SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS	CHANGE ORDER JUSTIFICATION	CHANGE ORDER NUMBER
		10
		7/25/2021
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PROJECT:	**Index – Galena Road Flood Repair**	**PROJECT #:**	**RC1532, RC1774, RR6322**
PROJECT ENGINEER:	**Sam Chi**	**FED AID #**	**ER-0701(063)**

WRITTEN JUSTIFICATION

1. DESCRIPTION OF CHANGE.

This Change Order adds two new bid items under Group 1 to compensate the Contractor for work associated with repairing the uphill roadside slope damaged from a localized landslide that occurred in the vicinity of "I" 46+50 RT to "I" 49+50 RT.

New item "Slide Repair Excavation and Embankment" by Force Account
New item "Rock Backfill for Slide Repair" per Ton.

2. WHAT IS REQUIRED BY CONTRACT? WHY THE CHANGE? (REFERENCE PLAN SHEETS & SPEC SECTIONS.)

The work to perform the slide repair is a change in conditions. Following periods of heavy rain, on October 29, 2021, a localized slide occurred along the uphill slope of the new road alignment from station 46+50 RT to 49+50 RT. This is in an area where the roadway cuts into the hillside. Weeks after completing the rough excavation through this section, the 1.5:1 cut slope above the roadway that was constructed per plan (TS02/Section Q) gave way mobilizing slide material (silt/clay/rock) on to the new roadway below. According to the geotechnical conditions exhibit (attached), the subsurface material in this area is classified as Qvrl – Quaternary Recessional Lacustrine Deposits with the top 14 feet approximately below grade consisting of soft to medium stiff silty clay; moist; scattered wet, silty, fine to medium sand. Work to repair the landslide is beyond the scope of the original contract.

3. HOW IS CHANGE ORDER THE SOLUTION?

The slide damage/repair is a change in conditions to the original contract and requires a change order to compensate the contractor for this additional work. This change order will add two new items - "Slide Repair Excavation and Embankment" and "Rock Backfill for Slide Repair". The first one is a force account item to compensate the contractor to excavate, embank, and mix the slide material with topsoil and brush from on-site. The second item compensates the contractor to furnish and place the backfill material. Due to the nature of the work and unknown depths of excavation, force account is an acceptable and agreed upon method to compensate for work, whether known or unknown.

4. ALTERNATIVE(S) CONSIDERED.

A soldier pile with tie-back wall was evaluated by S&W (Geotech Engineer of Record); however, this alternative comes at higher costs (engineering, construction, and maintenance), additional construction risks, potential schedule delays, and requires specialty equipment and staff to perform the work.

5. REASON FOR ENTITLEMENT AND WHY IT CANNOT BE PAID UNDER EXISTING CONTRACT.

The work to perform the slide repair is a change in conditions. The Contract has other bid items (roadway excavation, structure excavation, quarry spalls, etc.); however, the slide repair excavation and backfill differs in scope from existing bid items. Variability in excavation depths and additional work to embank this material on site requires a new force account as the work may require different equipment and construction practices; and could take longer to accomplish.

PROJECT:	**Index – Galena Road Flood Repair**	**PROJECT #:**	**RC1532, RC1774, RR6322**
PROJECT ENGINEER:	**Sam Chi**	**FED AID #**	**ER-0701(063)**

6. APPROVALS: PROJECT MANAGER, TECHNICAL ADVISOR (TRAFFIC, STRUCTURAL), JURISDICTION, OTHER AGENCY.

Standard change order approval (Construction Manager, Engineering Services Director, County Engineer). USFS was consulted and approval during this change order development to dispose slide material on site.

7. TIME: INCREASE OR DECREASE WORKING DAYS.

An additional 10 days will be added. Upon completing the slide repair, additional working days will be evaluated and processed in a future change order if needed.

8. COST: ESTABLISH OR VERIFY INCREASE OR DECREASE. (CONTRACTOR PROPOSAL, ENGINEER'S ESTIMATE, NEGOTIATED, SUPPLIER, BID ITEM, ETC.)

The overall slide repair is estimated between $600K and $800K; and will require approximately 6,500 CY of excavation and 7,500 tons of rock backfill.

