INSIGHT GEOLOGIC, INC.

October 11, 2022

Tom Daniells
2725 Schirm Loop Road NW
Olympia, Washington 98502

Report
Geotechnical Investigation and Retention Design
2725 Schirm Loop Road NW
Olympia, Washington
Project No. 2152-001-01

INTRODUCTION

Insight Geologic is pleased to provide our report of our investigation of subsurface conditions for your property located at 2725 Schirm Loop Road NW in unincorporated Thurston County, Washington. The site location is shown relative to surrounding physical features in the Vicinity Map, Figure 1 and Site Map, Figure 2.

We understand that a soil failure occurred on the waterfront bluff located on the south side of the property due to winter precipitation. We conducted a subsurface assessment of the conditions near the top of the slope in order to gain information for the engineered design of repair and retention options for the slope.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions as they pertain to geotechnical parameters of the soils and groundwater levels. We conducted the following tasks:

1. Reviewed readily available published literature regarding the geology in the area of the subject site. Our review included published reports, as well as water well logs to develop an understanding of site geology.
2. Provided for the location of subsurface utilities at the site using the "One Call" reporting system.
3. Evaluated subsurface conditions at the site by drilling two exploratory borings using a limited access hollow-stem auger drilling rig to the depth of 31.5 feet below ground surface (bgs).
4. Collected representative soil samples at intervals of approximately 5 feet during drilling. Blow counts, which provide an indication of the relative density of the soil, were collected at each sampling interval.
5. Logged the soils exposed in the borings in general accordance with ASTM D2487-06.

6. Performed laboratory testing on selected soil samples from the borings to assist in evaluating the physical and engineering properties of the site soils.
7. Used the commercially available design software Ruvolum developed by Geobrugg to design the recommended stabilization method for the bluff.
8. Prepared a report for review summarizing our field activities and including our recommended options for repair and retention of the soil.

FINDINGS

SITE GEOLOGY

The subject site is located on the west side of the Steamboat Island peninsula, located approximately 8 miles north of Olympia, Washington. The property is bounded by Eld Inlet to the southwest and developed residential properties to the north, east, and south. The residence is on a gently sloping upland area at an elevation of approximately 35 feet above mean sea level. A steep slope extends from this upland area down to sea level starting at an elevation of approximately 30 feet. The site is vegetated by landscaping and trees and the steep slopes are generally sparsely unvegetated. The top of the steep slope located southwest of the residence contains a concrete landing pad and the remains of a staircase that has collapsed due to the recent soil failure.

The site lies in an area of continental glaciation within the Puget Trough, the lowland area now occupied by Puget Sound. Several advances of the Puget lobe of the Cordilleran ice sheet resulted in the deposition of silt, sand, and gravel, which were subsequently overridden by glacial ice. The Washington State Department of Natural Resources maps the deposits beneath the property as Vashon age glacial till (Qgt). Glacial till is a dense, non-sorted mixture of silt, sand and gravel, that was deposited at the base of the ice sheet. It has the general look and consistency of weak concrete, with low permeability and high soil strength.

A review of the Washington State Department of Ecology well log records for the surrounding area indicate groundwater levels approximately 65 feet below ground surface. No well logs were found for the subject parcel, however, the closest identifiable well log was located approximately 800 feet north of the site. Bedrock was not indicated on the reviewed well log.

The Washington State Department of Natural Resources Geology Division maintains an interactive geologic map on its website. The area of the subject site was searched for mapped landslides using the interactive geologic map, with a single mapped landslide found along the southwest-facing slopes descending to Eld Inlet. This landslide was identified by LIDAR as shallow and undifferentiated. This type of soil failure is common along marine bluffs of Puget Sound which are underlain by glacial till.

The US Department of Agriculture, Soil Survey of Thurston County, Washington maps the soils beneath the site as Kapowsin silt loam, 3 to 15 percent slopes. This soil is described as moderately well-drained with very low to low permeability and derived from glacial till.

EXPLORATORY BORINGS

Insight Geologic contracted with Boretec, Inc. to provide drilling services for two borings located adjacent to the area experiencing movement. The borings were drilled using a limited-access hollow stem auger drilling rig. Boring B-1 was located approximately 20 feet northwest of the north end of the soil movement and boring B-2 was drilled in line with the center of the observed soil movement. Both borings were drilled to a depth of 31.5 feet bgs.

Borings B-1 and B-2 encountered approximately 4 to 5 feet of brown silt with sand (ML) in a stiff and moist, overlying brown fine to coarse sand with gravel and silt (SP-SM) in dense to very dense and moist condition to a depth of approximately 17.5 feet bgs in boring B-1 and 22.5 feet bgs in boring B-2. Underlying these soils, we encountered well to poorly-graded brown fine to coarse sand with gravel (SP, SW) in a very dense and moist to wet condition to a depth of 27.5 feet bgs. Each of the borings terminated at a depth of 31.5 feet bgs in a unit of brown fine to medium sand with silt (SP-SM) in a very dense and wet condition.

Groundwater was encountered in each of the borings drilled at the site. Water was encountered in boring B-1 and B-2 within the 25-foot sample. Detailed logs of the borings are contained in Attachment A.

LABORATORY ANALYSES

We selected seven soil samples for gradation analyses in general accordance with ASTM D422 to define soil class. The laboratory results are presented in Attachment B.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our review, subsurface explorations, and engineering analyses, it is our opinion that the soil failure has occurred due to weathering of the surficial soils and failed as a surficial failure and not as a larger failure in the hillside.

The geology of the site consists of surficial weathered glacial till overlying undisturbed glacial till with relatively low silt content. The till soils are generally stable on horizontal surfaces but can weather and fail on slopes. The weathered till unit consists of stiff silt with sand, which has begun to weaken from the undisturbed glacial till upslope from the bluff. Slopes with this sequence of geological units can be steep to near vertical. Failure occurs when the surficial soils on the face of the slope weather and become saturated. This results in decreased soil strength and increased soil weight, which causes the surficial 12 to 18 inches of weathered soil on the face of the slope to fail, carrying along the vegetation growing on the slope. The frequency of the cycle varies depending on a number of factors, but one should expect this type of failure to occur on the slope every 10 to 20 years under normal conditions.

