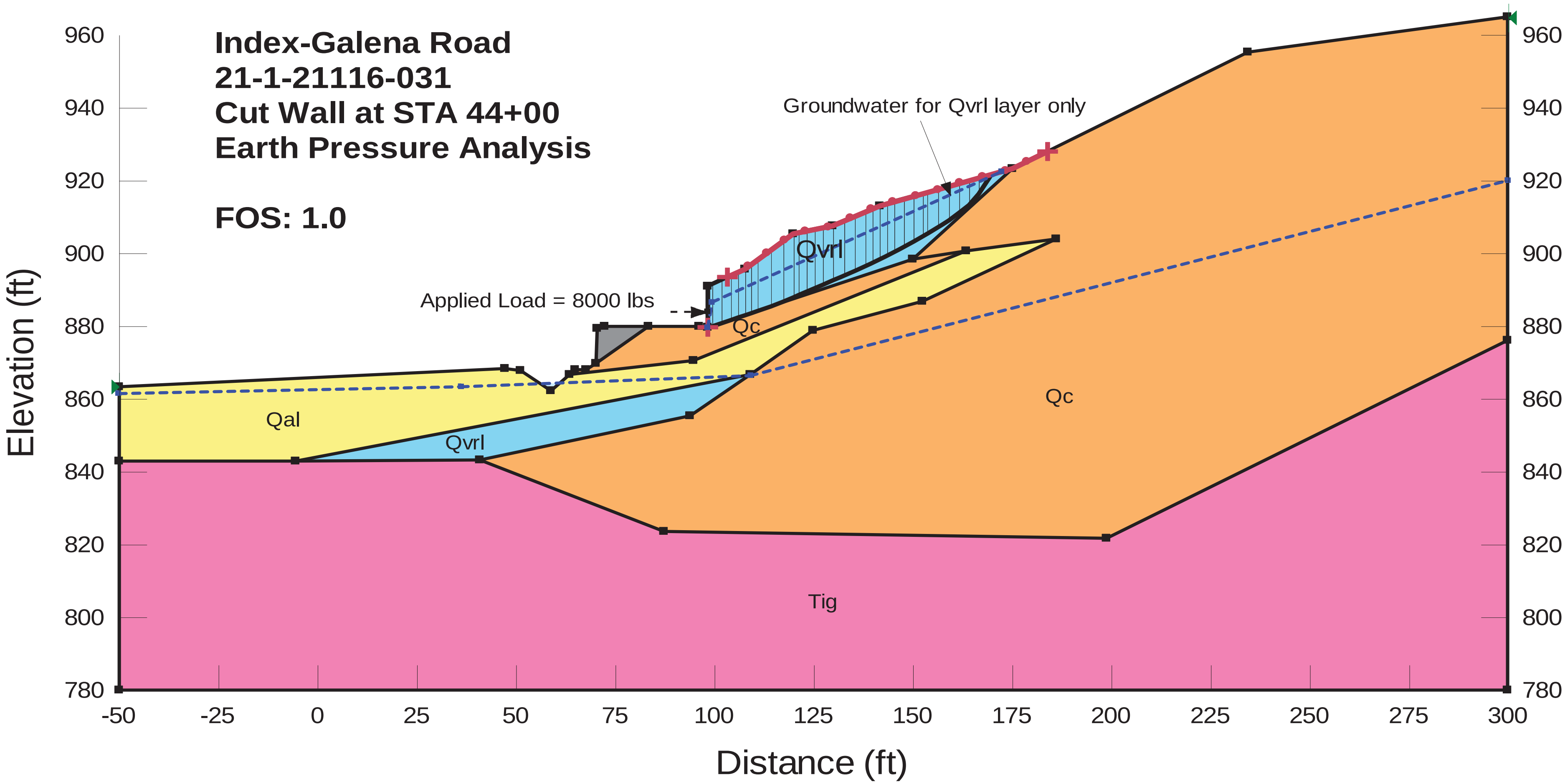
FIG. F-4



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Qvrl: Unit Weight - 120 pcf, Friction Angle - 28°, Cohesion - 100 psf

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 44+00 GLOBAL STABILITY
SOLDIER PILE WALL
EARTH PRESSURE ANALYSIS

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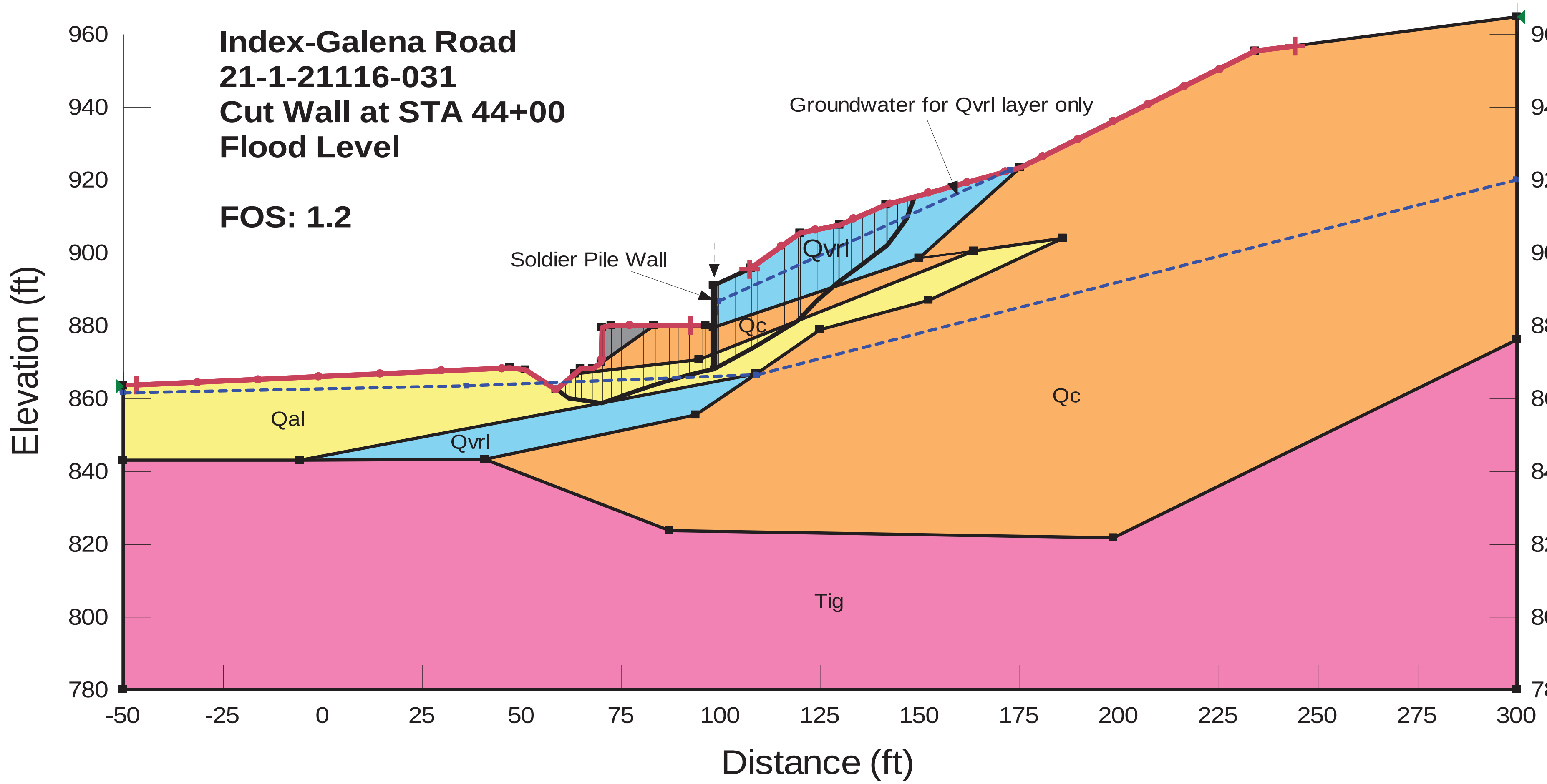
FIG. F-5