This is the first of two change orders, which will allow the Contractor to proceed with a portion of the work and take advantage of the weather/schedule window. An engineer's estimate (see attachment) was prepared for the item "Rock Backfill for Slide Repair" which supports the agreed upon cost of $45/ton. Using invoices and payments previously made by force account (Item 175 – Unsuitable Foundation Excavation), a per unit item was estimated at $37.42/ton (furnish only). A separate cost for placement was estimated at $9.17/ton, which combined equals $46.59/ton.

The quantity of 2,000 tons in this estimate was based on an overall target value of $90,000 to provide a balanced amount of work for excavation and backfill to occur during this first phase of the work.

ATTACHED BACKUP DOCUMENTATION:

1) Engineer's Estimate Backup Docs, 4 pages
2) Geotechnical Conditions Exhibit, 1 page
3) Repair Recommendation (S&W Geotechnical Engineer of Record), 3 pages

IGR Slide Repair Cost Estimate - 3 week

Owner:	Snohomish County	**Project Number:**	RC1532,RC1744,RR6322	**Date:**	7/20/22
Project Name:	Index-Galena Road Flood Repair	**Fed. Aid Number:**	ER-0701(063)	**BI No.:**	NEW

DESCRIPTION OF WORK:

Remove slide debris and backfill with quarry spalls or similar sized rock. Slide debris to be short-hauled to the base of rock embankment from 36+00 to 44+00. Slide material will be mixed with topsoil and brush. Assume 3 full weeks M-F @ 10 hr days and 2 hours OT each day. **No work on Saturday**.

LABOR:	Employee Class	Regular Hours	Overtime Hours	Regular Rate	Overtime Rate	Total
Foreman - Supervision 2 hrs/ day x 15 days	Operator	30		$ 89.28		$ 2,678.40
Operator x 6 full time x 8 hrs x 15 days	Operator	720		$ 89.28		$ 64,281.60
Operator x 6 full time x 2 hrs OT x 15 days	Operator	180			120.64	$ 21,715.20
Operator x 1 part time x 4 hrs x 15 days	Operator	60		$ 89.28		$ 5,356.80
Operator x 1 part time x 1 hrs x 15 days	Operator	15			120.64	$ 1,809.60
						$ -
						$ -
					SUBTOTAL	**$ 95,841.60**
				Mark-up On Labor	**31.0%**	**$ 125,552.50**

EQUIPMENT:	Equipment Code	Equipment Hours	Stand-by Time	Operating Rate	Stand-by Rate	Total
F-150 Foreman truck		30		$ 18.26		$ 547.80
Cat 470 Excavator		150		$ 200.00		$ 30,000.00
Cat 336 Excavator		150		$ 183.27		$ 27,490.50
Cat D6 Dozer		150		$ 193.88		$ 29,082.00
		75		$ 87.75		$ 6,581.25
Rock Truck (#2)		150		$ 145.00		$ 21,750.00
Rock Truck (#1)		150		$ 145.00		$ 21,750.00
Rock Truck (#3)		150		$ 145.00		$ 21,750.00
						$ -
						$ -
						$ -
						$ -
Rental by Invoice						
						$ -
						$ -
						$ -
					SUBTOTAL	**$ 158,951.55**
				Mark-up On Equipment	**21.0%**	**$ 192,331.38**

MATERIALS Tax Rate = 7.8%	Quantity	Units	Unit Cost	Extended Cost	Sale Tax	Total
Quarry Spalls Bid Item (Assume 5000 CY x 1.5T/CY)	7500	TONS	$ 45.00	$ 337,500.00	$ 27,000.00	$ 364,500.00
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
					SUBTOTAL	**$ 364,500.00**
				Mark-up On Materials	**0.0%**	**$ 364,500.00**

SUBCONTRACTORS:	Quantity	Units	Unit Cost		Total
					$ -
					$ -
				SUBTOTAL	
				Mark-up On Subcontractors	**12.0%**

Comments:	**SUBTOTAL**	
	Overall Markup	
	TOTAL	**$ 682,383.87**

Estimated by: S. Chi 7/20/2022 **Project Engineer: Sam Chi** **Date**

CHANGE ORDER #10
7/25/2022
Justification Attachment 1
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GOODFELLOW BROS., INC.