We recommend that the slope be stabilized using a mesh reinforcement system (Tecco by Geobrugg) consisting of a high-tensile wire mesh secured to the hillside by grouted soil nails. We have provided a design of the system using software provided by the manufacturer. The design program takes into account soil strength and unit weight and evaluates the design elements with respect to a factor of safety (resisting forces divided by driving forces). The output from the design software is included in

Attachment C. Our design includes installation of soil nails on 9.25 foot centers. The spacing may be reduced, which would result in an increased safety factor. We recommend that the anchors be installed at an inclination of 20 degrees to the face of the slope, and extend a minimum of 16 feet into the hillside to sufficiently anchor the mesh. The mesh design is for 3 millimeter diameter wire (Tecco G65/3) and P33 spike plates to anchor the mesh to the soil nails. We will work with the selected contractor to finalize the number and length of anchor elements.

Care should be taken during and after construction to maintain good, positive drainage from all areas in the slope area. All drainage, roof and impervious pavement runoff should be collected and contained in non-perforated piping for discharge at the base of the slope. We recommend that Insight Geologic, Inc. be retained to observe the construction of the proposed reinforcement system.

LIMITATIONS

We have prepared this report for use by Tom Daniells and his authorized agents regarding the proposed mitigation and stabilization of the failing slope located at 2725 Schirm Loop Road NW in unincorporated Thurston County, Washington.

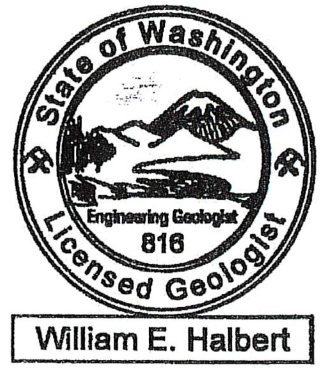
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment D titled "Report Limitations and Guidelines for Use" for additional information pertaining to the use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions regarding the work performed or require additional information.

Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert L.HG., L.E.G.
Principal



FIGURES

Source: USGS (c) 2020

SQUAXIN ISLAND QUADRANGLE
WASHINGTON - THURSTON COUNTY
7.5-MINUTE SERIES
Year 2020

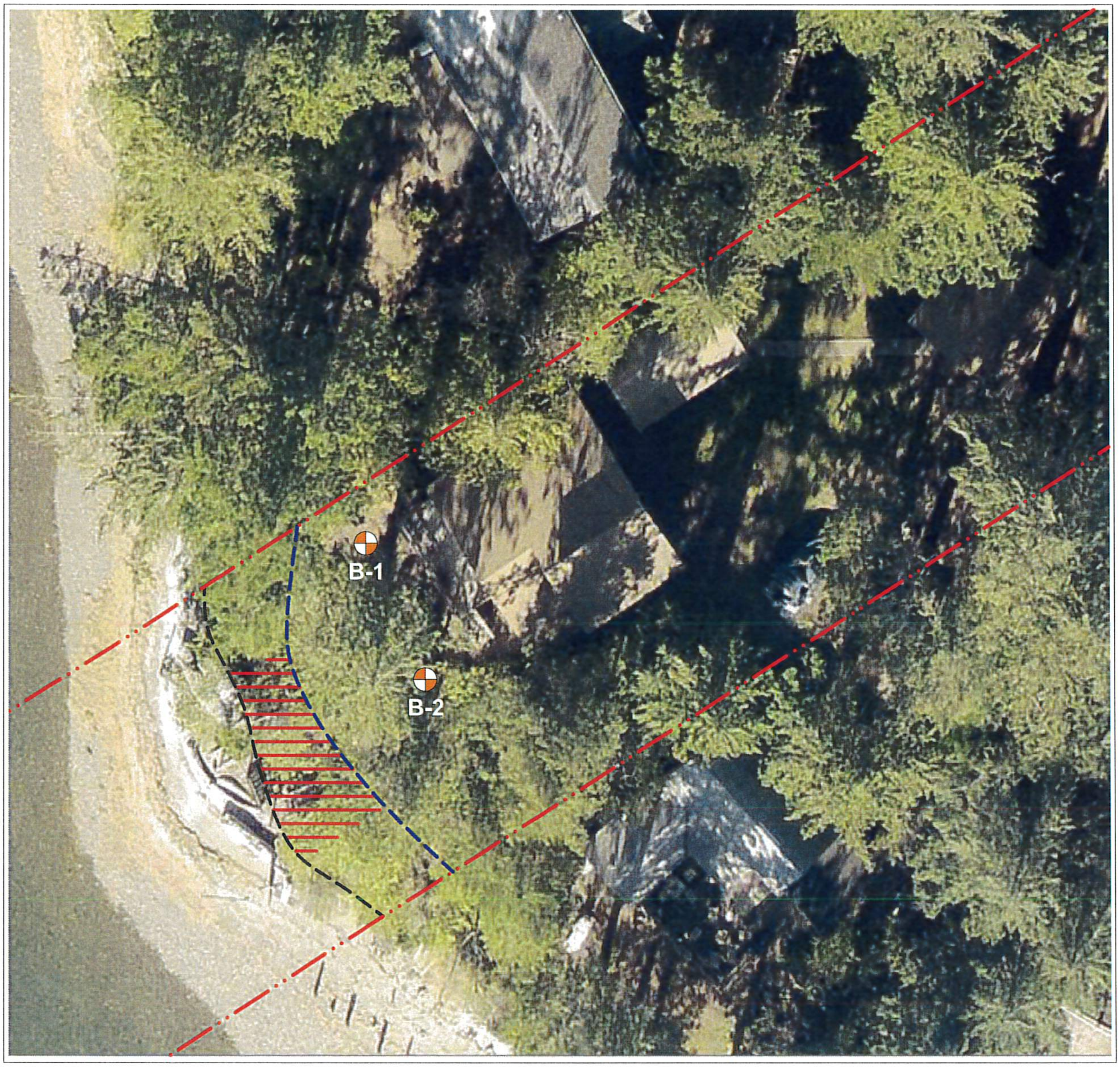
SCALE: 1" = 3000'