FIG. F-5



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Qvrl: Unit Weight - 120 pcf, Friction Angle - 28°, Cohesion - 100 psf

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).
2. Analysis assumes soldier pile wall embedment is equal to the exposed height.

FIG. F-6

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 44+00 GLOBAL STABILITY
SOLDIER PILE WALL
FLOOD LEVEL CONDITIONS

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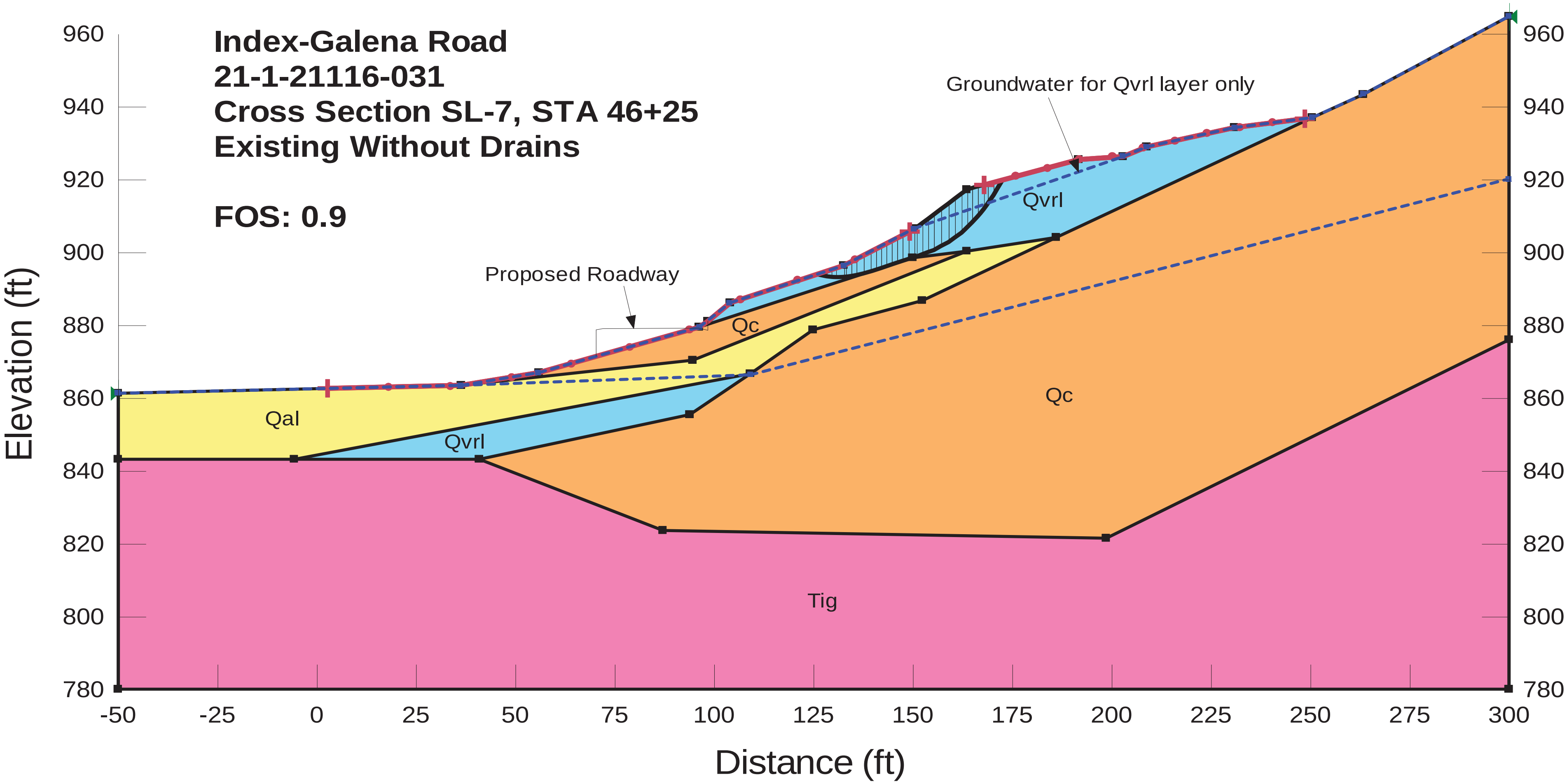
FIG. F-6



