Geosyntec consultants

COMPUTATION COVER SHEET

Client: Unisys **Project:** Former Sperry Remington North (EHS) **Project #:** MN0832D **Task #:** 05/03

TITLE OF COMPUTATIONS TEMPORARY CANTILEVER SHEET PILE WALL ANALYSIS

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REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

TEMPORARY CANTILEVER SHEET PILE WALL ANALYSIS

ELMIRA HIGH SCHOOL

PURPOSE

The purpose of this calculation package is to provide the engineering basis and design analysis conducted for the steel sheet pile (SSP) wall, which provides temporary excavation support during the removal of PCB-contaminated soils from the Elmira High School parking lot. The proposed excavation will be as much as 12-ft deep and will involve excavating adjacent to existing structures and parking lot. A schematic showing the location and depth of the proposed excavation is shown in Figure 1. The installation of sheet pile is recommended to prevent excessive movement of the surrounding ground surface, which could negatively impact the existing school building and parking lot. The proposed sheet pile layout for the site is shown in Figure 2.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The subsurface stratigraphy was characterized based on Generalized Cross Section A-A' from Geosyntec (2014) which runs through the eastern part of the site. This cross section, with the approximate extents of excavation for this project, is included as Attachment 1. Table 1 provides a summary of the design subsurface profile in the area of the proposed sheet pile wall. Subsurface layer boundaries are provided in terms of depth below the current ground surface (ft-bgs). The current ground surface is located at approximately elevation (El.) 857 ft above mean sea level (ft-msl).

Table 1. Subsurface profile

Subsurface Layer	Top of Layer (depth)	Bottom of Layer (depth)
Fill (Well Graded Sand)	0	6
Gravel with Silt and Sand	6	40
Silty Clay	40	75
Bedrock (Weathered Shale)	75	N/A

Water Table

A design water table located 16 ft-bgs was used for the analyses. This groundwater table is assumed based on Cross Section A-A' from Geosyntec (2014). This cross section is included as Attachment 1.

Soil Properties

Design soil parameters are based on Geosyntec's interpretation of the in-situ data and lab test results collected by Earth Tech (2003) and SJB Services, Inc (2012) for borings MW-15D, B-3, and B-5. These borings and lab tests are included in Attachment 2. Table 2 provides a summary of the estimated soil parameters used for the analyses.

Moist unit weights were estimated using correlations with the corrected Standard Penetration Blow Count [$(N_1)_{60}$] from CalTrans (2014). These correlations are shown in Figure 3. The saturated unit weight for the gravel was calculated assuming a void ratio of 0.6 and a specific gravity of 2.65.

Drained strength parameters for granular soils (fill and gravel layers) were developed using correlations to the Standard Penetration Test data from Peck et al. (1974). This correlation is shown in Figure 4. Drained strength parameters for cohesive soils (silty clay) were chosen based on correlations with Atterberg Limits from U.S. Dept. of Navy (1986) and Ladd et al. (1977). These correlations are shown in Figure 5.

Undrained strength parameters for cohesive soils (silty clay) were developed using correlations with uncorrected Standard Penetration Test blow counts (SPT N-value) from Kulhawy and Mayne (1990). This correlation can be found in Equation 1.

$$s_u = 0.29N^{0.72} * p_a \quad \text{(Eq. 1)}$$

Where: s_u = undrained shear strength (psf)

N = SPT N-value

p_a = atmospheric pressure (2,116 psf)

Table 2. Soil parameters used for analyses

Subsurface Layer	Moist Unit Weight, γ_m (pcf)	Saturated Unit Weight, γ_{sat} (pcf)	Rep. PI (%)	Rep. SPT N-value	Rep. SPT $(N_1)_{60}$	Drained Strength Parameters		Undrained Shear Strength Ratio, s_u/σ_v'
						Effective Angle of Internal Friction, φ' (°)	Effective cohesion, c' (psf)	
Fill	127		-	17	26	32	0	-
Gravel	116	125	-	16	10	32	0	-
Silty Clay	115	115	11	7	5	30	0	0.6

METHOD OF ANALYSIS

Design Cross Section

The design cross sections used in this analysis, designated Section 1-1' and 2-2' respectively, are shown in Figures 6 and 7. The locations of these sections are shown in plan view on Figure 2. For both sections, the sheet pile is assumed to be driven 26 ft-bgs, with a stick-up of 4-ft above the ground surface (total sheet length of 30 ft). The properties of the selected sheet pile, a Rollform XZ95, are shown in Attachment 3.

Section 1-1' is located directly next to the school building. To represent the loading from the building, a surcharge load of 1,000 psf, modeled as an infinite load, is assumed directly at the top of the sheet pile wall. The maximum expected excavation depth in this area (Figure 1) is approximately 8 ft-bgs.

Section 2-2' is located next to a road, where large trucks will be loaded. The surcharge load for a truck is assumed to be equal to approximately 400 psf based on the maximum operating weight and dimensions for a Caterpillar model 730 articulated truck (Caterpillar 2004). The maximum expected excavation depth in this area (Figure 1) is approximately 12 ft-bgs.

CT Shoring

CivilTech Shoring v. 8.12 (CT Shoring) was used to compute earth pressures, shear forces, and wall bending moments. For these analyses, "fixed-earth" behavior was assumed for the cantilever sheet pile wall wherein design pressures are computed using simplified distributions without consideration of moment reductions due to flexure, displacement, and stress redistribution. SSP sections were selected assuming deflections would control the design of the wall. In this analysis, drained soil conditions were assumed, as the only soil that may exhibit undrained behavior is the silty clay, which is located approximately 17 ft below the base of the SSP.

CT Shoring follows the "Simplified Method" design procedure presented in the United States Steel (USS) Steel Sheet Piling Design Manual (USS, 1984), which is a limit equilibrium approach. Because this method assumes a simplified pressure distribution below the point of contraflexure, CT Shoring increases the required embedment by 20% to account for the simplification and satisfy force equilibrium (as can be seen in the CT Shoring output reports in Appendix C). Although the added length is not intended to be a factor of safety, the increased embedment is actually a mixture of force equilibrium requirements and an embedment factor of safety. An alternative method of incorporating a factor of safety is to reduce the calculated earth pressures. Accordingly, a factor of safety of 1.3 was applied to the earth pressures on the passive side.

The wall was designed under the following assumptions:

- For Section 1-1', at-rest earth pressures are assumed because this section is located directly next to the school building, so deflections should be kept to a minimum.
- For Section 2-2', active earth pressures are assumed because there are no critical structures near this section, so deflections are not an issue.
- No construction surcharge will be present, SSPs will be installed using equipment located inside of the excavation;
- A wall-to-soil interface friction angle of 10 degrees was considered in the analyses.
- The above grade stickup of the sheet piles, as indicated in Figures 6 and 7was not modeled in CT Shoring as this length of the pile experiences no loading.

The minimum required section modulus was calculated from the CT Shoring maximum bending moment based on earth pressures developed from factored earth pressures. The required section modulus was calculated using the following relationship:

$$S_{req} = \frac{M_{max}}{F_b} \quad (4)$$

Where: S_{req} = required elastic section modulus
M_{max} = maximum bending moment
$F_b = F_y \times 0.6$
F_y = yield stress (50 ksi)

RESULTS AND RECOMMENDATIONS

CT Shoring earth pressure results, and shear, moment, and deflection results are provided in Attachment 4 for Section 1-1' and Attachment 5 for Section 2-2'. The following is a summary of the analysis results:

- The required minimum embedment for Section 1-1' is 17.5 ft, less than the planned embedment of 18 ft at this location (Figure 6).
- The required minimum embedment for Section 2-2' is 13.7 ft, less than the planned embedment of 14 ft at this location (Figure 7).
- The required minimum elastic section modulus is approximately 21.2 in^3/ft, lower than the 33.5 in^3/ft provided by the Rollform XZ95 (Attachments 3, 4).
- A Rollform XZ95 satisfies the shear and moment requirements (Attachments 4, 5).
- The estimated deflection at the ground surface based on the selected sheet is approximately 0.71 inches at Section 1-1' and 0.57 inches at Section 2-2'. .

Geosyntec finds the Rollform XZ95 to be acceptable for installation at the site. The SSP shall be driven to a depth of at least 26 ft-bgs to satisfy embedment depth requirements. Geosyntec recommends performing optical surveying of the SSP wall during construction to monitor wall movement. Measurements should be reported to the engineer on a daily basis and work shall be halted as directed by the engineer.

REFERENCES

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Kulhawy, F.H., and Mayne, P.W., "Manual on Estimating Soil Properties for Foundation Design", Report No. EL-6800, Electric Power Research Institute, Palo Alto, CA, 1990.

Ladd, C.C., Foote, R., Ishihara, K., Schlosser, F., and Poulos, H.G., (1977). "Stress-deformations and strength characteristics," State-of-the-Art Report. Proceedings of the Ninth International Conference on Soil Mechanics and Foundation Engineering, Tokyo, Vol. 2. pp. 421-494

Peck, R.B., Hanson, W.E., and Thornburn, T.H. (1974). "Foundation Engineering, 2nd Edition." John Wiley and Sons, New York, New York.

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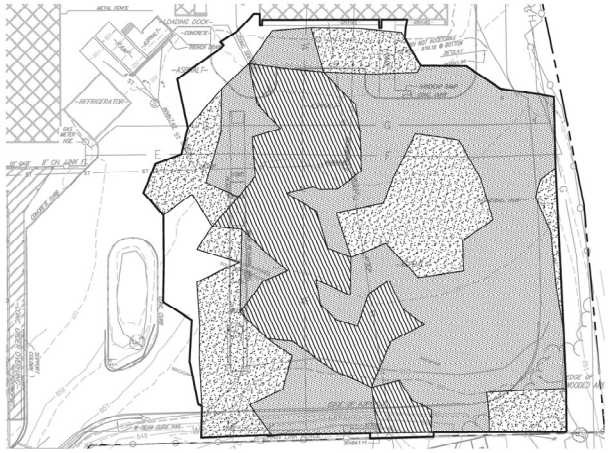
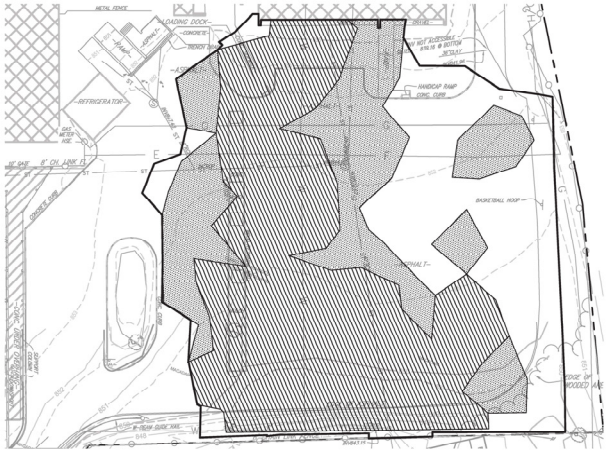
FIGURES



0-2 FT EXCAVATION

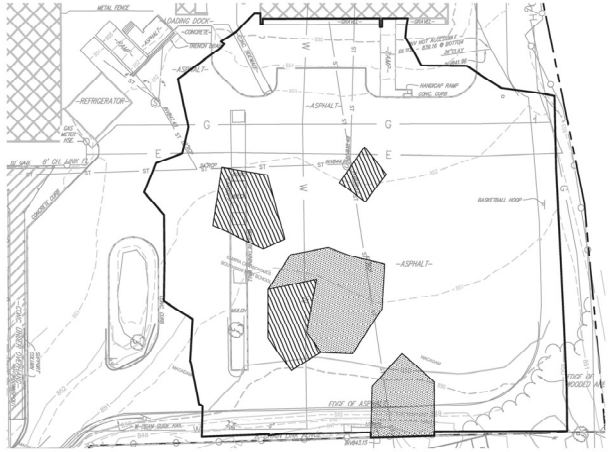


2-4 FT EXCAVATION

4-6 FT EXCAVATION

6-8 FT EXCAVATION

8-10 FT EXCAVATION



10-12 FT EXCAVATION

APPROXIMATE EXCAVATION DEPTHS

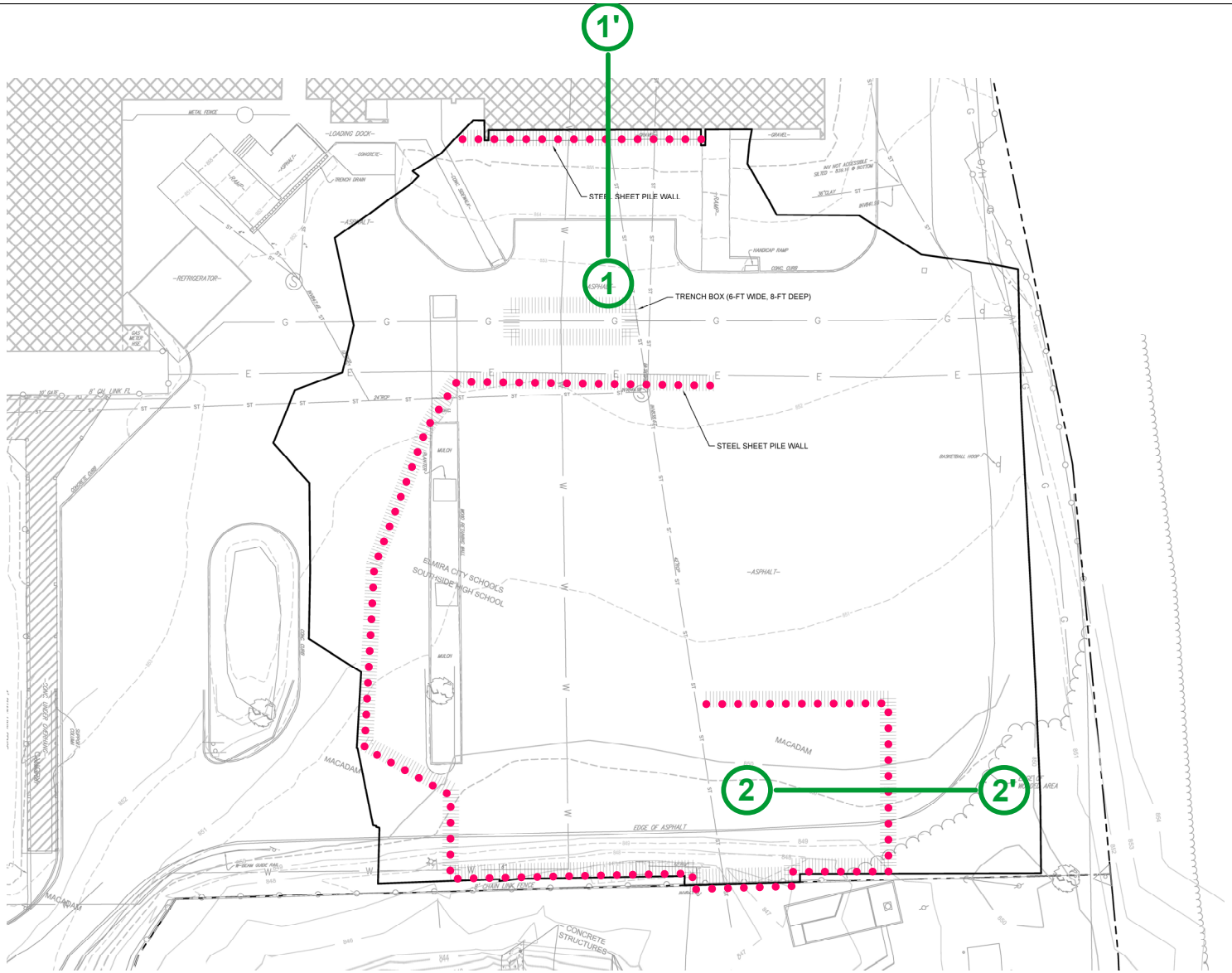
Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE 1

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Figures\Figure 1 - Excavation Depths.grf



APPROXIMATE LOCATION OF SHEET PILE

Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE 2

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Figures\Figure 2 - Sheet Pile Plan.grf

Chart 2: Correlation of SPT $N1_{60}$ with Unit Weight (after Bowles, 1977).