DANIELLS PROPERTY

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



Source: Google Earth

LEGEND:

B-1	APPROXIMATE SOIL BORING LOCATION
	APPROXIMATE PROJECT BOUNDARY
	APPROXIMATE TOP OF SLOPE
	APPROXIMATE BASE OF SLOPE
	APPROXIMATE FAILURE AREA

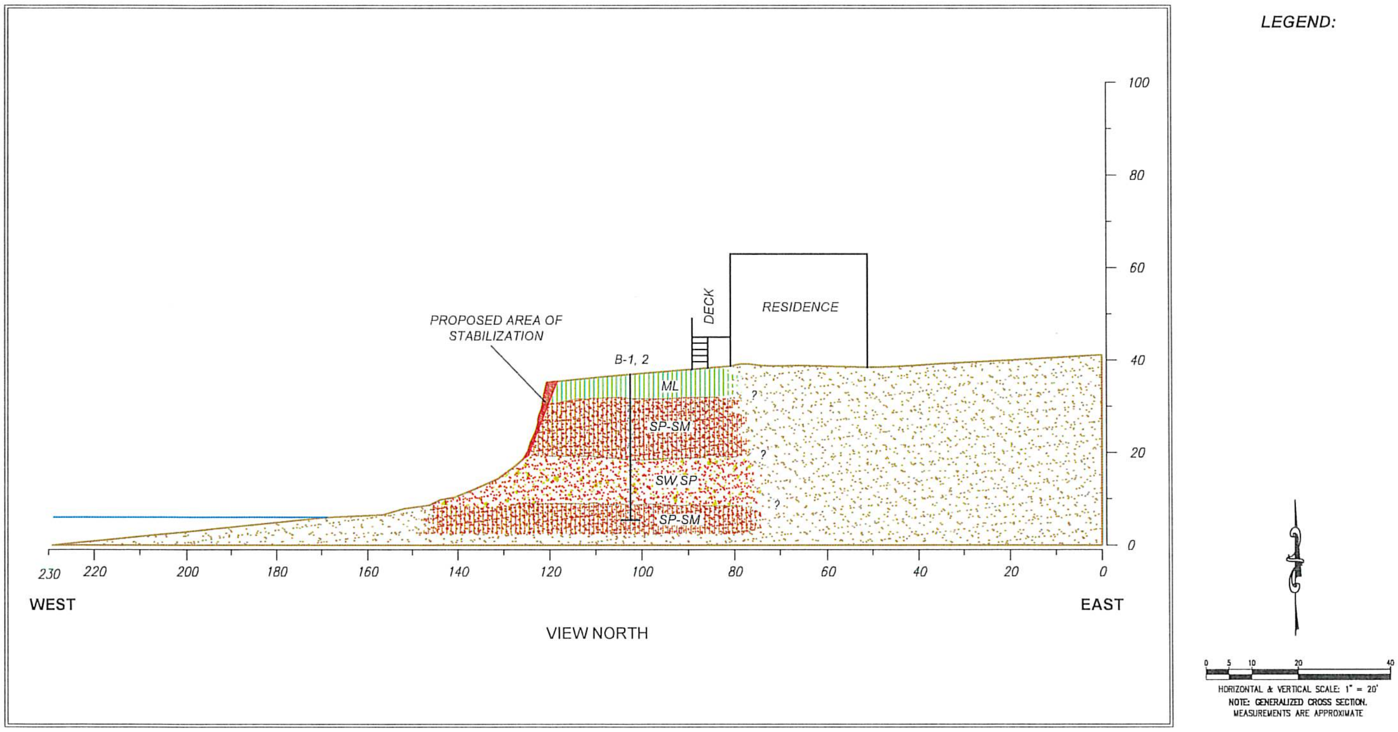
SCALE: 1"= 30'

DANIELLS PROPERTY

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 2
Site Plan



DANIELLS PROPERTY

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 3

Cross Section

ATTACHMENT A
EXPLORATION LOGS

PROJECT: **Daniells Landslide**

PROJECT NO.: **2152-001-01**

LOCATION: **Thurston County, Washington**

B-1

DATE: **September 19, 2022**

TOTAL DEPTH: **31.5**

DEPTH (FT)	SAMPLE NUMBER/ INTERVAL	INCHES DRIVEN/ RECOVERED	SPT "N" VALUE	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0				ML		**ML:** Brown silt with sand, stiff, moist	
5	1	18/16	24	SM		**SM:** Brown silty fine sand, medium dense, moist	
10	2	18/18	61	SP-SM		**SP-SM:** Brown fine to coarse sand with fine gravel and silt, very dense, moist	
15	3	16/16	94/ 10				
20	4	6/6	50/6	SW		**SW:** Brown fine to coarse sand with fine gravel, very dense, moist	
25	5	18/9	89	SP		**SP:** Brown fine to coarse sand with fine gravel, very dense, wet ▽	
30	6	18/18	75/ 12	SP-SM		**SP-SM:** Brown fine to medium sand with silt, very dense, wet	Boring completed at 31.5 feet. Groundwater encountered at 24 feet.
35							
40							
45							
50							

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Drilling Contractor: **Boretec Drilling**

Drill Equipment: **EC 65 Track**

Logged By: **Andrew Johnson**

Driller: **Tommy**

Drill Method: **Hollow Stem Auger**

Figure A-2

PROJECT: **Daniells Landslide**
PROJECT NO.: **2152-001-01**
LOCATION: **Thurston County, Washington**

B-2

DATE: **September 19, 2022**
TOTAL DEPTH: **31.5**

DEPTH (FT)	SAMPLE NUMBER/ INTERVAL	INCHES DRIVEN/ RECOVERED	SPT "N" VALUE	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0				ML		**ML:** Brown silt with sand, stiff, moist	
5	1	18/12	31	SM		**SM:** Brown silty fine to coarse sand with fine gravel, dense, moist	
10	2	18/4	57	SP-SM		**SP-SM:** Brown fine to coarse sand with fine gravel and silt, very dense, moist	
15	3	3/3	50/3				
20	4	7/4	83/7				
25	5	7/5	72/7	SW		**SW:** Brown fine to coarse sand with fine gravel, very dense, wet	
30	6	16/14	93/ 10	SP-SM		**SP-SM:** Brown fine to medium sand with silt, very dense, wet	Boring completed at 31.5 feet. Groundwater encountered at 24 feet.
35							
40							
45							
50							

INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Boretec Drilling**
Driller: **Tommy**
Drill Equipment: **EC 65 Track**
Drill Method: **Hollow Stem Auger**
Logged By: **Andrew Johnson**

Figure A-3

ATTACHMENT B

LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-1
Job Number:	2152-001-01	**Sample Name:**	B-1 5.0' - 6.5'
Date Tested:	10/4/22	**Depth:**	5 - 6.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 24.0%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	97.3
No. 4 (4.75-mm)	92.5
No. 10 (2.00-mm)	89.8
No. 20 (.850-mm)	87.0
No. 40 (.425-mm)	83.6
No. 60 (.250-mm)	79.9
No. 100 (.150-mm)	76.6
No. 200 (.075-mm)	73.5

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	7.5
Coarse Sand	2.7
Medium Sand	6.2
Fine Sand	10.1
Fines	73.5
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	2.00
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Daniells Landslide
Job Number: 2152-001-01
Date Tested: 10/4/22
Tested By: Andrew Johnson

Sample Location: B-1
Sample Name: B-1 10.0' - 11.5'
Depth: 10 - 11.5 Feet

Moisture Content (%) 8.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	84.4
No. 4 (4.75-mm)	72.9
No. 10 (2.00-mm)	61.7
No. 20 (.850-mm)	52.2
No. 40 (.425-mm)	41.0
No. 60 (.250-mm)	29.0
No. 100 (.150-mm)	18.6
No. 200 (.075-mm)	10.2

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	27.1
Coarse Sand	11.3
Medium Sand	20.7
Fine Sand	30.8
Fines	10.2
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.08
D_{30}	0.26
D_{60}	1.75
D_{90}	13.00
Cc	0.52
Cu	23.33

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel and Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-1
Job Number:	2152-001-01	**Sample Name:**	B-1 15.0' - 16.5'
Date Tested:	10/4/22	**Depth:**	15 - 16.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 8.4%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	80.5
No. 4 (4.75-mm)	70.0
No. 10 (2.00-mm)	59.7
No. 20 (.850-mm)	46.0
No. 40 (.425-mm)	26.1
No. 60 (.250-mm)	16.4
No. 100 (.150-mm)	10.7
No. 200 (.075-mm)	5.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	30.0
Coarse Sand	10.3
Medium Sand	33.6
Fine Sand	20.4
Fines	5.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.14
D_{30}	0.49
D_{60}	2.00
D_{90}	14.00
Cc	0.86
Cu	14.29

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel and Silt**
Symbol: **SP-SM**

Insight Geologic, Inc.

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-1
Job Number:	2152-001-01	**Sample Name:**	B-1 20.0' - 21.5'
Date Tested:	10/4/22	**Depth:**	20 - 21.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 8.0%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	93.5
No. 4 (4.75-mm)	72.3
No. 10 (2.00-mm)	47.5
No. 20 (.850-mm)	27.8
No. 40 (.425-mm)	16.5
No. 60 (.250-mm)	11.1
No. 100 (.150-mm)	7.8
No. 200 (.075-mm)	4.9

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	27.7
Coarse Sand	24.8
Medium Sand	31.0
Fine Sand	11.6
Fines	4.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.22
D_{30}	0.93
D_{60}	3.50
D_{90}	8.10
Cc	1.12
Cu	15.91

ASTM Classification
Group Name: **Well Graded Sand with Gravel**
Symbol: **SW**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-1
Job Number:	2152-001-01	**Sample Name:**	B-1 25.0' - 26.5'
Date Tested:	10/4/22	**Depth:**	25 - 26.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 5.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	79.7
No. 4 (4.75-mm)	64.9
No. 10 (2.00-mm)	52.7
No. 20 (.850-mm)	40.6
No. 40 (.425-mm)	17.2
No. 60 (.250-mm)	7.8
No. 100 (.150-mm)	5.0
No. 200 (.075-mm)	3.1

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	35.1
Coarse Sand	12.2
Medium Sand	35.5
Fine Sand	14.2
Fines	3.1
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.30
D_{30}	0.60
D_{60}	3.10
D_{90}	14.00
Cc	0.39
Cu	10.33

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-2
Job Number:	2152-001-01	**Sample Name:**	B-2 25.0' - 26.5'
Date Tested:	10/4/22	**Depth:**	25 - 26.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 10.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	81.0
No. 4 (4.75-mm)	54.2
No. 10 (2.00-mm)	32.7
No. 20 (.850-mm)	12.1
No. 40 (.425-mm)	10.8
No. 60 (.250-mm)	6.8
No. 100 (.150-mm)	4.3
No. 200 (.075-mm)	2.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	45.8
Coarse Sand	21.5
Medium Sand	21.9
Fine Sand	8.6
Fines	2.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.39
D_{30}	1.80
D_{60}	5.50
D_{90}	14.00
Cc	1.51
Cu	14.10

ASTM Classification
Group Name: **Well Graded Sand with Gravel**
Symbol: **SW**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name:	Daniells Landslide	**Sample Location:**	B-2
Job Number:	2152-001-01	**Sample Name:**	B-2 30.0' - 31.5'
Date Tested:	10/4/22	**Depth:**	30 - 31.5 Feet
Tested By:	Andrew Johnson		

Moisture Content (%) 20.4%

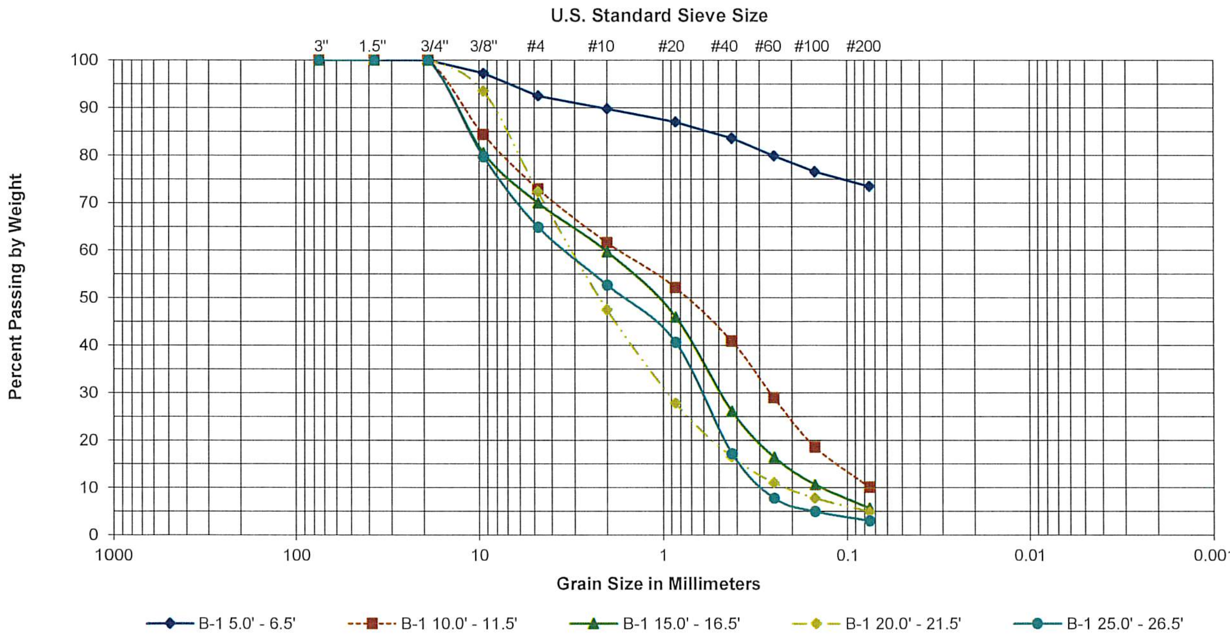
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	97.9
No. 4 (4.75-mm)	97.7
No. 10 (2.00-mm)	97.0
No. 20 (.850-mm)	94.9
No. 40 (.425-mm)	83.5
No. 60 (.250-mm)	53.0
No. 100 (.150-mm)	23.4
No. 200 (.075-mm)	10.4

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	2.3
Coarse Sand	0.7
Medium Sand	13.5
Fine Sand	73.1
Fines	10.4
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.07
D_{30}	0.18
D_{60}	0.28
D_{90}	0.55
Cc	1.56
Cu	4.00

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

Insight Geologic, Inc.



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>COARSE</td><td>FINE</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td></tr>
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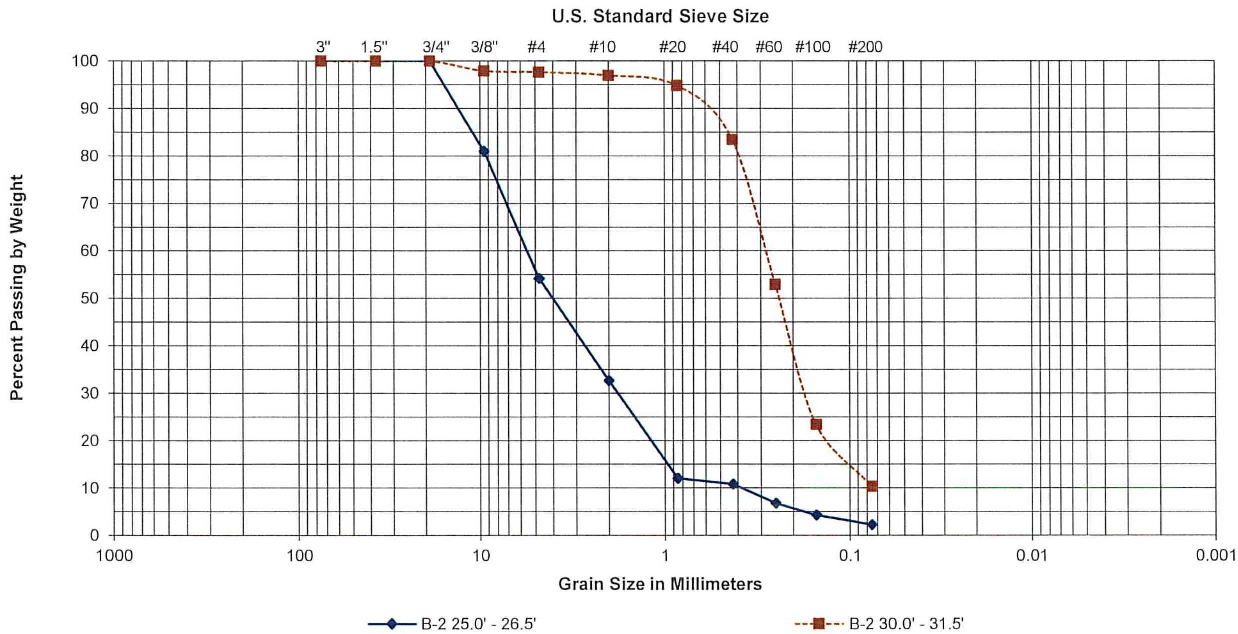
DANIELLS LANDSLIDE

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1

Gradation Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

DANIELLS LANDSLIDE

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2

Gradation Analysis Results

ATTACHMENT C
DESIGN SOFTWARE OUTPUT

GEOBRUGG BRUGG Safety is our nature

RUVOLUM® ONLINE TOOL

RUVOLUM® - The Program to dimension the slope stabilization system TECCO®/SPIDER®

Project No.	
Project Name	Daniells
Date, Author	10 October 2022

Input quantities			
Slope inclination	α=	75.0	degrees
Layer thickness	t=	2.50	ft
Friction angle ground (characteristic value)	Φ_k=	40.0	degrees
Volume weight ground (characteristic value)	γ_k=	120.0	lb/ft^3
Nail inclination	ψ=	5.0	degrees
Nail distance horizontal	a=	9.25	ft
Nail distance in line of slope	b=	9.25	ft