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°

Qal: Unit Weight - 125 pcf, Friction Angle - 32°

Qvrl: Unit Weight - 120 pcf, Friction Angle - 28°, Cohesion - 100 psf

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 46+25 GLOBAL STABILITY EXISTING QVRL SLOPE WITHOUT DRAINS

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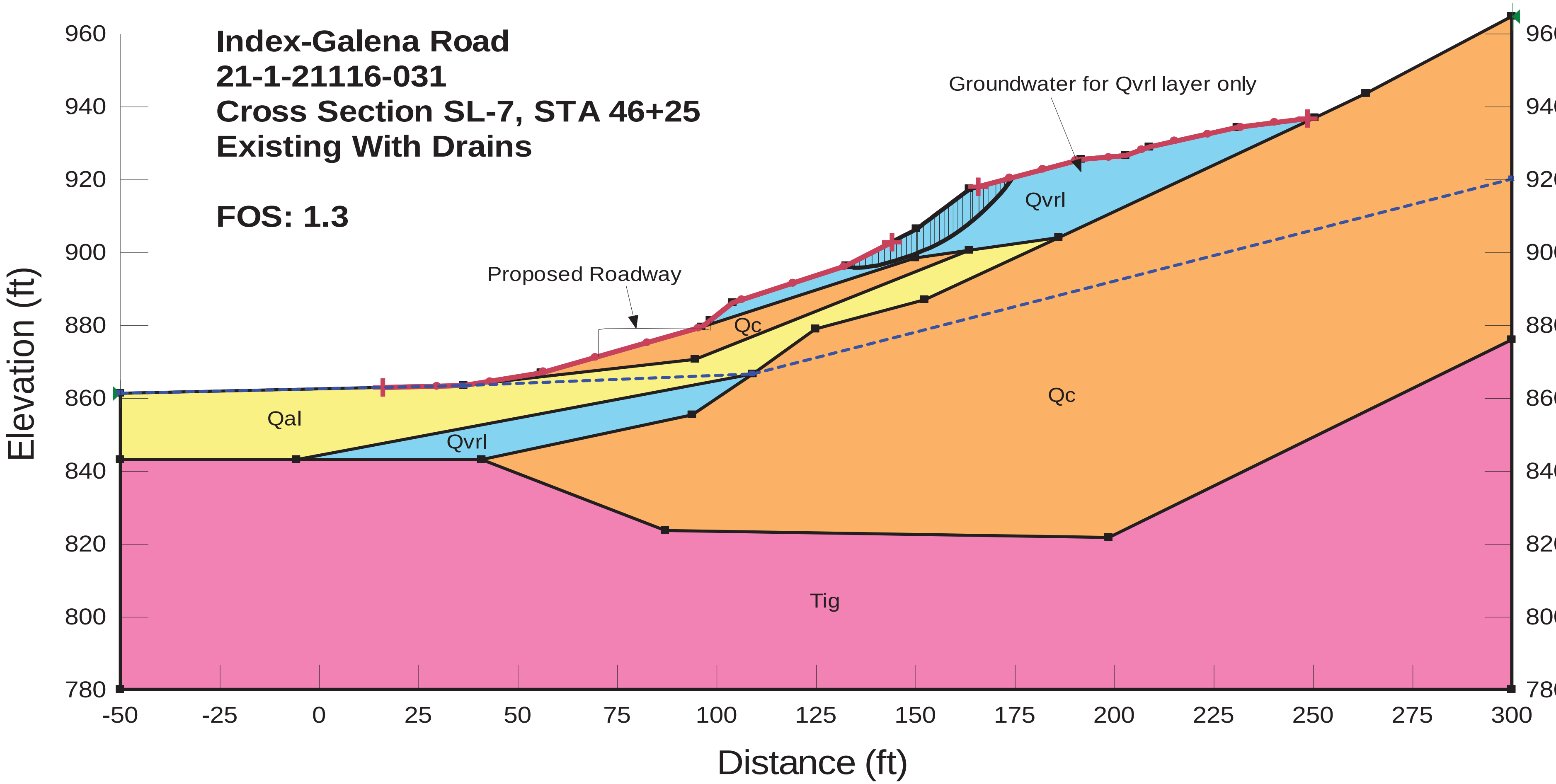
FIG. F-7

FIG. F-7



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Qvrl: Unit Weight - 120 pcf, Friction Angle - 28°, Cohesion - 100 psf

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project Mileposts 6.4 to 6.9 Snohomish County, Washington	
STA 46+25 GLOBAL STABILITY EXISTING QVRL SLOPE WITH DRAINS	
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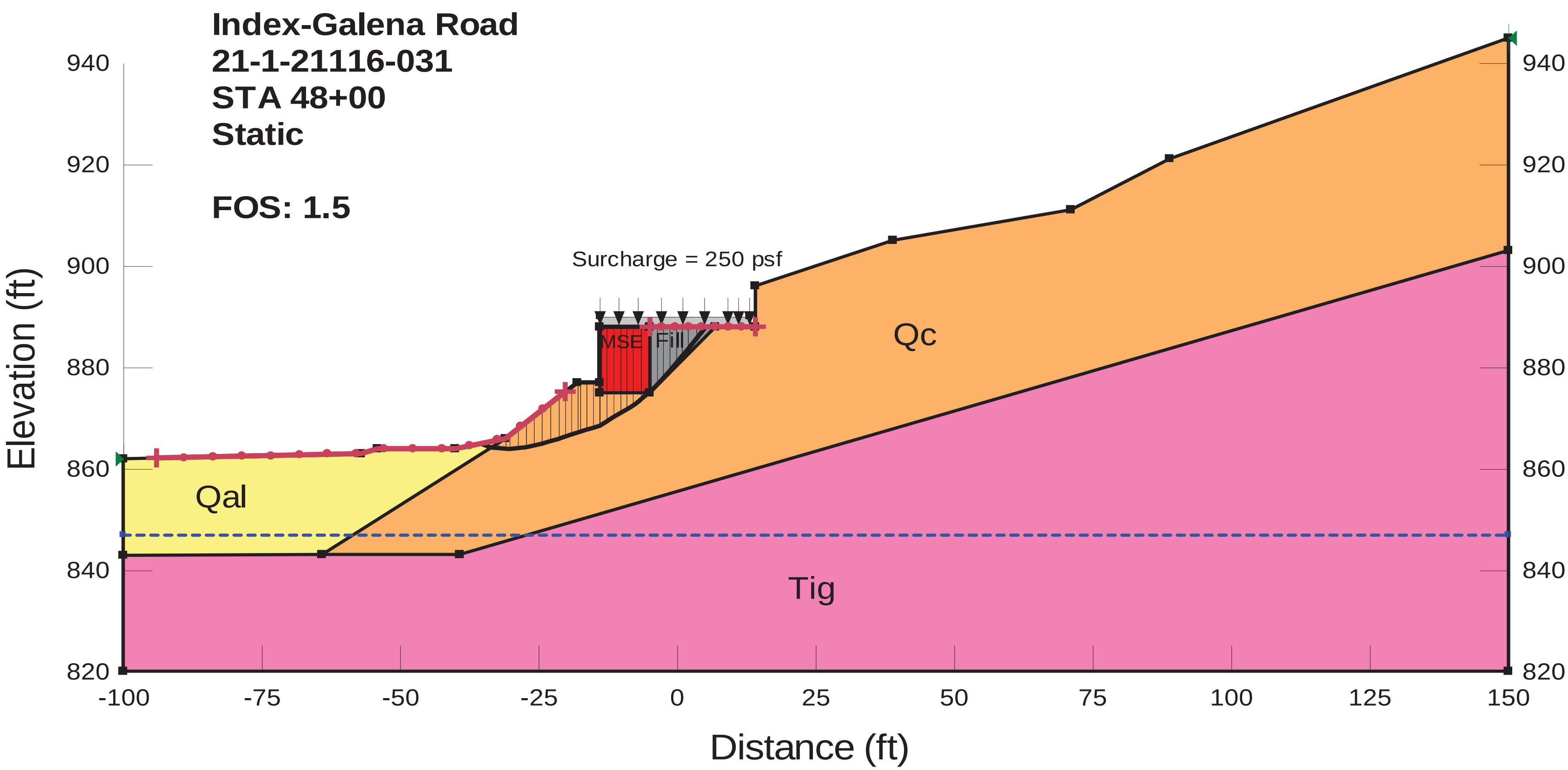
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants	**FIG. F-8**