ESTABLISHED 1921

425-432-2202

Goodfellow Bros., Inc. - Force Account Pricing Sheet

Customer Name:	Snohomish County	**GBI Project Number:**	202758	**Date:**	8/12/2021
Project Name:	INDEX/GALENA ROAD PROJECT	**Cost Code:**	850.0000.14.	**BI No.:**	

DESCRIPTION OF WORK: Force Account Cleaning Debris

Start over excavation of roadway at culvert 12.

Directed by: Sam Chi — **Date Received** 8/12/21

LABOR:	Employee Class	Regular Hours	Overtime Hours	Regular Rate	Overtime Rate	Total
Jimmy Nolte	541	1.00	-	$89.52	$154.73	$ 89.52
Luke Peterson	528	4.00	-	$82.54	$111.66	$ 330.16
Duane Warner	532	0.50		$82.54	$111.66	$ 41.27
Jason McReynolds	530	4.00	-	$82.54	$111.66	$ 330.16
					SUBTOTAL	$ 791.11
				Mark-up On Labor	31.0%	$ 245.24

EQUIPMENT:	Equipment Code	Equipment Hours	Stand-by Time	Operating Rate	Stand-by Rate	Total
F150 Pickup		1.00	-	$ 14.77	$ -	$ 14.77
Cat 950 Loader		0.50		$ 83.56		$ 41.78
John Deere 245 Excavator		4.00		$ 123.02	$ -	$ 492.08
John Deer 310 Articulating Truck		4.00	-	$ 122.71	$ -	$ 490.84
Outside Rental Equip.(Rates based on minimum daily or weekly charge):						
						$ -
						$ -
						$ -
					SUBTOTAL	$ 1,039.47
				Mark-up On Equipment	21.0%	$ 218.29

4x8" PACKING 2022

$3237.5

MATERIALS USED: Tax Rate = 0.00%	Quantity	Units	Unit Cost	Extended Cost	Sale Tax	Total
2-4" Quarry Spalls Invoice #95152733 8/11/2021	220.24	TN	$ ~~11.50~~ 14.70	$ ~~2,532.76~~	$ -	$ ~~2,532.76~~ $3237.5
Worker Right Impact Charge Invoice #95152733	220.24	EA	$ 0.25	$ 55.06	$ -	$ 55.06
Environmental Fee Invoice #951152733	220.24	EA	$ 1.00	$ 220.24	$ -	$ 220.24
2-4" Quarry Spalls Invoice #95157614 8/12/2021	136.93	TN	$ ~~11.50~~ 14.70	$ ~~1,574.70~~	$ -	$ 2012.87 ~~1,574.70~~
Environmental Fee Invoice #95157614	136.93	EA	$ 1.00	$ 136.93	$ -	$ 136.93
Worker Right Impact Charge Invoice #95157614	136.93	EA	$ 0.25	$ 34.23	$ -	$ 34.23
Backhaul Unsuitable Material 8/12/2021	96.00	CY	$ 8.00	$ 768.00	$ -	$ ~~768.00~~
					SUBTOTAL	$ $5525.67 ~~5,321.92~~
					TAX	
				Mark-up On Materials	21.0%	$ 1,117.60

357.2 TONS

SUBCONTRACTORS:	Quantity	Units	Unit Cost		Total
Hill Construction Trucking #3867 8/11/2021	9.00	HRS	$ ~~150.00~~	160	$ 1440 ~~1,350.00~~
Hill Construction Trucking #3868 8/12/2021	8.50	HRS	$ ~~150.00~~	160	$ 1360 ~~1,275.00~~
Dave Owens Trucking #966792 8/11/2021	8.50	HRS	$ ~~150.00~~	160	$ 1360 ~~1,275.00~~
Dave Owens Trucking #966793 8/12/2021	8.50	HRS	$ ~~150.00~~	160	$ 1360 ~~1,275.00~~
				SUBTOTAL	$ 5520 ~~5,175.00~~
			Mark-up On Subcontractors	12.0%	$ 621.00

2022 Rates

SUBTOTAL	$ 12,327.50
TAX	$ -
Overall Markup	$ 2,202.14
TOTAL	$ 14,529.63

Comments:

MATS. $ 5520 + 21% markup = $6679.20

TRUCK $ 5525.67 + 21% markup = $6,686.07

Owner Representative's Signature: **Date**

GBI Project Manager's Signature: D Diteman **Date** 7/26/2021

$13,365.27 / 357.2 TONS = $37.42/TON

Good

Delivered / NOT placed

Spalls average $37.42/ton furnished

CHANGE ORDER #10
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Justification Attachment 1
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CALPORTLAND

Visit our web site:
www.calportland.com

Cascade Quarry
43530 U.S. Hwy 2
Gold Bar, WA 98251

WSDOT Pit #D-290

Aggregate Quote (Quote Must Be Activated)

TO:	**goodfellow Bros**	PROJECT	**Index - Galena Road Flood Repair**
		JOB / PO#	
ATTN:	Mike Jacobs	ADDRESS:	Address Required
		CITY-STATE:	Index Wa. 98251
EMAIL:	mvestimating@goodfellowbros.com	DURATION:	12/31/2021
		BID DATE:	2/9/2021
PHONE:	425-432-2022	SALESMAN:	Jim Haskins
		PHONE:	206-580-8867
		EMAIL:	jhaskins@calportland.com

We offer the following from our **CASCADE QUARRY / PLANT 704A** - Scale House 360-242-3680

ITEM #	DESCRIPTION	UNIT	2021 F.O.B. PIT	2022 F.O.B. PIT	2023 F.O.B. PIT
9990	Environmental Compliance Charge	Ton	$ 1.00	$ 1.00	$ 1.00
9400	Workers Right Impact Charge	Ton	$ 0.25	$ 0.25	$ 0.25
	CASCADE QUARRY - 704A				
8510	4" x 8" Quarry Spalls	Ton	$ 12.75	$ 13.45	$ 14.19
9990	**Total Including E.C.C. & W.R.I.C.**	**Ton**	**$ 14.00**	**$ 14.70**	**$ 15.44**
[redacted]					

2022 material cost only for spalls

Sample stockpiles of riprap, filter material and Gravel will be produced for approal at the source.
WSDOT aggregate source approvals including lab results will be provided to ensure aggregate quality and soundness.
All materials are to be approved by visual inspection to confirm intended appearance, at the source.
Any and all modifications to the sample stockpiles are to be made prior to production of deliverable product.
Please schedule inspections with Jim Haskins 206-580-8867

Clean Soils Disposal - Cascade Quarry - 704A

[redacted]

All disposal of soils materials must comply with Calportland Clean Soils Disposal Policy
No Asphalt and No Concrete Disposal

This offer and the attached Terms and Conditions are based upon the presumption that CalPortland will be the exclusive aggregate supplier for this project, and shall remain in effect for 30 days. To lock in the material prices, please sign and return within the 30 day period. Material Prices Quoted herein, must be activated to be valid. A purchase order, including volumes and schedule, must be issued to commence production.

Material Prices are based on the current cost of fuel and are not guaranteed. Price fluctuations in fuel costs may necessitate a revision in the quoted material prices at the time of purchase. (fuel surcharge)

Should material deliveries for this project be subject to prevailing wage rules, please contact your salesman for a new quotation to acknowledge the change.

Material, E.C.C and W.R.I.C. are subject to a 5% increase after Dec 31, 2021. If the project is projected to continue past the expiration date, please notify salesman of the change.

Accepted:
By:_____
Date:_____

Glacier Northwest, Inc. DBA CalPortland
By:_____
Date:_____

GLACIER NORTHWEST

IGR Slide Repair Estimate

Owner:	Snohomish County	**Project Number:**	RC1532,RC1744,RR6322	**Date:**	7/20/22
Project Name:	Index-Galena Road Flood Repair	**Fed. Aid Number:**	ER-0701(063)	**BI No.:**	NEW

DESCRIPTION OF WORK:

Quarry Spall @ $45/ton justification using FA work that was completed last year to remove unsuitable roadbase and backfill with quarry spalls. Example used was for 8/12/2022 force account. Calculation below shows how much time is estimated to "place" one dump truck load delivered to the project. One rock truck = 15 CY or 22.5 tons. $206.25/22.5 tons = $9.17 placement cost.