Load cases			
Streaming pressure		No	
Earthquake		No	
Coefficient of horizontal acceleration due to earthquake	ε_h=	0.000	[-]
Coefficient of vertical acceleration due to earthquake	ε_v=	0.000	[-]

Defaults and Safety Factors			
Cohesion ground (characteristic value)	c_k=	0.0	lb/ft^2
Radius of pressure cone, top	ζ=	0.49	ft
Inclination of pressure cone to horizontal	δ=	45.0	degrees
Slope-parallel force	Z_d=	3.4	kips
Pretensioning force of the system	V=	6.7	kips
Partial safety correction value for friction angle	γ_φ	1.25	[-]
Partial safety correction value for cohesion	γ_c	1.25	[-]
Partial safety correction value for volume weight	γ_γ	1.00	[-]
Model uncertainty correction value	γ_{mod}	1.10	[-]

Dimensioning quantities	Φ_d=	33.9	degrees
	c_d=	0.0	lb/ft^2
	γ_d=	120.3	lb/ft^3

Elements of the system			
Applied mesh type	TECCO G65/3		
Applied spike plate	system spike plate P33		
Bearing resistance of mesh to selective, slope parallel tensile stress	Z_R=	7	kips
Bearing resistance of mesh to pressure stress in nail direction	D_R=	41	kips
Bearing resistance of mesh against shearing-off in nail direction	P_R=	20	kips
Elongation in longitudinal tensile strength test	δ<	6	%

Applied nail type	DYWIDAG 28 mm, Grad 75		
Taking into account rusting away		Yes	
Bearing resistance of nail to tensile stress	T_{Rred}=	53	kips
Bearing resistance of nail to shear stress	S_{Rred}=	30	kips
Cross-section surface of the applied nail with / without rusting away	A_{red}=	1	in^2

Proofs	
Proof of the mesh against shearing-off at the upslope edge of the spike plate	Fulfilled
Proof of the mesh to selective transmission of the force Z onto the nail	Fulfilled
Proof of the nail against sliding-off of a superficial layer parallel to the slope	Fulfilled
Proof of the mesh against puncturing	Fulfilled
Proof of the nail to combined stress	Fulfilled

The given proofs concern the investigation of superficial instabilities. Additional investigations are required if there is a risk regarding global stability of the slope. If necessary the nail type and nail pattern have to be adapted.

Investigation of local instabilities between single nails

Proof of the mesh against shearing-off at the upslope edge of the spike plate

Maximum stress on the mesh for shearing-off in nail direction at the upslope edge of the spike plate (dimensioning level).	P_d=	12.7	kips
Thickness of decisive sliding mechanism	t_{rel}=	2.49	ft
Bearing resistance of the mesh against shearing-off in nail direction at the upslope edge of the spike plate (characteristic value).	P_R=	20.2	kips
Resistance correction value for shearing-off of the mesh	γ_{PR}=	1.5	[-]
Dimensioning value of the bearing resistance of the mesh against shearing-off	P_R/γ_{PR}=	13.5	kips
Proof of bearing safety	$P_d<=P_R/\gamma_{PR}$	Fulfilled	

Proof of the mesh to selective transmission of the force Z onto the nail

Slope parallel force taken into account in the equilibrium considerations	Z_d=	3.4	kips
Bearing resistance of the mesh to selective, slope-parallel tensile stress	Z_R=	6.7	kips
Resistance correction value for selective, slope-parallel transmission of the force Z	γ_{ZR}=	1.5	[-]
Dimensioning value of the bearing resistance of the mesh to tensile stress	Z_R/γ_{ZR}=	4.5	kips
Proof of bearing safety	$Z_d<=Z_R/\gamma_{ZR}$	Fulfilled	

Investigation of slop-parallel instabilities

Proof of the nail against sliding-off of a superficial layer parallel to the slope

Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{VI}=$	0.8	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dI}=$	5.4	kips
Calculatorily required shear force at dimensioning level in function of V_{dI}	$S_d=$	16.6	kips
Bearing resistance of the nail to shear stress	$S_{Rred}=$	30.3	kips
Resistance correction value for shearing-off of the nail	$\gamma_{SR}=$	1.5	[-]
Dimensioning value of the bearing resistance of the nail to shear stress	$S_{Rred}/\gamma_{SR}=$	20.2	kips
Proof of bearing safety	$S_d<=S_{Rred}/\gamma_{SR}$	Fulfilled	

Proof of the mesh against puncturing

Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{VII}=$	1.5	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dII}=$	10.0	kips
Bearing resistance of the mesh to pressure stress in nail direction	$D_R=$	40.5	kips
Resistance correction value for puncturing	$\gamma_{DR}=$	1.5	[-]
Dimensioning value of the bearing resistance of the mesh to pressure stress	$D_R/\gamma_{DR}=$	27.0	kips
Proof of bearing safety	$V_{dII} <= D_R/\gamma_{DR}$	Fulfilled	

Proof of the nail to combined stress

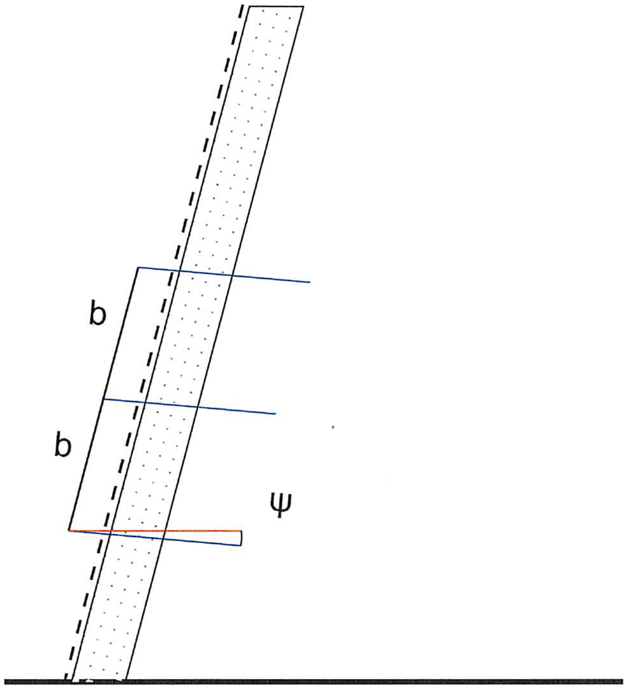
Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{VI}=$	0.8	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dI}=$	5.4	kips
Load factor for negative influence of pretension V	$\gamma_{VII}=$	1.5	[-]
Dimensioning value of the applied pretensioning force by negative influence of V	$V_{dII}=$	10.0	kips
Calculatorily required shear force at dimensioning level in function of V_{dII}	$S_d=$	16.6	kips
Maximum stress on the mesh for shearing-off	$P_d=$	12.7	kips
Bearing resistance of the nail to tensile stress	$T_{Rred}=$	52.6	kips
Bearing resistance of the nail to shear stress	$S_{Rred}=$	30.3	kips
Resistance correction value for tensile stress	$\gamma_{TR}=$	1.5	[-]
Resistance correction value for shear stress	$\gamma_{SR}=$	1.5	[-]
Proof of bearing safety $\{[V_{dII}/(T_{Rred}/\gamma_{TR})]^2 + [S_d/(S_{Rred}/\gamma_{SR})]^2\}^{0.5} <= 1.0$	0.87	Fulfilled	
Proof of bearing safety $\{[P_d/(T_{Rred}/\gamma_{TR})]^2 + [S_d/(S_{Rred}/\gamma_{SR})]^2\}^{0.5} <= 1.0$	0.90	Fulfilled	

Minimal tensile strength in the nail for superficial instabilities

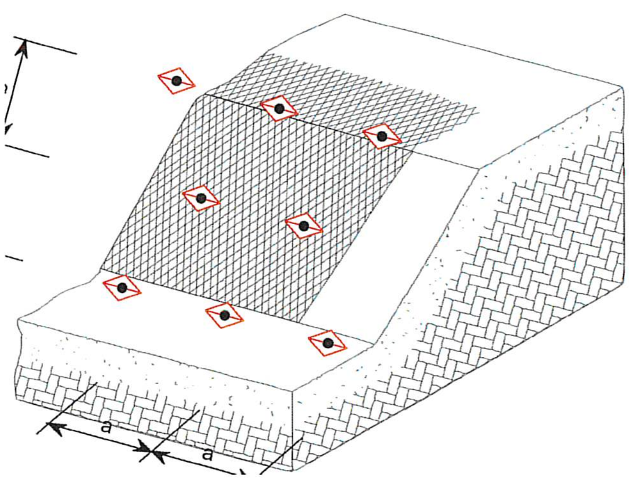
Dimensioning value of the static equivalent tensile force in the nail for determination of the nail length	$T_d=$	24.7	kips

Cross-section:

Layer thickness	t=	2.50	ft
Nail inclination	ψ=	5.0	degrees
Slope inclination	α=	75.0	degrees



View nail arrangement:



ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of the Tom Daniells (Client) and his authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic Inc. structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic, Inc. considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction. Insight Geologic cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by Insight Geologic should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Insight Geologic for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and pre-construction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with Insight Geologic and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

GEOBRUGG BRUGG
Safety is our nature

RUVOLUM® ONLINE TOOL

RUVOLUM® - The Program to dimension the slope stabilization system TECCO®/SPIDER®

Project No.	
Project Name	Daniells
Date, Author	10 October 2022

Input quantities			
Slope inclination	α=	75.0	degrees
Layer thickness	t=	2.50	ft
Friction angle ground (characteristic value)	Φ_k=	40.0	degrees
Volume weight ground (characteristic value)	γ_k=	120.0	lb/ft^3
Nail inclination	ψ=	5.0	degrees
Nail distance horizontal	a=	9.25	ft
Nail distance in line of slope	b=	9.25	ft

Load cases			
Streaming pressure		No	
Earthquake		No	
Coefficient of horizontal acceleration due to earthquake	ε_h=	0.000	[-]
Coefficient of vertical acceleration due to earthquake	ε_v=	0.000	[-]

Defaults and Safety Factors			
Cohesion ground (characteristic value)	c_k=	0.0	lb/ft^2
Radius of pressure cone, top	ζ=	0.49	ft
Inclination of pressure cone to horizontal	δ=	45.0	degrees
Slope-parallel force	Z_d=	3.4	kips
Pretensioning force of the system	V=	6.7	kips
Partial safety correction value for friction angle	γ_ϕ	1.25	[-]
Partial safety correction value for cohesion	γ_c	1.25	[-]
Partial safety correction value for volume weight	γ_γ	1.00	[-]
Model uncertainty correction value	γ_{mod}	1.10	[-]

Dimensioning quantities	Φ_d=	33.9	degrees
	c_d=	0.0	lb/ft^2
	γ_d=	120.3	lb/ft^3

Elements of the system

Applied mesh type		TECCO G65/3	
Applied spike plate		system spike plate P33	
Bearing resistance of mesh to selective, slope parallel tensile stress	Z_R=	7	kips
Bearing resistance of mesh to pressure stress in nail direction	D_R=	41	kips
Bearing resistance of mesh against shearing-off in nail direction	P_R=	20	kips
Elongation in longitudinal tensile strength test	δ<	6	%

Applied nail type		DYWIDAG 28 mm, Grad 75	
Taking into account rusting away		Yes	
Bearing resistance of nail to tensile stress	T_{Rred}=	53	kips
Bearing resistance of nail to shear stress	S_{Rred}=	30	kips
Cross-section surface of the applied nail with / without rusting away	A_{red}=	1	in^2

Proofs

Proof of the mesh against shearing-off at the upslope edge of the spike plate	Fulfilled
Proof of the mesh to selective transmission of the force Z onto the nail	Fulfilled
Proof of the nail against sliding-off of a superficial layer parallel to the slope	Fulfilled
Proof of the mesh against puncturing	Fulfilled
Proof of the nail to combined stress	Fulfilled

The given proofs concern the investigation of superficial instabilities. Additional investigations are required if there is a risk regarding global stability of the slope. If necessary the nail type and nail pattern have to be adapted.