FIG. F-8

48+00.xlsm 12/13/2012



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 48+00 GLOBAL STABILITY
MSE WALL
STATIC CONDITIONS

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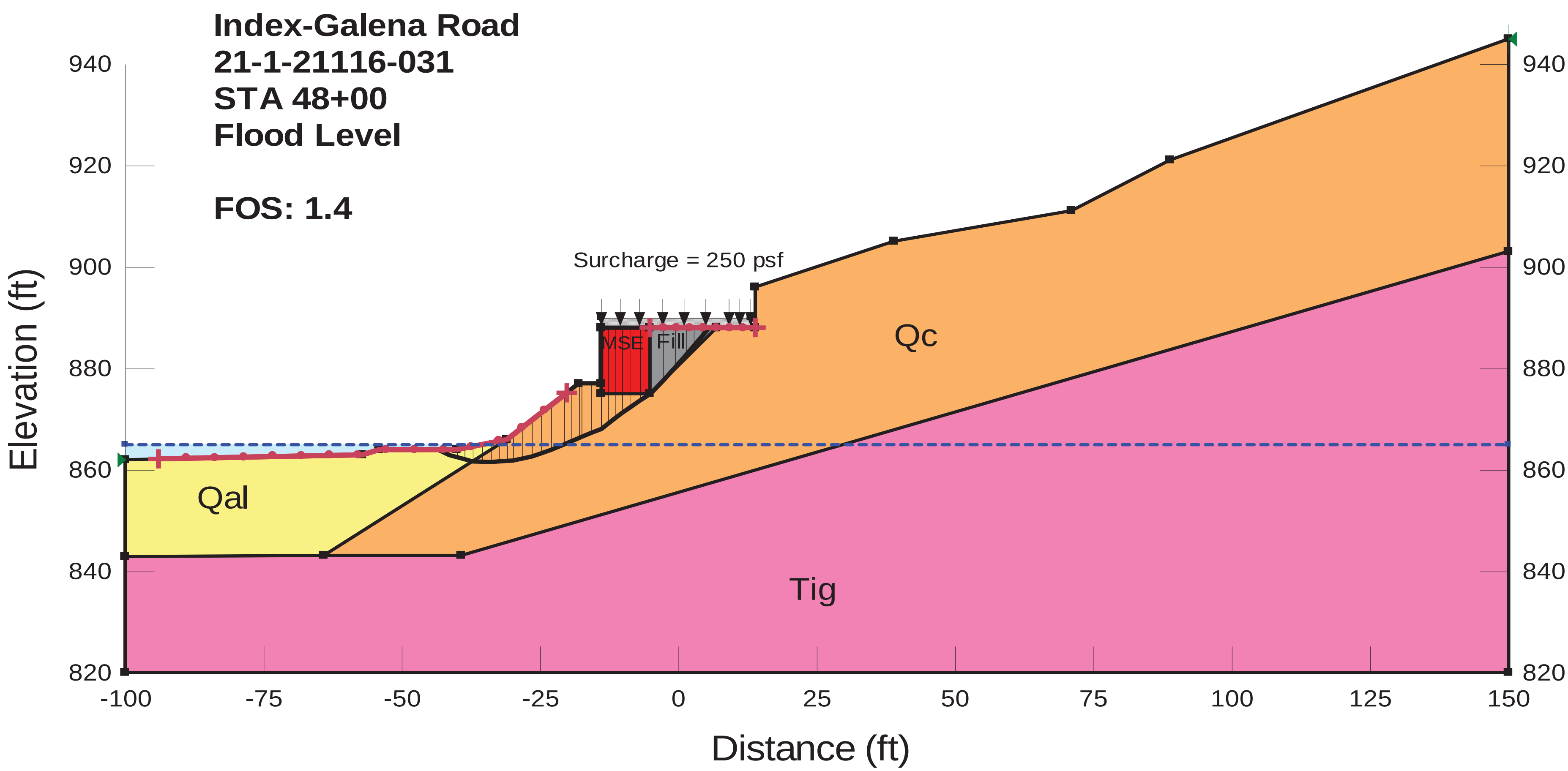
FIG. F-9

FIG. F-9

48+00.xlsm 12/13/2012



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project Mileposts 6.4 to 6.9 Snohomish County, Washington
STA 48+00 GLOBAL STABILITY **MSE WALL** **FLOOD LEVEL CONDITIONS**
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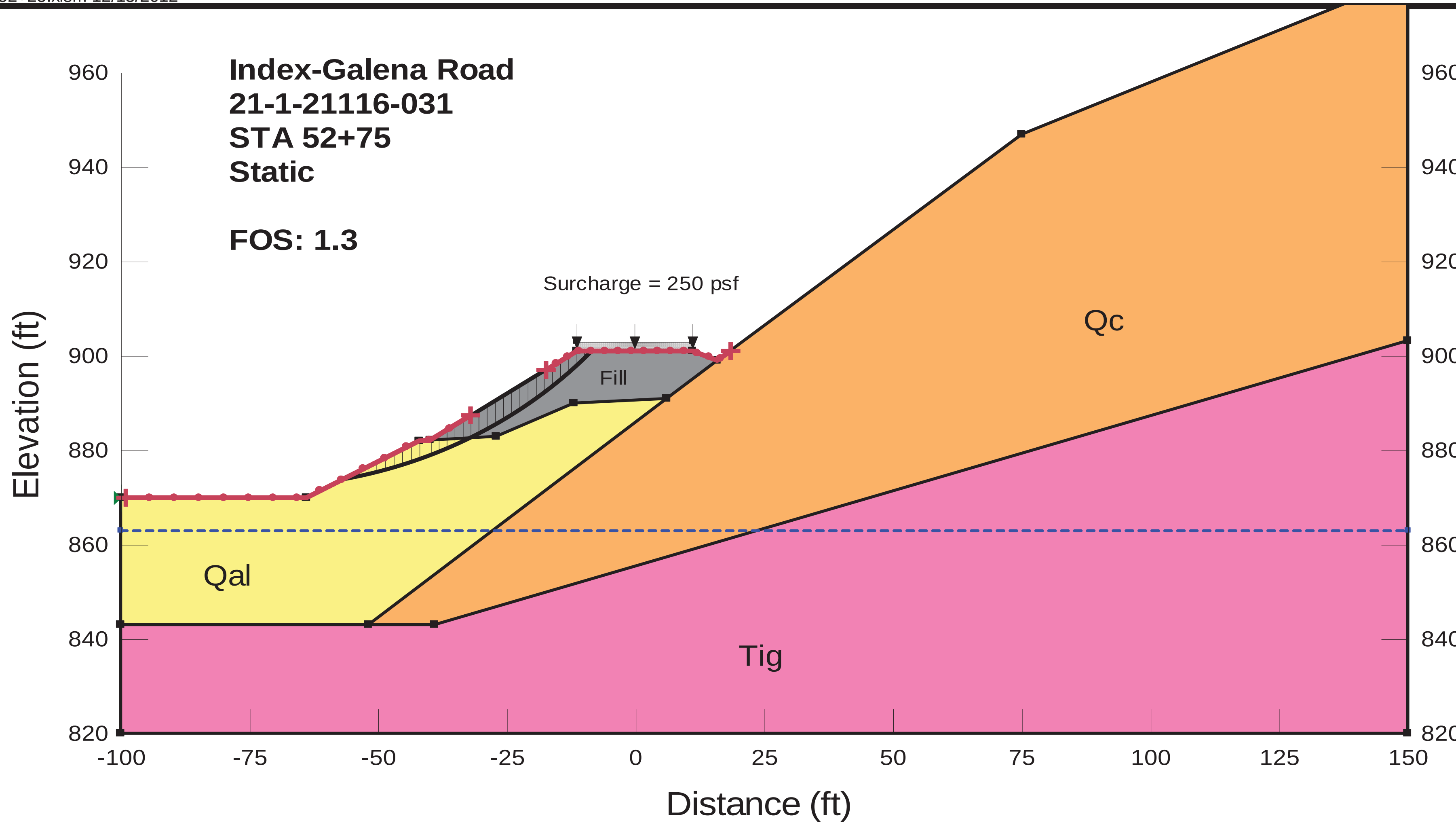
FIG. F-10



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 34°
Fill: Unit Weight - 130 pcf, Friction Angle - 38°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

2. Analysis assumes a minimum slip surface depth of 5 feet.

FIG. F-11

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 52+25 GLOBAL STABILITY
1.5H:1V ROCKFILL SLOPE
STATIC CONDITIONS

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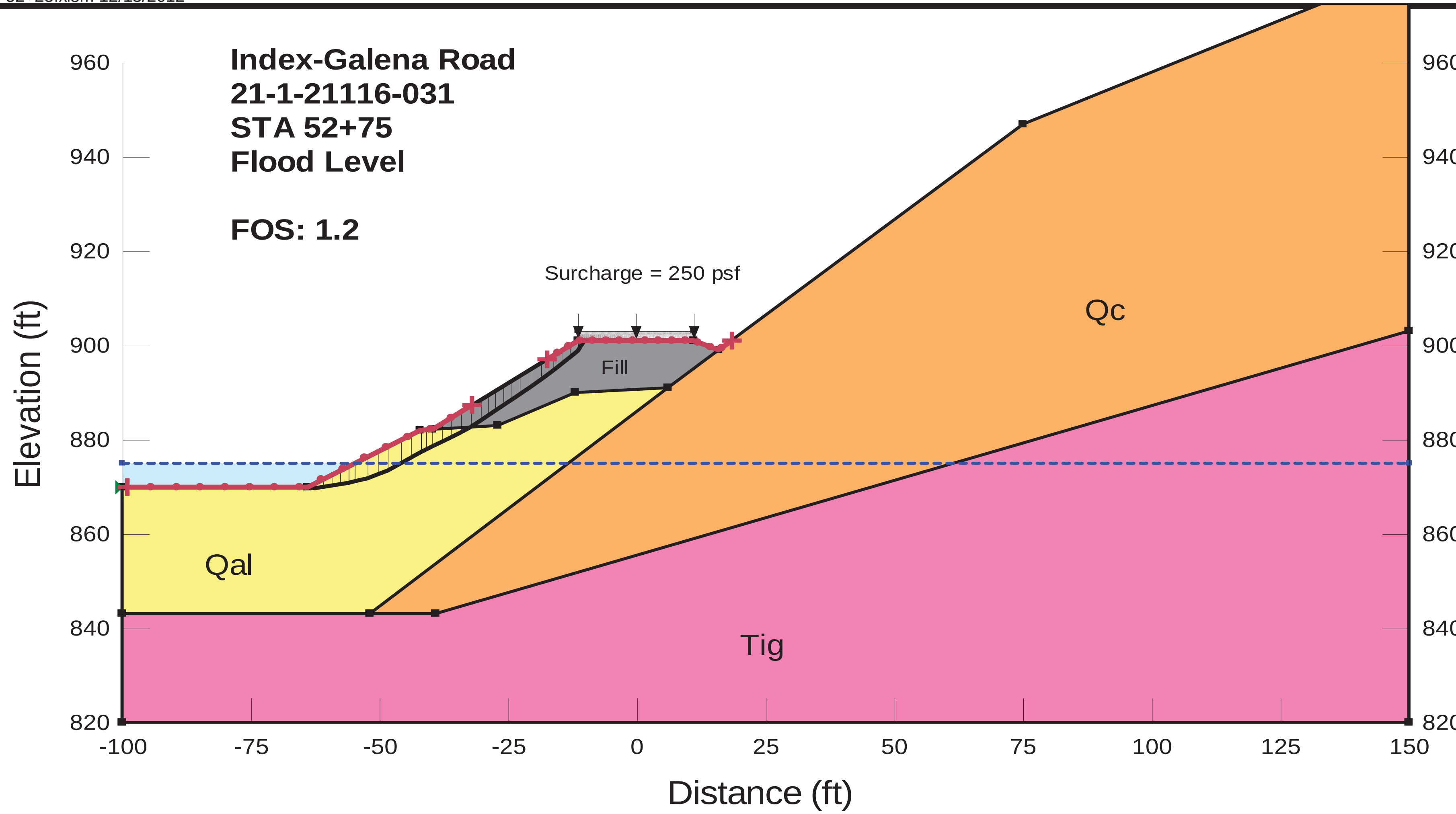
FIG. F-11

52+25.xlsm 12/13/2012



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 34°
Fill: Unit Weight - 130 pcf, Friction Angle - 38°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).
2. Analysis assumes a minimum slip surface depth of 5 feet.

FIG. F-12

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 52+25 GLOBAL STABILITY
1.5H:1V ROCKFILL SLOPE
FLOOD LEVEL CONDITIONS

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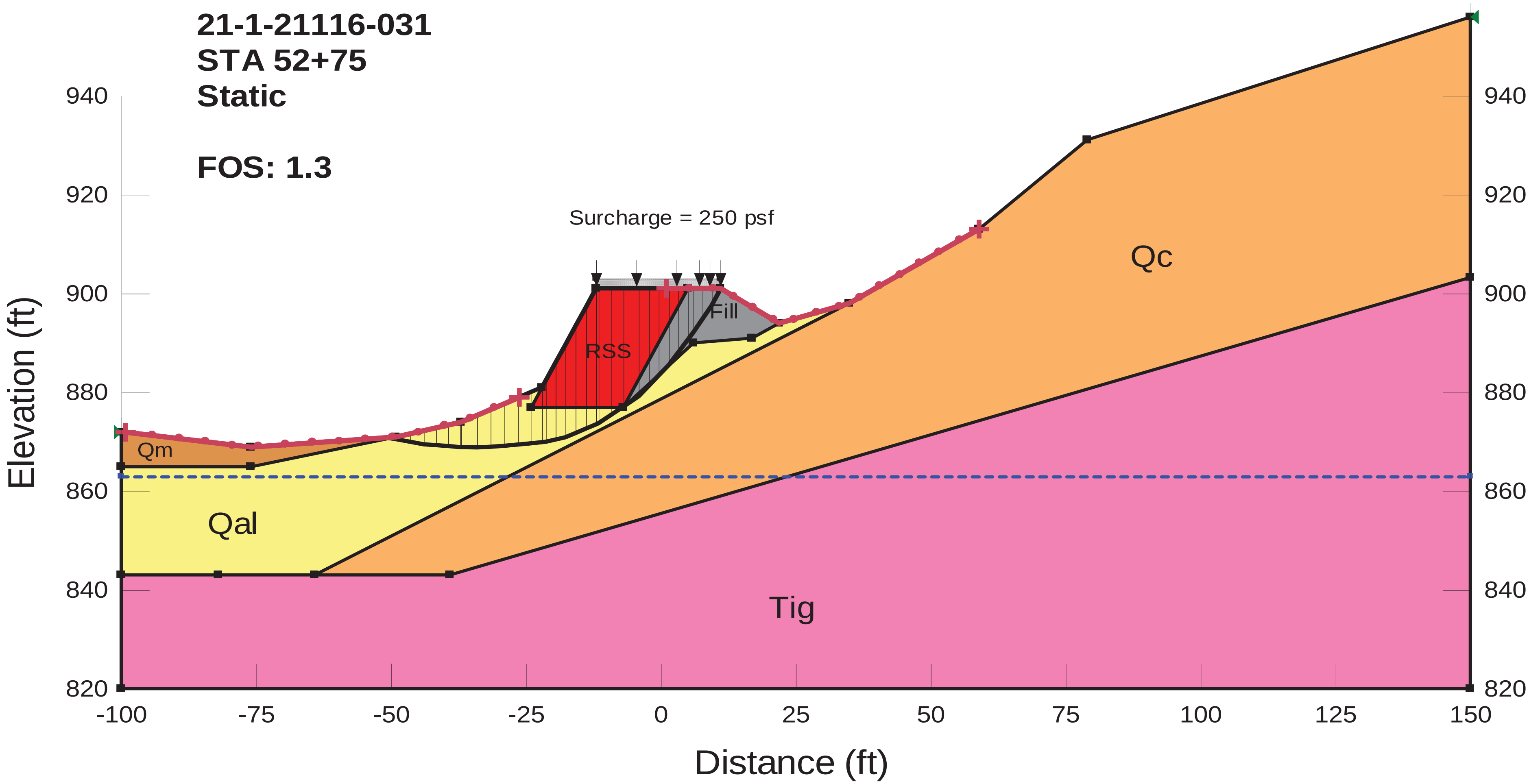
FIG. F-12

52+75.xlsm 12/13/2012

Index-Galena Road
21-1-21116-031
STA 52+75
Static

FOS: 1.3



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Qm: Unit Weight - 110 pcf, Friction Angle - 26°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project
Mileposts 6.4 to 6.9
Snohomish County, Washington

STA 52+75 GLOBAL STABILITY
0.5H:1V RSS
STATIC CONDITIONS

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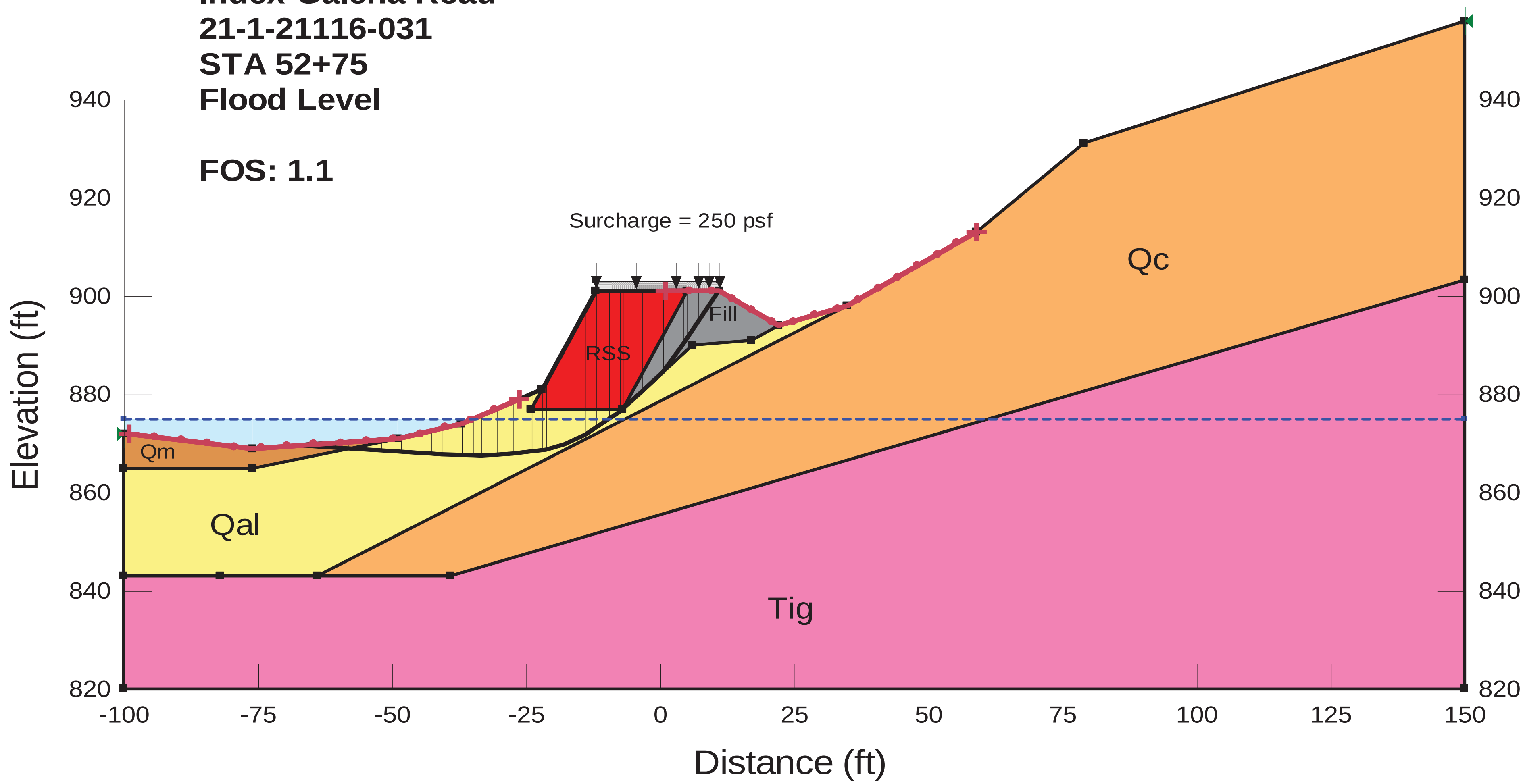
FIG. F-13

FIG. F-13

Index-Galena Road
21-1-21116-031
STA 52+75
Flood Level

FOS: 1.1



Soil Parameters:

Qc: Unit Weight - 135 pcf, Friction Angle - 42°
Qal: Unit Weight - 125 pcf, Friction Angle - 32°
Qm: Unit Weight - 110 pcf, Friction Angle - 26°
Fill: Unit Weight - 130 pcf, Friction Angle - 34°

NOTES

1. Slope stability analyses were performed with SLOPE/W version 7.17 (GeoSlope International, 2007).

Index Galena Flood Repair Project Mileposts 6.4 to 6.9 Snohomish County, Washington	
STA 52+75 GLOBAL STABILITY **0.5H:1V RSS** **FLOOD LEVEL CONDITIONS**	
December 2012	21-1-21116-031
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APPENDIX G

