

October 16, 2013

JN 11335

Ellsworth Builders
26007 Northeast 27th Drive
Redmond, Washington 98053

Attention: Thomas Ellsworth

Subject: **Slope Stability Analysis Related to Proposed Sanitary Sewer Extension**
Ellsworth Property
134XX Northeast 100th Street
Redmond, Washington

References: *Geotechnical Engineering Study*, same site and project; Geotech Consultants, Inc.;
October 18, 2011.
*Geotechnical Evaluations of Potential Landslide Hazard Related to Proposed
Sanitary Sewer Extension*; Geotech Consultants, Inc.; August 19, 2013.

Dear Mr. Ellsworth:

via email: tellsworth@ellsworthbuilders.com

This letter contains the results of our slope stability assessment related to the proposed sanitary sewer extension to be constructed in the southeastern corner of the subject property. As discussed in the referenced geotechnical evaluations of the potential landslide hazard letter, a section of the proposed sanitary sewer line will have to cross the 15-foot buffer zone from the steep slope in the southeastern corner of the property.

For this small section of sanitary sewer line that will be located within the 15 foot buffer zone of the steep eastern slope, additional slope stability analyses were conducted. Based on the results of our test pits and site observations, the ground is underlain at a depth of less than 5 feet by very dense glacial till. The soils above this are weathered, and somewhat looser. There is a potential for future shallow instability on the steep slope in these looser soils. However, it was our professional opinion that the risk of a failure in the glacial till in which the sewer and manholes would be supported is low. We completed a stability analysis on the slope using the program Slope/w. Our analyses were conducted both for potential shallow instability in the looser soils, and for failures that could extend into the glacial till. As we had originally thought, the steep slope has an existing factor of safety just above 1.0 for the loose soils. This safety factor was less than 1.0 when seismic loading was added. This confirms that a shallow failure is possible in the foreseeable future. However, the results from the analyses also show minimum safety factors against slope movement extending into the glacial till of 2.0 and 1.3 for static and seismic conditions, respectively. These are for failures that would just barely extend into the glacial till soils, and the safety factors get substantially higher for any deeper potential failure planes.

The results of the slope stability analyses confirm our earlier opinions regarding the potential for future instability on the steep slope. The resultant safety factors against failures that could extend into the glacial till are appropriate to verify adequate future support for the sewer and manholes even where they are closest to the steep slope.

Ellsworth Builders
October 16, 2013

JN 11335
Page 2

Attached to this letter are the diagramed slope stability analysis results from the Slope/w program and the corresponding data.

Please reference our previous August 19, 2013 letter for recommendations related to mitigation of the slope hazard for the proposed sewer extension.

Please contact us if you have any questions regarding this letter, or if we can be of further assistance.