Investigation of local instabilities between single nails

Proof of the mesh against shearing-off at the upslope edge of the spike plate

Maximum stress on the mesh for shearing-off in nail direction at the upslope edge of the spike plate (dimensioning level).	P_d=	12.7	kips
Thickness of decisive sliding mechanism	t_{rel}=	2.49	ft
Bearing resistance of the mesh against shearing-off in nail direction at the upslope edge of the spike plate (characteristic value).	P_R=	20.2	kips
Resistance correction value for shearing-off of the mesh	γ_{PR}=	1.5	[-]
Dimensioning value of the bearing resistance of the mesh against shearing-off	P_R/γ_{PR}=	13.5	kips
Proof of bearing safety	$P_d<=P_R/\gamma_{PR}$	Fulfilled	

Proof of the mesh to selective transmission of the force Z onto the nail

Slope parallel force taken into account in the equilibrium considerations	Z_d=	3.4	kips
Bearing resistance of the mesh to selective, slope-parallel tensile stress	Z_R=	6.7	kips
Resistance correction value for selective, slope-parallel transmission of the force Z	γ_{ZR}=	1.5	[-]
Dimensioning value of the bearing resistance of the mesh to tensile stress	Z_R/γ_{ZR}=	4.5	kips
Proof of bearing safety	$Z_d<=Z_R/\gamma_{ZR}$	Fulfilled	

Investigation of slop-parallel instabilities

Proof of the nail against sliding-off of a superficial layer parallel to the slope

Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{vI}=$	0.8	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dI}=$	5.4	kips
Calculatorily required shear force at dimensioning level in function of V_{dI}	$S_d=$	16.6	kips
Bearing resistance of the nail to shear stress	$S_{Rred}=$	30.3	kips
Resistance correction value for shearing-off of the nail	$\gamma_{SR}=$	1.5	[-]
Dimensioning value of the bearing resistance of the nail to shear stress	$S_{Rred}/\gamma_{SR}=$	20.2	kips
Proof of bearing safety	$S_d<=S_{Rred}/\gamma_{SR}$	Fulfilled	

Proof of the mesh against puncturing

Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{vII}=$	1.5	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dII}=$	10.0	kips
Bearing resistance of the mesh to pressure stress in nail direction	$D_R=$	40.5	kips
Resistance correction value for puncturing	$\gamma_{DR}=$	1.5	[-]
Dimensioning value of the bearing resistance of the mesh to pressure stress	$D_R/\gamma_{DR}=$	27.0	kips
Proof of bearing safety	$V_{dII} <= D_R/\gamma_{DR}$	Fulfilled	

Proof of the nail to combined stress

Pretensioning force effectively applied on nail	$V=$	6.7	kips
Load factor for positive influence of pretension V	$\gamma_{vI}=$	0.8	[-]
Dimensioning value of the applied pretensioning force by positive influence of V	$V_{dI}=$	5.4	kips
Load factor for negative influence of pretension V	$\gamma_{vII}=$	1.5	[-]
Dimensioning value of the applied pretensioning force by negative influence of V	$V_{dII}=$	10.0	kips
Calculatorily required shear force at dimensioning level in function of V_{dII}	$S_d=$	16.6	kips
Maximum stress on the mesh for shearing-off	$P_d=$	12.7	kips
Bearing resistance of the nail to tensile stress	$T_{Rred}=$	52.6	kips
Bearing resistance of the nail to shear stress	$S_{Rred}=$	30.3	kips
Resistance correction value for tensile stress	$\gamma_{TR}=$	1.5	[-]
Resistance correction value for shear stress	$\gamma_{SR}=$	1.5	[-]
Proof of bearing safety $\{[V_{dII}/(T_{Rred}/\gamma_{TR})]^2 + [S_d/(S_{Rred}/\gamma_{SR})]^2\}^{0.5} <= 1.0$	0.87	Fulfilled	
Proof of bearing safety $\{[P_d/(T_{Rred}/\gamma_{TR})]^2 + [S_d/(S_{Rred}/\gamma_{SR})]^2\}^{0.5} <= 1.0$	0.90	Fulfilled	

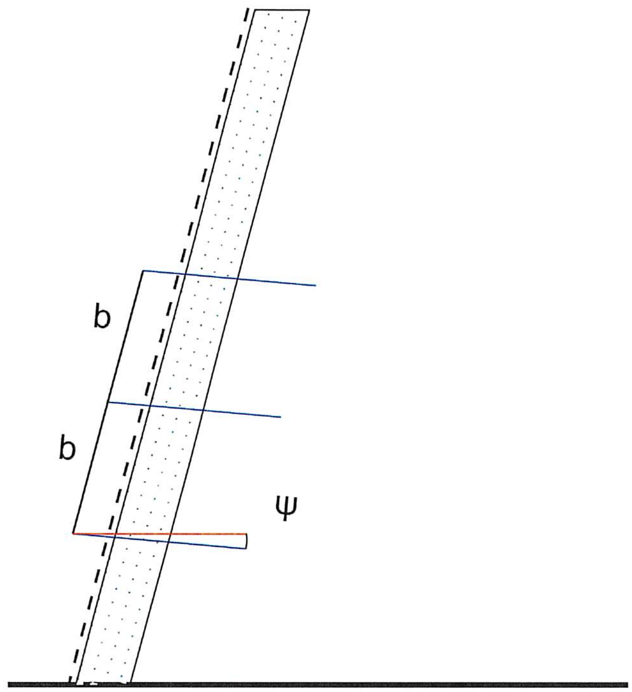
Minimal tensile strength in the nail for superficial instabilities

Dimensioning value of the static equivalent tensile force in the nail for determination of the nail length	$T_d=$	24.7	kips

Safety is our nature

Cross-section:

Layer thickness	t=	2.50	ft
Nail inclination	ψ=	5.0	degrees
Slope inclination	α=	75.0	degrees



View nail arrangement: