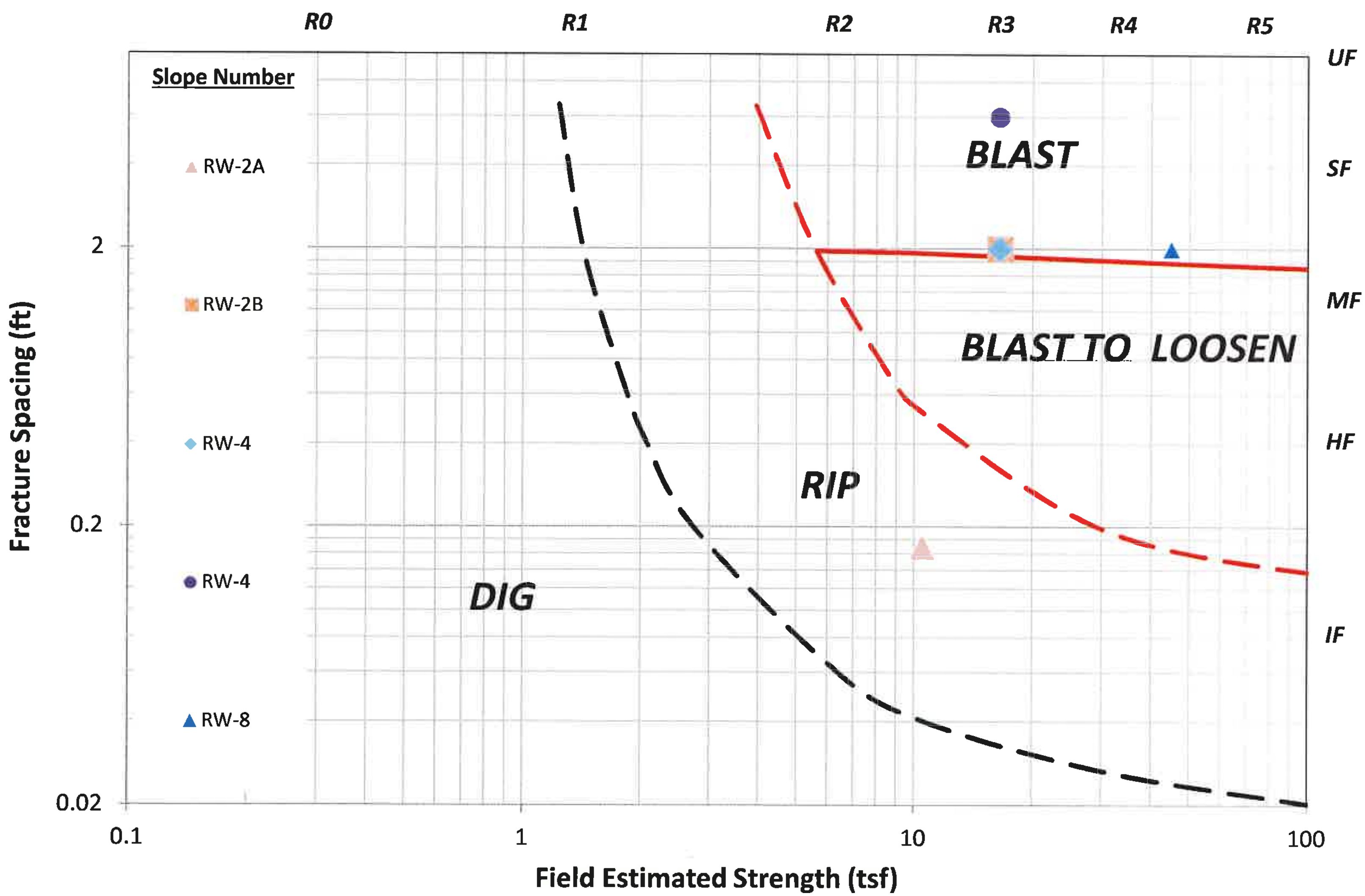
Excavatibility

Broch and Franklin Excavatability (1972)



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Calculation No. 9

CALCULATION SUMMARY

Project:	Reds Meadow Road Improvement	Job No:	100062-002
Project Feature and Subject:	Seismicity		

Calculation Purpose *(describe purpose/goal of calculation)*

Provide seismic design parameters for the upper 2.5 miles of the project. Original seismicity calc package was performed within phase 001 of the project.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

DESIGN GUIDANCE:

- The primary design is the Federal Lands Highway's Project Development and Design Manual (PDDM), specifically section 6.4.11.
- In addition, in this calc package I provide seismic design parameters based on AASHTO LRFD design criteria.
    - AASHTO LRFD Bridge Design Specifications, 8th edition, criteria was followed to determine the recommended Peak Ground Acceleration (PGA), short-period spectral acceleration coefficient (S_S), long-period spectral acceleration coefficient (S_1), and associated site factors.
- Excerpts from the PDDM and ASSHTO are shown on pages 3-14.

DESIGN REQUIREMENTS:

- The PDDM calls for a 10% probability of exceedances in 50 years, equivalent to a 475-year return period, for the seismic design event.
- AASHTO calls for a 7% probability of exceedance in 75 years, equivalent to approximately 1,000-year return period, for the seismic design event.

GENERAL APPROACH:

- In this calc package I provide seismic design parameters for the upper 2.5 miles of the project. The initial calc package was performed within phase 001 of the project.
- Site Location:
  Lat = 37.6533
  Long = -119.0609
- The site exploration consists of exploratory borings, test pits, and seismic refraction lines.
    - Refer to the report for the locations and results of the subsurface explorations.
    - The subsurface typically consists of 5 to 15 feet of artificial fill/Quaternary Talus and Slopewash, underlain by Triassic to Jurassic age, hard metasedimentary bedrock (JTrc) and undifferentiated volcanic rocks (JTru).
    - Based on seismic refraction lines, the primary wave velocity within the bedrock typically ranges from approximately 2,000 ft/s to 9,000 ft/s.
    - Due to the majority of the site being underlain by bedrock, and based on the seismic refraction data, I chose Site Class B to characterize the site.
- I used the U.S. Geologic Survey's (USGS's) Unified Hazard Tool to determine the PGA, S_1, and S_S coefficients, as well as the earthquake design magnitude, for both the 475-year return period and the 1,000-year return period events.

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 9

CALCULATION SUMMARY

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO Guide for Design of Pavement Structures, Published by the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington D.C., 20001.

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

U.S. Geological Survey Unified Hazard Tool, Available: https://earthquake.usgs.gov/hazards/interactive/, accessed January 2019.

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

In Table 1 below I present the recommended seismic design parameters for the PDDM design earthquake (10% exceedance in 50 years):

Table 1. Recommended Seismic Design Parameters for PDDM Design Level EQ Event

Peak Ground Acceleration (PGA)	F_{PGA}	Site Specific PGA	Short-Period Response, S_s	F_a	Long-Period Response, S_1	F_v	M_w
0.257 g	1.0	0.257 g	0.547 g	1.0	0.120 g	1.0	6.7

In Table 2 below I present the recommended seismic design parameters for the AASHTO design earthquake (7% exceedance in 75 years):

Table 2. Seismic Design Parameters for AASHTO EQ Event

Peak Ground Acceleration (PGA)	F_{PGA}	A_s	Short-Period Response, S_s	F_a	Long-Period Response, S_1	F_v	M_w
0.343 g	1.0	0.343 g	0.739 g	1.0	0.167 g	1.0	6.7

Results of the USGS Unified Hazard Tool are shown on pages 15-23.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Brian Trott	1/7/19			23
PM Review of Assumptions and Input Properties			by: _________ on _________		
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

USGS UNIFIED HAZARD TOOL

RESULTS

10% IN 50 YEARS

PDDM CRITERIA RESULTS

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (v4.1.

Latitude

Decimal degrees

37.6533

Longitude

Decimal degrees, negative values for western longitudes

-119.0609

Site Class

1150 m/s (Site class B)

Spectral Period

Peak ground acceleration

Time Horizon

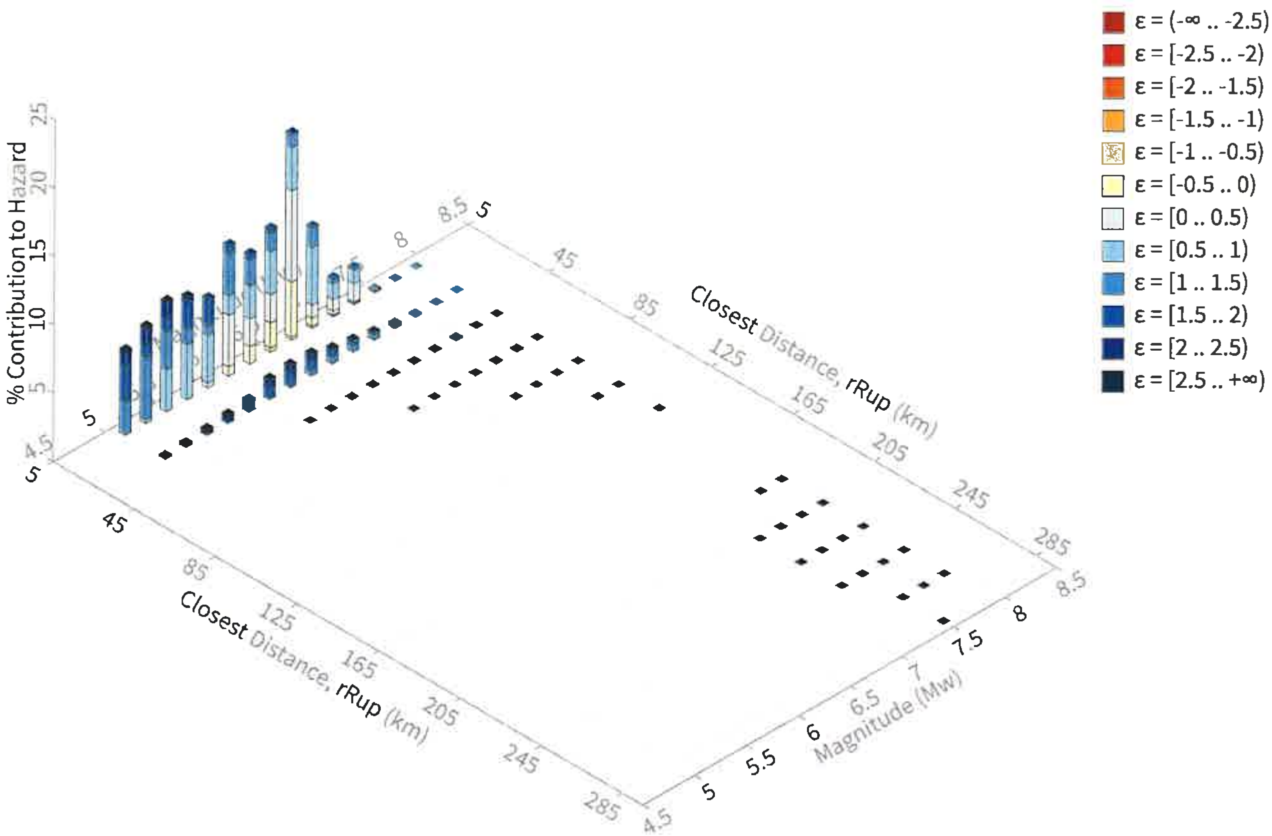
Return period in years

475

^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.25729859 g

Recommend a PGA of 0.257 g

Recovered targets

Return period: 498.01425 yrs
Exceedance rate: 0.0020079747 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.12 %

Mean (for all sources)

r: 12.37 km
m: 6.17
ε_0: 0.95 σ

Mode (largest r-m bin)

r: 7.89 km
m: 6.66

Recommend a magnitude of 6.7

ε_0: 0.29 σ
Contribution: 15.08 %

Mode (largest ε_0 bin)

r: 6.91 km
m: 6.65
ε_0: 0.26 σ
Contribution: 6.67 %

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
0.2 s SA ground motion: 0.54696955 g

Recovered targets

Return period: 493.54295 yrs
Exceedance rate: 0.0020261661 yr^{-1}

Recommend a Ss of 0.547 g

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
1.0 s SA ground motion: 0.12011973 g

Recovered targets

Return period: 496.24338 yrs
Exceedance rate: 0.0020151402 yr^{-1}

Recommend a S1 of 0.120 g

7% IN 75 YEARS

AASHTO CRITERIA RESULTS

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (v4.1.

Latitude

Decimal degrees

37.6533

Longitude

Decimal degrees, negative values for western longitudes

-119.0609

Site Class

1150 m/s (Site class B)

Spectral Period

Peak ground acceleration

Time Horizon

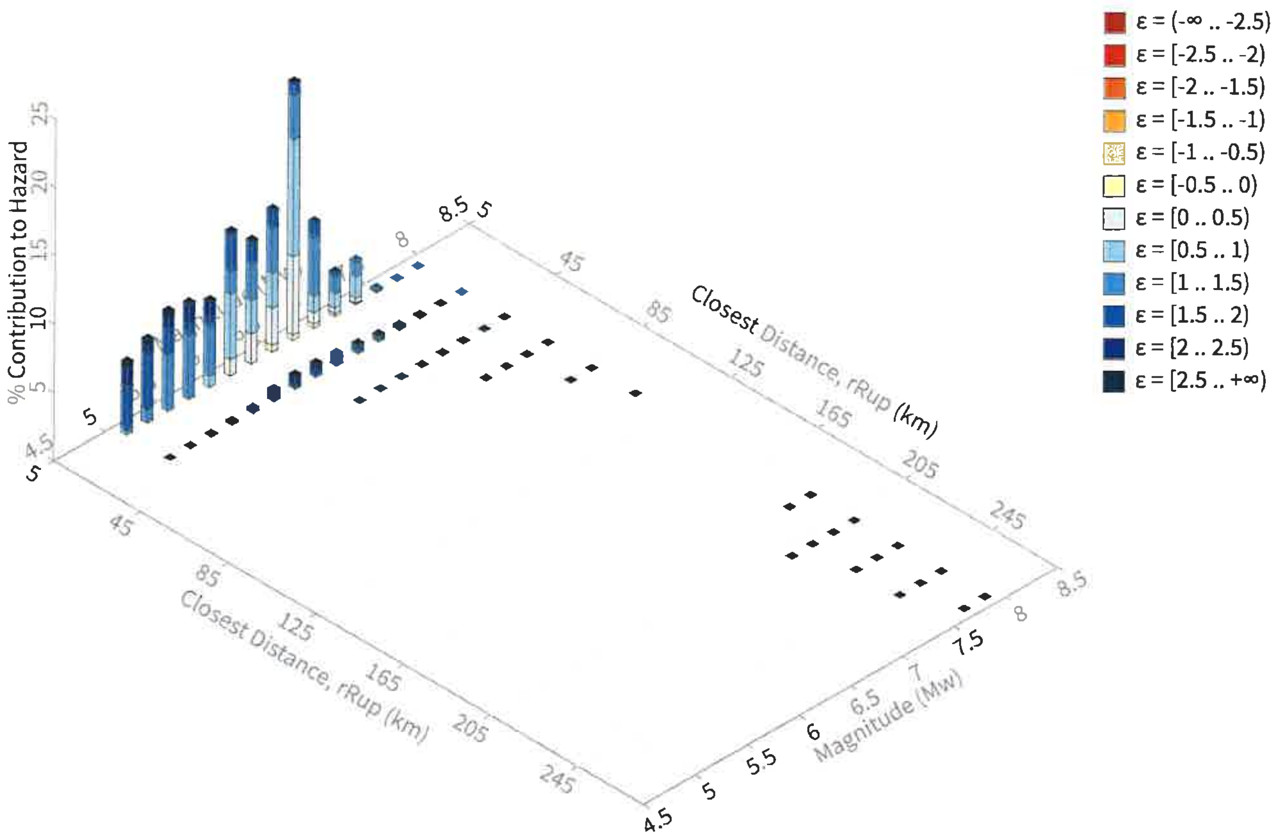
Return period in years

1000

^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 1000 yrs
Exceedance rate: 0.001 yr^{-1}
PGA ground motion: 0.34268385 g

Recovered targets

Return period: 1069.3487 yrs
Exceedance rate: 0.00093514866 yr^{-1}

Recommend a PGA = 0.343 g

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.12 %

Mean (for all sources)

r: 10.87 km
m: 6.23
ε_0: 1.2 σ

Mode (largest r-m bin)

r: 7.57 km
m: 6.66
ε_0: 0.7 σ
Contribution: 18.78 %

Recommend a magnitude of 6.7

Mode (largest ε_0 bin)

r: 6.95 km
m: 6.65
ε_0: 0.72 σ
Contribution: 8.58 %

Deaggregation targets

Return period: 1000 yrs
Exceedance rate: 0.001 yr^{-1}
0.2 s SA ground motion: 0.73926278 g

Recovered targets

Return period: 1062.4681 yrs
Exceedance rate: 0.0009412047 yr^{-1}

Recommend a Ss = 0.739 g

Deaggregation targets

Return period: 1000 yrs
Exceedance rate: 0.001 yr^{-1}
1.0 s SA ground motion: 0.16696322 g

Recovered targets

Return period: 1049.8776 yrs
Exceedance rate: 0.00095249195 yr^{-1}

Recommend a S1 = 0.167 g

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 1

CALCULATION SUMMARY

Project: Reds Meadows Road Improvement   Job No: 100062-003

Project Feature and Subject: Soil Nail Wall_Development of Cross Sections

Calculation Purpose *(describe purpose/goal of calculation)*

To evaluate the subsurface conditions and geometry of proposed soil nail walls located along the upper 2.5 miles of Reds Meadow Road. 14 proposed soil nail walls have been provided to us within the 80% Design Submittal Plan Sheets. The proposed walls vary in conditions such as wall height, backslope geometry, and retained soil properties. This calculation package shows the development of the cross sections which will be used to represent the areas of the proposed soil nail walls. To this extent, we developed 14 cross sections in total. Stability evaluation is provided in a separate calculation package, Calculation No 2.

A previous soil nail calculation package was developed as part of our 2019 Geotechnical Design Report, within Phase 002 of the project (project number 100062-002). This calculation is provided as an update based on the more recent plan sheets and supersedes our previous analysis.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

Design Criteria/Design Guidance:

- Federal Highway Administration, Project Development and Design (PDDM) Manual, 2012.
- Federal Highway Administration (FHWA), Soil Nail Walls Reference Manual, Publication No. FHWA-NHI-14-007, GEC 007, February 2015.
    - FHWA's GEC No. 7 typically follows AASHTO's LRFD methodology. However, it also relies on ASD-based stability calculations, as is the current standard of practice for slope stability evaluation. In general, it relies on ASD-based stability calculations for overall evaluation purposes, and then uses these results to perform LRFD checks.

Provided Plan Sheet Data:

- Jacobs provided 80% Design Submittal plan sheets (dated 11/12/19).
- Edited/updated sheets were provided on the following dates:
    - Profile Sheets and Cross Section Sheets, Sheets C03, C08, X12, and X4_provided 12/16/2019
    - "Wall Site Plan and General Notes", Sheet G3_provided 3/19/2020
        - The revised Sheet G3 has updated soil nail wall locations and soil nail wall names. Wall 35 from the 11/12/19 plan sheets has been changed to Wall 34 within the revised plan sheet.

Subsurface Data:

- Hollow-stem exploratory borings were performed in May/June 2018 (labeled SW-B-3 through SW-B-21) and in October/November 2018 (labeled SW-B-44 through SW-B-51).
- Exploratory test pits (labeled TP-1 through TP-8) were performed in May 2018.
- Geophysical exploration, consisting of seismic refraction lines (labeled S-1 through S-15), were performed in October 2018.
- In general, the site consists of artificial fill (af), underlain by Quaternary Talus and Slopewash (Qts) and valley fill (Qal), further underlain by undifferentiated sedimentary rock (JTrc) and undifferentiated volcanic rocks (JTru), which will be referred to as bedrock.
- Results of the subsurface explorations are presented within the Phase 002, 2019 Geotechnical Design Report (S&W, 2019), and are discussed in the current (Phase 003) design report.

CALCULATION SUMMARY

Development of Soil and Bedrock Parameters:

- As part of the Phase 002 work and preparation of the 2019 Design Report, we developed a "Cross Sections and Material Property Development" calculation package (Calculation No. 1 of Phase 002). Within this calculation, we developed the recommended strength parameters for af and Qts/Qal. For the analysis, we assumed the same material properties for Qts and Qal.
  - We recommend using the same material properties for af and Qts/Qal within this calculation package as was developed within Calc No 1 of Phase 002.
  - These parameters consist of drained (effective stress) parameters. For all soil units, cohesion is assumed to be zero.
  - Qts/Qal soil parameters vary for the different cross sections, depending if the soil is pumice rich or non-pumice rich. For pumice rich soil, we recommend using a unit weight of 90 pcf and a friction angle of 30°. For non-pumice rich soil, we recommend using a unit weight of 120 pcf and a friction angle of 32°.
  - For artificial fill, we recommend using a unit weight of 120 pcf and a friction angle of 30°
  - Refer to Calc No 1 of Phase 002 for additional discussion or detail with regard to development of af and Qts/Qal strength parameters.
- For structural fill, we recommend using a unit weight of 125 pounds-per-cubic foot (pcf) and a friction angle of 34°.
- In addition, we performed an MSE Wall evaluation calculation package as part of the Phase 002 work (Calculation No. 2 of Phase 002). Within this calculation, we developed recommendation strength parameters for bedrock material.
  - We recommend using the same material properties for bedrock within this calculation package as was developed within Calc No 2 of Phase 002.
  - For bedrock, we recommend using a unit weight of 145 pcf, a friction angle of 40°, and a cohesion of 10,000 psf.
  - Refer to Calc No 2 of Phase 002 for additional discussion or detail with regard to development of bedrock strength parameters.

Wall and Slope Geometry:

- Plan Sheet G3, provided on page 8, presents the 'Wall Design Schedule', which lists the locations and maximum design wall height.
- We developed 14 cross sections to represent the areas of the proposed soil nail walls. These representative cross sections were developed using the surficial geometry presented in the cross sections provided in the referenced plan sheets. We developed the anticipated subsurface conditions based on nearby explorations and surficial mapping performed during site visits.
- The location of the 14 sections and other associated details is provided in the table shown on the next page.

CALCULATION SUMMARY

X-Section ID[1]	Wall #	Wall Station (approx.)	Section Station (approx.)	Exposed Wall Height (approx.)	Wall Height (approx.)	Blackslope Angle (approx.)	Remarks
C	27 & 34	24+10 to 29+45.25, 31+15 to 37+24.53	32+50	6.7 ft	7.8 ft	35°	Non-pumice rich
D			35+00	6.8 ft	8.1 ft	38°	Non-pumice rich
E	48 & 50	47+00 to 48+84.26, 49+56 to 50+33.83	47+50	7.6 ft	8.6 ft	29°	Non-pumice rich
G	62	55+05 to 68+53.62	61+00	9.3 ft	10.3 ft	35°	Pumice rich
H			66+50	6.5 ft	7.5 ft	35°	Pumice rich
I	85	84+45 to 85+50.14	84+50	8.2 ft	9.4 ft	28°	Pumice rich
J	92 & 93	91+20 to 92+13.97, 92+35 to 92+88.18	91+50	6.3 ft	7.6 ft	26°	Non-pumice rich
K	95	94+70 to 95+26.18	95+00	8.3 ft	9.4 ft	36°	Pumice rich
N	99 & 100	98+56 to 99+01.54, 99+26 to 101+51.59	99+50	8.8 ft	9.6 ft	39°	Pumice rich
O			100+00	5.9 ft	7.0 ft	37°	Pumice rich
Q	111	110+10 to 111+85.65	110+50	5.8 ft	7.0 ft	30°	Non-pumice rich
R	119	116+30 to 121+32.94	117+00	6.6 ft	7.6 ft	34°	Pumice rich
S			119+00	6.8 ft	7.9 ft	32°	Pumice rich
T	131	130+25 to 132+16.15	131+50	5.7 ft	6.7 ft	34°	Pumice rich

Note:

[1]X-Section ID are based on numerical order in terms of station location. However, they also take into consideration of cross sections created as part of the RSS evaluation (Calculation No 3). Thus, cross sections A, B, F, L, M, P, and U are used to represent RSS cross sections. See Calculation No 3 for RSS section locations.

The associated plan sheet cross sections for each station are provided on pages 11-23.

Soil Nail Parameters:

- Soil Nail Pullout Resistance:
  - For nails in the Qts/Qal material and assuming rotary drilling method, **the nominal bond strength of 20 psi (2,880 psf)** was estimated using Table 4.4a in FHWA Soil Nail Walls Reference Manual, see page 25. The bond strength will need to be achieved in the field by the contractor and confirmed by testing. **We recommend testing shall confirm the nominal pullout capacity per unit length of bond, which is approximately 4.5 kips per foot** (kips/ft). See pull-out capacity hand calculations on page 27.
  - For nails in bedrock, a nominal bond strength of 160 psi was estimated using recommendations provided by the Post-Tensioning Institute (PTI, 2014), see page 26. We recommend that the contractor does not need to test the bedrock bond strength, as our design evaluation assumes the alluvial soil bond strength.

CALCULATION SUMMARY

- The nominal pullout capacity per unit length of bond (aka the load transfer rate) of approximately **4.5 kips/ft** and **36.2 kips/ft** were calculated for the Qts and bedrock, respectively (see pull-out capacity hand calculations on page 27).
- Considering that the depth to rock from the proposed wall face is variable along the alignment and relatively unknown, we compared the load transfer rate in the Qts to the load transfer rate in the bedrock. According to this calculation, **every foot of rock is equivalent to 8 foot of Qts**.

- Soil Nail Tensile Forces:
  - According to plan sheet G3, shown on page 8, the maximum design wall height is 12 ft.
  - Using Coulomb's earth pressure theory and input parameters for the soil and the slope geometry, we used the Shannon & Wilson's AASHTO Earth Pressure spreadsheet to estimate the active earth pressure coefficient, k_a. See page 31.
  - The tensile force at the nail head (T_o) and the maximum nail tensile force (T_{max}) due to static earth pressure loading were calculated in accordance to FHWA GEC No.7 manual and were found to be equal to $T_{o,static}$ = 10.4 kips and $T_{max,static}$ =14.6 kips. In addition, we performed an alternative check to back-calculate the tensile force at the nail head (T_o) by performing slope stability evaluation.
    - We created a simplified slope stability model within SLOPE/W, assumed a maximum wall height of 12 feet, inputted pumice rich soil parameters (since the location of the proposed 12-foot wall is within a pumice zone), and used an iterative process to estimate the active earth pressure value (P_a) by assuming P_a acts at H/3 above the base of the wall height.
    - The slope stability search extent was set at the base of the wall and ranged backwards a distance of 3H to 6H (i.e. 36 feet to 72 feet behind the wall face).
    - P_a values were iteratively changed in order to determine a factor of safety value of 1.
    - Slope stability results are provided on pages 35 to 39.
  - Based on FHWA GEC No. 7 guidance and the alternative calculation of checking via performing a slope stability calculation, **we recommend the following design values for the tensile force at the nail head due to earth pressure loading:**

    T_o, static = 12,100 lbs

    T_o, seismic = 17,600 lbs
  - Based on allowable tensile load on bars, **we recommend soil nails consisting of No.8, Grade 75 steel bars.** Based on the nail properties and the allowable tensile load on the bars, these bars result with T_o = 23.5 kips and T_{max} = 32.9 kips, which is greater than tensile forces caused by earth pressure. These values are assumed the bars will be centered in a grouted 6.0 inch (0.5 feet) drillhole and is recommended to account for the maximum design height of 12 ft.
- **Minimum soil nail length**:
  - **All soil nails should have a minimum length of 10 feet**
  - **Recommended soil nail lengths are provided based on stability evaluation (provided in Calculation Package No 2). Soil nails should be advanced to the plan length.**
  - **If bedrock is encountered during installation, the soil nail lengths may be reduced from the plan length if the nails have a minimum embedment of 3 feet into bedrock and meet the requirement of a minimum total nail length of 10 feet.**

CALCULATION SUMMARY

Slope Stability Evaluation Methodology:

- The internal and general global stability analyses will be performed using the commercially available GeoStudio software SLOPE/W. The software allows soil reinforcement, including soil nails, to be modeled in the analyses.
- The soil nails are characterized by their geometry, bond strength, tensile strength, and associated factor of safeties.
- The soil nail input parameters into the SLOPE/W analysis are presented in the table below. The applicable reduction factors were determined following Table 5.1 of FHWA GEC No. 7, shown on page 41.

Loading Case	Pullout Resistance (psf)	Pullout Resistance Factor of Safety	Bond Diameter (ft)	Horizontal Spacing, S_H (ft)	Tensile Capacity (lbf)	Tensile Capacity Factor of Safety
Static	2,880	2.0	0.5	5.0	59,200	1.8
Pseudo-static	2,880	1.5	0.5	5.0	59,200	1.35

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

American Association of State Highway and Transportation Officials (AASHTO), 2017, AASHTO LRFD Bridge Design Specifications, Customary U.S. units, 8th edition: Washington, D.C., American Association of State Highway and Transportation Officials.

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

Federal Highway Administration (FHWA), 2015, Soil Nail Walls Reference Manual, FHWA NHI-14-007, GEC-007, February 2015.

Jacobs, 2019, Reds Meadow Road: Plans, profiles, and cross sections prepared by Jacobs, for Central Federal Lands, November 12, 75 sheets (C01 to C12, X01 to X63).

Post-Tensioning Institute, 2016, Recommendations for Prestressed Rock and Soil Anchors, PTI DC-35.

Shannon & Wilson, Inc. (S&W), 2019, Geotechnical Report, Reds Meadow Roads Improvements, Madera County, California, Project No. 100062-002, dated May 30.

Previous Shannon & Wilson Calc Packages, from Phase 002 Analysis, Project No. 100062-002:

- Calculation No 1, Cross Sections and Material Properties Development, Rev 1
- Calculation No 2, Mechanically Stabilized Earth (MSE) Walls, Rev 2

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 1

CALCULATION SUMMARY

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

The location of the 14 cross sections and their applicable station ranges which the sections represent are provided within the General Approach section.

The recommended soil nail parameters, such as pullout resistance strength, tensile capacity, bond diameter and recommended factor of safeties are provided within the General Approach section.

The minimum soil nail length requirements is outlined within the General Approach section.

A hand sketch of the recommended soil nail pattern is presented on page 42. The number of rows and the general pattern of the nail locations is dependent upon the height range of the wall.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Ali Tarokh	02/12/2020	Brian Trott	02/26/2020	81
1	Ali Tarokh	02/27/2020	Brian Trott	02/28/2020	64
2	Ali Tarokh	03/11/2020	Brian Trott	03/13/2020	64
3	Ali Tarokh	03/16/2020	Paul Macklin	03/24/2020	64
4	Brian Trott	03/30/2020	Steve Diem	4/16/20	70
5	Brian Trott	5/7/20			42
PM Review of Assumptions and Input Properties			by: _________ on _________		
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

SOIL NAIL PULLOUT RESISTANCE

other measures can be taken to increase the pullout capacity of soil nails. For example, the Contractor may simply increase the diameter of the drill hole or improve the cleaning method to obtain larger pullout resistances.

When nails are installed in ground considered to be unfavorable for soil nailing, some adjustments in the conventional soil nail installation procedures will be necessary to achieve the required design bond strengths. An example is when soil nails are installed in dry loess using the gravity grouting method. In this case, the bottom and lateral portions of the drill hole wall are weakened because the grout provides moisture to the dry loess, possibly causing the drill hole walls to collapse. Also, along portions of the nail, the grout may permeate and develop a void between the nails and the drill hole wall. Experience has shown that adequate bond strengths can be achieved in loess, using pressure grouting or re-grouting with a tremie tube.

Table 4.4a: Estimated Bond Strength for Soil Nails in Coarse-Grained Soils (Modified after Elias and Juran 1991)

Drill-Hole Drilling Method	Soil Type	Bond Strength, q_u (psi)
Rotary Drilled	Sand/gravel	15 - 26
Rotary Drilled	Silty sand	15 - 22
Rotary Drilled	Silt	9 - 11
Rotary Drilled	Piedmont residual	6 - 17
Rotary Drilled	Fine Colluvium	11 - 22
Driven Casing	Sand/gravel w/low overburden (1)	28 - 35
Driven Casing	Sand/gravel w/high overburden (1)	41 - 62
Driven Casing	Dense Moraine	55 - 70
Driven Casing	Colluvium	15 - 26
Augered	Silty sand fill	3 - 6
Augered	Silty fine sand	8 - 13
Augered	Silty clayey sand	9 - 20

Note: (1) Low and high overburden are defined as effective overburden pressure being, respectively, less than and greater than 1.5 tsf.

We assume rotary drilled method and the soil type to be sand/gravel.
We assume the ultimate bond strength to vary between 15 to 26 psi.

For design, assume q_u = 20 psi = 2,880 psf

RECOMMENDATIONS **COMMENTARY**

Table C6.1 — Typical average ultimate bond strengths—rock/grout

Rock	Average ultimate bond strength—rock/grout, MPa (psi)
Granite and basalt	1.7 to 3.1 (250 to 450)
Dolomite limestone	1.4 to 2.1 (200 to 300)
Soft limestone	1.0 to 1.4 (150 to 200)
Slates and hard shales	0.8 to 1.4 (120 to 200)
Soft shales	0.2 to 0.8 (30 to 120)
Sandstones	0.8 to 1.7 (120 to 250)
Weathered sandstones	0.7 to 0.8 (100 to 120)
Chalk	0.2 to 1.1 (30 to 155)
Weathered marl	0.15 to 0.25 (25 to 35)
Concrete	1.4 to 2.8 (200 to 400)

Minimum soil nail length:

- 4.5 m (15 ft) for ASTM A416/A416M strand;
- 3.0 m (10 ft) for ASTM A722/A722M Type II bars 44 mm (1.75 in.) diameter or smaller; or
- 4.5 m (15 ft) for ASTM A722/A722M Type II bars larger than 44 mm (1.75 in.) diameter.

These minimum lengths may be reduced if special provisions are provided.

These minimum bond lengths for bars are based on ACI 318 development length requirements of deformed reinforcement in tension, assuming full confinement of the grout, as would be provided by a rock socket.

Borings encountered meta-sedimentary bedrock. Assume the meta-sedimentary bedrock has similar strength-rock/grout values as the slates and hard shale values shown above.

For design: assume q_u = 160 psi = 23,040 psf

6.7.1 — Rock anchors

The average ultimate bond strength in rock depends on the following:

1. Strength and modulus of elasticity of the rock;
2. Discontinuities in the rock mass, including spacing, orientation, and width of bedding planes, joints, and fractures;
3. Minerals in the rock, which may lubricate the bond length or reduce the grout strength;
4. Method of drilling and cleaning the drill hole;
5. Drill hole wall roughness;
6. Timing between drilling and grouting in soft rocks;
7. In-place strength of grout;
8. Grouting methods, pressures, and mixture designs; and
9. Bond length.

C6.7.1 — Rock anchors

Table C6.1 provides typical values of ultimate bond strength for anchors in rock. Ultimate bond strength values can also be approximated using a value of 10% of the unconfined compressive strength of the rock, up to a maximum bond strength value of 4.2 MPa (600 psi).

For conventional rock anchors installed in competent rock, the bond stresses are typically concentrated at the top of the bond length. The maximum strain in the tendon bond length occurs at the top of the tendon bond length and may cause local load redistribution within the rock or the displacement of a small cone of rock. When this occurs, the peak stress position moves down the tendon bond length.

Most bond lengths are less than 10 m (35 ft). Bond lengths greater than 10 m (35 ft) become less efficient, unless special provisions are taken to transfer load throughout the bond length.

It is recommended that grouting be done as soon as possible after drilling, especially in rock prone to time-dependent degradation.

Soil Nail pullout Resistance:

Goal: To calculate the pull-out capacity per unit length of bond in rock and to compare it with Quaternary Talus and slopewash (Qts).

Assumptions:

① 6 inch (0.5 ft) diameter drill hole.

② Nominal bond strength:

Qts: $q_u = 20$ psi $= 2{,}880$ psf

Rock: $q_u = 160$ psi $= 23{,}040$ psf

Calculations: pullout capacity per unit length:

Qts: $r_{p_o} = \pi D q_u = \pi (0.5\ ft)(2{,}880\ lb/ft^2) = 4{,}524\ lb/ft = 4.5\ kip/ft$

Rock: $r_{p_o} = \pi D q_u = \pi (0.5\ ft)(23{,}040\ lb/ft^2) = 36{,}190\ lb/ft = 36.2\ kip/ft$

$\frac{36.2\ kip/ft}{4.5\ kip/ft} = 8$ ⇒ Every foot of rock is equivalent to 8 ft of Qts.

SOIL NAIL TENSILE FORCES

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

JOB NAME Reds Meadow
SUBJECT Soil Nail wall – Earth pressures
BY AYT CHK'D
JOB NO. 100062-003
DATE 02/10/2020
SHEET ___ of ___

Active Earth Pressure Coefficient:

Assumptions: ① Coulomb earth pressure theory → Using S&W spreadsheet (see attached)

② Input parameters for the soil (QTs):

γ = 90 pcf

ϕ = 30°

$\delta = \frac{2}{3}\phi$ = (2/3)*30 = 20°

③ Input parameters for the Geometry:

H = 12.0 ft (maximum design wall height) according to 20191112 – CAFLAP035(1)(1) 80 per QC

β = 30°

Note: backfill slope is closer to 36 degrees, however in Coulomb's earth pressure theory, the backslope cannot be greater than the soil friction angle. Therefore, recommend 30 degrees.

$\theta = 0°$ (assumed based on the very small wall batter angles shown in the plans).

Result: Active earth pressure Coefficient: K_a = 0.80

Tensile forces at Nail head / wall facing (due to earth pressure):

According to FHWA GEC NO.7 (2015) soil nail walls reference manual section 5.2.1C, the average tensile force in the nail head ranges from approximately $T_o = 0.5\,K_a \gamma_s H S_V S_H$ to $T_o = 0.6\,K_a \gamma_s H S_V S_H$. Additionally, the manual indicates that the normalized values of T_o vary from approximately 0.40 to 0.70 in the upper 2/3 of the wall. Therefore, we assume $T_o = 0.6\,K_a \gamma_s H S_V S_H$.

K_a = 0.80 H = 12.0 ft

γ_s = 90 pcf S_V = 4 ft; SH = 5 ft

⇒ T_o = 0.6*(0.80)*(90 pcf)*(12')*(4')*(5') = 10,368 lbs = 10.4 kips

Maximum soil nail load due to earth pressure (static):

$$* \; T_o = T_{max}\left[0.6 + 0.057\,(S_{max}[ft] - 3)\right] \Rightarrow T_{max} = \frac{T_o}{0.6 + 0.057\,(S_{max}[ft] - 3)}$$

REV EQ. 5.1: maximum Soil nail load at head

$\Rightarrow T_{max} = \dfrac{10.4 \text{ kips}}{0.6 + 0.057(5-3)} \Rightarrow$ T_{max} = 14.6 kips

Maximum soil nail load [based on allowable tensile load on bars]:

Soil nails: No. 6 Bars; Grade 60 ksi ($f_y = 60$ ksi)

Based on Table A.1a of the FHWA manual (properties of solid-threaded Bars – Grade 60)

The maximum cross-sectional area for the No. 6 Bar is 0.44 inch^2.

with F.S. = 1.8 (for static): $T_{max} = \dfrac{(60 \text{ ksi})(0.44 \text{ in}^2)}{1.8} = 14.7$ Kips

Since T_{max} = 14.7 Kips ~= T_{max} = 14.6 kips, recommend grade 75, No 8 bars (tensile values are too close)

No. 8 bars, grade 75 ksi $\Rightarrow T_{max} = \dfrac{(75 \text{ ksi})*(0.79 \text{ in2})}{1.8} =$ 32.9 kips

Tensile forces at nail head / wall facing [based on allowable tensile load on bars]:

$T_o = T_{max} [0.6 + 0.057 (S_{max} [ft] - 3)]$

= 32.9 kips $[0.6 + 0.057(5-3)] \Rightarrow T_o$ = 23.5 Kips

DESIGN VALUES: T_{max} = 32.9 Kips

T_o = 23.5 Kips

SHANNON & WILSON SHANNON & WILSON AASHTO EARTH PRESSURE SPREADSHEET

view "Readme" tab before using

GEOMETRY INPUT

height of retained soil, H (feet)	12
slope behind wall, β (degrees)	30
slope of wall back face, θ (degrees)	0

Earth Pressure Theory
- Coulomb
- Rankine

SOIL INPUT

soil unit weight, γ (pcf)	90
soil effective friction angle, φ'_f (degrees)	30
wall-soil friction angle, δ (degrees)	20
overconsolidation ratio, OCR	1
cohesion for static loading, c (psf)	0

Consider OCR for k_0

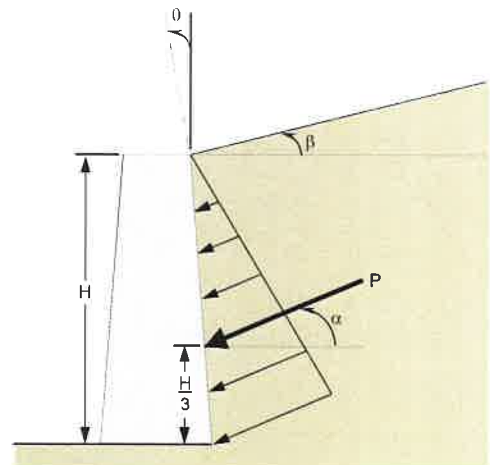
Consider Soil Cohesion for Static Loading

SEISMIC INPUT

enter acceleration coefficients for each loading type below	
cohesion for seismic loading, c (psf)	0
soil-wall adhesion for seismic, c_a (psf)	0

use k_h estimator

Consider Soil Cohesion for Seismic Loading



STATIC LOADING RESULTS

	Active	At-Rest	Passive
earth pressure coefficient, k	0.80		
equivalent fluid unit weight, γ_{eq} (pcf)	71.8		
resultant earth pressure, P (pounds)	5,172		
acting angle of resultant, α (degrees)	20.0		

NOTES

Active: Based on AASHTO (2012) Equation 3.11.5.3-1 and standard Coulomb earth pressure theory.

At-Rest: Based on USACE (1989) Equation 3-6. Calculation does not consider wall friction, wall batter, or soil cohesion.

Passive: Based on AASHTO (2012) Figures 3.11.5.4-1 and -2, which use logarithmic spirals. See 'kp FIGURES' tab.

SEISMIC LOADING RESULTS

	Active	At-Rest	Passive
horizontal acceleration coefficient, k_h (g)			
vertical acceleration coefficient, k_v (g)			
earth pressure coefficient, k			
uniform. dist. pressure increase, $\Delta P/H^2$ (psf/ft)			
equivalent fluid unit weight, γ_{eq} (pcf)			
resultant earth pressure, P (pounds)			
acting angle of resultant, α (degrees)			

use k_h estimator

NOTES

Active: Based on AASHTO (2012) Equation A11.3.1-1 (Mononabe-Okabe).

At-Rest: Based on Zhang and others (1998), Equation 24 with R = 0. Consider using higher seismic coefficient for nonyielding structures.

Passive: Based on Anderson (2008).

Table A.1a: Properties of Solid-Threaded Bars - Grade 60

Bar Designation	Maximum Diameter (w/ threads)	Minimum Cross-Sectional Area	Unit Weight	ASTM Grade	Yield Stress	Yield Load
Conventional	inch	$inch^2$	lb/ft	Conventional	ksi	kip
#6	0.86	0.44	1.50	60	60	26
#7	0.99	0.60	2.04	60	60	36
#8	1.12	0.79	2.67	60	60	47
#9	1.26	1.00	3.40	60	60	60
#10	1.43	1.27	4.30	60	60	76
#11	1.61	1.56	5.31	60	60	93
[illegible]	[illegible]	[illegible]	[illegible]	60	60	135

Tensile capacity of bar:
Yield load = 75,000 psi × 0.79 $inch^2$ = 59,250 lbf

Table A.1b: Properties of Solid-Threaded Bars - Grade 75

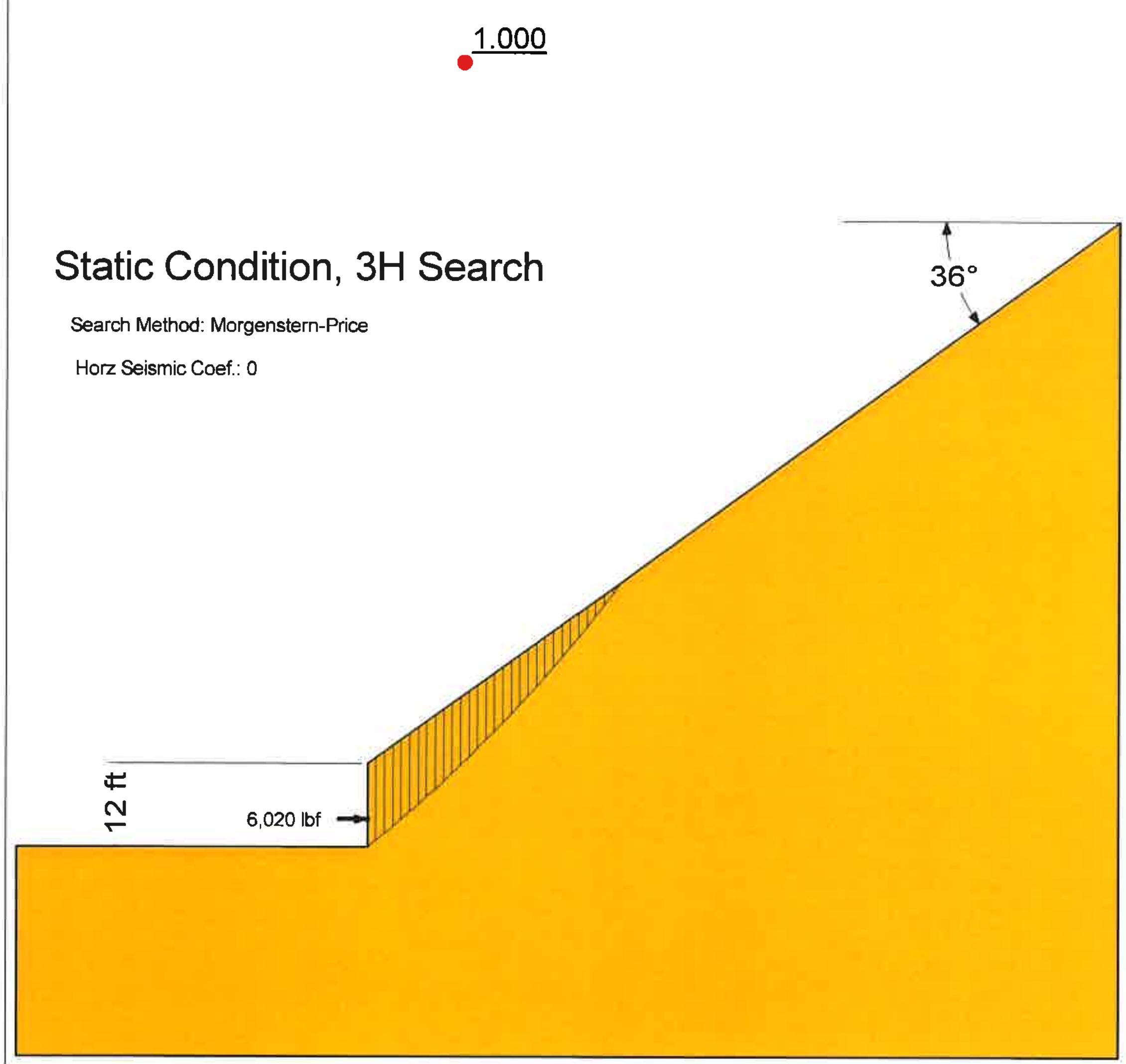
Bar Designation	Maximum Diameter (w/ threads)	Minimum Cross-Sectional Area	Unit Weight	ASTM Grade	Yield Stress	Yield Load
Conventional	inch	$inch^2$	lb/ft	Conventional	ksi	kip
#6	0.86	0.44	1.50	75	75	33
#7	0.99	0.60	2.04	75	75	45
#8	1.12	0.79	2.67	75	75	59
#9	1.26	1.00	3.40	75	75	75
#10	1.43	1.27	4.30	75	75	95
#11	1.61	1.56	5.31	75	75	117
#14	1.86	2.25	7.65	75	75	168

Sources: Dywidag, Williams and Contech

Static Condition, 3H Search

Search Method: Morgenstern-Price

Horz Seismic Coef.: 0

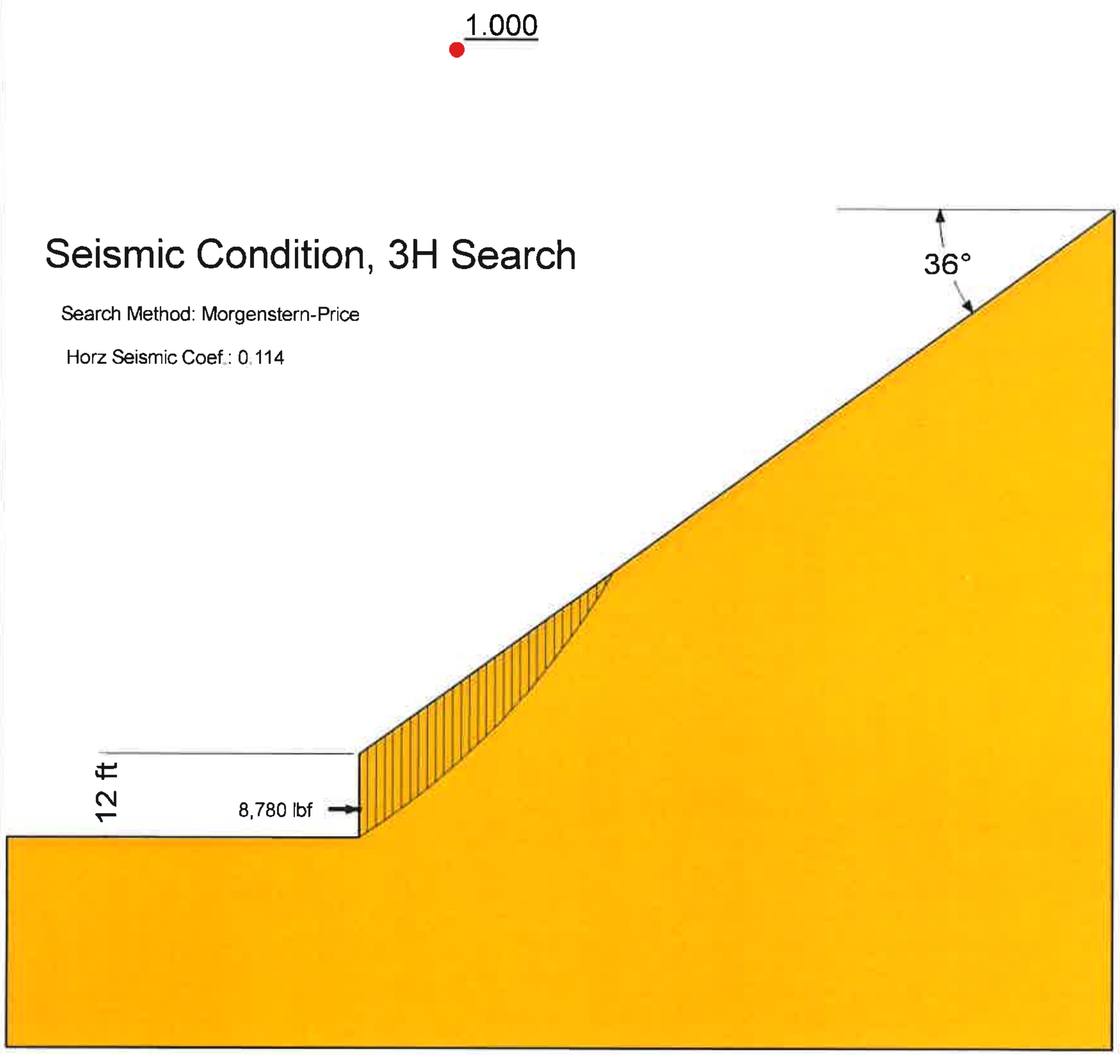


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	Qts/Qal	Mohr-Coulomb	90	0	30

Seismic Condition, 3H Search

Search Method: Morgenstern-Price

Horz Seismic Coef.: 0.114

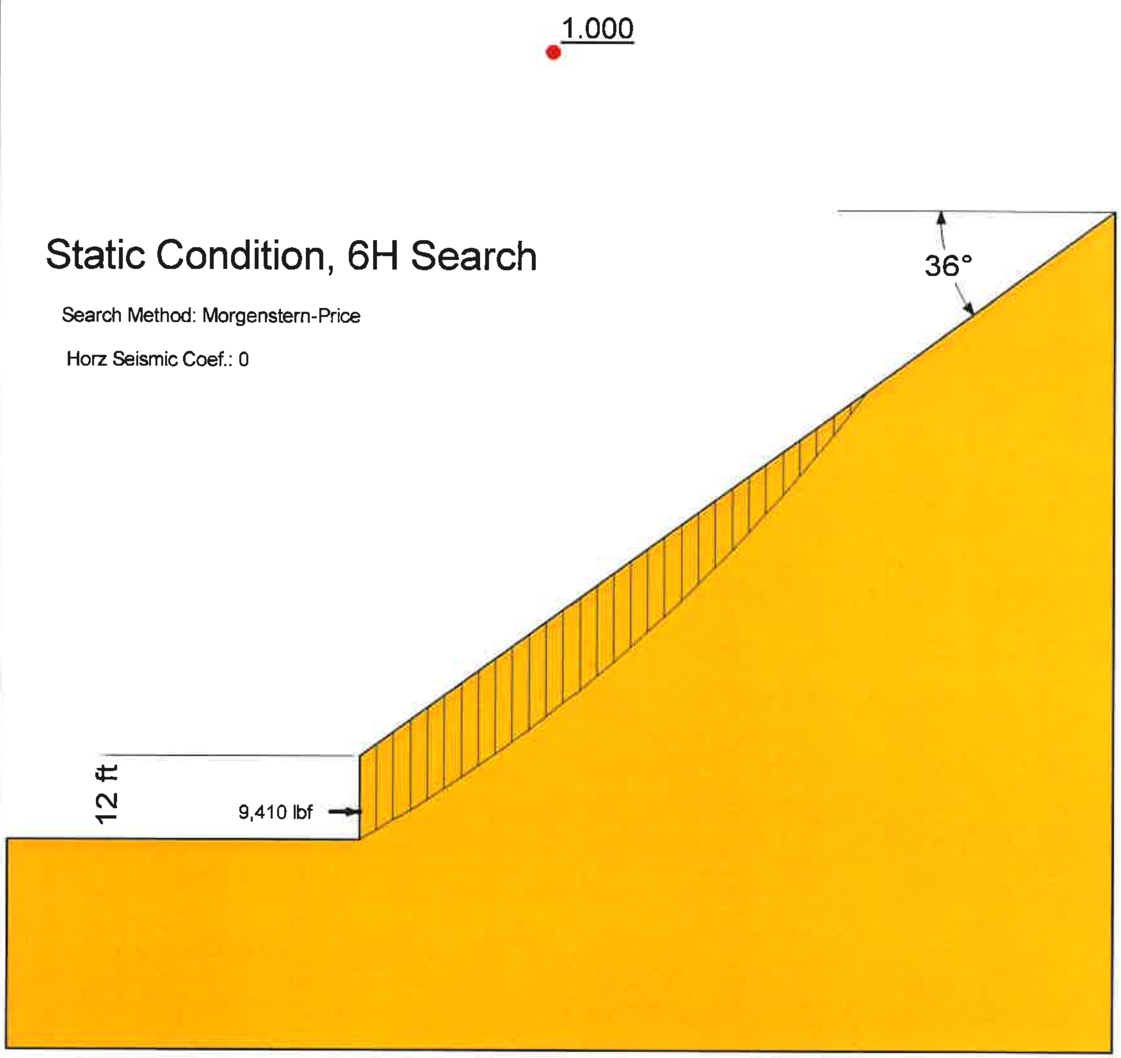


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Qts/Qal	Mohr-Coulomb	90	0	30

Static Condition, 6H Search

Search Method: Morgenstern-Price

Horz Seismic Coef.: 0

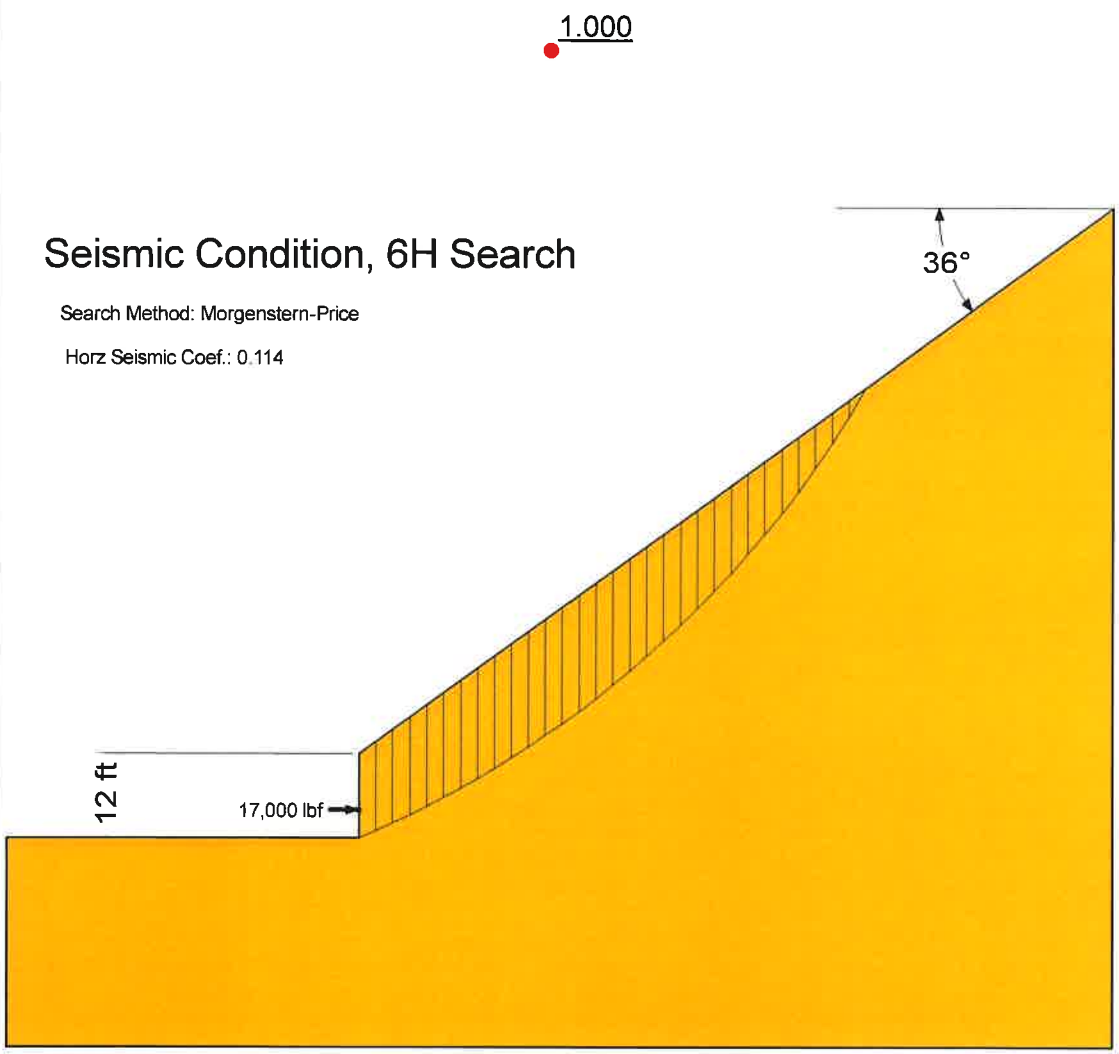


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Qts/Qal	Mohr-Coulomb	90	0	30

Seismic Condition, 6H Search

Search Method: Morgenstern-Price

Horz Seismic Coef.: 0.114



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Qts/Qal	Mohr-Coulomb	90	0	30

Calculated T_o Load Values based on Slope Stability Analysis

Active Earth Pressure Equation:

$$Pa = \frac{1}{2} * {H_0}^2 * k_a * \gamma$$

$$k_a * H_0 * \gamma = \frac{2 * P_a}{H_0}$$

Based on Section 5.2.1c of the Soil Nail Wall Manual (GEC-007), average tensile forces in the nail head ranges from:

$$T_0 = 0.5 * k_a * \gamma * H_0 * S_V * S_H \quad \text{to} \quad T_0 = 0.6 * k_a * \gamma * H_0 * S_V * S_H$$

The average tensile force equation can be written as:

$$T_0 = 0.5 * \left(\frac{2 * P_a}{H_0}\right) * S_V * S_H \quad \text{to} \quad T_0 = 0.6 * \left(\frac{2 * P_a}{H_0}\right) * S_V * S_H$$

Calculated Unfactored T_O Load Values due to Earth Pressures:

S_H = 5 ft

S_V = 4 ft

H_0 = 12 ft

Condition Analyzed	Search Distance from Wall	P_a (lbs/ft)	FS	T_O (lbs) 0.5	T_O (lbs) 0.6
Static	3H	6,020	1	10,033	12,040
Seismic		8,780	1	14,633	17,560
Static	6H	9,410	1	15,683	18,820
Seismic		17,000	1	28,333	34,000

Note: Following GEC 7 calculation procedure for T_O results with a static T_O value of 10,400 lbs

From SLOPEW approach:

Static Range: ~10,000 to ~18,800 lbs

Seismic Range: ~14,600 to ~34,000 lbs

Recommend from SLOPEW Results:

Static: 12,100 lbs (favors 3H search distance, 0.6 for normalized nail head load)

Seismic: 17,600 lbs (favors 3H search distance, 0.5 for normalized nail head load)

We recommend No 8 bars, 75 ksi grade, which results with:

To = 23,500 lbs based on steel properties (see Hand Calc provided earlier)

This is greater than both static and seismic recommended values.

Therefore, No 8 bars, 75 ksi grade satisfies loading condition resulting from active earth pressures.

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 2

CALCULATION SUMMARY

Project: Reds Meadows Road Improvement Job No: 100062-003

Project Feature and Subject: Soil Nail Wall_ Stability Analysis and Evaluation

Calculation Purpose *(describe purpose/goal of calculation)*

To evaluate the overall stability of the 14 soil nail wall cross sections developed within Calculation No. 1 of Phase 003.

The 80% Design Submittal Plan Sheets calls for 14 permanent soil nail walls located along the upper 2.5 miles of Reds Meadow road. The proposed walls vary in conditions such as wall height, backslope geometry, and retained soil properties. We previously developed 14 cross sections within Calculation No. 1 of Phase 003 to represent the areas of the proposed soil nail walls. Relevant plan sheets used to develop the cross sections are presented within Calculation No 1.

The overall stability analysis considers both static and seismic conditions. Reinforced shotcrete/concrete facing design and stability will be performed by others.

A previous soil nail calculation package was developed as part of our 2019 Geotechnical Design Report, within Phase 002 of the project (project number 100062-002). This calculation and Calculation No. 1 of Phase 003 are provided as an update based on the more recent plan sheets and supersede our Phase 002 analysis.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

Design Criteria/Design Guidance:

- Federal Lands Highway, Project Development and Design (PDDM) Manual, 2012.
- Federal Highway Administration (FHWA), Soil Nail Walls Reference Manual, Publication No. FHWA-NHI-14-007, GEC 007, February 2015.
    - FHWA's GEC No. 7 typically follows AASHTO's LRFD methodology. However, it also relies on ASD-based stability calculations, as is the current standard of practice for slope stability analysis. In general, it relies on ASD-based stability calculations for overall evaluation purposes, and then uses these results to perform LRFD checks.

Provided Plan Sheet Data:

- Jacobs provided 80% Design Submittal plan sheets (dated 11/12/19).
- Edited/updated sheets were provided on the following dates:
    - Profile Sheets and Cross Section Sheets, Sheets C03, C08, X12, and X41_provided 12/16/19
    - "Wall Site Plan and General Notes", Sheet G3_provided 3/19/2020.
        - The revised Sheet G3 has updated soil nail wall locations and soil nail wall names. Wall 35 from the 11/12/19 plan sheets has been changed to Wall 34 within the revised plan sheet.

Design requirements:

- Design requirements are determined from FHWA Reference Manual, GEC No. 7.
- From Table 5.1, shown on page 6:
    - Minimum static overall (global) Factor of Safety = 1.35
    - Minimum seismic overall (global) Factor of Safety = 1.1

CALCULATION SUMMARY

Wall and Slope Geometry:

- 14 cross sections were developed as part of Calculation No. 1 to represent the areas of the proposed soil nail walls. Refer to Calc No. 1 for further discussion on how the cross sections were developed. Based on the wall profile, the final exposed wall height ranges from about 3 to 9 feet. The cross sections indicate the backslopes vary between approximately 26 and 40 degrees.
- This calculation analyzes and performs slope stability for 14 cross sections.

Seismic Design Parameters:

- We previously prepared a 2019 Geotechnical Design Report (S&W, 2019) as part of the project development within Phase 002. In preparation of the 2019 Design Report, we developed a seismicity calc package within Phase 002 (Calculation No. 9 of Phase 002). Based on this calculation package, the peak design spectral acceleration (A_s) for the site, following AASHTO's recommended design event of 7 percent probability of exceedance in 75 years (i.e. 1,000-year return period), is 0.343 g; see page 8.
- Per FHWA GEC No. 7 (2015), we completed seismic slope stability using pseudo-static analysis with an applied horizontal seismic coefficient (k_h). k_h was developed following the design procedures outlined in Section 6.8.2 and 6.8.3 of GEC No. 7. See the "Seismic Parameters and Design Approach" section, presented on pages 7-13.
    - **We recommend k_h = 0.206 g**.

Analysis Methodology:

- We used the GeoStudio software SLOPE/W to perform a limit-equilibrium stability analysis on the developed soil nail wall cross sections, checking for slip surfaces that intersect the soil nails and extend beyond the end of the soil nails (i.e. internal stability and global stability, respectively). The software allows soil reinforcement, including soil nails, to be modeled in the analyses.
- We used the Morgenstern-Prime limit-equilibrium search method, which satisfies both moment and force equilibrium, to determine the locations of the critical slip surfaces and their corresponding FS value. Trial circular slip surfaces were defined by specifying entry and exit lines along the ground surface.
- As described above, our evaluation considered both static and seismic loading conditions.
- The stability evaluation considers two different subsurface profile conditions: the anticipated bedrock depth and the no bedrock depth.
    - The no bedrock condition is performed to determine the minimum soil nail length necessary to meet the required factor of safety criteria if bedrock is not encountered during construction (i.e. stability meets FS requirements without relying on bedrock for help).
- Because the slope is essentially "infinite" above the proposed wall, we limited the potential slip surfaces generated in the stability analyses to approximately three times the maximum height of the wall, from the top of the proposed wall. We also limited the potential slip surfaces below the roadway to approximately three times the maximum height. This approach is described in the FHWA Manual for Design and Construction Monitoring of Soil Nail Wall (FHWA, 1998), see pages 14-16.
- The SLOPE/W analyses also provide a means of evaluating the pullout resistance of the soil nails. FHWA GEC No. 7 indicates that the global stability analysis automatically satisfies the condition for pullout resistance. The FSs determined in our analyses indicate the nail lengths satisfy pullout resistance criteria for the permanent wall.
- The Contractor is responsible for the construction stages, i.e. intermediate levels required for nail installation and for the stability of the excavations, slopes, and existing structures during construction
- As described in FHWA GEC No. 7, the potential for basal heave should be evaluated when soft, fine-grained soils are present beneath a soil nail wall excavation. FHWA GEC No. 7 also indicates that lateral sliding can be considered a special case of global stability limit state, which

CALCULATION SUMMARY

may arise when a weak soil layer underlies the block of reinforced soil. Based on our understanding of the subsurface soil and rock conditions, it is our opinion that these conditions do not exist at the project site. Therefore, we did not perform analyses for basal heave and lateral sliding stability.

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

American Association of State Highway and Transportation Officials (AASHTO), 2017, AASHTO LRFD Bridge Design Specifications: Customary U.S. units (8th ed.): Washington D.C., AASHTO, 1v.

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

Federal Highway Administration (FHWA), 2015, Soil Nail Walls Reference Manual, FHWA NHI-14-007, GEC-007, February 2015.

Federal Highway Administration (FHWA), 1998, Manual For Design & Construction Monitoring of Soil Nail Walls, FHWA-SA-96-069R, October.

Jacobs, 2019, Reds Meadow Road: Plans, profiles, and cross sections prepared by Jacobs, for Central Federal Lands, November 12, 75 sheets (C01 to C12, X01 to X63).

Shannon & Wilson, Inc. (S&W), 2019, Geotechnical Report, Reds Meadow Roads Improvements, Madera County, California, Project No. 100062-002, dated May 30.

Previous Shannon & Wilson Calc Packages, from Phase 003 Analysis, Project No. 100062-003:

- Calculation No 1, Soil Nail Wall_Development of Cross Sections, Rev 5

Previous Shannon & Wilson Calc Packages, from Phase 002 Analysis, Project No. 100062-002:

- Calculation No 9, Seismicity, Rev 0

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

Table 1 on page 5 presents a summary of the slope stability results for the 14 cross sections evaluated. The graphical results produced from SLOPE/W are presented on pages 17-101.

Table 1 provides the critical factor of safety results for both Anticipated Bedrock Depth and No Bedrock conditions and provides recommended soil nail lengths and spacing required to meet factor of safety criteria. We recommend planned soil nail lengths be based on the No Bedrock condition.

This calculation has not evaluated the effect of movement on any adjacent infrastructure or utilities. If sensitive infrastructure and/or utilities are present behind the wall, others should evaluate the response of the infrastructure and/or utilities with respect to the shoring system.

This calculation has not evaluated the temporary and permanent wall facing. We understand this will be performed by others.

CALCULATION SUMMARY

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Ali Tarokh	03/09/2020	BPT	03/10/2020	120
1	Ali Tarokh	03/11/2020	BPT	03/11/2020	108
2	Ali Tarokh	03/17/2020	Paul Macklin	03/24/2020	110
3	Brian Trott	04/08/2020	Steve Diem	04/16/2020	100
4	Brian Trott	04/21/2020	Steve Diem	04/22/2020	102
5	Brian Trott	05/12/2020			101
PM Review of Assumptions and Input Properties			by: SDD	on 5/12/2020	
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

Table 1. Summary of Soil Nail Wall Analysis

Cross Section Analyzed	Loading Condition Analyzed	Anticipated Bedrock Depth				No Bedrock			Minimum Bar Size	Bond Diameter (ft)	Vertical Spacing, S_V (ft)	Horizontal Spacing, S_H (ft)	Ultimate Bond Strength (psi)	Ultimate Pullout Capacity per Unit Length (klf)
		Global Stability Critical FS	Internal Stability Critical FS	No of Rows of Nails	Minimum Nail Length (ft)	Critical FS (either Global or Internal)	No. of Rows of Nails	Minimum Nail Length (ft)						
Cross Section C Wall 27 & 34 Sta. 32+50	Static	14.55	19.15	2	10 10	1.45	2	14 14	No. 8, Grade 75	0.5	2.7	5.0	20	4.5
	Seismic	10.1	12.7			1.1								
Cross Section D Wall 27 & 34 Sta. 35+00	Static	19.78	>> 1.35	2	10 10	1.46	2	15 15	No. 8, Grade 75	0.5	2.8	5.0	20	4.5
	Seismic	11.7	13.5			1.1								
Cross Section E Wall 48 & 50 Sta. 47+50	Static	20.62	26.73	2	10 10	1.47	2	12 12	No. 8, Grade 75	0.5	3.6	10.0	20	4.5
	Seismic	13.6	17.1			1.1								
Cross Section G Wall 62 Sta. 61+00	Static	13.77	19.11	2	10 10	1.43	2	17 17	No. 8, Grade 75	0.5	4.0	5.0	20	4.5
	Seismic	9.8	12.7			1.1								
Cross Section H Wall 62 Sta. 66+50	Static	14.46	1.77	2	10 10	1.45	2	17 17	No. 8, Grade 75	0.5	2.5	5.0	20	4.5
	Seismic	10.2	1.1			1.1								
Cross Section I Wall 85 Sta. 84+50	Static	18.68	25.15	2	10 10	1.58	2	14 14	No. 8, Grade 75	0.5	4.0	5.0	20	4.5
	Seismic	12.5	16.3			1.1								
Cross Section J Wall 92 & 93 Sta. 91+50	Static	24.32	34.08	2	10 10	1.53	2	11 11	No. 8, Grade 75	0.5	2.3	10.0	20	4.5
	Seismic	14.8	19.4			1.1								
Cross Section K Wall 95 Sta. 95+00	Static	13.66	21.76	2	10 10	1.47	2	20 20	No. 8, Grade 75	0.5	4.0	5.0	20	4.5
	Seismic	12.4	15.0			1.1								
Cross Section N Wall 99 & 100 Sta. 99+50	Static	>> 1.35	24.19	2	10 10	1.52	2	18 18	No. 8, Grade 75	0.5	4.0	5.0	20	4.5
	Seismic	>> 1.1	16.0			1.1								
Cross Section O Wall 99 & 100 Sta. 100+00	Static	16.10	21.46	1	10	1.61	1	25	No. 8, Grade 75	0.5	-	5.0	20	4.5
	Seismic	11.1	14.4			1.1								
Cross Section Q Wall 111 Sta. 110+50	Static	14.57	1.50	1	10	1.48	1	13	No. 8, Grade 75	0.5	-	5.0	20	4.5
	Seismic	11.9	1.1			1.1								
Cross Section R Wall 119 Sta. 117+00	Static	16.98	1.82	2	10 10	1.45	2	14 14	No. 8, Grade 75	0.5	2.6	5.0	20	4.5
	Seismic	12.7	1.1			1.1								
Cross Section S Wall 119 Sta. 119+00	Static	17.46	23.51	2	10 10	1.49	2	14 14	No. 8, Grade 75	0.5	2.8	5.0	20	4.5
	Seismic	11.9	15.5			1.1								
Cross Section T Wall 131 Sta. 131+50	Static	19.60	25.10	1	10	1.46	1	15	No. 8, Grade 75	0.5	-	5.0	20	4.5
	Seismic	13.1	16.4			1.1								

[1]Factor of safety (FS) values shown for critical failure surfaces as determined by GeoStudio. Per FHWA GEC-7, required FS values are 1.35 for static analysis and 1.1 for pseudo-static analysis.

FHWA GEC No 7

Table 5.1: Minimum Recommended Factors of Safety for the Design of Soil Nail Walls Using the ASD Method [1]

Limit State	Condition	Symbol	Minimum Recomm. Factors of Safety, Static Loads	Minimum Recomm. Factors of Safety, Seismic Loads
Overall	Overall Stability	FS_{OS}	~~1.5~~[2]	1.1[6]
Overall	Short Term Condition, Excavation	FS_{OS}	1.25-1.33[3]	NA
Overall	Basal Heave	FS_{BH}	2.0[4], 2.5[5]	2.3[5]
Strength – Geotechnical	Pullout Resistance	FS_{PO}	2.0	1.5
Strength – Geotechnical	Lateral Sliding	FS_{LS}	1.5	1.1
Strength – Structural	Tendon Tensile Strength (Grades 60 and 75)	FS_T	1.8	1.35
Strength – Structural	Tendon Tensile Strength (Grades 95 and 150)	FS_T	2.0	1.50
Strength – Structural	Facing Flexural	FS_{FF}	1.5	1.1
Strength – Structural	Facing Punching Shear	FS_{FP}	1.5	1.1
Strength – Structural	Headed Stud Tensile (A307 Bolt)	FS_{FH}	2.0	1.5
Strength – Structural	Headed Stud Tensile (A325 Bolt)	FS_{FH}	1.7	1.3

Notes: (1) The limit state and symbol nomenclature differ from that presented in the previous version of this manual. Many of these changes reflect the move toward using LRFD terminology as presented in AASHTO (2014).

(2) For non-critical, permanent structures, some Owners may accept a design for static loads and long-term conditions with FS_{OS} = 1.35 when uncertainty is considered to be limited due to the availability of sufficient geotechnical information and successful local experience on soil nailing.

(3) This range of safety factors for global stability corresponds to the case of temporary [illegible]

Email from CFL on 12/18/2018 concurs proposed improvements are non-critical structures and a FS of 1.35 is appropriate for design.

(4) This factor of safety for basal heave is applicable to permanent walls for short-term [illegible]ions.

FS Static = 1.35
FS Seismic = 1.1

(5) [illegible]actor of safety for basal heave is applicable to permanent walls for long-term [illegible]ions.

(6) The minimum FS_{OS} for seismic overall stability should be 1.0, when horizontal seismic coefficients are used and these were derived from estimated, allowable seismic deformations.

SEISMIC PARAMETERS AND DESIGN APPROACH

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 9

CALCULATION SUMMARY

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO Guide for Design of Pavement Structures, Published by the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington D.C., 20001.

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

U.S. Geological Survey Unified Hazard Tool, Available: https://earthquake.usgs.gov/hazards/interactive/, accessed January 2019.

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

In Table 1 below I present the recommended seismic design parameters for the PDDM design earthquake (10% exceedance in 50 years):

Table 1. Recommended Seismic Design Parameters for PDDM Design Level EQ Event

Peak Ground Acceleration (PGA)	F_{PGA}	Site Specific PGA	Short-Period Response, S_s	F_a	Long-Period Response, S_1	F_v	M_w
0.257 g	1.0	0.257 g	0.547 g	1.0	0.120 g	1.0	6.7

In Table 2 below I present the recommended seismic design parameters for the AASHTO design earthquake (7% exceedance in 75 years):

Table 2. Seismic Design Parameters for AASHTO EQ Event

Peak Ground Acceleration (PGA)	F_{PGA}	A_s	Short-Period Response, S_s	F_a	Long-Period Response, S_1	F_v	M_w
0.343 g	1.0	0.343 g	0.739 g	1.0	0.167 g	1.0	6.7

Results of the USGS Unified Hazard Tool are shown on pages 15-23.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Brian Trott	1/7/19	2019.01.08 10:20:28 -08'00'		23
	Brian Trott				

PM Review of Assumptions and Input Properties	by: 2019.01.08 10:20:09 -08'00' on ________
NOTES:	

* Number of pages is the total number of pages including the cover sheet.

affected by lateral movement extends a distance D_{DEF} that can be up to 1.5 times H for a vertical soil nail wall constructed in fine-grained soils.

6.7.2 Step 8b Evaluate Lateral Squeeze (if applicable)

Verification for lateral squeeze may be necessary if a soil nail wall becomes part of a bridge abutment overlying soft soils, and unbalanced embankment loads develop behind the wall. In these cases, the lateral deflections must be evaluated. Guidance for evaluating lateral squeeze, as well as methods for stabilizing soils to prevent problems related to lateral squeeze, are presented in Samtani and Nowatzki (2006).

6.8 Step 9 Seismic Design

6.8.1 Overview

The performance of soil nail walls during earthquakes has been historically observed to be much better than that of gravity retaining structures. Observations made after recent earthquakes indicate that soil nail walls did not show significant distress or permanent deflections, although some of the surveyed walls were subjected to ground accelerations as large as 0.7g (Felio et al. 1990; Tatsuoka et al. 1997; Tufenkjian 2002). Vucetic et al. (1993) and Tufenkjian and Vucetic (2000) observed similar trends in centrifuge tests performed on reduced-scale models of soil nail walls. These findings suggest that soil nail walls have an intrinsic satisfactory seismic performance, which is attributed to their flexibility and design redundancy.

Soil nail walls still need to be fully designed for seismic loads when applicable. AASHTO (2014), Article 11.5.4.2, gives guidance about when earth-retaining structures require analysis for loads at the Extreme-Event I limit state. The criteria for MSE walls, another earth-supporting system regarded as flexible, can be considered appropriate for soil nail walls. It is stated in that article that a seismic design is not mandatory for MSE walls in AASHTO-defined Seismic Zone 1 (i.e., for a design response acceleration for 1-sec period, $S_{1D} \leq 0.15$), Seismic Zone 2 ($0.15 < S_{1D} \leq 0.30$), and Seismic Zone 3 ($0.30 < S_{1D} \leq 0.50$), or for walls at sites where the site-adjusted, design PGA_D is ≤ 0.4 g, and as long as the soils behind the wall do not liquefy (mainly cohesionless soils), or sustain significant strength degradation (mainly fine-grained soils) during dynamic loading.

AASHTO Article 11.5.4.2: "The no-seismic analysis option should be limited to internal and external seismic stability design of the wall. If the wall is part of a bigger slope, overall seismic stability of the wall and slope combination should still be evaluated."

Although the design PGA is less than 0.4 g, the soil nail walls are a portion of an overall bigger slope. We recommend included seismic design for the proposed soil nail walls.

6.8.2 Step 9a Select Design Seismic Parameters

(1) Obtain seismic parameters (PGA and S_1) from AASHTO (2014) for a 1,000-year return period for a reference Site Class B, as described in Section 4.9. Select alternative values for a different return period if required by Owner.

(2) Determine the average shear-wave velocity ($v_{\_bar}$), average N_{60} ($N_{\_bar}$), or average S_{u_bar} (for cohesive soils) in the upper 100 ft from the site ground surface. Consider the 100 ft from the planned top of wall.

(3) Assign a Site Class (from A through F) using Table 4.8.

(4) If Site Class is between A and E, obtain site modification factors F_{PGA} and F_v from Tables 4.9 and 4.10, respectively. If Site Class is F, perform site-specific site response analysis (beyond the scope of this manual, see Kavazanjian et al. 2011).

(5) Calculate the design, site-corrected peak ground acceleration and 1-sec response acceleration as: $PGA_D = F_{PGA}\,PGA$ and $S_{D1} = F_v\,S_1$.

(6) Determine the maximum seismic coefficient, k_{max}, which will be the basis for input in the limit-equilibrium analysis, as follows:

For Site Classes C through E:

$$k_{max} = PGA_D$$

Equation 6.31: Design, site-corrected peak ground acceleration (Site Classes C through E).

For Site Classes A and B (not typical conditions for soil nail walls):

$$k_{max} = 1.2\,PGA_D$$

$k_{max} = 1.2 \times 0.343 = 0.412$

Equation 6.32: Design, site-corrected peak ground acceleration (Site Classes A and B).

6.8.3 Step 9b Adjustment of Design Seismic Coefficients

<u>Wall height</u>

If the wall is 20 ft high or more, the maximum seismic coefficient can be reduced. This reduction is done to account for the decrease of seismic wave intensity as the waves propagate through the soil behind the wall from the base to the top of the wall. The longer method (1965) or sliding of a rigid block subjected to cyclic loading. Details of this method can be found in Kavazanjian et al. (2011). As a simplification, the permanent wall displacement after an earthquake, d_e, can be estimated as follows:

$$\log(d_e) = -1.51 - 0.74\log\left(\frac{k_y}{k_{max}}\right) + 3.27\log\left(1 - \frac{k_y}{k_{max}}\right) - 0.80\,k_{max} + 1.59\,PGV$$

Equation 6.35: Estimated wall seismic displacement.

Where:

k_y = yield acceleration, as calculated from overall stability analysis

PGV = peak ground velocity, which is estimated as $PGV = 38\ S_{D1}$

The yield acceleration is the seismic coefficient that will result in $FS_{OS} = 1.0$ in stability analysis. This value is obtained when the wall is being designed for static loads using a limit-equilibrium-based computer program.

Finally, the modified seismic coefficient is calculated as follows:

- Rigid retaining wall systems:

  $k_h = k_{max}$

  Equation 6.36: Seismic coefficient for rigid wall.

$k_h = 0.5 \times 0.412 = 0.206$

- Walls able to sustain 1-2 in. of lateral displacement:

  $k_h = 0.5 \times k_{max}$

  Equation 6.37: Seismic coefficient assuming wall can tolerate a lateral movement up to 2 in.

- Walls able to sustain more than 2 in. of lateral displacement:

  $k_h = r \times k_{max}$

  Equation 6.38: Seismic coefficient assuming wall can tolerate a lateral movement greater than 2 in.

  Where r is a ductility reduction factor defined as:

  $r = k_y / k_{max}$

  Equation 6.39: Reduction factor.

DESIGN APPROACH FOR "INFINITE" SLOPE CONDITION

4.10.9 Ground Water Seepage Forces or Water Table Close to Wall Base

As with slope stability problems, ground water and the associated seepage forces can significantly affect the stability of a soil nail structure. As discussed in section 2.2, the use of soil nailing in situations below the ground water table is not generally recommended. There may be special circumstances where consideration of seepage forces is required, such as when an unanticipated ground water table is encountered above the wall base. Most of the problems associated with the presence of ground water and the associated seepage forces are related to constructability, and these issues must be considered by personnel experienced with such conditions. From a design perspective, however, the inclusion of seepage forces in the stability analysis poses no special difficulty and most of the computer design models currently available permit the inclusion of water seepage pressures in the analysis.

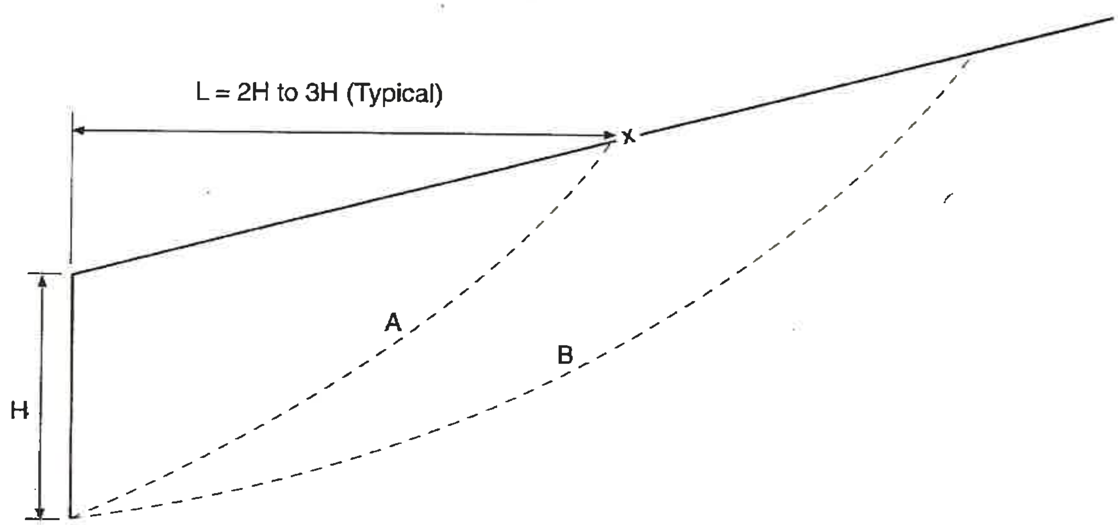
As noted in Step 8 (sections 4.7.1 and 4.7.2), a ground water table that is close to the base of the wall will tend to promote more deep-seated instabilities that pass beneath the base of the wall and exit downslope or in front of the toe of the wall. This condition must be checked for in design.

4.10.10 Infinite Slope Condition

In instances where a soil nail retaining wall is installed at the toe of a long ("infinite") slope, and that slope has a calculated factor of safety (e.g., 1.25) less than that recommended for the retaining wall itself (e.g., 1.35), then the design requirements may have to be modified. The reason: if potential slip surfaces considered in the design of the reinforced soil nail wall are unrestricted, then very large failure zones that encompass essentially the entire slope will be considered. The analysis may therefore indicate that very long, high capacity nails are required with the nails being installed in the toe region of an essentially "infinite" slope. This is generally considered to be an inappropriate use for such a retaining system. Under these circumstances, it is recommended that 1) the overall stability of the slope be independently determined and modified by other methods, if necessary, and 2) the soil nail wall be designed by limiting the scope of potential slip surfaces to the immediate area of the wall itself e.g., to within typically two to three times the height of the cut from the top of the proposed wall. This recommendation is shown graphically on figure 4.23.

4.10.11 Performance Under Seismic Loading

Recent experience has demonstrated that soil nail walls perform well under seismic loading. A number of observations of the performance of soil nail walls was made for the October 17, 1989 Magnitude 7.1 Loma Prieta earthquake in California. A post-earthquake report [4], presents field observations on eight soil nail walls in existence in the San Francisco Bay area during the earthquake. The walls, varying in height between 2.7 meters and 9.8 meters, were the subject of detailed post-earthquake visual inspections. In some cases, nails were retested after the earthquake.



Slip Surface Type A – Limited to slip surfaces that exit the surface at L≤ 2H to 3H behind wall. Conventional safety factors required.

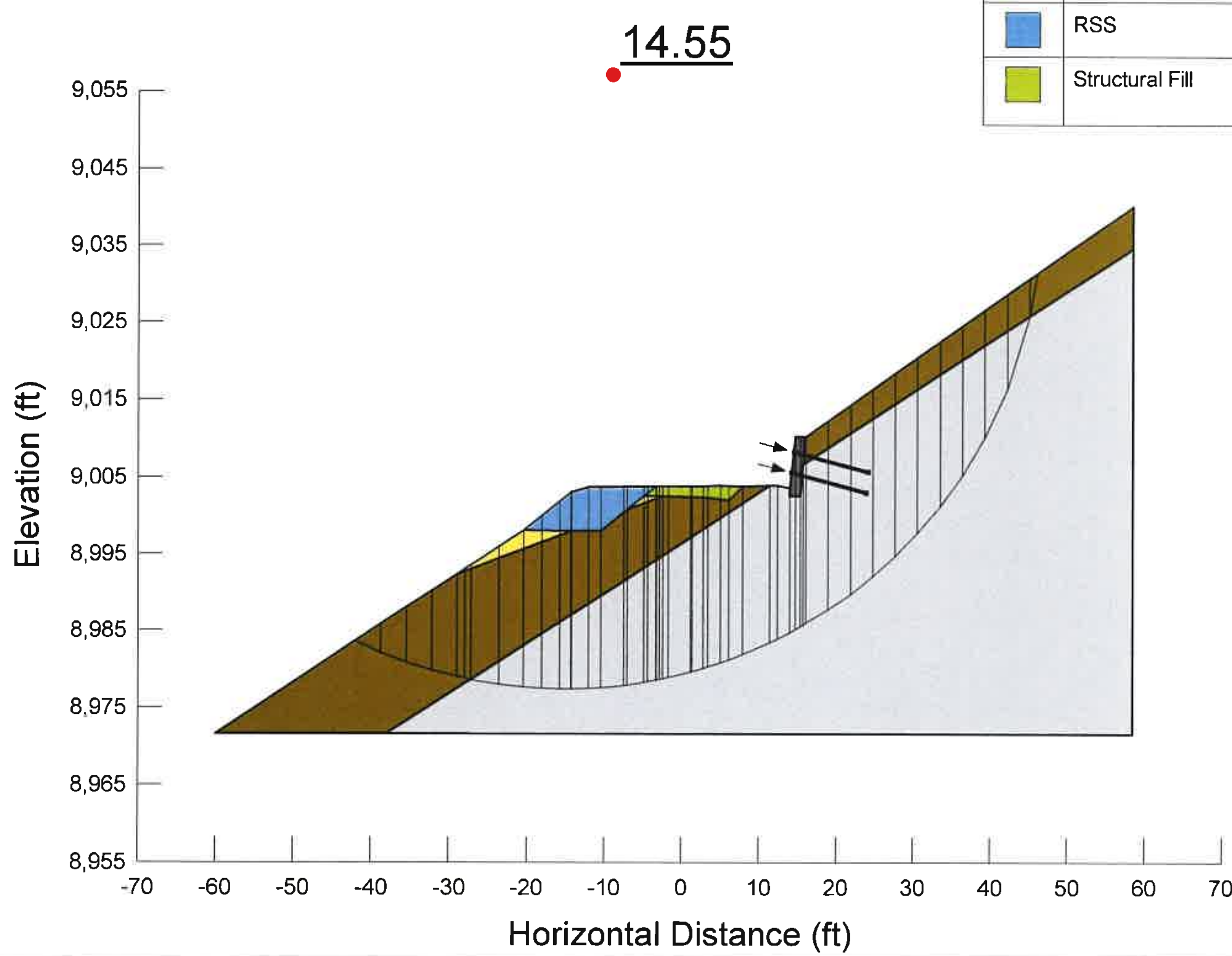
Slip Surface Type B - More deep-seated slip surfaces. Required safety factors consistent with overall slope stability requirements.

Figure 4.23 "Infinite" Slope Conditions - Design Approach

STABILITY ANALYSIS RESULTS

Reds Meadow Road Improvement
Cross Section C
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



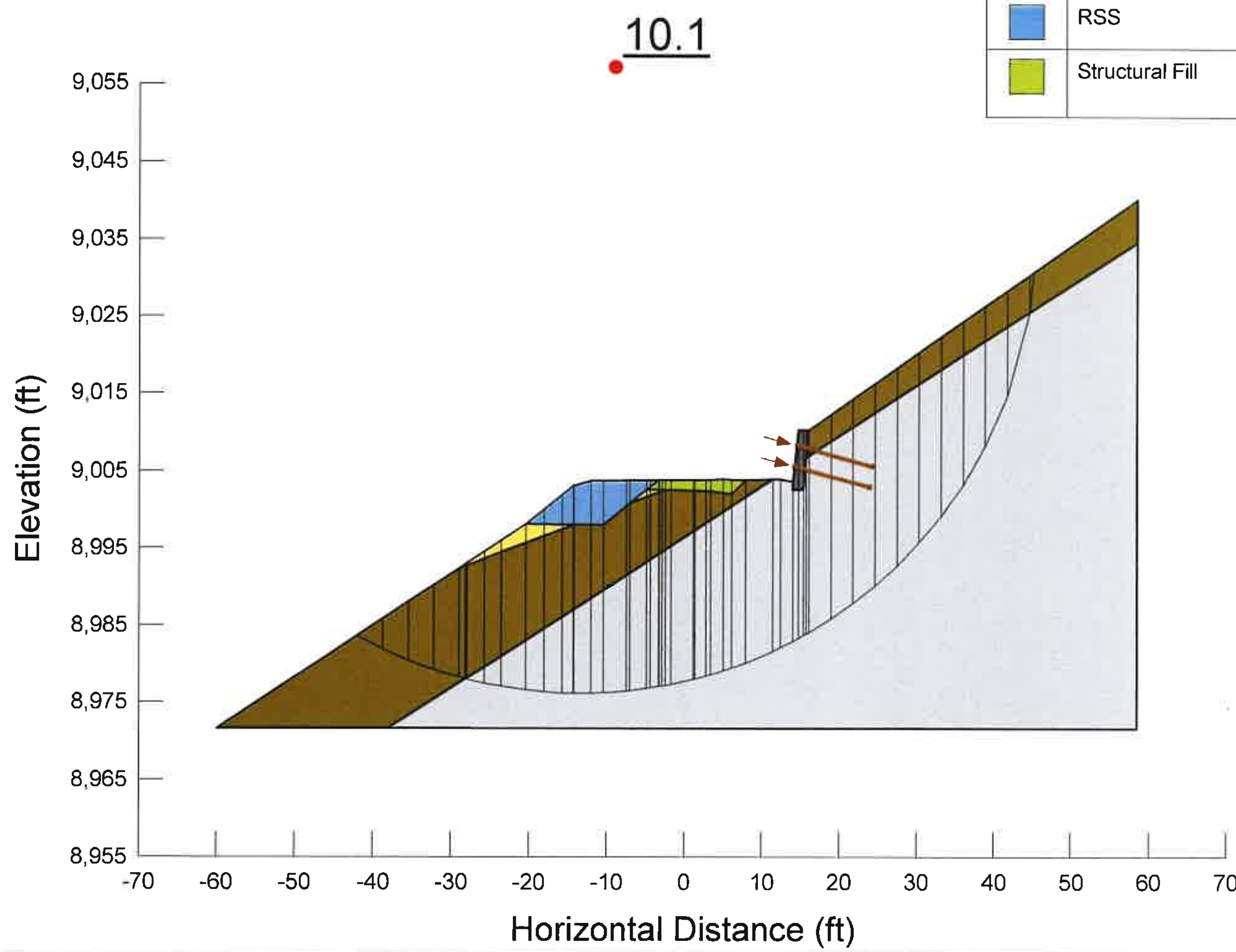
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section C
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



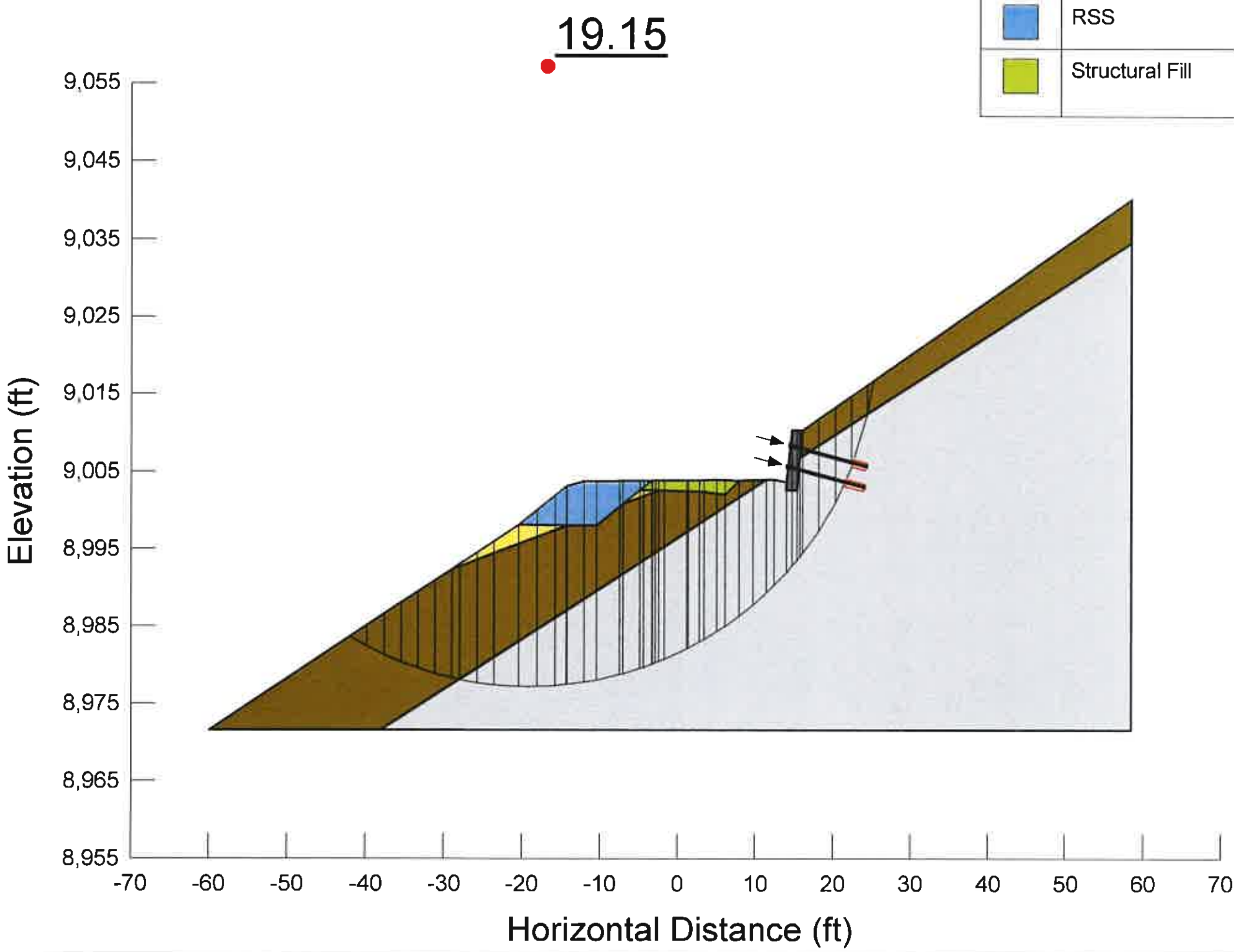
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section C
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Brown	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



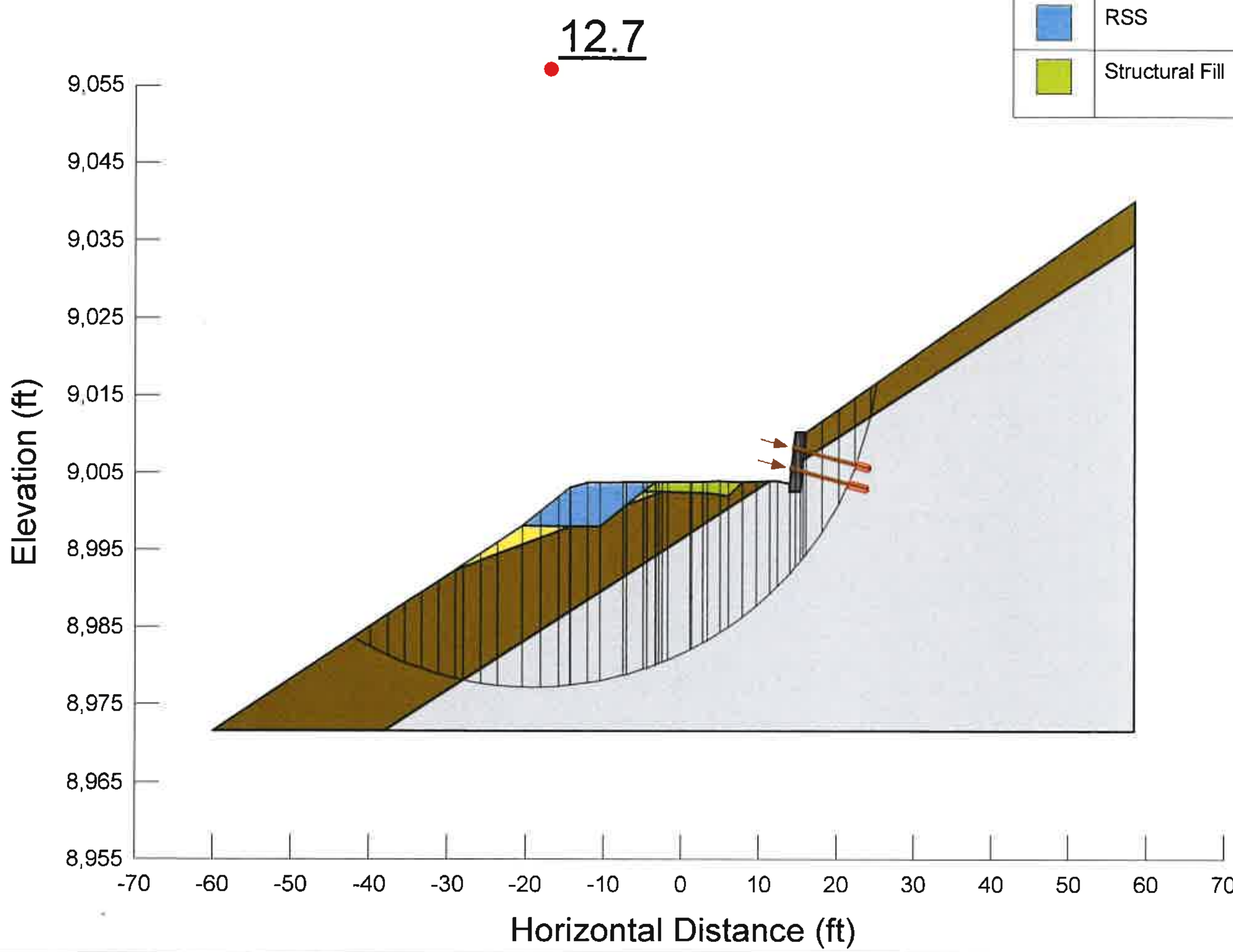
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section C
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Brown	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



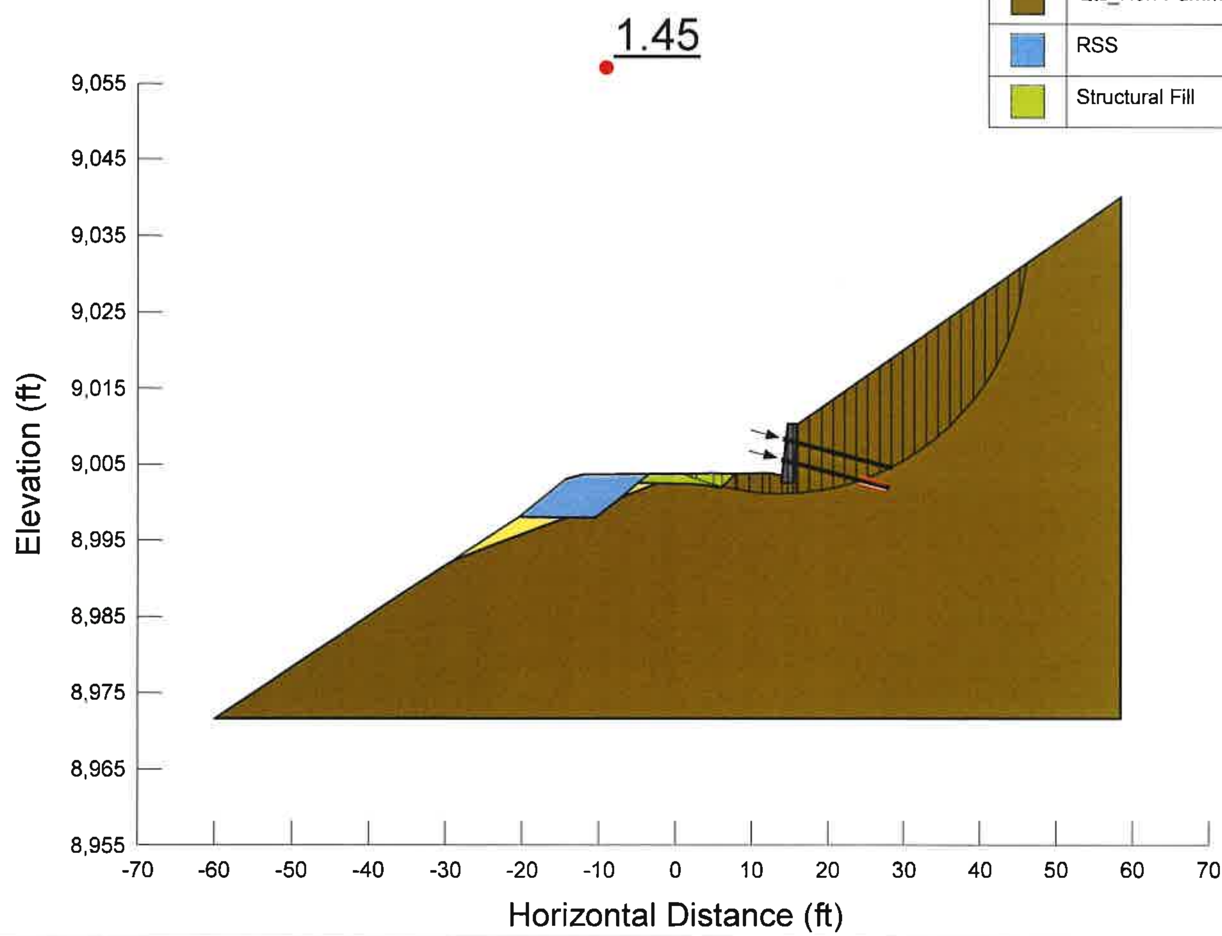
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section C
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



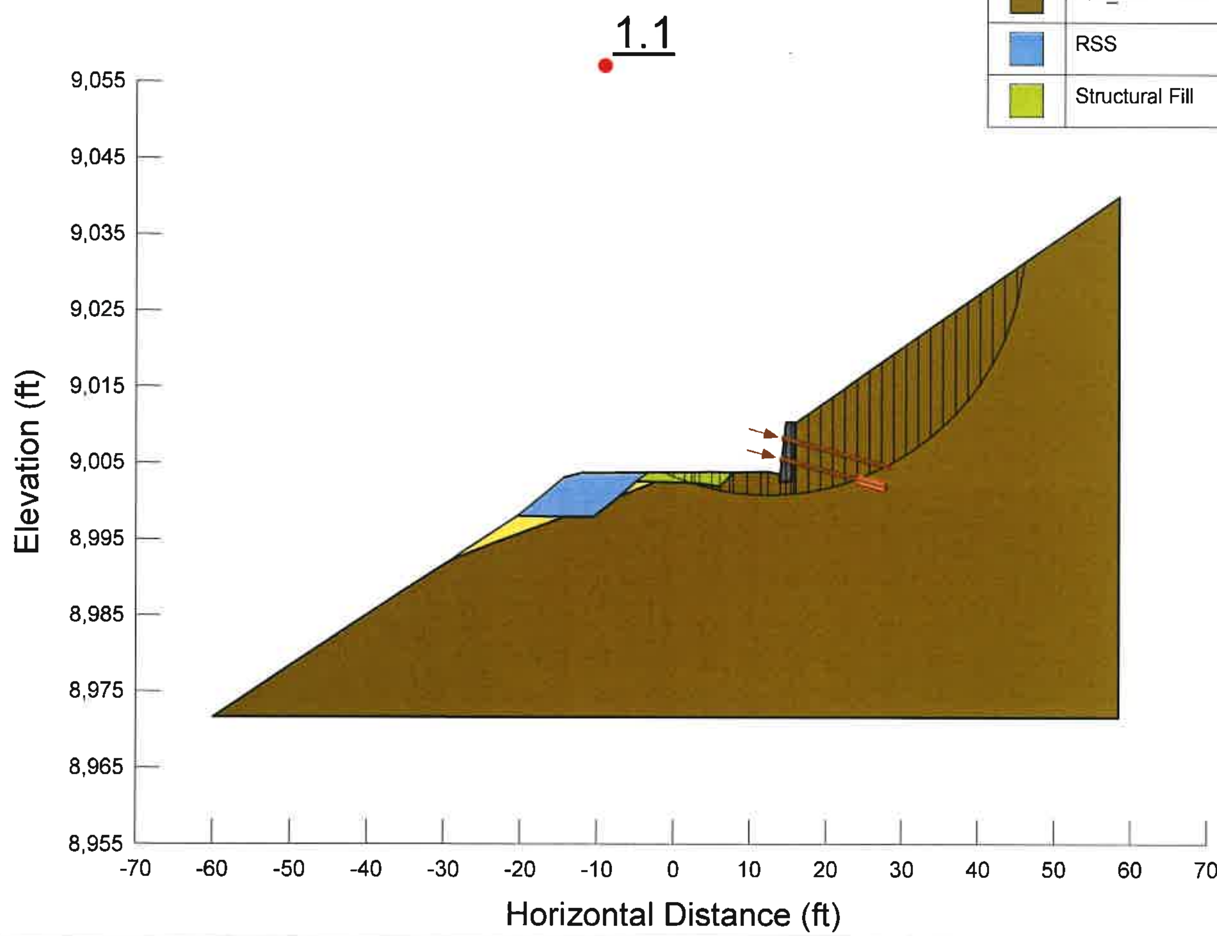
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section C
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



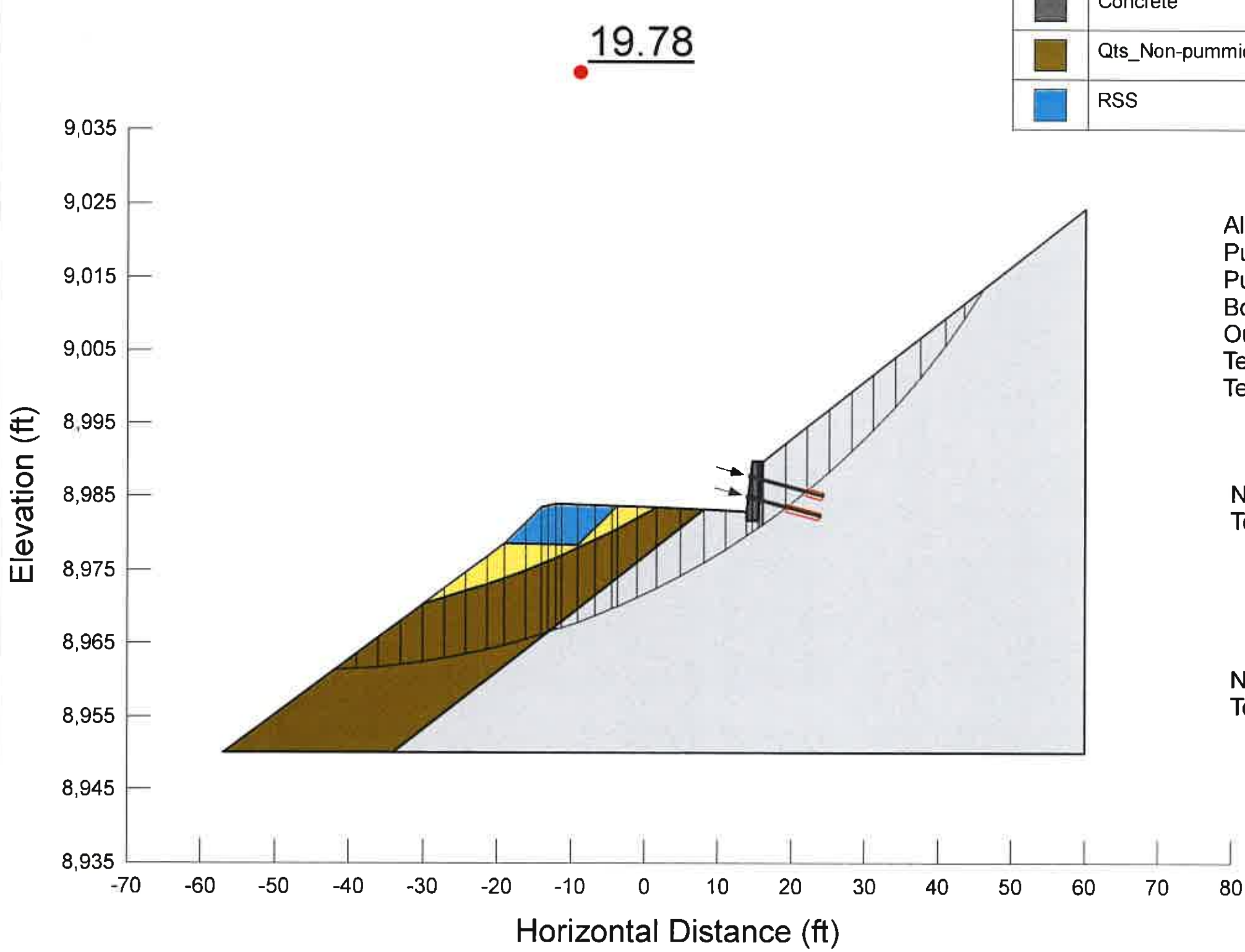
All Nails
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section D
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af - artificial fill	Mohr-Coulomb	120	0	30
(light gray)	Bedrock	Mohr-Coulomb	145	10,000	40
(dark gray)	Concrete	High Strength	150		
(brown)	Qts_Non-pummice	Mohr-Coulomb	120	0	32
(blue)	RSS	High Strength	125		



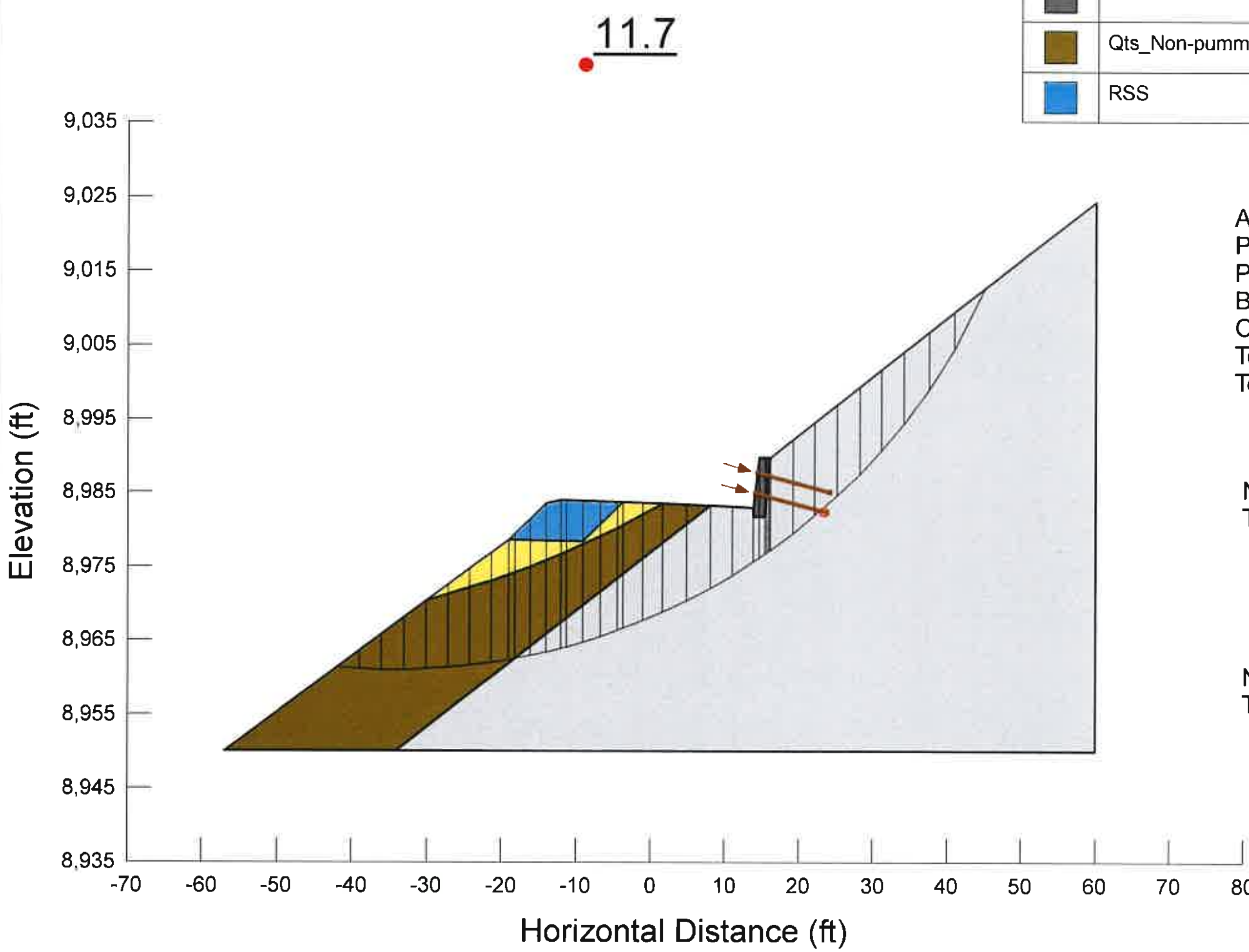
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section D
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		



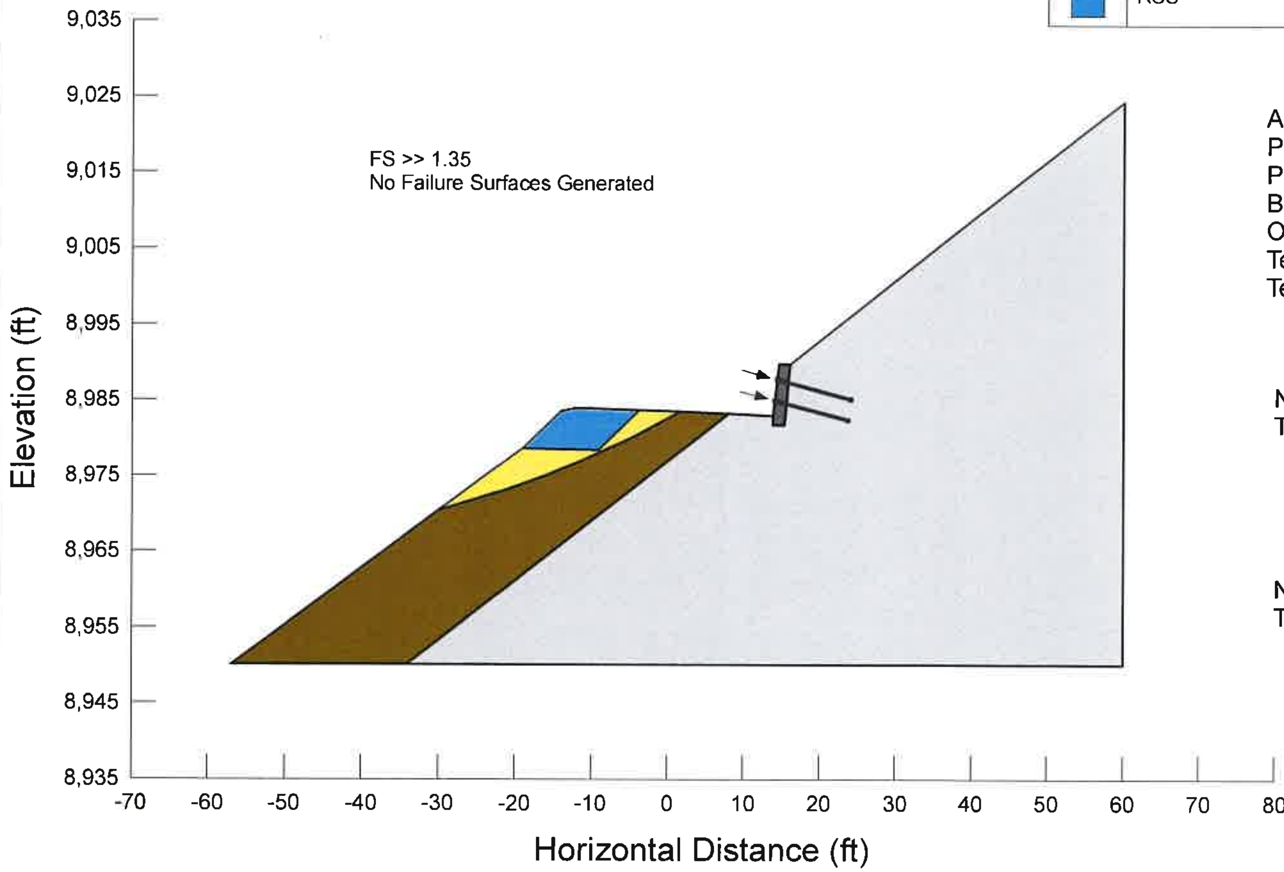
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section D
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Brown	Qts_Non-pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		



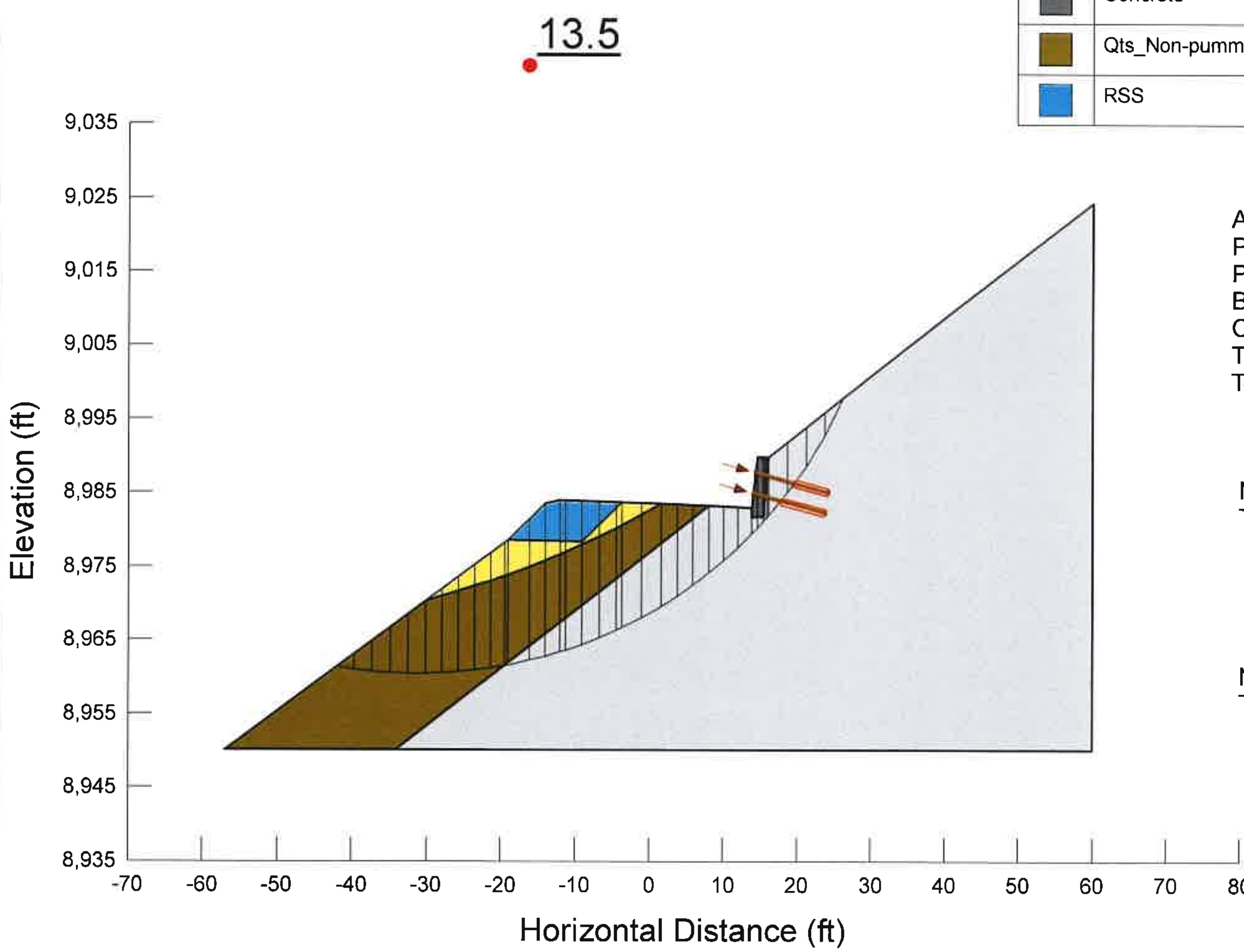
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section D
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		



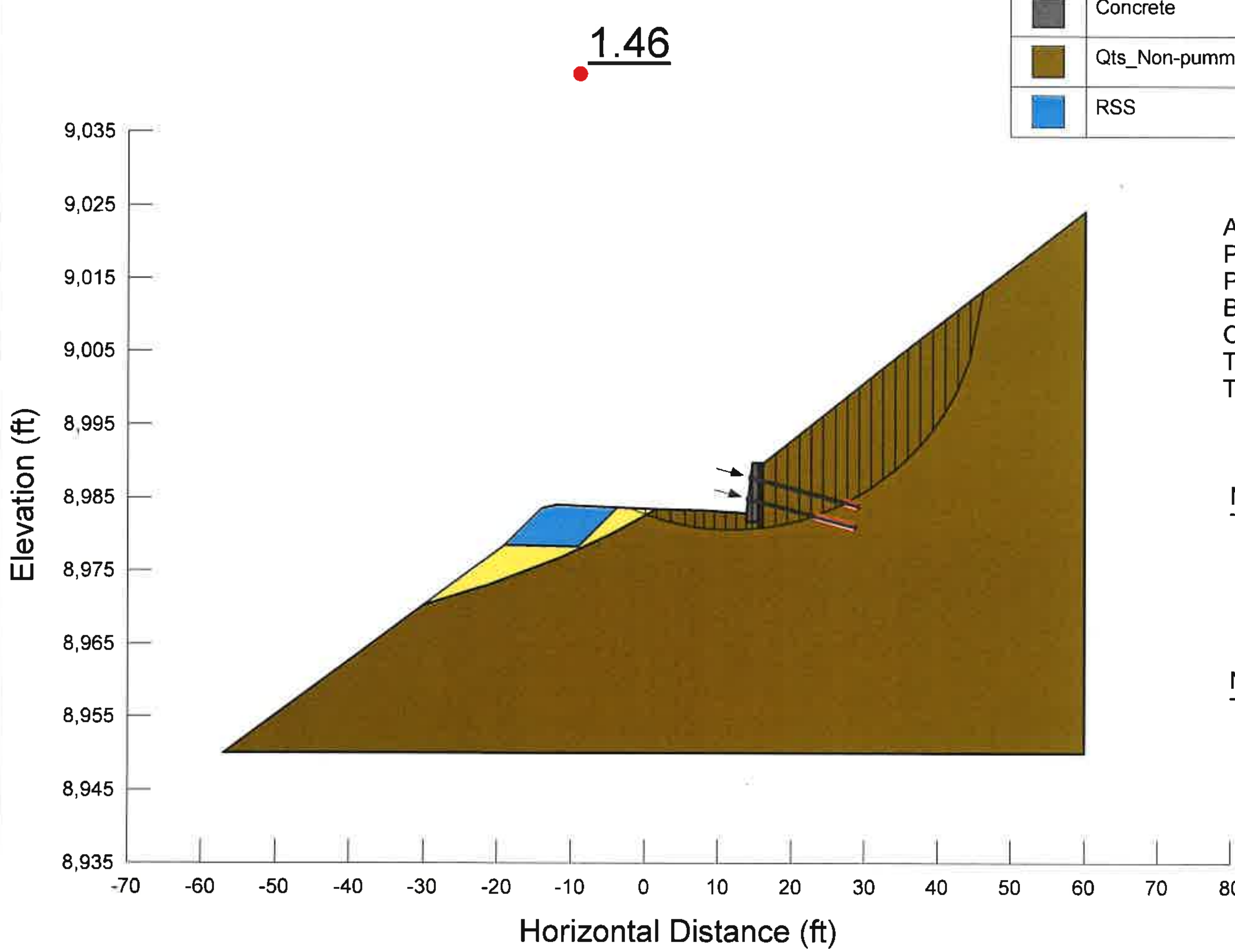
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section D
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		



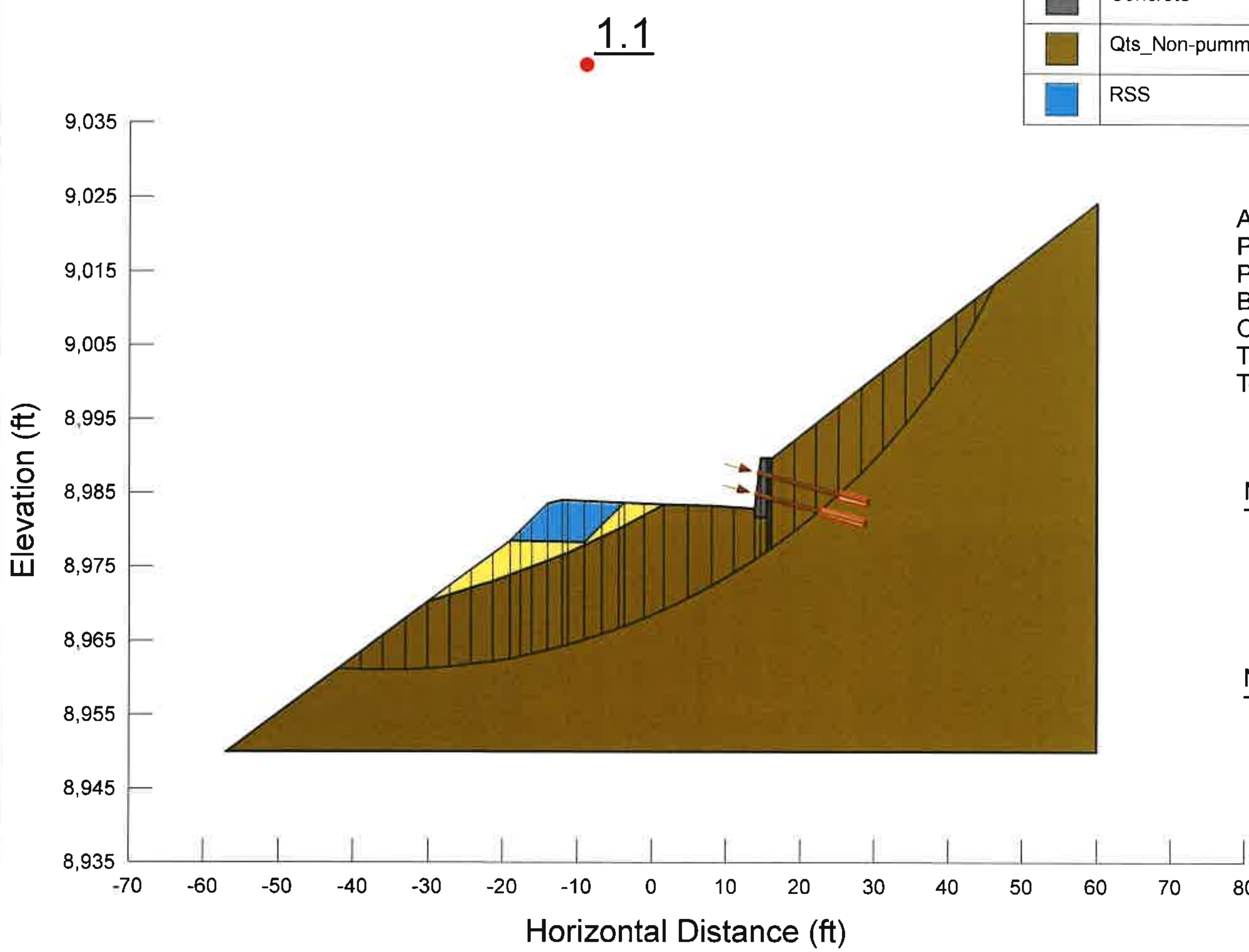
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 15 ft

Nail (Second Row):
Total Length: 15 ft

Reds Meadow Road Improvement
Cross Section D
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Grey	Concrete	High Strength	150		
Brown	Qts_Non-pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		



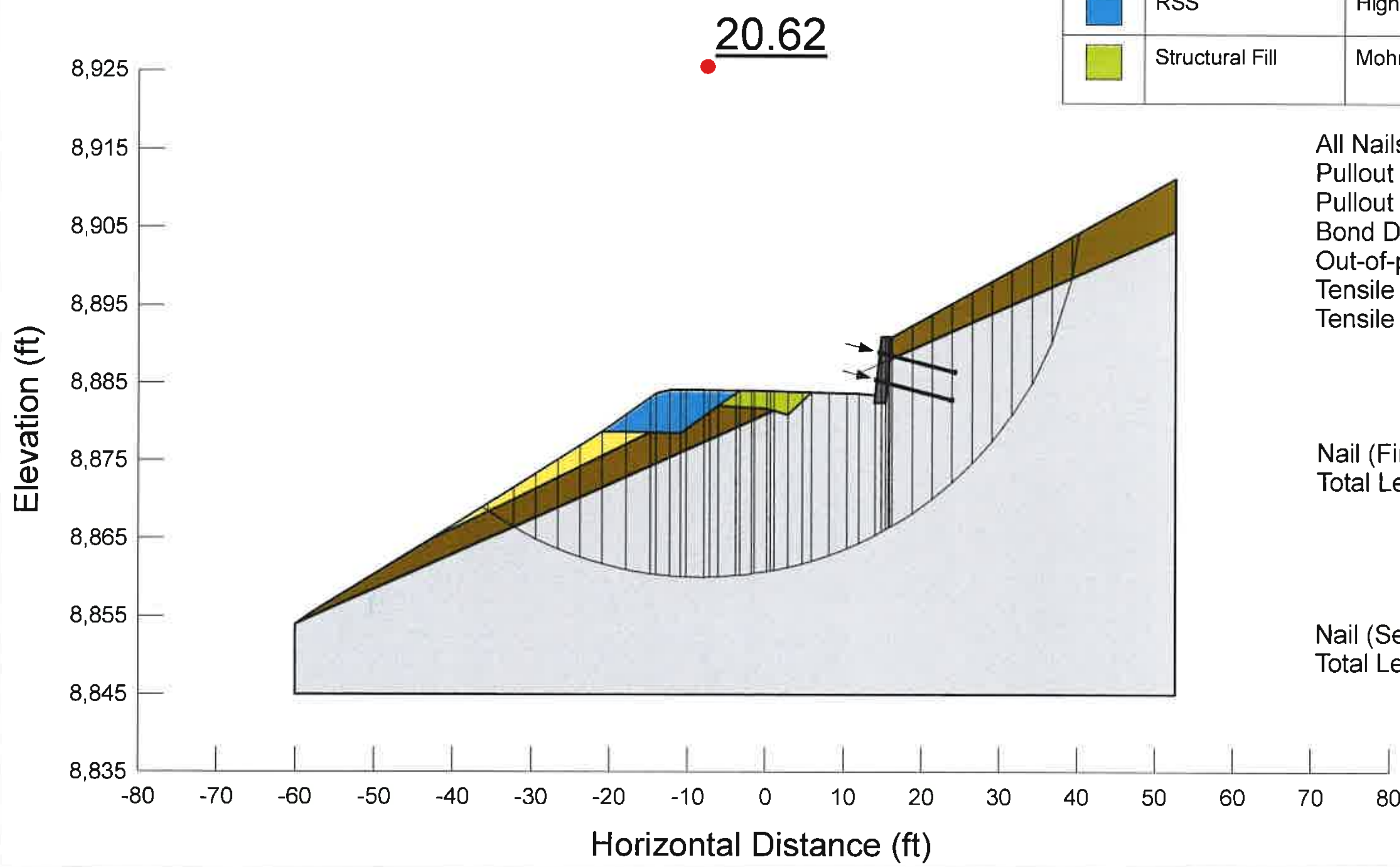
All Nails:
Pullout Resistance: Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 15 ft

Nail (Second Row):
Total Length: 15 ft

Reds Meadow Road Improvement
Cross Section E
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



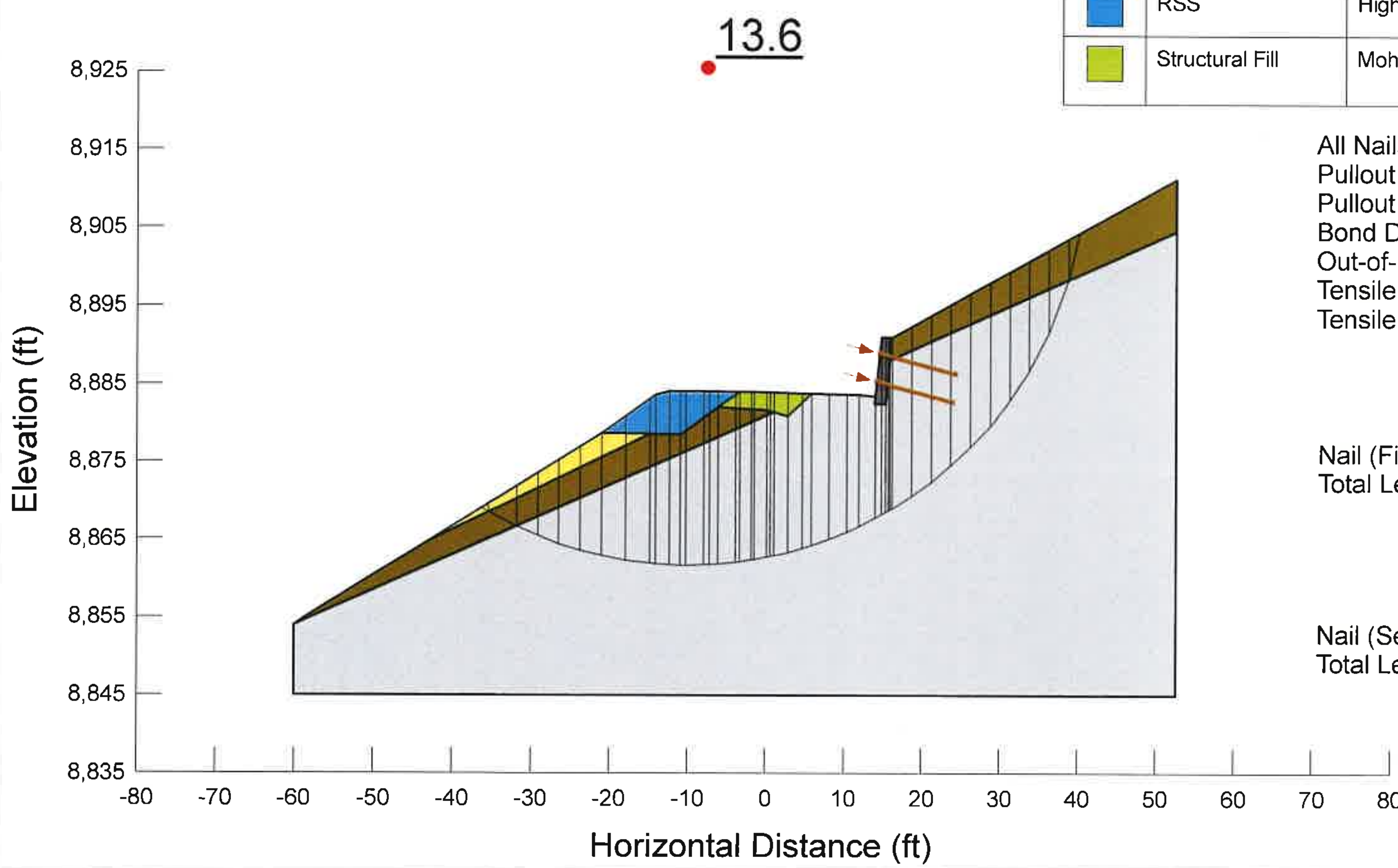
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section E
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



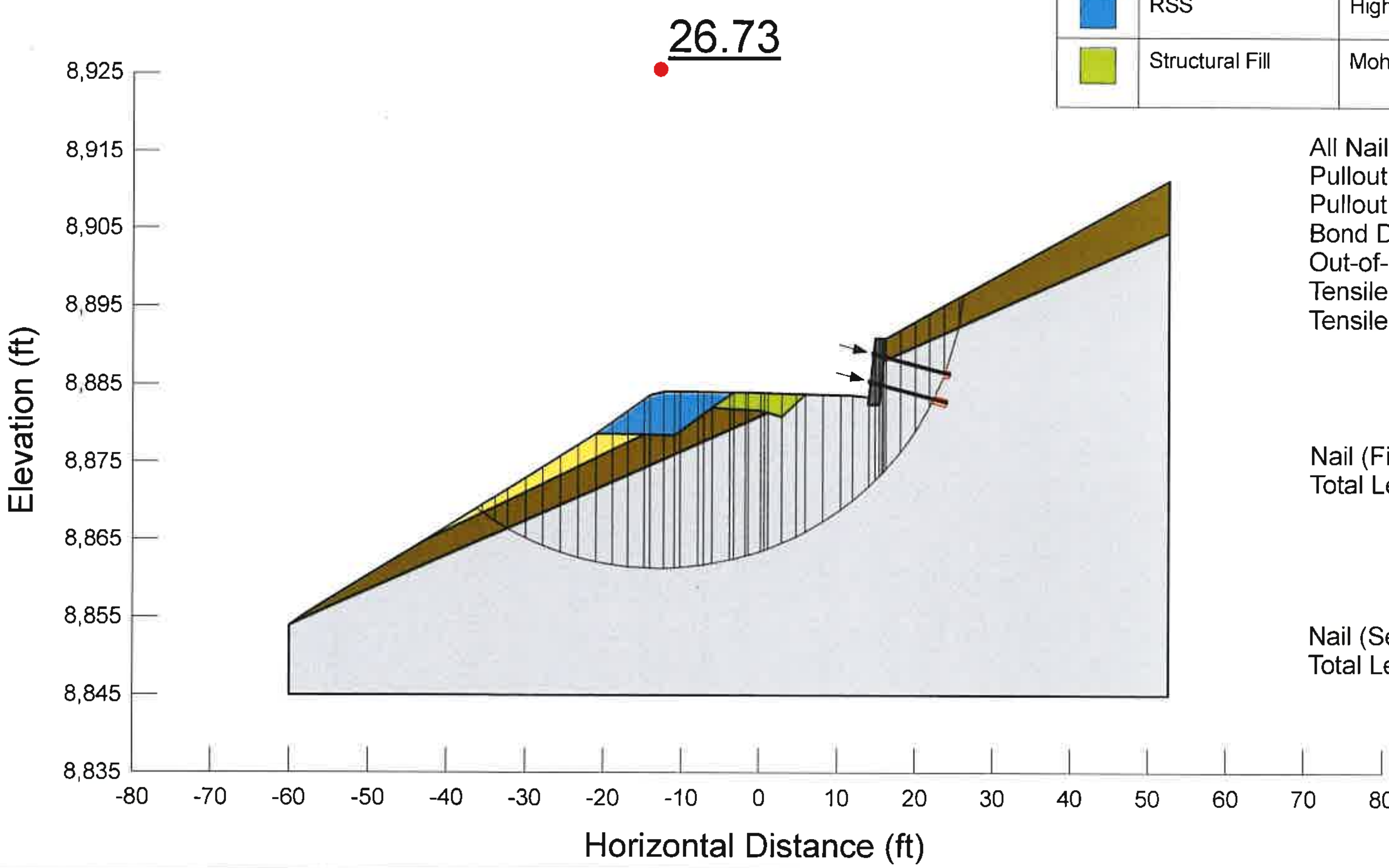
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section E
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



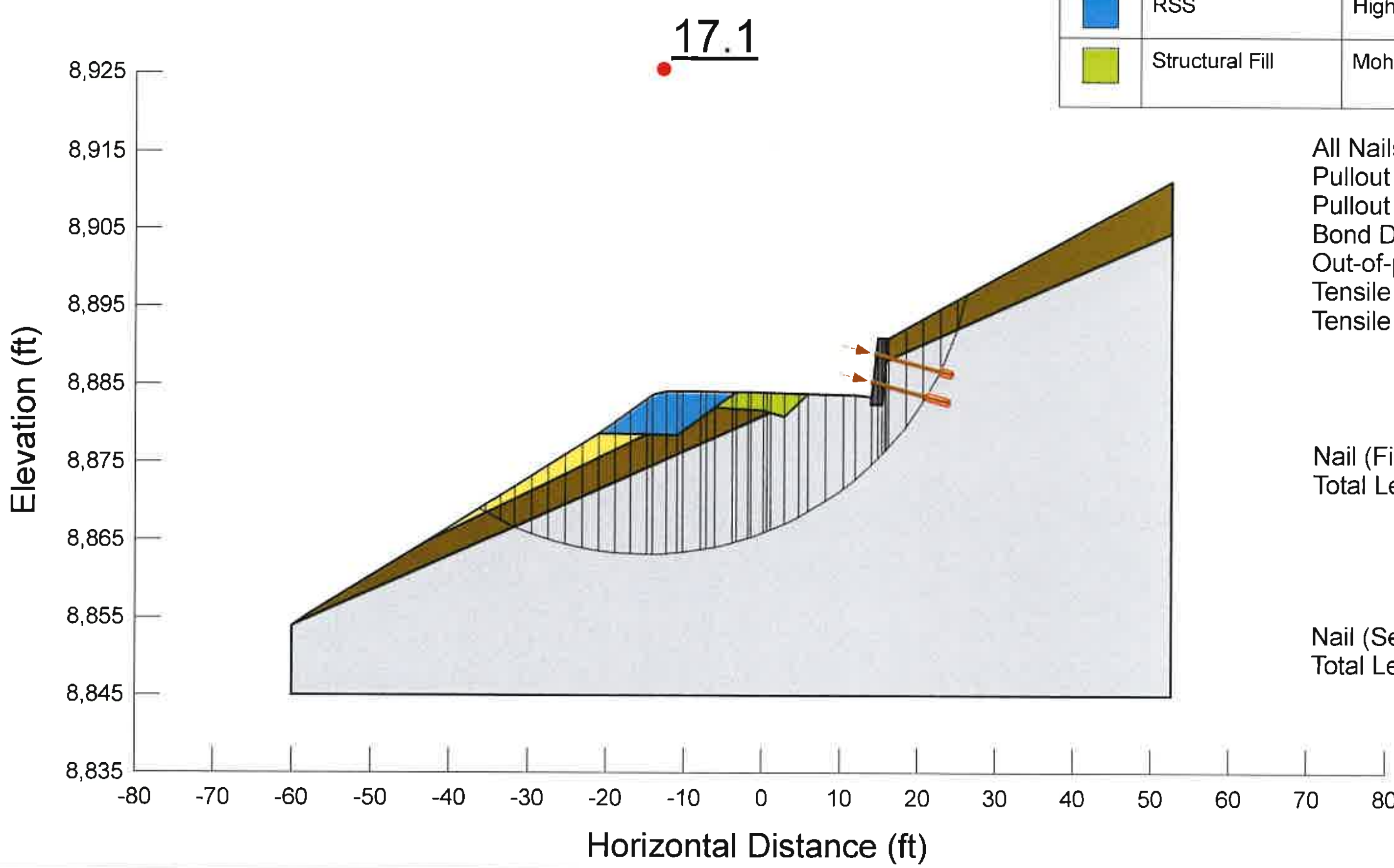
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section E
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



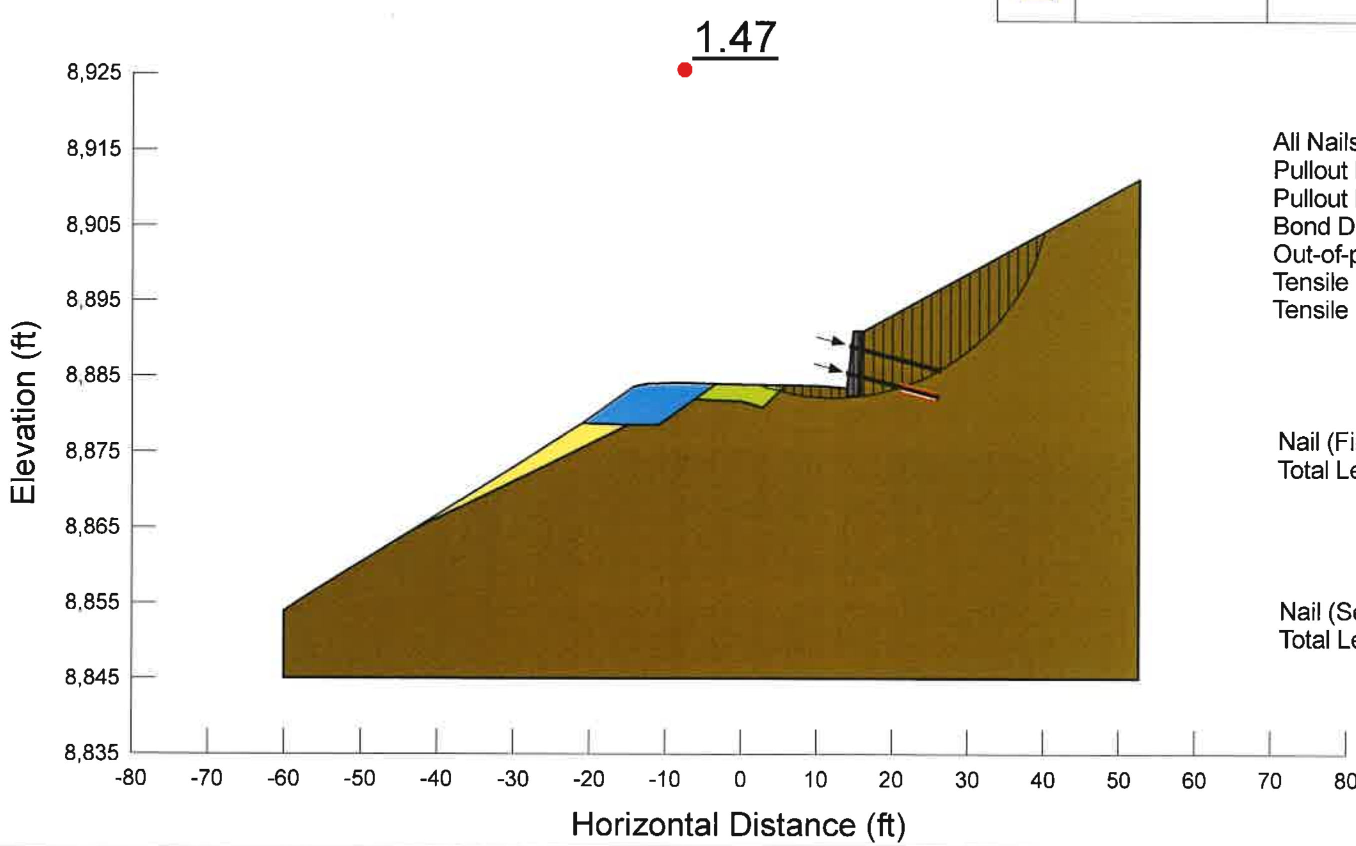
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section E
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



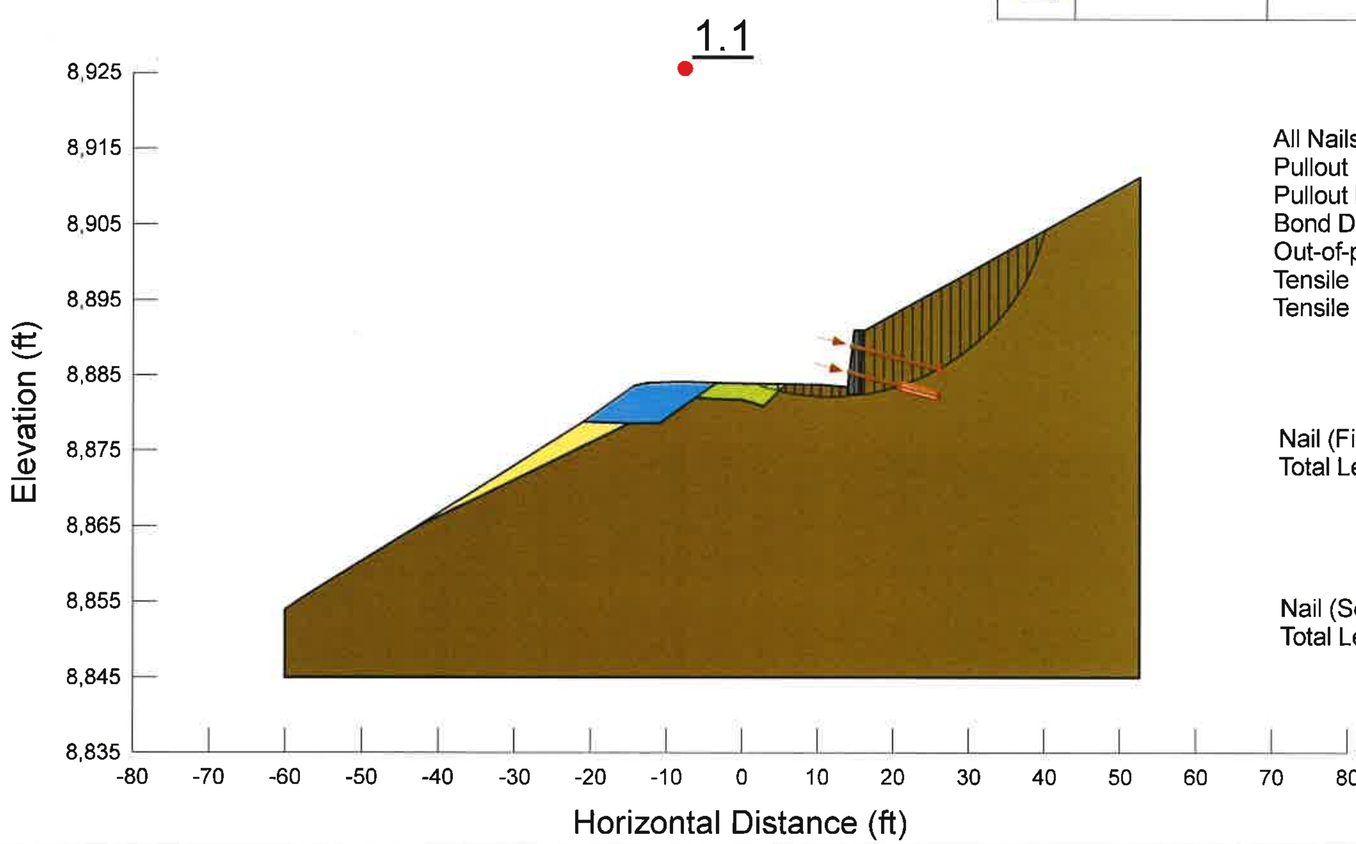
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 12 ft

Nail (Second Row):
Total Length: 12 ft

Reds Meadow Road Improvement
Cross Section E
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Non-Pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



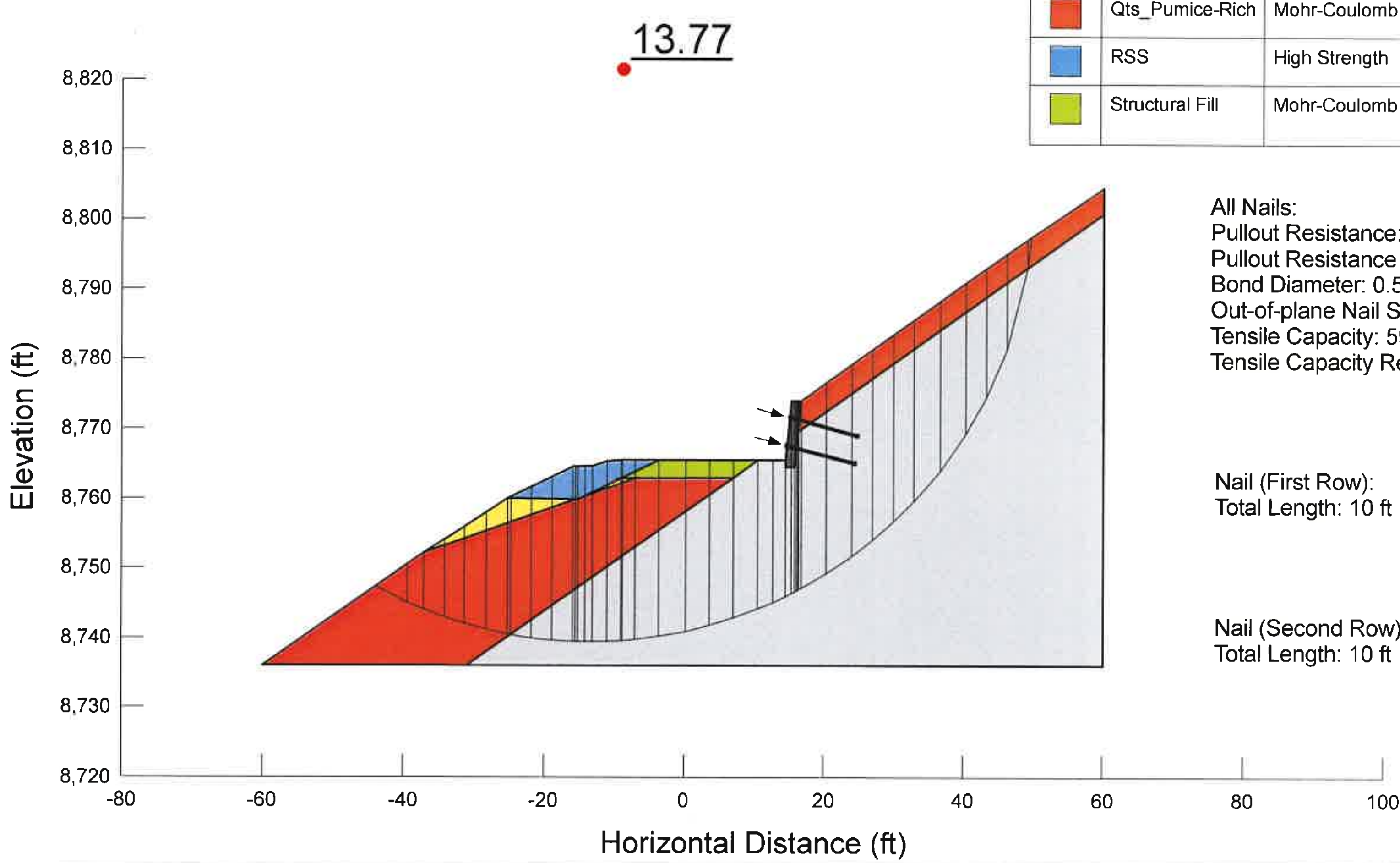
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 12 ft

Nail (Second Row):
Total Length: 12 ft

Reds Meadow Road Improvement
Cross Section G
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



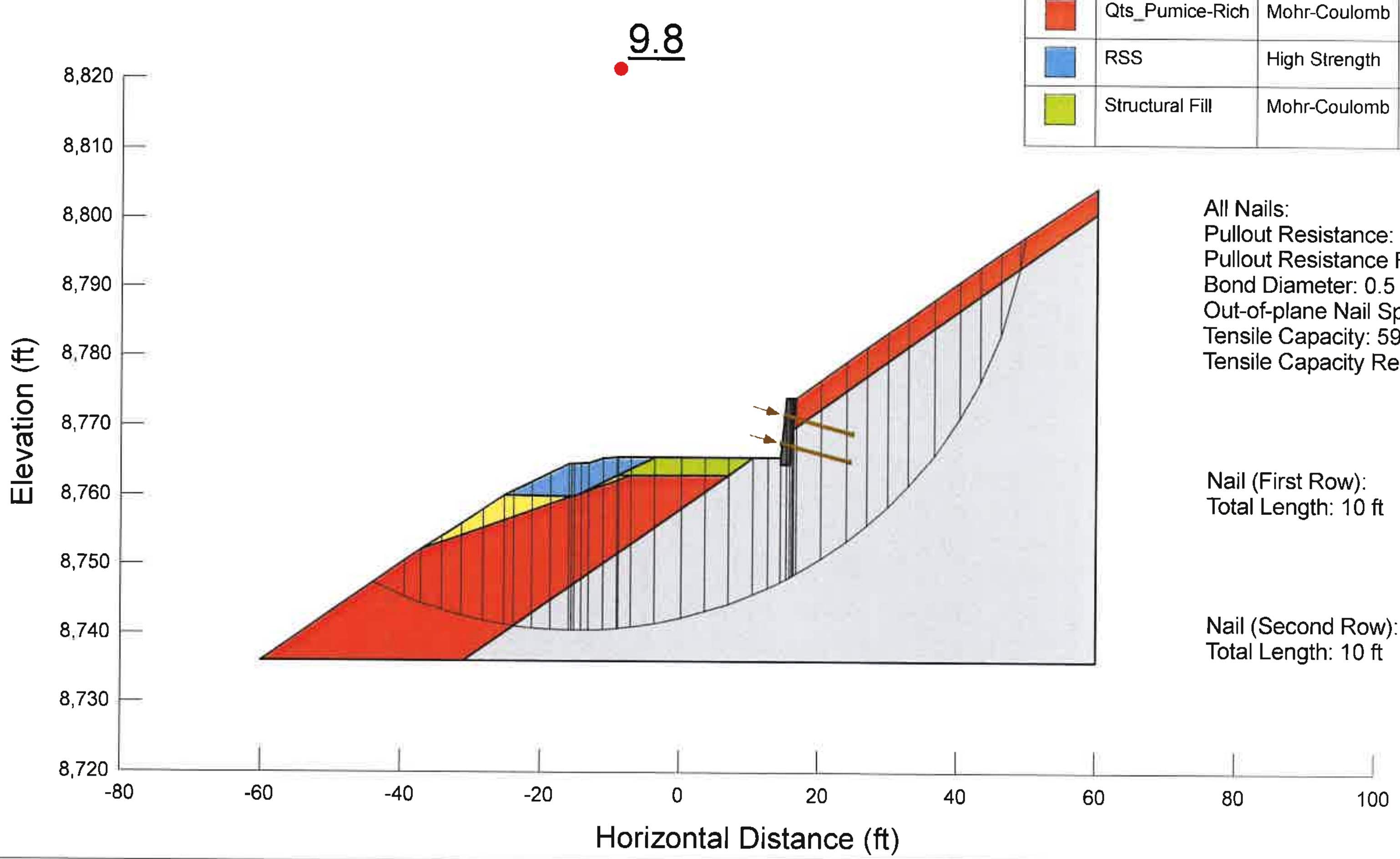
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section G
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



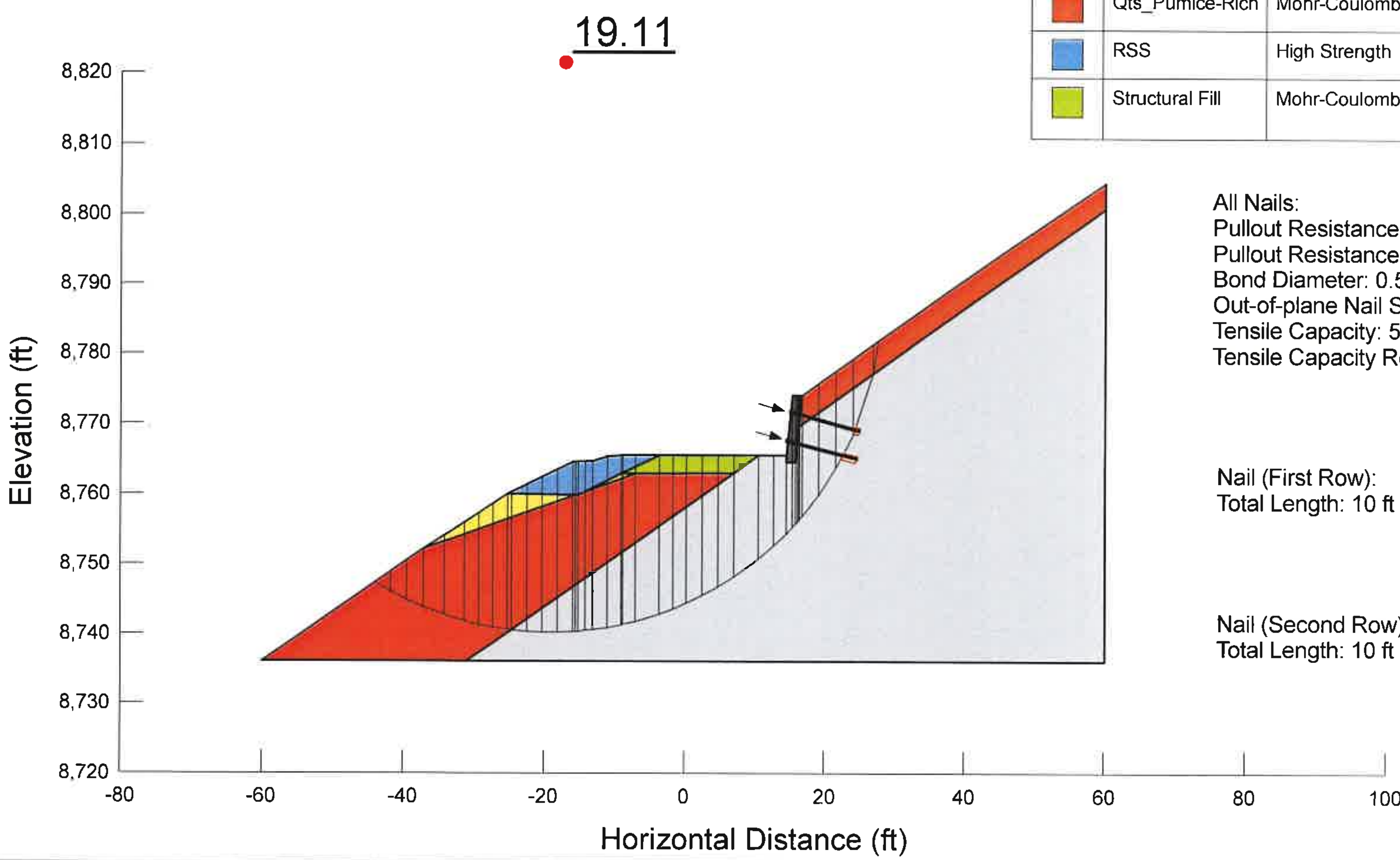
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section G
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



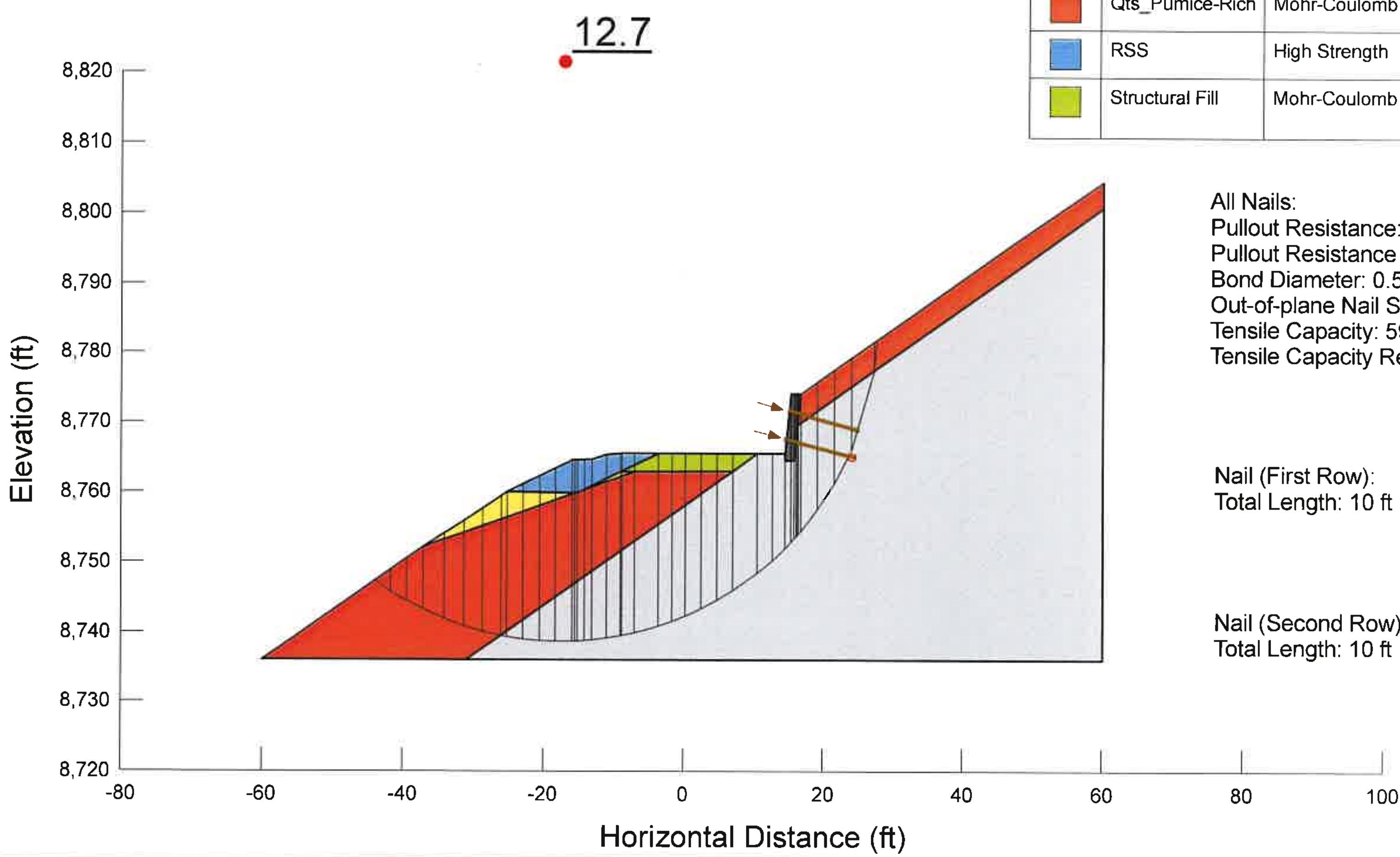
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section G
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



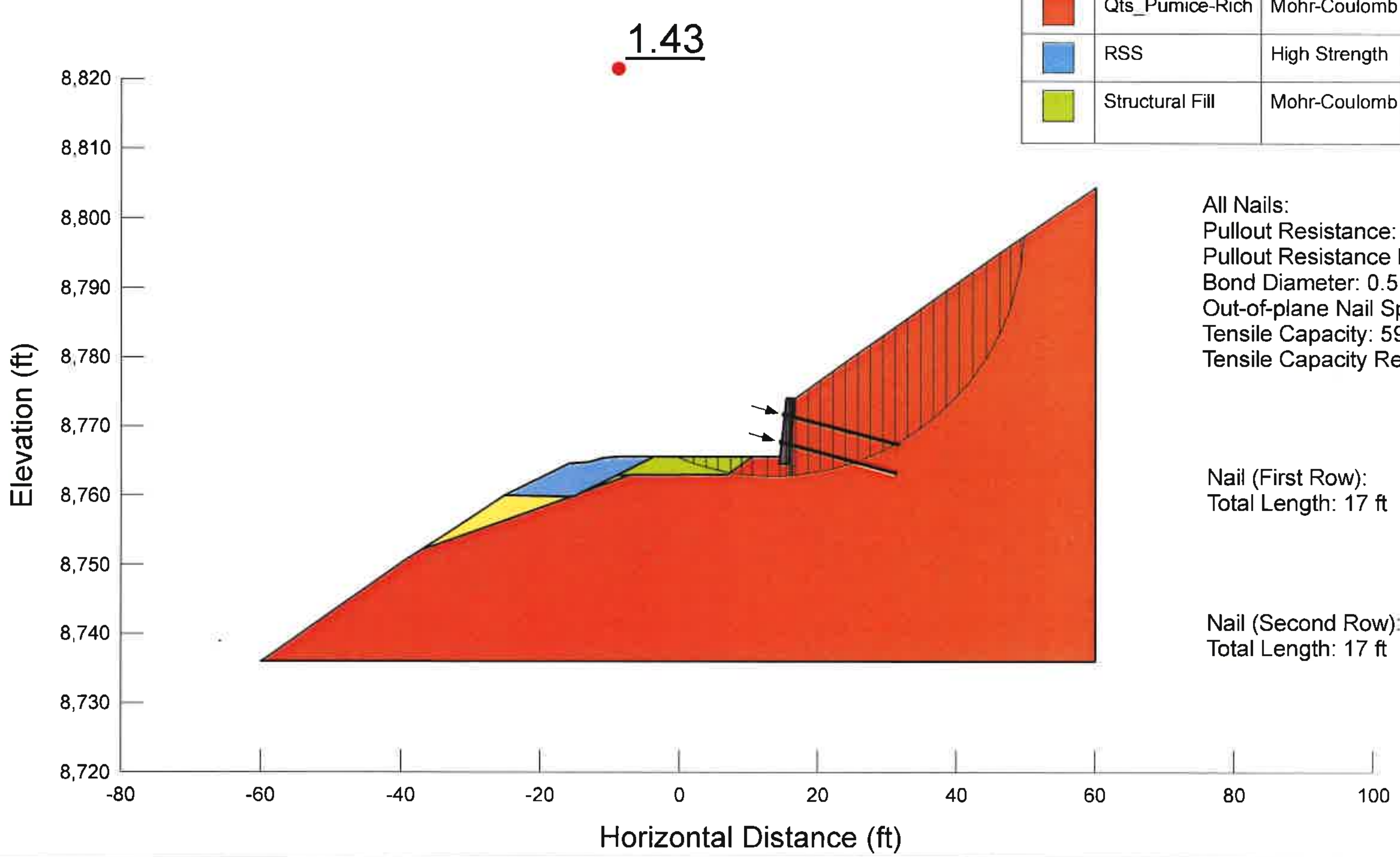
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section G
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



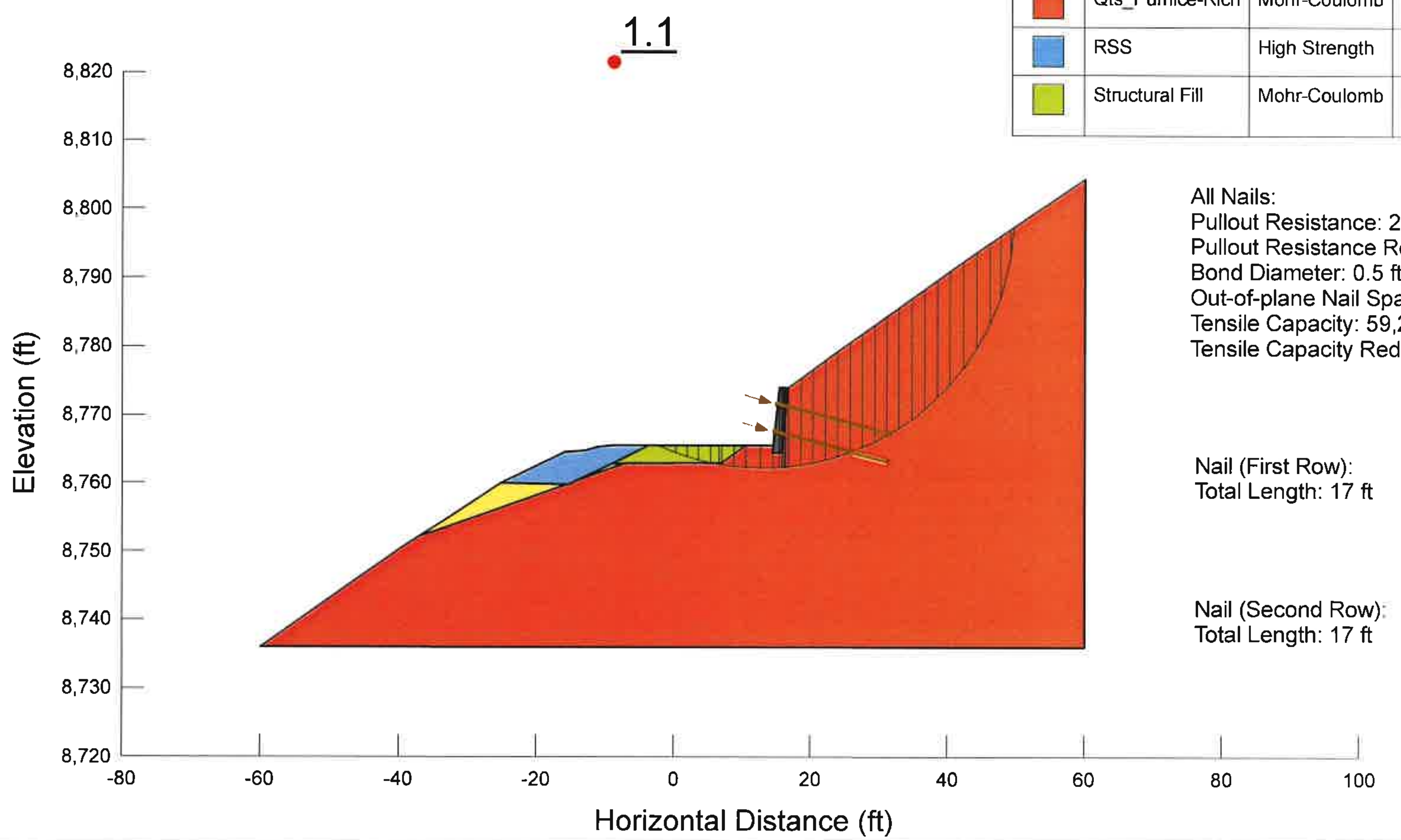
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 17 ft

Nail (Second Row):
Total Length: 17 ft

Reds Meadow Road Improvement
Cross Section G
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		
(yellow-green)	Structural Fill	Mohr-Coulomb	125	0	34



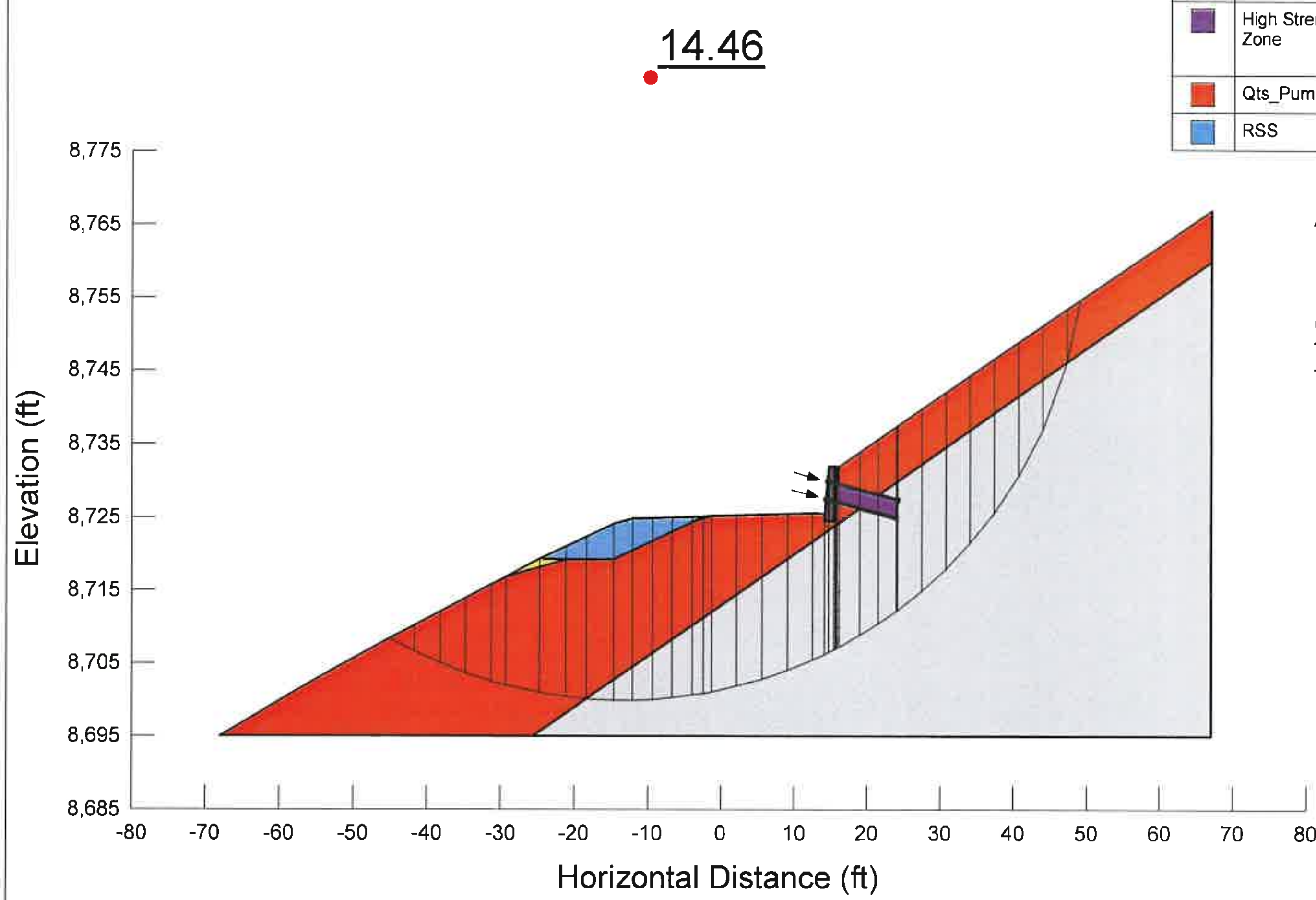
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 17 ft

Nail (Second Row):
Total Length: 17 ft

Reds Meadow Road Improvement
Cross Section H
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Purple	High Strength Zone	High Strength	120		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



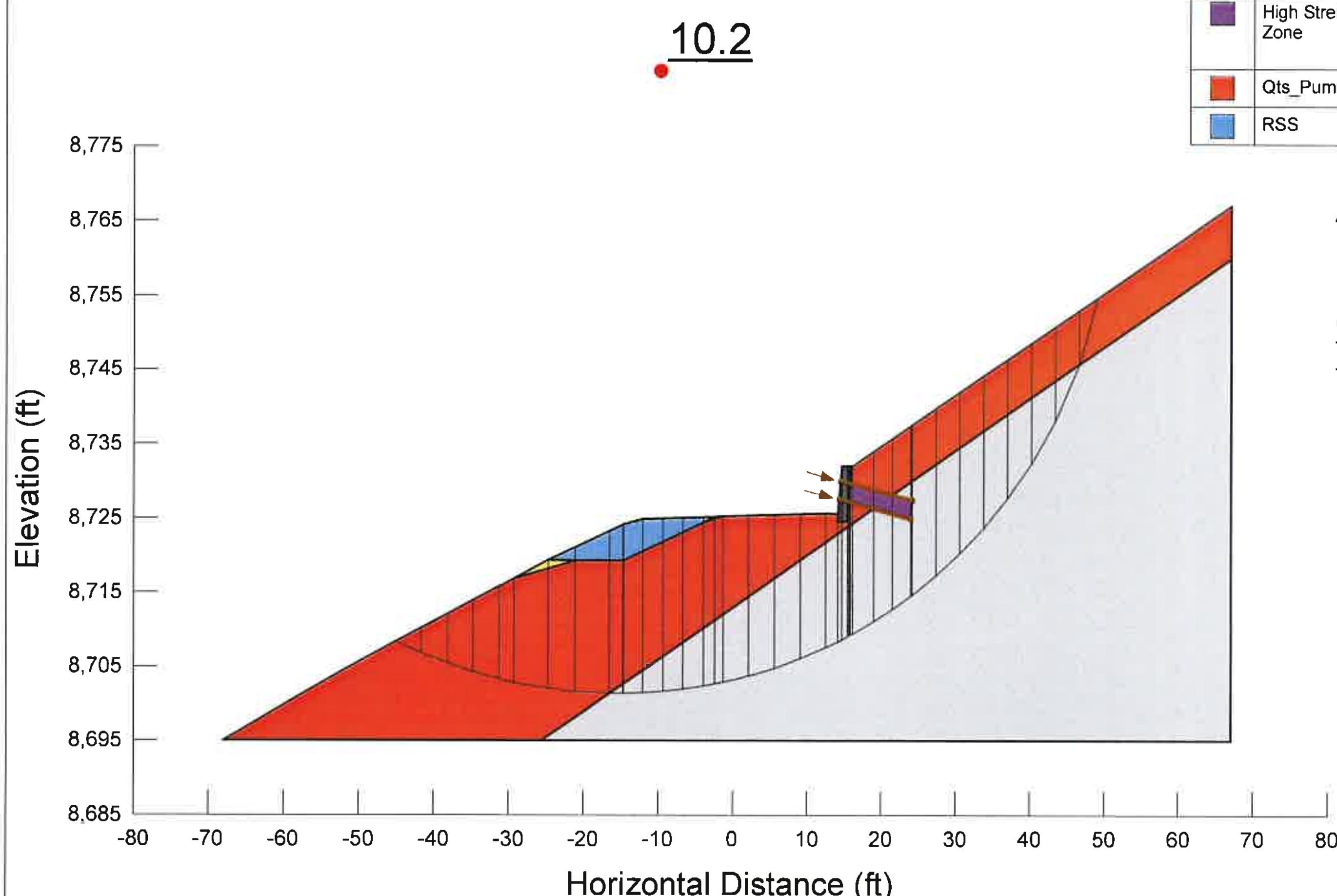
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section H
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Purple	High Strength Zone	High Strength	120		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



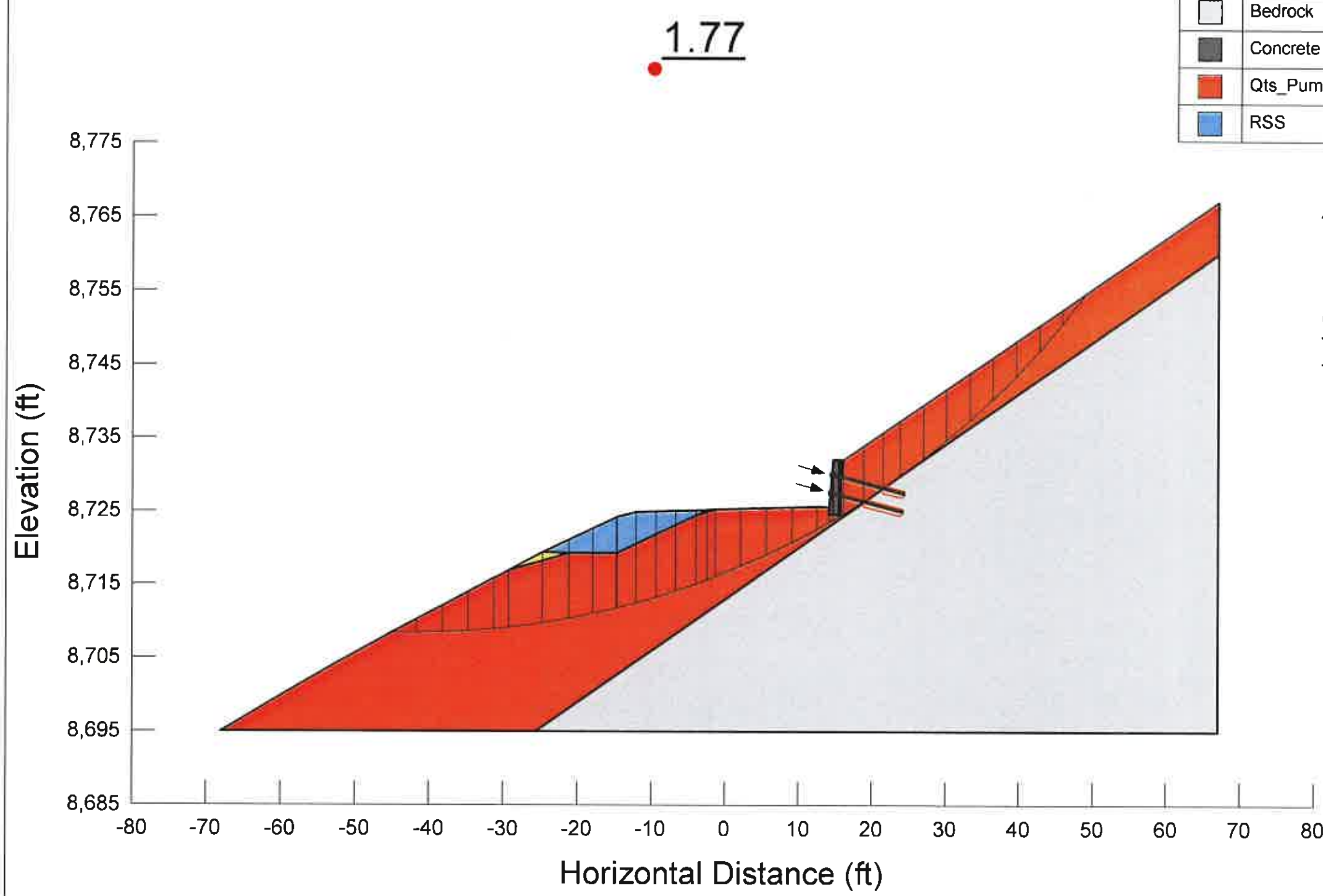
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section H
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		



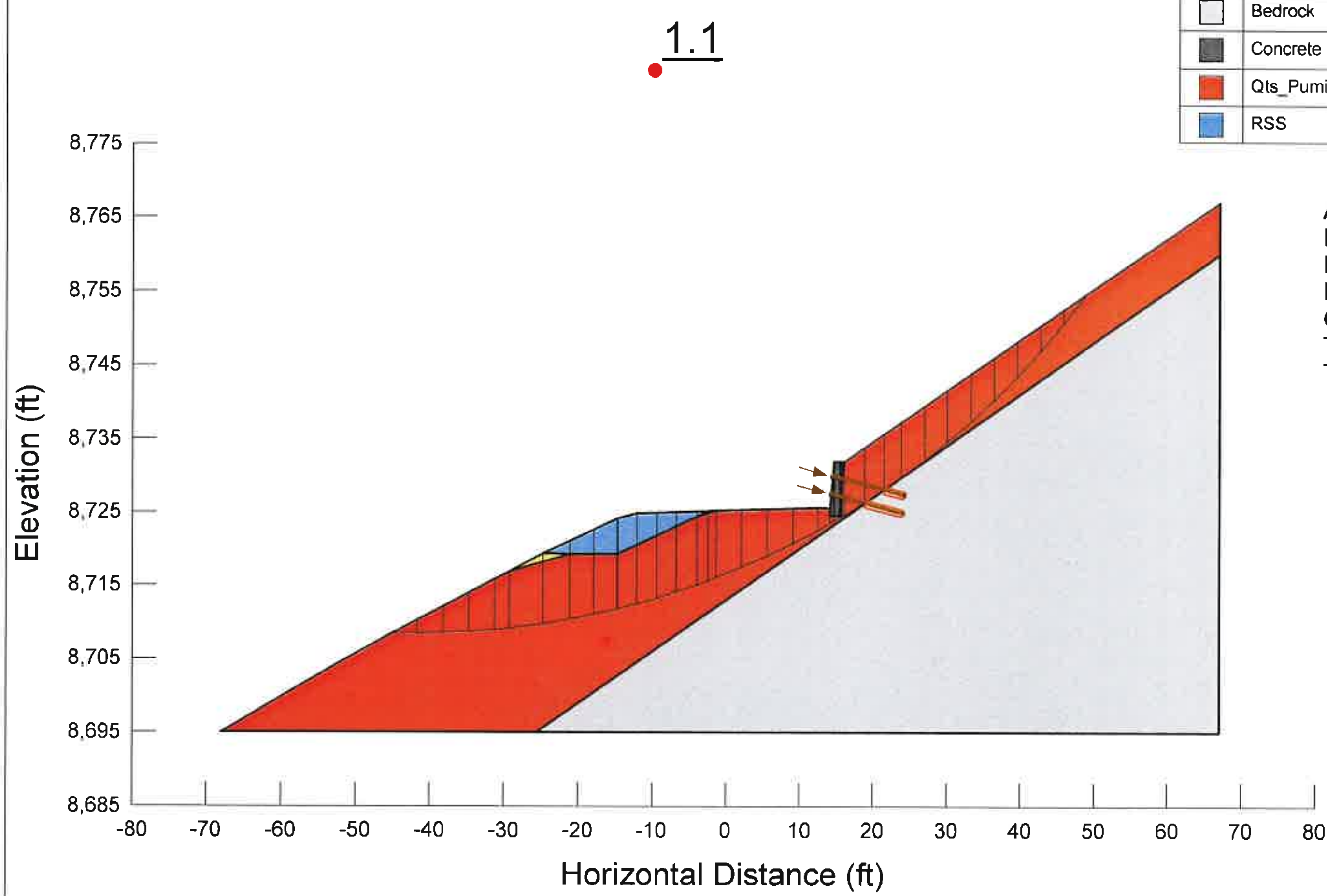
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section H
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		



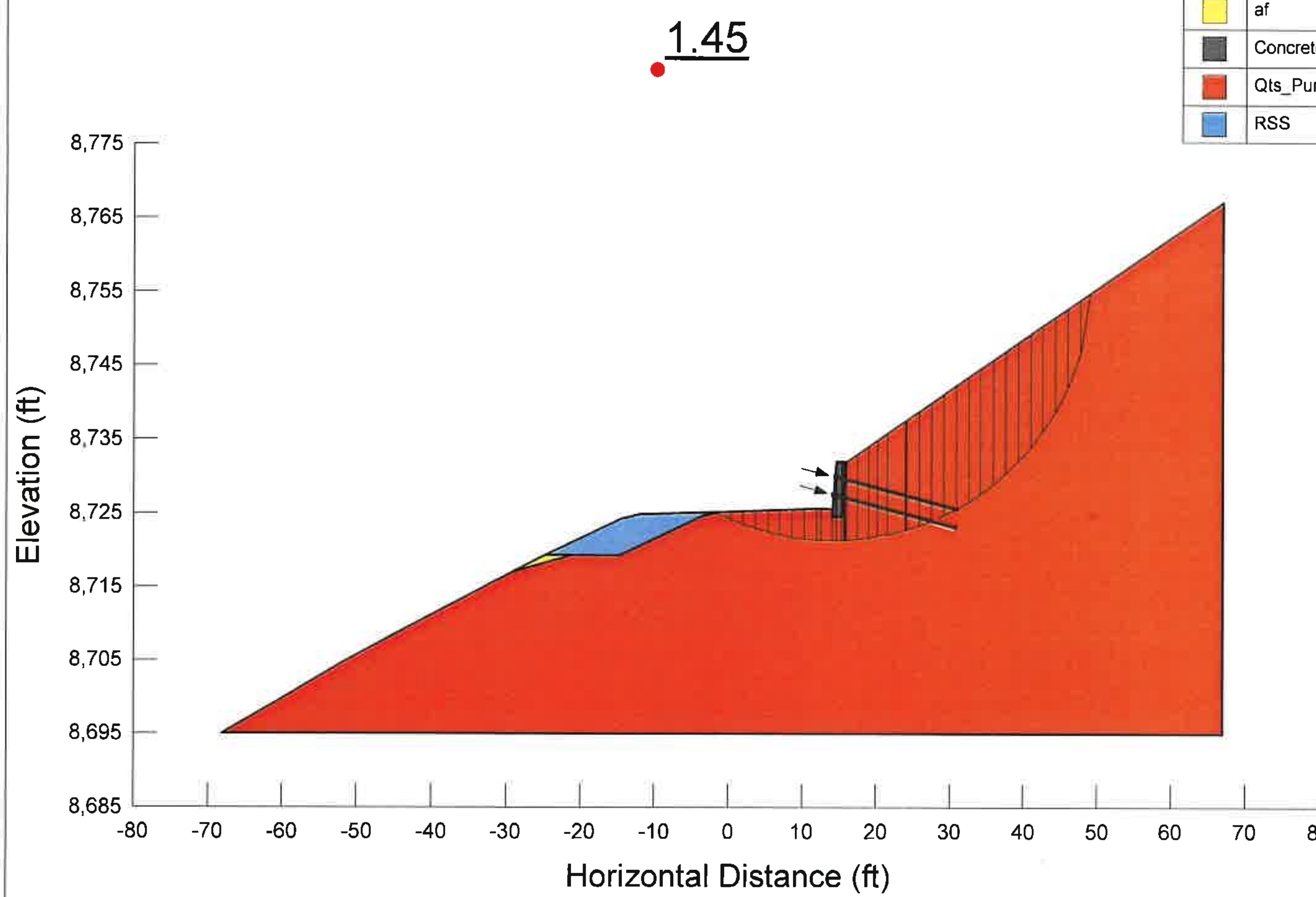
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section H
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		



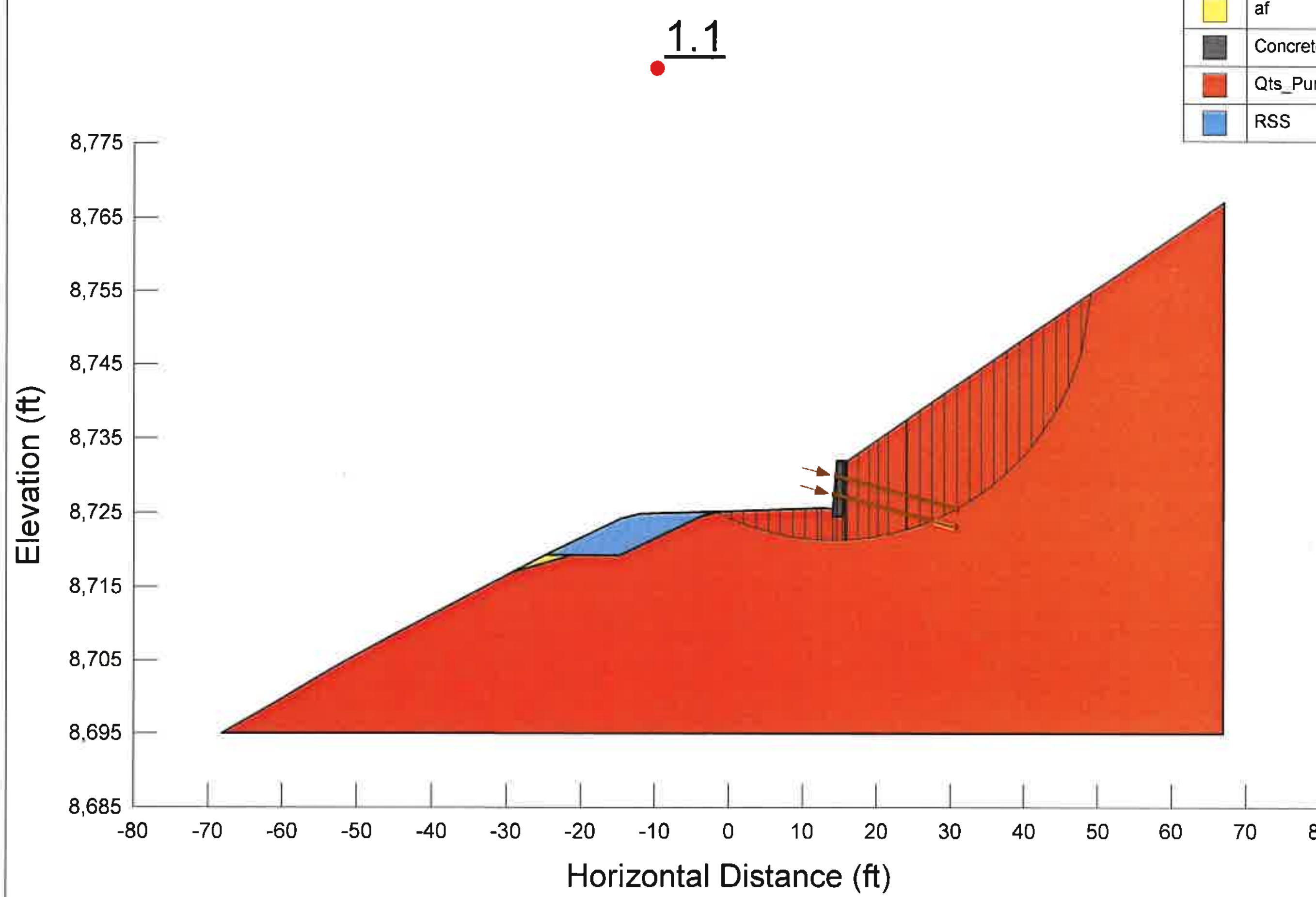
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 17 ft

Nail (Second Row):
Total Length: 17 ft

Reds Meadow Road Improvement
Cross Section H
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		



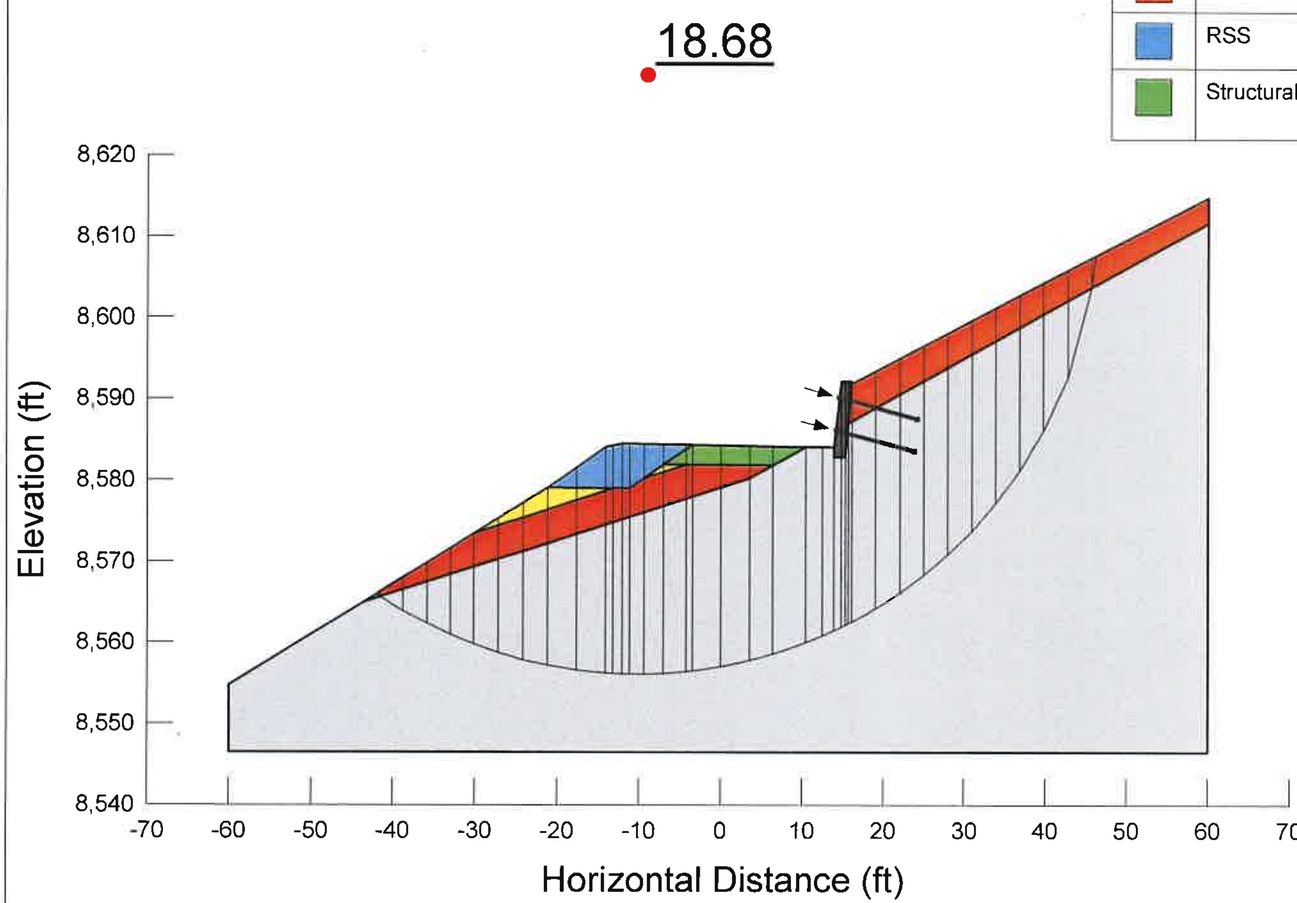
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 17 ft

Nail (Second Row):
Total Length: 17 ft

Reds Meadow Road Improvement
Cross Section I
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



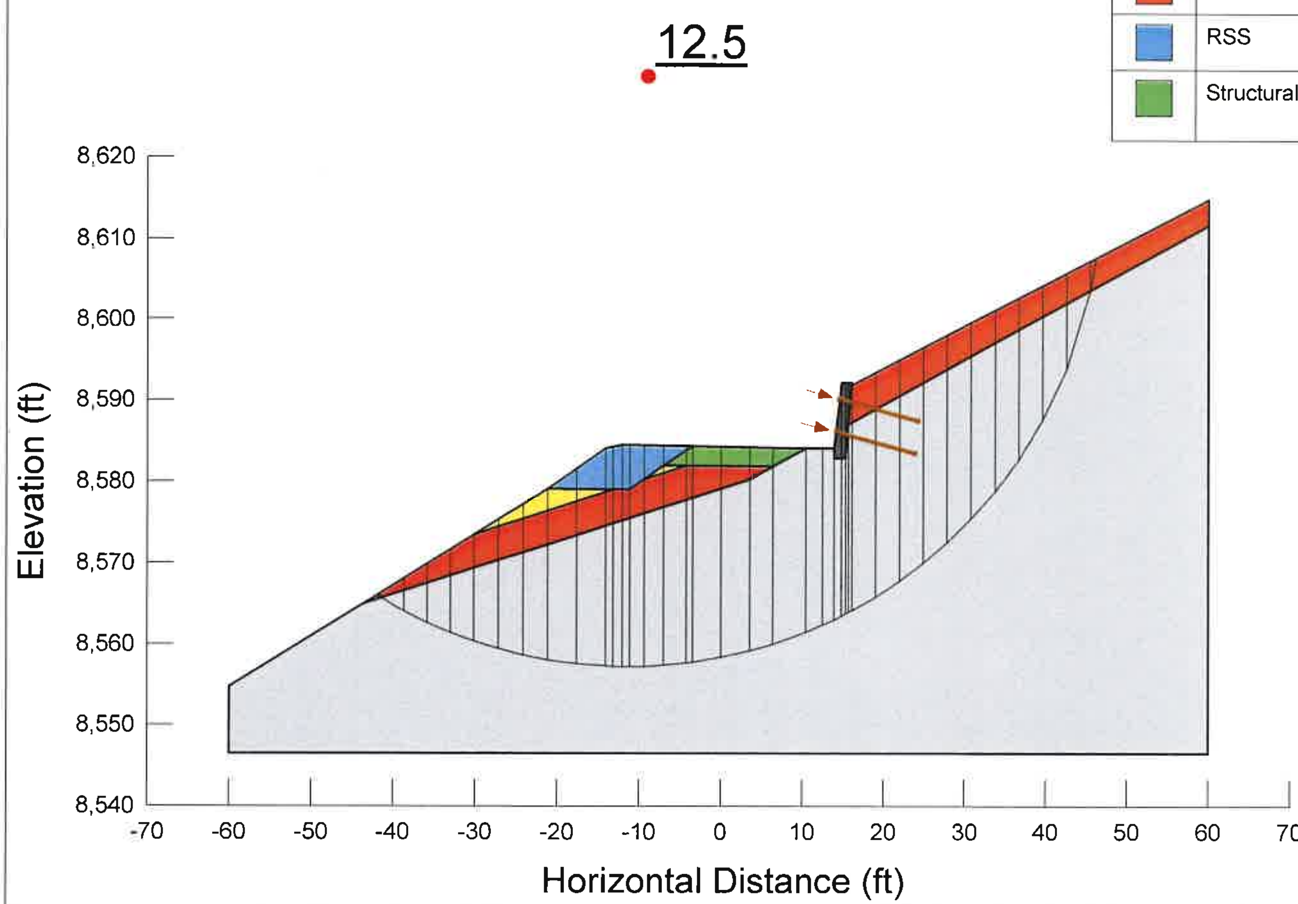
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section I
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



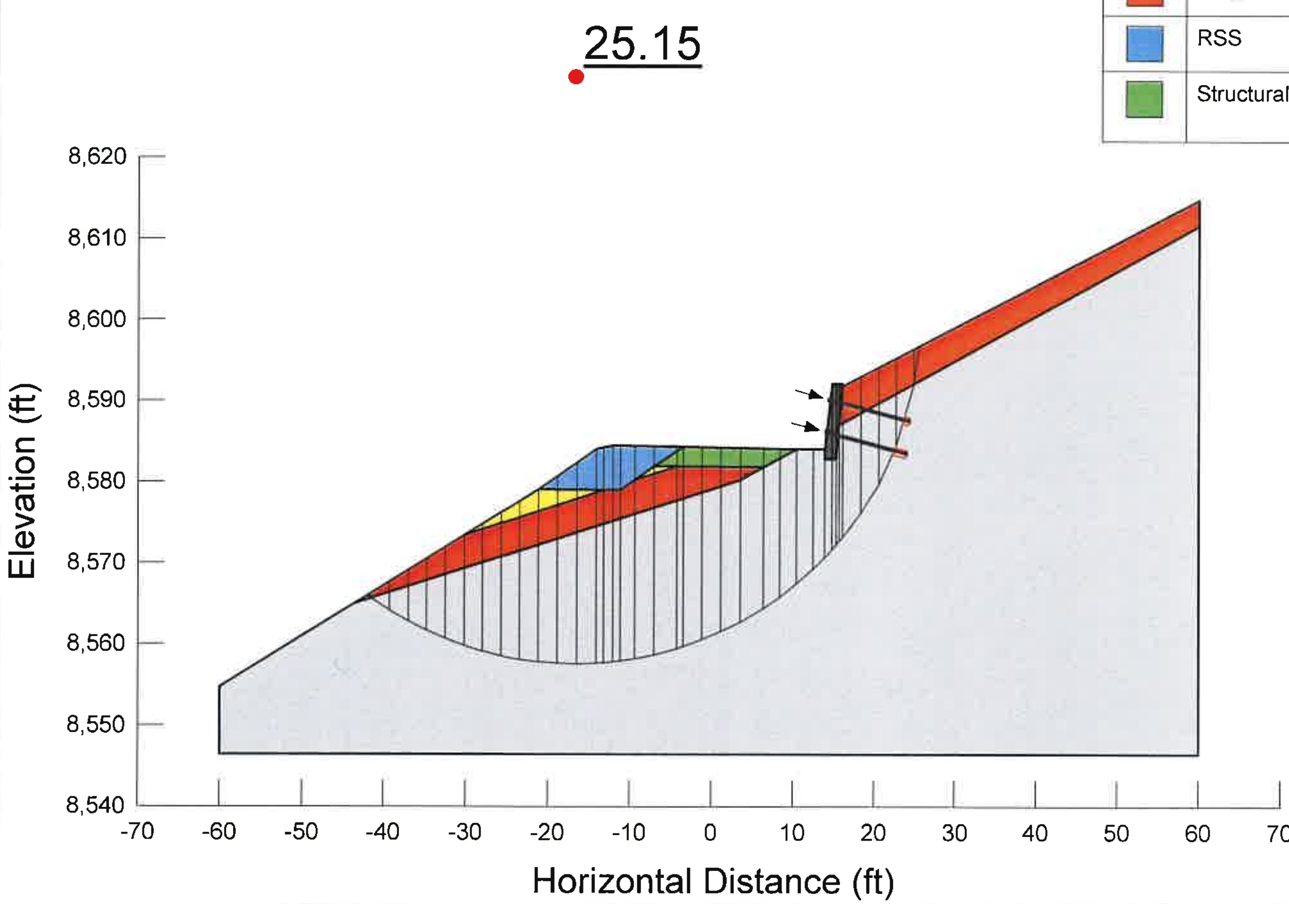
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section I
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



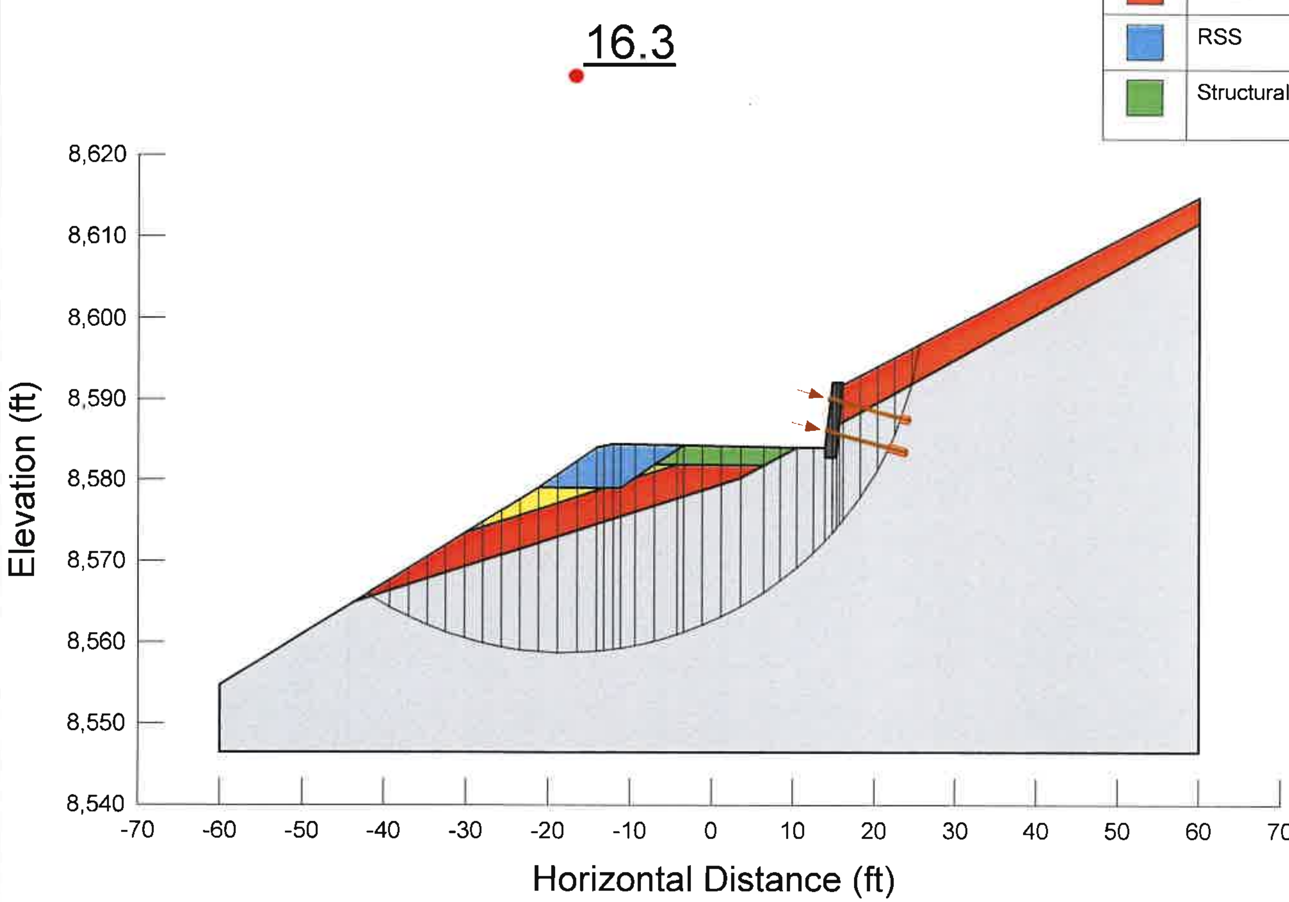
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section I
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



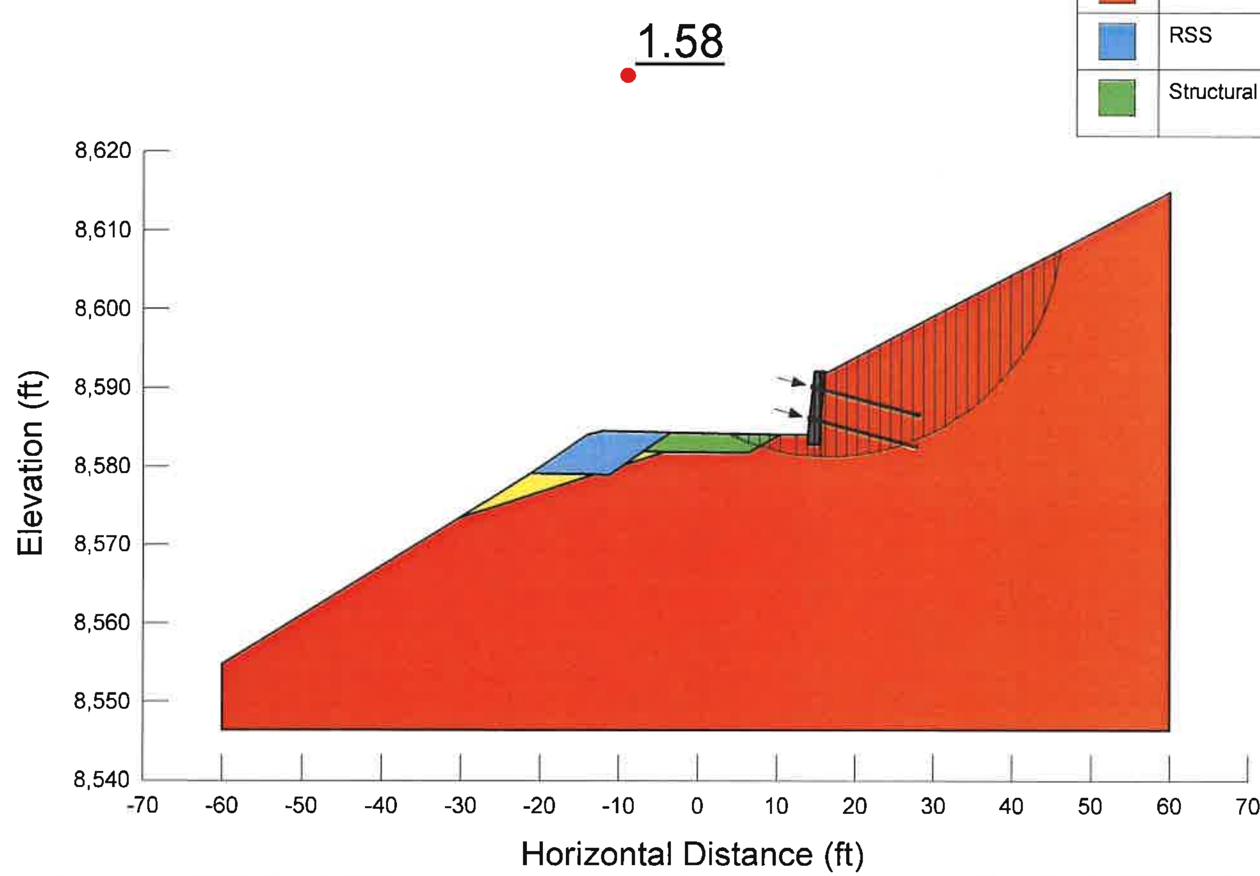
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section I
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



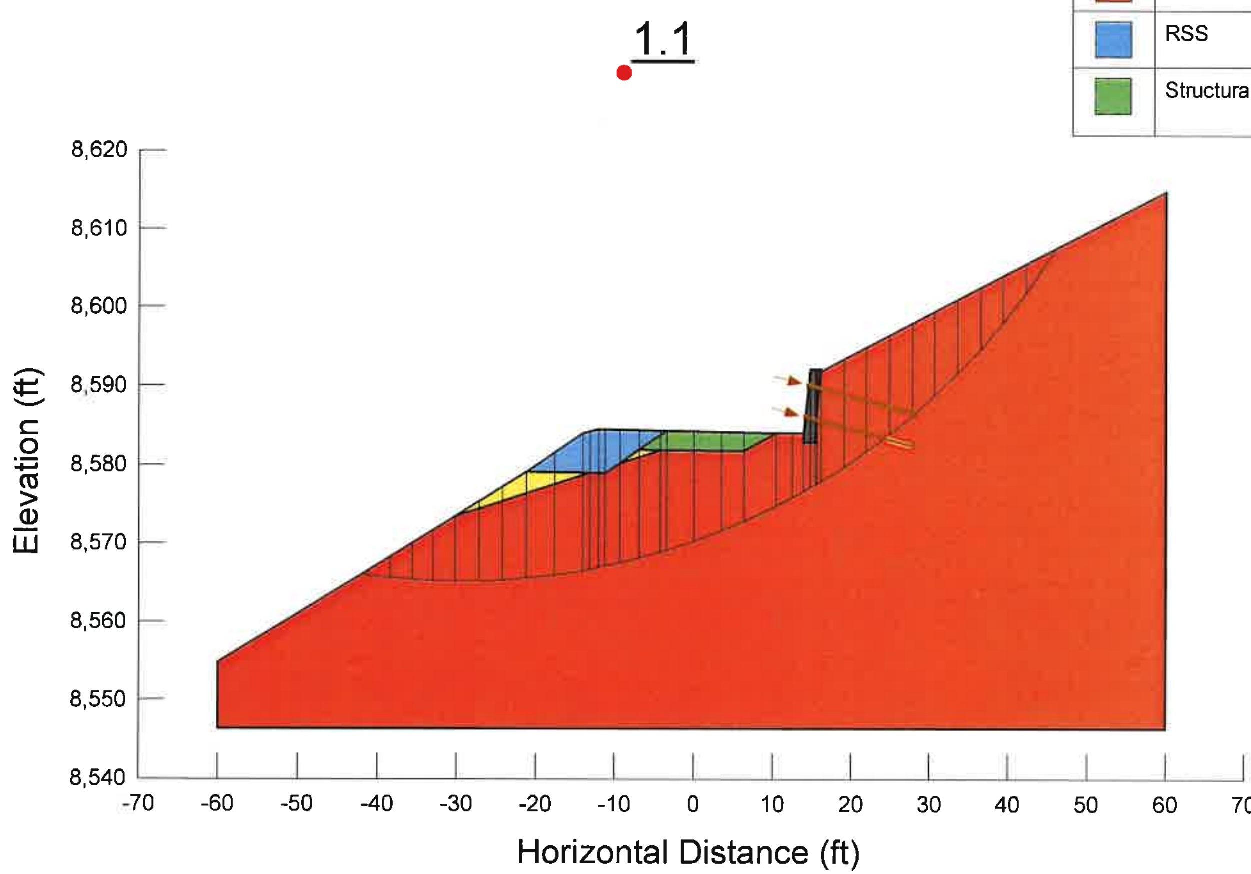
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section I
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



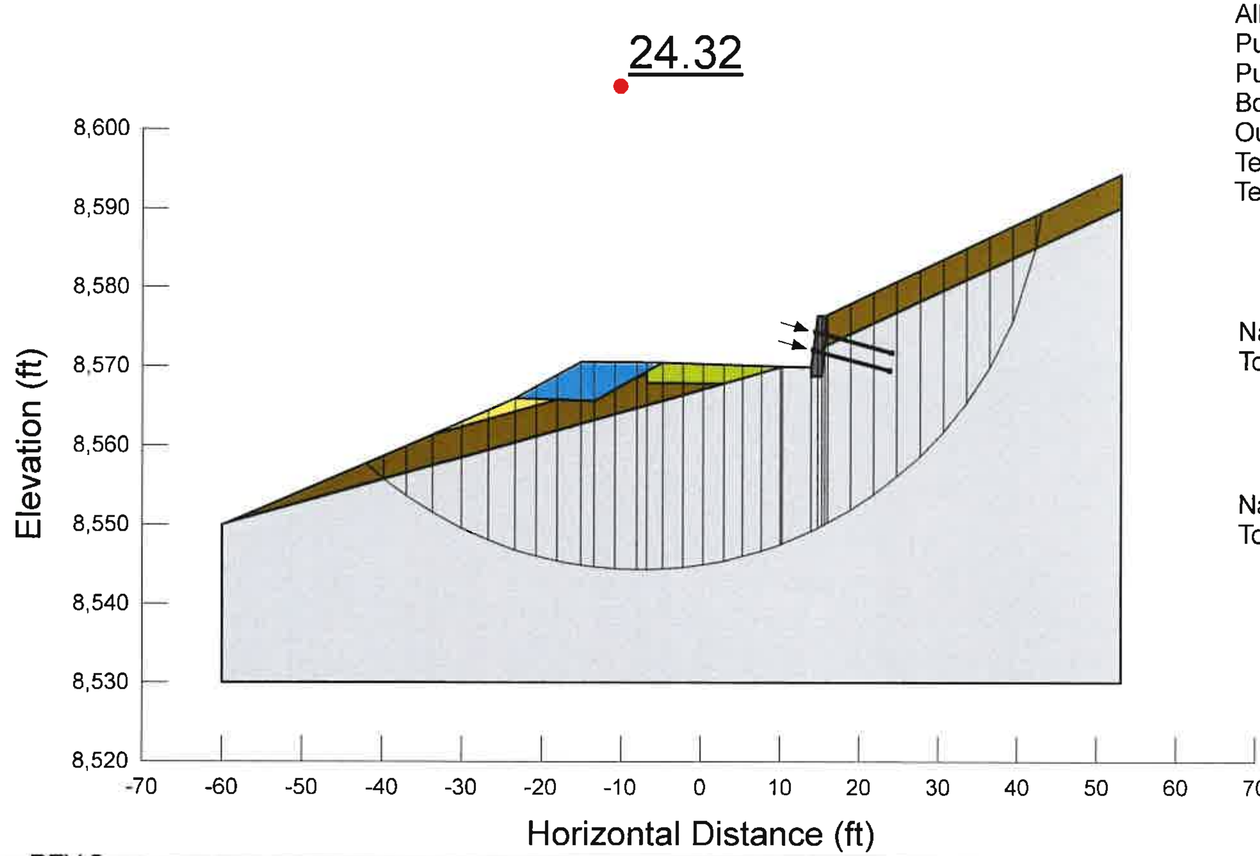
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section J
Static Analysis (Global)

			Weight (pcf)	(psf)	[illegible]
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



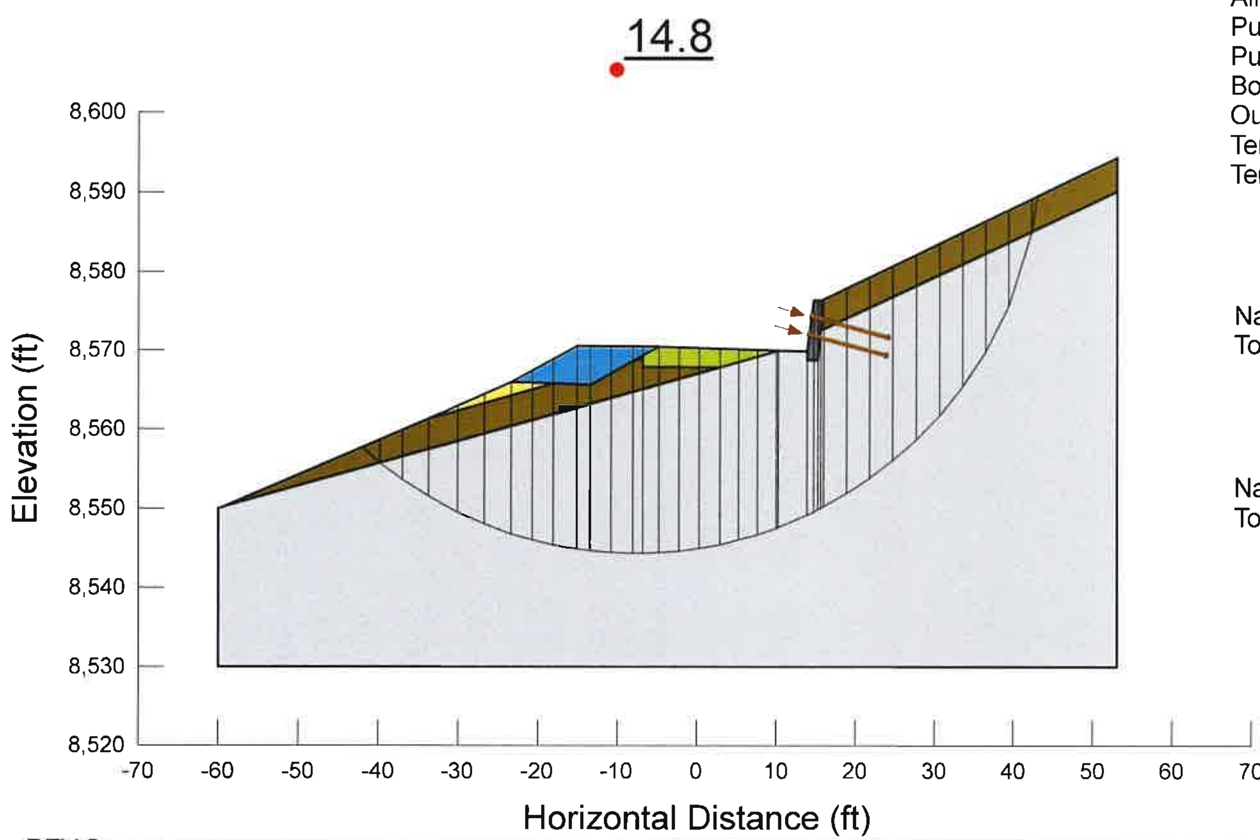
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section J
Pseudo-static Analysis, kh = 0.206 g (Global)

			Weight (pcf)	(psf)	(°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



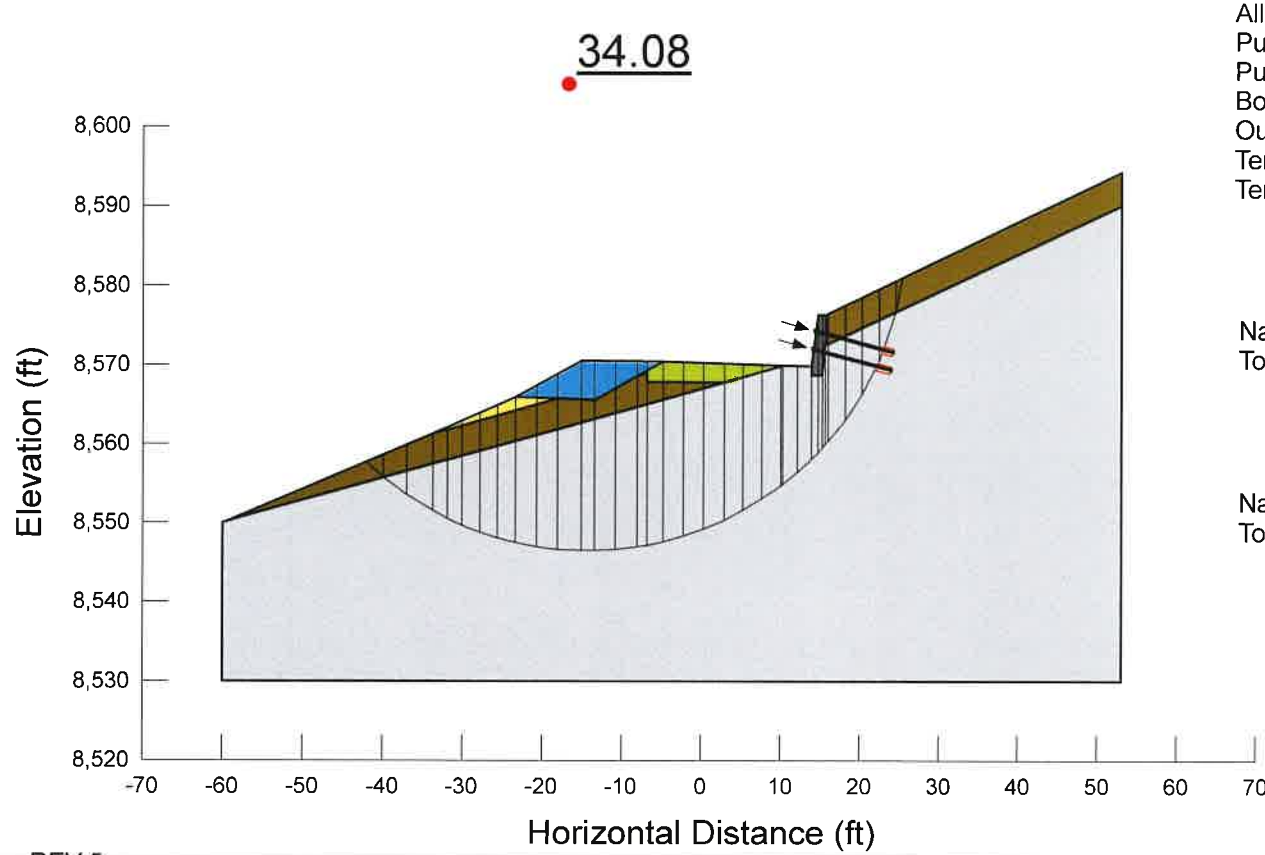
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section J
Static Analysis (Internal)

			Weight (pcf)	(psf)	(°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



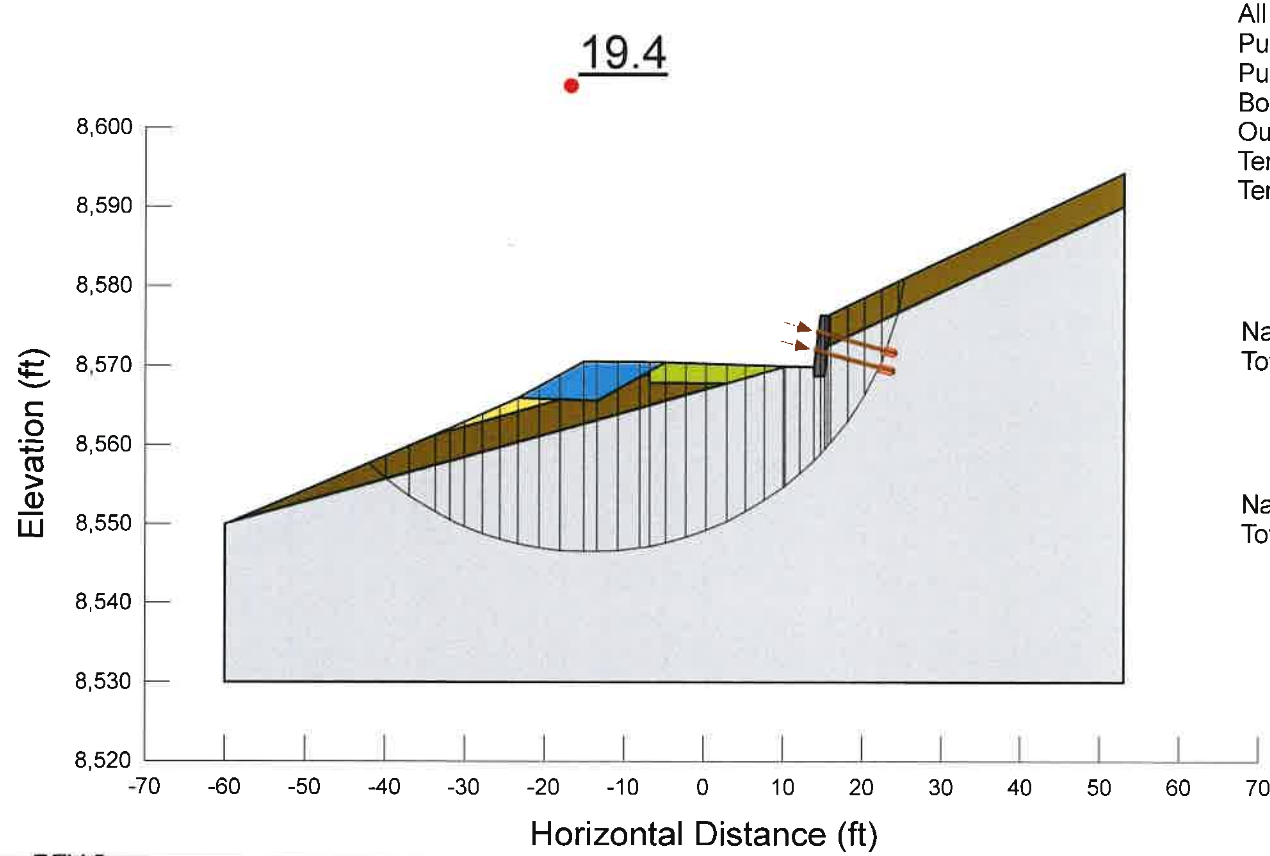
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section J
Pseudo-static Analysis, kh = 0.206 g (Internal)

			Weight (pcf)	(psf)	(°)
	af - artificial fill	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



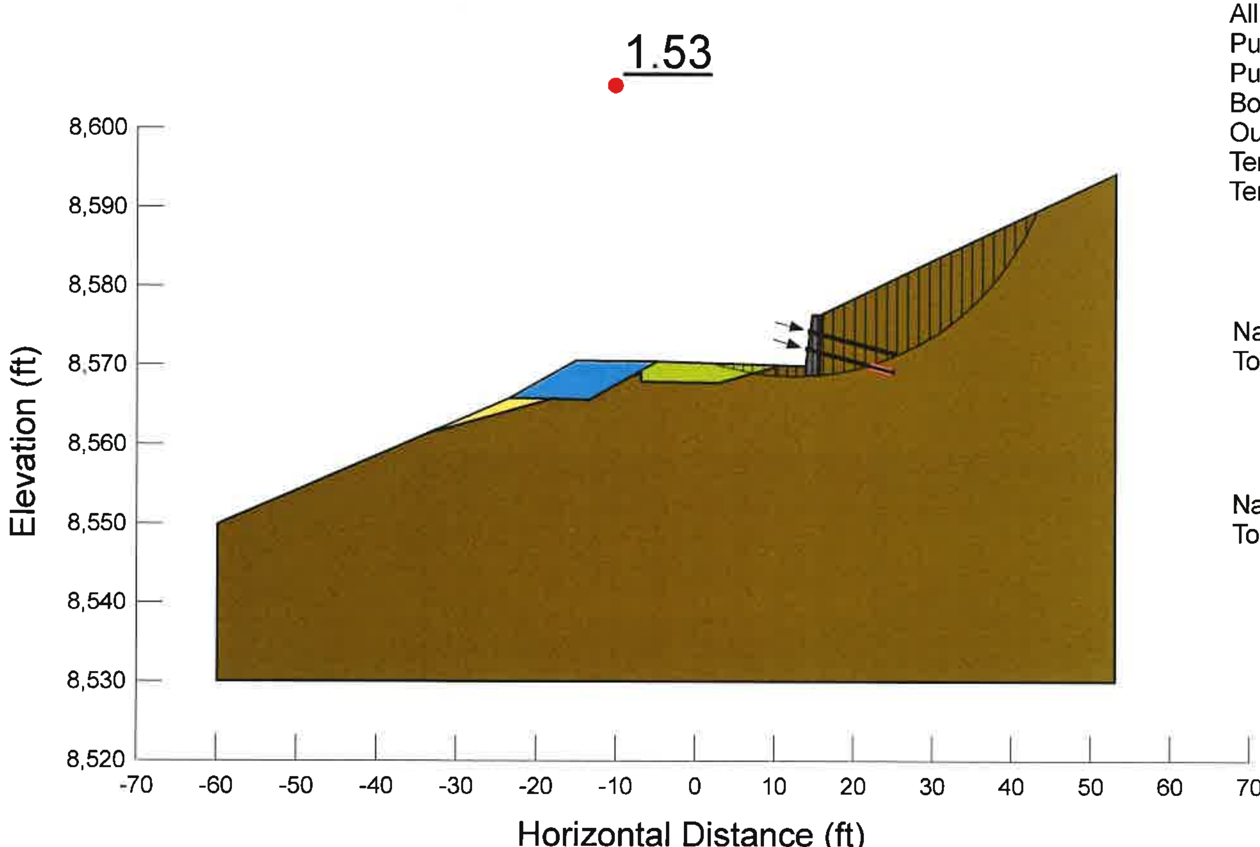
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section J
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Brown	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



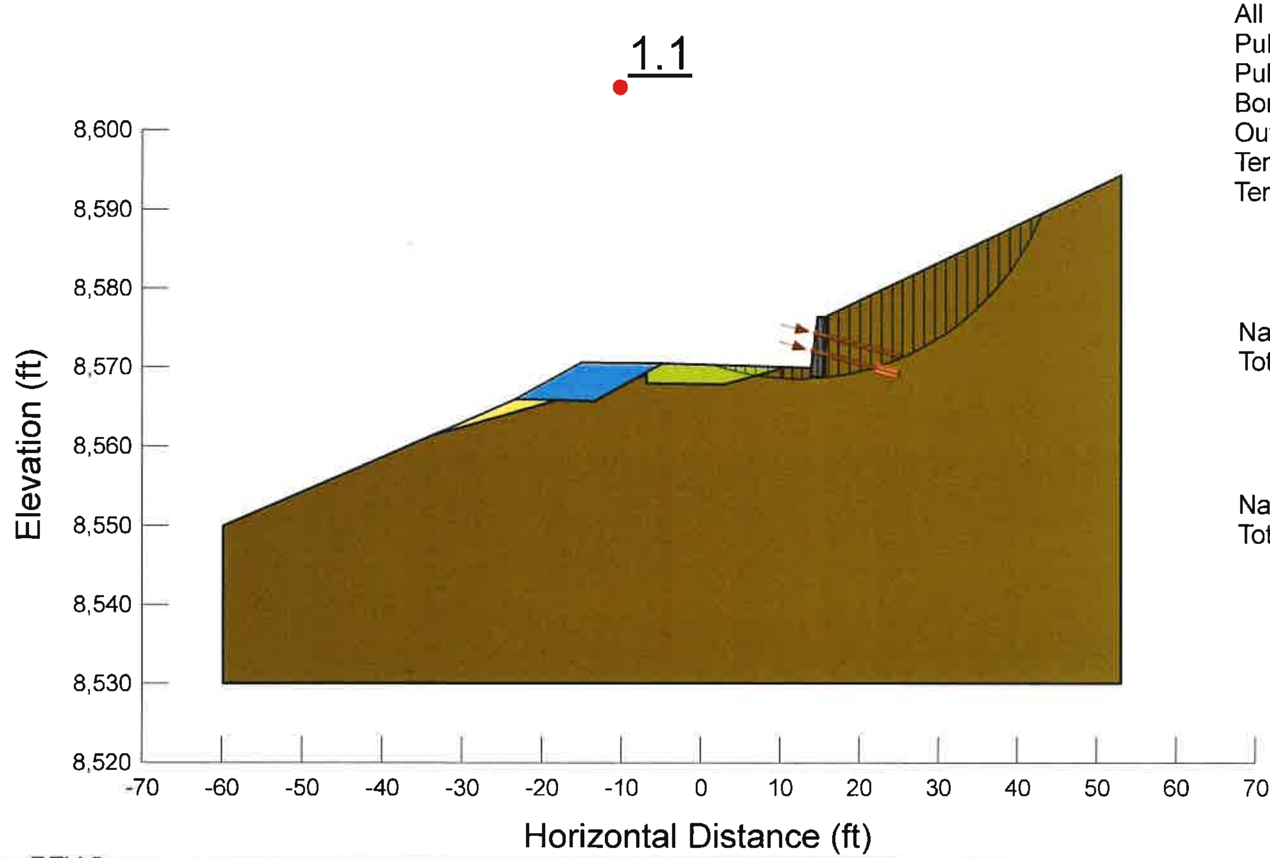
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 11 ft

Nail (Second Row):
Total Length: 11 ft

Reds Meadow Road Improvement
Cross Section J
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af - artificial fill	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Brown	Qts_ Non-pummice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



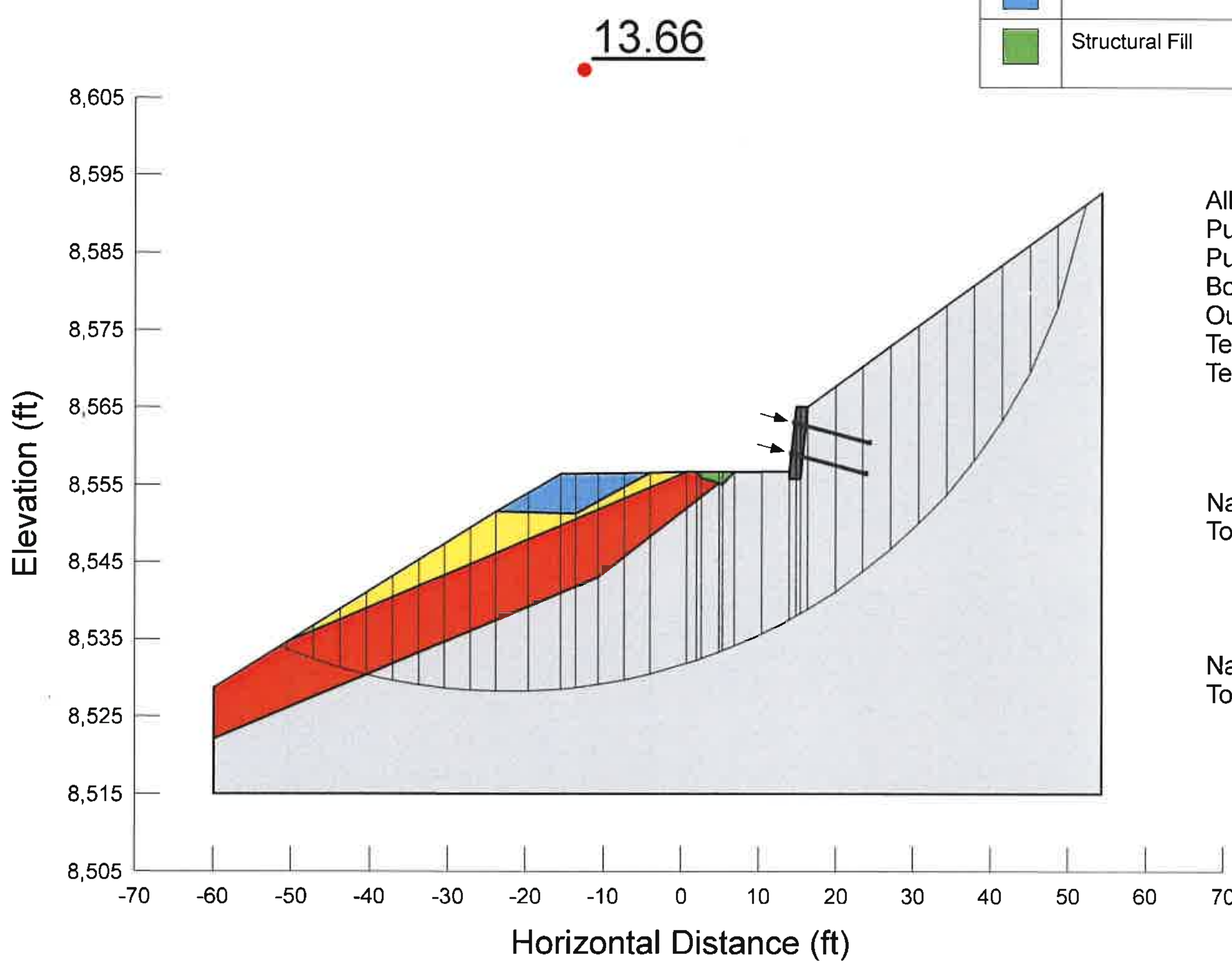
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 10 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 11 ft

Nail (Second Row):
Total Length: 11 ft

Reds Meadow Road Improvement
Cross Section K
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



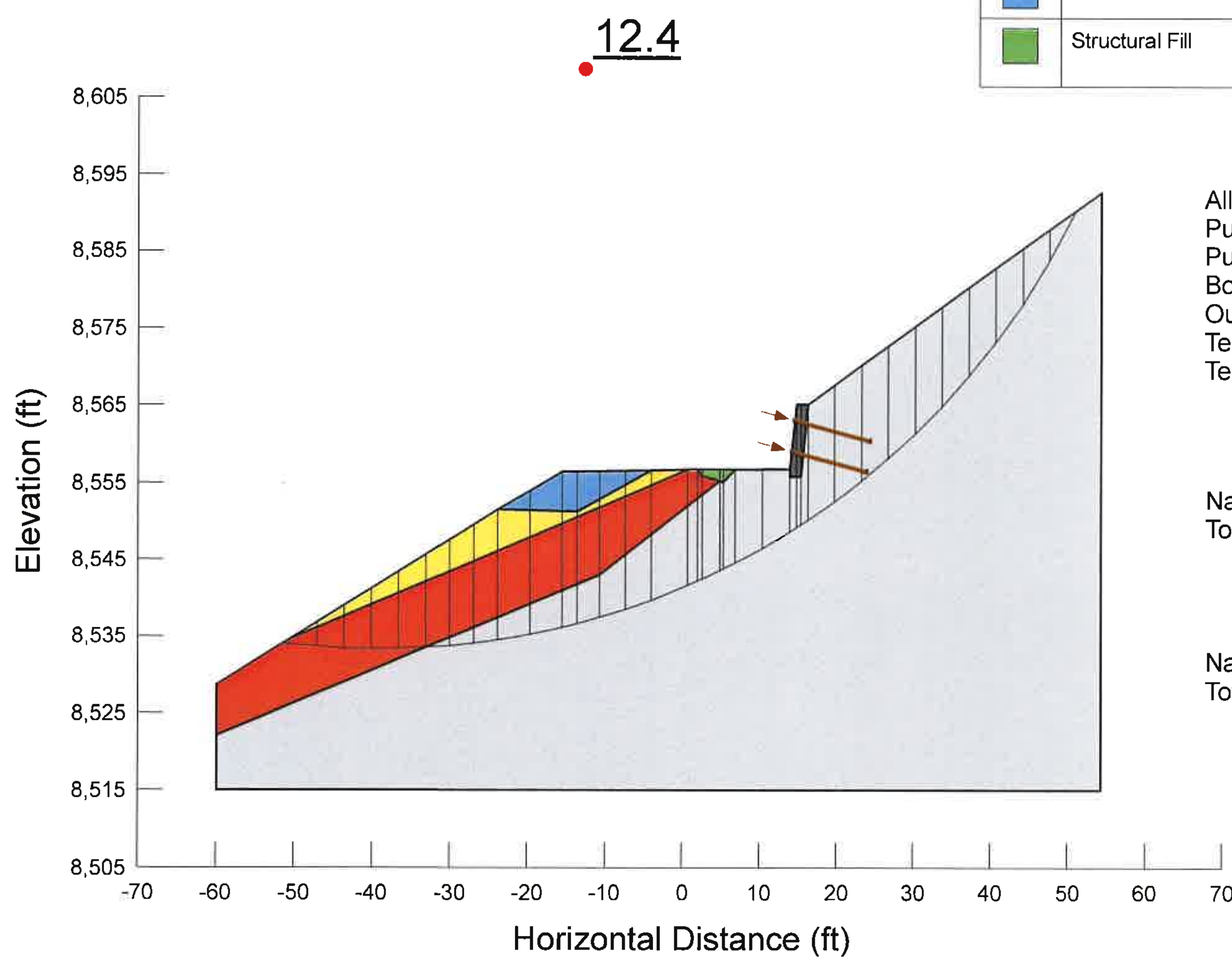
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section K
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



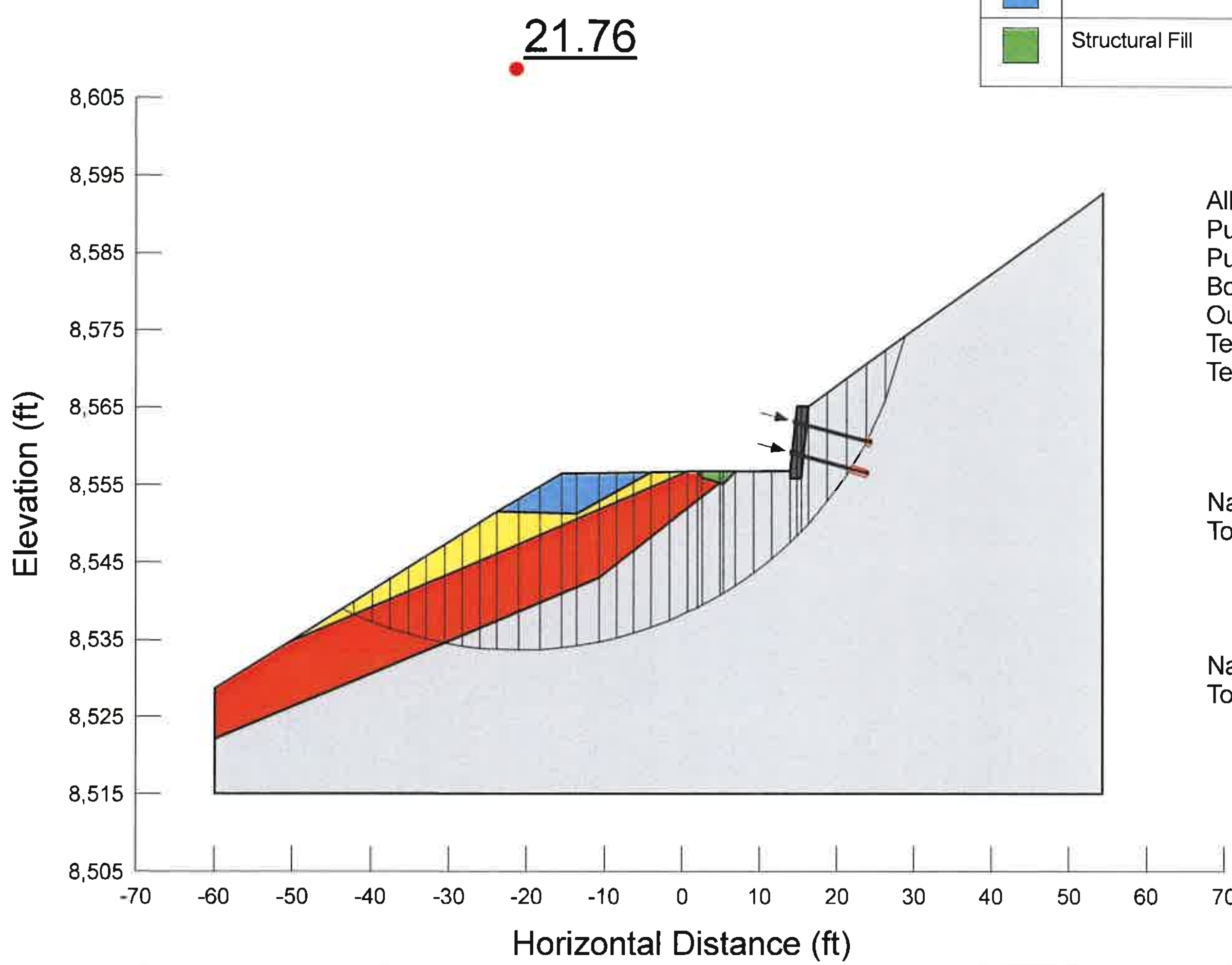
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section K
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



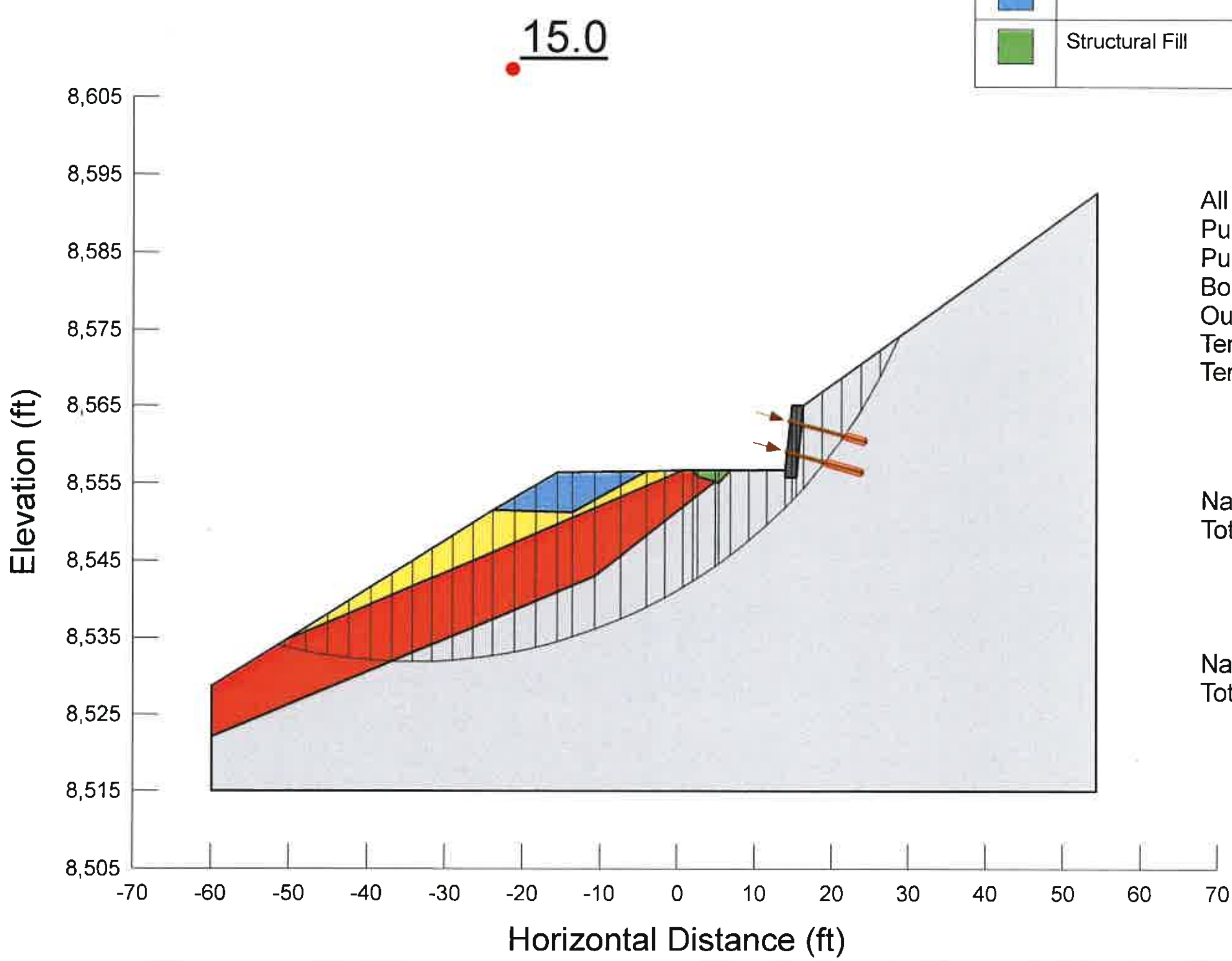
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section K
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



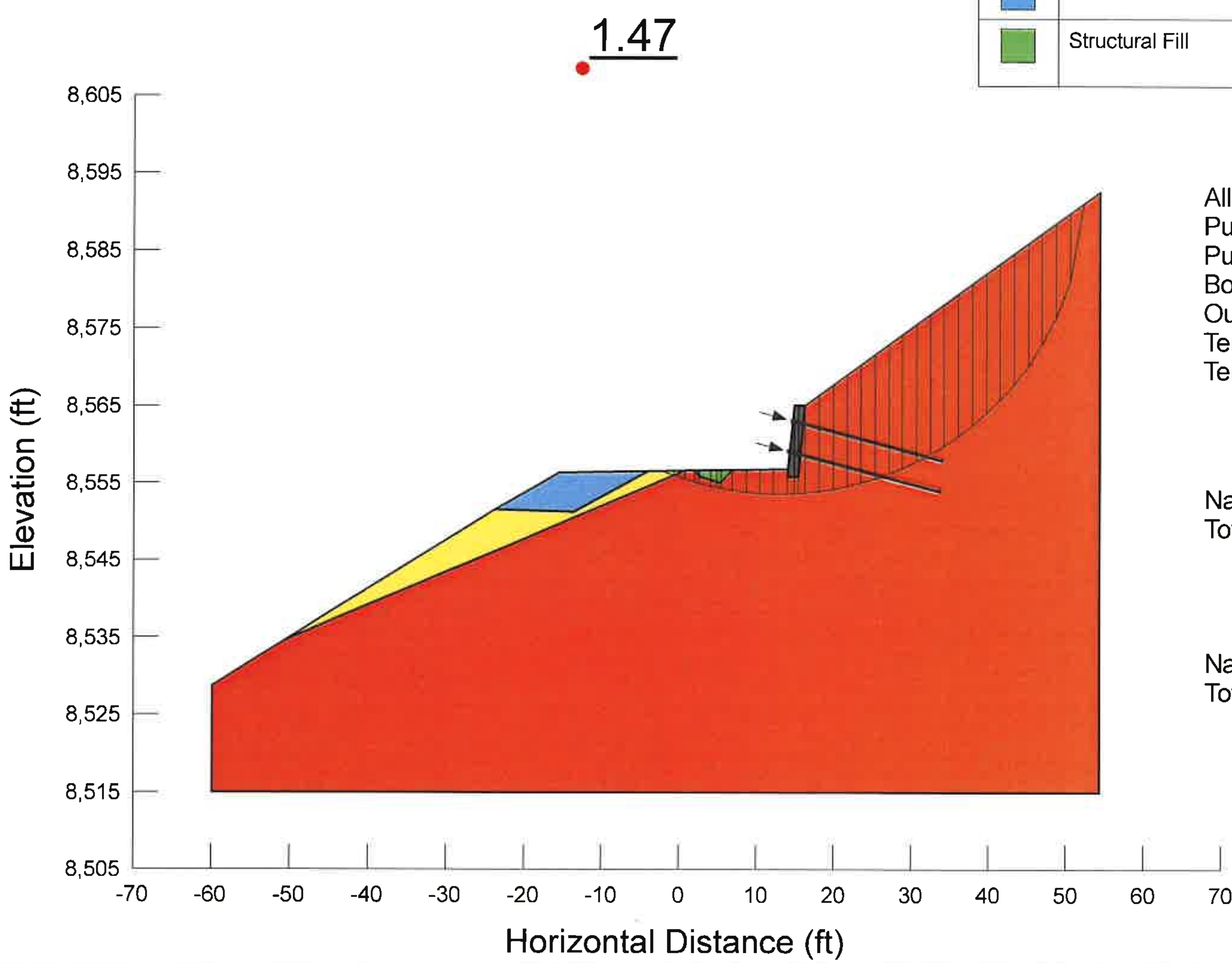
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section K
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



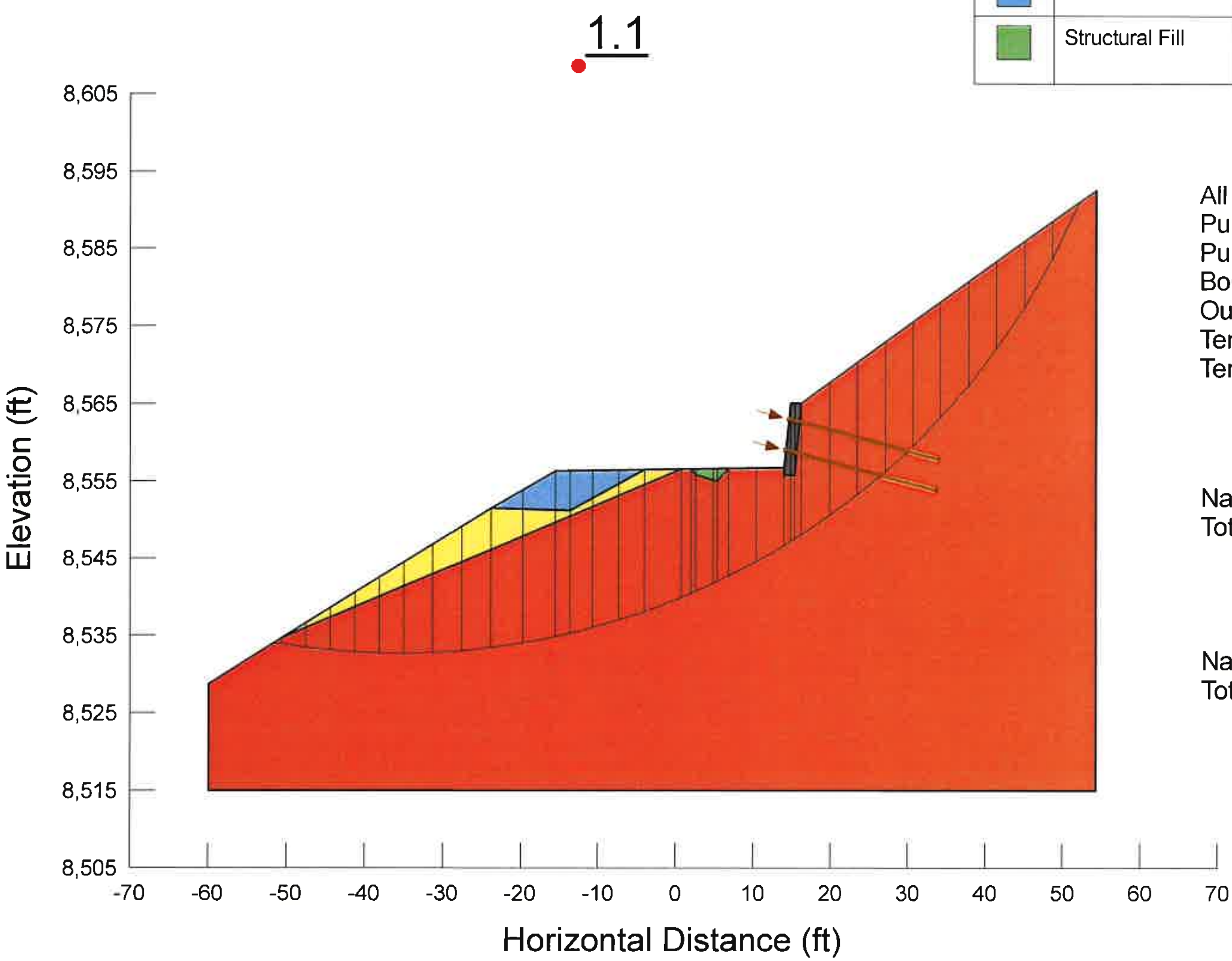
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 20 ft

Nail (Second Row):
Total Length: 20 ft

Reds Meadow Road Improvement
Cross Section K
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



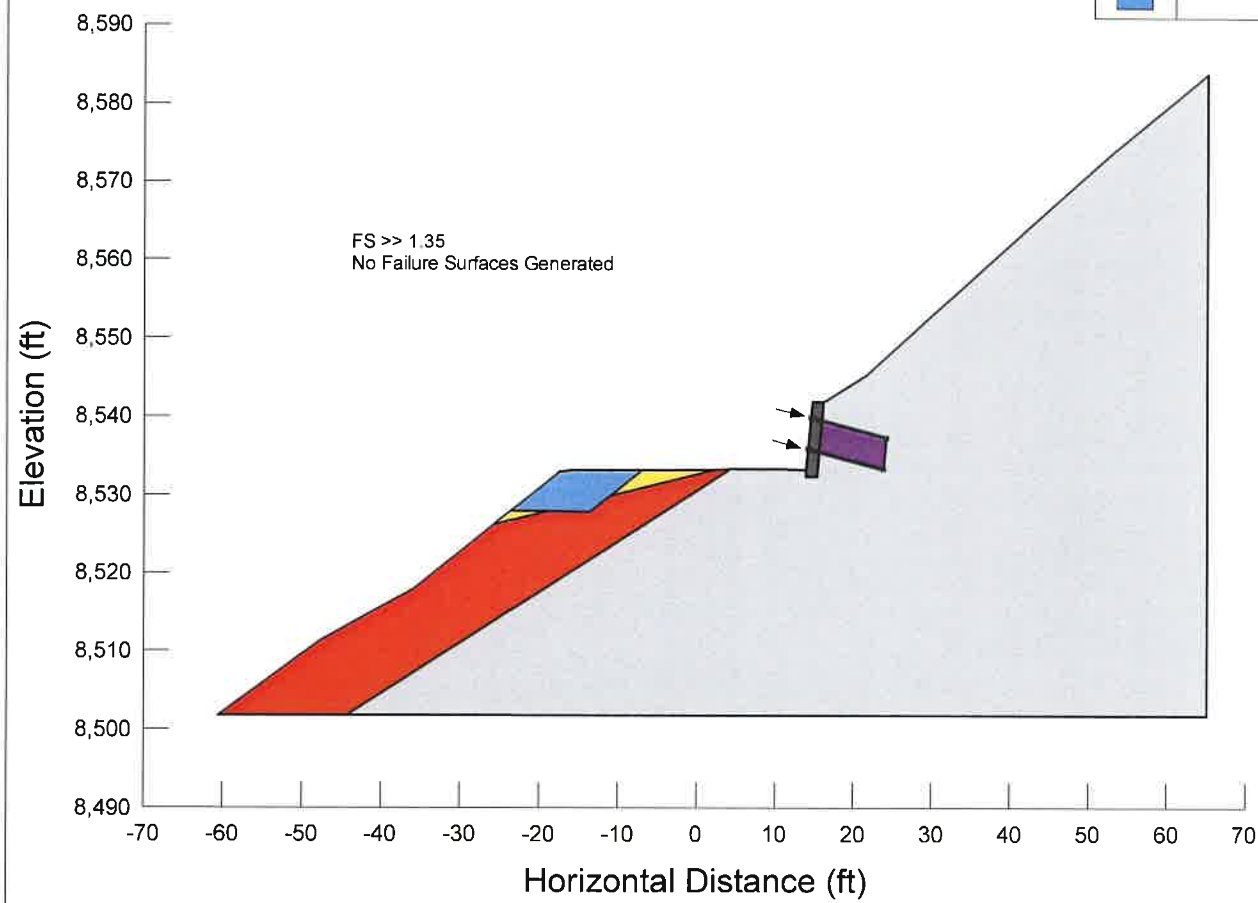
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 20 ft

Nail (Second Row):
Total Length: 20 ft

Reds Meadow Road Improvement
Cross Section N
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	High Strength Zone	High Strength	145		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		



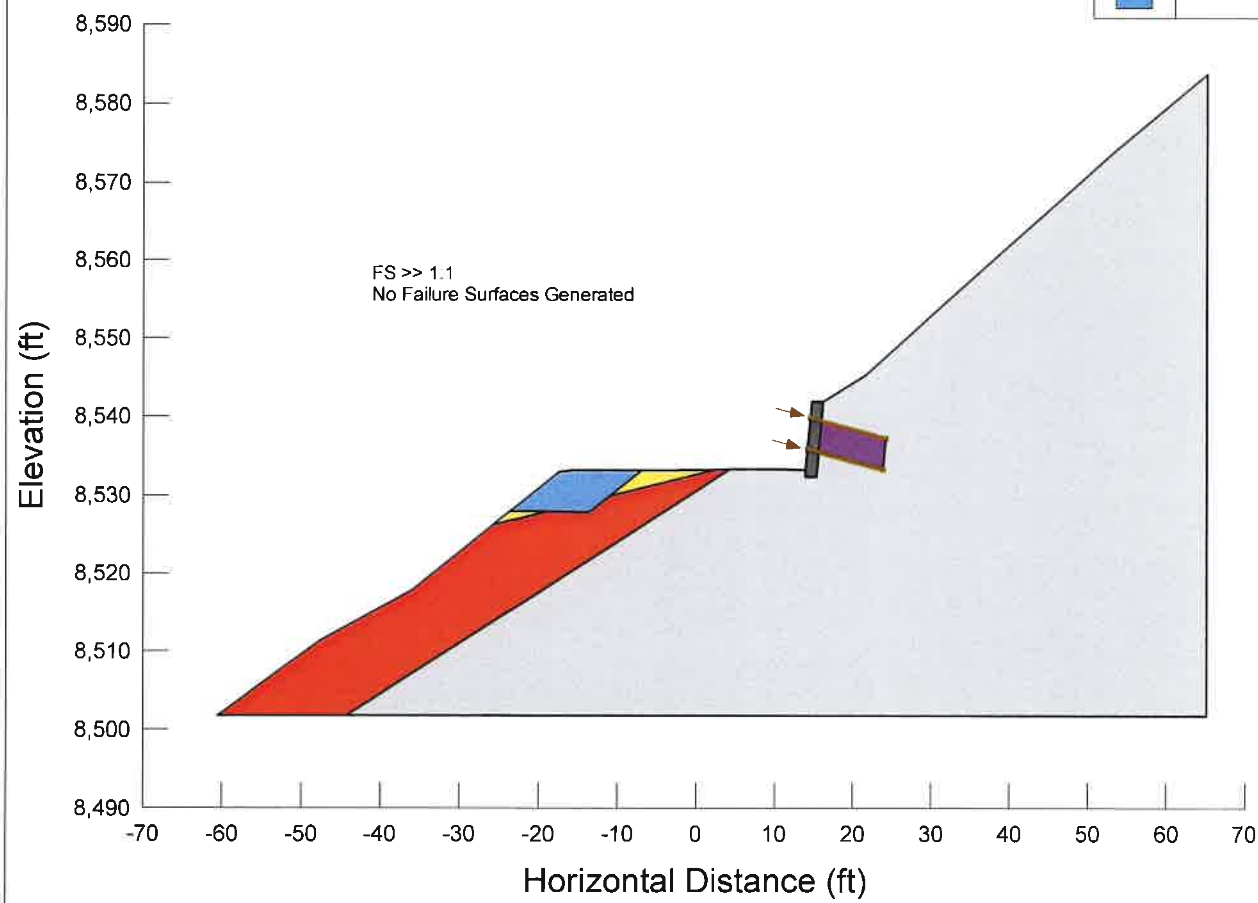
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section N
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Purple	High Strength Zone	High Strength	145		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



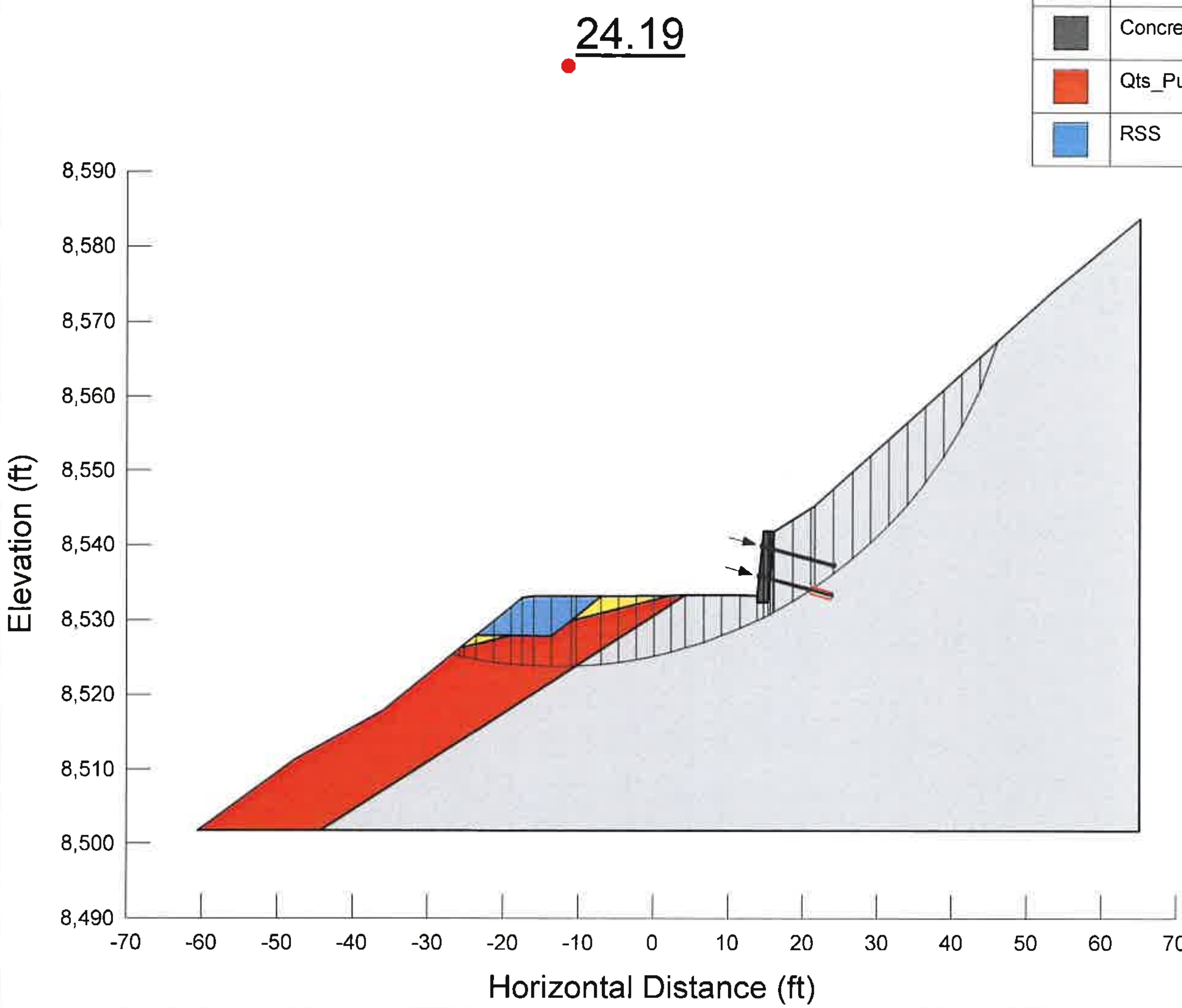
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section N
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



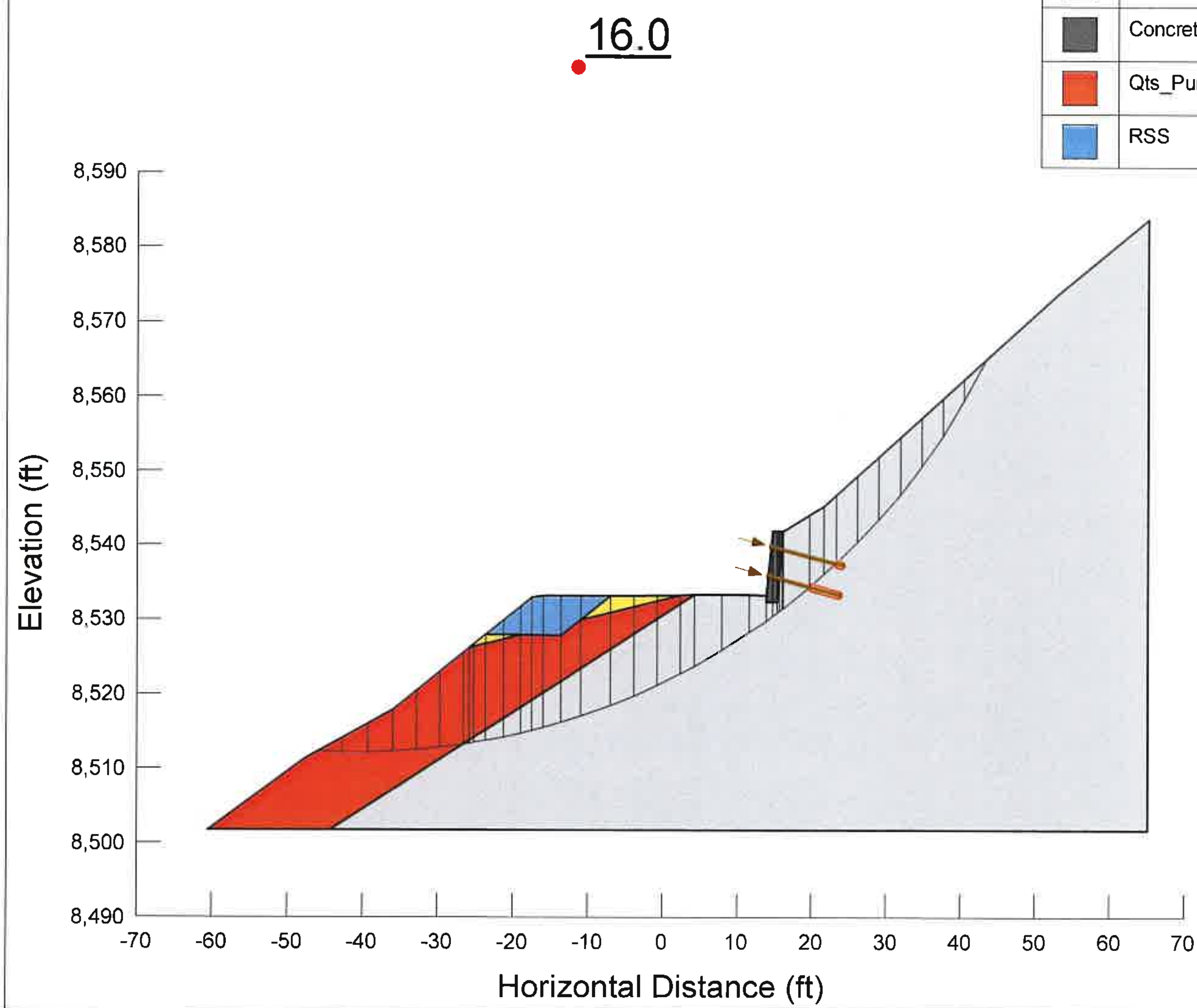
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section N
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



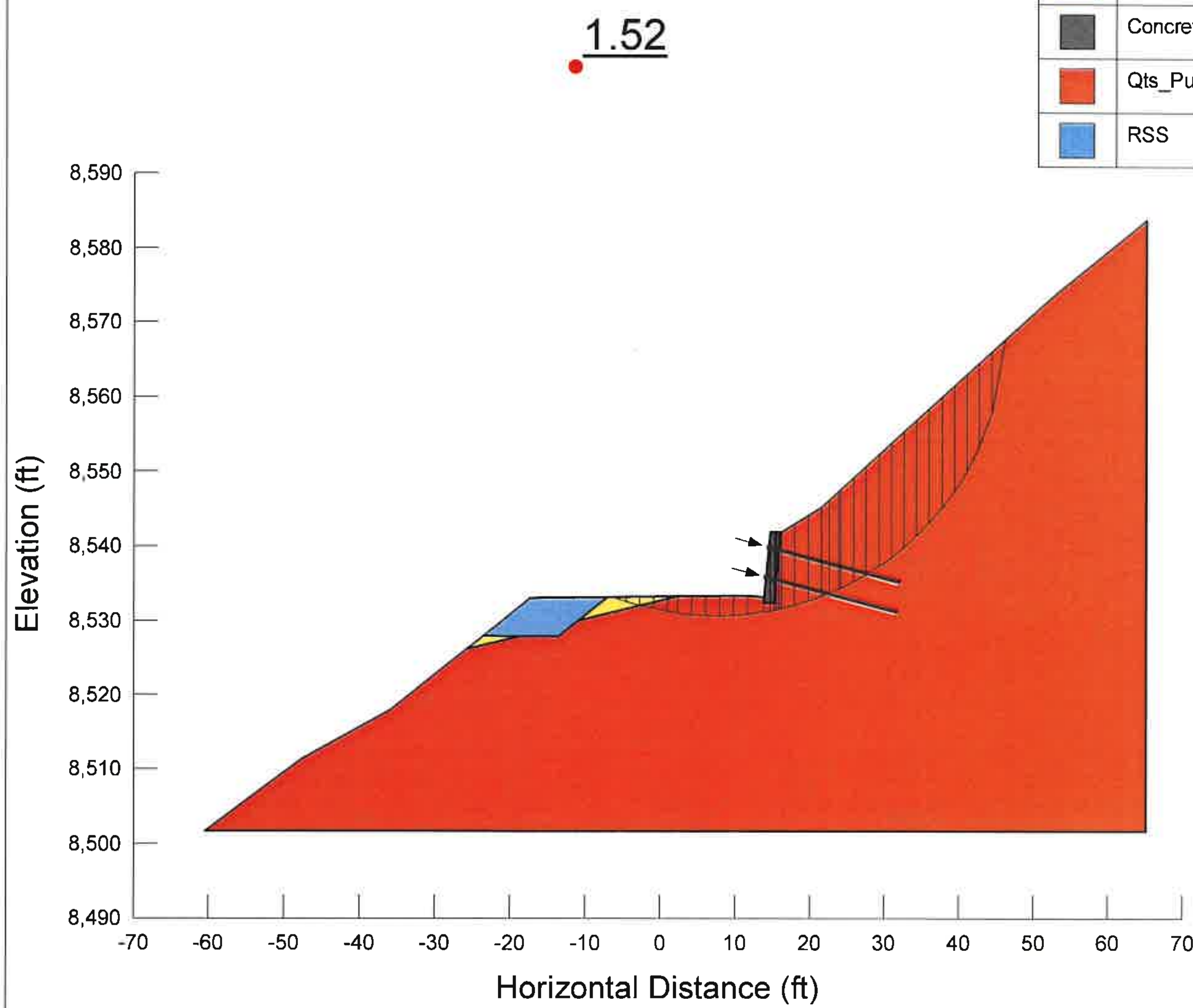
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section N
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



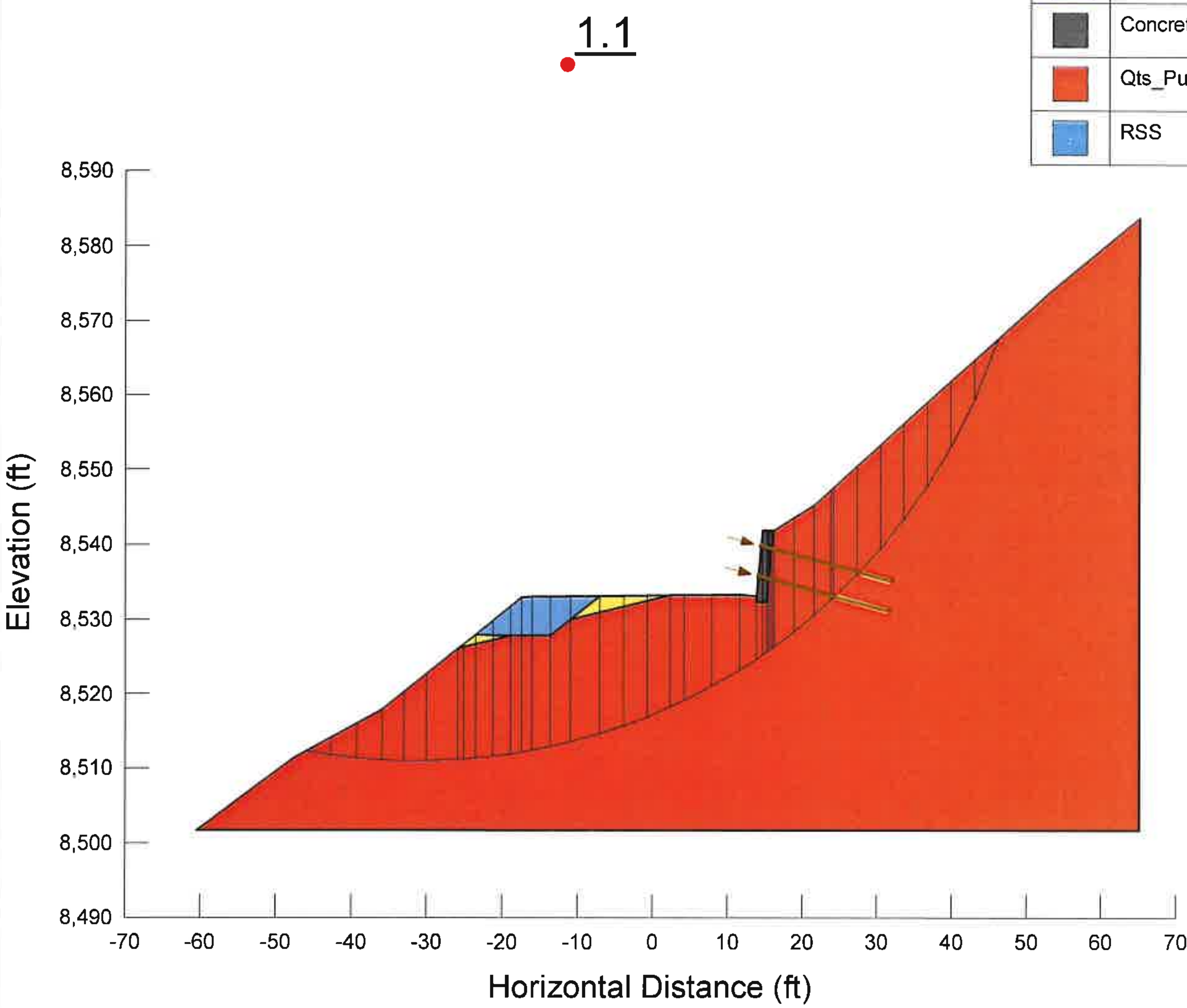
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 18 ft

Nail (Second Row):
Total Length: 18 ft

Reds Meadow Road Improvement
Cross Section N
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		



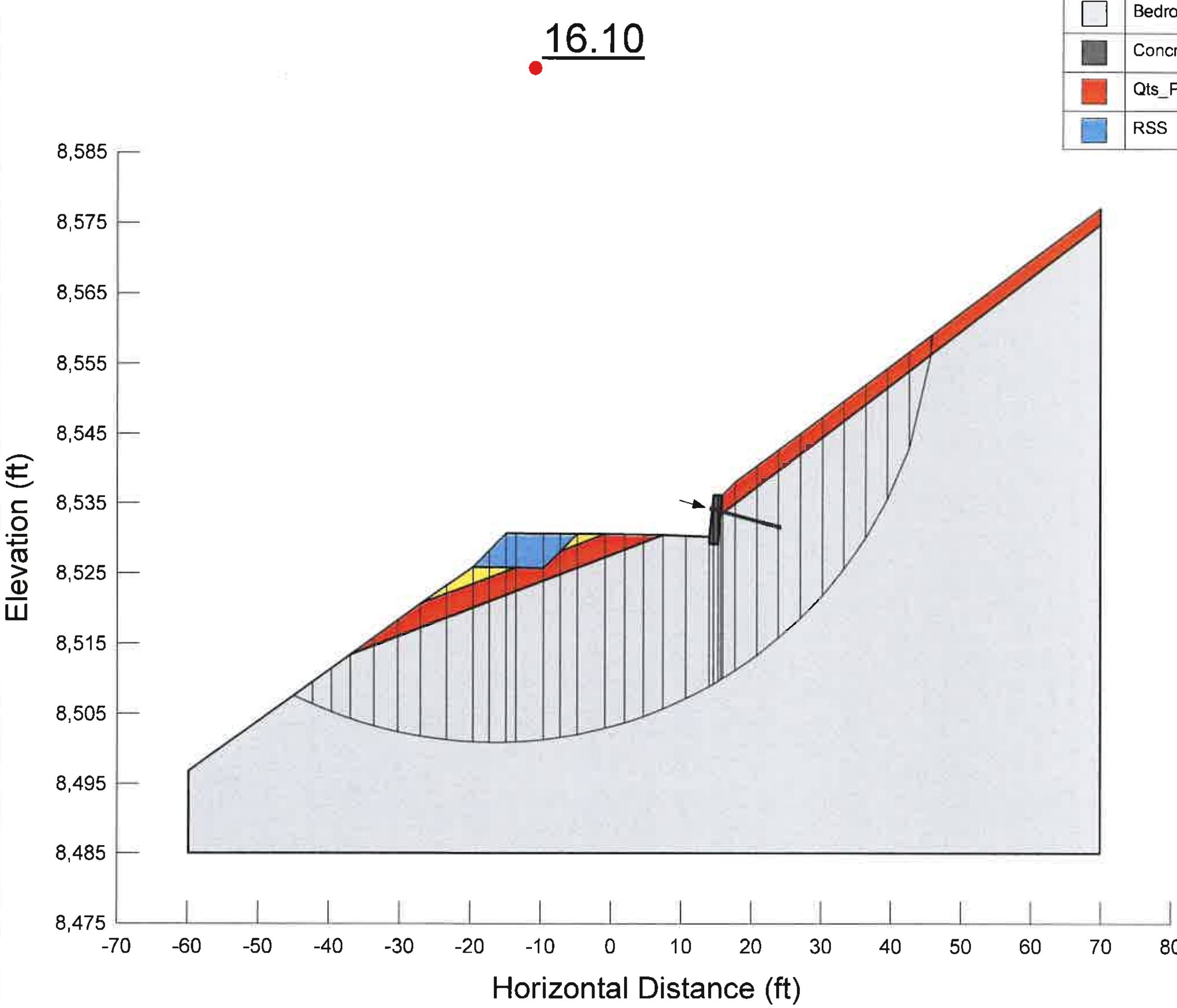
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 18 ft

Nail (Second Row):
Total Length: 18 ft

Reds Meadow Road Improvement
Cross Section O
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		

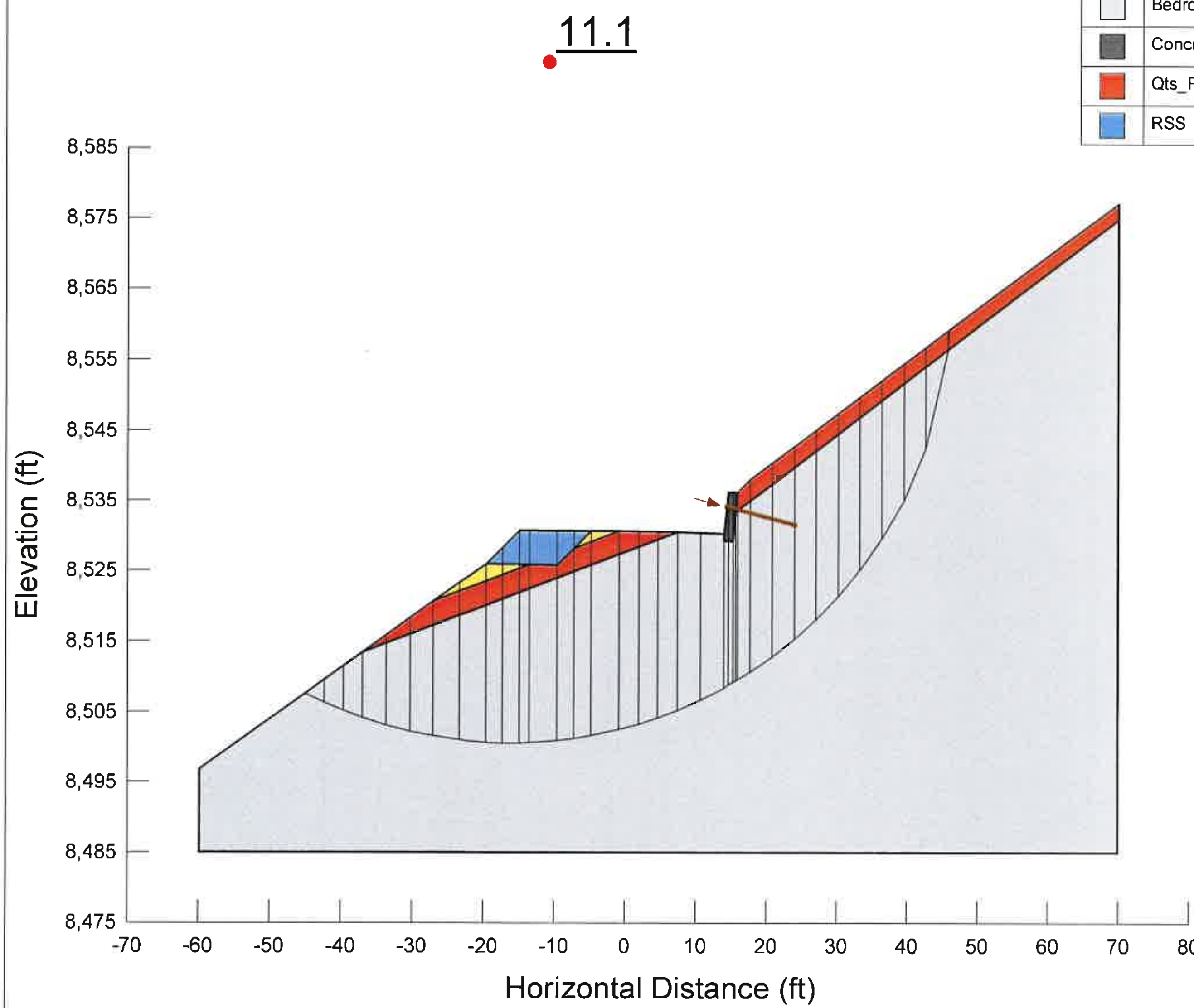


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section O
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		

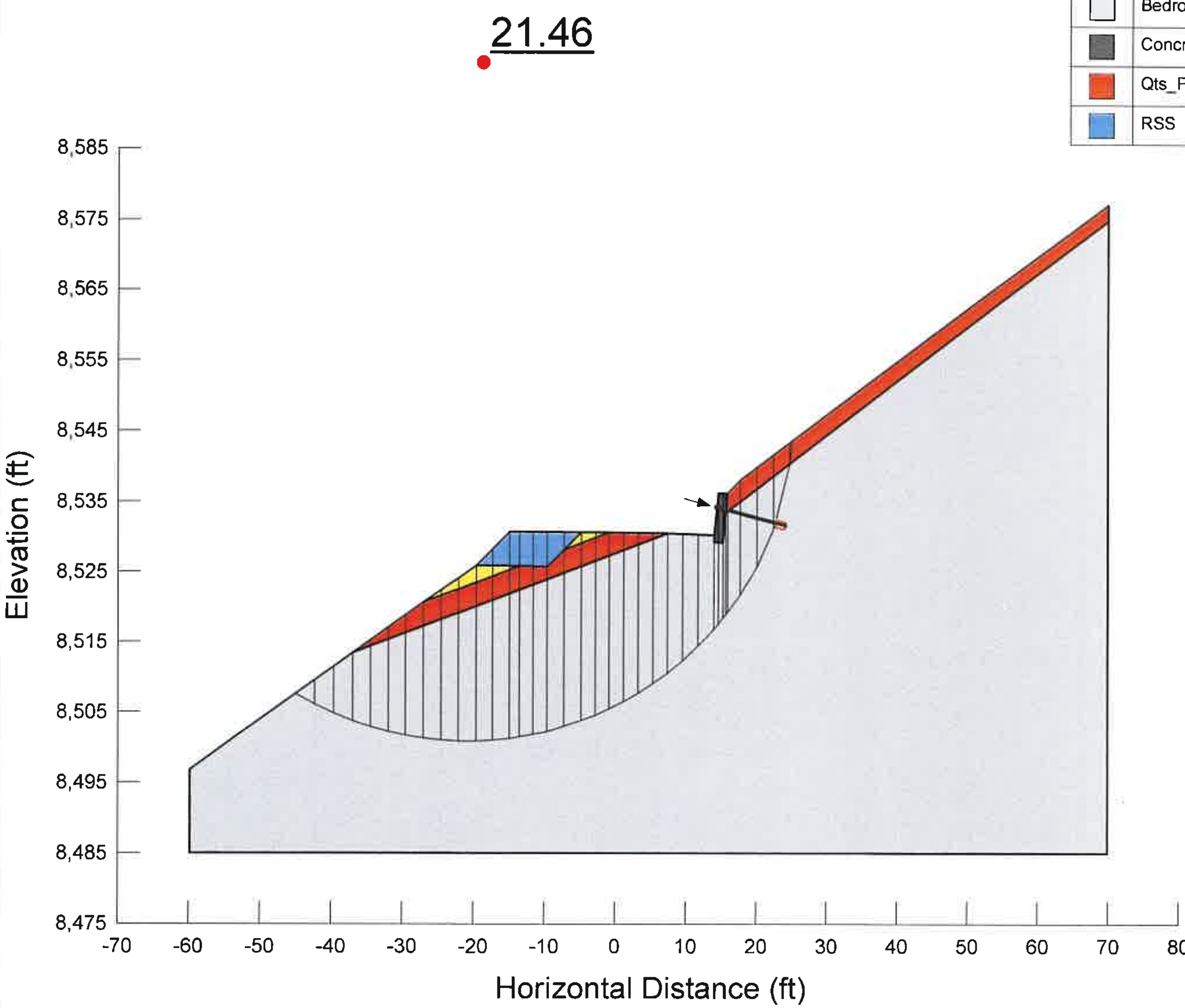


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section O
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		