GROUNDWATER DATA

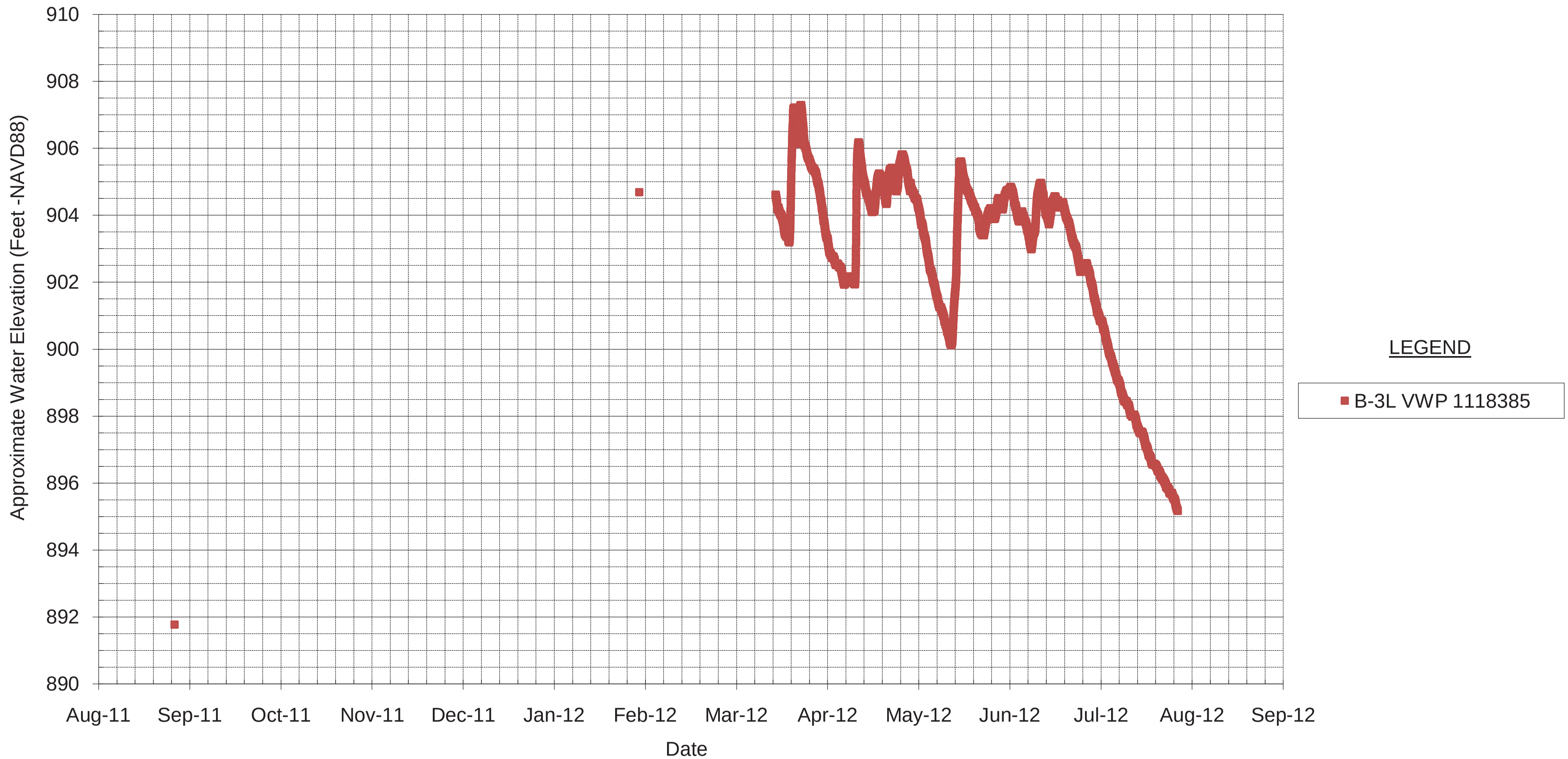
APPENDIX G

GROUNDWATER DATA

TABLE OF CONTENTS

FIGURES

G-1 Groundwater Elevation Boring B-3L
G-2 Groundwater Elevation Boring B-5L



NOTE

1. Times are on Pacific Standard Time (PST).

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GROUNDWATER ELEVATION
BORING B-3L

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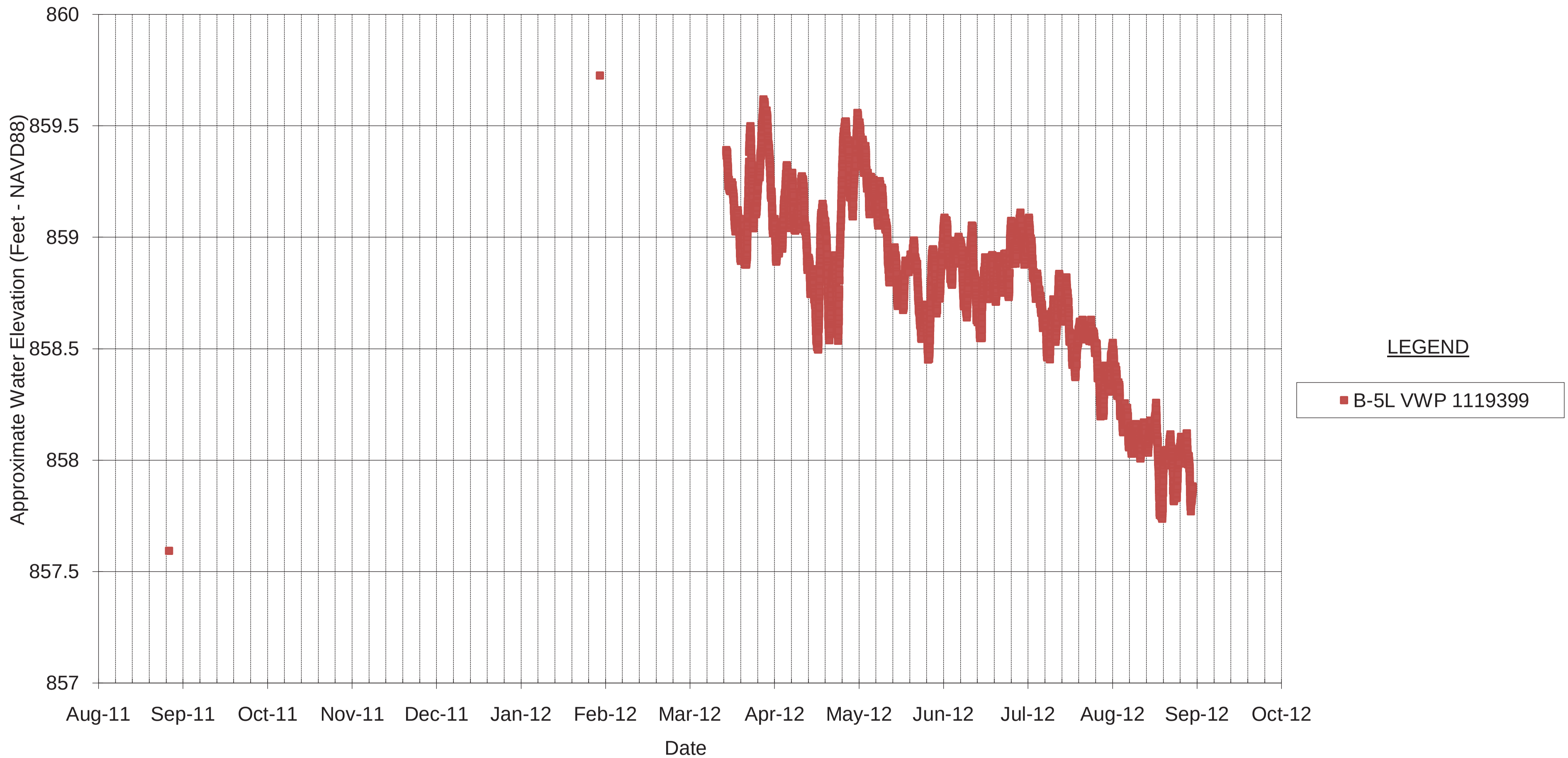
FIG. G-1

FIG. G-1



NOTE

1. Times are on Pacific Standard Time (PST).

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GROUNDWATER ELEVATION
BORING B-5L

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FIG. G-2

FIG. G-2

APPENDIX H

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

Attachment to and part of Report 21-1-21116-031

Date: December 28, 2012
To: Mr. Dale Topham
Snohomish County Public Works

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland