

November 9, 2022
NewFields Project No. 475.0398.000

HDR Inc.
9805 Double R Boulevard, Suite 101
Reno, Nevada 89521

Attention: Mr. Ruedy Edgington, P.E.
Project Manager

Re: Sound Wall Design Memo, Rev. 1
US395 North Valleys Project
Washoe County, Nevada

1. INTRODUCTION

This memo presents the results of Newfield's geotechnical analyses for the proposed sound walls in support of the US395 North Valleys Project in Washoe County, Nevada. Based on a review of the Wall Location Plan, Sheet No. MSE01, sound walls will be constructed along the southbound shoulder of US395 beginning near the intersection of Clear Acre Lane and continuing towards the I-1093S bridge structure at North Virginia Street.

2. PRECAST SOUND WALL DESIGN

Sound walls SW1, SW2-1, SW2-2, SW3-1, SW3-2, and SW6 will be of precast concrete panel construction. Sound walls SW2-1, SW2-2, SW3-1, and SW3-2 will be built on top of barrier rail and supported by a moment slab with geotechnical recommendations provided by HDR.

Sound walls SW1 and SW6 will be supported on conventional cast-in-place shallow spread foundations. Geotechnical design recommendations for sound walls SW1 and SW6 are provided in the following subsections 2.1.1 through 2.1.3.

2.1.1. Shallow Spread Foundation Design

Sound walls SW1 and SW6 will be supported on shallow spread foundations as shown on preliminary typical cross sections as presented in Attachment A. The walls heights, foundation dimensions and loads for sound walls SW1 and SW6 as provided by HDR are presented in Tables 1 and 2 and were used in the bearing resistance calculations.



Table 1: Sound Walls SW1 and SW6 Dimensions

Sound Wall	Maximum Design Height (ft)	Footing Width (ft)	Footing Embedment (ft)
SW1	19.0	7.4	4.0
SW6	24.5	7.6	3.7

Table 2: Sound Walls SW1 and SW6 Design Loads

Sound Wall Location	Vertical Weight (kips)			Overturning Moment (kip*ft)		
	Strength Limit	Extreme Limit	Service Limit	Strength Limit	Extreme Limit	Service Limit
SW1	8	6	6	10	13	9
SW6	9	8	7	14	23	13

Effective footing widths were used in the bearing resistance calculations in accordance with Section 10.6.3.1.1, *AASHTO LRFD Bridge Design Specifications* (2020). Effective footing widths were calculated in accordance with Section 10.6.1.3, *AASHTO LRFD Bridge Design Specifications* (2020) with the eccentric distance computed by dividing the applied moment by the applied vertical load in accordance with Section 6.4.1 of *Geotechnical Engineering Circular No. 6, Shallow Foundations* (FHWA, 2002).

2.1.2. Strength and Extreme Bearing Resistance

Nominal bearing resistances under the strength and extreme limit states for sound walls SW1 and SW6 were calculated using Equation 10.6.3.1.2c-1, *AASHTO LRFD Bridge Design Specifications* (2020). Since foundations will be constructed adjacent to sloping ground, a reduction coefficient (RC_{BC}) must be applied. An RC_{BC} value was determined using linear interpolation between values provided on Table 10.6.3.1.2c-1, *AASHTO LRFD Bridge Design Specifications* (2020).

A RC_{BC} value of 0.43 was estimated for sound wall SW1 based on a slope height (H) of 15 feet below bottom of foundation, slope angle (β) of 26.6 degrees, and offset (b) of 8 feet. For sound wall SW6, an RC_{BC} value of 0.66 was used for design based on a slope height (H) of 2.9 feet below bottom of foundation, a slope angle (β) of 26.6 degrees, and an offset (b) of 8 feet.

Factored bearing resistances at the strength and extreme limit states were determined in accordance with *AASHTO LRFD Bridge Design Specifications*, Equation 10.6.3.1. A resistance factor of 0.45 per Table 11.5.7-1, *AASHTO LRFD Bridge Design Specifications* (2020) was applied to nominal bearing resistance values to calculate the factored bearing resistance at the strength



limit state. A resistance factor of 1.0 per Section 10.5.5.3, *AASHTO LRFD Bridge Design Specifications* (2020) was applied to nominal bearing resistance values to calculate the factored bearing resistance at the extreme limit states.

Factored bearing resistance values for the strength and extreme limit states are summarized in Table 3. Supporting calculations are provided in Attachment B.

Table 3: Factored Strength and Extreme Limit State Bearing Resistances

Sound Wall Location	Strength Limit (ksf)	Extreme Limit (ksf)
SW1 (2:1 Toe Slope)	2.7	5.9
SW6 (2:1 Toe Slope)	3.7	8.2

The values presented above are maximum estimated values based on the theoretical bearing capacity formulas presented in *AASHTO LRFD Bridge Design Specifications* (2020).

2.1.1. Service Limit State Bearing Resistance

The service limit state is related to deformation of a foundation element under an applied vertical bearing stress. This typically includes settlement of foundations and global stability for foundations located adjacent or within sloping embankments.

Additional discussion regarding settlement calculations for service limit state is presented in Subsection 2.1.1.1. Information regarding model development, analysis, and results of global stability calculations are discussed in Subsections 2.1.1.2 through 2.1.1.4.

2.1.1.1. Settlement

Settlement of shallow spread foundations for sound walls were estimated using foundation widths and lengths and elastic theory procedures. To estimate settlement, the elastic modulus value was estimated using N-values in accordance with *AASHTO LRFD Bridge Design Specifications* (2020), a Boussinesq vertical stress distribution, and a rigid foundation in the program Settle3. The depth of the soil profile used in the model to assess potential settlement was developed following guidance for stress influence and test hole depths provided in Section 10.4.2, *AASHTO LRFD Bridge Design Specifications* (2020).

Per Section 10.5.5 of the *AASHTO LRFD Bridge Design Specifications* (2020) a resistance factor of 1.0 should be used for the service limit state. Therefore, the nominal bearing resistance is equal



to the factored bearing resistance. No further reduction was applied. The service limit bearing resistance was limited to a maximum of 2.7 ksf for SW1 and 3.7 for SW6.

Settle3 estimates indicate a maximum settlement of 1 inch or less, with differential settlement estimated to be ½ inch or less across each wall structure. Copies of the Settle3 outputs and reports are provided in Attachment C.

2.1.1.2. Slope Stability Assessment

Sound wall SW1 and SW6 will be founded on a shallow spread foundation adjacent a 2:1 (H:V) embankment slope with an estimated total slope height of 19 feet and 6.4 feet, respectively based on the typical sections provided by HDR. Therefore, a global stability analysis was performed for both static and pseudostatic loading conditions using the Spencer method and the program Slide by Rocscience Inc. Soil layering was simplified and modeled as a single homogenous material based on nearby soil boring information. Due to the depth of groundwater in the vicinity, groundwater was not considered in the slope stability analyses.

For pseudostatic loading conditions, slope stabilities were assessed using one-half of the recommended peak ground acceleration (PGA) per Section 12.3.5 of the *NDOT Structures Manual* (2008).

2.1.1.3. Slope Stability Assessment

The angle of internal shearing resistance (ϕ) for the embankment fill and underlying granular soils was estimated using the Peck, Hanson, and Thornburn correlation (AASHTO, 2020) based on corrected blow counts $(N1)_{60}$. Blow count corrections and angle of internal shearing resistance correlations are provided in Attachment A.

The internal angle of shearing resistance for the subsurface profile of SW1 and SW6 was based on an assumed $(N1)_{60}$ value of 15, yielding a friction angle of 32 degrees. This corresponds to a lower bound relative density of medium dense. Table 4 presents the material properties used in the stability analysis.

Table 4: Material Properties Used in the Stability Analyses

Material	Unit Weight (pcf)	Estimated Friction Angle (degrees)	Cohesion (psf)
Embankment Fill/Clayey Sand (SC)	120	32	100



A distributed load of 2.7 ksf and 3.7 ksf was applied representing the foundation load from sound wall SW1 and SW6, respectively.

2.1.1.4. Slope Stability Assessment

Results of the stability analysis are shown in Table 5 and the stability outputs are provided in Appendix D.

Table 5: Sound Wall Stability Results

Sound Wall	Minimum Factor of Safety (FOS)	
	Static	Pseudostatic
SW1	1.6	1.1
SW6	1.7	1.5

Section 11.6.3.7 of the *AASHTO LRFD Bridge Design Specifications (2020)* states a resistance factor of 0.65 should be applied to the evaluation of overall stability of earth slopes under the service limit state, where the geotechnical parameters and subsurface stratigraphy are highly variable or based on limited information. The applied resistance factor is equivalent to a factor of safety of approximately 1.5 using the allowable stress design (ASD) design methodology. Section 6.2.2 of the *LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual (FHWA, 2011)* recommends a minimum factor of safety of 1.1 for pseudostatic (seismic) analyses.

Stability results indicate the walls meet the minimum factors for safety for static and pseudostatic conditions.

3. SLIDING RESISTANCE

Sliding resistance between the base of shallow spread foundations/moment slabs and the granular embankment and native soils is determined by the coefficient of friction ($\tan \delta$) between the bottom of footing and the soil. For foundations cast against the ground and assuming a ϕ value of 32 degrees, a nominal coefficient of friction of 0.62 is recommended for sliding resistance based on Section 10.6.3.4 of *AASHTO LRFD Bridge Design Specifications (2020)*. A strength limit resistance factor of 0.8 should be applied to the sliding resistance in accordance with Table 10.5.5.2.2-1 of *AASHTO LRFD Bridge Design Specifications (2020)*.



4. LIMITATIONS

The recommendations contained in this report are based on field exploration, laboratory testing, and our understanding of the proposed construction. The soil data used in the preparation of this report are based on the field explorations performed at the locations referenced in the *Geotechnical Design Report, Phase 1B: US395 North Valleys* (NewFields, 2020). It is possible that variation in the soil conditions may exist between the locations explored. Therefore, if any soil conditions are encountered at the site that are different from those outlined in this report, NewFields should be immediately notified so that we may review and make supplementary recommendations if warranted.

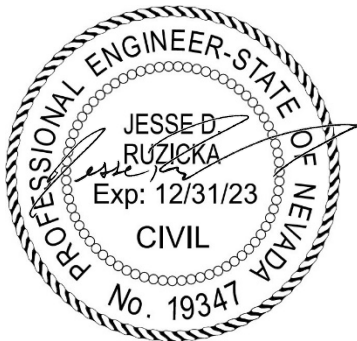
This report has been prepared solely for the use of HDR and their client for design of the US395 North Valleys Project. Our services were performed using generally accepted geotechnical engineering practice common to the area at the time of this report. No other warranties, either expressed or implied, are included or intended.

If you have any questions or require additional information, please contact the undersigned.

Sincerely,

NewFields Mining Design & Technical Services

Reviewed by:



Jesse Ruzicka, P.E. 11/9/2022
Senior Engineer

Mark Doehring, P.E.
Senior Engineer

JR/MD/ng

- LIST OF ATTACHMENTS:**
- Attachment A – Typical Sections and Blow Count Corrections
 - Attachment B – Bearing Resistance Calculations
 - Attachment C – Settle3 Results
 - Attachment D – SLIDE Global Stability Results

Addressee: Electronic

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ATTACHMENT A
Typical Sections and Blow Count Corrections

Typical Sections (Provided by HDR)

LOADS

SW1

STRENGTH:

FACTORED VERTICAL WEIGHT = 8 KIPS

FACTORED OVERTURNING MOMENT = 10 KIP.FT

EXTREME EVENT I (SEISMIC):

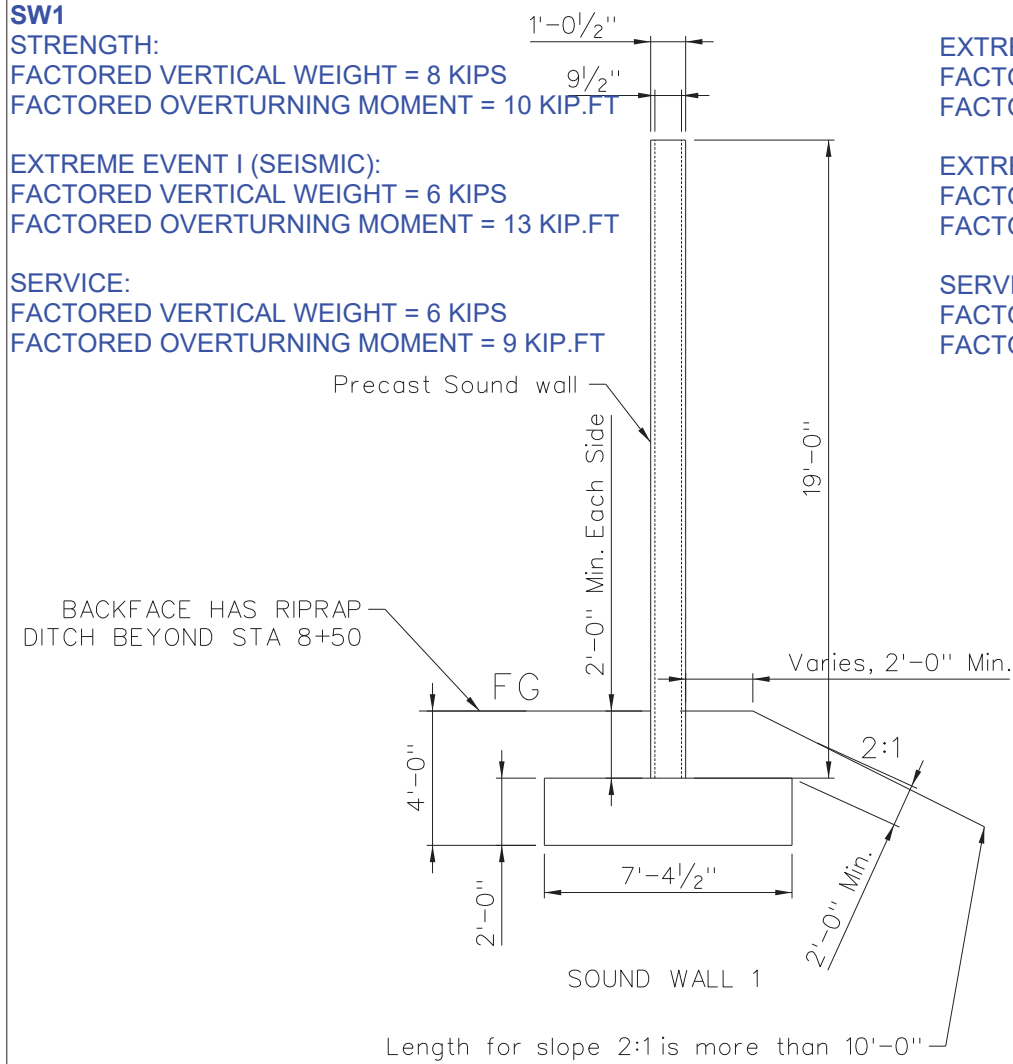
FACTORED VERTICAL WEIGHT = 6 KIPS

FACTORED OVERTURNING MOMENT = 13 KIP.FT

SERVICE:

FACTORED VERTICAL WEIGHT = 6 KIPS

FACTORED OVERTURNING MOMENT = 9 KIP.FT



SW6

STRENGTH:

FACTORED VERTICAL WEIGHT = 9 KIPS

FACTORED OVERTURNING MOMENT = 14 KIP.FT

EXTREME EVENT I (SEISMIC):

FACTORED VERTICAL WEIGHT = 7 KIPS

FACTORED OVERTURNING MOMENT = 21 KIP.FT

EXTREME EVENT II (VEHICULAR COLLISION):

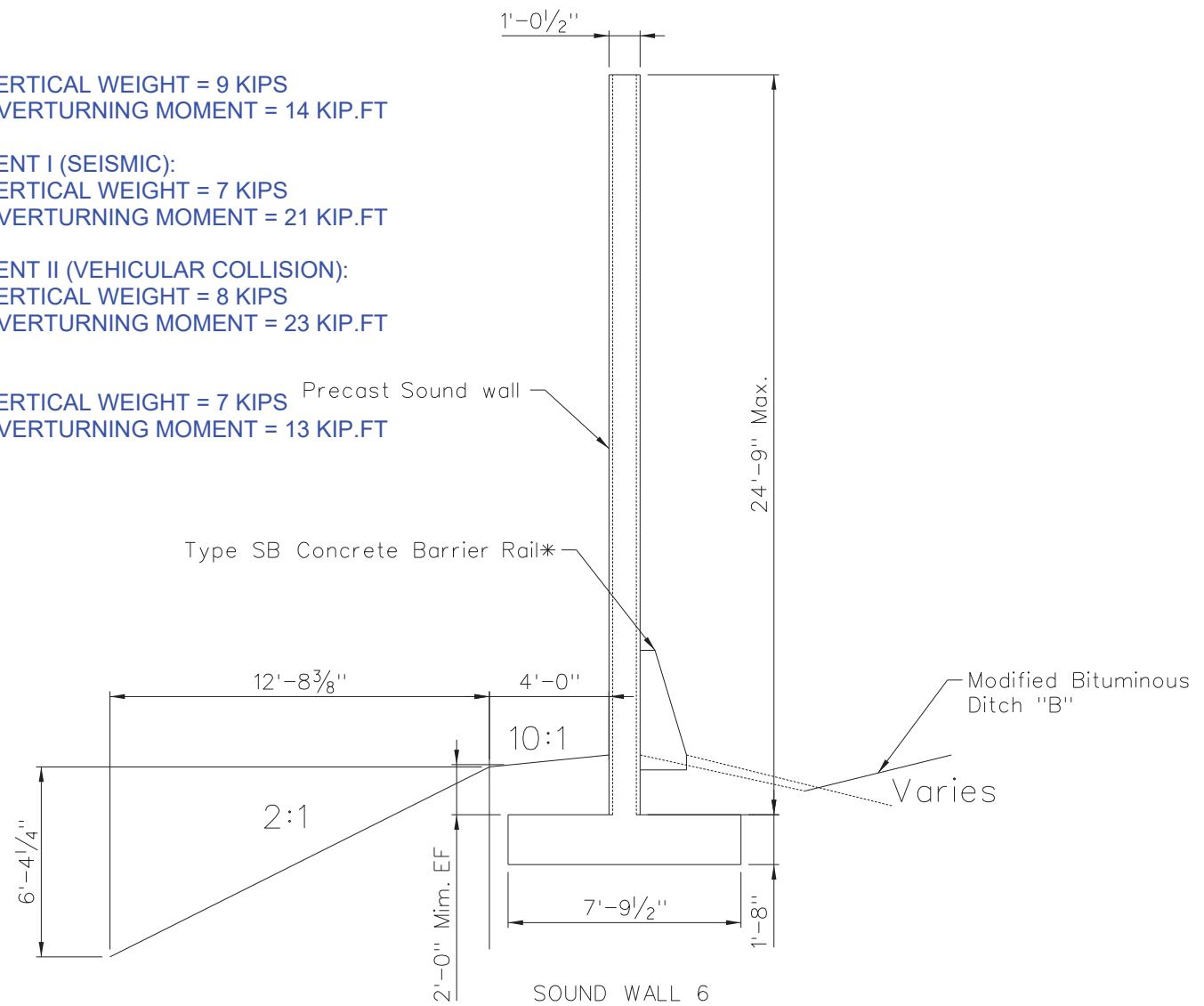
FACTORED VERTICAL WEIGHT = 8 KIPS

FACTORED OVERTURNING MOMENT = 23 KIP.FT

SERVICE:

FACTORED VERTICAL WEIGHT = 7 KIPS

FACTORED OVERTURNING MOMENT = 13 KIP.FT



Note:

* See Drainage Plans for Location of Type SB Concrete Barrier Rail and Modified Bituminous Ditch "B".