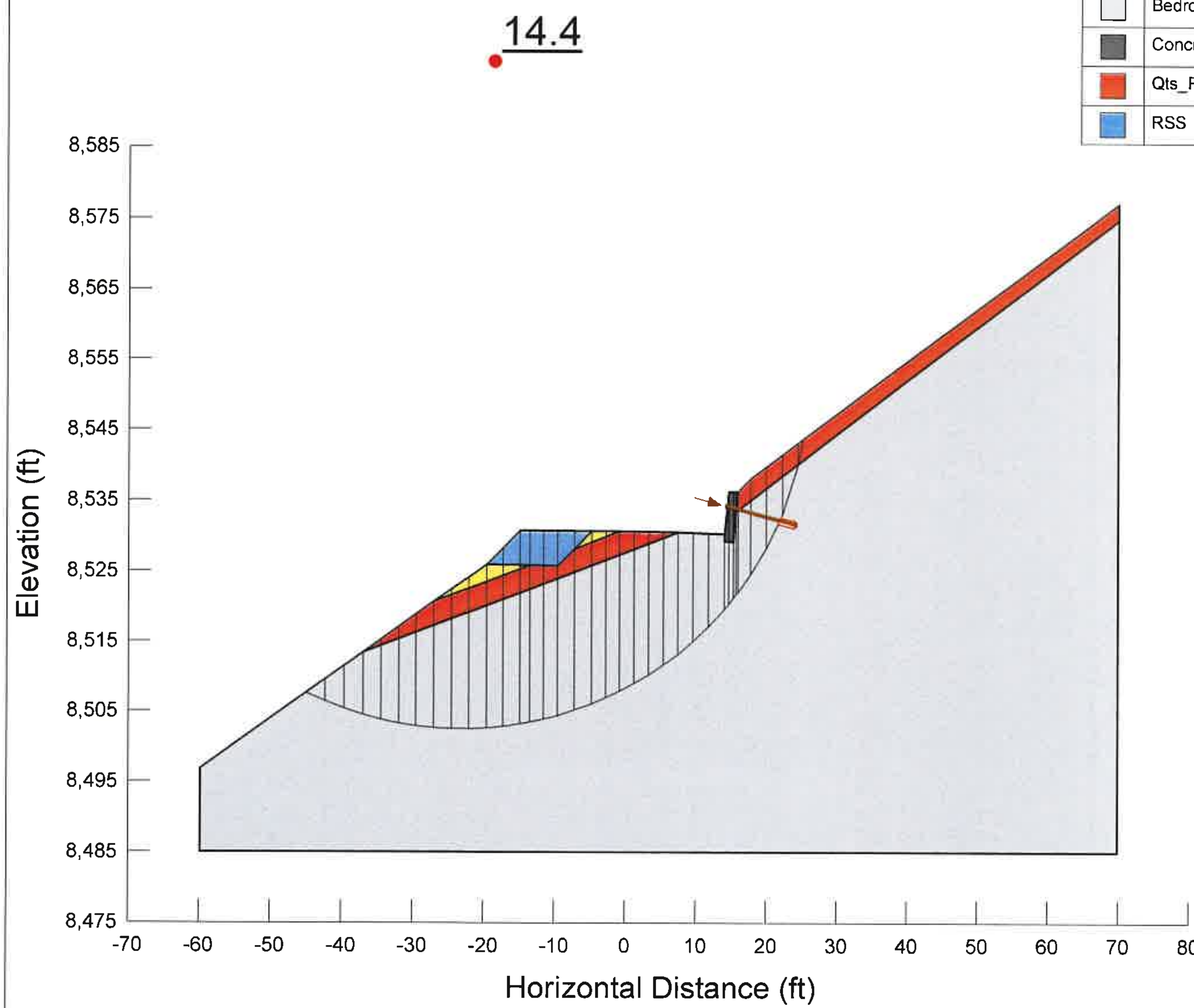


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section O
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		

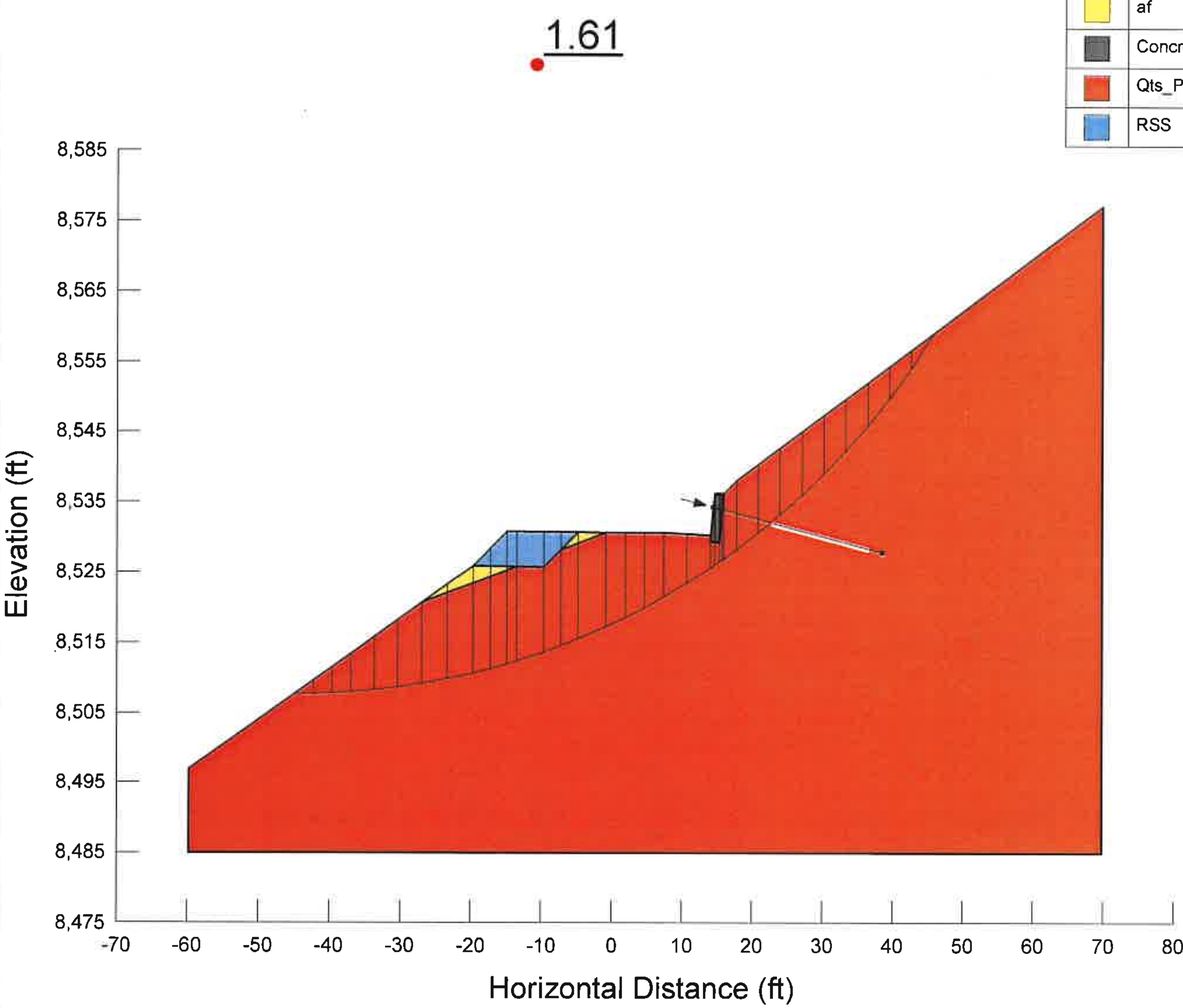


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section O
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(grey)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		

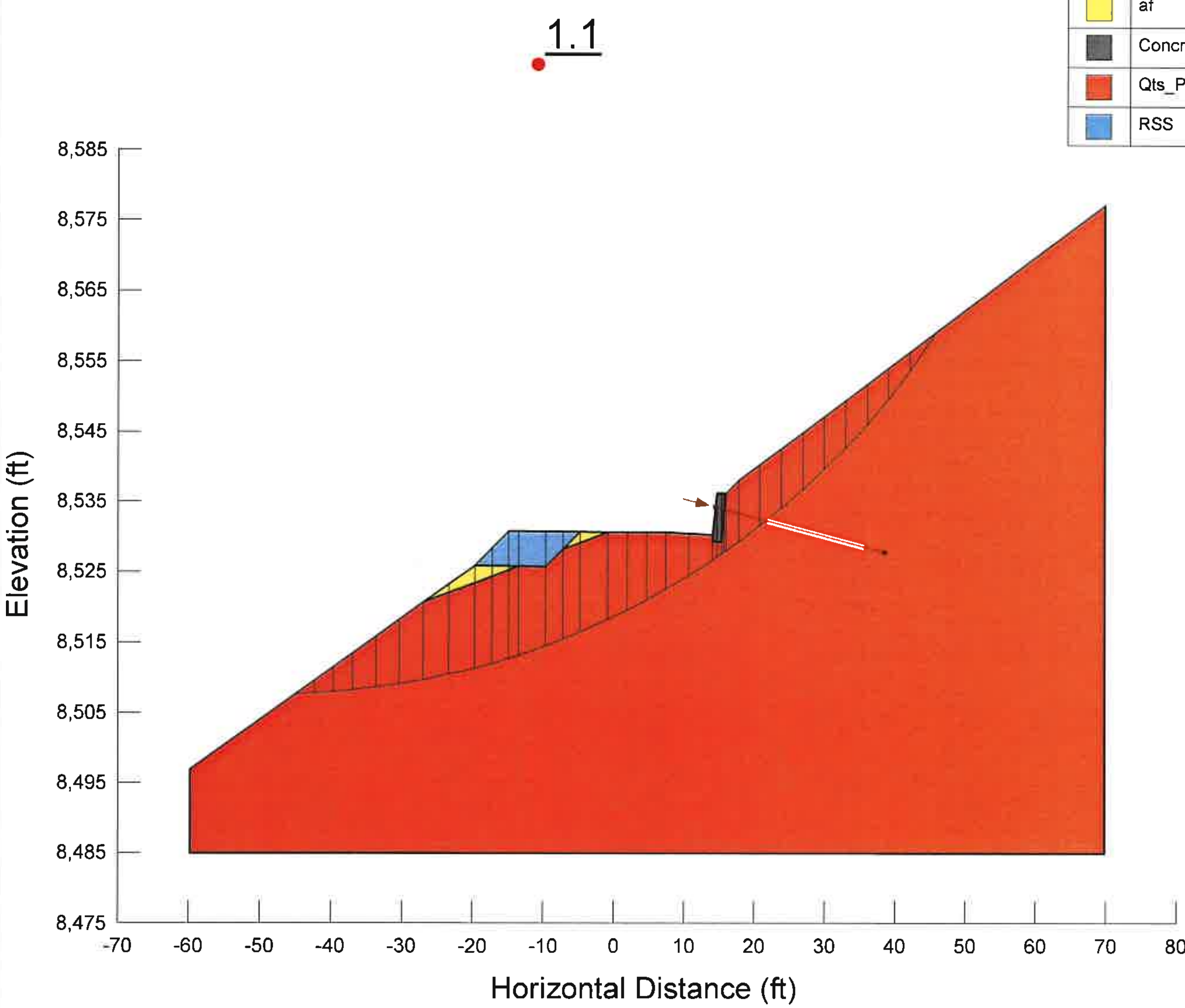


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 25 ft

Reds Meadow Road Improvement
Cross Section O
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		

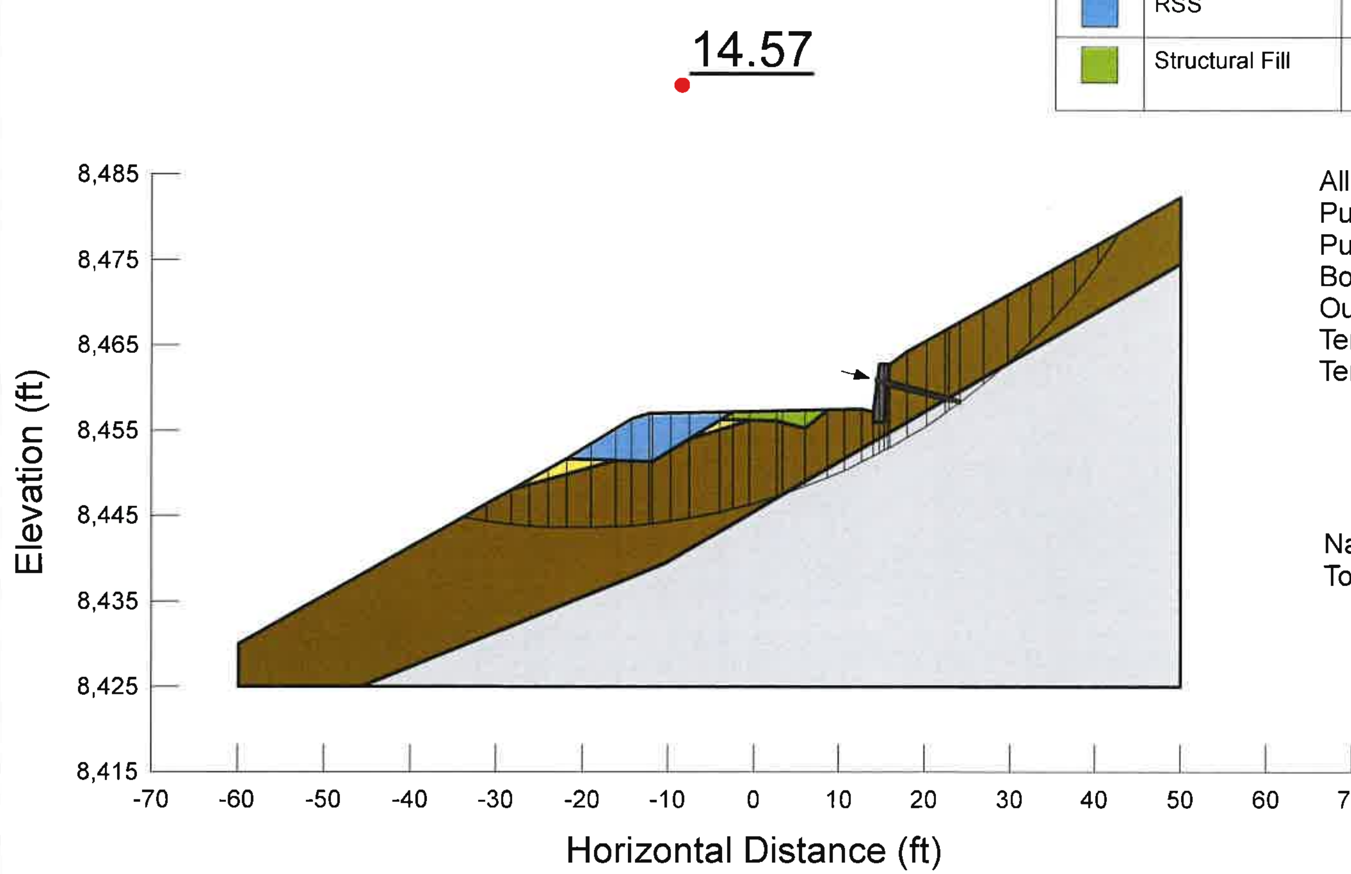


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 25 ft

Reds Meadow Road Improvement
Cross Section Q
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	High Strength Zone	High Strength	120		
	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34

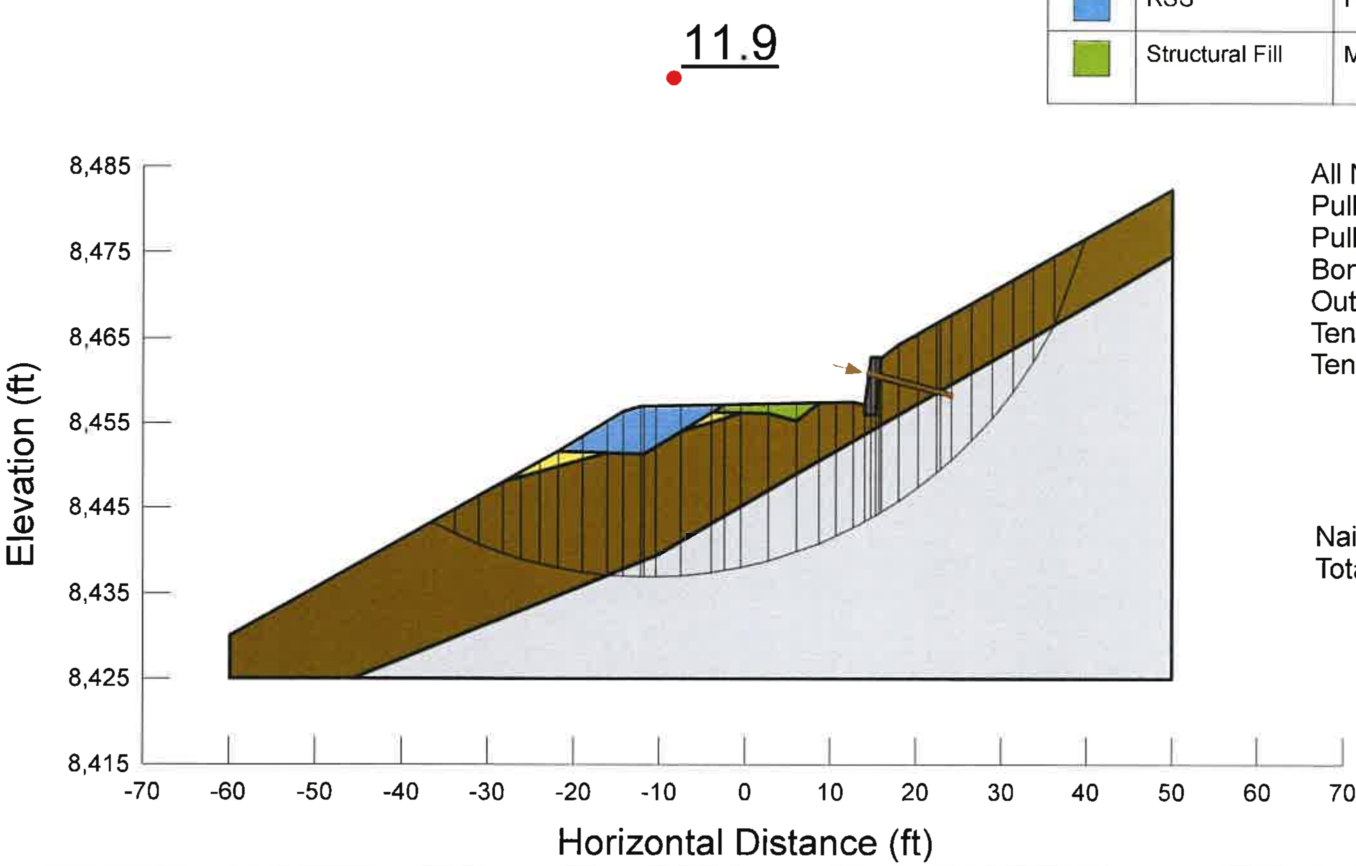


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section Q
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	High Strength Zone	High Strength	120		
	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34

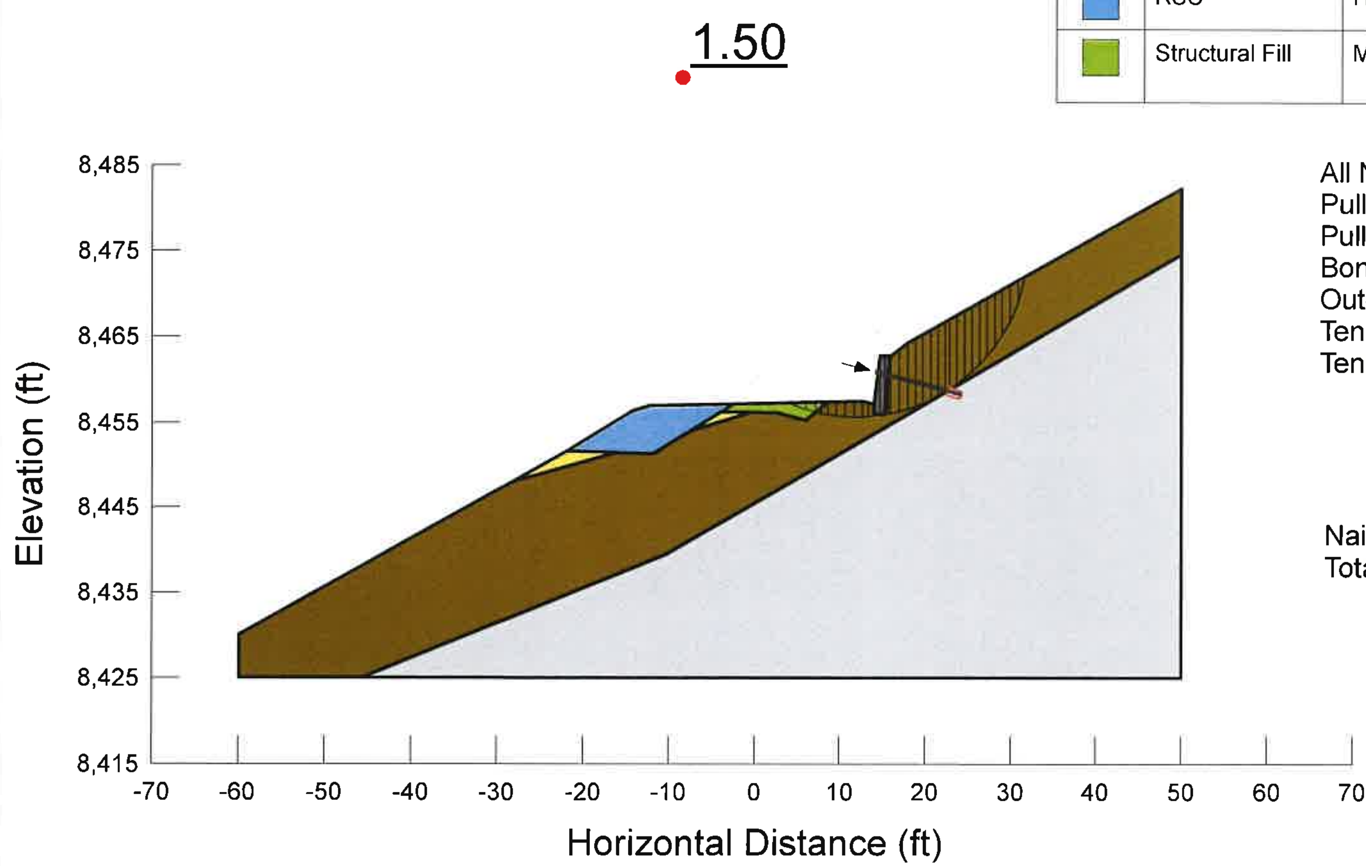


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section Q
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Brown	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34

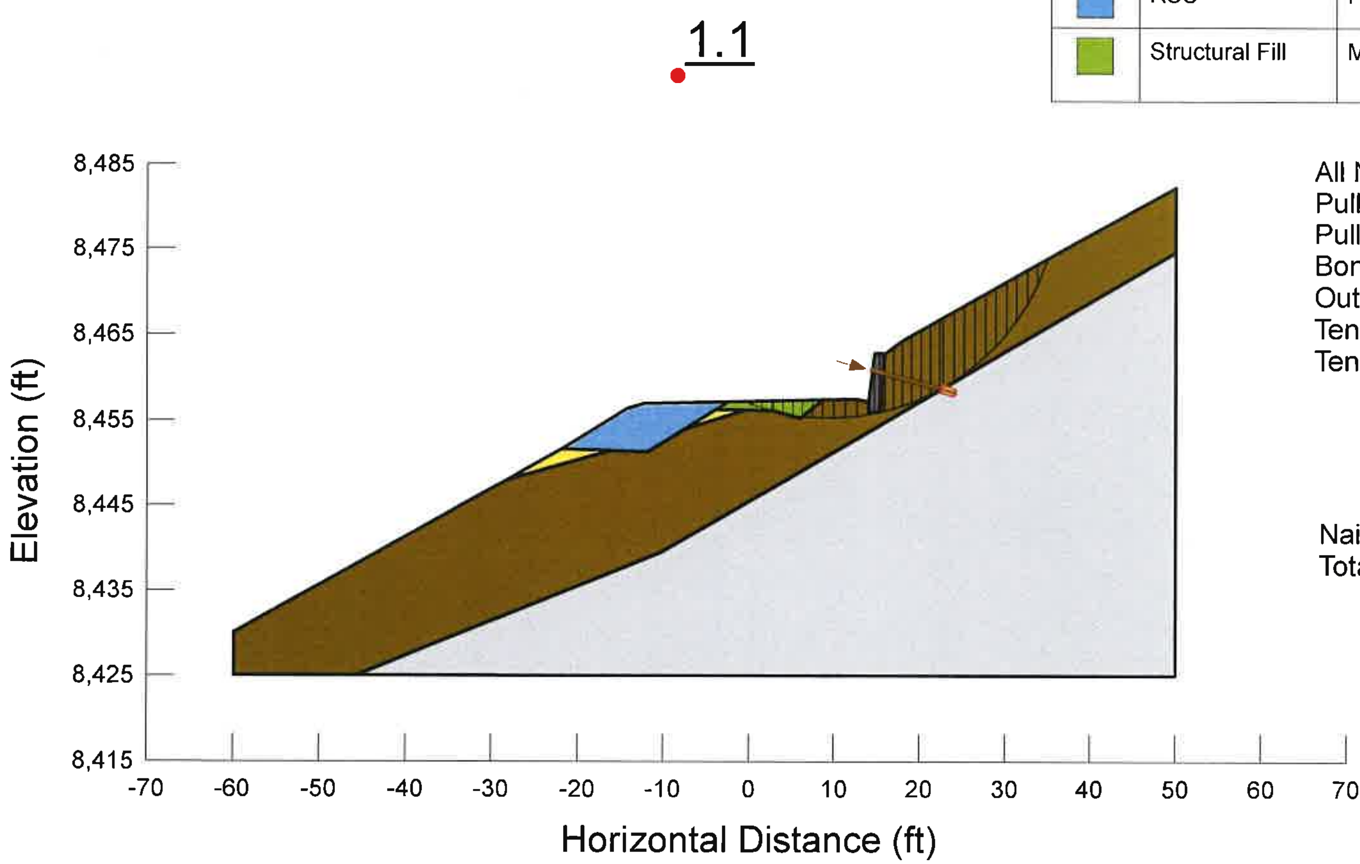


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section Q
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34

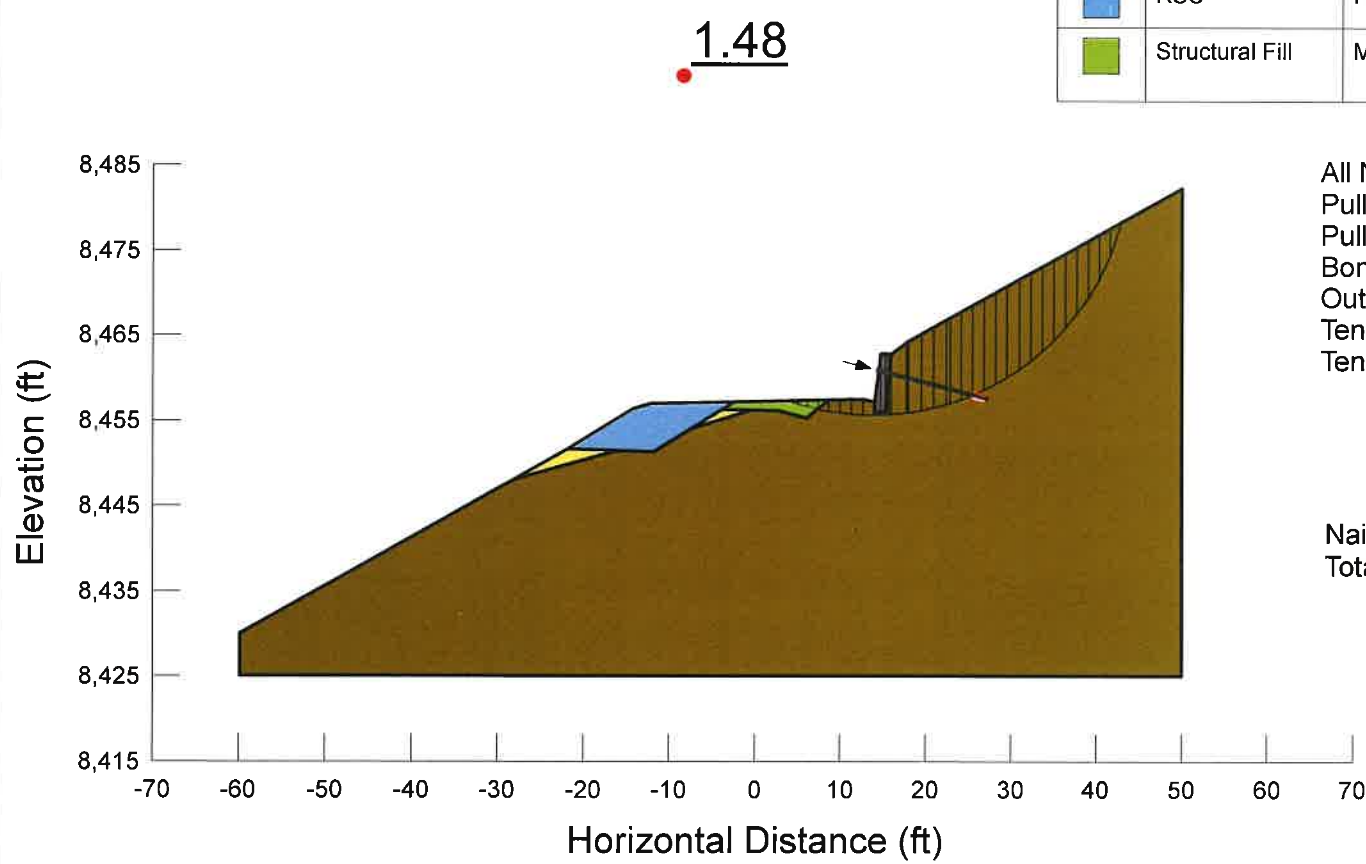


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section Q
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Gray	Concrete	High Strength	150		
Brown	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34

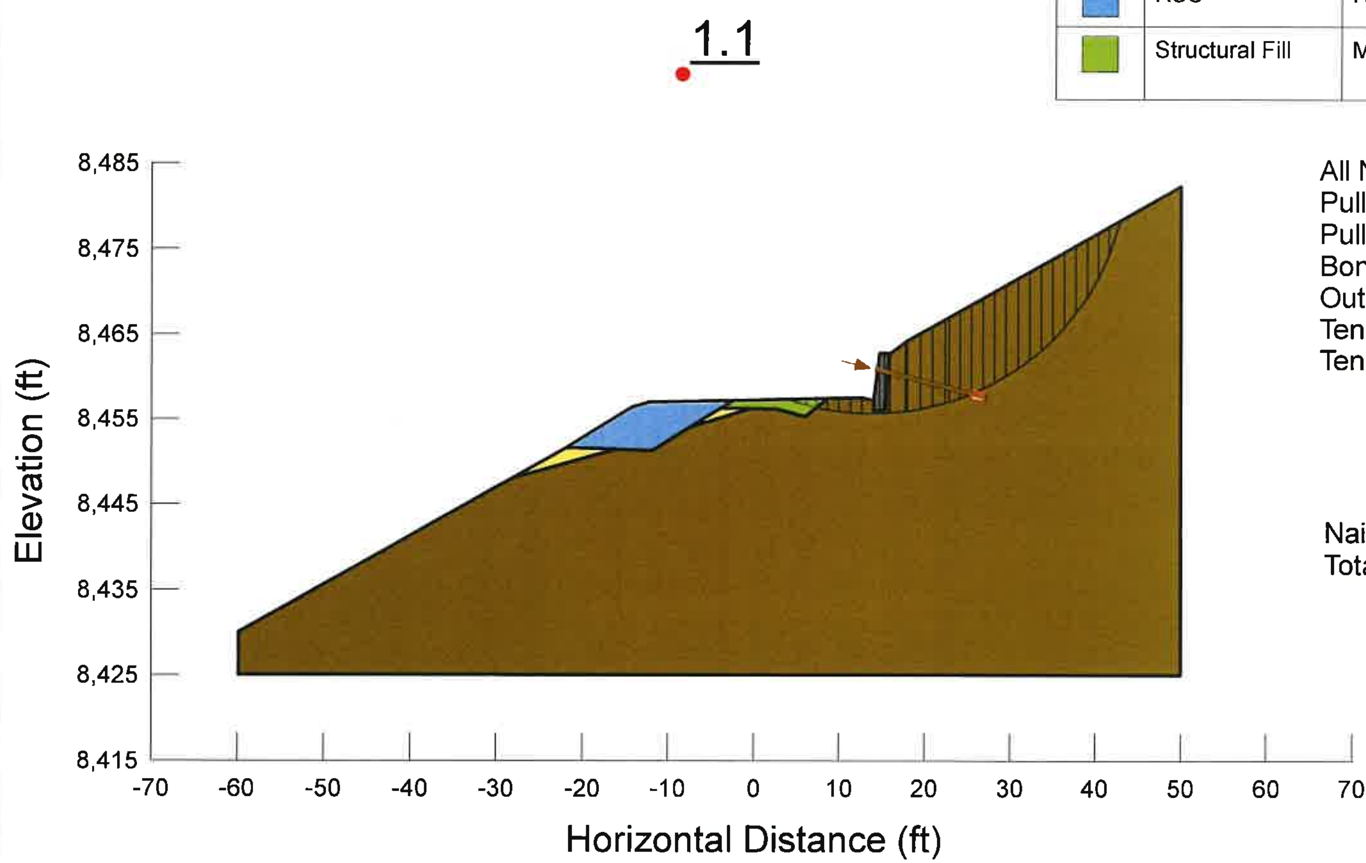


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 13 ft

Reds Meadow Road Improvement
Cross Section Q
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Gray	Concrete	High Strength	150		
Brown	Qts_Non-Pumice	Mohr-Coulomb	120	0	32
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34

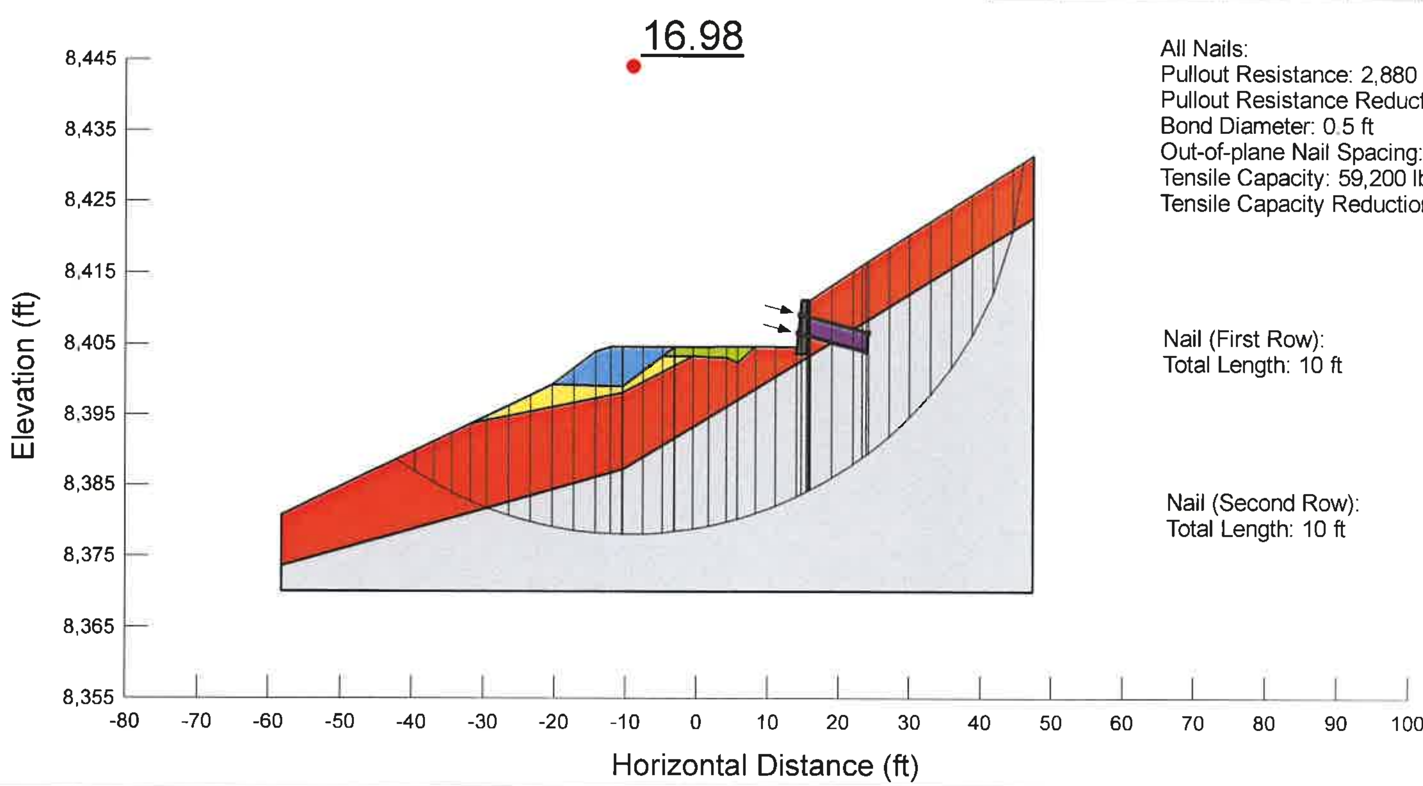


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 13 ft

Reds Meadow Road Improvement
Cross Section R
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	High Strength Zone	High Strength	120		
	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



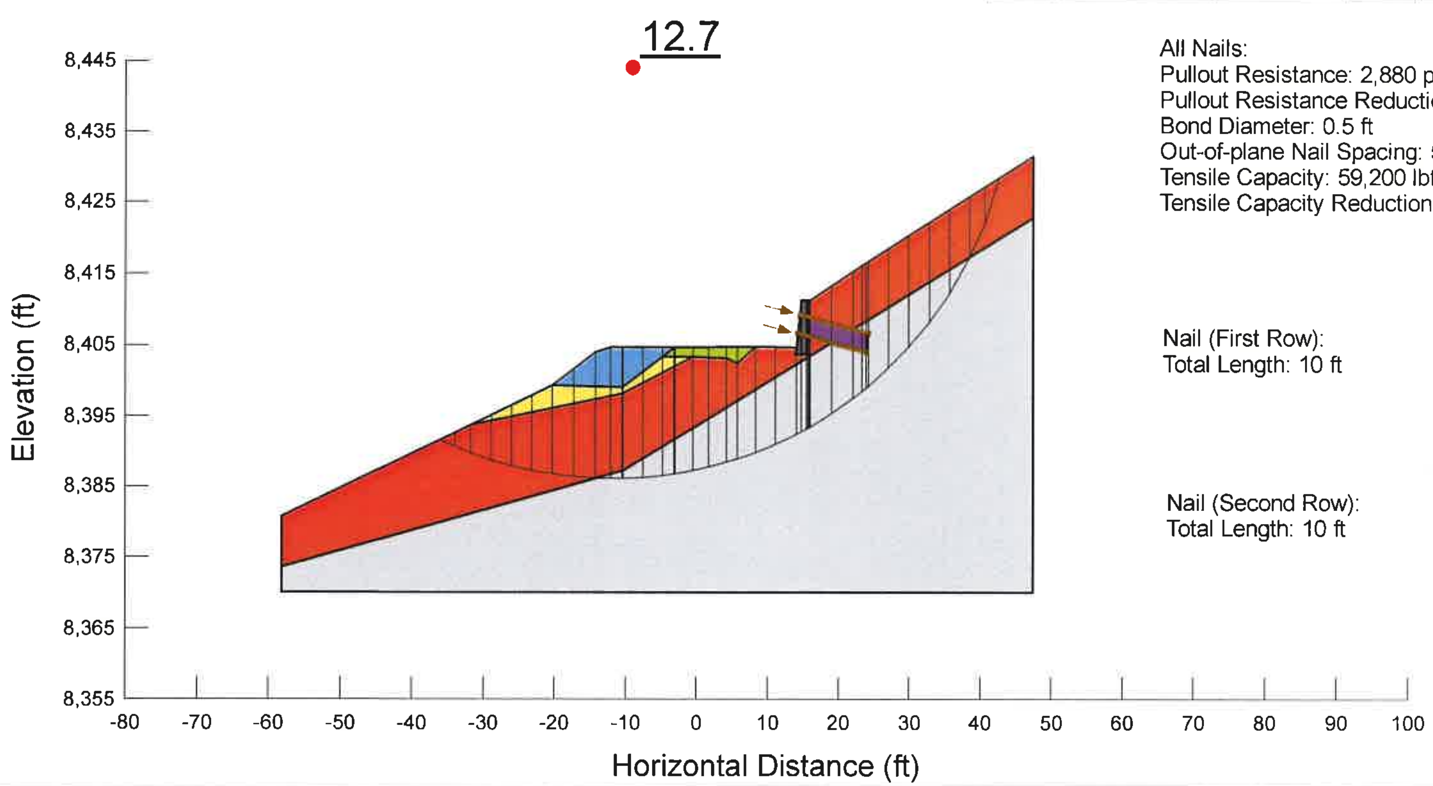
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section R
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	High Strength Zone	High Strength	120		
	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



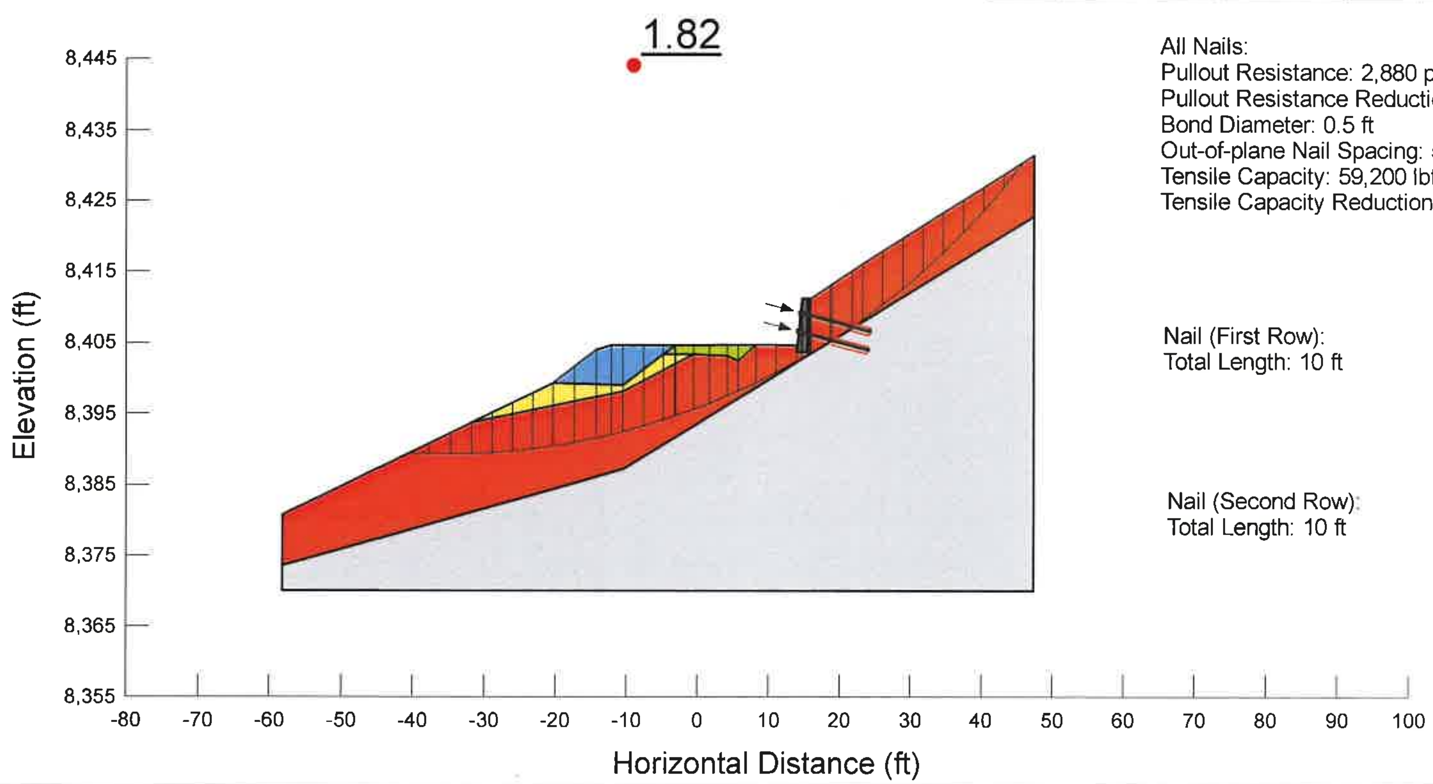
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section R
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Yellow-green	Structural Fill	Mohr-Coulomb	125	0	34



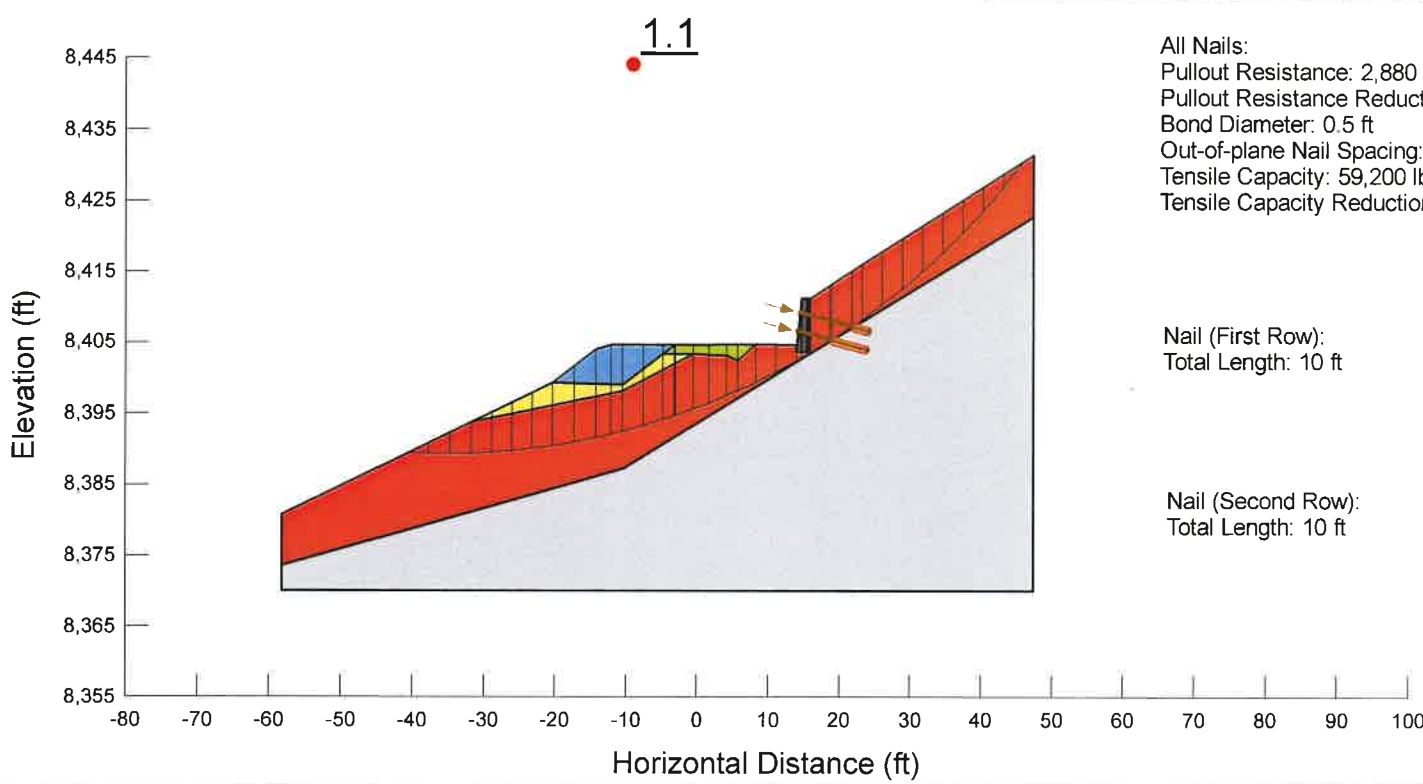
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section R
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



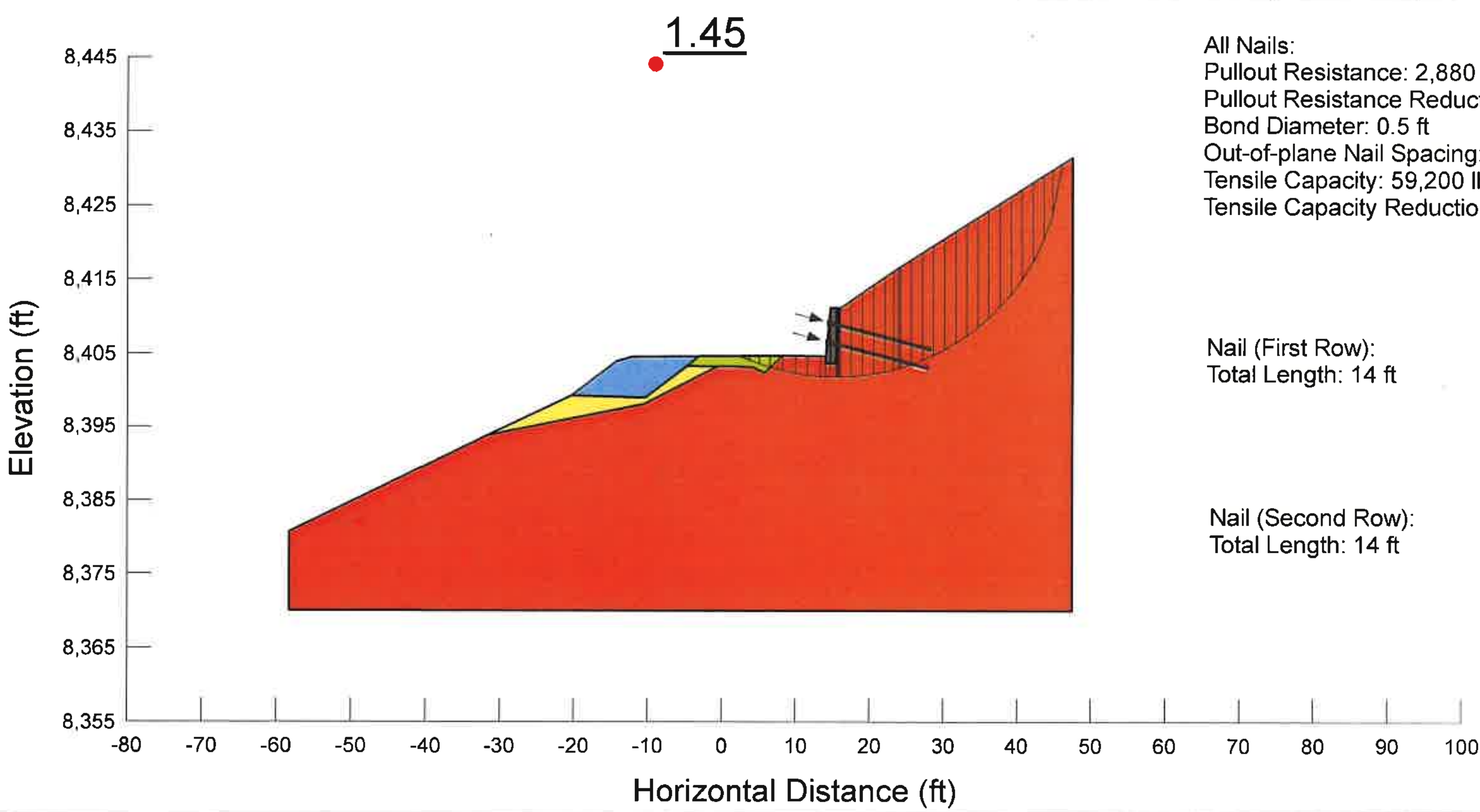
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section R
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



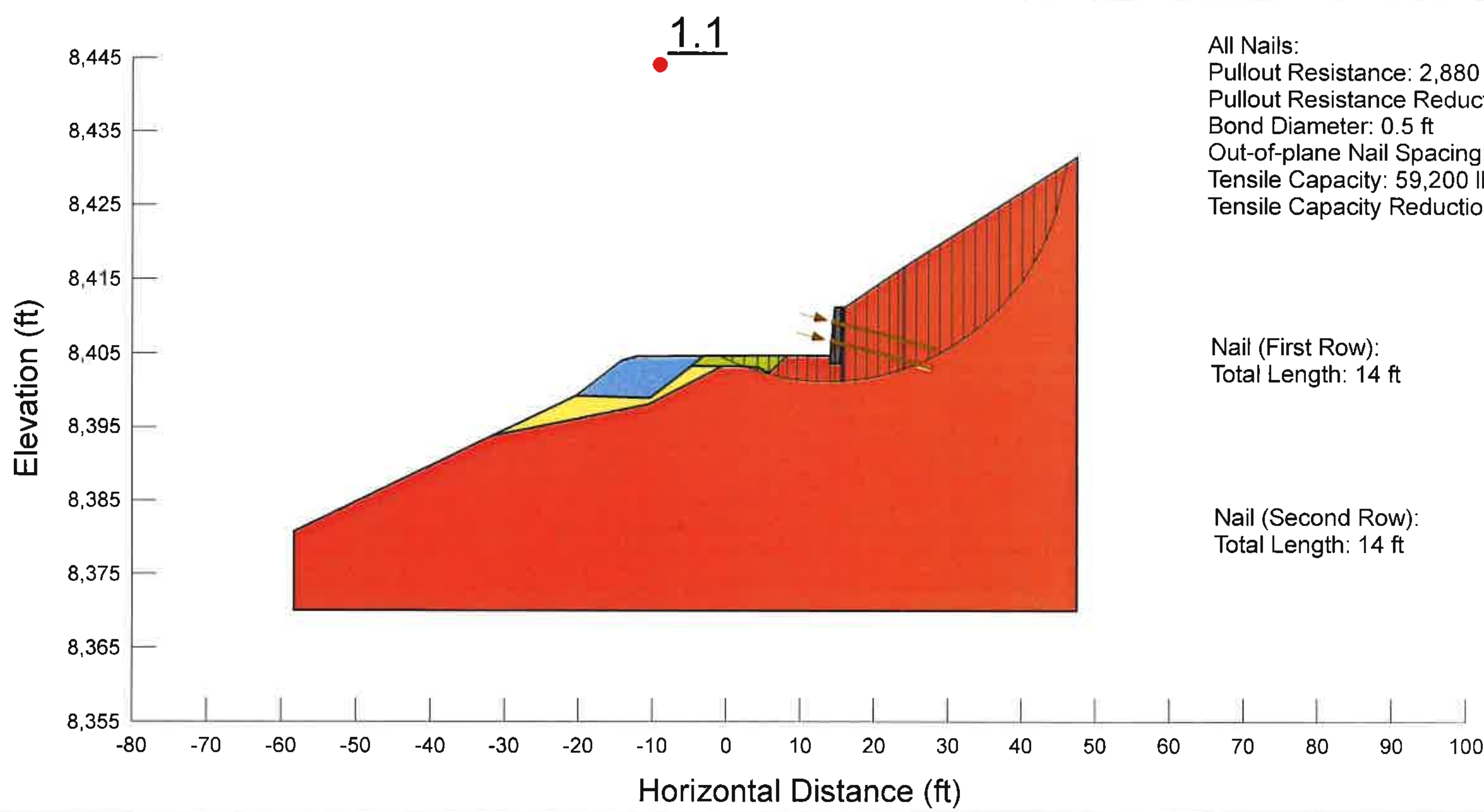
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section R
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pummice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



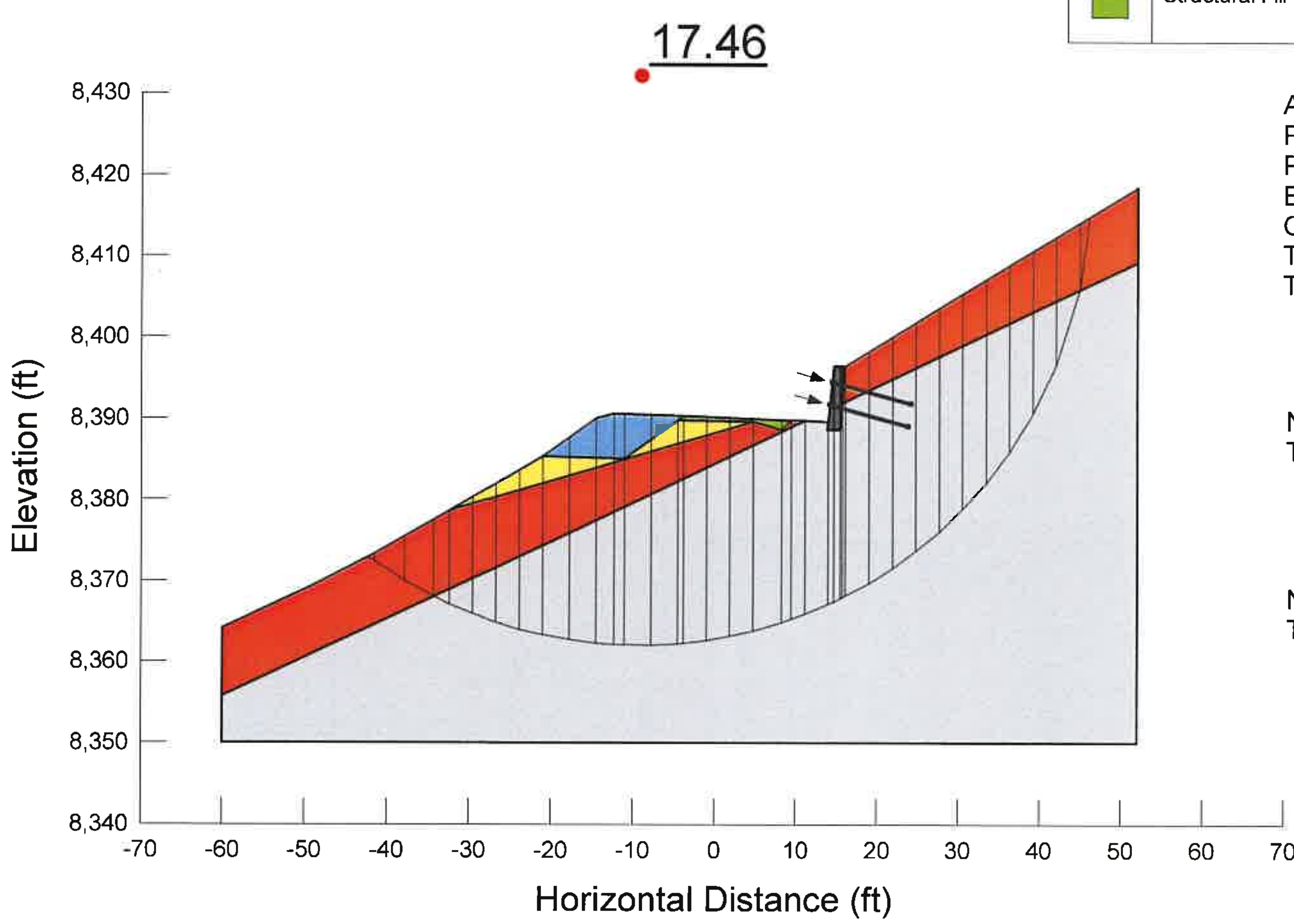
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section S
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



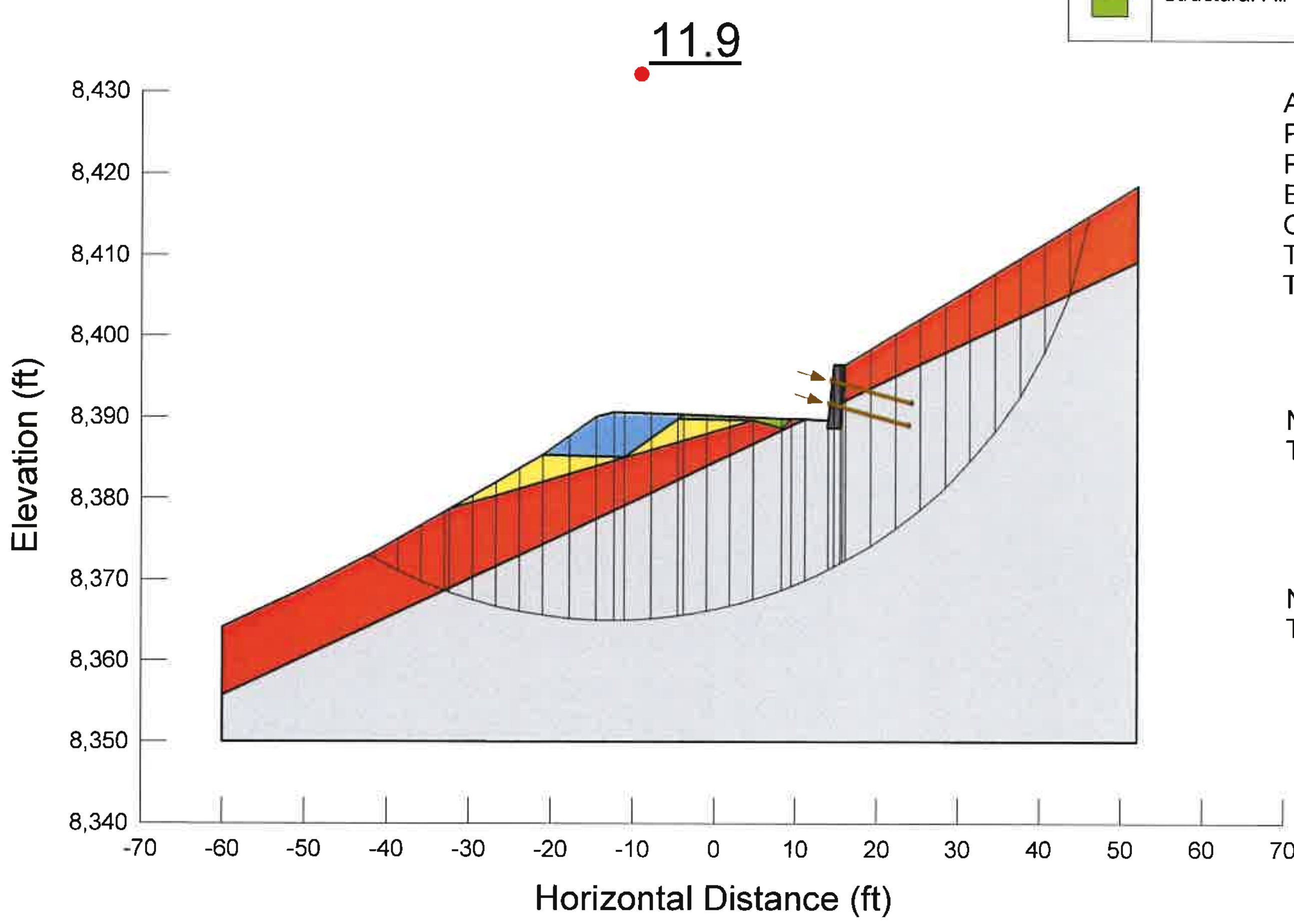
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section S
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



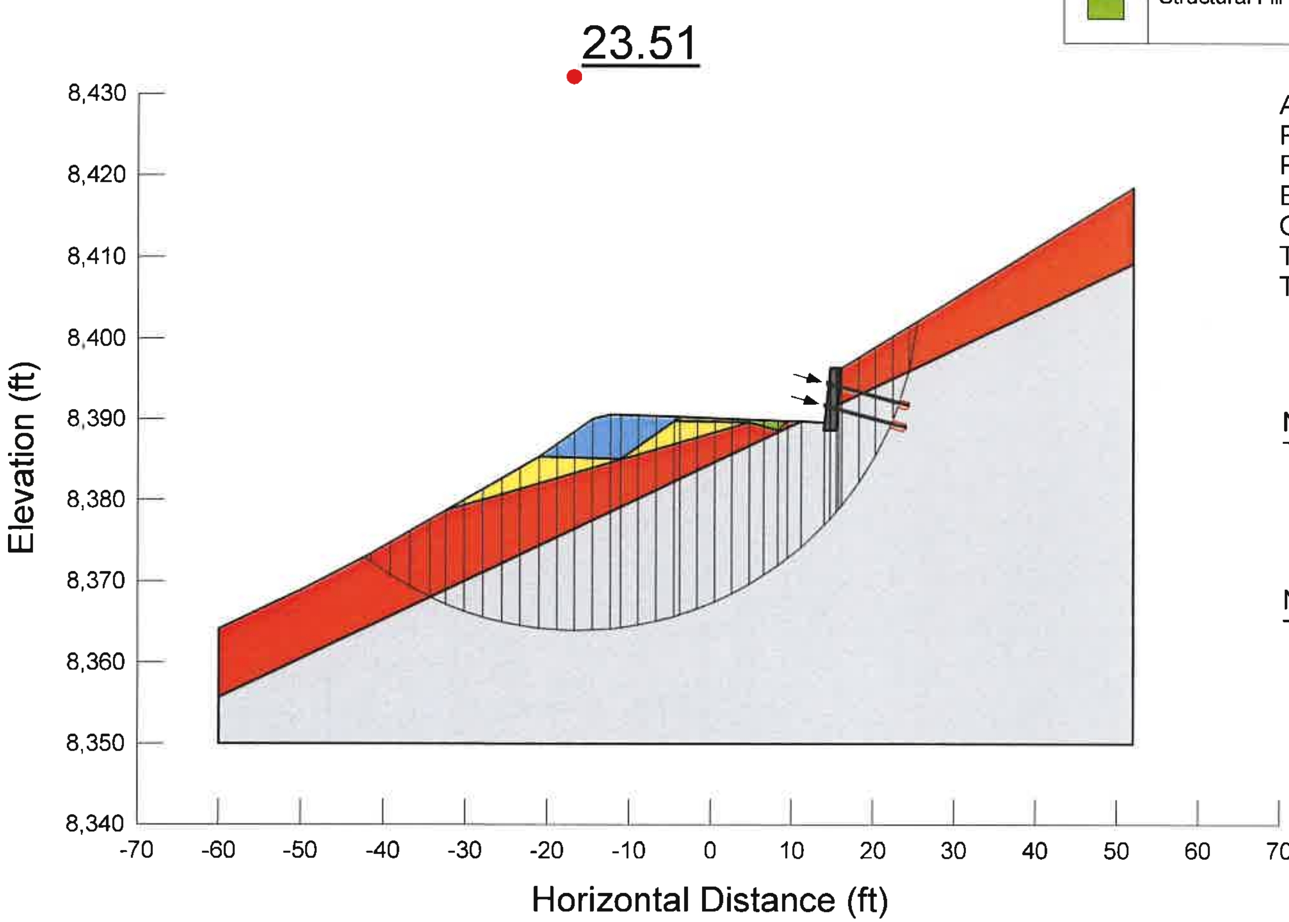
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section S
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Bedrock	Mohr-Coulomb	145	10,000	40
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



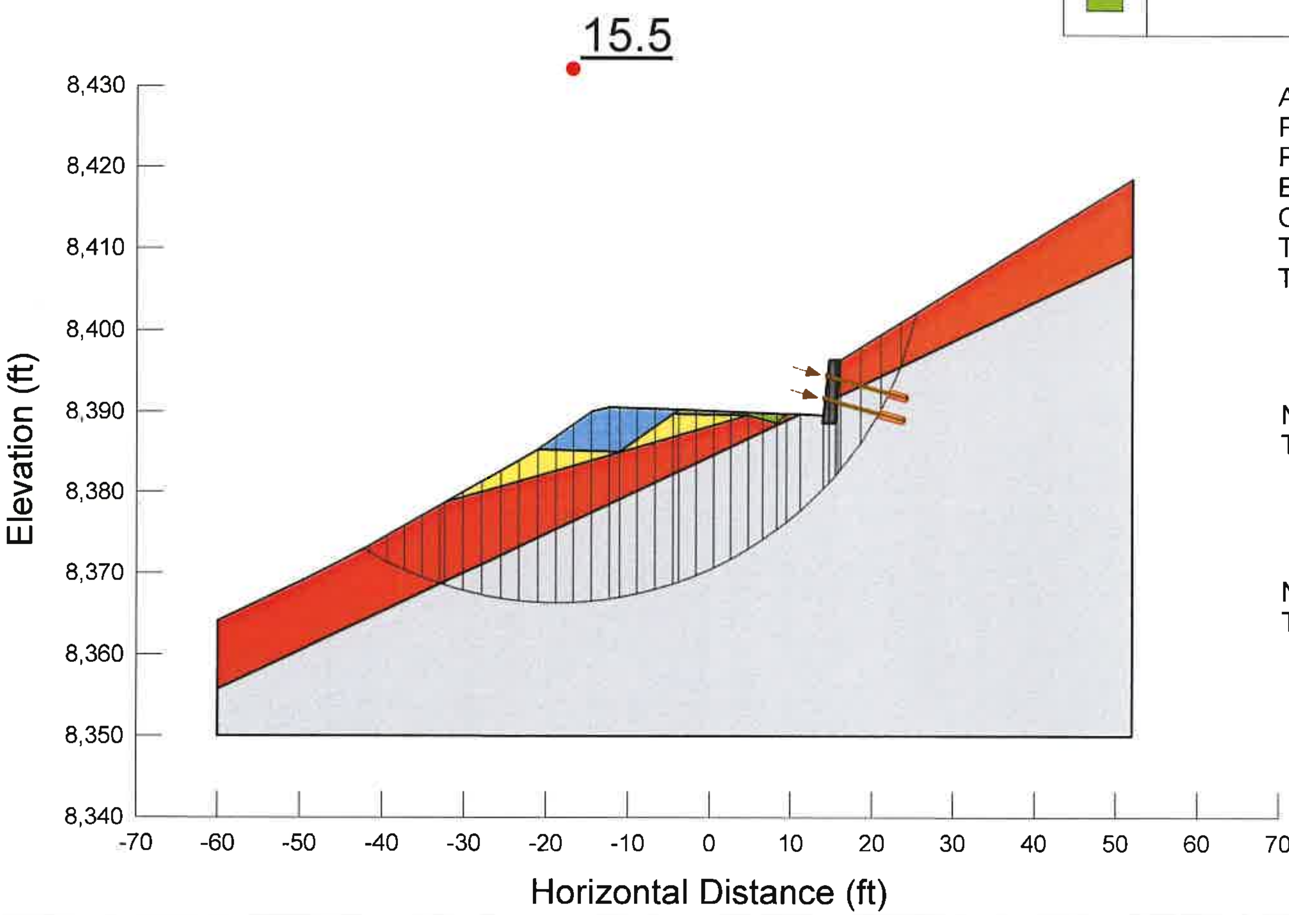
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section S
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



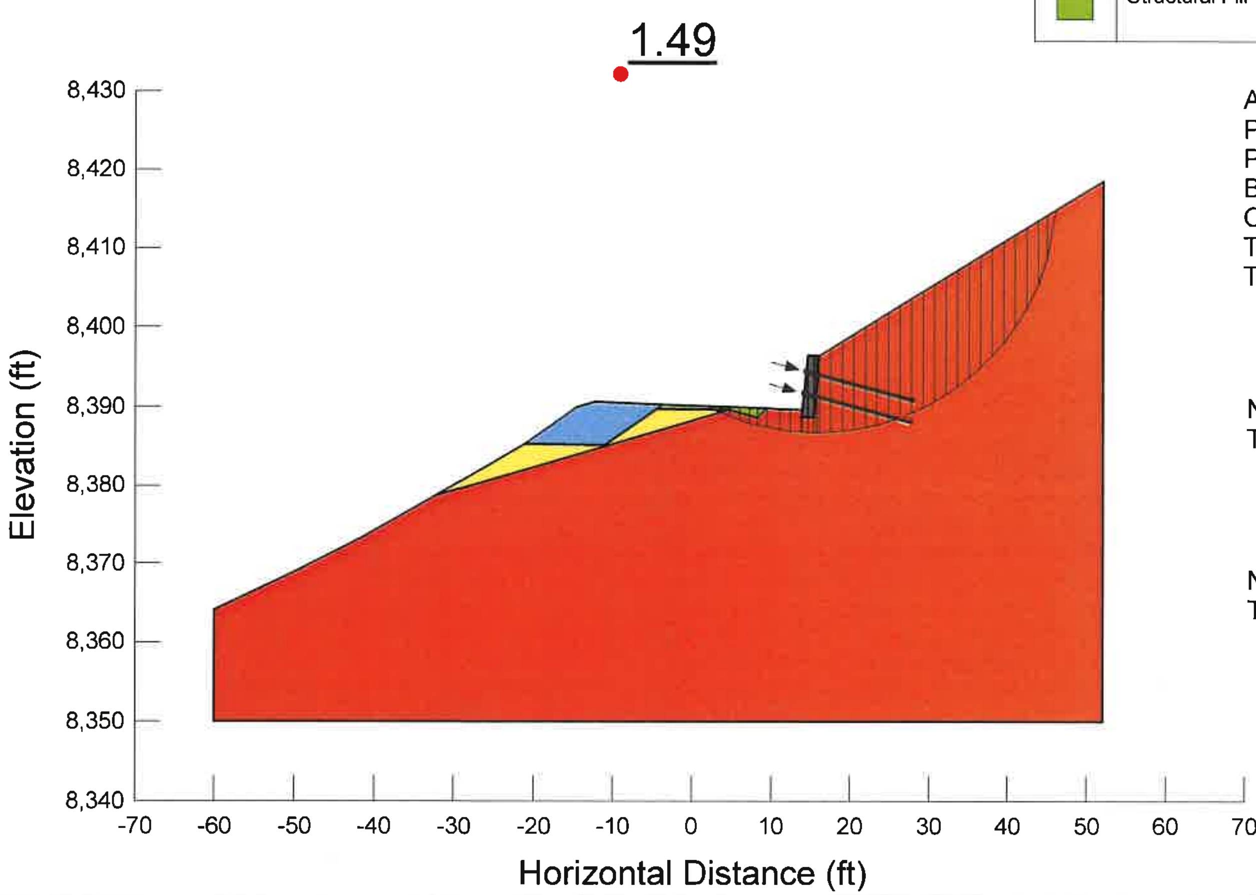
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Nail (Second Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section S
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	af	Mohr-Coulomb	120	0	30
	Concrete	High Strength	150		
	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
	RSS	High Strength	125		
	Structural Fill	Mohr-Coulomb	125	0	34



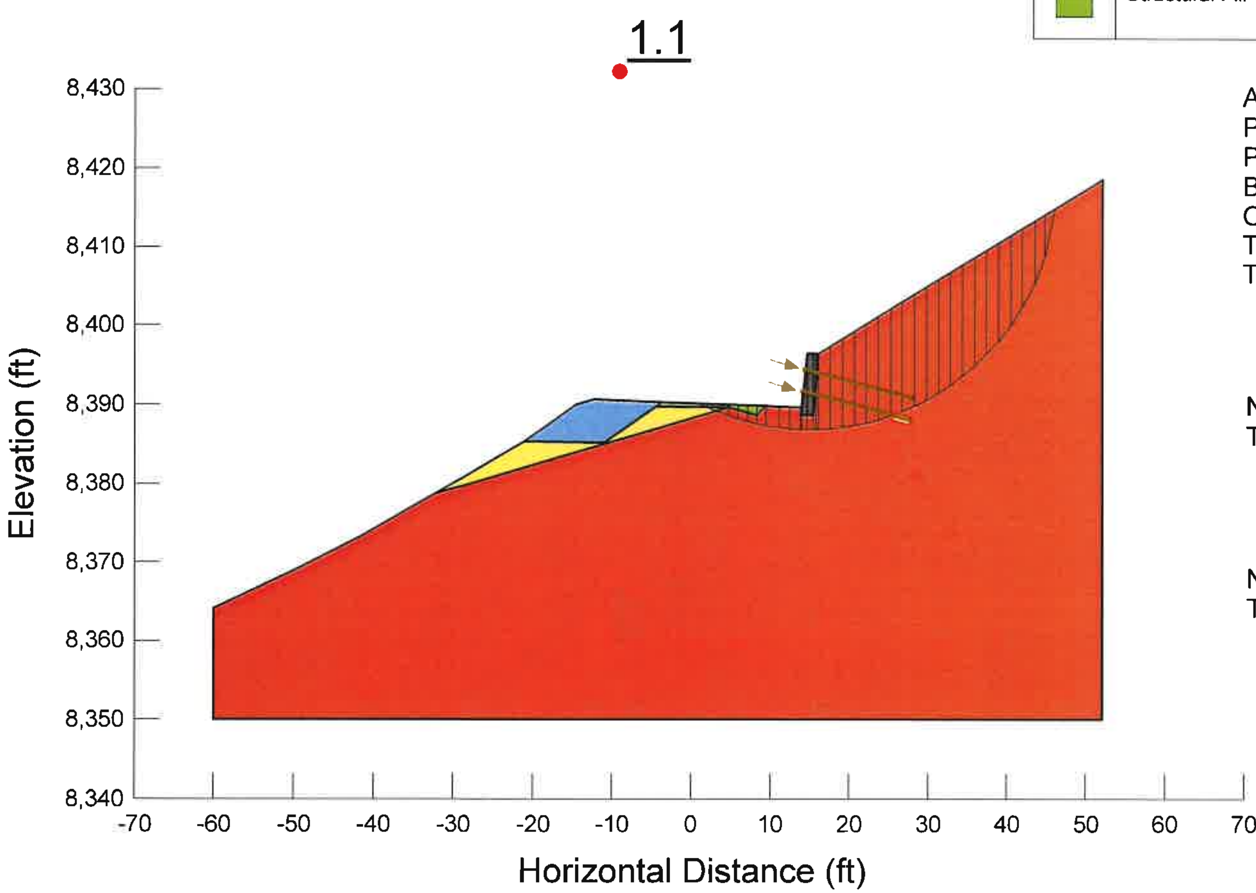
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section S
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		
Green	Structural Fill	Mohr-Coulomb	125	0	34



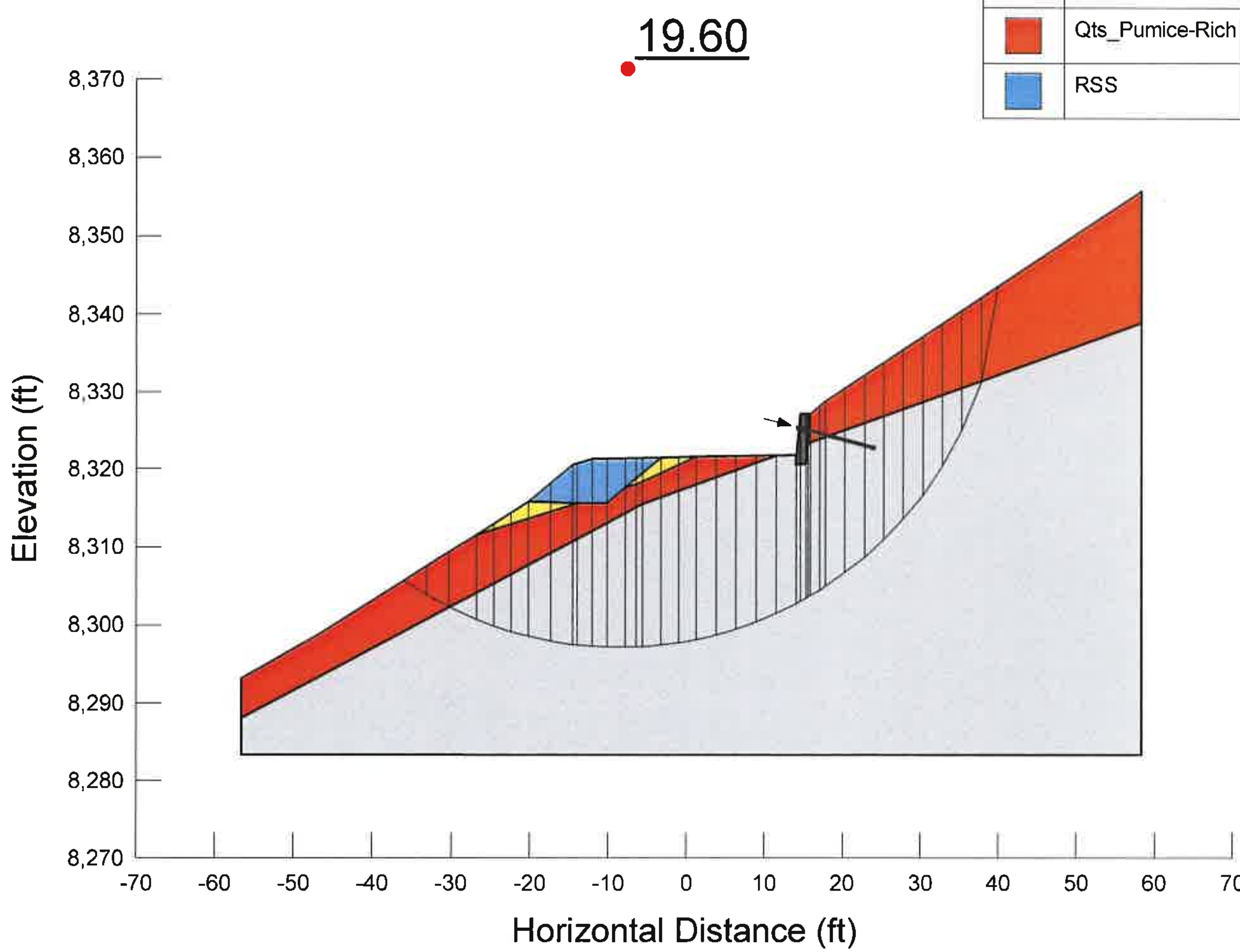
All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 14 ft

Nail (Second Row):
Total Length: 14 ft

Reds Meadow Road Improvement
Cross Section T
Static Analysis (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(light gray)	Bedrock	Mohr-Coulomb	145	10,000	40
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		

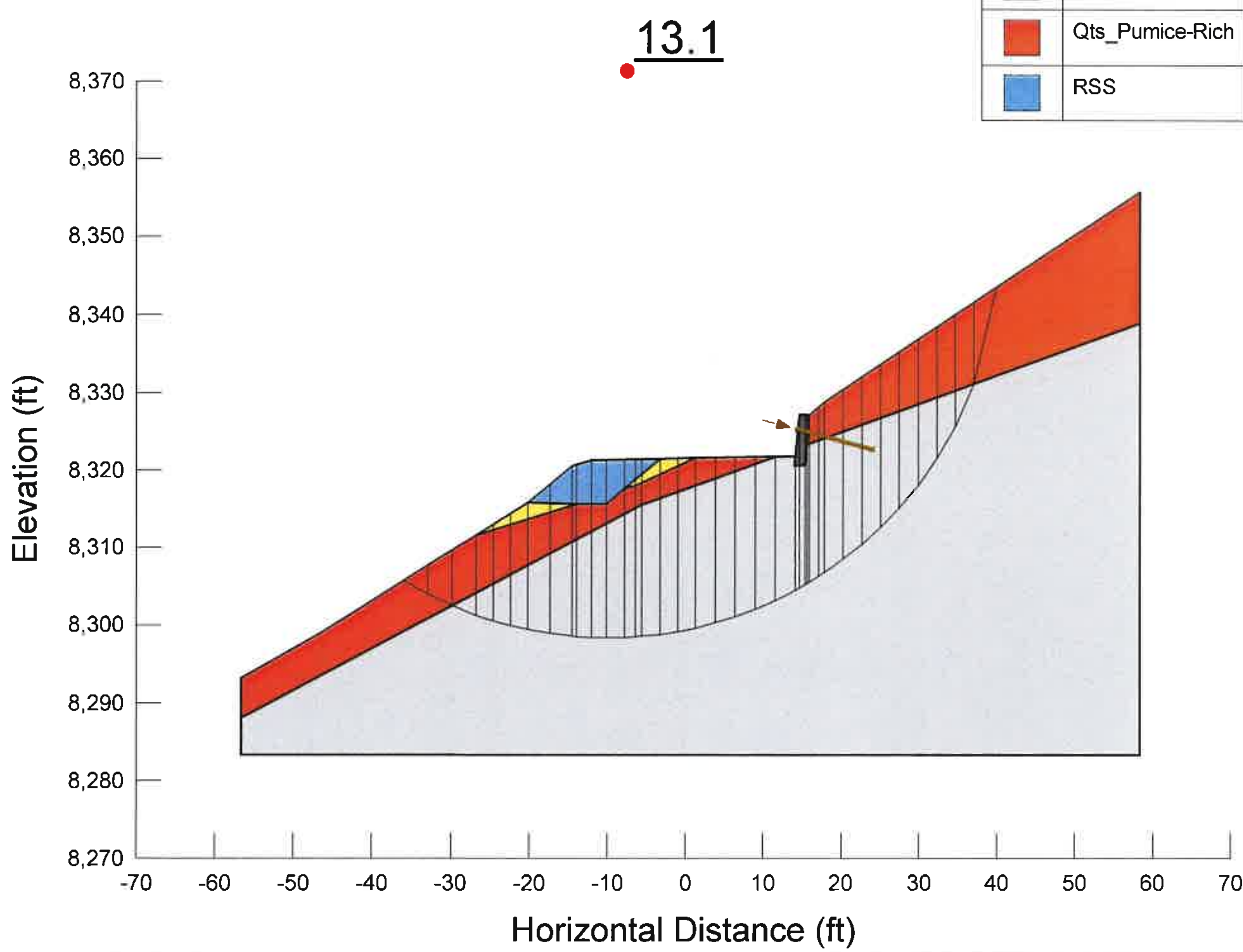


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section T
Pseudo-static Analysis, kh = 0.206 g (Global)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(light gray)	Bedrock	Mohr-Coulomb	145	10,000	40
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		

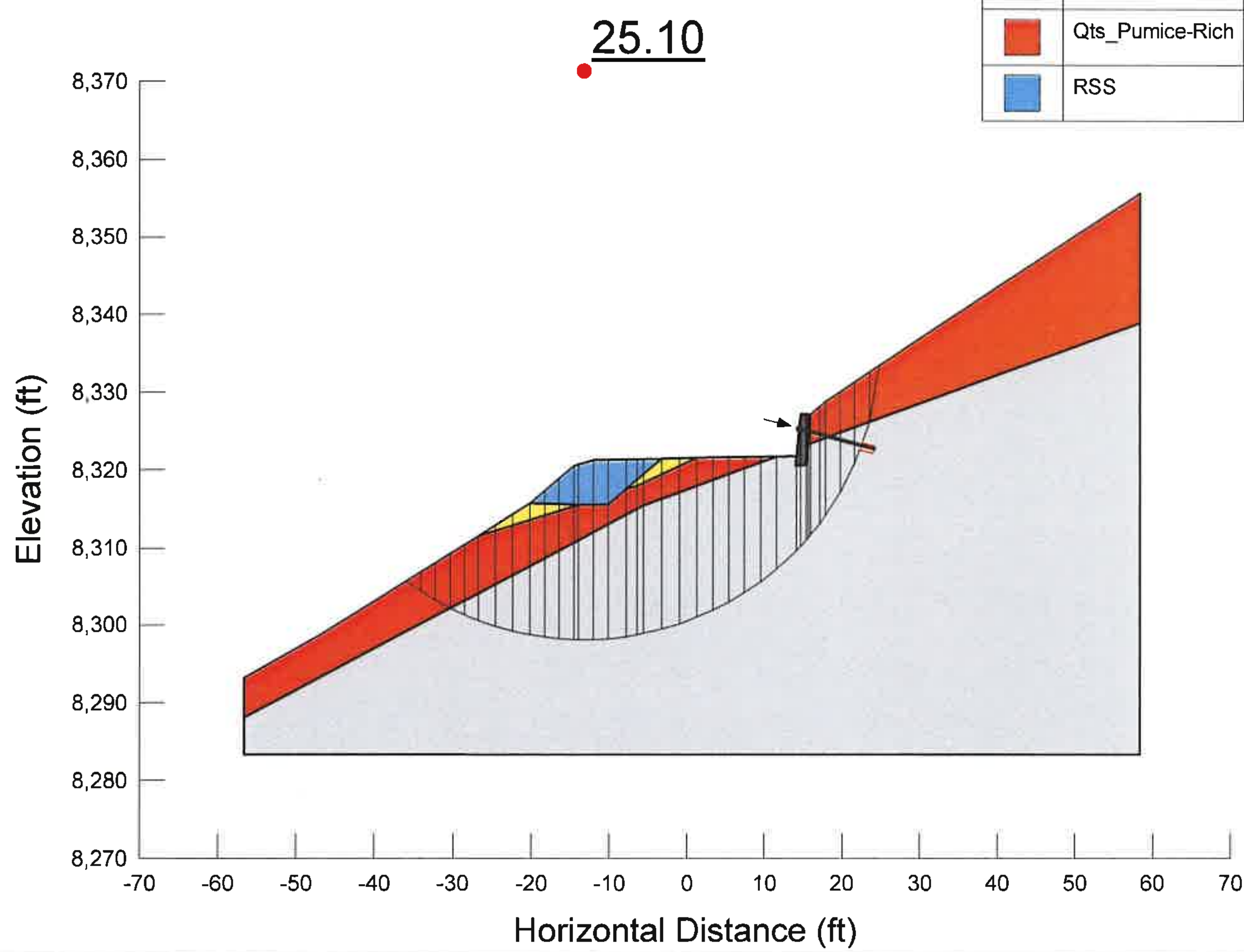


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section T
Static Analysis (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light gray	Bedrock	Mohr-Coulomb	145	10,000	40
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		

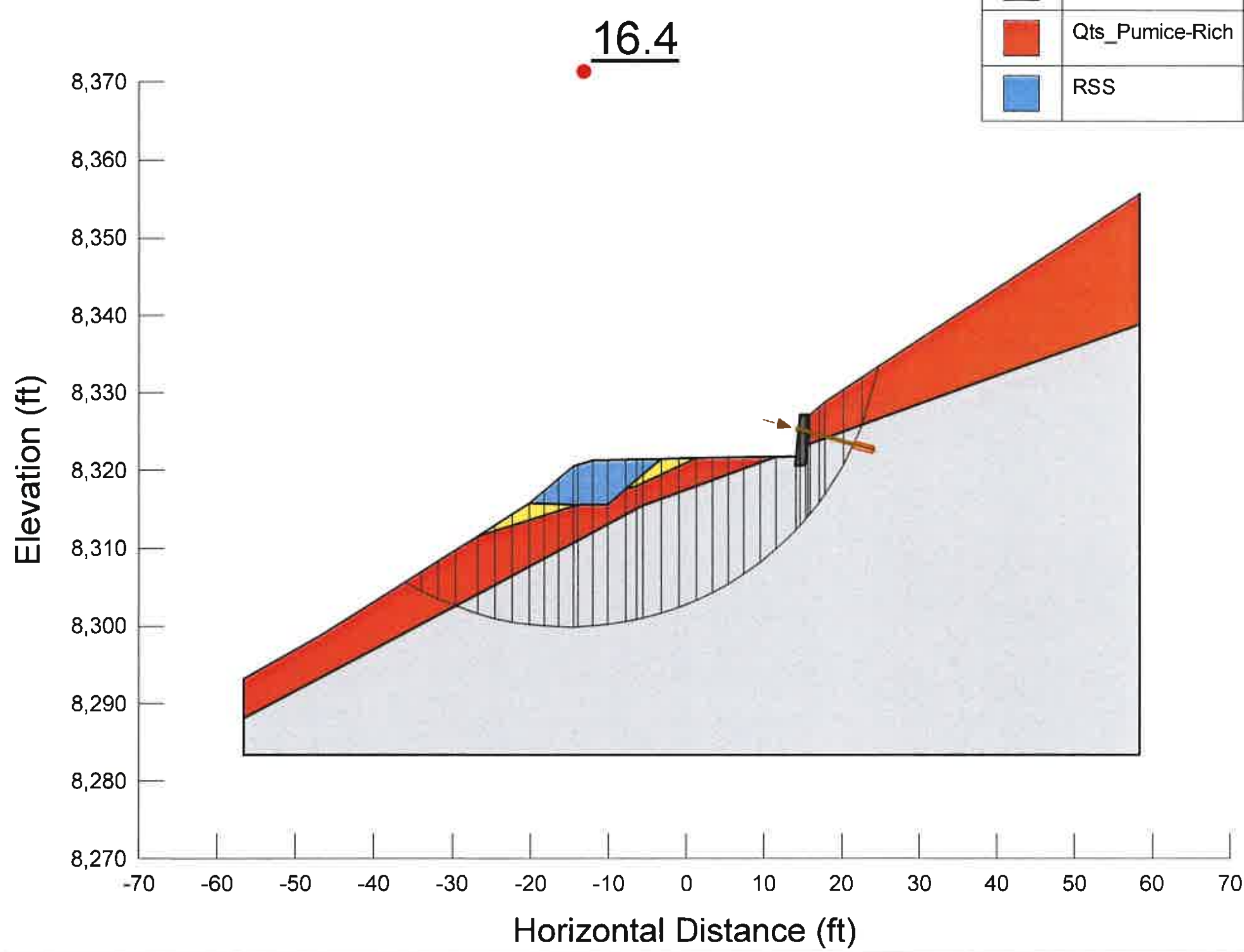


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section T
Pseudo-static Analysis, kh = 0.206 g (Internal)

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Light grey	Bedrock	Mohr-Coulomb	145	10,000	40
Dark grey	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		

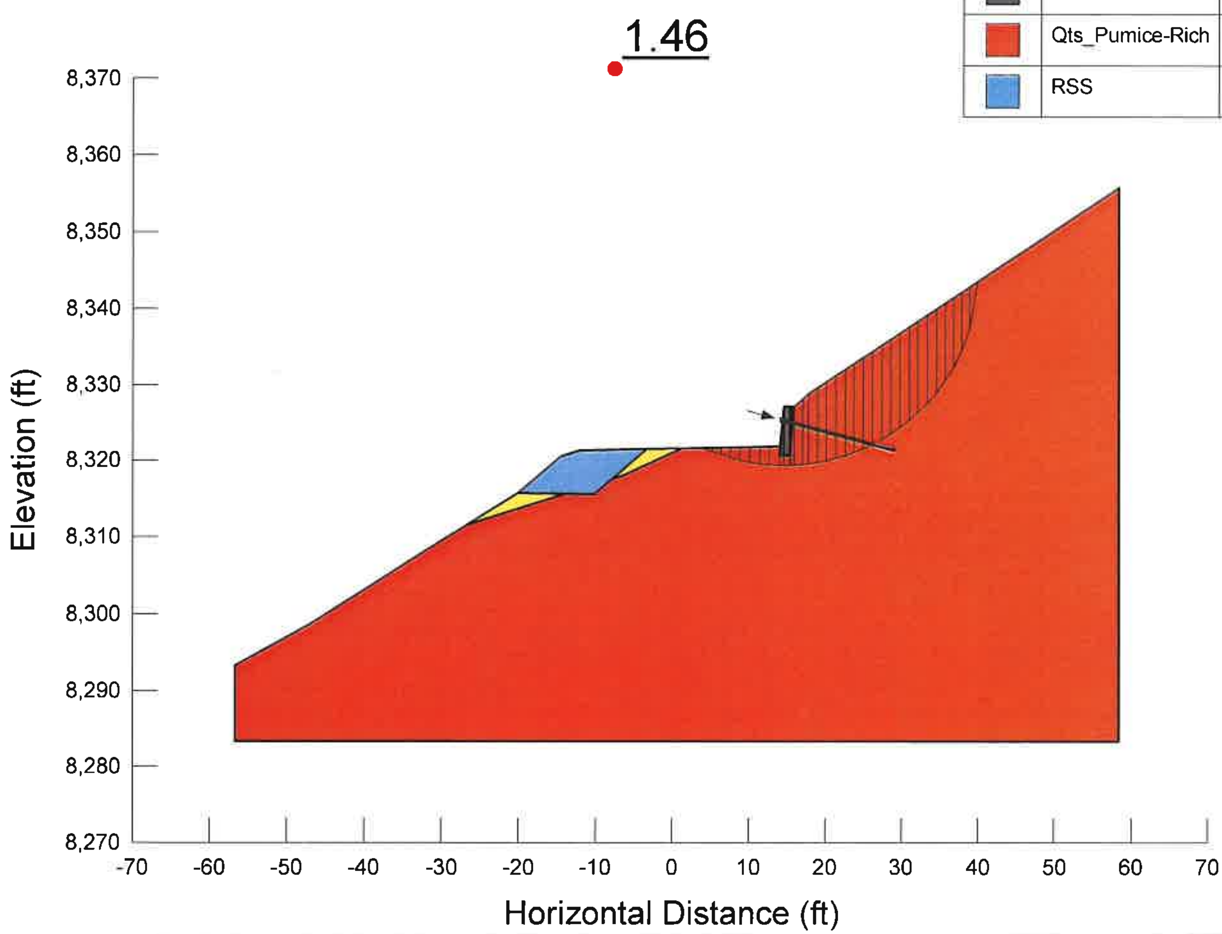


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 10 ft

Reds Meadow Road Improvement
Cross Section T
Static Analysis
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
(yellow)	af	Mohr-Coulomb	120	0	30
(dark gray)	Concrete	High Strength	150		
(red)	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
(blue)	RSS	High Strength	125		

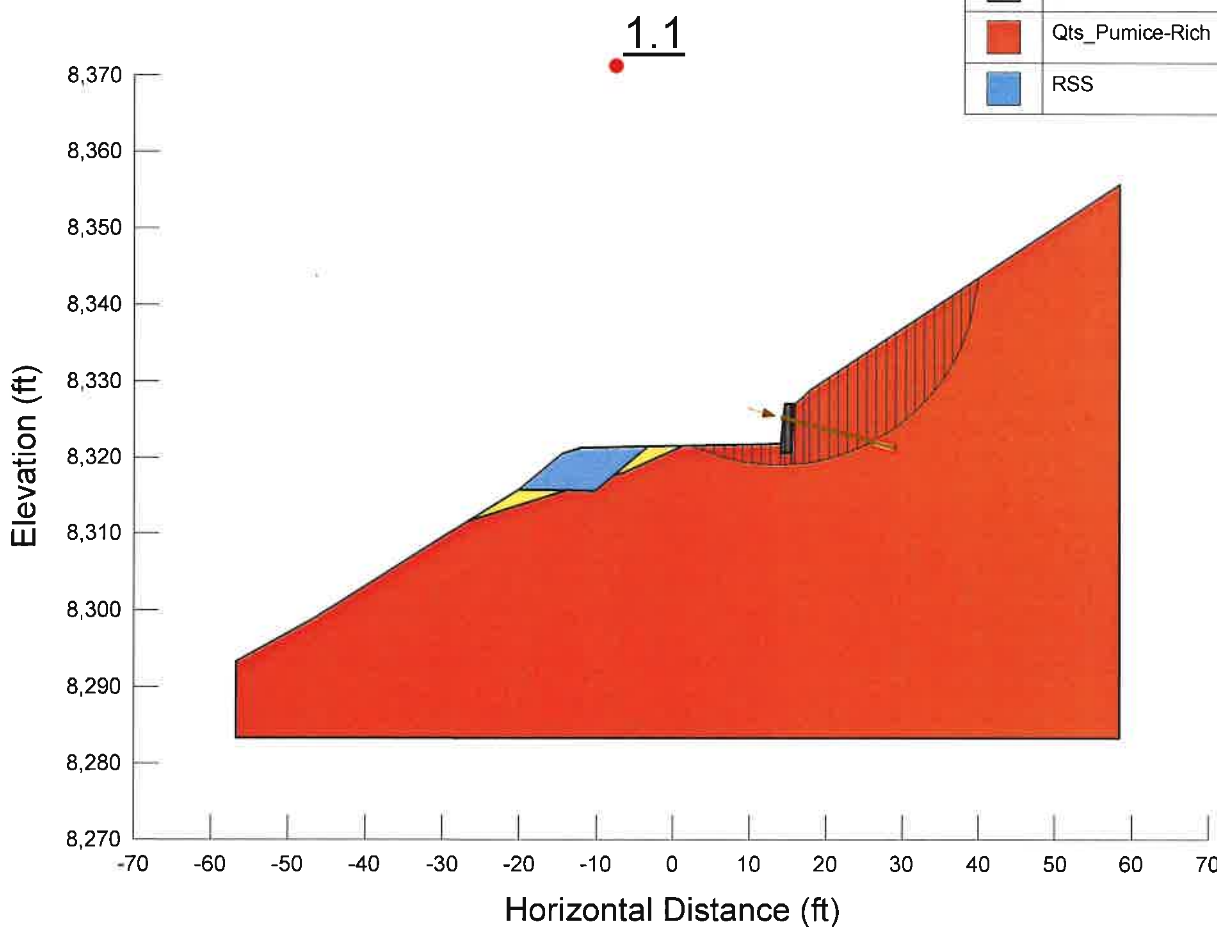


All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 2
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.8

Nail (First Row):
Total Length: 15 ft

Reds Meadow Road Improvement
Cross Section T
Pseudo-static Analysis, kh = 0.206 g
No Bedrock

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
Yellow	af	Mohr-Coulomb	120	0	30
Dark gray	Concrete	High Strength	150		
Red	Qts_Pumice-Rich	Mohr-Coulomb	90	0	30
Blue	RSS	High Strength	125		



All Nails:
Pullout Resistance: 2,880 psf
Pullout Resistance Reduction Factor: 1.5
Bond Diameter: 0.5 ft
Out-of-plane Nail Spacing: 5 ft
Tensile Capacity: 59,200 lbf
Tensile Capacity Reduction Factor: 1.35

Nail (First Row):
Total Length: 15 ft