Placement cost per ton of quarry spalls

LABOR:	Employee Class	Regular Hours	Overtime Hours	Regular Rate	Overtime Rate	Total
Operator	Operator	0.17		$ 89.28		$ 15.18
Operator	Operator	0.17		$ 89.28		$ 15.18
Operator	Operator	0.17		$ 89.28		$ 15.18
Operator	Operator	0.17		$ 89.28		$ 15.18
						$ -
						$ -
					SUBTOTAL	$ 60.71
				Mark-up On Labor	31.0%	$ 79.53

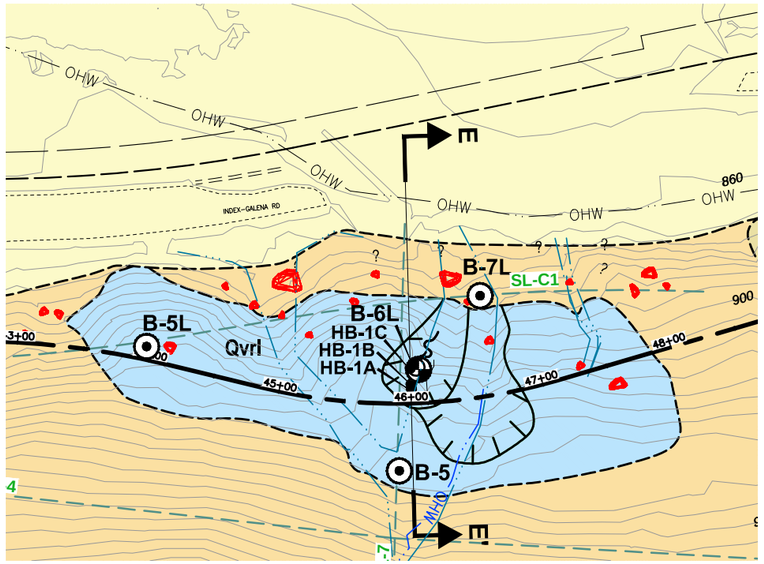
EQUIPMENT:	Equipment Code	Equipment Hours	Stand-by Time	Operating Rate	Stand-by Rate	Total
Cat 470 Excavator (10 mins)		0.17		$ 200.00		$ 34.00
Cat 336 Excavator (10mins)		0.17		$ 183.27		$ 31.16
950 Loader (10 mins)		0.17		$ 87.75		$ 14.92
Rock Truck (to and from = 10 mins)		0.17		$ 145.00		$ 24.65
						$ -
						$ -
						$ -
						$ -
Rental by Invoice						
						$ -
						$ -
						$ -
					SUBTOTAL	$ 104.72
				Mark-up On Equipment	21.0%	$ 126.72

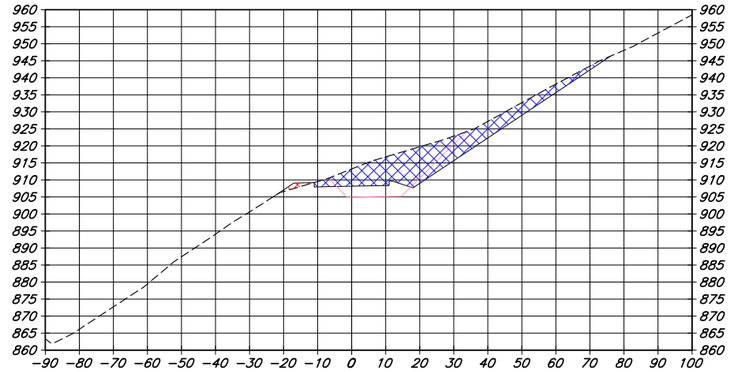
MATERIALS Tax Rate = 7.8%	Quantity	Units	Unit Cost	Extended Cost	Sale Tax	Total
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
				$ -	$ -	$ -
					SUBTOTAL	$ -
				Mark-up On Materials	0.0%	$ -

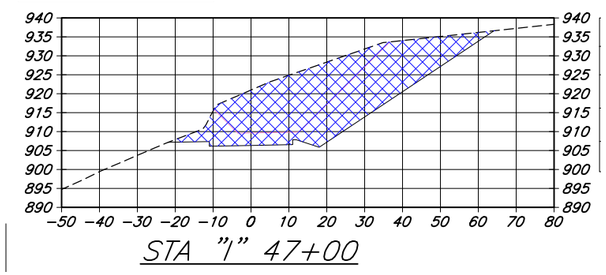
SUBCONTRACTORS:	Quantity	Units	Unit Cost		Total
					$ -
					$ -
				SUBTOTAL	
				Mark-up On Subcontractors 12.0%	

Comments:		
	SUBTOTAL	
	Overall Markup	
	TOTAL	$ 206.25

Estimated by: S. Chi 7/20/2022 **Project Engineer: Sam Chi** **Date**







GEOLOGIC UNITS

Qaf	Quaternary Alluvial Fan Deposits
Qal	Quaternary Alluvium
Qtal	Quaternary Terrace Alluvium
Qc	Quaternary Colluvium (bouldery where noted)
Qm	Quaternary Marsh Deposits
Qvrl	Quaternary Recessional Lacustrine Deposits
Tig	Tertiary Granodiorite of the Index Batholith

LEGEND

B-1	Boring Designation and Approximate Location
B-1L	Boring with Vibrating Wire Piezometer (VWP) Designation and Approximate Location
HB-1A	Hand Boring Designation and Approximate Location
OHW	Ordinary High Water Line
OHW	Stream Channel
	Landslide Hazard Area (LHA)
	Boulder
	Approximate Geologic Contact
SL-B1	Seismic Profile or Cross Section
A	Subsurface Profile or Cross Section (See Figures 3 through 8)

Total Depth:	50.2 ft.	Northing:	644,768 ft.	Drilling Method:	Core
Top Elevation:	909.0 ft.	Easting:	1,811,513 ft.	Drilling Company:	Salisbury
Vert. Datum:	NAVD 88	Station:	-	Drill Rig Equipment:	Viper
Horiz. Datum:	Project Datum	Offset:	-	Other Comments:	

Hole Diam.:	2 in.
Rod Diam.:	
Hammer Type:	Cathead

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

TOPSOIL.

Soft to medium stiff, gray to gray-brown, slightly sandy to sandy, silty CLAY; moist; scattered wet, silty, fine to medium sand seams with abundant iron-oxide staining; (Qvrl) CL.
- Boulder from 1.3 - to 2.4 feet, UCS (Point Load) = 23,300 psi

Note: Blow counts for S-5 are artificially high due to the presence of gravel, cobbles, and boulders in the underlying unit.

Dense to very dense, brown, slightly sandy to sandy GRAVEL, trace of silt; wet; scattered cobbles and boulders; (Qc) GP.
Note: Blow counts are artificially high due to the presence of gravel, cobbles, and boulders.

Loose, brown, slightly fine sandy SILT, trace of clay; moist to wet; non-plastic, scattered pockets with iron-oxide staining; (Qvrl) ML.

Depth, ft.: 1.0, 13.4, 24.5

Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)
▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

50/1" | 50/5" | 50/5" | 73/11"

CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Rock Core
- Grab Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

RQD (%) | Recovery (%)
◇ % Fines (<0.075mm)
● % Water Content ←(use scale at top)
Plastic Limit ├●┤ Liquid Limit

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Index-Galena Road Flood Repair M.P. 6.4 to 6.9
Geotechnical Data Report
Snohomish County, Washington

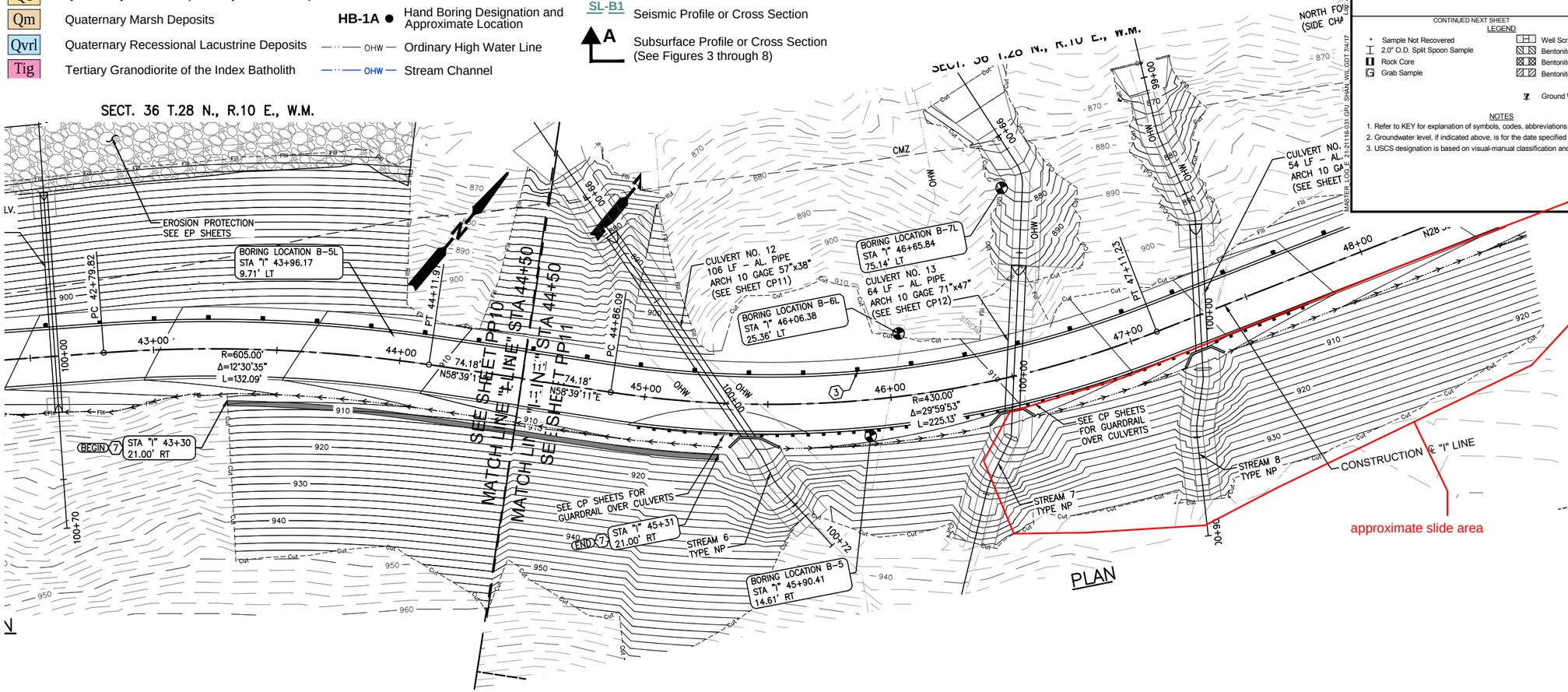
LOG OF BORING B-5L

October 2018 | 21-1-21882-200

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A.1-11
Sheet 1 of 2

REV 3 - Approved for Submittal



approximate slide area

CHANGE ORDER #10
7/25/2022
Justification Attachment 2
Page 7 of 10

VonAschen-Cook, Melissa

From: Niehl, Michael <michael.niehl@wsp.com>
Sent: Tuesday, June 28, 2022 4:20 PM
To: Chi, Sam
Subject: FW: Landslide

Categories: HOT

CAUTION : This email originated from outside of this organization. Please exercise caution with links and attachments.

Sam,

See below and then give me a call when you have a sec today or tomorrow.

From: Mike Harney <Mike.Harney@shanwil.com>
Sent: Tuesday, June 28, 2022 3:46 PM
To: Niehl, Michael <michael.niehl@wsp.com>
Subject: RE: Landslide

Hey, Mike.

Yes, your interpretation is correct. We are really taking an educated guess. It'll probably be deeper in some areas and thinner in others. If we start going much beyond 10-ft down, we would re-evaluate then.

Michael D. Harney, PE*, P.Eng.**, ENV SP
VICE PRESIDENT | SEATTLE OFFICE MANAGER
SHANNON & WILSON
Direct: **(206) 695-6850**
Mobile: **(206) 595-1830**
mike.harney@shanwil.com
Please note, my email address has been updated. You can still reach me at the old address.

*Licensed in WA, ID, MT, NE, OR, WI, WY
**Licensed in AB, BC

From: Niehl, Michael <michael.niehl@wsp.com>
Sent: Tuesday, June 28, 2022 2:53 PM
To: Mike Harney <Mike.Harney@shanwil.com>
Subject: RE: Landslide

Thank you Mike! From what I read here, we don't know how much is going to need to be excavated out and it will need to be directed in the field but if we needed an estimate you would suggest the length and width of the slide by about 10' down. Is that a correct interpretation of the below?

From: Mike Harney <Mike.Harney@shanwil.com>
Sent: Tuesday, June 28, 2022 12:53 PM
To: Niehl, Michael <michael.niehl@wsp.com>
Subject: RE: Landslide

Hi, Mike.

Yes. We just wrapped up our stability analyses.

Landslide mechanism and extents

Based on our review of the available information, including our design phase borings and surveys before and after the landslide, and two site visits by our senior engineering geologist (Erik Scott), we interpret that the landslide occurred in the near-surface layer of recessional lacustrine clay (Qvrl) which was known to be a potential issue soil unit (i.e., it is relatively weak). Erik has interpreted the extents of the main landslide area as shown in the attached figure. We believe that the landslide mass is relatively thin and surficial, and within the Qvrl, which we believe is underlain by a stronger soil unit, Qc. Qc is prevalent throughout the job alignment, and visible at the surface to either side of the landslide. We note that this is based on relatively few, design-phase borings; we did not drill borings after the slide, and in fact we only able to observe the slide itself in isolated areas because it remains covered in plastic. We recommend assuming an average thickness of the slide mass of 10 feet.

Analysis

We used the commercially-available limit equilibrium global stability software GeoStudio to analyze the stability of the landslide and potential remedial solutions. We back-analyzed the landslide event to calibrate the constitutive parameters in our model, assuming the pre-landslide conditions were approximately equivalent to a Factor of Safety of 1.0. We targeted a Static Factor of Safety of 1.3 for remedial solutions. We did not analyze seismic stability.

Remediation

Our interpretation and analyses indicate that the most efficient and effective means of repairing the slope is to remove and replace the disturbed soil composing the landslide mass. Alternatives that would retain the disturbed landslide debris would entail significant structural elements (e.g., retaining walls) and potentially specialty contractors. Ultimately, we concluded that the landslide may be effectively repaired (meeting the FS=1.3 target) by:

1. Over excavation and removal of the landslide debris, down to intact (non-disturbed) native soil, and
2. Replacement with strong (i.e., minimum friction angle of 42 degrees) well-drained earthen material.

We recommend:

1. Goodfellow Brothers overexcavate the disturbed landslide debris, down to intact native soil. A representative from Shannon & Wilson should be on-site, at least initially, to confirm that intact native soil has been reached. Once the criteria for that are well-established and communicated, it may be sufficient for the on-site Snohomish County representative to confirm native soil has been reached.
2. The resulting temporary cut slope should be benched, with benches of approximately2-3 foot wide and 2-3 high.
3. The slope should be re-constructed no steeper than 1.5H:1V using angular, free-draining aggregate backfill, placed according to the Project Specifications. Examples of suitable materials include (but are not limited to): Quarry Spalls [WSDOT Std Spec 9-13.1(5)] and Permeable Ballast [WSDOT Std Spec 9-03.9(2)].

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Please note, my email address has been updated. You can still reach me at the old address.

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From: Niehl, Michael <michael.niehl@wsp.com>
Sent: Tuesday, June 28, 2022 11:26 AM
To: Mike Harney <Mike.Harney@shanwil.com>
Subject: Landslide

Hey Mike,

How is the landslide information coming. Sam is hoping to meet this week

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