Blow Count Corrections

CORRECTION OF BLOW COUNTS

Project Number **475.0398.000**
 Project Name **US395 North Valleys Phase 1B**

SW 1

FORMULA:

$$(N_1)_{corrected}' = C_N * C_s * C_E * N_{field}$$

where:

- $(N_1)_{corrected}'$ = Corrected blow count for 1 tsf, 60% efficiency
- C_N = Overburden correction factor (See Reference 1)
- C_E = Energy correction (Efficiency/60%)
- C_s = Sampler Correction (Burmister, 1948)
- Efficiency = **60%** **Enter Drill** HSA HAZ TECH DRILLING

CALCULATIONS:

Boring: **BH19-SW1-05** Boring Elevation (ft msl): **4680**
 Depth to water (ft bgs): **0** Groundwater Elevation (ft msl): **4680.0**

Depth (ft bgs)	Elevation (ft msl)	Unit Weight (pcf)	Total Stress (psf)	Effective Stress (psf)	Sampler SPT = 1 MC = 2	Uncorrected Blow Count (N)** 1	Soil Type (1=fine-grained, 2=coarse-grained)	C_N	C_E	C_s	$(N_1)_{corr}$ (for cohesionless behavior)	$(N)_{corr}$ (for cohesive behavior)	ϕ' (for cohesionless soils) 2	S_u (psf) 3	Material Type	tan (phi)	Multiplier Table C10.4.6.3.1	Es (ksi) 4	Es (ksf)
4	4676.0	120	480	230	SPT	1	2	1.51	1.00	1.00	15	-	32	-	SC	0.883	0.139	2.10	302
5	4675.0	120	600	288	MC	2	2	1.57	1.00	0.67	64	-	43	-	SC	1.613	0.139	8.89	1280
7.5	4672.5	120	900	432	SPT	1	2	1.51	1.00	1.00	58	-	42	-	SC	1.332	0.139	8.00	1152
10	4670.0	120	1200	576	MC	2	1	1.42	1.00	0.67	-	31	-	CH	1.393	0.139			
15	4665.0	120	1800	864	SPT	1	2	1.28	1.00	1.00	128	-	49	4,475	GM	1.714	0.167	21.42	3084
20	4660.0	120	2400	1152	MC	2	2	1.19	1.00	0.67	111	-	48	-	GM	1.841	0.167	18.50	2664
25	4655.0	120	3000	1440	SPT	1	2	1.11	1.00	1.00	111	-	48	-	GM	1.581	0.167	18.56	2673

¹ Field counts limited to 100 blows for SPT and 140 for California Modified Sampler

² Based on Peck, Hanson, Thorton (1974), $\phi' = 54^\circ - 27.6034 * \exp(-0.014(N_1)_{60})$

³ Based on Stroud (1974), $S_u = f_1 * N_{60} * (Pa/100)$, $f_1 = 4.5$ to 5.5

⁴ Based on Bowles 1998, AASHTO Table C10.4.6.2.1: Coarse sands and sands with little gravel $0.139N_{60}$ and Coarse Sandy gravel and gravel $0.167N_{60}$

CORRECTION OF BLOW COUNTS

Project Number **475.0398.000**
 Project Name **US395 North Valleys Phase 1B**

SW-6

FORMULA:

$$(N_1)_{corrected}' = C_N * C_s * C_E * N_{field}$$

where:

- $(N_1)_{corrected}'$ = Corrected blow count for 1 tsf, 60% efficiency
- C_N = Overburden correction factor (See Reference 1)
- C_E = Energy correction (Efficiency/60%)
- C_s = Sampler Correction (Burmister, 1948)
- Efficiency = **79%** **Enter Drill** HSA HAZ TECH DRILLING

CALCULATIONS:

Boring: **BH19-SW7-47**
 Depth to water (ft bgs): **0**

Boring Elevation (ft msl): **5090**
 Groundwater Elevation (ft msl): **5090.0**

Depth (ft bgs)	Elevation (ft msl)	Unit Weight (pcf)	Total Stress (psf)	Effective Stress (psf)	Sampler SPT = 1 MC = 2	Uncorrected Blow Count (N)** 1	Soil Type (1=fine-grained, 2=coarse-grained)	C_N	C_E	C_s	$(N_1)_{corr}$ (for cohesionless behavior)	$(N)_{corr}$ (for cohesive behavior)	ϕ' (for cohesionless soils) 2	S_u (psf) 3	Material Type	tan (phi)	Multiplier Table C10.4.6.3.1	Es (ksi) 4	Es (ksf)
0	5090.0	120	0	0	SPT	1	74	2.00	1.32	1.00	195	-	52	-	FILL	2.027	0.139	27.09	3900.45
2.5	5087.5	120	300	144	SPT	1	16	1.42	1.32	1.00	30	-	36	-	FILL	1.161	0.139	4.16	598.75
5	5085.0	120	600	288	MC	2	140	1.57	1.32	0.67	193	-	52	-	FILL	2.349	0.139	26.86	3867.59
7.5	5082.5	120	900	432	SPT	1	10	1.51	1.32	1.00	20	-	33	-	FILL	0.929	0.139	2.77	399.08
10	5080.0	120	1200	576	MC	2	19	1.42	1.32	0.67	24	-	34	-	FILL	1.124	0.167	3.95	569.02
15	5075.0	120	1800	864	SPT	1	100	1.28	1.32	1.00	169	-	51	-	SC	1.882	0.167	28.20	4060.71
20	5070.0	130	2450	1202	MC	2	140	1.17	1.32	0.67	144	-	50	-	SC	2.008	0.167	24.07	3465.44
25	5065.0	130	3100	1540	SPT	1	42	1.09	1.32	1.00	60	-	42	-	SC	1.276	1.167	70.29	10121.95

¹ Field counts limited to 100 blows for SPT and 140 for California Modified Sampler

² Based on Peck, Hanson, Thornton (1974), $\phi' = 54^\circ - 27.6034 * \exp(-0.014(N_1)_{60})$

³ Based on Stroud (1974), $S_u = f_1 * N_{60} * (Pa/100)$, $f_1 = 4.5$ to 5.5

⁴ Based on Bowles 1998, AASHTO Table C10.4.6.2.1: Coarse sands and sands with little gravel $0.139N_{60}$ and Coarse Sandy gravel and gravel $0.167N_{60}$

ATTACHMENT B
Bearing Resistance Calculations

SW1 Strength Limit State

Project: US395 North Valleys, Phase 1B
 Structure: SW 1
 Stationing:
 Borings: BH19-SW1-05

Project No: 475.0398.000

Ground surface elevation (ft)
 Footing elevation (ft)
 Boring elevation (ft)
 Depth to groundwater (ft) 100

Groundwater elevation (ft)
 Depth of groundwater below footing (ft)

Bearing Pressure Calculations (AASHTO LRFBDS, 2020)

- 10.6.3.1.1-1 $q_R = \phi_R q_n$
- 10.6.3.1.2a-1 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{ym} C_{wy}$
- 10.6.3.1.2a-2 $N_{cm} = N_c S_c i_c$
- 10.6.3.1.2a-3 $N_{qm} = N_q S_q d_q i_q$
- 10.6.3.1.2a-4 $N_{ym} = N_y S_y i_y$
- 10.6.3.1.2a-6 $i_c = i_q - [(1-i_q)/(N_q - 1)]$
- 10.6.3.1.2a-7 $i_q = [1-H/(V+cBL\cot\phi_f)]^{(n)}$
- 10.6.3.1.2a-8 $i_y = [1-H/(V+cBL\cot\phi_f)]^{(n+1)}$
- 10.6.3.1.2a-9 $n = [(2+L/B)/(1+L/B)]\cos^2\theta + [2+B/L]/(1+B/L)\sin^2\theta$

Table 10.6.3.1.2a-3
 $S_c = 1 + (B/L)(N_q/N_c)$
 $S_y = 1 - 0.4(B/L)$
 $S_q = 1 + (B/L)\tan\phi_f$

Bearing resistance (q_R) (ksf)

Resistance factor (ϕ_R) Section 10 5.5.3 0.45

Nominal bearing resistance (q_n) (ksf)

Reduction coef. for slope effects (RC_{BC}) Tables 10.6.3.1.2c-2 0.43

Cohesion (c) (ksf) 0

Cohesion term (N_c) 35.5

Surcharge/embedment term (N_q) Table 10.6.3.1.2a-1 23.2

Unit weight term (N_y) Table 10.6.3.1.2a-1 30.2

Total (moist) unit wt (γ) (kcf) Table 10.6.3.1.2a-1 0.12

Footing embedment depth (D_f) (ft) 4

Effective Footing width (B') (ft) Section 10.6.1.3 4.9

Footing length (L) (ft)(based on stationing) 1419

Correction factors for location of groundwater (C_{wq}) 1

(C_{wy}) Table 10.6.3.1.2a-2 1

Shearing correction factor (d_q) Table 10.6.3.1.2a-4 1.2

Load inclination factors (i_c) 1

(i_q) 1

(i_y) 1

Angle of internal friction (ϕ_f) (degrees) 32

Radians 0.56

Gross Bearing (ksf) 1.1

Factored Overturning moment (k-ft) 10

Factored Vertical Weight (k) 8

Load Case	Calculated Values	
Strength	q_n	5.93
	q_R	2.67

N_{cm}	35.58
N_{qm}	27.90
N_{ym}	30.26
i_c	1
i_q	1
i_y	1
n	1.80
S_c	1.00
S_y	1.00
S_q	1.00

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$$B' = B - 2e_y \quad (10.6.1.3-1)$$

$$L' = L - 2e_z$$

where:

e_y = eccentricity parallel to dimension B (ft)

e_z = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Resistance Type	Method/Soil/Condition	Resistance Factor
Bearing Resistance	ϕ_b	
	Theoretical method (Munfakh et al., 2001), in clay	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using <i>CPT</i>	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using <i>SPT</i>	0.45
	Semi-empirical methods (Meyerhof, 1957), all soils	0.45
	Footings on rock	0.45
Sliding	ϕ_r	
	Plate Load Test	0.55
	Precast concrete placed on sand	0.90
	Cast-in-Place Concrete on sand	0.80
	Cast-in-Place or precast Concrete on Clay	0.85
	Soil on soil	0.90
ϕ_{sp}	Passive earth pressure component of sliding resistance	0.50

Table 10.6.3.1.2a-2—Coefficients C_{wq} and C_{wy} for Various Groundwater Depths

D_w	C_{wq}	C_{wy}
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_y (Vesic, 1975)

ϕ_f	N_c	N_q	N_y	ϕ_f	N_c	N_q	N_y
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
37	1	1.20
	2	1.25
	4	1.30
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

SECTION 10: FOUNDATIONS

for footings on or adjacent to slopes. Use linear interpolation to obtain reduction coefficients for values not provided. The slope stability factor, N_s , in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 shall be taken as:

$$N_s = \frac{\gamma H_z}{c} \quad (10.6.3.1.2c-2)$$

where:

N_s = slope stability factor (dim)

H_z = height of sloping ground surface below bottom of footing (ft)

and other variables are as defined in Article 10.6.3.1.2a.

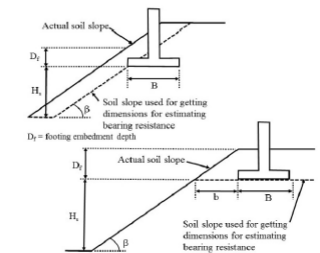


Figure 10.6.3.1.2c-1—Definition of Footing and Slope Geometric Parameters for Determination of RC_{ac}

SW1 Extreme Limit State

Project: US395 North Valleys, Phase 1B
 Structure: SW 1
 Stationing:
 Borings: BH19-SW1-05

Project No: 475.0398.000

Ground surface elevation (ft)
 Footing elevation (ft)
 Boring elevation (ft)
 Depth to groundwater (ft) 100

Groundwater elevation (ft)
 Depth of groundwater below footing (ft)

Bearing Pressure Calculations (AASHTO LRFBDS, 2020)

- 10.6.3.1.1-1 $q_R = \phi_R q_n$
- 10.6.3.1.2a-1 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{ym} C_{wy}$
- 10.6.3.1.2a-2 $N_{cm} = N_c S_c i_c$
- 10.6.3.1.2a-3 $N_{qm} = N_q S_q d_q i_q$
- 10.6.3.1.2a-4 $N_{ym} = N_y S_y i_y$
- 10.6.3.1.2a-6 $i_c = i_q - [(1-i_q)/(N_q - 1)]$
- 10.6.3.1.2a-7 $i_q = [1 - H/(V + cBL \cot \phi_f)]^{(n)}$
- 10.6.3.1.2a-8 $i_y = [1 - H/(V + cBL \cot \phi_f)]^{(n+1)}$
- 10.6.3.1.2a-9 $n = [(2+L/B)/(1+L/B)] \cos^2 \theta + [2+B/L]/(1+B/L) \sin^2 \theta$

- Table 10.6.3.1.2a-3**
- $S_c = 1 + (B/L)(N_q/N_c)$
 - $S_y = 1 - 0.4(B/L)$
 - $S_q = 1 + (B/L) \tan \phi_f$

Bearing resistance (q_R) (ksf)		
Resistance factor (ϕ_R)	Section 10.5.5.3	1
Nominal bearing resistanc (q_n) (ksf)		
Reduction coef. for slope effects (RC_{BC})	Tables 10.6.3.1.2c-2	0.43
Cohesion (c) (ksf)		0
Cohesion term (N_c)		35.5
Surcharge/embedment term (N_q)	Table 10.6.3.1.2a-1	23.2
Unit weight term (N_y)	Table 10.6.3.1.2a-1	30.2
Total (moist) unit wt (γ) (kcf)	Table 10.6.3.1.2a-1	0.12
Footing embedment depth (D_f) (ft)		4
Effective Footing width (B') (ft)	Section 10.6.1.3	3.0
Footing length (L) (ft)(based on stationing)		1419
Correction factors for location of groundwater	(C_{wq})	1
	Table 10.6.3.1.2a-2 (C_{wy})	1
Shearing correction factor (d_q)	Table 10.6.3.1.2a-4	1.2
Load inclination factors	(i_c)	1
	(i_q)	1
	(i_y)	1
Angle of internal friction (ϕ_f) (degrees)		32
Radians		0.56
Gross Bearing (ksf)		0.8
Factored Overturning moment (k-ft)		13
Factored Vertical Weight (k)		6

Load Case	Calculated Values	
Extreme	q_n	5.87
	q_R	5.87

N_{cm}	35.55
N_{qm}	27.88
N_{ym}	30.24
i_c	1
i_q	1
i_y	1
n	1.80
S_c	1.00
S_y	1.00
S_q	1.00

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$$B' = B - 2e_x \quad (10.6.1.3-1)$$

$$L' = L - 2e_z$$

where:

- e_x = eccentricity parallel to dimension B (ft)
- e_z = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Resistance	Method/Soil/Condition	Resistance Factor	
Bearing Resistance	ϕ_b	Theoretical method (Munfakh et al., 2001), in clay	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using CPT	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using SPT	0.45
		Semi-empirical methods (Meyerhof, 1957), all soils	0.45
		Footings on rock	0.45
		Plate Load Test	0.55
Sliding	ϕ_r	Precast concrete placed on sand	0.90
		Cast-in-Place Concrete on sand	0.80
		Cast-in-Place or precast Concrete on Clay	0.85
		Soil on soil	0.90
		ϕ_{sp} Passive earth pressure component of sliding resistance	0.50

Table 10.6.3.1.2a-2—Coefficients C_{wq} and C_{wy} for Various Groundwater Depths

D_w	C_{wq}	C_{wy}
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_y (Vesic, 1975)

ϕ_f	N_c	N_q	N_y	ϕ_f	N_c	N_q	N_y
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

SECTION 10: FOUNDATIONS

for footings on or adjacent to slopes. Use linear interpolation to obtain reduction coefficients for values not provided. The slope stability factor, N_z , in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 shall be taken as:

$$N_z = \frac{\gamma H_z}{c} \quad (10.6.3.1.2c-2)$$

where:

- N_z = slope stability factor (dim)
- H_z = height of sloping ground surface below bottom of footing (ft)

and other variables are as defined in Article 10.6.3.1.2a.

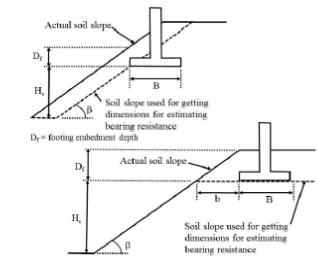


Figure 10.6.3.1.2c-1—Definition of Footing and Slope Geometric Parameters for Determination of RCBC

SW6 Strength Limit State

Project: US395 North Valleys, Phase 1B
 Structure: SW 6
 Stationing:
 Borings: BH19-SW7-47

Project No: 475.0398.000

Ground surface elevation (ft)
 Footing elevation (ft)
 Boring elevation (ft)
 Depth to groundwater (ft) 100

Groundwater elevation (ft)
 Depth of groundwater below footing (ft)

Bearing Pressure Calculations (AASHTO LRFDBDS, 2020)

10.6.3.1.1-1 $q_R = \phi_R q_n$
 10.6.3.1.2a-1 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{ym} C_{wy}$
 10.6.3.1.2a-2 $N_{cm} = N_c s_c i_c$
 10.6.3.1.2a-3 $N_{qm} = N_q s_q d_q i_q$
 10.6.3.1.2a-4 $N_{ym} = N_y s_y i_y$
 10.6.3.1.2a-6 $i_c = i_q - [(1 - i_q) / (N_q - 1)]$
 10.6.3.1.2a-7 $i_q = [1 - H / (V + cBL \cot \phi_f)]^{(n)}$
 10.6.3.1.2a-8 $i_y = [1 - H / (V + cBL \cot \phi_f)]^{(n+1)}$
 10.6.3.1.2a-9 $n = [(2 + L/B) / (1 + L/B)] \cos^2 \theta + [2 + B/L] / (1 + B/L) \sin^2 \theta$

Table 10.6.3.1.2a-3 $s_c = 1 + (B/L)(N_q/N_c)$
 $s_y = 1 - 0.4(B/L)$
 $s_q = 1 + (B/L) \tan \phi_f$

Bearing resistance (q_R) (ksf)

Resistance factor (ϕ_R) Section 10 5.5.3 0.45

Nominal bearing resistance (q_n) (ksf)

Reduction coef. for slope effects (RC_{BC}) Tables 10.6.3.1.2c-2 0.66

Cohesion (c) (ksf) 0

Cohesion term (N_c) 35.5

Surcharge/embedment term (N_q) Table 10.6.3.1.2a-1 23.2

Unit weight term (N_y) Table 10.6.3.1.2a-1 30.2

Total (moist) unit wt (γ) (ksf) Table 10.6.3.1.2a-1 0.12

Footing embedment depth (D_f) (ft) 3.67

Effective Footing width (B') (ft) Section 10.6.1.3 4.7

Footing length (L) (ft)(based on stationing) 1017

Correction factors for location of groundwater (C_{wq}) 1

(C_{wy}) Table 10.6.3.1.2a-2 1

Shearing correction factor (d_q) Table 10.6.3.1.2a-4 1.2

Load inclination factors (i_c) 1

(i_q) 1

(i_y) 1

Angle of internal friction (ϕ_f) (degrees) 32

Radians 0.56

Gross Bearing (ksf) 1.2

Factored Overturning moment (k-ft) 14

Factored Vertical Weight (k) 9

eccentricity (ft) 1.6

Load Case	Calculated Values		
Strength	q_n	8.30	q_R 3.74

N_{cm}	35.61
N_{qm}	27.92
N_{ym}	30.29
i_c	1
i_q	1
i_y	1
n	1.80
s_c	1.00
s_y	1.00
s_q	1.00

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$B' = B - 2e_x$ (10.6.1.3-1)

$L' = L - 2e_z$

where:

e_x = eccentricity parallel to dimension B (ft)

e_z = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Resistance Type	Method/Soil/Condition	Resistance Factor
Bearing Resistance	ϕ_b	
	Theoretical method (Munfakh et al., 2001), in clay	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using <i>CPT</i>	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using <i>SPT</i>	0.45
	Semi-empirical methods (Meyerhof, 1957), all soils	0.45
	Footings on rock	0.45
Sliding	ϕ_r	
	Plate Load Test	0.55
	Precast concrete placed on sand	0.90
	Cast-in-Place Concrete on sand	0.80
	Cast-in-Place or precast Concrete on Clay	0.85
	Soil on soil	0.90
	ϕ_{ep}	Passive earth pressure component of sliding resistance

Table 10.6.3.1.2a-2—Coefficients C_{wq} and C_{wy} for Various Groundwater Depths

D_w	C_{wq}	C_{wy}
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_y (Vesic, 1975)

ϕ_f	N_c	N_q	N_y	ϕ_f	N_c	N_q	N_y
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
37	1	1.20
	2	1.25
	4	1.30
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

SECTION 10: FOUNDATIONS

for footings on or adjacent to slopes. Use linear interpolation to obtain reduction coefficients for values not provided. The slope stability factor, N_s , in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 shall be taken as:

$N_s = \frac{\gamma H_z}{c}$ (10.6.3.1.2c-2)

where:

N_s = slope stability factor (dim)

H_z = height of sloping ground surface below bottom of footing (ft)

and other variables are as defined in Article 10.6.3.1.2a.

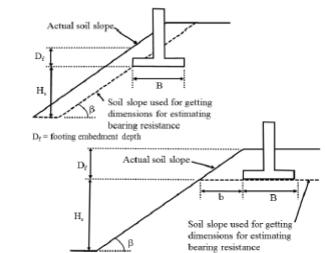


Figure 10.6.3.1.2c-1—Definition of Footing and Slope Geometric Parameters for Determination of RC_{ac}

SW6 Extreme I Limit State

Project: US395 North Valleys, Phase 1B
 Structure: SW 6
 Stationing:
 Borings: BH19-SW7-47

Project No: 475.0398.000

Ground surface elevation (ft)
 Footing elevation (ft)
 Boring elevation (ft)
 Depth to groundwater (ft) 100

Groundwater elevation (ft)
 Depth of groundwater below footing (ft)

Bearing Pressure Calculations (AASHTO LRFDDBS, 2020)

10.6.3.1.1-1 $q_R = \phi_R q_n$
 10.6.3.1.2a-1 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{ym} C_{wy}$
 10.6.3.1.2a-2 $N_{cm} = N_c S_c i_c$
 10.6.3.1.2a-3 $N_{qm} = N_q S_q d_q i_q$
 10.6.3.1.2a-4 $N_{ym} = N_y S_y i_y$
 10.6.3.1.2a-6 $i_c = i_q - [(1-i_q)/(N_q - 1)]$
 10.6.3.1.2a-7 $i_q = [1 - H / (V + cBL \cot \phi_f)]^{(n)}$
 10.6.3.1.2a-8 $i_y = [1 - H / (V + cBL \cot \phi_f)]^{(n+1)}$
 10.6.3.1.2a-9 $n = [(2+L/B)/(1+L/B)] \cos^2 \theta + [2+B/L]/(1+B/L) \sin^2 \theta$

Table 10.6.3.1.2a-3 $S_c = 1 + (B/L)(N_q/N_c)$
 $S_y = 1 - 0.4(B/L)$
 $S_q = 1 + (B/L) \tan \phi_f$

Bearing resistance (q_R) (ksf)		
Resistance factor (ϕ_R)	Section 10.5.5.3	1
Nominal bearing resistance (q_n) (ksf)		
Reduction coef. for slope effects (RC_{BC})	Tables 10.6.3.1.2c-2	0.66
Cohesion (c) (ksf)		0
Cohesion term (N_c)		35.5
Surcharge/embedment term (N_q)	Table 10.6.3.1.2a-1	23.2
Unit weight term (N_y)	Table 10.6.3.1.2a-1	30.2
Total (moist) unit wt (γ) (kcf)	Table 10.6.3.1.2a-1	0.12
Footing embedment depth (D_f) (ft)		3.67
Effective Footing width (B') (ft)	Section 10.6.1.3	1.8
Footing length (L) (ft) (based on stationing)		1017
Correction factors for location of groundwater	(C_{wq})	1
	Table 10.6.3.1.2a-2 (C_{wy})	1
Shearing correction factor (d_q)	Table 10.6.3.1.2a-4	1.2
Load inclination factors	(i_c)	1
	(i_q)	1
	(i_y)	1
Angle of internal friction (ϕ_f) (degrees)		32
Radians		0.56
Gross Bearing (ksf)		0.9
Factored Overturning moment (k-ft)		21
Factored Vertical Weight (k)		7
eccentricity (ft)		3.0

Load Case	Calculated Values			
Extreme I	q_n	8.17	q_R	8.17

N_{cm}	35.54
N_{qm}	27.87
N_{ym}	30.23
i_c	1
i_q	1
i_y	1
n	1.80
S_c	1.00
S_y	1.00
S_q	1.00

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$B' = B - 2e_y$ (10.6.1.3-1)

$L' = L - 2e_z$

where:

e_y = eccentricity parallel to dimension B (ft)
 e_z = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Resistance Type	Method/Soil/Condition	Resistance Factor
Bearing Resistance	Theoretical method (Munfakh et al., 2001), in clay	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using CPT	0.50
	Theoretical method (Munfakh et al., 2001), in sand, using SPT	0.45
	Semi-empirical methods (Meyerhof, 1957), all soils	0.45
	Footings on rock	0.45
Sliding	Plate Load Test	0.55
	Precast concrete placed on sand	0.90
	Cast-in-Place Concrete on sand	0.80
	Cast-in-Place or precast Concrete on Clay	0.85
	Soil on soil	0.90
	ϕ_{ep} Passive earth pressure component of sliding resistance	0.50

Table 10.6.3.1.2a-2—Coefficients C_{wq} and C_{wy} for Various Groundwater Depths

D_w	C_{wq}	C_{wy}
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_y (Vesic, 1975)

ϕ_f	N_c	N_q	N_y	ϕ_f	N_c	N_q	N_y
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
37	1	1.20
	2	1.25
	4	1.30
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

SECTION 10: FOUNDATIONS

for footings on or adjacent to slopes. Use linear interpolation to obtain reduction coefficients for values not provided. The slope stability factor, N_z , in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 shall be taken as:

$N_z = \frac{\gamma H_z}{c}$ (10.6.3.1.2c-2)

where:

N_z = slope stability factor (dim)
 H_z = height of sloping ground surface below bottom of footing (ft)

and other variables are as defined in Article 10.6.3.1.2a.

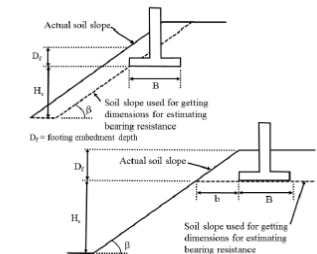


Figure 10.6.3.1.2c-1—Definition of Footing and Slope Geometric Parameters for Determination of RC_{ac}

SW6 Extreme II Limit State

Project: US395 North Valleys, Phase 1B
 Structure: SW 6
 Stationing:
 Borings: BH19-SW6-47

Project No: 475.0398.000

Ground surface elevation (ft)
 Footing elevation (ft)
 Boring elevation (ft)
 Depth to groundwater (ft) 100

Groundwater elevation (ft)
 Depth of groundwater below footing (ft)

Bearing Pressure Calculations (AASHTO LRFDDBS, 2020)

10.6.3.1.1-1 $q_R = \phi_R q_n$
 10.6.3.1.2a-1 $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{ym} C_{wy}$
 10.6.3.1.2a-2 $N_{cm} = N_c s_c i_c$
 10.6.3.1.2a-3 $N_{qm} = N_q s_q d_q i_q$
 10.6.3.1.2a-4 $N_{ym} = N_y s_y i_y$
 10.6.3.1.2a-6 $i_c = i_q - [(1-i_q)/(N_q - 1)]$
 10.6.3.1.2a-7 $i_q = [1 - H / (V + cBL \cot \phi_f)]^{(n)}$
 10.6.3.1.2a-8 $i_y = [1 - H / (V + cBL \cot \phi_f)]^{(n+1)}$
 10.6.3.1.2a-9 $n = [(2+L/B)/(1+L/B)] \cos^2 \theta + [2+B/L]/(1+B/L) \sin^2 \theta$

Table 10.6.3.1.2a-3 $s_c = 1 + (B/L)(N_q/N_c)$
 $s_y = 1 - 0.4(B/L)$
 $s_q = 1 + (B/L) \tan \phi_f$

Bearing resistance (q_R) (ksf)		
Resistance factor (ϕ_R)	Section 10.5.5.3	1
Nominal bearing resistanc (q_n) (ksf)		
Reduction coef. for slope effects (RC_{BC})	Tables 10.6.3.1.2c-2	0.66
Cohesion (c) (ksf)		0
Cohesion term (N_c)		35.5
Surcharge/embedment term (N_q)	Table 10.6.3.1.2a-1	23.2
Unit weight term (N_y)	Table 10.6.3.1.2a-1	30.2
Total (moist) unit wt (γ) (kcf)	Table 10.6.3.1.2a-1	0.12
Footing embedment depth (D_f) (ft)		3.67
Effective Footing width (B') (ft)	Section 10.6.1.3	2.0
Footing length (L) (ft)(based on stationing)		1017
Correction factors for location of groundwater	(C_{wq})	1
	Table 10.6.3.1.2a-2 (C_{wy})	1
Shearing correction factor (d_q)	Table 10.6.3.1.2a-4	1.2
Load inclination factors	(i_c)	1
	(i_q)	1
	(i_y)	1
Angle of internal friction (ϕ_f) (degrees)		32
Radians		0.56
Gross Bearing (ksf)		0.9
Factored Overturning moment (k-ft)		23
Factored Vertical Weight (k)		8
eccentricity (ft)		2.9

Load Case	Calculated Values			
Extreme II	q_n	8.18	q_R	8.18

N_{cm}	35.55
N_{qm}	27.87
N_{ym}	30.24
i_c	1
i_q	1
i_y	1
n	1.80
s_c	1.00
s_y	1.00
s_q	1.00

10.6.1.3—Effective Footing Dimensions

For eccentrically loaded footings, a reduced effective area, $B' \times L'$, within the confines of the physical footing shall be used in geotechnical design for settlement or bearing resistance. The point of load application shall be at the centroid of the reduced effective area.

The reduced dimensions for an eccentrically loaded rectangular footing shall be taken as:

$B' = B - 2e_y$ (10.6.1.3-1)

$L' = L - 2e_z$

where:

e_y = eccentricity parallel to dimension B (ft)
 e_z = eccentricity parallel to dimension L (ft)

Footings under eccentric loads shall be designed to ensure that the factored bearing resistance is not less than the effects of factored loads at all applicable limit states.

Table 10.5.5.2.2-1—Resistance Factors for Geotechnical Resistance of Shallow Foundations at the Strength Limit State

Resistance Type	Method/Soil/Condition	Resistance Factor	
Bearing Resistance	ϕ_b	Theoretical method (Munfakh et al., 2001), in clay	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using <i>CPT</i>	0.50
		Theoretical method (Munfakh et al., 2001), in sand, using <i>SPT</i>	0.45
		Semi-empirical methods (Meyerhof, 1957), all soils	0.45
		Footings on rock	0.45
		Plate Load Test	0.55
Sliding	ϕ_r	Precast concrete placed on sand	0.90
		Cast-in-Place Concrete on sand	0.80
		Cast-in-Place or precast Concrete on Clay	0.85
		Soil on soil	0.90
		ϕ_{ep} Passive earth pressure component of sliding resistance	0.50

Table 10.6.3.1.2a-2—Coefficients C_{wq} and C_{wy} for Various Groundwater Depths

D_w	C_{wq}	C_{wy}
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_y (Vesic, 1975)

ϕ_f	N_c	N_q	N_y	ϕ_f	N_c	N_q	N_y
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
37	1	1.20
	2	1.25
	4	1.30
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

SECTION 10: FOUNDATIONS

for footings on or adjacent to slopes. Use linear interpolation to obtain reduction coefficients for values not provided. The slope stability factor, N_z , in Tables 10.6.3.1.2c-1 and 10.6.3.1.2c-2 shall be taken as:

$N_z = \frac{\gamma H_z}{c}$ (10.6.3.1.2c-2)

where:

N_z = slope stability factor (dim)
 H_z = height of sloping ground surface below bottom of footing (ft)

and other variables are as defined in Article 10.6.3.1.2a.

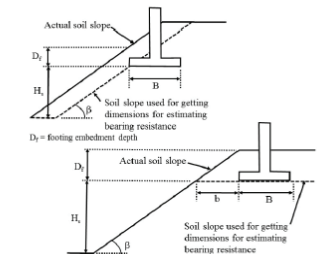
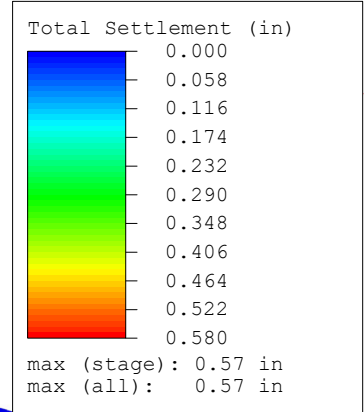
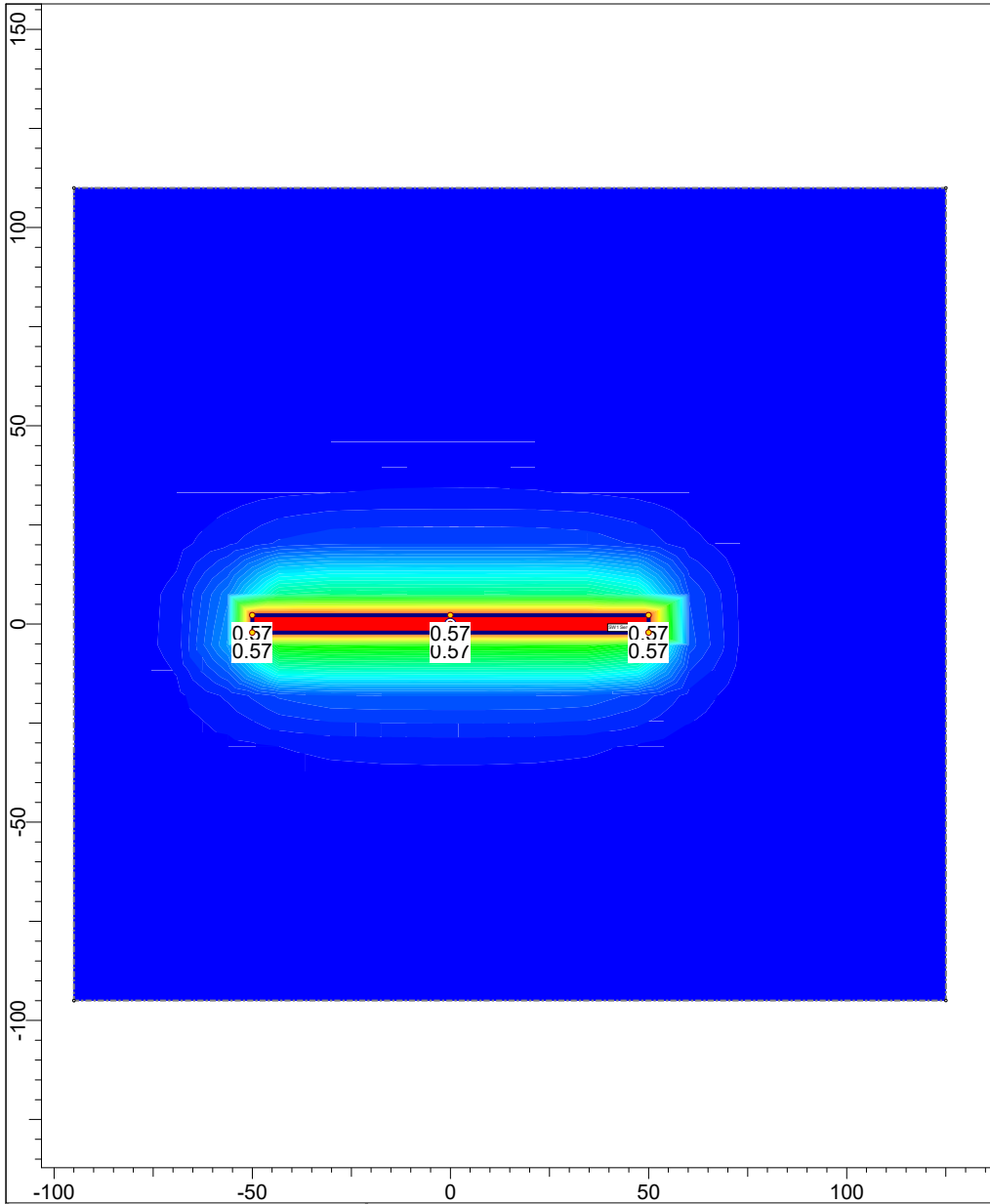



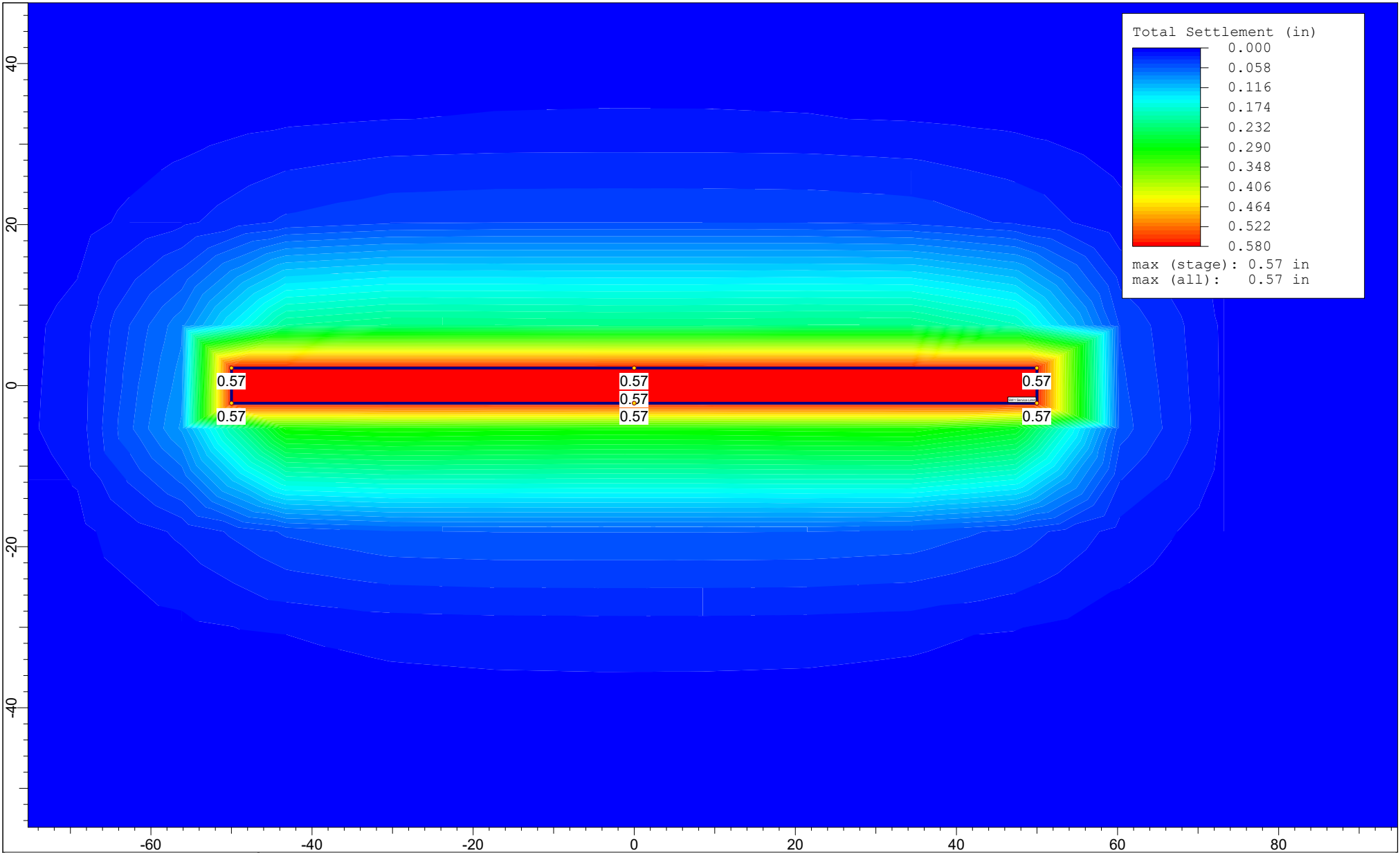
Figure 10.6.3.1.2c-1—Definition of Footing and Slope Geometric Parameters for Determination of RC_{ac}


ATTACHMENT C
Settle3 Results

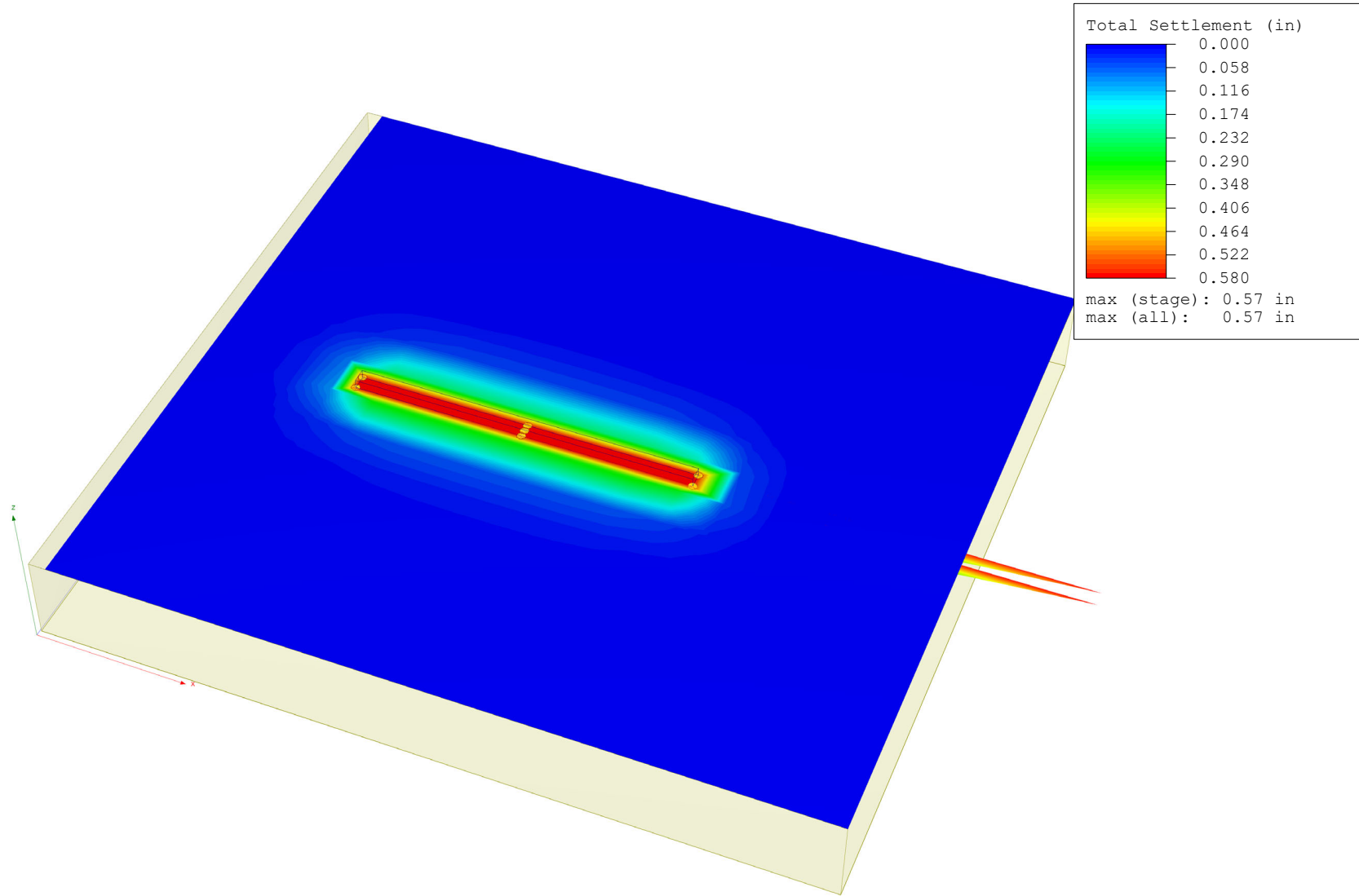
SW1



	Project			NDOT US395 North Valleys		
	Analysis Description			SW1: Service Limit		
	Drawn By	T. Sturgeon	Scale	\$ModelScale	Company	NewFields
	Date	11/2/2022		File Name	SW1_REV3.s3z	



	<i>Project</i> NDOT US395 North Valleys		
	<i>Analysis Description</i> SW1: Service Limit		
	<i>Drawn By</i> T. Sturgeon	<i>Scale</i> \$ModelScale	<i>Company</i> NewFields
	<i>Date</i> 11/2/2022	<i>File Name</i> SW1_REV3.s3z	



<i>Project</i>	NDOT US395 North Valleys		
<i>Analysis Description</i>	SW1: Service Limit		
<i>Drawn By</i>	T. Sturgeon	<i>Scale</i>	<i>Company</i>
<i>Date</i>	11/2/2022	<i>File Name</i>	NewFields
			SW1_REV3.s3z



NDOT US395 North Valleys
NewFields

Report Creation Date: 2022/11/02, 11:45:26

Table of Contents

Project Settings	3
Stage Settings	4
Results	5
Stage: Stage 1	5
Loads	6
1. Rectangular Load: "SW1 Service Limit"	6
Coordinates	6
Soil Layers	7
Soil Properties	8
Query Points	9
Field Point Grid	10
Grid Coordinates	10

Settle3 Analysis Information

NDOT US395 North Valleys

Project Settings

Document Name	SW1_REV3
Project Title	NDOT US395 North Valleys
Analysis	SW1: Service Limit
Author	T. Sturgeon
Company	NewFields
Date Created	11/2/2022
Stress Computation Method	Boussinesq
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Improve consolidation accuracy	
Ignore negative effective stresses in settlement calculations	

Stage Settings

Stage #	Name
1	Stage 1

Results

Time taken to compute: 0.481588 seconds

Stage: Stage 1

Data Type	Minimum	Maximum
Total Settlement [in]	0	0.574768
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0.574768
Loading Stress ZZ [ksf]	6.97958e-13	2.83892
Loading Stress XX [ksf]	-1.60879	1.89135
Loading Stress YY [ksf]	-0.440427	2.33511
Total Stress ZZ [ksf]	6.97958e-13	3.32374
Total Stress XX [ksf]	-0.851359	4.5992
Total Stress YY [ksf]	-0.204396	3.77359
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	45.2634
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	45.2634
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00946308
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.00306	3.32235
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0.032303

Loads

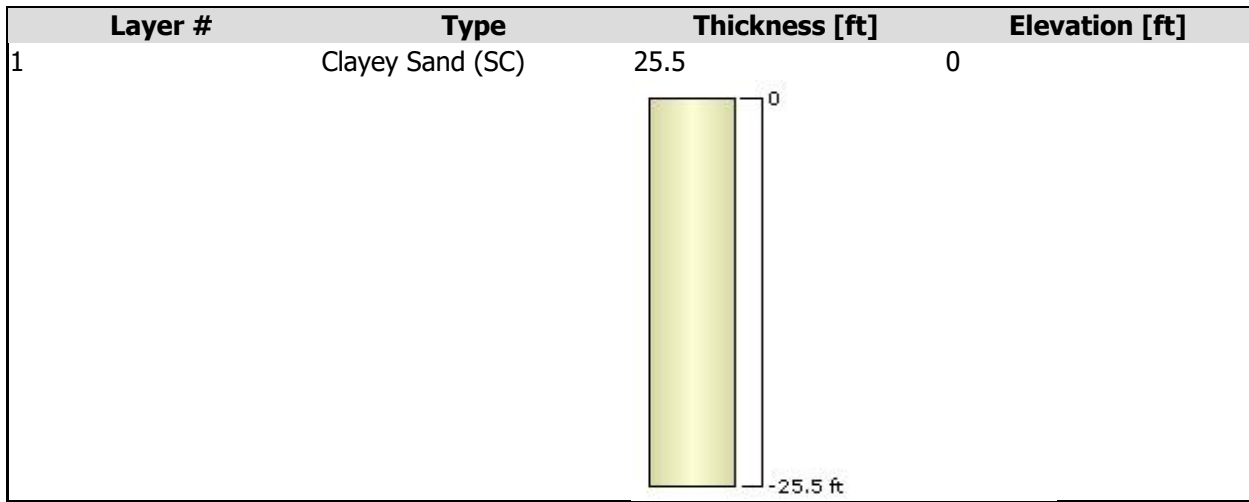
1. Rectangular Load: "SW1 Service Limit"

Length	100 ft
Width	4.375 ft
Rotation angle	0 degrees
Load Type	Rigid
Area of Load	437.5 ft ²
Load	2.7 ksf
Elevation	0 ft
Installation Stage	Stage 1


Coordinates

	X [ft]	Y [ft]
-50	-2.1875	
50	-2.1875	
50	2.1875	
-50	2.1875	

Soil Layers



Soil Properties

Property	Clayey Sand (SC)
Color	
Unit Weight [kips/ft3]	0.12
K0	1
Immediate Settlement	Enabled
Es [ksf]	300
Esur [ksf]	300
Undrained Su A [kips/ft2]	0
Undrained Su S	0.2
Undrained Su m	0.8

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Query Point 1	0, 0	Auto: 31
2	Query Point 2	0, -2.1875	Auto: 31
3	Query Point 3	0, 2.1875	Auto: 31
4	Query Point 4	-50, 2.1875	Auto: 31
5	Query Point 5	-50, -2.1875	Auto: 31
6	Query Point 6	50, 2.1875	Auto: 31
7	Query Point 7	50, -2.1875	Auto: 31

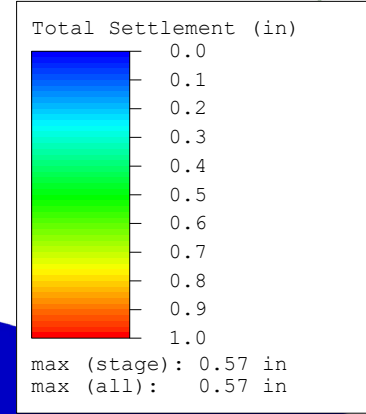
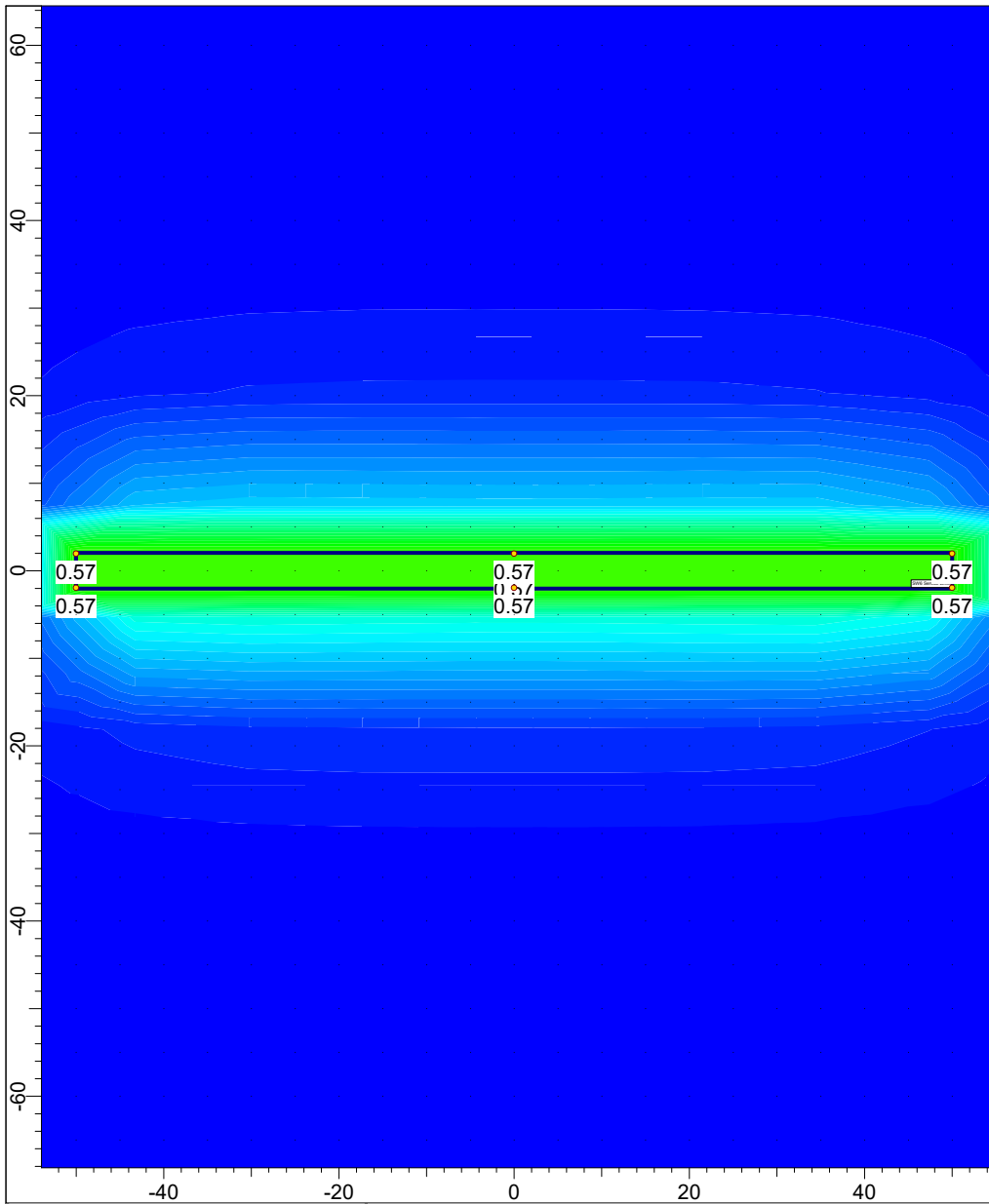
Field Point Grid

Number of points 326
Expansion Factor 2

Grid Coordinates

	X [ft]	Y [ft]
125	110	
125	-95	
-100	-95	
-100	110	


SW6

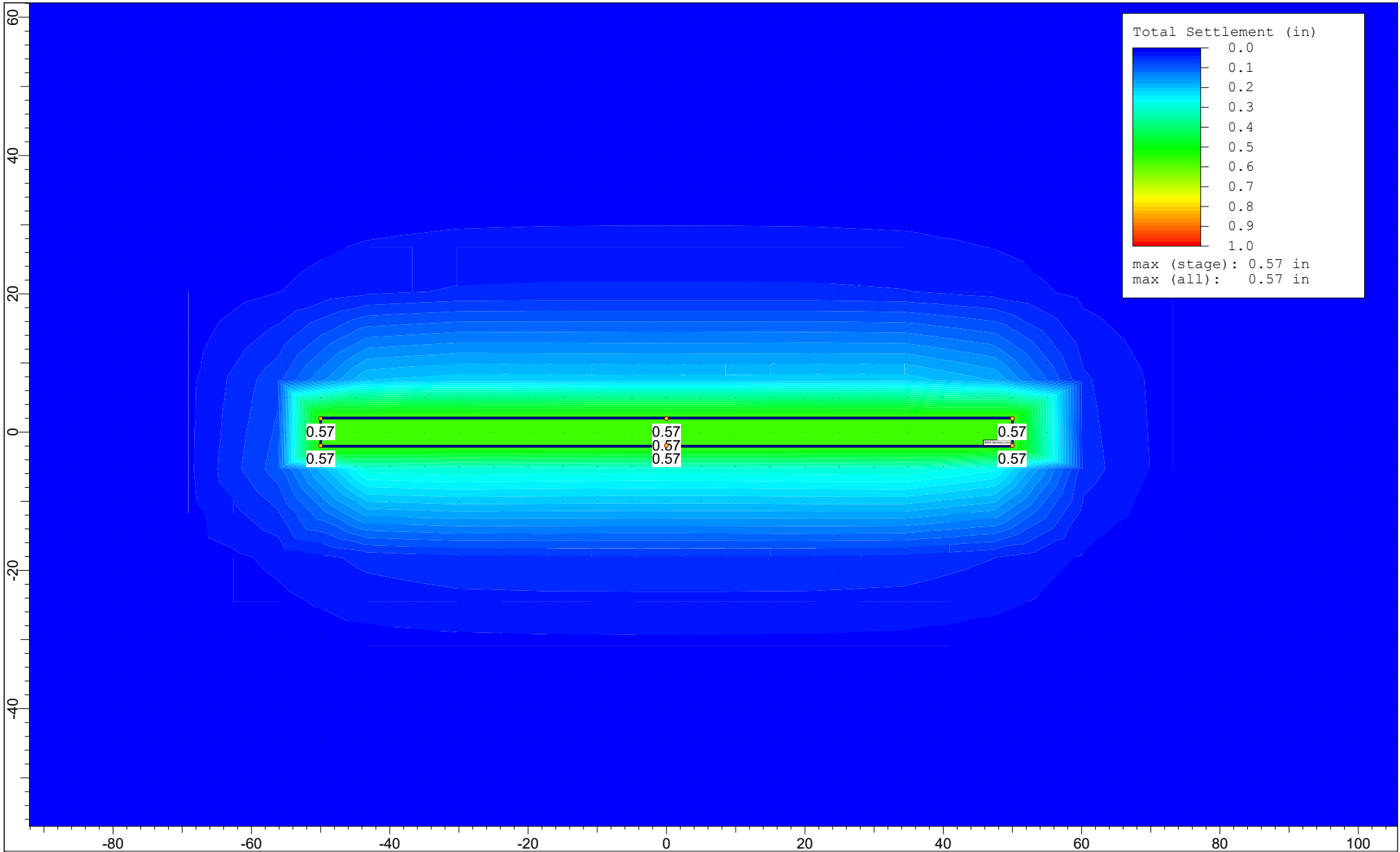



Total Settlement (in)

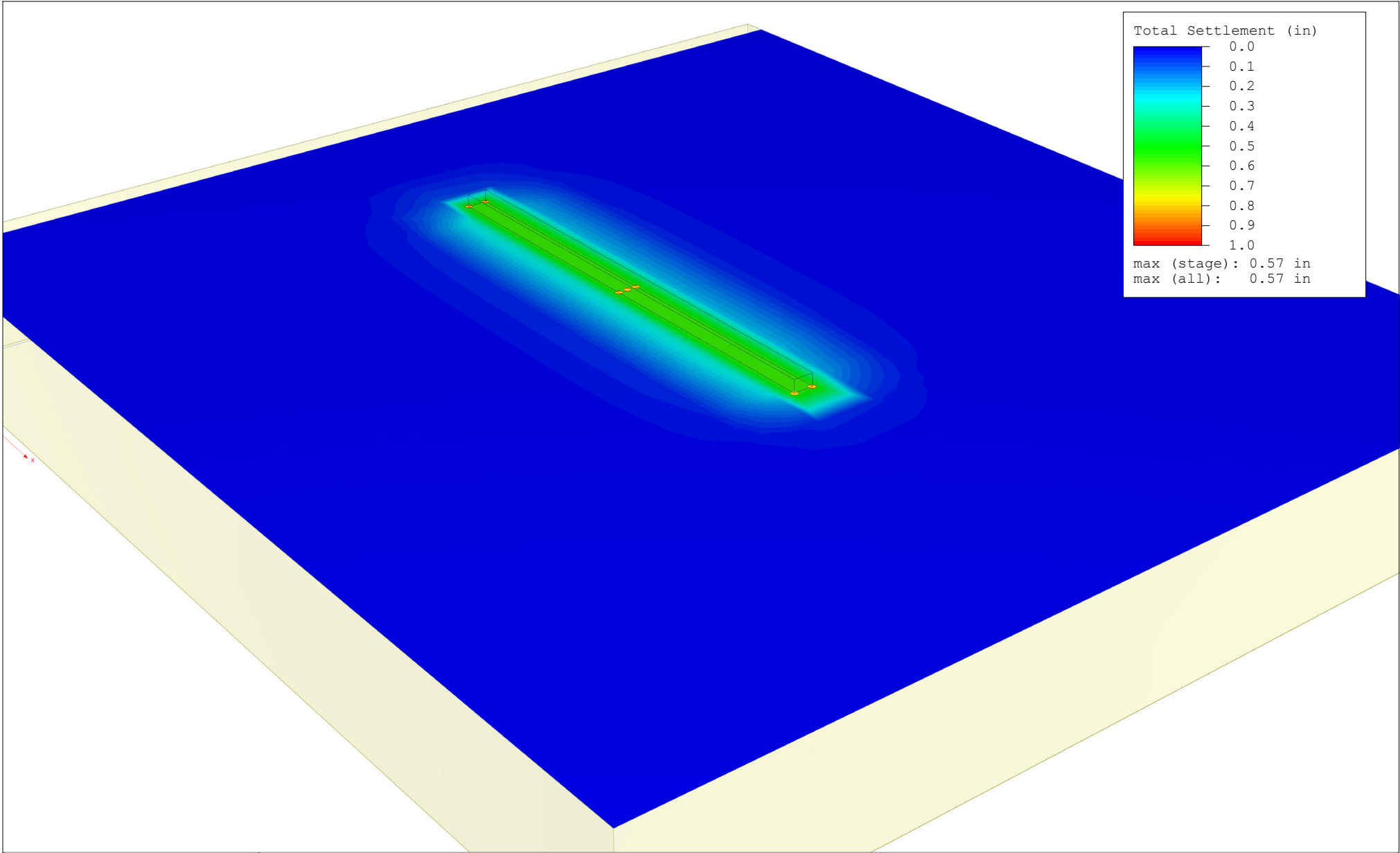
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0


max (stage): 0.57 in
max (all): 0.57 in

	Project			NDOT US395 North Valleys		
	Analysis Description			SW6: Service Limit		
	Drawn By	A. Gonzalez	Scale	\$ModelScale	Company	NewFields
	Date	11/2/2022, 10:17:23 AM		File Name	SW6_Rev3.s3z	



	Project			NDOT US395 North Valleys		
	Analysis Description			SW6: Service Limit		
	Drawn By	A. Gonzalez	Scale	\$ModelScale	Company	NewFields
	Date	11/2/2022, 10:17:23 AM		File Name	SW6_Rev3.s3z	



	Project			NDOT US395 North Valleys		
	Analysis Description			SW6: Service Limit		
	Drawn By	A. Gonzalez	Scale	\$ModelScale	Company	NewFields
	Date	11/2/2022, 10:17:23 AM		File Name	SW6_Rev3.s3z	



NDOT US395 North Valleys
NewFields

Report Creation Date: 2022/11/07, 15:33:19

Table of Contents

- Project Settings 3
 - Advanced Settings 3
 - Soil Profile 3
- Stage Settings 4
- Results 5
 - Stage: Stage 1 5
- Loads 6
 - 1. Rectangular Load: "SW6 Service Limit" 6
 - Coordinates 6
- Soil Layers 7
- Soil Properties 8
- Query 9
 - Query Points 9
 - Field Point Grid 9
 - Grid Coordinates 9

Settle3 Analysis Information

NDOT US395 North Valleys

Project Settings

Document Name	SW6_Rev3.s3z
Project Title	NDOT US395 North Valleys
Analysis	SW6: Service Limit
Author	A. Gonzalez
Company	NewFields
Date Created	11/2/2022, 10:17:23 AM
Last saved with Settle3 version	5.017
Stress Computation Method	Boussinesq
Stress Units	Imperial, stress as ksf
Settlement Units	inches

Advanced Settings

Start of secondary consolidation (% of primary)	95
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	No
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Horizontal Soil Layers
Vertical Axis	Elevation
Ground Elevation (ft)	0

Stage Settings

Stage #	Name
1	Stage 1

Results

Time taken to compute: 0.880669 seconds

Stage: Stage 1

Data Type	Minimum	Maximum
Total Settlement [in]	0	0.569646
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0.569646
Loading Stress ZZ [ksf]	8.89342e-13	3.87095
Loading Stress XX [ksf]	-2.12719	2.54033
Loading Stress YY [ksf]	-0.559607	3.19907
Total Stress ZZ [ksf]	8.89342e-13	3.89548
Total Stress XX [ksf]	-1.33241	5.41692
Total Stress YY [ksf]	-0.257028	3.97902
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	80.5758
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	80.5758
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00970163
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.00306	3.89143
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0.038125

Loads

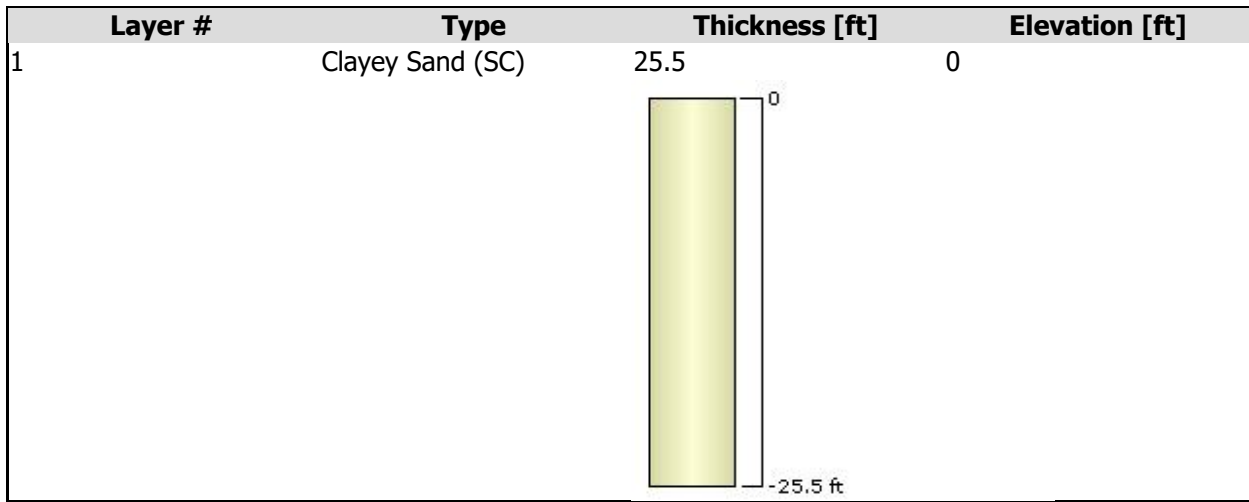
1. Rectangular Load: "SW6 Service Limit"

Length	100 ft
Width	4.07 ft
Rotation angle	0 degrees
Load Type	Rigid
Area of Load	407 ft ²
Load	3.7 ksf
Elevation	0 ft
Installation Stage	Stage 1


Coordinates

	X [ft]	Y [ft]
-50		-2.035
50		-2.035
50		2.035
-50		2.035

Soil Layers



Soil Properties

Property	Clayey Sand (SC)
Color	
Unit Weight [kips/ft3]	0.12
K0	1
Immediate Settlement	Enabled
Es [ksf]	399
Esur [ksf]	399
Undrained Su A [kips/ft2]	0
Undrained Su S	0.2
Undrained Su m	0.8

Query

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Query Point 1	0, 0	Auto: 31
2	Query Point 2	0, -1.955	Auto: 31
3	Query Point 3	0, 1.955	Auto: 31
4	Query Point 4	-50, 1.955	Auto: 31
5	Query Point 5	-50, -1.955	Auto: 31
6	Query Point 6	50, 1.955	Auto: 31
7	Query Point 7	50, -1.955	Auto: 31

Field Point Grid

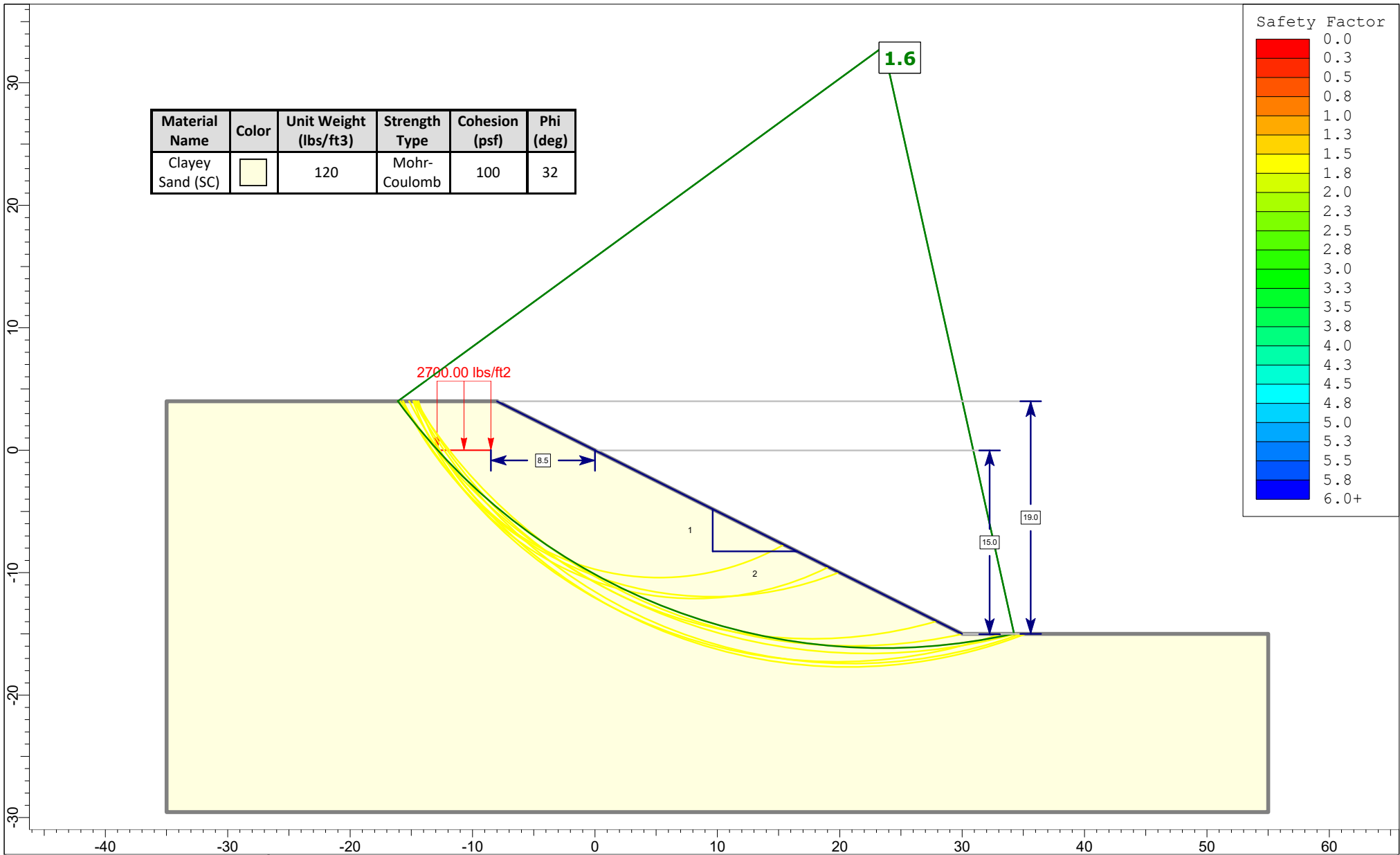
Number of points 326
 Expansion Factor 2

Grid Coordinates

X [ft]	Y [ft]
125	110
125	-95
-100	-95
-100	110

ATTACHMENT D
SLIDE Global Stability Results

SW1



Sound Wall SW1 - Static Condition



Analysis Description

Drawn By T. Sturgeon

Scale 1:130

Company Newfields

Date Printed 11/2/2022

File Name SW1 Service Limit Static_Rev3.slm



SW1 Service Limit Static_Rev3
Sound Wall SW1 - Static Condition
Newfields
Date Created: 11/01/2022
Software Version: 9.02

Table of Contents

Project Summary	3
General Settings	4
Analysis Options	5
Groundwater Analysis	6
Random Numbers	7
Surface Options	8
Seismic Loading	9
Loading	10
Materials	11
Entity Information	12
Group 1	12
Shared Entities	12
Scenario-based Entities	12

Slide Analysis Information

SW1 Service Limit Static_Rev3

Project Summary

File Name:	SW1 Service Limit Static_Rev3.slmd
Last saved with Slide version:	9.02
Project Title:	Sound Wall SW1 - Static Condition
Author:	T. Sturgeon
Company:	Newfields
Date Created:	11/01/2022

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft ³]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	10
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

1 Distributed Load present

Distributed Load 1

Distribution:	Constant
Magnitude [psf]:	2700
Orientation:	Vertical

Materials

Clayey Sand (SC)

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	None
Ru Value	0

Entity Information

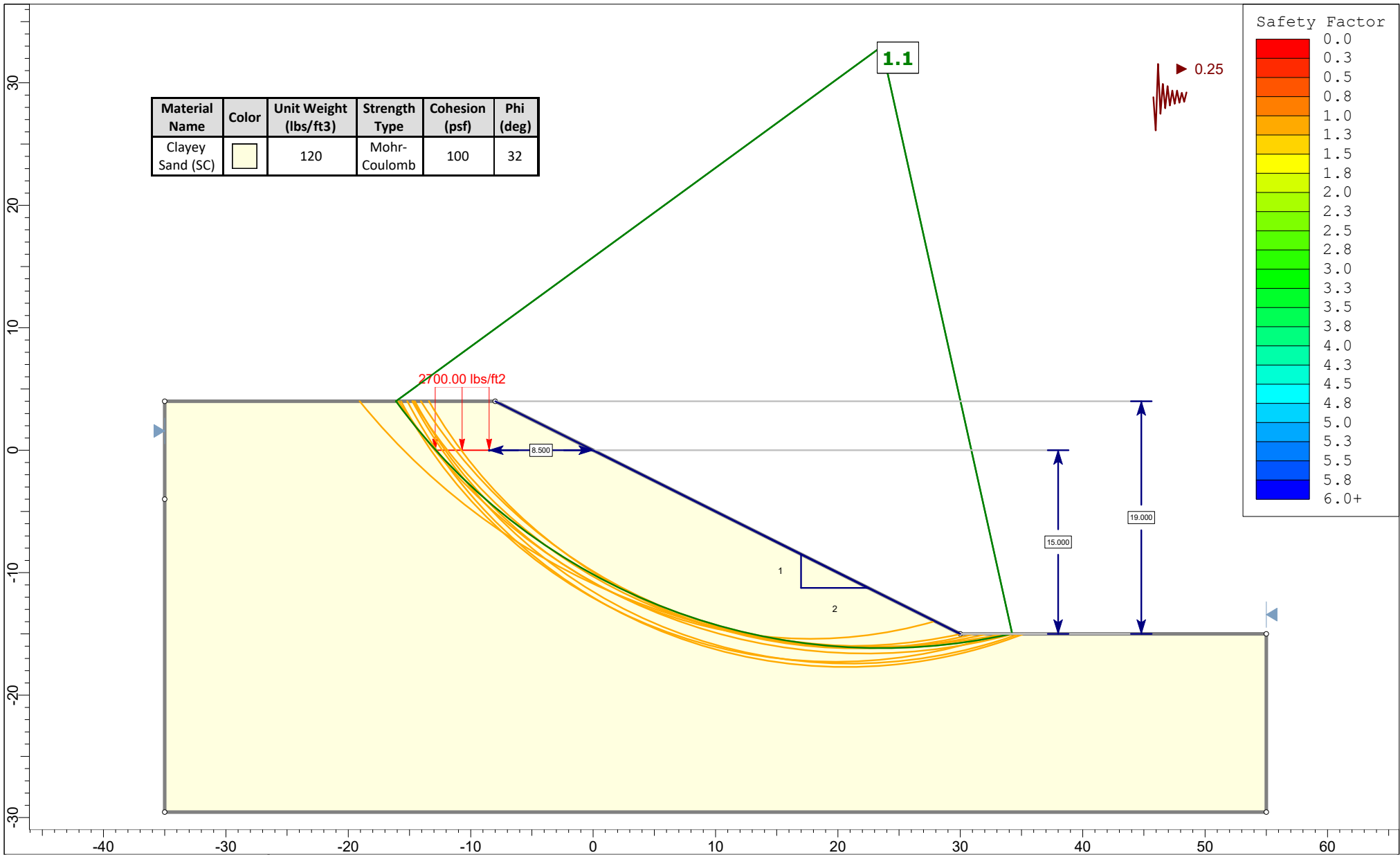
◆ **Group 1**

Shared Entities

Type	Coordinates (x,y)
External Boundary	-8, 4 -35, 4 -35, -4 -35, -29.5521 55, -29.5521 55, -15 30, -15

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Distributed Load	-8.5, 0 -12.9, 0	Constant DistributionOrientation: VerticalMagnitude: 2700 lbs/ft2Creates Excess Pore Pressure: No



Sound Wall SW1 - Seismic Condition



Analysis Description

Drawn By T. Sturgeon

Scale 1:130

Company Newfields

Date Printed 11/2/2022

File Name SW1 Service Limit Seismic_Rev4_.slmd



SW1 Service Limit Seismic_Rev4_
Sound Wall SW1 - Seismic Condition
Newfields
Date Created: 11/01/2022
Software Version: 9.02

Table of Contents

Project Summary	3
General Settings	4
Analysis Options	5
Groundwater Analysis	6
Random Numbers	7
Surface Options	8
Seismic Loading	9
Loading	10
Materials	11
Global Minimums	12
Method: spencer	12
Valid and Invalid Surfaces	13
Method: spencer	13
Error Code Descriptions	13
Slice Data	14
Global Minimum Query (spencer) - Safety Factor: 1.10264	14
Interslice Data	16
Global Minimum Query (spencer) - Safety Factor: 1.10264	16
Entity Information	17
Group 1	17
Shared Entities	17
Scenario-based Entities	17

Slide Analysis Information

SW1 Service Limit Seismic_Rev4_

Project Summary

File Name:	SW1 Service Limit Seismic_Rev4_.slmd
Slide Modeler Version:	9.02
Compute Time:	00h:00m:00.582s
Project Title:	Sound Wall SW1 - Seismic Condition
Author:	T. Sturgeon
Company:	Newfields
Date Created:	11/01/2022

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft ³]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	10
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.25

Loading

1 Distributed Load present

Distributed Load 1

Distribution:	Constant
Magnitude [psf]:	2700
Orientation:	Vertical

Materials

Clayey Sand (SC)

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	None
Ru Value	0

Global Minimums

Method: spencer

	FS	1.102640
Center:		23.577, 32.959
Radius:		49.130
Left Slip Surface Endpoint:		-16.111, 4.000
Right Slip Surface Endpoint:		34.238, -15.000
Resisting Moment:		1.66659e+06 lb-ft
Driving Moment:		1.51146e+06 lb-ft
Resisting Horizontal Force:		29890.7 lb
Driving Horizontal Force:		27108.4 lb
Total Slice Area:		329.564 ft ²
Surface Horizontal Width:		50.3491 ft
Surface Average Height:		6.54557 ft

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 1851

Number of Invalid Surfaces: 3149

Error Codes

Error Code -103 reported for 22 surfaces

Error Code -106 reported for 27 surfaces

Error Code -111 reported for 4 surfaces

Error Code -114 reported for 576 surfaces

Error Code -115 reported for 2520 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-106 = Average slice width is less than $0.0001 * (\text{maximum horizontal extent of soil region})$. This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.

-111 = Safety factor equation did not converge

-114 = Surface with Reverse Curvature.

-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.10264

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.00698	80.4727	-52.9092	Clayey Sand (SC)	100	32	90.5663	99.862	-0.220816	0	-0.220816	119.569	119.569
2	1.00698	236.084	-51.0024	Clayey Sand (SC)	100	32	129.039	142.283	67.6675	0	67.6675	227.031	227.031
3	1.00698	381.635	-49.1711	Clayey Sand (SC)	100	32	168.262	185.533	136.881	0	136.881	331.616	331.616
4	1.00698	518.225	-47.4054	Clayey Sand (SC)	100	32	820.951	905.213	1288.61	0	1288.61	2181.56	2181.56
5	1.00698	646.74	-45.697	Clayey Sand (SC)	100	32	1082.17	1193.24	1749.55	0	1749.55	2858.37	2858.37
6	1.00698	767.914	-44.0395	Clayey Sand (SC)	100	32	1153.33	1271.71	1875.13	0	1875.13	2990.42	2990.42
7	1.00698	882.357	-42.4271	Clayey Sand (SC)	100	32	1224.37	1350.04	2000.49	0	2000.49	3119.55	3119.55
8	1.00698	990.584	-40.8553	Clayey Sand (SC)	100	32	886.798	977.819	1404.8	0	1404.8	2171.76	2171.76
9	1.00698	1065.84	-39.3199	Clayey Sand (SC)	100	32	404.39	445.897	553.55	0	553.55	884.774	884.774
10	1.00698	1102.14	-37.8176	Clayey Sand (SC)	100	32	426.831	470.641	593.149	0	593.149	924.443	924.443
11	1.00698	1133.29	-36.3452	Clayey Sand (SC)	100	32	448.285	494.297	631.007	0	631.007	960.85	960.85
12	1.00698	1159.66	-34.9002	Clayey Sand (SC)	100	32	468.763	516.877	667.143	0	667.143	994.16	994.16
13	1.00698	1181.5	-33.4803	Clayey Sand (SC)	100	32	488.252	538.366	701.531	0	701.531	1024.46	1024.46
14	1.00698	1199.04	-32.0832	Clayey Sand (SC)	100	32	506.732	558.743	734.143	0	734.143	1051.81	1051.81
15	1.00698	1212.48	-30.7072	Clayey Sand (SC)	100	32	524.188	577.991	764.945	0	764.945	1076.28	1076.28
16	1.00698	1221.98	-29.3506	Clayey Sand (SC)	100	32	540.6	596.087	793.904	0	793.904	1097.9	1097.9
17	1.00698	1227.72	-28.0118	Clayey Sand (SC)	100	32	555.945	613.007	820.983	0	820.983	1116.73	1116.73
18	1.00698	1229.83	-26.6895	Clayey Sand (SC)	100	32	570.201	628.726	846.138	0	846.138	1132.79	1132.79
19	1.00698	1228.44	-25.3824	Clayey Sand (SC)	100	32	583.34	643.214	869.324	0	869.324	1146.09	1146.09
20	1.00698	1223.67	-24.0892	Clayey Sand (SC)	100	32	595.333	656.438	890.486	0	890.486	1156.66	1156.66
21	1.00698	1215.62	-22.809	Clayey Sand (SC)	100	32	606.148	668.363	909.57	0	909.57	1164.48	1164.48
22	1.00698	1204.38	-21.5407	Clayey Sand (SC)	100	32	615.748	678.948	926.506	0	926.506	1169.56	1169.56
23	1.00698	1190.04	-20.2834	Clayey Sand (SC)	100	32	624.091	688.148	941.238	0	941.238	1171.89	1171.89
24	1.00698	1172.68	-19.0363	Clayey Sand (SC)	100	32	631.135	695.915	953.665	0	953.665	1171.43	1171.43
25	1.00698	1152.36	-17.7984	Clayey Sand (SC)	100	32	636.83	702.194	963.709	0	963.709	1168.15	1168.15
26	1.00698	1129.15	-16.5691	Clayey Sand (SC)	100	32	641.118	706.922	971.277	0	971.277	1162.03	1162.03
27	1.00698	1103.11	-15.3475	Clayey Sand (SC)	100	32	643.939	710.033	976.259	0	976.259	1152.99	1152.99
28	1.00698	1074.29	-14.1331	Clayey Sand (SC)	100	32	645.225	711.451	978.521	0	978.521	1140.99	1140.99
29	1.00698	1042.73	-12.9251	Clayey Sand (SC)	100	32	644.899	711.091	977.952	0	977.952	1125.95	1125.95
30	1.00698	1008.48	-11.723	Clayey Sand (SC)	100	32	642.876	708.861	974.384	0	974.384	1107.79	1107.79

31	1.00698	971.567	-10.526	Clayey Sand (SC)	100	32	639.063	704.656	967.652	0	967.652	1086.4	1086.4
32	1.00698	932.03	-9.33374	Clayey Sand (SC)	100	32	633.354	698.361	957.577	0	957.577	1061.68	1061.68
33	1.00698	889.898	-8.1455	Clayey Sand (SC)	100	32	625.628	689.843	943.947	0	943.947	1033.49	1033.49
34	1.00698	845.193	-6.96077	Clayey Sand (SC)	100	32	615.758	678.959	926.528	0	926.528	1001.71	1001.71
35	1.00698	797.938	-5.77903	Clayey Sand (SC)	100	32	603.591	665.544	905.06	0	905.06	966.147	966.147
36	1.00698	748.149	-4.59976	Clayey Sand (SC)	100	32	588.963	649.414	879.247	0	879.247	926.631	926.631
37	1.00698	695.842	-3.42243	Clayey Sand (SC)	100	32	571.684	630.362	848.757	0	848.757	882.946	882.946
38	1.00698	641.026	-2.24655	Clayey Sand (SC)	100	32	551.543	608.153	813.215	0	813.215	834.852	834.852
39	1.00698	583.711	-1.07162	Clayey Sand (SC)	100	32	528.297	582.521	772.196	0	772.196	782.078	782.078
40	1.00698	523.899	0.102865	Clayey Sand (SC)	100	32	501.672	553.164	725.215	0	725.215	724.314	724.314
41	1.00698	461.592	1.27739	Clayey Sand (SC)	100	32	471.358	519.738	671.721	0	671.721	661.21	661.21
42	1.00698	396.789	2.45245	Clayey Sand (SC)	100	32	436.994	481.847	611.082	0	611.082	592.366	592.366
43	1.00698	329.484	3.62855	Clayey Sand (SC)	100	32	398.17	439.038	542.575	0	542.575	517.325	517.325
44	1.00698	259.669	4.80618	Clayey Sand (SC)	100	32	354.414	390.791	465.363	0	465.363	435.564	435.564
45	1.00698	187.333	5.98585	Clayey Sand (SC)	100	32	305.178	336.502	378.482	0	378.482	346.483	346.483
46	1.00698	113.791	7.16808	Clayey Sand (SC)	100	32	250.988	276.749	282.858	0	282.858	251.293	251.293
47	1.00698	78.1742	8.35338	Clayey Sand (SC)	100	32	226.866	250.151	240.292	0	240.292	206.98	206.98
48	1.00698	59.0132	9.54229	Clayey Sand (SC)	100	32	216.285	238.484	221.62	0	221.62	185.263	185.263
49	1.00698	37.2508	10.7354	Clayey Sand (SC)	100	32	202.175	222.926	196.724	0	196.724	158.393	158.393
50	1.00698	12.858	11.9332	Clayey Sand (SC)	100	32	197.994	218.316	189.345	0	189.345	147.502	147.502

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.10264

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	-16.1107	4	0	0	0
2	-15.1037	2.66809	-71.6667	-39.5297	28.8801
3	-14.0967	1.42446	-58.8486	-32.4595	28.8801
4	-13.0897	0.259051	26.1031	14.3979	28.8802
5	-12.0828	-0.83624	737.731	406.915	28.8801
6	-11.0758	-1.86803	1611.36	888.791	28.8802
7	-10.0688	-2.8418	2464.19	1359.19	28.8801
8	-9.06181	-3.76217	3289.1	1814.19	28.8801
9	-8.05483	-4.63307	3864.34	2131.48	28.8801
10	-7.04785	-5.45786	4178.85	2304.95	28.88
11	-6.04087	-6.23945	4486.79	2474.81	28.8801
12	-5.03388	-6.98038	4784.79	2639.18	28.8801
13	-4.0269	-7.68287	5069.81	2796.39	28.8801
14	-3.01992	-8.34888	5339.18	2944.97	28.8801
15	-2.01294	-8.98014	5590.47	3083.58	28.8802
16	-1.00595	-9.57822	5821.55	3211.03	28.8801
17	0.0010287	-10.1445	6030.48	3326.28	28.8802
18	1.00801	-10.6802	6215.59	3428.37	28.8801
19	2.01499	-11.1864	6375.36	3516.5	28.8801
20	3.02198	-11.6642	6508.52	3589.95	28.8801
21	4.02896	-12.1144	6613.94	3648.09	28.8801
22	5.03594	-12.5379	6690.7	3690.43	28.8801
23	6.04292	-12.9354	6738.03	3716.54	28.8801
24	7.04991	-13.3075	6755.38	3726.11	28.8801
25	8.05689	-13.655	6742.31	3718.9	28.8801
26	9.06387	-13.9782	6698.62	3694.8	28.8801
27	10.0709	-14.2778	6624.24	3653.78	28.8801
28	11.0778	-14.5542	6519.32	3595.91	28.8801
29	12.0848	-14.8078	6384.19	3521.37	28.8801
30	13.0918	-15.0389	6219.39	3430.47	28.8801
31	14.0988	-15.2478	6025.68	3323.62	28.8801
32	15.1058	-15.4349	5804.04	3201.37	28.8801
33	16.1127	-15.6004	5555.72	3064.4	28.8801
34	17.1197	-15.7446	5282.23	2913.55	28.8801
35	18.1267	-15.8675	4985.39	2749.83	28.8801
36	19.1337	-15.9694	4667.36	2574.41	28.8801
37	20.1407	-16.0504	4330.65	2388.69	28.8801
38	21.1477	-16.1107	3978.21	2194.29	28.8801
39	22.1546	-16.1502	3613.42	1993.08	28.8801
40	23.1616	-16.169	3240.2	1787.22	28.8801
41	24.1686	-16.1672	2863.07	1579.2	28.8801
42	25.1756	-16.1447	2487.22	1371.89	28.8801
43	26.1826	-16.1016	2118.6	1168.57	28.8801
44	27.1896	-16.0378	1764.09	973.033	28.8802
45	28.1965	-15.9531	1431.58	789.624	28.88
46	29.2035	-15.8475	1130.15	623.367	28.8802
47	30.2105	-15.7209	869.23	479.447	28.8801
48	31.2175	-15.573	624.063	344.219	28.8801
49	32.2245	-15.4037	382.809	211.149	28.8802
50	33.2314	-15.2128	150.326	82.9162	28.8801
51	34.2384	-15	0	0	0

Discharge Sections

Entity Information

◆ **Group 1**

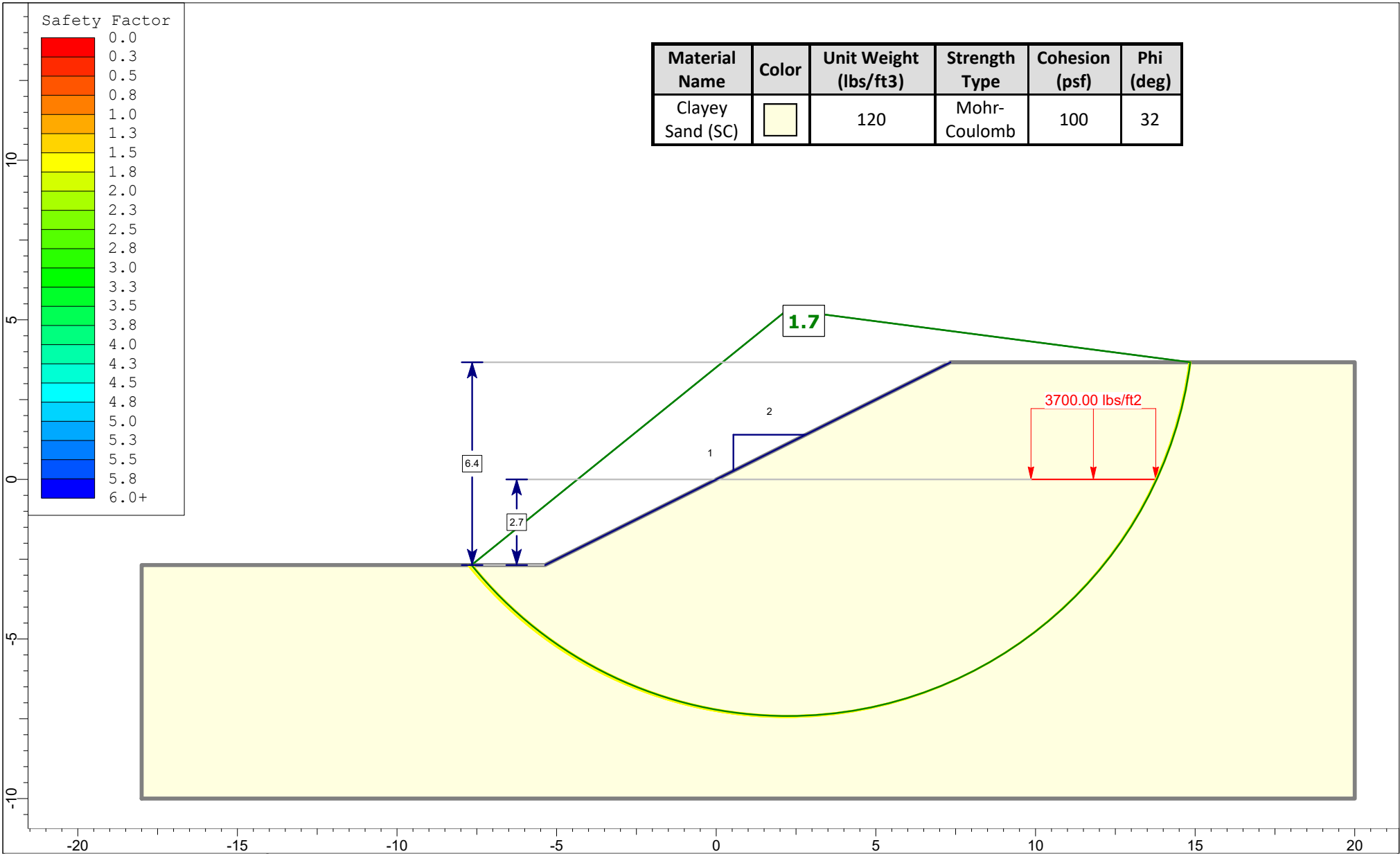
Shared Entities


Type	Coordinates (x,y)
External Boundary	-8, 4 -35, 4 -35, -4 -35, -29.5521 55, -29.5521 55, -15 30, -15


Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Distributed Load	-8.5, 0 -12.9, 0	Constant DistributionOrientation: VerticalMagnitude: 2700 lbs/ft2Creates Excess Pore Pressure: No

SW6



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Clayey Sand (SC)		120	Mohr-Coulomb	100	32

Sound Wall SW6 - Static Condition						
	<i>Analysis Description</i>					
	<i>Drawn By</i>	A. Gonzalez	<i>Scale</i>	1:50	<i>Company</i>	Newfields
	<i>Date Printed</i>	11/7/2022		<i>File Name</i>	SW6 Service Limit Static_Rev1.slmd	
	<small>SLIDEINTERPRET 9.025</small>					



SW6 Service Limit Static_Rev1
Sound Wall SW6 - Static Condition
Newfields
Date Created: 10/31/2022, 10:49:40 AM
Software Version: 9.025

Table of Contents

Project Summary	3
General Settings	4
Analysis Options	5
Groundwater Analysis	6
Random Numbers	7
Surface Options	8
Seismic Loading	9
Loading	10
Materials	11
Global Minimums	12
Method: spencer	12
Valid and Invalid Surfaces	13
Method: spencer	13
Slice Data	14
Global Minimum Query (spencer) - Safety Factor: 1.71754	14
Interslice Data	16
Global Minimum Query (spencer) - Safety Factor: 1.71754	16
Entity Information	17
Group 1	17
Shared Entities	17
Scenario-based Entities	17

Slide2 Analysis Information

SW6 Service Limit Static_Rev1

Project Summary

File Name:	SW6 Service Limit Static_Rev1.slmd
Slide2 Modeler Version:	9.025
Compute Time:	00h:00m:00.678s
Project Title:	Sound Wall SW6 - Static Condition
Author:	A. Gonzalez
Company:	Newfields
Date Created:	10/31/2022, 10:49:40 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft ³]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	10
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

1 Distributed Load present

Distributed Load 1

Distribution:	Constant
Magnitude [psf]:	3700
Orientation:	Vertical

Materials

Clayey Sand (SC)

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	None
Ru Value	0

Global Minimums

Method: spencer

	FS	1.717540
Center:		2.230, 5.314
Radius:		12.726
Left Slip Surface Endpoint:		-7.669, -2.684
Right Slip Surface Endpoint:		14.850, 3.670
Resisting Moment:		316682 lb-ft
Driving Moment:		184381 lb-ft
Resisting Horizontal Force:		19484.5 lb
Driving Horizontal Force:		11344.4 lb
Total Slice Area:		146.657 ft ²
Surface Horizontal Width:		22.5185 ft
Surface Average Height:		6.51272 ft

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	1064
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.71754

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.450371	14.2489	-49.4992	Clayey Sand (SC)	100	32	243.853	418.828	510.232	0	510.232	224.724	224.724
2	0.450371	41.307	-46.466	Clayey Sand (SC)	100	32	270.367	464.366	583.108	0	583.108	298.539	298.539
3	0.450371	65.7032	-43.594	Clayey Sand (SC)	100	32	286.733	492.475	628.091	0	628.091	355.097	355.097
4	0.450371	87.8149	-40.8536	Clayey Sand (SC)	100	32	298.172	512.123	659.534	0	659.534	401.672	401.672
5	0.450371	107.924	-38.2225	Clayey Sand (SC)	100	32	306.675	526.727	682.907	0	682.907	441.382	441.382
6	0.450371	130.9	-35.6837	Clayey Sand (SC)	100	32	320.981	551.298	722.227	0	722.227	491.717	491.717
7	0.450371	159.691	-33.2235	Clayey Sand (SC)	100	32	344.2	591.177	786.048	0	786.048	560.608	560.608
8	0.450371	187.104	-30.8307	Clayey Sand (SC)	100	32	364.034	625.243	840.565	0	840.565	623.292	623.292
9	0.450371	213.152	-28.4964	Clayey Sand (SC)	100	32	381.106	654.565	887.49	0	887.49	680.598	680.598
10	0.450371	237.929	-26.2126	Clayey Sand (SC)	100	32	395.936	680.036	928.253	0	928.253	733.32	733.32
11	0.450371	261.51	-23.973	Clayey Sand (SC)	100	32	408.885	702.277	963.844	0	963.844	782.028	782.028
12	0.450371	283.96	-21.7716	Clayey Sand (SC)	100	32	420.213	721.733	994.982	0	994.982	827.15	827.15
13	0.450371	305.333	-19.6037	Clayey Sand (SC)	100	32	430.114	738.738	1022.19	0	1022.19	869.007	869.007
14	0.450371	325.674	-17.4645	Clayey Sand (SC)	100	32	438.734	753.544	1045.89	0	1045.89	907.856	907.856
15	0.450371	345.022	-15.3503	Clayey Sand (SC)	100	32	446.189	766.347	1066.38	0	1066.38	943.894	943.894
16	0.450371	363.408	-13.2573	Clayey Sand (SC)	100	32	452.568	777.304	1083.91	0	1083.91	977.285	977.285
17	0.450371	380.859	-11.1822	Clayey Sand (SC)	100	32	457.945	786.538	1098.69	0	1098.69	1008.16	1008.16
18	0.450371	397.396	-9.12189	Clayey Sand (SC)	100	32	462.376	794.149	1110.87	0	1110.87	1036.63	1036.63
19	0.450371	413.038	-7.07341	Clayey Sand (SC)	100	32	465.909	800.218	1120.58	0	1120.58	1062.77	1062.77
20	0.450371	427.798	-5.03399	Clayey Sand (SC)	100	32	468.585	804.813	1127.94	0	1127.94	1086.66	1086.66
21	0.450371	441.686	-3.00095	Clayey Sand (SC)	100	32	470.432	807.986	1133.01	0	1133.01	1108.35	1108.35
22	0.450371	454.709	-0.971696	Clayey Sand (SC)	100	32	471.476	809.779	1135.89	0	1135.89	1127.89	1127.89
23	0.450371	466.869	1.05634	Clayey Sand (SC)	100	32	471.737	810.228	1136.6	0	1136.6	1145.3	1145.3
24	0.450371	478.166	3.0857	Clayey Sand (SC)	100	32	471.23	809.357	1135.21	0	1135.21	1160.61	1160.61
25	0.450371	488.598	5.11895	Clayey Sand (SC)	100	32	469.966	807.185	1131.73	0	1131.73	1173.83	1173.83
26	0.450371	498.157	7.1587	Clayey Sand (SC)	100	32	467.95	803.723	1126.19	0	1126.19	1184.97	1184.97
27	0.450371	506.833	9.20762	Clayey Sand (SC)	100	32	465.188	798.979	1118.6	0	1118.6	1194.01	1194.01
28	0.450371	514.613	11.2685	Clayey Sand (SC)	100	32	461.678	792.95	1108.95	0	1108.95	1200.94	1200.94
29	0.450371	521.48	13.3443	Clayey Sand (SC)	100	32	457.416	785.63	1097.24	0	1097.24	1205.74	1205.74
30	0.450371	527.41	15.4381	Clayey Sand (SC)	100	32	452.395	777.007	1083.44	0	1083.44	1208.37	1208.37

31	0.450371	532.377	17.5533	Clayey Sand (SC)	100	32	446.604	767.061	1067.52	0	1067.52	1208.79	1208.79
32	0.450371	536.349	19.6935	Clayey Sand (SC)	100	32	440.029	755.767	1049.44	0	1049.44	1206.94	1206.94
33	0.450371	539.288	21.8628	Clayey Sand (SC)	100	32	432.648	743.09	1029.16	0	1029.16	1202.76	1202.76
34	0.450371	538.376	24.0656	Clayey Sand (SC)	100	32	422.543	725.735	1001.38	0	1001.38	1190.09	1190.09
35	0.450371	527.568	26.307	Clayey Sand (SC)	100	32	405.823	697.018	955.427	0	955.427	1156.06	1156.06
36	0.450371	514.918	28.5927	Clayey Sand (SC)	100	32	388.167	666.693	906.898	0	906.898	1118.47	1118.47
37	0.450371	500.993	30.9294	Clayey Sand (SC)	100	32	369.981	635.458	856.913	0	856.913	1078.6	1078.6
38	0.450371	485.699	33.3247	Clayey Sand (SC)	100	32	351.226	603.244	805.359	0	805.359	1036.29	1036.29
39	0.450371	468.924	35.788	Clayey Sand (SC)	100	32	416.645	715.605	985.174	0	985.174	1285.54	1285.54
40	0.450371	450.529	38.3304	Clayey Sand (SC)	100	32	1280.7	2199.65	3360.14	0	3360.14	4372.68	4372.68
41	0.450371	430.341	40.9656	Clayey Sand (SC)	100	32	1228.35	2109.74	3216.25	0	3216.25	4282.75	4282.75
42	0.450371	408.14	43.711	Clayey Sand (SC)	100	32	1173.47	2015.48	3065.41	0	3065.41	4187.23	4187.23
43	0.450371	383.641	46.5891	Clayey Sand (SC)	100	32	1115.47	1915.86	2905.99	0	2905.99	4085.12	4085.12
44	0.450371	356.461	49.6298	Clayey Sand (SC)	100	32	1053.54	1809.5	2735.76	0	2735.76	3974.97	3974.97
45	0.450371	326.069	52.8752	Clayey Sand (SC)	100	32	986.551	1694.44	2551.63	0	2551.63	3854.91	3854.91
46	0.450371	291.684	56.3868	Clayey Sand (SC)	100	32	912.794	1567.76	2348.91	0	2348.91	3722.09	3722.09
47	0.450371	252.072	60.2628	Clayey Sand (SC)	100	32	829.506	1424.71	2119.97	0	2119.97	3572.06	3572.06
48	0.450371	205.047	64.6781	Clayey Sand (SC)	100	32	483.386	830.234	1168.62	0	1168.62	2190.22	2190.22
49	0.450371	145.859	70.0171	Clayey Sand (SC)	100	32	83.4217	143.28	69.2626	0	69.2626	298.674	298.674
50	0.450371	56.1954	77.7804	Clayey Sand (SC)	100	32	45.2315	77.6869	-35.7084	0	-35.7084	173.149	173.149

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.71754

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	-7.66874	-2.68415	0	0	0
2	-7.21837	-3.21145	378.639	90.9906	13.5125
3	-6.768	-3.68548	776.556	186.614	13.5125
4	-6.31763	-4.11427	1174.74	282.302	13.5125
5	-5.86726	-4.50375	1565.62	376.235	13.5126
6	-5.41688	-4.85845	1945.67	467.565	13.5126
7	-4.96651	-5.18188	2323.52	558.365	13.5125
8	-4.51614	-5.47686	2710.08	651.258	13.5125
9	-4.06577	-5.74566	3099.63	744.871	13.5125
10	-3.6154	-5.99015	3487.89	838.175	13.5125
11	-3.16503	-6.21189	3871.66	930.398	13.5125
12	-2.71466	-6.41215	4248.44	1020.94	13.5125
13	-2.26429	-6.59203	4616.27	1109.34	13.5126
14	-1.81392	-6.75243	4973.53	1195.19	13.5125
15	-1.36355	-6.89412	5318.91	1278.19	13.5126
16	-0.913177	-7.01776	5651.27	1358.06	13.5126
17	-0.462806	-7.12387	5969.68	1434.57	13.5125
18	-0.0124355	-7.2129	6273.31	1507.54	13.5125
19	0.437935	-7.28521	6561.44	1576.78	13.5125
20	0.888306	-7.34109	6833.45	1642.15	13.5126
21	1.33868	-7.38077	7088.79	1703.51	13.5125
22	1.78905	-7.40438	7326.97	1760.74	13.5125
23	2.23942	-7.41202	7547.53	1813.75	13.5125
24	2.68979	-7.40371	7750.11	1862.43	13.5125
25	3.14016	-7.37943	7934.32	1906.7	13.5126
26	3.59053	-7.33909	8099.88	1946.48	13.5125
27	4.0409	-7.28252	8246.48	1981.71	13.5125
28	4.49127	-7.20952	8373.88	2012.33	13.5125
29	4.94164	-7.11978	8481.86	2038.27	13.5125
30	5.39201	-7.01295	8570.21	2059.51	13.5125
31	5.84238	-6.88858	8638.78	2075.98	13.5125
32	6.29275	-6.74611	8687.41	2087.67	13.5125
33	6.74313	-6.58492	8716	2094.54	13.5125
34	7.1935	-6.40421	8724.46	2096.57	13.5125
35	7.64387	-6.20307	8712.95	2093.81	13.5125
36	8.09424	-5.98041	8682.6	2086.51	13.5125
37	8.54461	-5.73494	8634.43	2074.94	13.5125
38	8.99498	-5.46508	8569.46	2059.33	13.5125
39	9.44535	-5.16897	8488.83	2039.95	13.5125
40	9.89572	-4.84429	8356.22	2008.08	13.5125
41	10.3461	-4.48822	7735.35	1858.88	13.5125
42	10.7965	-4.0972	7029.76	1689.32	13.5125
43	11.2468	-3.66665	6237.33	1498.89	13.5125
44	11.6972	-3.19058	5355.19	1286.9	13.5125
45	12.1476	-2.66083	4379.42	1052.42	13.5125
46	12.5979	-2.06587	3304.67	794.146	13.5125
47	13.0483	-1.38835	2123.46	510.289	13.5125
48	13.4987	-0.599955	824.883	198.227	13.5125
49	13.9491	0.351871	-70.1949	-16.8685	13.5125
50	14.3994	1.5904	-118.487	-28.4737	13.5126
51	14.8498	3.67	0	0	0

Discharge Sections

Entity Information

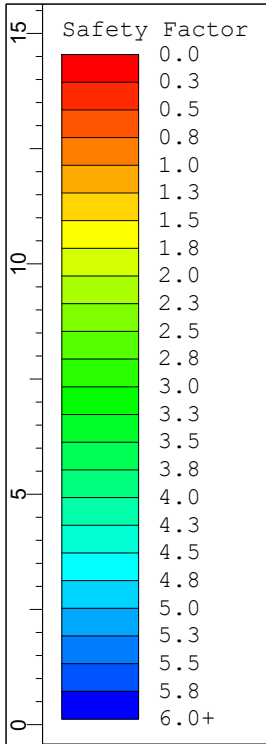
◆ Group 1

Shared Entities

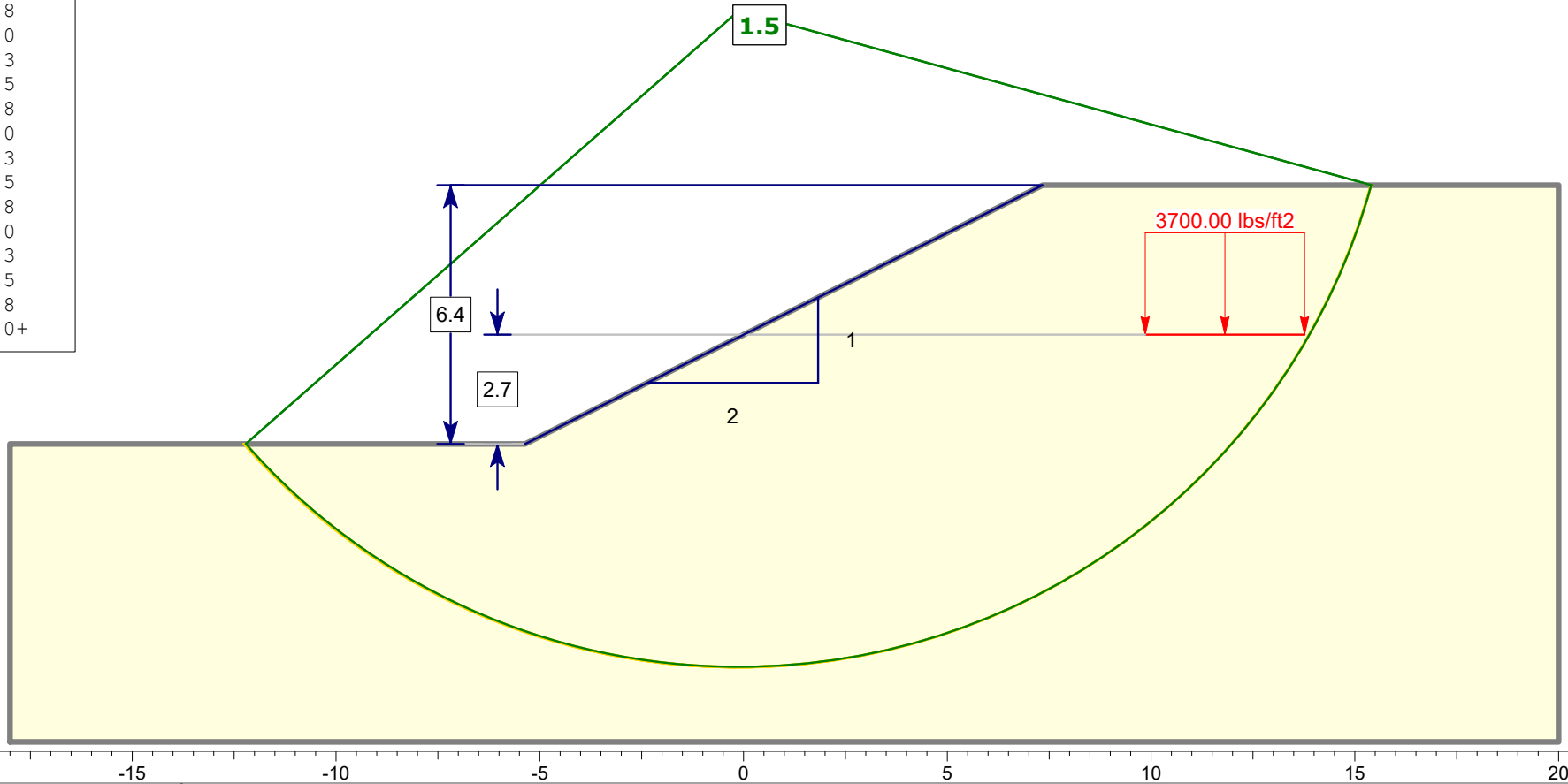
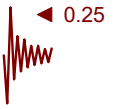
Type	Coordinates (x,y)
External Boundary	-18, -10 20, -10 20, 0 20, 3.67 7.34, 3.67 0.00472243, 0 -5.36012, -2.68415 -18, -2.68415

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Distributed Load	9.8575, 0 13.7675, 0	Constant DistributionOrientation: VerticalMagnitude: 3700 lbs/ft2Creates Excess Pore Pressure: No



Material Name	Color	Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Clayey Sand (SC)		120	Mohr-Coulomb	100	32	None



Sound Wall SW6 - Seismic Condition



Analysis Description

Drawn By

A. Gonzalez

Scale

1:50

Company

Newfields

Date Printed

11/7/2022

File Name

SW6 Service Limit Seismic_Rev1.slmd



SW6 Service Limit Seismic_Rev1
Sound Wall SW6 - Seismic Condition
Newfields
Date Created: 10/31/2022, 10:49:40 AM
Software Version: 9.025

Table of Contents

Project Summary	3
General Settings	4
Analysis Options	5
Groundwater Analysis	6
Random Numbers	7
Surface Options	8
Seismic Loading	9
Loading	10
Materials	11
Global Minimums	12
Method: spencer	12
Valid and Invalid Surfaces	13
Method: spencer	13
Slice Data	14
Global Minimum Query (spencer) - Safety Factor: 1.46964	14
Interslice Data	16
Global Minimum Query (spencer) - Safety Factor: 1.46964	16
Entity Information	17
Group 1	17
Shared Entities	17
Scenario-based Entities	17

Slide2 Analysis Information

SW6 Service Limit Seismic_Rev1

Project Summary

File Name:	SW6 Service Limit Seismic_Rev1.slmd
Slide2 Modeler Version:	9.025
Compute Time:	00h:00m:00.581s
Project Title:	Sound Wall SW6 - Seismic Condition
Author:	A. Gonzalez
Company:	Newfields
Date Created:	10/31/2022, 10:49:40 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft ³]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:

10116

Random Number Generation Method:

Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	10
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.25

Loading

1 Distributed Load present

Distributed Load 1

Distribution:	Constant
Magnitude [psf]:	3700
Orientation:	Vertical

Materials

Clayey Sand (SC)

Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	None
Ru Value	0

Global Minimums

Method: spencer

	FS	1.469640
Center:		-0.116, 7.950
Radius:		16.108
Left Slip Surface Endpoint:		-12.214, -2.684
Right Slip Surface Endpoint:		15.413, 3.670
Resisting Moment:		438147 lb-ft
Driving Moment:		298132 lb-ft
Resisting Horizontal Force:		22024.6 lb
Driving Horizontal Force:		14986.3 lb
Total Slice Area:		174.416 ft ²
Surface Horizontal Width:		27.6272 ft
Surface Average Height:		6.3132 ft

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	609
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.46964

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.552544	19.8082	-47.2379	Clayey Sand (SC)	100	32	413.667	607.942	812.877	0	812.877	365.564	365.564
2	0.552544	57.5641	-44.4144	Clayey Sand (SC)	100	32	430.313	632.405	852.027	0	852.027	430.421	430.421
3	0.552544	91.8453	-41.7218	Clayey Sand (SC)	100	32	436.848	642.009	867.396	0	867.396	477.881	477.881
4	0.552544	123.086	-39.138	Clayey Sand (SC)	100	32	440.398	647.227	875.747	0	875.747	517.36	517.36
5	0.552544	151.62	-36.646	Clayey Sand (SC)	100	32	442.665	650.558	881.077	0	881.077	551.774	551.774
6	0.552544	177.712	-34.2324	Clayey Sand (SC)	100	32	444.077	652.633	884.399	0	884.399	582.238	582.238
7	0.552544	201.572	-31.8863	Clayey Sand (SC)	100	32	444.74	653.608	885.958	0	885.958	609.279	609.279
8	0.552544	223.374	-29.5986	Clayey Sand (SC)	100	32	444.677	653.515	885.81	0	885.81	633.213	633.213
9	0.552544	243.259	-27.3617	Clayey Sand (SC)	100	32	443.896	652.367	883.972	0	883.972	654.254	654.254
10	0.552544	261.347	-25.1693	Clayey Sand (SC)	100	32	442.405	650.176	880.465	0	880.465	672.575	672.575
11	0.552544	277.736	-23.0157	Clayey Sand (SC)	100	32	440.215	646.957	875.314	0	875.314	688.312	688.312
12	0.552544	292.511	-20.896	Clayey Sand (SC)	100	32	437.341	642.734	868.556	0	868.556	701.587	701.587
13	0.552544	308.99	-18.8058	Clayey Sand (SC)	100	32	437.395	642.813	868.683	0	868.683	719.732	719.732
14	0.552544	337.567	-16.7414	Clayey Sand (SC)	100	32	450.926	662.699	900.507	0	900.507	764.867	764.867
15	0.552544	366.213	-14.6991	Clayey Sand (SC)	100	32	464.014	681.934	931.29	0	931.29	809.566	809.566
16	0.552544	393.468	-12.6758	Clayey Sand (SC)	100	32	475.231	698.418	957.67	0	957.67	850.783	850.783
17	0.552544	419.369	-10.6685	Clayey Sand (SC)	100	32	484.76	712.422	980.08	0	980.08	888.761	888.761
18	0.552544	443.945	-8.67428	Clayey Sand (SC)	100	32	492.747	724.16	998.865	0	998.865	923.69	923.69
19	0.552544	467.219	-6.69066	Clayey Sand (SC)	100	32	499.31	733.806	1014.3	0	1014.3	955.728	955.728
20	0.552544	489.209	-4.71507	Clayey Sand (SC)	100	32	504.545	741.5	1026.61	0	1026.61	984.999	984.999
21	0.552544	509.928	-2.7451	Clayey Sand (SC)	100	32	508.531	747.358	1035.99	0	1035.99	1011.61	1011.61
22	0.552544	529.385	-0.778367	Clayey Sand (SC)	100	32	511.333	751.475	1042.58	0	1042.58	1035.63	1035.63
23	0.552544	547.584	1.18745	Clayey Sand (SC)	100	32	513	753.926	1046.5	0	1046.5	1057.13	1057.13
24	0.552544	564.525	3.15466	Clayey Sand (SC)	100	32	513.579	754.776	1047.86	0	1047.86	1076.17	1076.17
25	0.552544	580.203	5.12561	Clayey Sand (SC)	100	32	513.102	754.075	1046.74	0	1046.74	1092.76	1092.76
26	0.552544	594.607	7.10266	Clayey Sand (SC)	100	32	511.597	751.864	1043.2	0	1043.2	1106.95	1106.95
27	0.552544	607.724	9.08827	Clayey Sand (SC)	100	32	509.087	748.175	1037.3	0	1037.3	1118.73	1118.73
28	0.552544	619.535	11.085	Clayey Sand (SC)	100	32	505.586	743.029	1029.06	0	1029.06	1128.12	1128.12
29	0.552544	630.015	13.0954	Clayey Sand (SC)	100	32	501.104	736.442	1018.52	0	1018.52	1135.09	1135.09
30	0.552544	639.134	15.1224	Clayey Sand (SC)	100	32	495.646	728.421	1005.68	0	1005.68	1139.63	1139.63

31	0.552544	646.854	17.169	Clayey Sand (SC)	100	32	489.214	718.968	990.555	0	990.555	1141.7	1141.7
32	0.552544	653.131	19.2385	Clayey Sand (SC)	100	32	481.802	708.075	973.123	0	973.123	1141.27	1141.27
33	0.552544	657.914	21.3345	Clayey Sand (SC)	100	32	473.4	695.727	953.364	0	953.364	1138.26	1138.26
34	0.552544	661.139	23.4608	Clayey Sand (SC)	100	32	463.995	681.905	931.243	0	931.243	1132.62	1132.62
35	0.552544	662.734	25.6221	Clayey Sand (SC)	100	32	453.565	666.577	906.713	0	906.713	1124.24	1124.24
36	0.552544	659.196	27.8233	Clayey Sand (SC)	100	32	440.125	646.826	875.104	0	875.104	1107.38	1107.38
37	0.552544	640.313	30.0702	Clayey Sand (SC)	100	32	418.168	614.557	823.464	0	823.464	1065.58	1065.58
38	0.552544	618.096	32.3693	Clayey Sand (SC)	100	32	394.876	580.325	768.68	0	768.68	1018.98	1018.98
39	0.552544	593.787	34.7287	Clayey Sand (SC)	100	32	371.008	545.248	712.546	0	712.546	969.719	969.719
40	0.552544	567.206	37.1577	Clayey Sand (SC)	100	32	406.971	598.101	797.129	0	797.129	1105.56	1105.56
41	0.552544	538.132	39.6675	Clayey Sand (SC)	100	32	1398.43	2055.19	3128.95	0	3128.95	4288.61	4288.61
42	0.552544	506.289	42.2725	Clayey Sand (SC)	100	32	1333.25	1959.4	2975.65	0	2975.65	4187.65	4187.65
43	0.552544	471.325	44.9903	Clayey Sand (SC)	100	32	1265.32	1859.56	2815.89	0	2815.89	4080.78	4080.78
44	0.552544	432.779	47.8444	Clayey Sand (SC)	100	32	1193.98	1754.72	2648.1	0	2648.1	3966.93	3966.93
45	0.552544	390.032	50.866	Clayey Sand (SC)	100	32	1118.32	1643.53	2470.17	0	2470.17	3844.59	3844.59
46	0.552544	342.213	54.0993	Clayey Sand (SC)	100	32	1037.09	1524.15	2279.12	0	2279.12	3711.77	3711.77
47	0.552544	288.032	57.6103	Clayey Sand (SC)	100	32	948.362	1393.75	2070.43	0	2070.43	3565.4	3565.4
48	0.552544	225.41	61.5054	Clayey Sand (SC)	100	32	137.945	202.73	164.403	0	164.403	418.524	418.524
49	0.552544	150.558	65.9807	Clayey Sand (SC)	100	32	88.9684	130.751	49.2126	0	49.2126	248.858	248.858
50	0.552544	54.7257	71.4931	Clayey Sand (SC)	100	32	54.9622	80.7747	-30.7669	0	-30.7669	133.432	133.432

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.46964

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	-12.2143	-2.68415	0	0	0
2	-11.6618	-3.28163	708.899	191.201	15.0944
3	-11.1092	-3.823	1393.11	375.745	15.0944
4	-10.5567	-4.31567	2038.45	549.802	15.0944
5	-10.0041	-4.76532	2644.37	713.228	15.0944
6	-9.45159	-5.17637	3212.79	866.54	15.0944
7	-8.89905	-5.55233	3745.81	1010.3	15.0943
8	-8.3465	-5.89608	4245.26	1145.01	15.0944
9	-7.79396	-6.20995	4712.72	1271.09	15.0943
10	-7.24141	-6.49589	5149.52	1388.9	15.0943
11	-6.68887	-6.75554	5556.81	1498.76	15.0944
12	-6.13632	-6.99026	5935.64	1600.93	15.0943
13	-5.58378	-7.20121	6286.96	1695.69	15.0944
14	-5.03124	-7.38937	6614.42	1784.01	15.0944
15	-4.47869	-7.55558	6928.42	1868.7	15.0944
16	-3.92615	-7.70053	7227.79	1949.45	15.0944
17	-3.3736	-7.8248	7510.57	2025.72	15.0944
18	-2.82106	-7.92889	7775.12	2097.07	15.0944
19	-2.26851	-8.01319	8020.12	2163.15	15.0944
20	-1.71597	-8.07801	8244.47	2223.66	15.0944
21	-1.16343	-8.12358	8447.25	2278.35	15.0944
22	-0.610882	-8.15008	8627.7	2327.03	15.0944
23	-0.0583379	-8.15758	8785.22	2369.51	15.0944
24	0.494206	-8.14613	8919.3	2405.67	15.0944
25	1.04675	-8.11568	9029.53	2435.41	15.0944
26	1.59929	-8.06611	9115.62	2458.62	15.0944
27	2.15184	-7.99726	9177.33	2475.27	15.0944
28	2.70438	-7.90888	9214.51	2485.3	15.0944
29	3.25693	-7.80062	9227.09	2488.69	15.0944
30	3.80947	-7.67209	9215.07	2485.45	15.0944
31	4.36202	-7.52277	9178.5	2475.59	15.0944
32	4.91456	-7.35206	9117.53	2459.14	15.0944
33	5.4671	-7.15922	9032.34	2436.16	15.0944
34	6.01965	-6.94341	8923.23	2406.74	15.0944
35	6.57219	-6.70361	8790.56	2370.95	15.0944
36	7.12474	-6.43861	8634.78	2328.93	15.0944
37	7.67728	-6.147	8457.55	2281.13	15.0944
38	8.22983	-5.82709	8264.68	2229.11	15.0944
39	8.78237	-5.47684	8058.74	2173.57	15.0944
40	9.33491	-5.09384	7842.02	2115.12	15.0944
41	9.88746	-4.67507	7590.89	2047.38	15.0944
42	10.44	-4.21687	6794	1832.45	15.0944
43	10.9925	-3.71458	5908.16	1593.52	15.0944
44	11.5451	-3.16222	4932.87	1330.47	15.0944
45	12.0976	-2.5519	3867.05	1043.01	15.0945
46	12.6502	-1.87282	2708.94	730.644	15.0944
47	13.2027	-1.10953	1455.79	392.65	15.0944
48	13.7553	-0.238515	103.495	27.9143	15.0944
49	14.3078	0.779374	-44.114	-11.8982	15.0943
50	14.8604	2.01928	-93.7	-25.2723	15.0944
51	15.4129	3.67	0	0	0

Discharge Sections

Entity Information

◆ Group 1

Shared Entities

Type	Coordinates (x,y)
External Boundary	-18, -10 20, -10 20, 0 20, 3.67 7.34, 3.67 0.00472243, 0 -5.36012, -2.68415 -18, -2.68415

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Distributed Load	9.8575, 0 13.7675, 0	Constant DistributionOrientation: VerticalMagnitude: 3700 lbs/ft2Creates Excess Pore Pressure: No