Respectfully submitted,

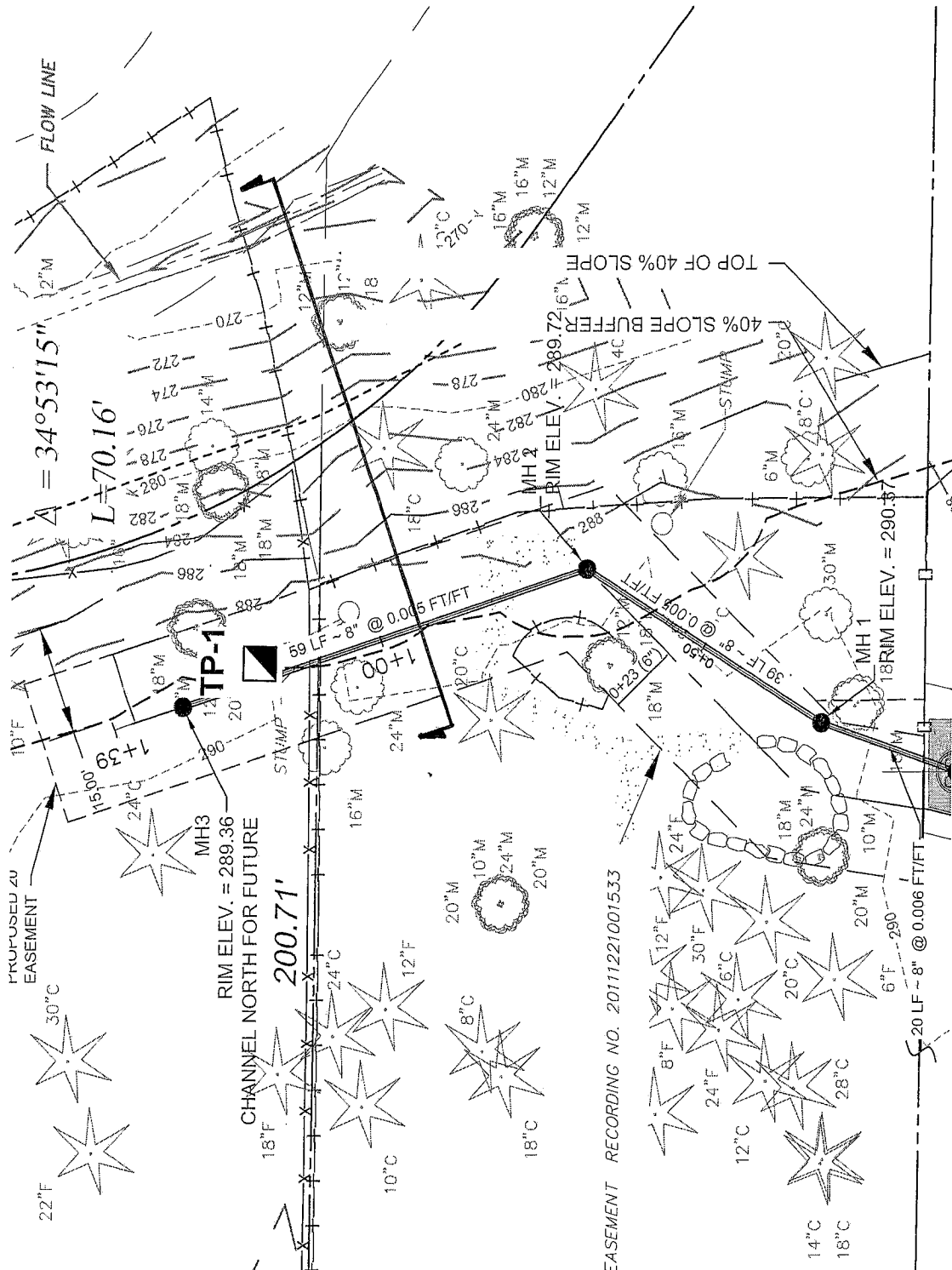
GEOTECH CONSULTANTS, INC.



Marc R. McGinnis, P.E.
Principal

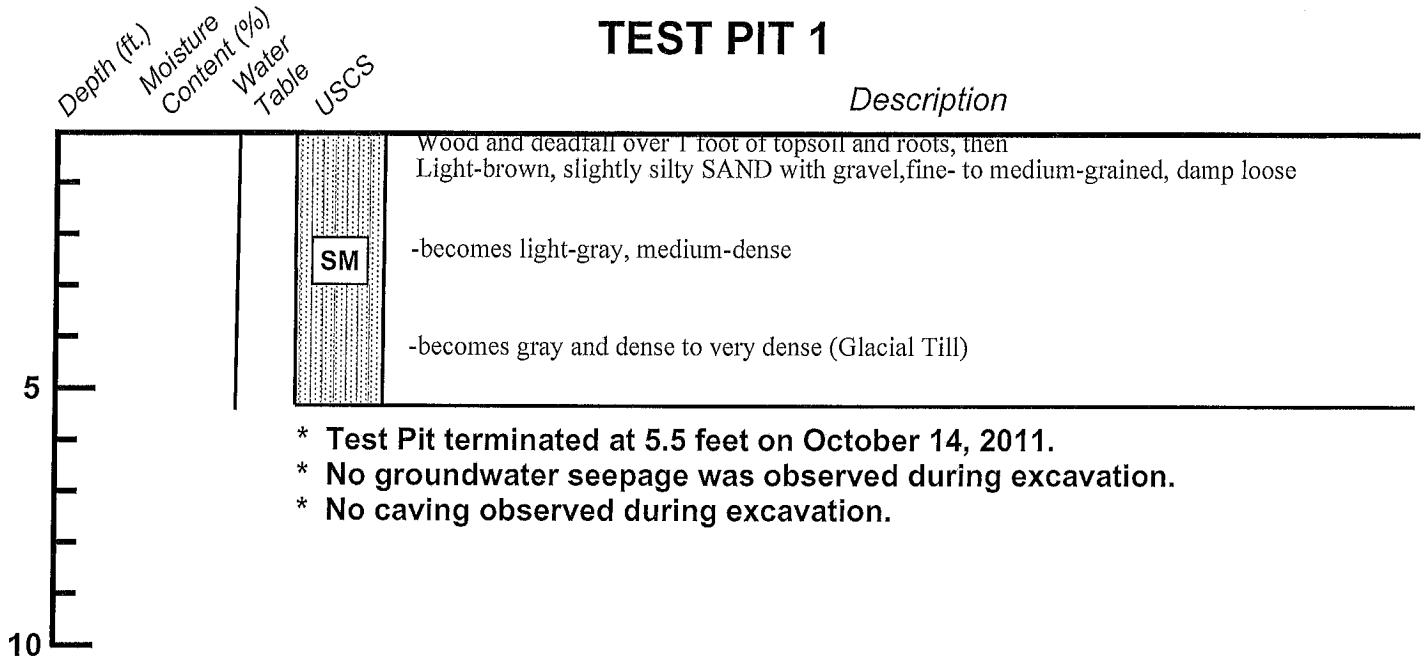
cc: **Land Development Advisors**
via email: landdevadvisors@comcast.net

MRM: jyb

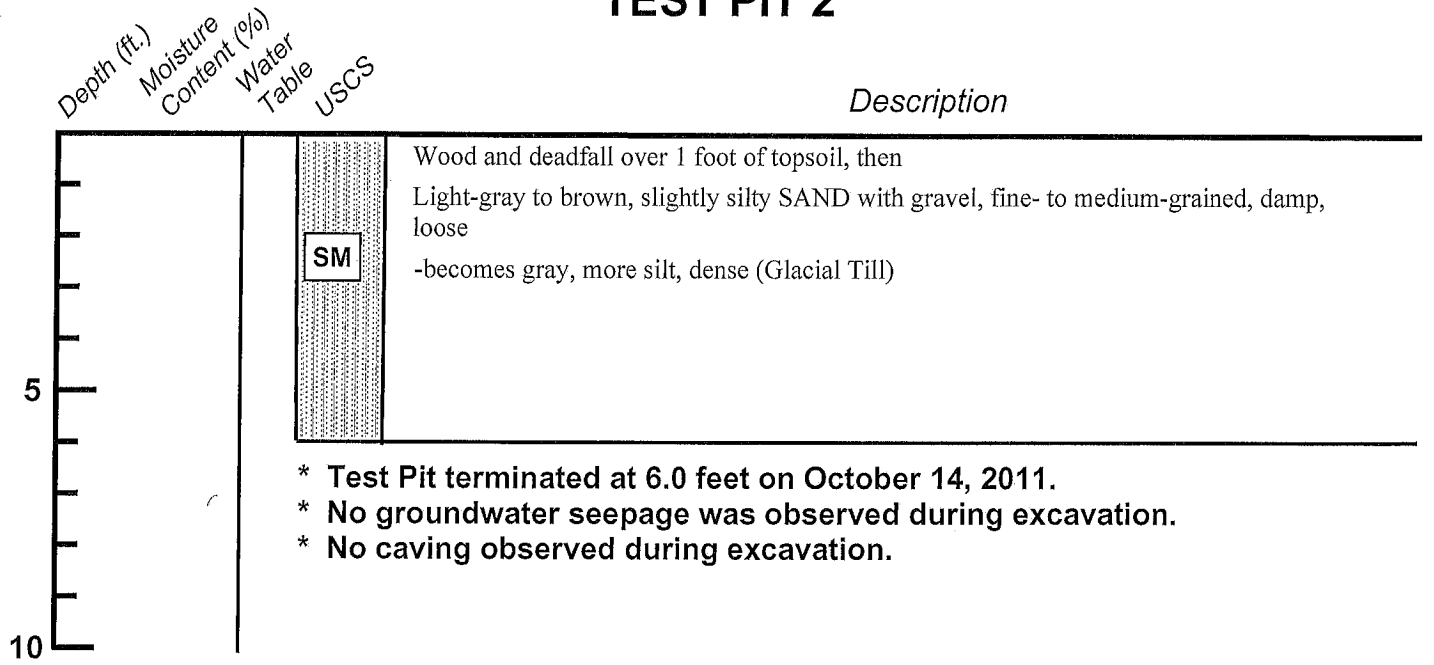


EASEMENT RECORDING NO. 20111221001533

TEST PIT 1



TEST PIT 2



TEST PIT LOG
 N.E. 100th Street at 134th Ave. N.E.
 Redmond Washington

Job	Date:	Logged by:	Plate:
11335	October 2011		3

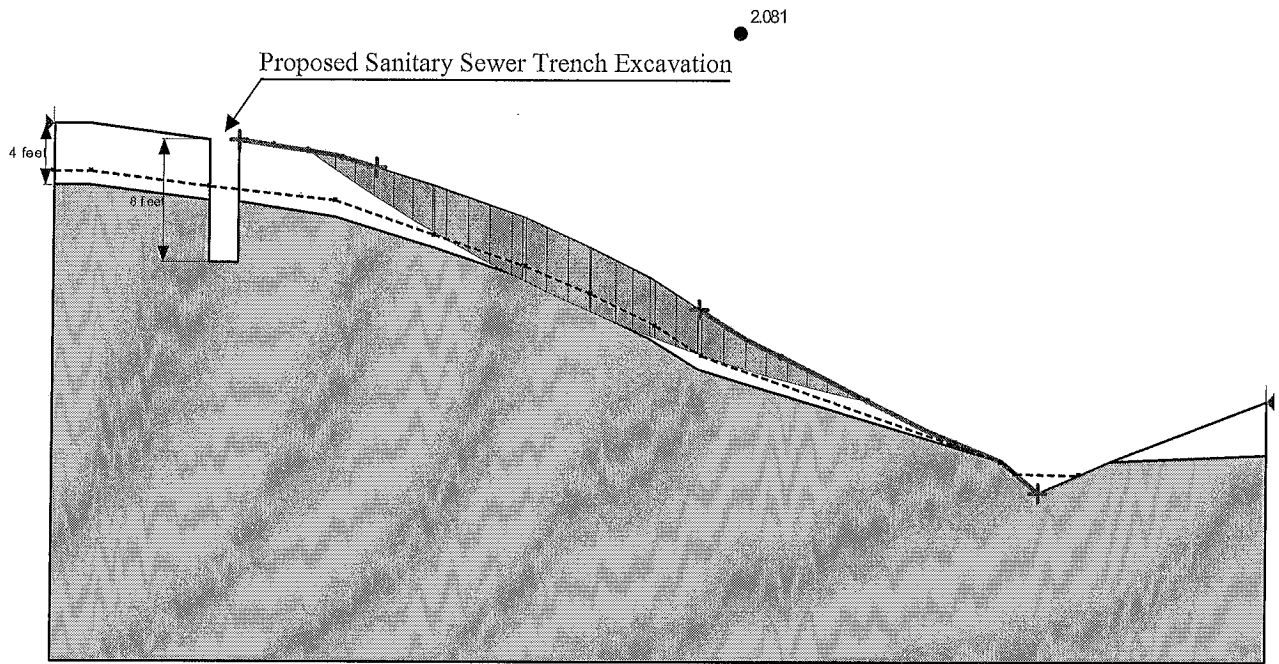


Figure 1 Minimum Safety Factor for Static Condition

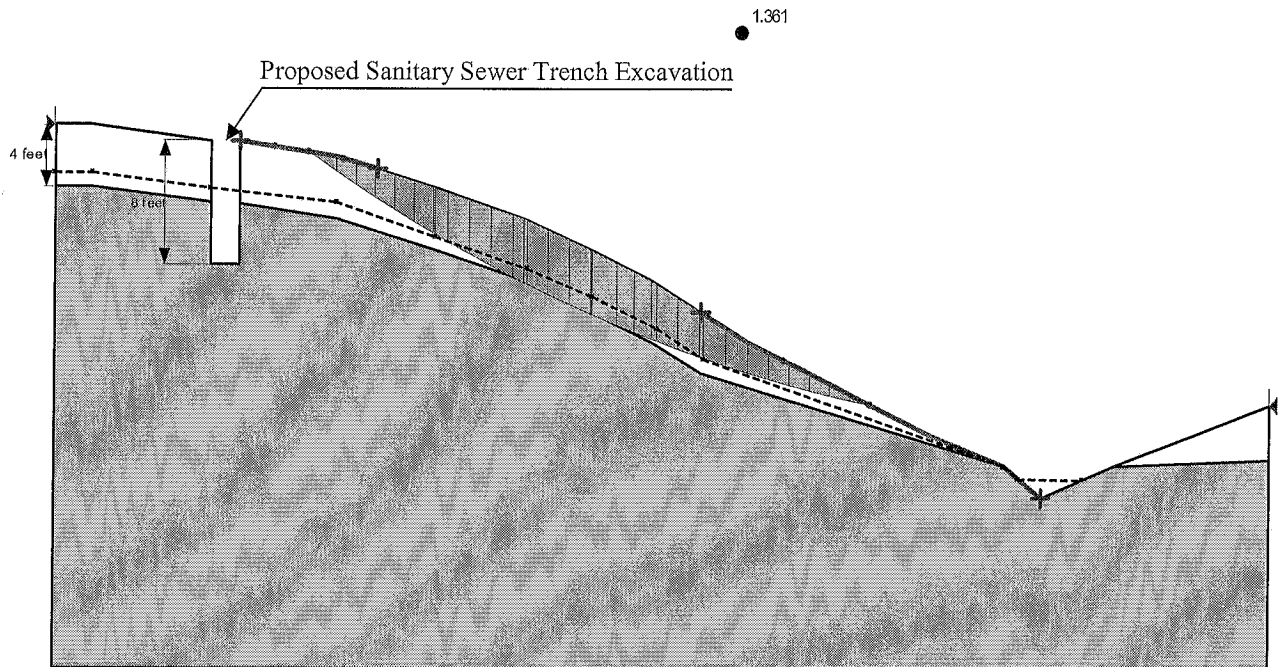


Figure 2 Minimum Safety Factor for Seismic Condition

JN 11335 Static Condition

Report generated using GeoStudio 2012. Copyright © 1991-2013 GEO-SLOPE International Ltd.

File Information

Created By: Adam Moyer
Last Edited By: Adam Moyer
Revision Number: 101
File Version: 8.2
Tool Version: 8.12.2.7663
Date: 10/16/2013
Time: 8:16:50 AM
File Name: JN 11335 slope stability.gsz
Directory: C:\Users\adamm\Desktop\
Last Solved Date: 10/16/2013
Last Solved Time: 8:16:52 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

JN 11335

Kind: SLOPE/W
Method: Bishop

Settings

PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: Yes
Use Staged Rapid Drawdown: No

Slip Surface

Direction of movement: Left to Right
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: Yes

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Glacial Till

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 50 psf
Phi': 42 °
Phi-B: 0 °

Weathered Till

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (13.4, 289) ft
Left-Zone Right Coordinate: (23.4, 287.15493) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (47, 278) ft
Right-Zone Right Coordinate: (71.85, 266.01887) ft
Right-Zone Increment: 4
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 290) ft

Right Coordinate: (88.6, 272) ft

Piezometric Lines**Piezometric Line 1****Coordinates**

	X (ft)	Y (ft)
Coordinate 1	0	286.90057
Coordinate 2	2.75	286.90057
Coordinate 3	11.29324	285.91619
Coordinate 4	20.45	285.02131
Coordinate 5	27.65	282.78409
Coordinate 6	34.35	280.7706
Coordinate 7	39.1	278.98082
Coordinate 8	43.8	276.87784
Coordinate 9	47.25	274.90909
Coordinate 10	69.1	268
Coordinate 11	70.16236	267.21307
Coordinate 12	74.85	267.15094

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	255
Point 2	88.6	255
Point 3	0	290
Point 4	88.6	272
Point 5	2.7	290
Point 6	20.4	288
Point 7	27.5	286

Point 8	34.1	284
Point 9	39	282
Point 10	43.4	280
Point 11	47	278
Point 12	50.5	276
Point 13	55	274
Point 14	59.4	272
Point 15	63.8	270
Point 16	69.1	268
Point 17	71.8	266
Point 18	77.1	268
Point 19	82.9	270
Point 20	0	286
Point 21	11.4	281
Point 22	13.4	281
Point 23	11.3	289
Point 24	13.4	289
Point 25	13.40994	284.96464
Point 26	11.29129	285.02694
Point 27	88.6	268.46591
Point 28	2.7	286
Point 29	20.4	284
Point 30	27.5	282
Point 31	34.1	280
Point 32	39	278
Point 33	43.4	276
Point 34	47	274

Regions

	Material	Points	Area (ft ²)
Region 1	Glacial Till	20,1,2,27,18,17,16,34,33,32,31,30,29,25,22,21,26,28	1,865.8
Region 2	Weathered Till	3,20,28,26,23,5	45.071
Region 3	Weathered Till	24,25,29,30,31,32,33,34,16,15,14,13,12,11,10,9,8,7,6	171.7
Region 4	Weathered Till	18,19,4,27	20.221

Current Slip Surface

Slip Surface: 134
 F of S: 2.081
 Volume: 106.38342 ft³
 Weight: 13,311.567 lbs
 Resisting Moment: 1,210,309.4 lbs-ft
 Activating Moment: 581,718.3 lbs-ft
 F of S Rank: 15
 Exit: (59.455873, 271.9746) ft
 Entry: (18.442714, 288.27961) ft
 Radius: 117.19389 ft
 Center: (81.469934, 387.08233) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	19.421357	287.6688	-157.42659	37.402869	21.594557	50
Slice 2	20.425	287.04272	-124.79191	89.042784	51.408875	50
Slice 3	21.155	286.60427	-102.54547	114.405	66.051757	50
Slice 4	22.565	285.77117	-80.068825	162.23136	93.664318	50
Slice 5	23.975	284.96433	-59.086804	207.61871	119.86872	50
Slice 6	25.385	284.18314	-39.564237	250.58915	144.67771	50
Slice 7	26.795	283.42702	-21.468117	291.1635	168.10333	50
Slice 8	27.575	283.01631	-11.888499	312.74051	180.56082	50
Slice 9	28.108456	282.743	-5.5336382	325.59061	187.97983	50
Slice 10	29.359458	282.11508	8.8868195	355.51009	200.12304	50
Slice 11	30.944551	281.34293	25.816073	391.67577	211.22919	50
Slice 12	32.529644	280.59996	41.074513	424.54622	221.39749	50

ATTACHMENT 16

Ellsworth Builders
August 19, 2013

JN 11335
Page 11

Slice 13	33.711095	280.06215	0	416.62898	375.13442	50
Slice 14	34.225	279.83353	0	424.63991	382.34749	50
Slice 15	35.125	279.44478	0	428.90906	386.19145	50
Slice 16	36.675	278.79051	0	434.48282	391.21008	50
Slice 17	38.225	278.16223	0	436.96692	393.44679	50
Slice 18	39.05	277.83512	0	437.13065	393.5942	50
Slice 19	40.00989	277.47154	0	430.22006	387.37188	50
Slice 20	41.539834	276.90266	51.287932	444.60397	227.08112	50
Slice 21	42.779945	276.46108	45.397383	431.70582	223.03528	50
Slice 22	43.6	276.17592	41.146047	420.02331	218.74489	50
Slice 23	44.580367	275.84883	27.475223	395.12945	212.26527	50
Slice 24	46.141102	275.3433	9.3478044	353.9116	198.934	50
Slice 25	46.960735	275.08447	-0.48522168	331.43181	191.35224	50
Slice 26	47.125	275.03405	-2.5245848	326.66929	188.6026	50
Slice 27	48.0625	274.75409	-5.7818173	298.10175	172.10913	50
Slice 28	49.6875	274.28352	-8.2357187	246.55223	142.347	50
Slice 29	51.25	273.85442	-11.92124	204.943	118.3239	50
Slice 30	52.75	273.46466	-16.717843	173.66445	100.26522	50
Slice 31	54.25	273.09598	-22.709767	139.67748	80.642831	50

Slice 32	55.733333	272.7518	-29.79281	102.54517	59.204481	50
Slice 33	57.2	272.43149	-37.930639	62.31805	35.979343	50
Slice 34	58.666667	272.13078	-47.180622	19.48108	11.247407	50
Slice 35	59.427936	271.97995	-52.280153	-3.4968467	-2.0189054	50

JN 11335 Seismic Condition

Report generated using GeoStudio 2012. Copyright © 1991-2013 GEO-SLOPE International Ltd.

File Information

Created By: Adam Moyer
Last Edited By: Adam Moyer
Revision Number: 100
File Version: 8.2
Tool Version: 8.12.2.7663
Date: 10/16/2013
Time: 8:13:20 AM
File Name: JN 11335 slope stability.gsz
Directory: C:\Users\adamm\Desktop\
Last Solved Date: 10/16/2013
Last Solved Time: 8:13:21 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

JN 11335

Kind: SLOPE/W

Method: Bishop

Settings

PWP Conditions Source: Piezometric Line

Apply Phreatic Correction: Yes

Use Staged Rapid Drawdown: No

Slip Surface

Direction of movement: Left to Right

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: Yes

Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft

Optimization Maximum Iterations: 2,000

Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8

Ending Optimization Points: 16

Complete Passes per Insertion: 1

Driving Side Maximum Convex Angle: 5 °

Resisting Side Maximum Convex Angle: 1 °

Materials

Glacial Till

Model: Mohr-Coulomb

Unit Weight: 140 pcf

Cohesion': 50 psf

Phi': 42 °

Phi-B: 0 °

Weathered Till

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 50 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (13.4, 289) ft

Left-Zone Right Coordinate: (23.4, 287.15493) ft

Left-Zone Increment: 4

Right Projection: Range

Right-Zone Left Coordinate: (47, 278) ft

Right-Zone Right Coordinate: (71.85, 266.01887) ft

Right-Zone Increment: 4

Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 290) ft

Right Coordinate: (88.6, 272) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	286.90057
Coordinate 2	2.75	286.90057
Coordinate 3	11.29324	285.91619
Coordinate 4	20.45	285.02131
Coordinate 5	27.65	282.78409
Coordinate 6	34.35	280.7706
Coordinate 7	39.1	278.98082
Coordinate 8	43.8	276.87784
Coordinate 9	47.25	274.90909
Coordinate 10	69.1	268
Coordinate 11	70.16236	267.21307
Coordinate 12	74.85	267.15094

Seismic Coefficients

Horz Seismic Coef.: 0.18

Ignore seismic load in strength: No

Points

	X (ft)	Y (ft)
Point 1	0	255
Point 2	88.6	255
Point 3	0	290
Point 4	88.6	272
Point 5	2.7	290
Point 6	20.4	288

Point 7	27.5	286
Point 8	34.1	284
Point 9	39	282
Point 10	43.4	280
Point 11	47	278
Point 12	50.5	276
Point 13	55	274
Point 14	59.4	272
Point 15	63.8	270
Point 16	69.1	268
Point 17	71.8	266
Point 18	77.1	268
Point 19	82.9	270
Point 20	0	286
Point 21	11.4	281
Point 22	13.4	281
Point 23	11.3	289
Point 24	13.4	289
Point 25	13.40994	284.96464
Point 26	11.29129	285.02694
Point 27	88.6	268.46591
Point 28	2.7	286
Point 29	20.4	284
Point 30	27.5	282
Point 31	34.1	280
Point 32	39	278
Point 33	43.4	276
Point 34	47	274

Regions

	Material	Points	Area (ft ²)
Region 1	Glacial Till	20,1,2,27,18,17,16,34,33,32,31,30,29,25,22,21,26,28	1,865.8
Region 2	Weathered Till	3,20,28,26,23,5	45.071
Region 3	Weathered Till	24,25,29,30,31,32,33,34,16,15,14,13,12,11,10,9,8,7,6	171.7
Region 4	Weathered Till	18,19,4,27	20.221

Current Slip Surface

Slip Surface: 134
 F of S: 1.361
 Volume: 106.38342 ft³
 Weight: 13,311.567 lbs
 Resisting Moment: 1,139,858.6 lbs-ft
 Activating Moment: 837,382.37 lbs-ft
 F of S Rank: 16
 Exit: (59.455873, 271.9746) ft
 Entry: (18.442714, 288.27961) ft
 Radius: 117.19389 ft
 Center: (81.469934, 387.08233) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	19.421357	287.6688	-157.42659	28.437674	16.418499	50
Slice 2	20.425	287.04272	-124.79191	76.569493	44.207417	50
Slice 3	21.155	286.60427	-102.54547	100.31576	57.917333	50
Slice 4	22.565	285.77117	-80.068825	145.22931	83.848182	50
Slice 5	23.975	284.96433	-59.086804	188.02913	108.55867	50
Slice 6	25.385	284.18314	-39.564237	228.72085	132.05204	50
Slice 7	26.795	283.42702	-21.468117	267.30954	154.33123	50
Slice 8	27.575	283.01631	-11.888499	287.89949	166.21885	50
Slice 9	28.108456	282.743	-5.5336382	300.21348	173.32833	50
Slice 10	29.359458	282.11508	8.8868195	329.48336	185.0965	50
Slice 11	30.944551	281.34293	25.816073	365.34098	196.02479	50
Slice 12	32.529644	280.59996	41.074513	398.05948	206.10537	50

Slice 13	33.711095	280.06215	0	379.4604	341.66768	50
Slice 14	34.225	279.83353	0	387.21743	348.65214	50
Slice 15	35.125	279.44478	0	391.81784	352.79437	50
Slice 16	36.675	278.79051	0	398.1222	358.47084	50
Slice 17	38.225	278.16223	0	401.58479	361.58857	50
Slice 18	39.05	277.83512	0	402.35677	362.28366	50
Slice 19	40.00989	277.47154	0	396.6435	357.13942	50
Slice 20	41.539834	276.90266	51.287932	422.51979	214.33081	50
Slice 21	42.779945	276.46108	45.397383	410.60599	210.85329	50
Slice 22	43.6	276.17592	41.146047	399.68523	207.00269	50
Slice 23	44.580367	275.84883	27.475223	375.78206	201.09505	50
Slice 24	46.141102	275.3433	9.3478044	336.30294	188.76764	50
Slice 25	46.960735	275.08447	-0.48522168	314.74387	181.71746	50
Slice 26	47.125	275.03405	-2.5245848	310.24751	179.12148	50
Slice 27	48.0625	274.75409	-5.7818173	283.21859	163.51633	50
Slice 28	49.6875	274.28352	-8.2357187	234.26912	135.25534	50
Slice 29	51.25	273.85442	-11.92124	194.70352	112.41213	50
Slice 30	52.75	273.46466	-16.717843	164.96023	95.239833	50
Slice 31	54.25	273.09598	-22.709767	132.48988	76.493067	50

Slice 32	55.733333	272.7518	-29.79281	96.851543	55.917264	50
Slice 33	57.2	272.43149	-37.930639	58.08058	33.532839	50
Slice 34	58.666667	272.13078	-47.180622	16.637627	9.6057385	50
Slice 35	59.427936	271.97995	-52.280153	-5.653011	-3.2637674	50