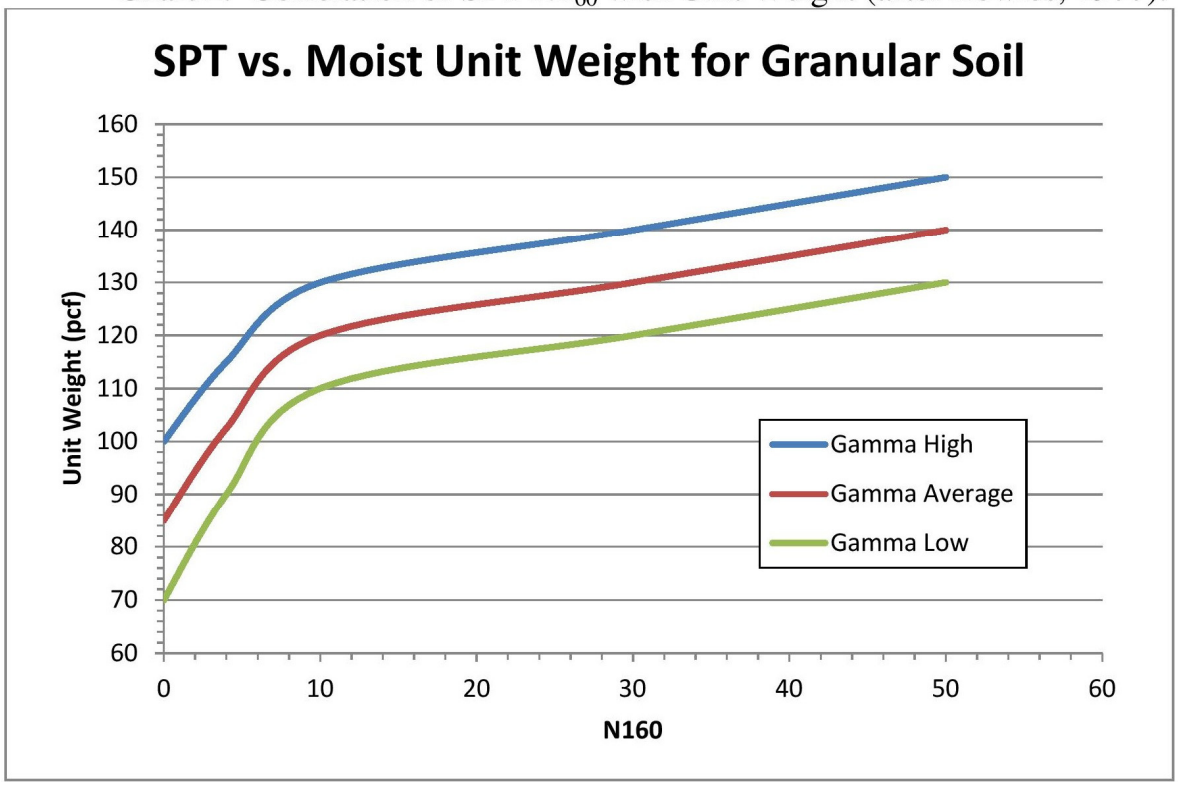
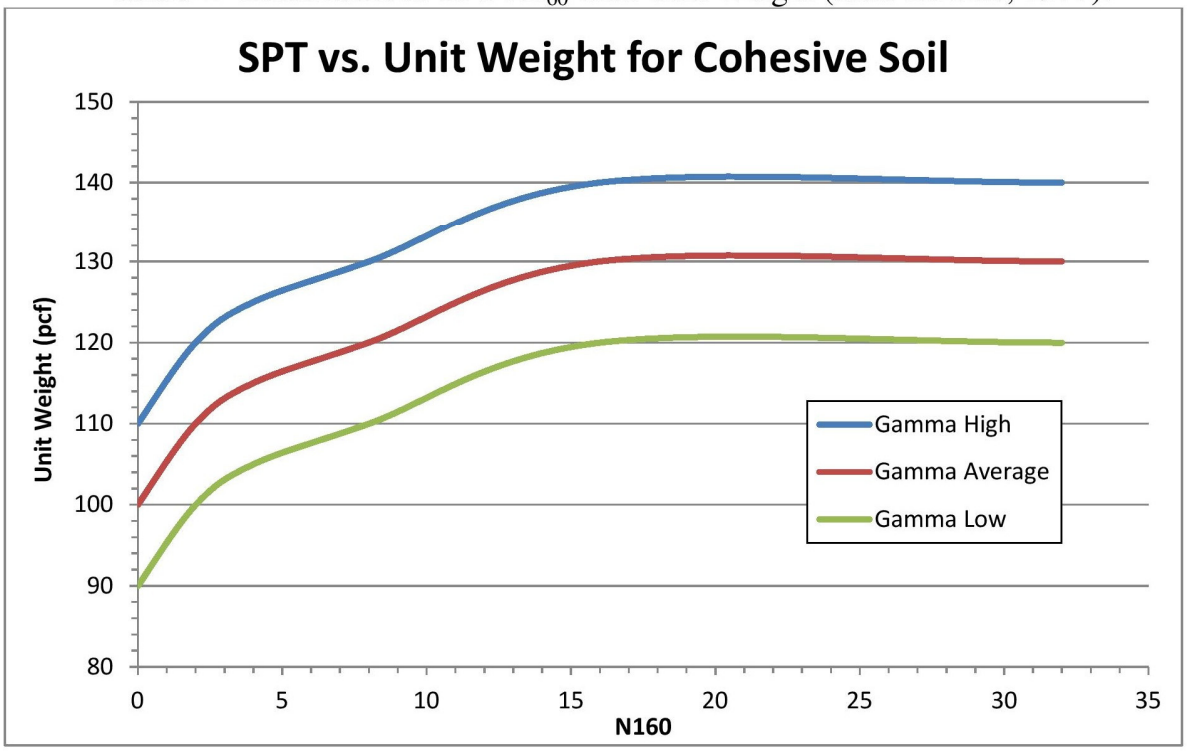


Chart 4: Correlation of SPT $N1_{60}$ with Unit Weight (after Bowles, 1977).



UNIT WEIGHT CORRELATIONS WITH CORRECTED SPT N-VALUE

Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE 3

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Figures\Figure 3 - Unit Weight Correlations.grf

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees) (a)	(b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

a - Source: Peck, Hanson, and Thornburn (12), p. 310.
b - Source: Meyerhof (13), p. 17.

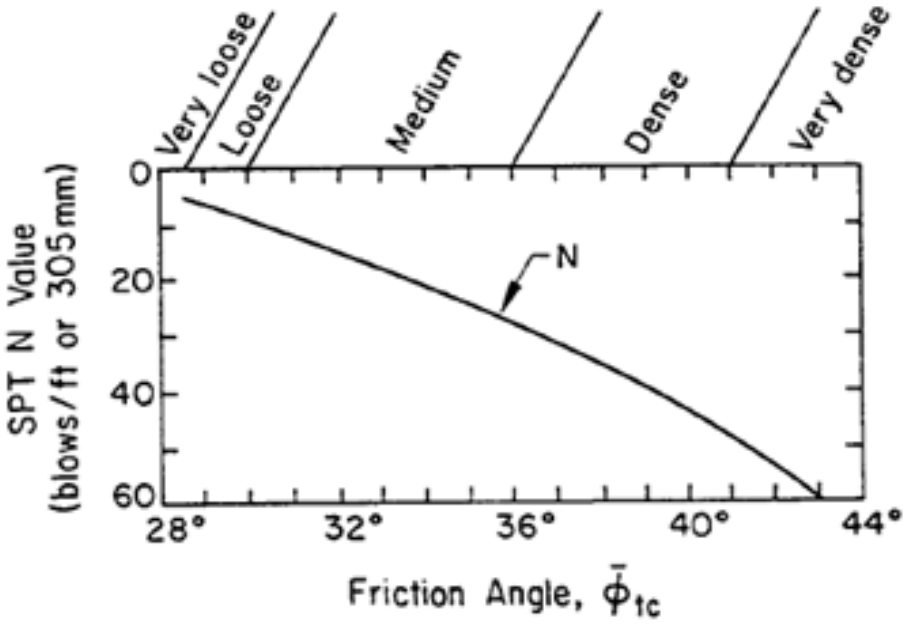


Figure 4-12. N versus $\bar{\phi}_{tc}$

Source: Peck, Hanson, and Thornburn (12), p. 310.

CORRELATIONS OF FRICTION ANGLE WITH SPT N-VALUE

Former Sperry Remington Site North (EHS)
Elmira, New York

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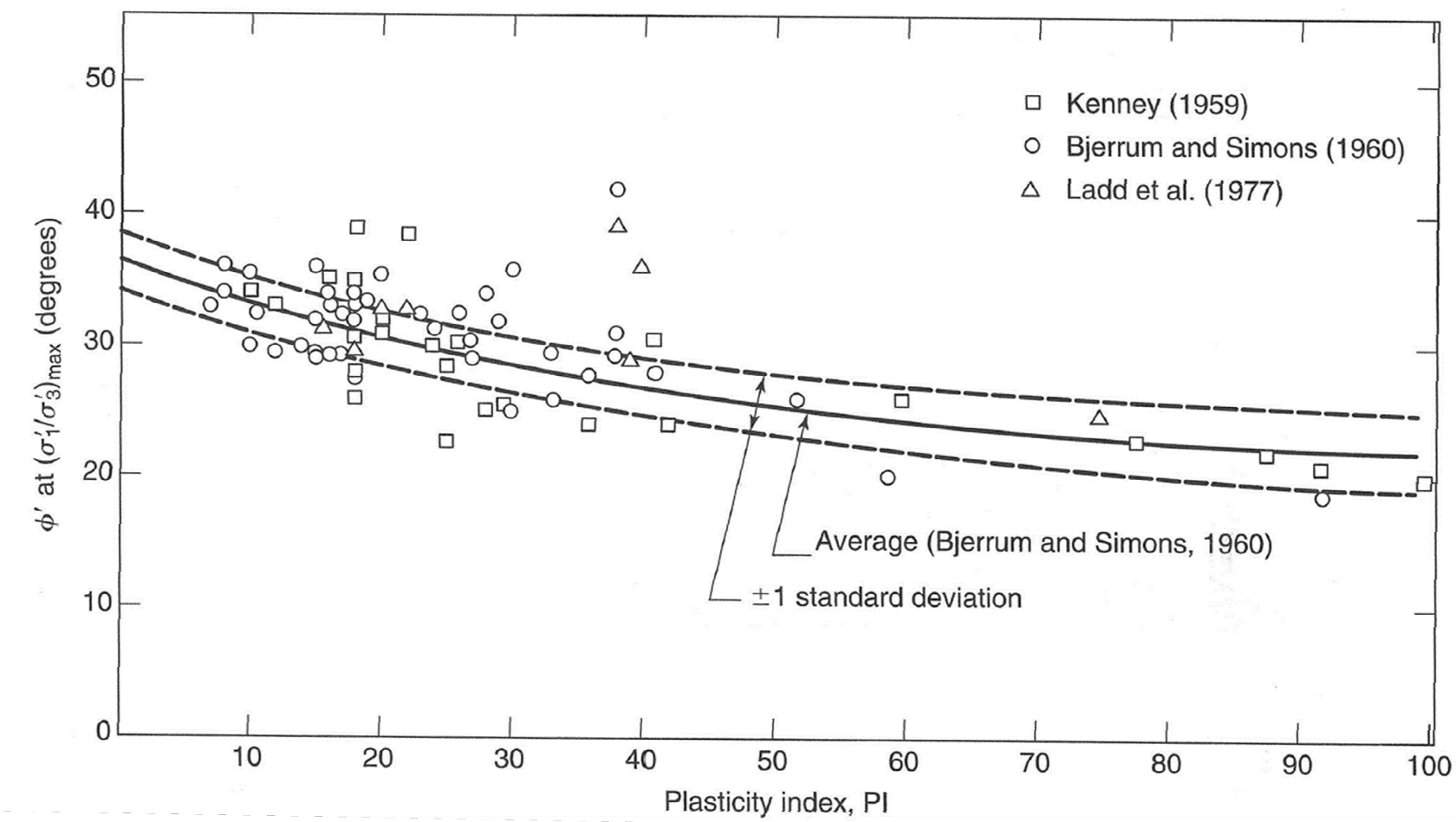
Columbia, Maryland | March 2018

FIGURE 4

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Figures\Figure 4 - Phi' granular correlation.grf



CORRELATIONS OF FRICTION ANGLE WITH PLASTICITY INDEX

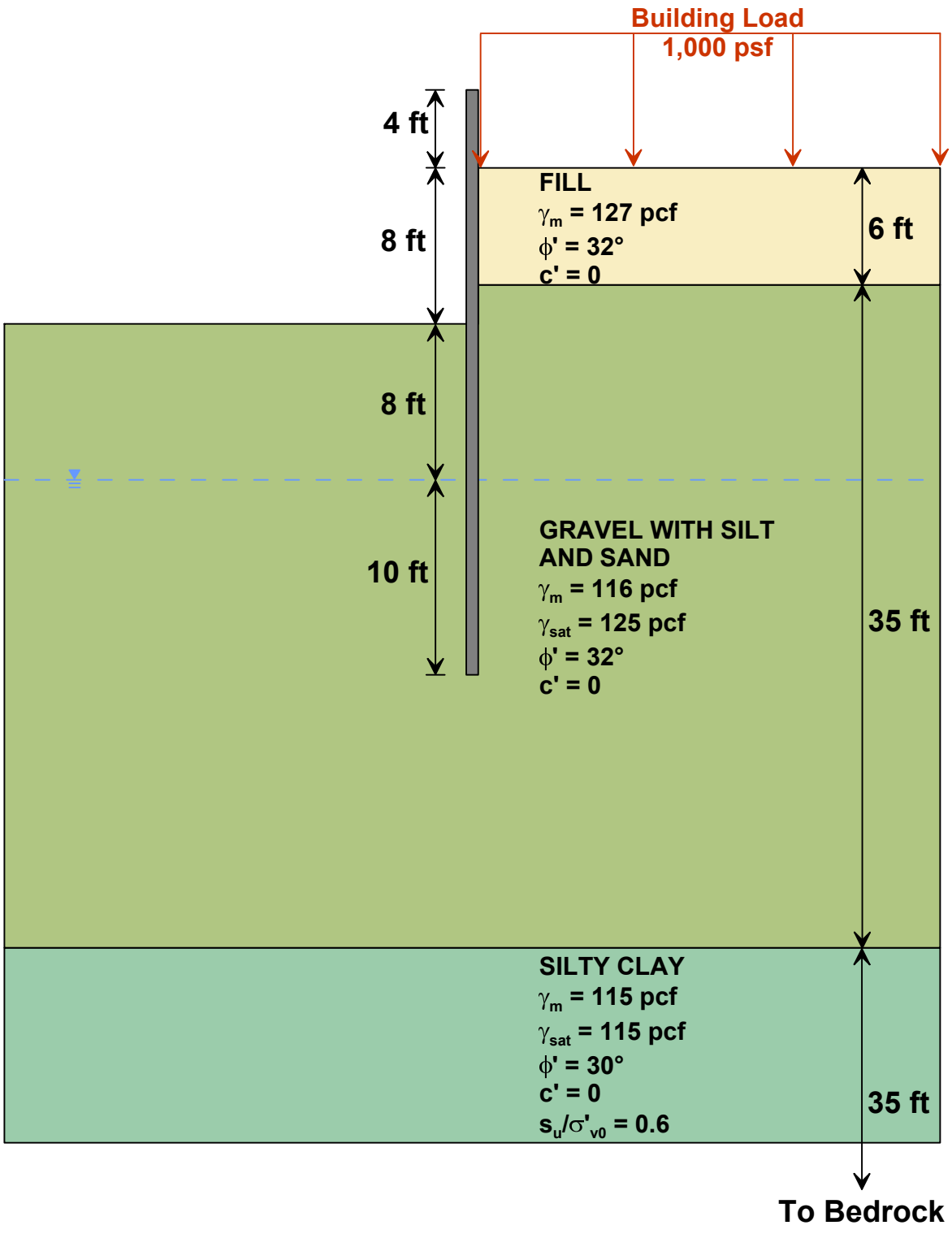
Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE 5

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Figures\Figure 5 - Phi' cohesive correlation.grf



CROSS SECTION 1-1'

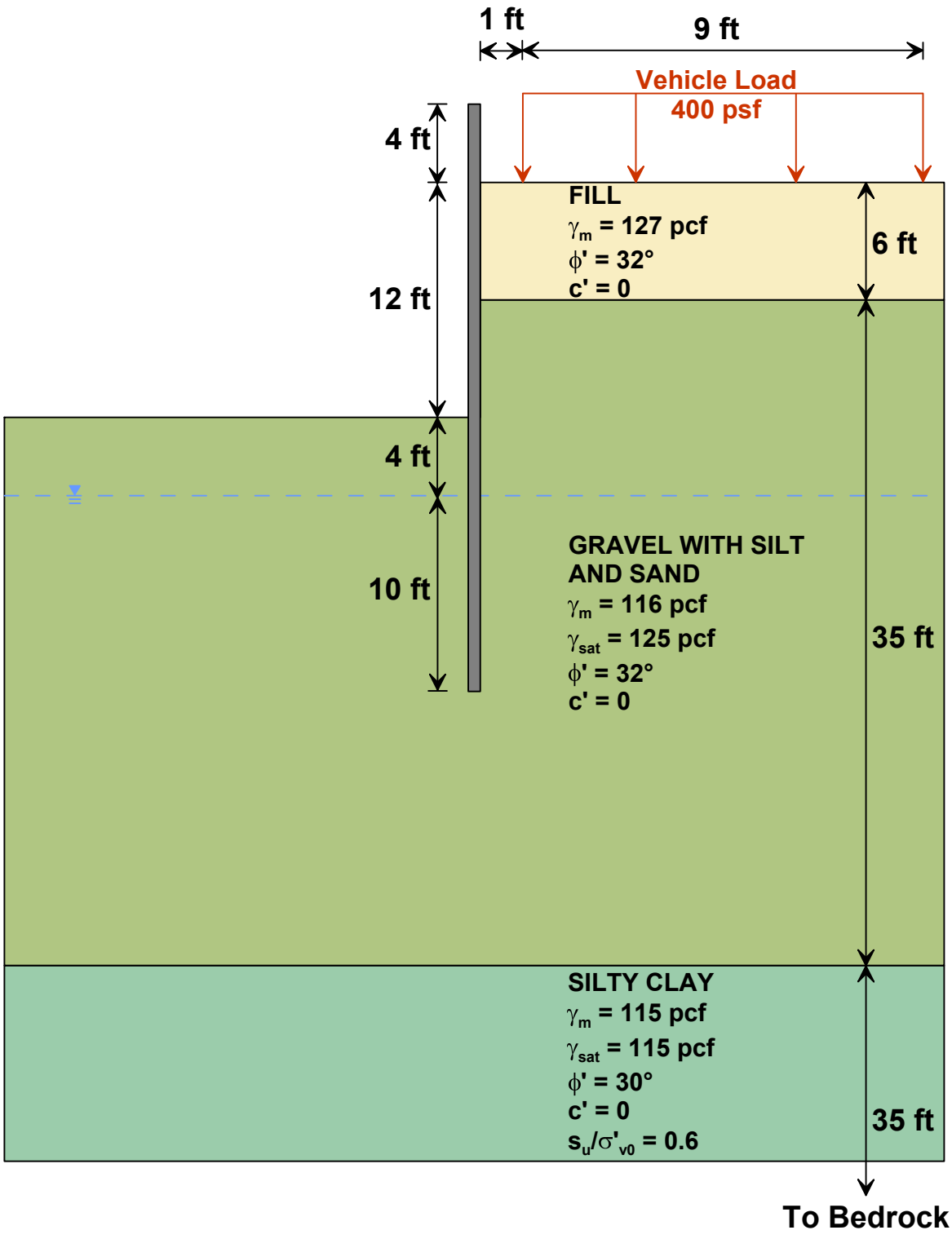
Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE 6

C:\Users\sodonnell\Desktop\Elmira\Sheet Pile\Analysis\Soil and Sheet Pile Stratigraphy.grf



CROSS SECTION 2-2'

Former Sperry Remington Site North (EHS)
Elmira, New York

Geosyntec consultants

Columbia, Maryland | March 2018

FIGURE

7

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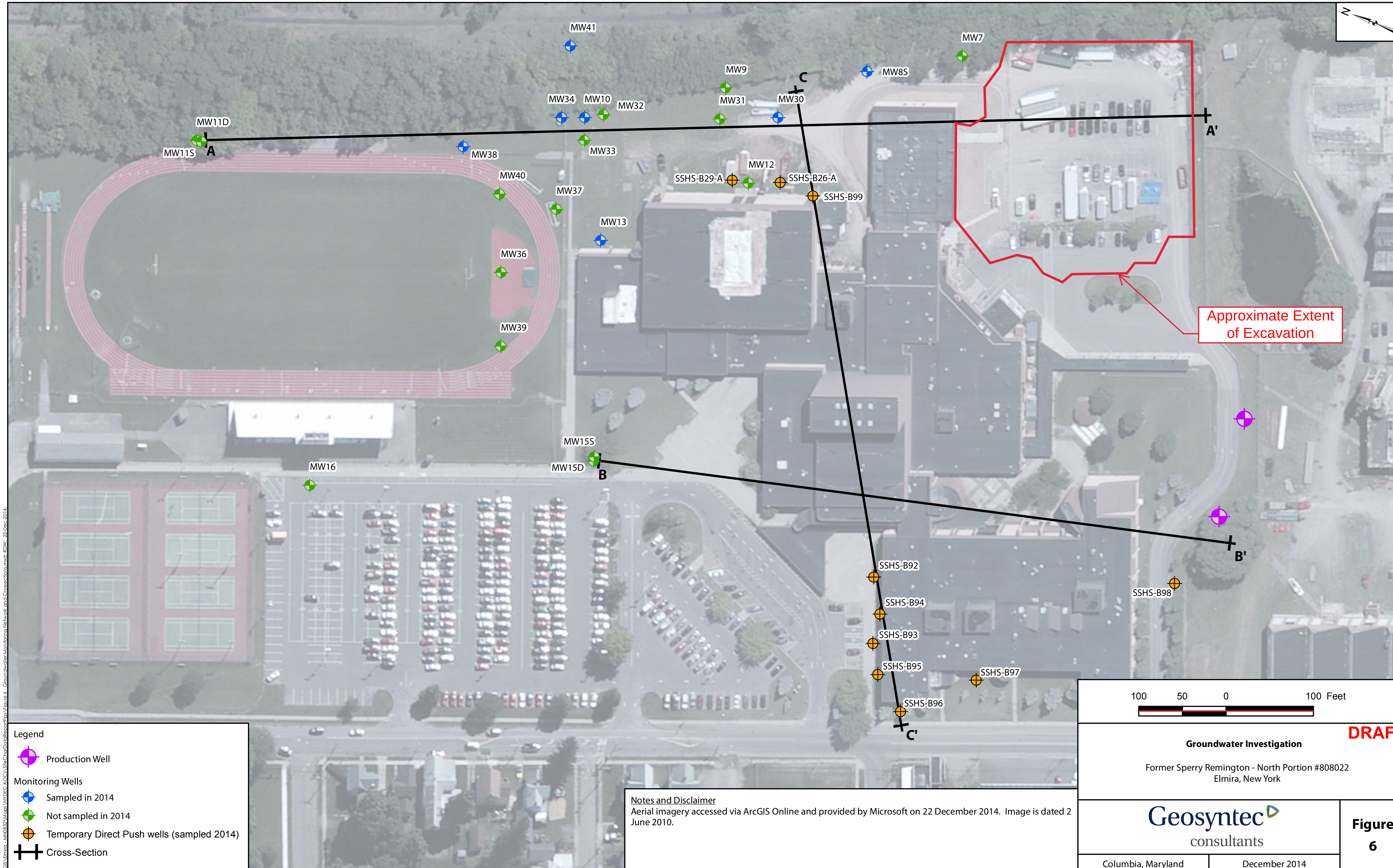
ATTACHMENT 1

Cross Section A-A’ from Geosyntec (2015)



Legend

- Production Well

Monitoring Wells

- Sampled in 2014
- Not sampled in 2014
- Temporary Direct Push wells (sampled 2014)
- Cross-Section

Notes and Disclaimer

Aerial imagery accessed via ArcGIS Online and provided by Microsoft on 22 December 2014. Image is dated 2 June 2010.

DRAFT

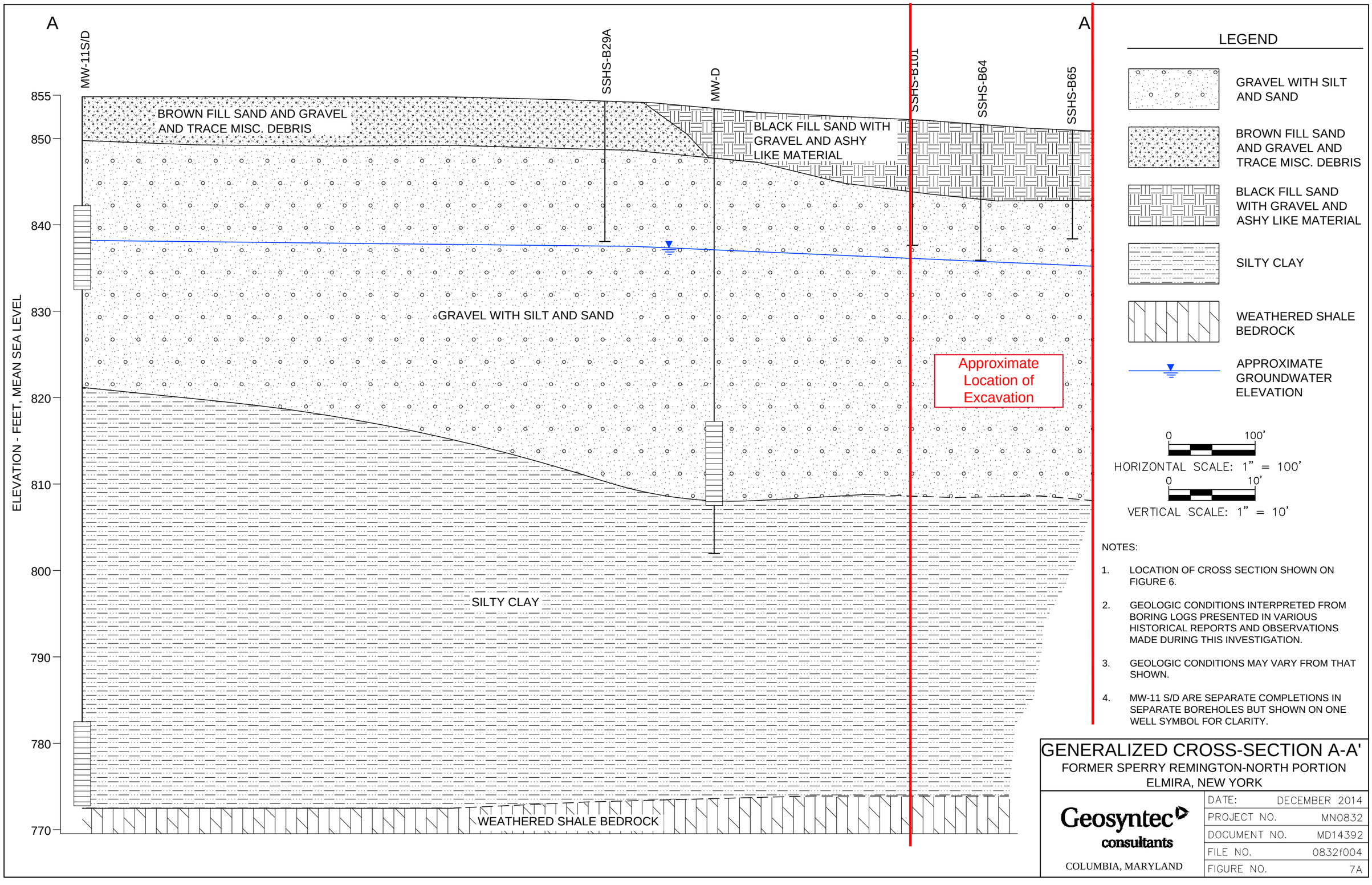
Groundwater Investigation

Former Sperry Remington - North Portion #808022
Elmira, New York

Geosyntec consultants

Columbia, Maryland | December 2014

Figure 6



LEGEND

- GRAVEL WITH SILT AND SAND
- BROWN FILL SAND AND GRAVEL AND TRACE MISC. DEBRIS
- BLACK FILL SAND WITH GRAVEL AND ASHY LIKE MATERIAL
- SILTY CLAY
- WEATHERED SHALE BEDROCK
- APPROXIMATE GROUNDWATER ELEVATION

0 100'

HORIZONTAL SCALE: 1" = 100'

0 10'

VERTICAL SCALE: 1" = 10'

NOTES:

1. LOCATION OF CROSS SECTION SHOWN ON FIGURE 6.
2. GEOLOGIC CONDITIONS INTERPRETED FROM BORING LOGS PRESENTED IN VARIOUS HISTORICAL REPORTS AND OBSERVATIONS MADE DURING THIS INVESTIGATION.
3. GEOLOGIC CONDITIONS MAY VARY FROM THAT SHOWN.
4. MW-11 S/D ARE SEPARATE COMPLETIONS IN SEPARATE BOREHOLES BUT SHOWN ON ONE WELL SYMBOL FOR CLARITY.

GENERALIZED CROSS-SECTION A-A'

FORMER SPERRY REMINGTON-NORTH PORTION
ELMIRA, NEW YORK

Geosyntec consultants
COLUMBIA, MARYLAND

DATE:	DECEMBER 2014
PROJECT NO.	MN0832
DOCUMENT NO.	MD14392
FILE NO.	0832f004
FIGURE NO.	7A

ATTACHMENT 2

Borings and Laboratory Test Data

EARTH TECH	PROJECT:	BORING NUMBER **MW-15D**
40 British American Boulevard Latham, New York 12110	Southside High School Elmira, New York	SHEET 1 OF 4 PROJECT # 66837 FILE

BORING COMPANY	GeoLogic, Inc.	BORING LOCATION	West side of school bldg.
FOREMAN	Scott	GROUND ELEVATION	
EARTH TECH INSPECTOR	Paul Sleasman	DATE STARTED 4/29/03	DATE ENDED 4/30/03

	CASING		SAMPLER		
SIZE	NA	TYPE	2" Split Spoon	OTHER:	
HAMMER	NA	HAMMER	140 lb	4¼" I.D. Augers	
FALL	NA	FALL	30"		

GROUNDWATER READINGS			
DATE	DEPTH	CASING	STABILIZATION TIME
5/7/03 09:00	17.0' Top of Casing	2" PVC	

SAMPLE					SAMPLE DESCRIPTION	STRATA CHANGE AND GENERAL DESCRIPTION	FIELD TESTING OVM (ppm)	EQUIPMENT OR WELL INSTALLED
	NO.	REC.	DEPTH	BLOWS				
0'	1	1.5'	0-2'	4-7-9-10	LOAM, damp. Brown fine(+)-med SAND, some fine-crs Gravel, damp.	0-0.7' 0.7'-1.5'	0	PVC RISER PIPE
	2	0	2'-4'	11-24-8-9	No Recovery.			
5'	3	1.5'	4'-6'	9-6-6-6	Brown fine SAND, and (-) fine-crs Gravel (red brick, concrete – evidence of fill material), damp.	4'-5.5'	0	
	4	0.4'	6'-8'	8-12-9-9	Brown silty-fine SAND, and (-) fine-crs Gravel (red brick, concrete – evidence of fill material), damp.	6'-6.4'	0	
	5	1.1'	8'-10'	14-17-19-19	Brown-black fine(+)-med SAND, some(-) fine-crs Gravel (red brick particles observed), dry-damp.	8'-9.1'	1.3	
10'					(FILL)			
	6	0.9'	10'-12'	8-4-4-5	Red, tan, black fine-crs(+) GRAVEL, and (+) brown-black fine-crs Sand, dry-damp.	10'-10.9'	64	
	7	0.5'	12'-14'	14-16-23-100/0.4'	Red brick. Fine-crs GRAVEL and fine-crs gray-white Sand, some(+) fine-crs gravel, dry-damp.	12'-12.2' 12.2'-12.5'	1.0	
15'	8	0.3'	14'-16'	100/0.3	Black-brown silty-fine SAND, some(+) fine-crs Gravel, moist.	14'-14.3'	0	
	9	1.1'	16'-18'	16-23-27-20	Black-gray fine-crs GRAVEL, little brown silty-fine Sand, wet.	16'-17.1'	0	
	10	0.5'	18'-20'	20-24-17-20	Fine-crs gravel, little brown silty-fine SAND, wet.	18'-18.5'	0	
20'					(GLACIAL OUTWASH)			

WELL CONSTRUCTION LEGEND

BENTONITE, CONCRETE, GROUT, SILICA SAND, NATURAL BACKFILL, BEDROCK

PROPORTIONS USED		PENETRATION RESISTANCE 140 LB WT FALLING 30" ON 2" O.D. SAMPLER			
		COHESIONLESS DENSITY		COHESIVE CONSISTENCY	
TRACE	0 TO 10%	0-4	VERY LOOSE	0-2	VERY SOFT
LITTLE	10 TO 20%	5-9	LOOSE	3-4	SOFT
SOME	20 TO 35%	10-29	MED. DENSE	5-8	M/STIFF
AND	35 TO 50%	30-49	DENSE	9-15	STIFF
		50+	VERY DENSE	16-30	V-STIFF
				31+	HARD

L:/Work/38379/Proj/Environmental/Logs

EARTH TECH	PROJECT:	BORING NUMBER **MW-15D**
40 British American Boulevard Latham, New York 12110	Southside High School Elmira, New York	SHEET 2 OF 4 PROJECT # 66837 FILE

BORING COMPANY	GeoLogic, Inc.	BORING LOCATION	West side of school bldg.
FOREMAN	Scott	GROUND ELEVATION	
EARTH TECH INSPECTOR	Paul Sleasman	DATE STARTED 4/29/03	DATE ENDED 4/30/03

	CASING		SAMPLER		
SIZE	NA	TYPE	2" Split Spoon	OTHER:	
HAMMER	NA	HAMMER	140 lb	4¼" I.D. Augers	
FALL	NA	FALL	30"		

GROUNDWATER READINGS			
DATE	DEPTH	CASING	STABILIZATION TIME
5/7/03 09:00	17.0' Top of Casing	2" PVC	

SAMPLE NO.	REC.	DEPTH	BLOWS	SAMPLE DESCRIPTION	STRATA CHANGE AND GENERAL DESCRIPTION	FIELD TESTING OVM (ppm)	EQUIPMENT OR WELL INSTALLED
11	1.0'	20'-22'	30-18-12-15	Fine-crs GRAVEL, little(-) brown fine-crs Sand, wet.	20'-21'	0	PVC RISER PIPE
12	0.3'	22'-24'	23-9-6-9	Brown-black-gray-red fine-crs SAND, and fine-crs Gravel, wet.	22'-22.3'	0	
13	0.7'	24'-26'	12-14-8-8	Brown-black-gray-red fine-crs SAND, and fine-crs Gravel, wet. Brown med SAND, wet.	24'-24.3' 24.3'-24.7'	0 0	
14	0	26'-28'	12-12-10-6	No Recovery.			
15	2.0'	28'-30'	40-27-23-20	Brown med SAND, wet, no odor. Brown fine(+)-crs SAND, some fine-crs Gravel, wet.	28'-28.2' 28.2'-30'	0 0	
16	1.3'	30'-32'	12-6-4-5	Fine-crs GRAVEL, and brown fine-crs Sand (coarsens downward), wet.	30'-31.3'	0	
17	1.4'	32'-34'	12-10-20-11	Brown fine-crs SAND, wet. Brown fine-crs SAND, and (-) fine-crs Gravel, wet.	32'-33.4'	0	
18	0.7'	34'-36'	28-25-15-13	Brown fine-crs SAND, and fine-crs Gravel, wet.	34'-34.7'	0	
19	0.9'	36'-38'	20-18-16-19	Same. (GLACIAL OUTWASH)	36'-36.8'	0	
				Brown Silty CLAY, moist.	36.8'-36.9'	0	
20	0.3'	38'-40'	7-5-5-6	Same.	38'-38.3'	0 0	
21	0.8'	40'-42'	2-3-4-3	Brown-gray Silty CLAY, moist.	40'-40.8'	0	
22	0.9'	42'-44'	2-3-3-2	Gray Silty CLAY, moist. (GLACIO LACUSTRINE)	42'-42.9'	NR	

PROPORTIONS USED

TRACE	0 TO 10%
LITTLE	10 TO 20%
SOME	20 TO 35%
AND	35 TO 50%

PENETRATION RESISTANCE
140 LB WT FALLING 30" ON 2" O.D. SAMPLER

COHESIONLESS DENSITY		COHESIVE CONSISTENCY	
0-4	VERY LOOSE	0-2	VERY SOFT
5-9	LOOSE	3-4	SOFT
10-29	MED. DENSE	5-8	M/STIFF
30-49	DENSE	9-15	STIFF
50+	VERY DENSE	16-30	V-STIFF
		31+	HARD

WELL CONSTRUCTION LEGEND

BENTONITE ËËËË CONCRETE ***** GROUT ======

SILICA SAND NATURAL BACKFILL BEDROCK ++++++

L:/Work/38379/Proj/Environmental/Logs

EARTH TECH	PROJECT:	BORING NUMBER **MW-15D**
40 British American Boulevard Latham, New York 12110	Southside High School Elmira, New York	SHEET 3 OF 4 PROJECT # 66837 FILE

BORING COMPANY	GeoLogic, Inc.	BORING LOCATION	West side of school bldg.
FOREMAN	Scott	GROUND ELEVATION	
EARTH TECH INSPECTOR	Paul Sleasman	DATE STARTED 4/29/03	DATE ENDED 4/30/03

	CASING		SAMPLER		
SIZE	NA	TYPE	2" Split Spoon	OTHER:	
HAMMER	NA	HAMMER	140 lb	4¼" I.D. Augers	
FALL	NA	FALL	30"		

GROUNDWATER READINGS			
DATE	DEPTH	CASING	STABILIZATION TIME
5/7/03 09:00	17.0' Top of Casing	2" PVC	

	SAMPLE NO.	REC.	DEPTH	BLOWS	SAMPLE DESCRIPTION	STRATA CHANGE AND GENERAL DESCRIPTION	FIELD TESTING OVM (ppm)	EQUIPMENT OR WELL INSTALLED
45'	23	0.8'	44'-46'	2-2-2-2	Gray Silty CLAY, moist.	44'-44.8'	NR	
	24	1.3'	46'-48'	0-1-2-3	Same.	46'-47.3'	NR	
	25	1.8	48'-50'	1-1-2-3	Same.	48'-49.8'	NR	
50'	26	1.3	50'-52'	0-1-2-2	Same.	50'-51.3'	NR	
	27	2.0'	52'-54'	0-2-2-3	Same.	52'-54'	NR	
	28	1.6	54'-56'	0-0-2-3	Same.	54'-55.6'	NR	
55'	29	2.0'	56'-58'	0-0-3-4	Same.	56'-58'	NR	
	30	2.0'	58'-60'	2-3-4-5	Same.	58'-60'	NR	
60'	31	2.0'	60'-62'	2-3-3-4	Same.	60'-62'	NR	
	32	2.0'	62'-64'	2-3-4-5	Same.	62'-64'	NR	61.6'-
65'	33	2.0'	64'-66'	2-2-3-3	Same.	64'-66'	NR	
	34	2.0'	66'-68'	1-1-3-6	Same.	66'-68'	NR	65.5'- 66.5'-
	35	1.7'	68'-70'	2-2-3-3	Same. (GLACIO LACUSTRINE)	68'-69.7'	NR	

PVC RISER PIPE

WELL CONSTRUCTION LEGEND

BENTONITE, CONCRETE, GROUT, SILICA SAND, NATURAL BACKFILL, BEDROCK

PROPORTIONS USED

TRACE	0 TO 10%
LITTLE	10 TO 20%
SOME	20 TO 35%
AND	35 TO 50%

PENETRATION RESISTANCE
140 LB WT FALLING 30" ON 2" O.D. SAMPLER

COHESIONLESS DENSITY		COHESIVE CONSISTENCY	
0-4	VERY LOOSE	0-2	VERY SOFT
5-9	LOOSE	3-4	SOFT
10-29	MED. DENSE	5-8	M/STIFF
30-49	DENSE	9-15	STIFF
50+	VERY DENSE	16-30	V-STIFF
		31+	HARD

EARTH TECH	PROJECT:	BORING NUMBER **MW-15D**
40 British American Boulevard Latham, New York 12110	Southside High School Elmira, New York	SHEET 4 OF 4 PROJECT # 66837 FILE

BORING COMPANY	GeoLogic, Inc.	BORING LOCATION	West side of school bldg.
FOREMAN	Scott	GROUND ELEVATION	
EARTH TECH INSPECTOR	Paul Sleasman	DATE STARTED 4/29/03	DATE ENDED 4/30/03

	CASING		SAMPLER		
SIZE	NA	TYPE	2" Split Spoon	OTHER:	
HAMMER	NA	HAMMER	140 lb	4¼" I.D. Augers	
FALL	NA	FALL	30"		

GROUNDWATER READINGS			
DATE	DEPTH	CASING	STABILIZATION TIME
5/7/03 09:00	17.0' Top of Casing	2" PVC	

	SAMPLE					STRATA CHANGE AND GENERAL DESCRIPTION	FIELD TESTING OVM (ppm)	EQUIPMENT OR WELL INSTALLED
	NO.	REC.	DEPTH	BLOWS	SAMPLE DESCRIPTION			
70'	36	2.0'	70'-72'	3-4-8-5	Gray Silty CLAY, moist.	70'-72'	NR	
	37	1.1'	72'-74'	6-9-15-15	Same. (GLACIO LACUSTRINE)	72'-72.6'	NR	
					Gray SILT and fine-med Sand, and fine-crs gravel, wet.	72.6'-73.1'	NR	
	38	0.8'	74'-76'	35-30-18-90	Gray Silty CLAY, and (+) fine-crs Gravel (abundant shale fragments).	74'-74.8'	NR	
75'	39	0.8'	76'-78'	30-100/0.4'	Gray fine-crs gravel, and Silty Clay. (GLACIAL TILL OR WEATHERED BEDROCK)	76'-76.8'	NR	76.5'-77.0'-
					END OF BORING TOTAL BORING DEPTH = 77.0' 4/30/03 12:15			0-61.6: Grout 61.6'-65.5': Bentonite Seal 65.0'-65.5': #00 Silica Choke Sand 65.5'-77.0': #0 Silica Filter Pack 0-66.5: 2" I.D. PVC Riser Pipe 66.5'-76.5': 2" I.D. PVC Well Screen (0.01" slot)
80'								
85'								
90'								

PROPORTIONS USED

TRACE	0 TO 10%
LITTLE	10 TO 20%
SOME	20 TO 35%
AND	35 TO 50%

PENETRATION RESISTANCE
140 LB WT FALLING 30" ON 2" O.D. SAMPLER

COHESIONLESS DENSITY		COHESIVE CONSISTENCY	
0-4	VERY LOOSE	0-2	VERY SOFT
5-9	LOOSE	3-4	SOFT
10-29	MED. DENSE	5-8	M/STIFF
30-49	DENSE	9-15	STIFF
50+	VERY DENSE	16-30	V-STIFF
		31+	HARD

WELL CONSTRUCTION LEGEND

BENTONITE, CONCRETE, GROUT, SILICA SAND, NATURAL BACKFILL, BEDROCK

L:/Work/38379/Proj/Environmental/Logs

STARTED: 11-11-12
FINISHED: 11-12-12

SJB SERVICES, INC.

SUBSURFACE LOG

HOLE NO. B-3
SURF. ELEV. g.s.
G.W. DEPTH See Notes
SHEET 1 of 2

PROJECT: Southside High School Building Addition
CLIENT: HUNT Engineers, Architects, & Land Surveyors, P.C.
LOCATION: 777 South Main Street, Elmira, New York 14904

DEPTH-FT.	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0 6 12 18 24 N	Rec (ft)	SOIL OR ROCK CLASSIFICATION	NOTES
		S-1	- 6 16 20 36	0.8	Fill: Brown-gray GRAVEL and SAND, trace silt (Moist, Compact)	Drillers noted approximately 0.3 feet of concrete at ground surface.
		S-2	16 22 24 16 46	1.4	Fill: Dark brown-black SAND, little Gravel, little Silt, little Clay, trace; ash, cinders, bricks, cement (Moist)	
5		S-3	10 4 2 2 6	1.2	Fill: Reddish brown SILT, little Sand, little Ash, trace gravel, (Moist to Wet, Loose)	S-3 & S-4: slight to some odor.
		S-4	1 3 3 5 6	0.8	Fill: Brown-black SAND and CERAMIC or TILE pieces, little Silt, trace decaying wood (Moist to Wet, Loose)	
		S-5	WH WH WH 6 WH	1.6	FILL: Brown-gray CLAY, little Silt (Moist, Very Soft)	WH: weight of hammer and the drilling rods.
10		S-6	12 6 6 4 12	0.6	Fill: Brown-gray GRAVEL, some Sand, some silty Clay (Moist, Firm)	
		S-7	7 5 3 9 8	0.2	Fill: Brown-gray SAND and GRAVEL, some clayey Silt trace organics (Moist to Wet, Loose)	S-7: poor recovery.
15		S-8	3 5 9 15 14	1.0	Fill: Brown GRAVEL and clayey SILT, little Sand (Moist, Firm)	S-8: contains gray silty sand seam.
		S-9	14 8 4 5 12	0.2	Brown GRAVEL, some Sand, trace silt (Wet, Firm)	S-9: poor recovery. Subangular to angular gravel.
		S-10	4 6 4 6 10	0.5	(Wet, Loose)	S-9 through S-12: slight odor and oil sheen.
20		S-11	4 4 4 3 8	0.3	(Wet to Saturated, Loose)	
		S12	3 2 1 2 3	0.2	(Wet to Saturated, Very Loose)	S-12: poor recovery.
25		S13	4 2 1 2 3	1.0	Brown-gray f.-m. SAND, little Silt (Saturated, Very Loose)	
		S-14	3 4 7 4 11	1.5	Brown-gray GRAVEL and SAND, trace Silt (Wet to Saturated, Firm)	Rounded to subrounded gravel.
		S-15	1 1 2 2 3	0.3	Brown-gray SAND and f. GRAVEL, trace silt (Saturated, Very Loose)	
30		S-16	2 2 2 3 4	0.3	Brown-gray GRAVEL, some SAND, trace silt (Saturated, Loose)	
		S-17	5 4 4 2 8	1.0	Brown GRAVEL, little Sand, trace silt (Wet, Loose)	Subangular to angular gravel.
35		S-18	7 11 12 10 23	0.5	Gray SAND and f. GRAVEL, trace silt (Wet, Firm)	Rounded gravel.
		S-19	3 3 3 6 6	0.5	Brown-gray SAND and GRAVEL, trace silt (Wet, Loose)	
40		S-20	3 4 3 3 7	0.4		

DRILLER: M. Warner / G. Spizzirri
DRILL RIG: CME-850
METHOD OF INVESTIGATION: 4 1/4 inch augers, 2" Split Spoon Sampler (ASTMD1586)
JOB NUMBER: CE-12-42
CLASSIFIED BY: Geotechnical Engineer

STARTED: 11-11-12
FINISHED: 11-12-12

SJB SERVICES, INC.

SUBSURFACE LOG

HOLE NO. B-3
SURF. ELEV. g. s.
G.W. DEPTH See Notes
SHEET 2 of 2

PROJECT: Southside High School Building Addition
CLIENT: HUNT Engineers, Architects, & Land Surveyors, P.C.
LOCATION: 777 South Main Street, Elmira, New York 14904

DEPTH-FT.	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0 6	6 12	12 18	18 24	N	Rec (ft)	SOIL OR ROCK CLASSIFICATION	NOTES
		S-21	5	2	4	8	6	1.7	Gray CLAY, trace to little Silt, trace f. sand	Driller noted top of clay at depth of about 40.5 feet.
									(Moist, Medium)	
		S-22	4	4	4	6	8	1.6	Grades to "some" Silt	
45		S-23	4	3	4	6	7	1.8		
		S-24	6	6	6	8	12	1.8		Driller noted gravel at about 46 to 46.5 feet.
									(Wet, Stiff)	
		S-25	4	5	3	5	8	0.4	Contains "little" f. Gravel	
									(Wet, Medium)	
50		S-26	2	2	3	4	5	2.0		
55		S-27	WH	1	2	4	3	2.0		WH: weight of hammer and the drilling rods.
									(Wet, Soft)	
60		S-28	WR	WH	2	3	2	2.0		WR: weight of drilling rods.
65		S-29	WH	2	2	5	4	2.0	Contains "some" Silt	
70		S-30	WH	3	4	5	7	2.0		
									(Wet, Medium)	
		S-31	5	4	5	5	9	2.0		Freestanding water was initially encountered at 15.4 with augers at 18 feet, and at 15.5 feet with augers at 44 feet. Borehole side walls caved-in at about 16 feet after the augers were removed.
									(Wet, Stiff)	
75									Test boring complete at 74 feet.	
80										

DRILLER: M. Warner / G. Spizzirri
DRILL RIG: CME-850
METHOD OF INVESTIGATION: 4 1/4 inch augers, 2" Split Spoon Sampler (ASTMD1586)
JOB NUMBER: CE-12-042
CLASSIFIED BY: Geotechnical Engineer

STARTED: 11-10-12
FINISHED: 11-10-12

SJB SERVICES, INC.

SUBSURFACE LOG

HOLE NO. B-5
SURF. ELEV. g.s.
G.W. DEPTH See Notes
SHEET 1 of 2

PROJECT: Southside High School Building Addition
CLIENT: HUNT Engineers, Architects, & Land Surveyors, P.C.
LOCATION: 777 South Main Street, Elmira, New York 14904

DEPTH-FT.	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0-6	6-12	12-18	18-24	N	Rec (ft)	SOIL OR ROCK CLASSIFICATION	NOTES
		S-1	-	4	6	5	11	0.5	Fill: Red BRICK fragments and brown silty SAND with gravel (Moist, Firm)	Drillers noted approximately 0.3 feet of concrete at ground surface.
		S-2	8	8	8	5	16	1.2	Fill: Black SAND and CINDERS, some Gravel (Moist, Firm)	
5		S-3	4	6	6	7	12	1.2	Fill: Brown SAND and GRAVEL, little to some Silt (Moist, Firm)	
		S-4	6	5	4	4	9	1.2	(Moist, Loose)	
		S-5	4	3	2	7	5	0.5	Fill: Brown SILT and CLAY (Moist, Stiff)	S-6 to S-12: Subangular to angular gravel.
10		S-6	6	8	6	7	14	1.0	Fill: Brown GRAVEL, some Sand, little clayey Silt (Moist, Firm)	
		S-7	8	8	9	7	17	0.2		
15		S-8	8	12	12	16	24	1.1	Brown GRAVEL and SAND, little Silt (Moist, Firm)	
		S-9	8	6	3	4	9	0.7	Contains "some" Sand (Wet, Loose)	
		S-10	6	6	6	5	12	0.5	Grades to "little" Sand, "trace" silt (Wet, Firm)	
20		S-11	2	4	4	1	8	0.8	(Wet, Loose)	
		S12	6	2	2	3	4			
25		S13	1	2	2	2	4		Grades to "and" f.-m. SAND	S-13 to S-20: Rounded to subrounded gravel.
		S-14	4	7	4	4	11		(Wet, Firm)	
		S-15	3	3	3	3	6	0.3	(Wet, Loose)	
30		S-16	5	3	2	3	5	0.8		
		S-17	2	3	4	6	7	0.8	Brown f.-m. SAND, some f. Gravel, trace silt (Wet to Saturated, Loose)	
35		S-18	5	3	2	2	5	0.0	No recovery	
		S-19	1	1	5	3	6	0.7		
		S-20	3	2	2	2	4	0.3	Reddish brown, Contains "little" f. Gravel	
40										

DRILLER: M. Warner / G. Spizzirri
DRILL RIG: CME-850
METHOD OF INVESTIGATION: 4 1/4 inch augers, 2" Split Spoon Sampler (ASTMD1586)
JOB NUMBER: CE-12-42
CLASSIFIED BY: Geotechnical Engineer

STARTED: 11-10-12
FINISHED: 11-10-12

SJB SERVICES, INC.

SUBSURFACE LOG

HOLE NO. B-5
SURF. ELEV. g. s.
G.W. DEPTH See Notes
SHEET 2 of 2

PROJECT: Southside High School Building Addition
CLIENT: HUNT Engineers, Architects, & Land Surveyors, P.C.
LOCATION: 777 South Main Street
Elmira, New York 14904

DEPTH-FT.	SAMPLES	SAMPLE NO.	BLOWS ON SAMPLER 0-6	6-12	12-18	18-24	N	Rec (ft)	SOIL OR ROCK CLASSIFICATION	NOTES
		S-21	2	3	3	6	6	1.2	Brown CLAY, trace silt, trace f. sand (Moist, Medium)	Driller noted top of clay at about 40.5 feet.
		S-22	5	5	5	7	10	1.6	Becomes gray (Moist, Stiff)	
45		S-23	2	2	4	5	6	2.0	(Moist, Medium)	
		S-24	5	4	4	5	8	0.5	Brown f.-m. SAND, trace silt (Wet, Loose)	
		S-25	6	5	6	7	11	2.0	Gray CLAY, trace silt, trace gravel (Moist, Stiff)	
50									Test boring complete at 50 feet.	Freestanding water was initially encountered at 15.6 feet with augers at 18 feet, and at 24.6 feet with augers at 44 feet. Borehole side walls caved-in at about 16 feet after the augers were removed.
55										
60										
65										
70										
75										
80										

DRILLER: M. Warner, G. Spizzirri
DRILL RIG: CME-850
METHOD OF INVESTIGATION: 4 1/4 inch augers, 2" Split Spoon Sampler (ASTMD1586)
JOB NUMBER: CE-12-042
CLASSIFIED BY: Geotechnical Engineer

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

November 19, 2012
12LS2756.01

Sterling Environmental Engineering, P.C.
24 Wade Road
Latham, NY 12110

Attn: Peter Kelleher

RE: GEOTECHNICAL TEST RESULTS
PROJECT 28014 ELMIRA CSD

Dear Mr. Kelleher:

Submitted herein are the results of geotechnical tests performed on twelve (12) jar samples submitted for testing. As noted on the testing assignment sheet, jar B-3 / S-22 at 42 to 44 ft was combined with jar B-3 / S-3 at 44 to 46 ft resulting in eleven (11) sets of test results. All testing was performed per ASTM Standards while subject to JLT's internal QA / QC and data validation procedures. Testing included:

Gradation per ASTM D-422
Moisture Content per ASTM D-2216
Atterberg Limits per ASTM D-4318

We appreciate the opportunity to provide our services to you and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

JLT LABORATORIES, INC.

John Boschuk, Jr., P.E., C.F.E.
President

Enclosures
JB/mlb
\wp10\letter\12357
Inv# 5094

938 South Central Avenue • Canonsburg, Pennsylvania 15317 Tel: (724) 746-4441 Fax: (724) 745-4261

GEOTECHNICAL TEST REQUEST AND CHAIN OF CUSTODY

PAGE 1 of 2

Split Spoon, Jar, and Other Samples

CLIENT: Sterling Environmental Engineering, P.C.

JLT JOB No.: 12L2756.01

DATE RECEIVED: 11-15-12

PROJECT ID: 28014 - Elmira CSD

DATE ASSIGNED:

DATE COMPLETED:

BORING AND SAMPLE I.D.	DEPTH (feet)	PHYSICAL PROPERTIES: MC ☐ D2216	SIEVE ☐ D422	HYDROM ☐ D422	LIQUID LIMIT ☐ D4318	PLASTIC LIMIT ☐ D4318	SPEC GRAVITY ☐ D854 ☐ C127	ORG CONT ☐ D2974 ☐ D2974	pH ☐ 4972	CLASS. ☐ D2487 ☐ D3282 ☐ C127			PERMEABILITY (1): PERM ☐ D5084	PERM ☐ D2434	ENGINEERING PROPERTIES (1): CONSOL TEST ☐ D2435	DIRECT SHEAR ☐ D3080	UNCONF TEST ☐ D2166	UU TEST ☐ D4767	CU TEST ☐ D4767	CU w/pp TEST ☐ D4767					
B3-S6	10-12	X	X	X																					
B3-S8	14-16	X	X																						
B3-S14	26-28	X	X																						
B3-S16	30-32	X	X																						
B3-S19	36-38	X	X																						
B3-S22	42-46	X	X	X	X	X																			
B3-S28	60-62	X	X	X	X	X																			

COMPLETE THIS SECTION AND INCLUDE WITH SHIPMENT. ALSO FAX COPY AS PRE-NOTIFICATION

SHIPPER: Empire Geo Services, Inc.

ADDRESS: 60 Miller Street
Cortland, NY 13045

CONTACT: Peter Kelleher (Sterling); Parvis Akbari (Empire)

TEL: 518-456-4900 (Sterling) FAX: 518-456-3532 (Sterling)
607-758-7182 (Empire) 607-758-7188 (Empire)

SHIP TO: JLT Laboratories Inc.
938 South Central Avenue
Canonsburg, PA 15317
Tel: (724) 745-4441
Fax: (724) 745-4261
e-mail: jlt@jltlabs.com or
e-mail: jboschuk@jltlabs.com

NOTES / INSTRUCTIONS
- B3-S22 combine with B3-S23 for sample volume if needed.
- Sieve with C136.
- Samples collected @ Elmira Southside H.S.
- Reference STERLING ENVIRONMENTAL for information regarding (potential) environmentally impacted material.

Relinquished By: WJ Jablonski via Fedex Date: 11/14/2012

Received By: Date:

☑ ASSIGNED TEST

(1) Test parameters to be provided by the Engineer.

JLT GEOTECHNICAL LABORATORY
soilcocjar.wpd

GEOTECHNICAL TEST REQUEST AND CHAIN OF CUSTODY

Split Spoon, Jar, and Other Samples

CLIENT: Sterling Environmental Engineering, P.C.

JLT JOB No.: 12 LS 2756.01

DATE RECEIVED: 11/15/12

PROJECT ID: 28014 - Elmira CSD

DATE ASSIGNED: 11/15/12

DATE COMPLETED:

BORING AND SAMPLE I.D.	DEPTH (feet)	PHYSICAL PROPERTIES											PERMEABILITY [2]		ENGINEERING PROPERTIES [3]																	
		W/C ☐ D2216	SIEVE ☐ D422	HYDRO ☐ D422	LIQUID LIMIT ☐ D4318	PLASTIC LIMIT ☐ D4318	SPEC GRAVITY ☐ D854 ☐ C127	ORG CONT ☐ D2974 ☐ D6258	pH ☐ 4972	CLASS. ☐ D2487 ☐ D2488 ☐ C127			PERM ☐ D5084	PERM ☐ D2434	CONSOL TEST ☐ D2435	DIRECT SHEAR ☐ D3080	UNCONF TEST ☐ D2166	UU TEST ☐ D2850	CU TEST ☐ D4767	CIU w/pp TEST ☐ D4767										
BS-S4	6-8	X	X																												
BS-S9	16-18	X	X																												
BS-S12	22-24	X	X																												
BS-S22	42-44	X	X	X	X	X																									

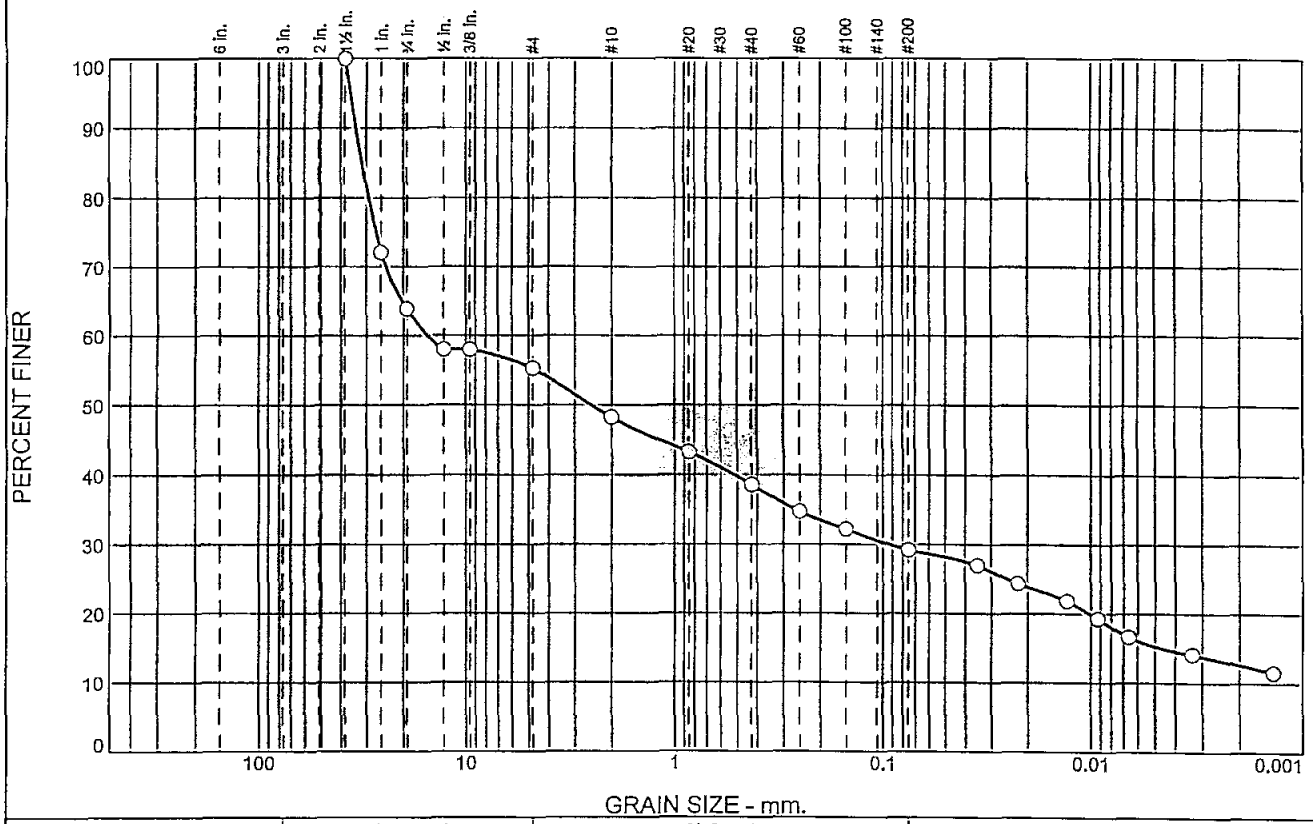
☑ ASSIGNED TEST

8 Sieve
4 Hy
3 Att
1 M/C

(1) Test parameters to be provided by the Engineer.

JLT GEOTECHNICAL LABORATORY
soilcocjar.wpd

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	36.1	8.6	7.0	9.7	9.4	13.9	15.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	72.1		
0.75	63.9		
0.50	57.9		
0.375	57.9		
#4	55.3		
#10	48.3		
#20	43.3		
#40	38.6		
#60	34.7		
#100	32.2		
#200	29.2		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 33.5960 D_{85}= 31.4321 D_{60}= 15.3469
D_{50}= 2.5034 D_{30}= 0.0929 D_{15}= 0.0046
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 11.1%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-6 Depth: 10-12 Date: 11/19/2012

JLT Laboratories, Inc.

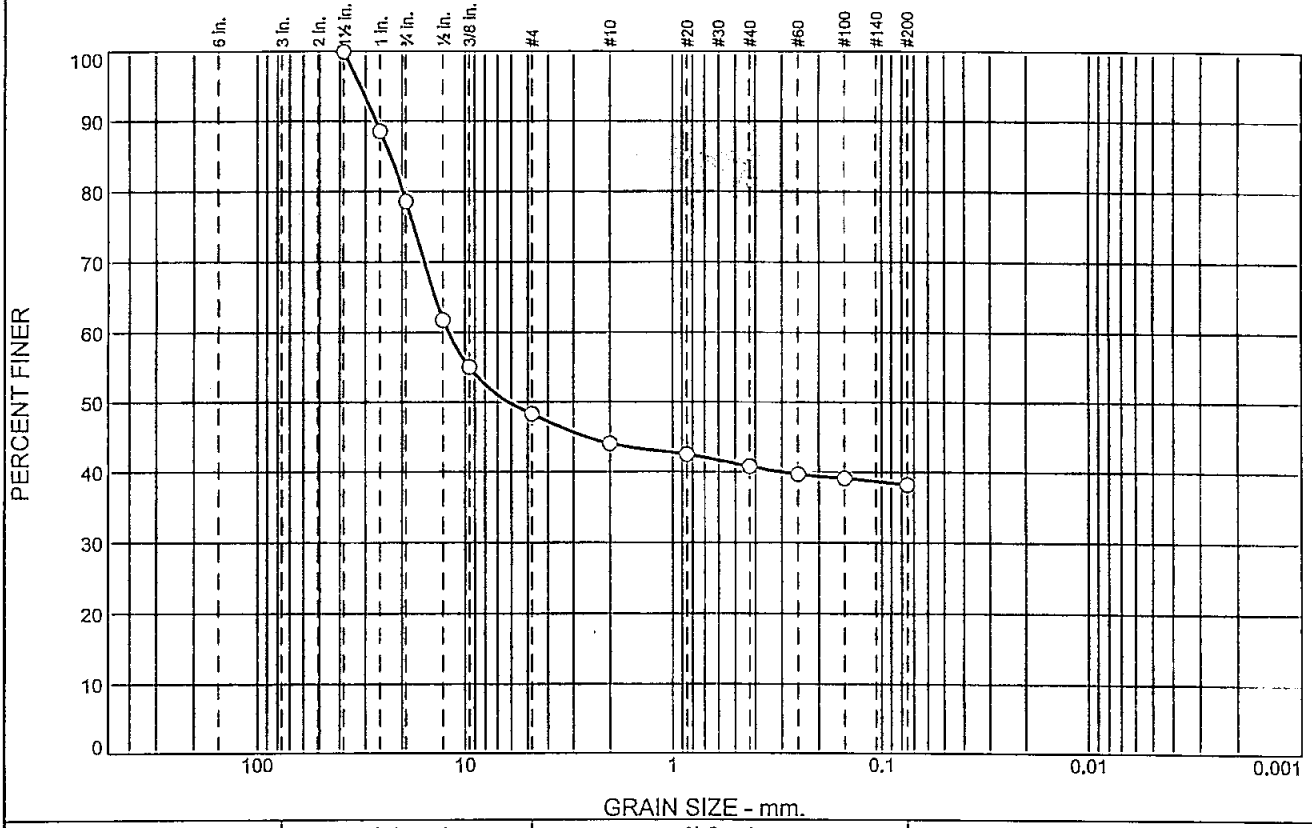
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 Figure

Tested By: RL Checked By: JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.4	30.3	4.2	3.3	2.6	38.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	88.5		
0.75	78.6		
0.50	61.8		
0.375	55.0		
#4	48.3		
#10	44.1		
#20	42.5		
#40	40.8		
#60	39.7		
#100	39.1		
#200	38.2		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 26.6676 D_{85}= 22.7294 D_{60}= 11.9913
D_{50}= 6.1451 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 7.3%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-8 Depth: 14-16 Date: 11/16/2012

JLT Laboratories, Inc.

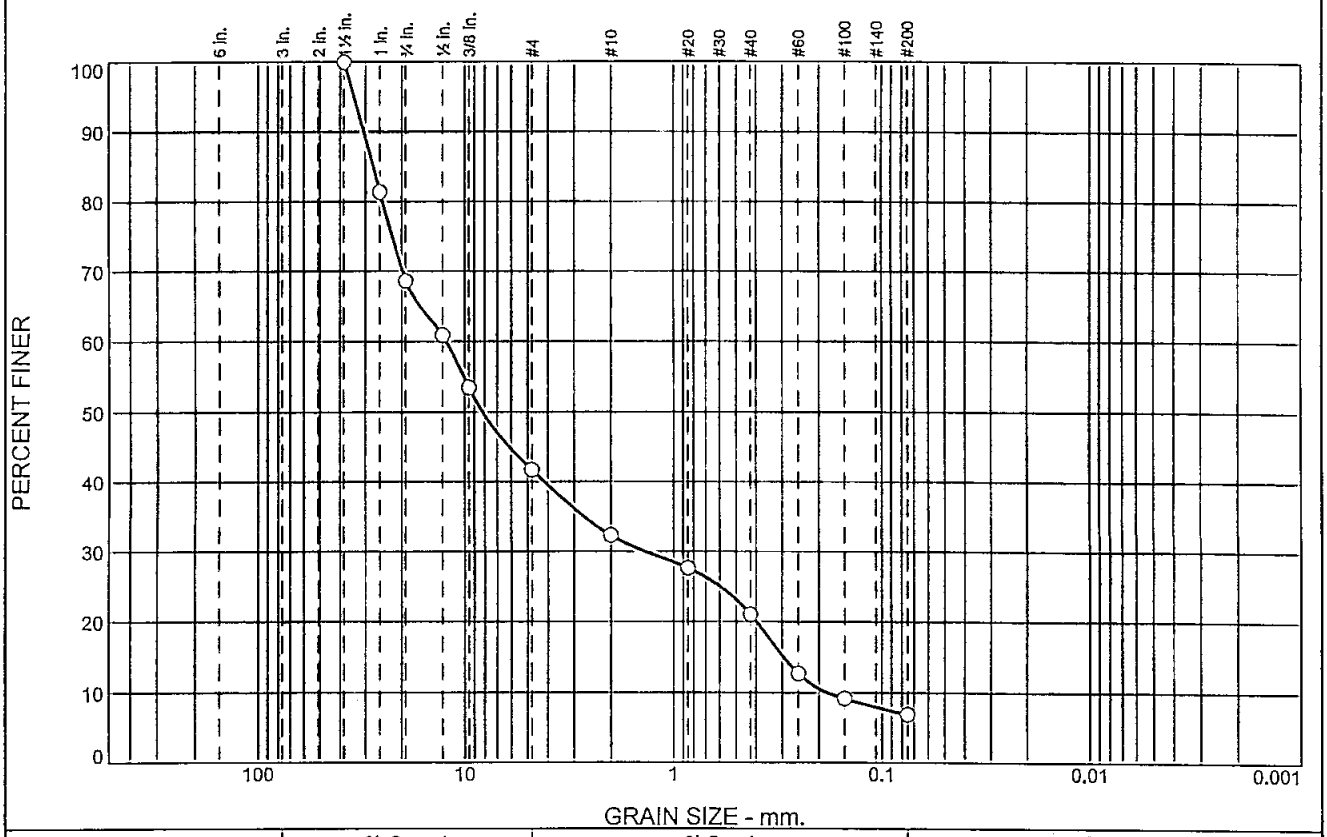
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 Figure

Tested By: RL Checked By: JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.4	26.9	9.3	11.4	14.1	6.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	81.3		
0.75	68.6		
0.50	60.9		
0.375	53.5		
#4	41.7		
#10	32.4		
#20	27.6		
#40	21.0		
#60	12.6		
#100	9.2		
#200	6.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 30.5152 D_{85}= 27.4082 D_{60}= 12.2089
D_{50}= 8.1941 D_{30}= 1.3607 D_{15}= 0.2953
D_{10}= 0.1821 C_u= 67.04 C_c= 0.83

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 10.2%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-14 **Depth:** 26-28 **Date:** 11/16/2012

JLT Laboratories, Inc.

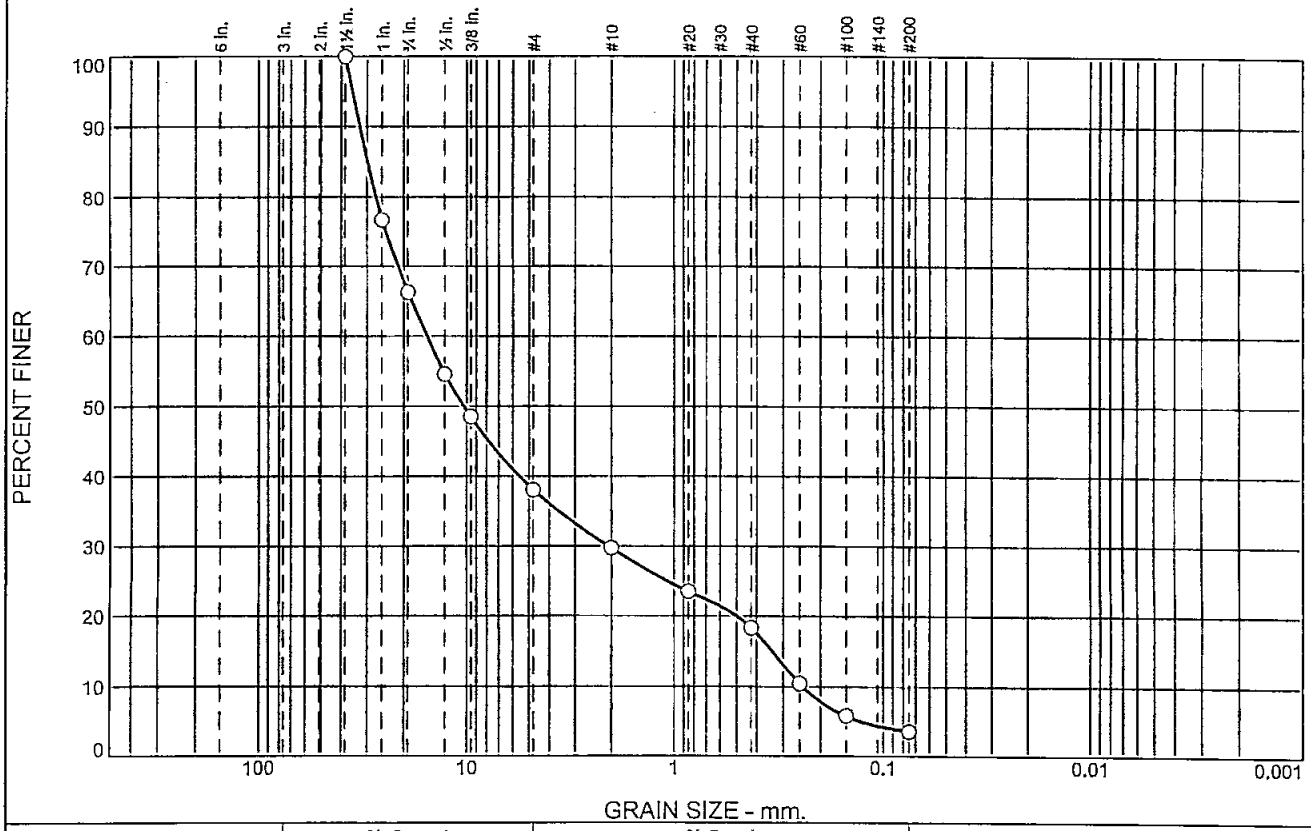
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	33.7	28.2	8.3	11.5	14.7	3.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	76.7		
0.75	66.3		
0.50	54.6		
0.375	48.5		
#4	38.1		
#10	29.8		
#20	23.5		
#40	18.3		
#60	10.4		
#100	5.8		
#200	3.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 32.4980 D_{85}= 29.8632 D_{60}= 15.5015
D_{50}= 10.3077 D_{30}= 2.0604 D_{15}= 0.3383
D_{10}= 0.2422 C_u= 63.99 C_c= 1.13

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 9.8%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-16 **Depth:** 30-32 **Date:** 11/16/2012

JLT Laboratories, Inc.

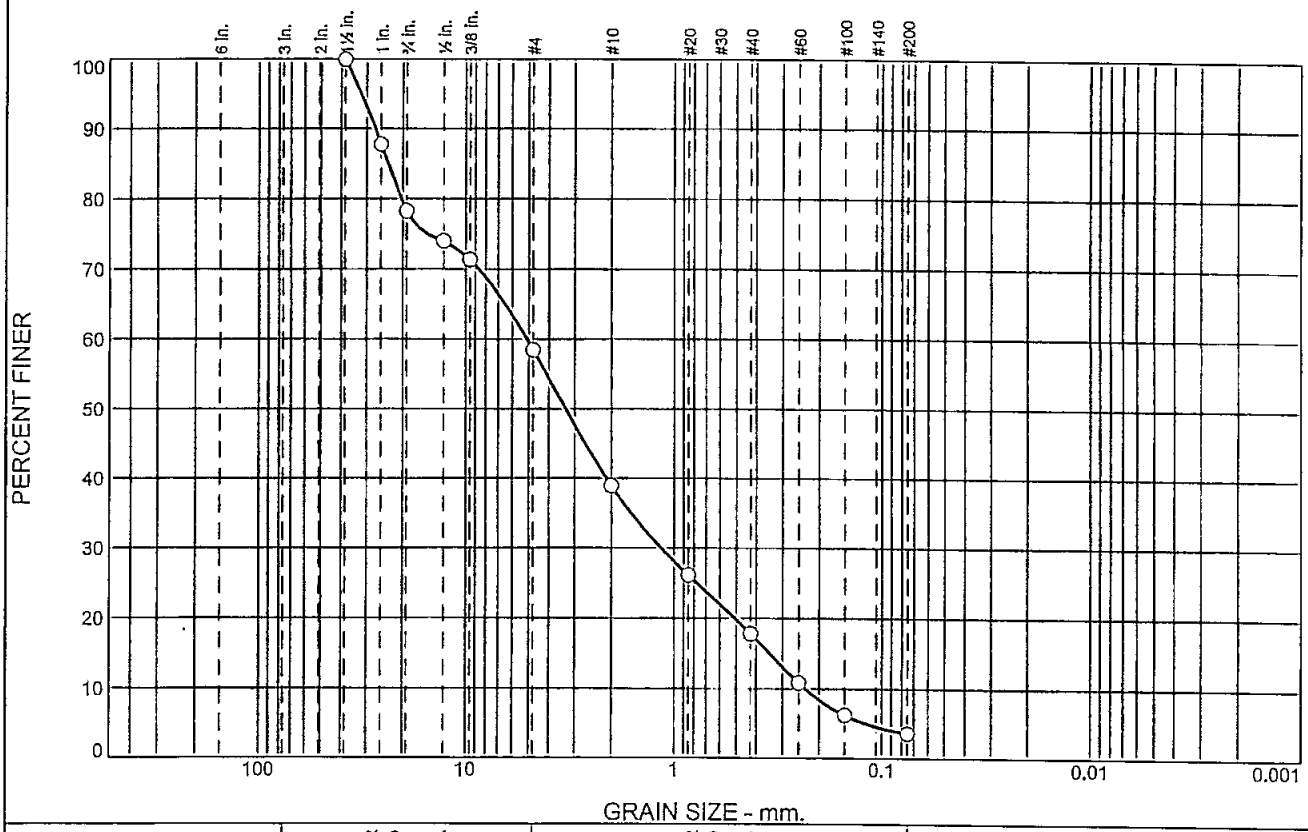
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.8	19.8	19.5	21.1	14.2	3.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	87.7		
0.75	78.2		
0.50	74.0		
0.375	71.3		
#4	58.4		
#10	38.9		
#20	26.1		
#40	17.8		
#60	10.8		
#100	6.3		
#200	3.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 27.1471 D_{85}= 23.5290 D_{60}= 5.0953
D_{50}= 3.3113 D_{30}= 1.1512 D_{15}= 0.3455
D_{10}= 0.2329 C_u= 21.88 C_c= 1.12

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 13.1%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-19 **Depth:** 36-38 **Date:** 11/16/2012

JLT Laboratories, Inc.

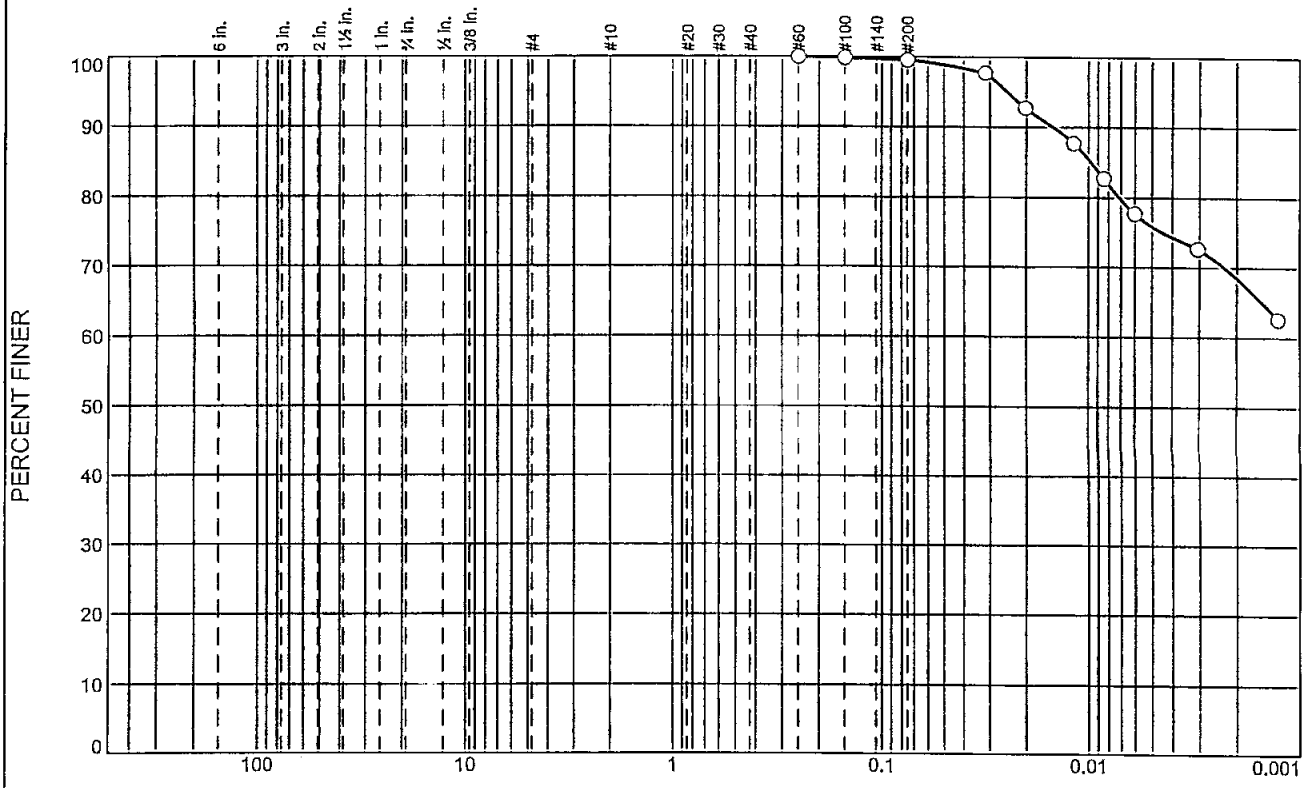
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.4	23.8	75.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#60	100.0		
#100	99.9		
#200	99.6		

* (no specification provided)

Material Description

Composite of 2 Jars
B-3 / S-22 (42-44) & B-3 / S-23 (44-46)

Atterberg Limits

PL= 24 LL= 35 PI= 11

Coefficients

D_{90}= 0.0148 D_{85}= 0.0097 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'D M/C = 29.9%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: Composite

Date: 11/19/2012

JLT Laboratories, Inc.

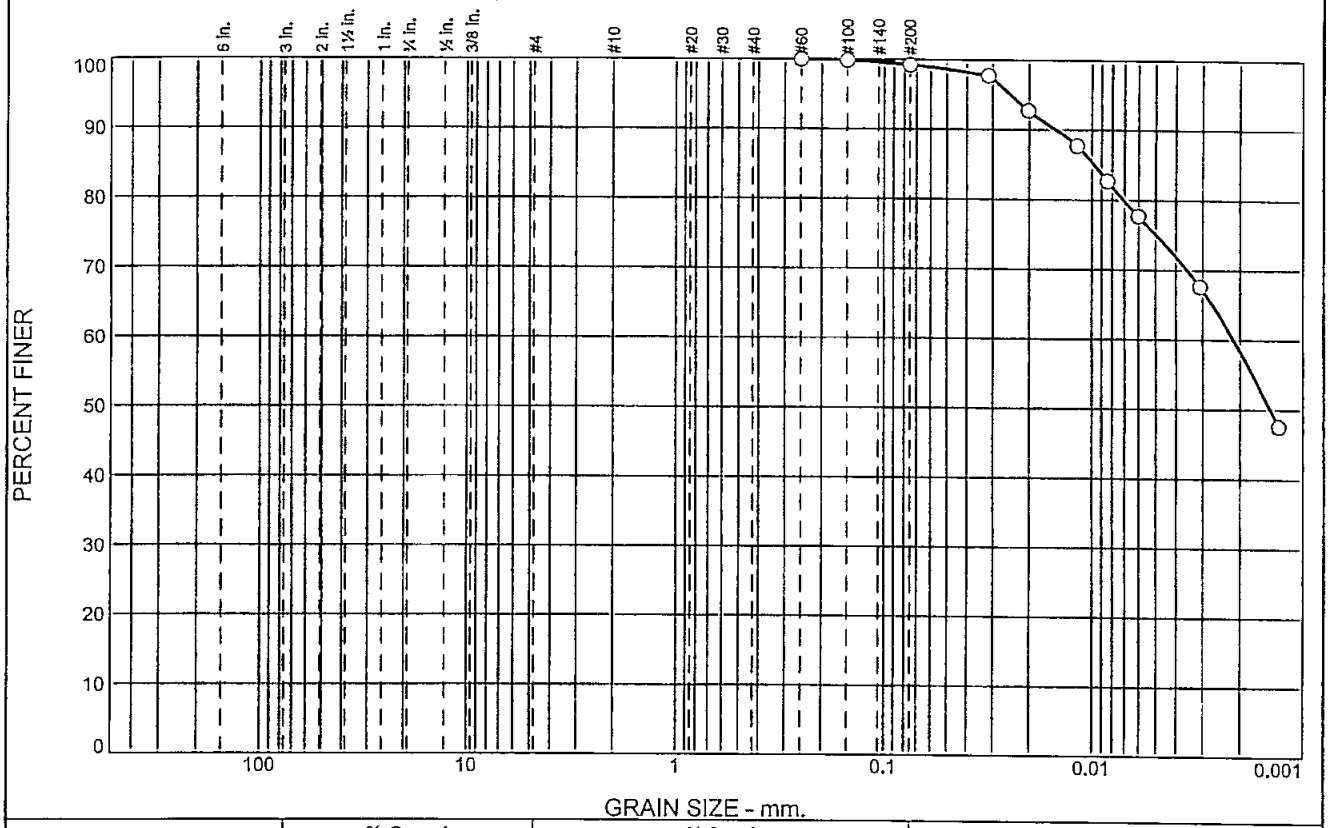
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 Figure

Tested By: RL Checked By: JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.7	24.2	75.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#60	100.0		
#100	99.9		
#200	99.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.0148 D_{85}= 0.0097 D_{60}= 0.0021
D_{50}= 0.0014 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'd M/C = 36.9%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-3 / S-28 **Depth:** 60-62 **Date:** 11/19/2012

JLT Laboratories, Inc.

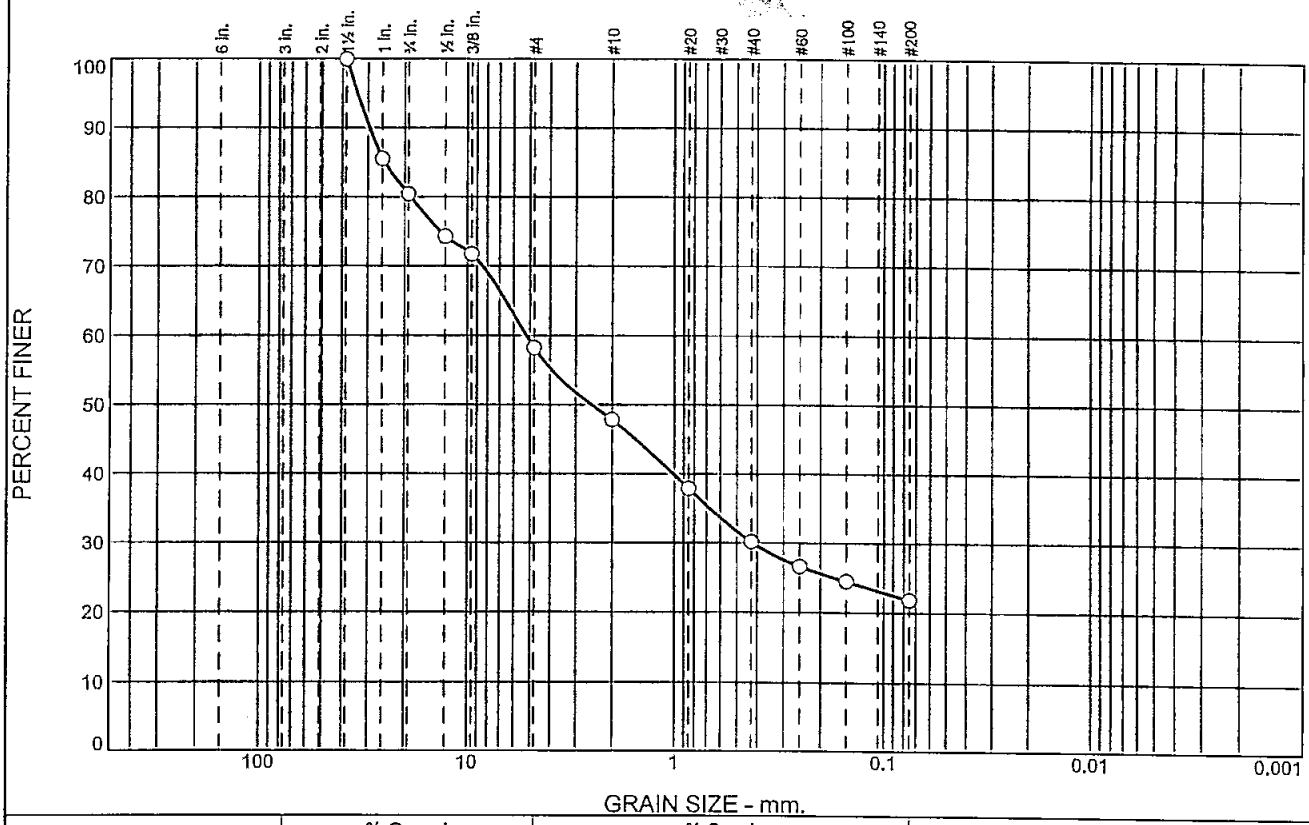
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.6	22.2	10.4	17.6	8.4	21.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	85.5		
0.75	80.4		
0.50	74.3		
0.375	71.7		
#4	58.2		
#10	47.8		
#20	37.9		
#40	30.2		
#60	26.6		
#100	24.5		
#200	21.8		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 29.5033 D_{85}= 24.8769 D_{60}= 5.1941
D_{50}= 2.5117 D_{30}= 0.4171 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 8.9%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-5 / S-4 **Depth:** 6-8 **Date:** 11/16/2012

JLT Laboratories, Inc.

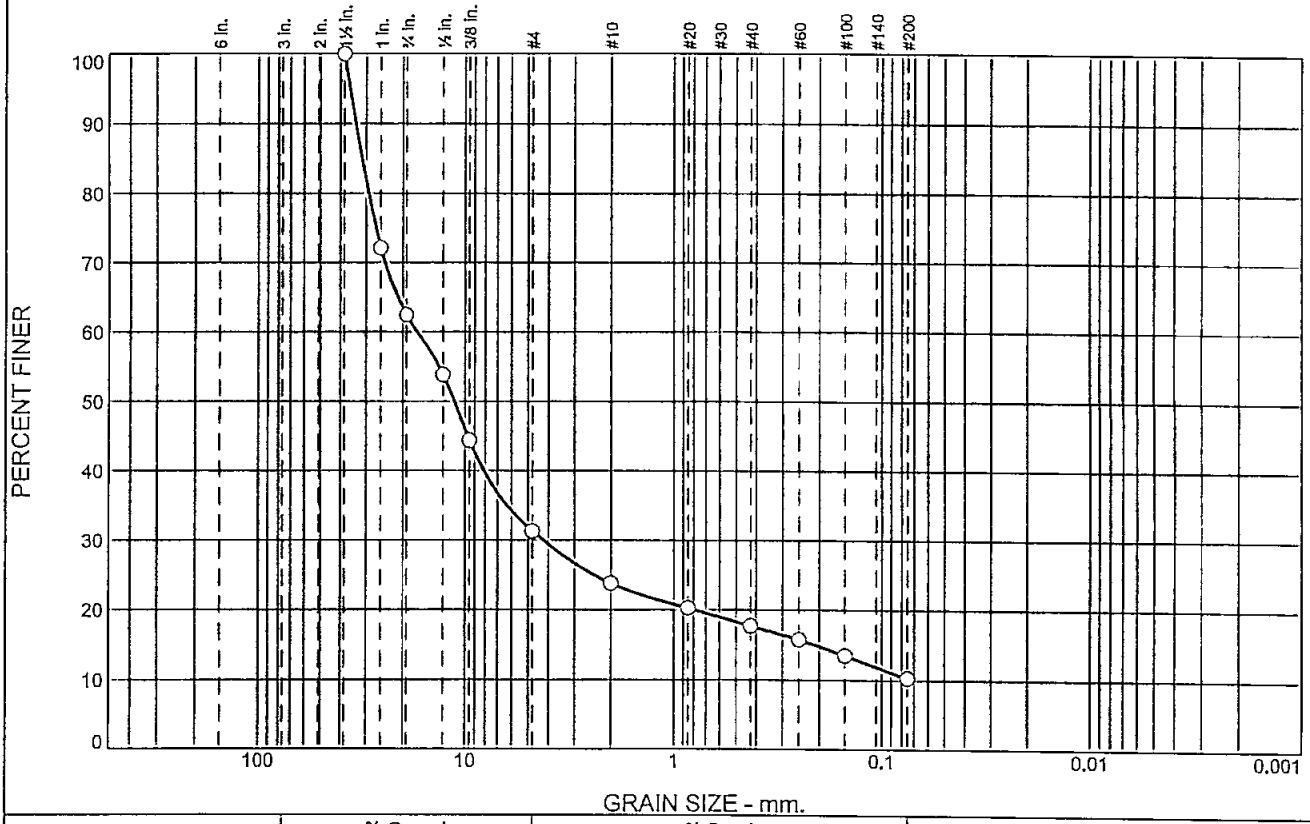
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 Figure

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	37.6	31.1	7.5	6.1	7.4	10.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	72.1		
0.75	62.4		
0.50	53.8		
0.375	44.4		
#4	31.3		
#10	23.8		
#20	20.3		
#40	17.7		
#60	15.8		
#100	13.5		
#200	10.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 33.4909 D_{85}= 31.2966 D_{60}= 16.9279
D_{50}= 11.2568 D_{30}= 4.2129 D_{15}= 0.2069
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

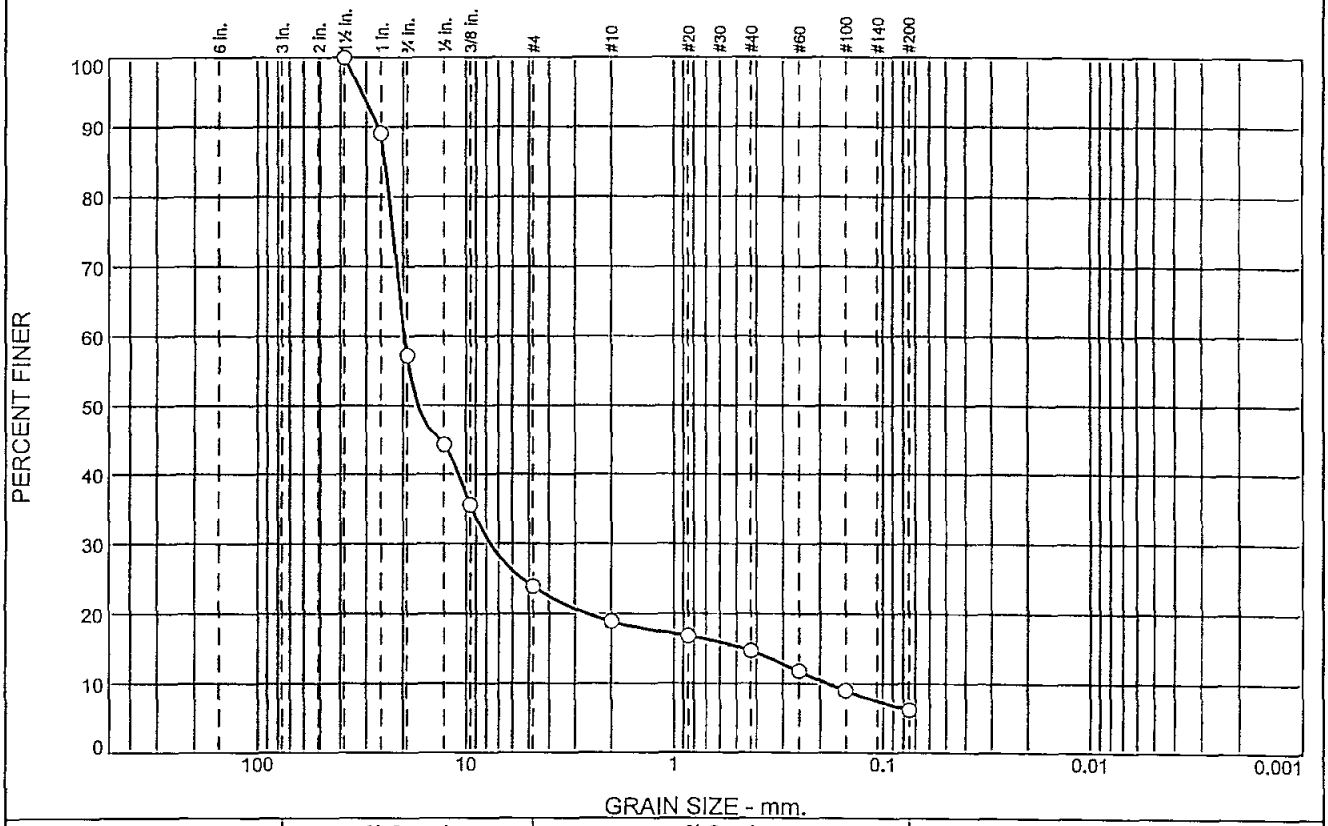
As-Rec'd M/C = 9.1%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-5 / S-9 **Depth:** 16-18 **Date:** 11/16/2012

JLT Laboratories, Inc. Canonsburg, PA	Client: Sterling Environmental Engineering, P.C. Project: Elmira CSD - 28014 Project No: 12LS2756.01 Figure

Tested By: RL Checked By: JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	42.8	33.3	5.0	4.2	8.5	6.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.50	100.0		
1.00	89.0		
0.75	57.2		
0.50	44.3		
0.375	35.6		
#4	23.9		
#10	18.9		
#20	16.8		
#40	14.7		
#60	11.7		
#100	9.0		
#200	6.2		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 26.3173 D_{85}= 24.3734 D_{60}= 19.6253
D_{50}= 16.9714 D_{30}= 7.6566 D_{15}= 0.4577
D_{10}= 0.1830 C_u= 107.21 C_c= 16.32

Classification

USCS= AASHTO=

Remarks

As-Rec'd M/C = 12.0%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-5 / S-12 **Depth:** 22-24 **Date:** 11/16/2012

JLT Laboratories, Inc.

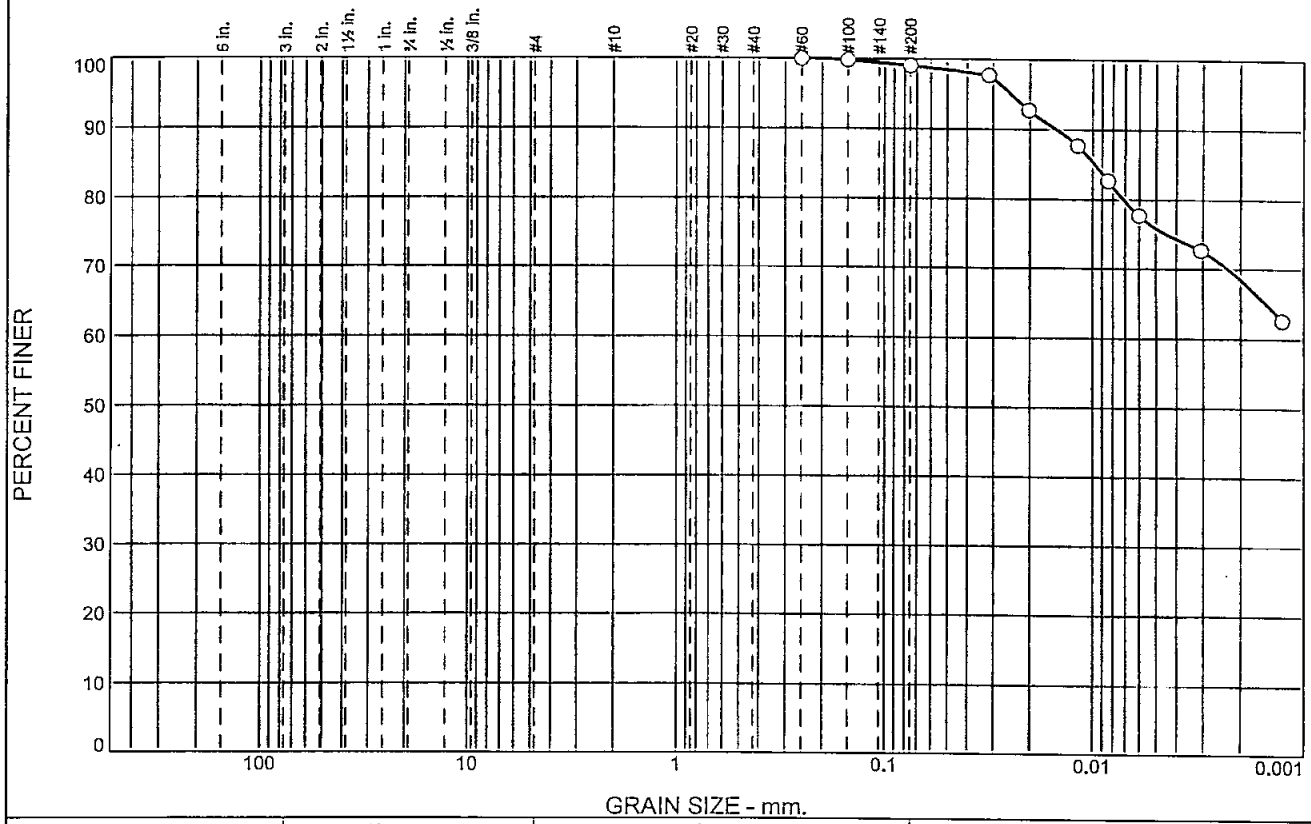
Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.9	23.3	75.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#60	100.0		
#100	99.8		
#200	99.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= 24 LL= 35 PI= 11

Coefficients

D_{90}= 0.0148 D_{85}= 0.0097 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO=

Remarks

As-Rec'd M/C = 29.7%
Gradation: D-422 Moisture: D-2216

Location: 28014
Sample Number: B-5 / S-22 **Depth:** 42-44 **Date:** 11/19/2012

JLT Laboratories, Inc.

Canonsburg, PA

Client: Sterling Environmental Engineering, P.C.
Project: Elmira CSD - 28014

Project No: 12LS2756.01 **Figure**

Tested By: RL **Checked By:** JB

ATTACHMENT 3

Sheet pile Specs: Rollform XZ95

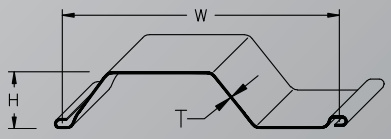
30ft long sheets

Roll Form Group

a division of SAMUEL

SHEET PILING

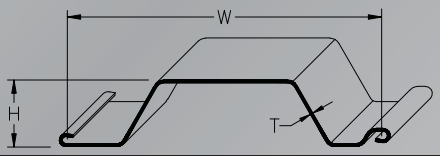
"L" SERIES



NOTE: METRIC VALUES IN BRACKETS

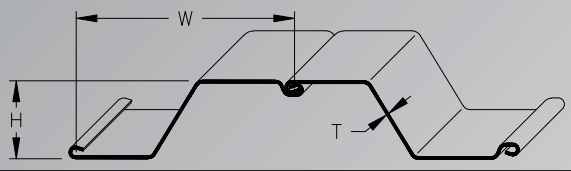
Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
L34	.134 (3.4)	4.10 (104)	19.7 (500)	3.58 (23.1)	12.5 (18.6)	7.62 (37.2)	5.89 (806)	1.64 (41.9)	2.77 (149)
L41	.164 (4.1)	4.12 (105)	19.7 (500)	4.39 (28.3)	15.0 (22.4)	9.17 (44.7)	7.02 (961)	1.64 (41.9)	3.30 (178)
L45	.177 (4.5)	4.13 (105)	19.7 (500)	4.47 (30.6)	16.2 (24.1)	9.90 (48.1)	7.69 (1050)	1.64 (41.9)	3.62 (195)
L50	.197 (5.0)	4.15 (106)	19.7 (500)	5.29 (34.1)	18.9 (28.2)	11.5 (56.3)	9.82 (1340)	1.74 (44.2)	4.14 (223)
L60	.236 (6.0)	4.18 (106)	19.7 (500)	6.37 (41.1)	22.3 (33.1)	13.6 (66.1)	11.8 (1610)	1.74 (44.2)	4.97 (268)
L65	.256 (6.5)	4.20 (107)	19.7 (500)	6.90 (44.5)	24.1 (35.8)	14.7 (71.6)	12.8 (1750)	1.74 (44.2)	5.38 (290)

"S" SERIES



Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
S64	.250 (6.35)	5.91 (150)	27.75 (705)	9.97 (64.4)	33.9 (50.4)	14.7 (71.7)	24.0 (3280)	2.36 (59.9)	7.89 (424)
S80	.313 (8.00)	5.97 (152)	27.75 (705)	12.36 (79.7)	42.1 (62.6)	18.2 (88.8)	30.0 (4100)	2.37 (60.0)	9.82 (528)

"Z" SERIES



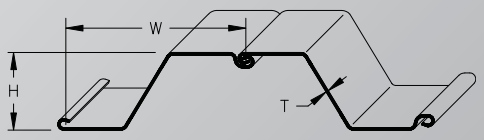
Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
Z55	.217 (5.50)	8.64 (219)	24.0 (610)	7.57 (48.8)	25.8 (38.4)	12.9 (63.0)	49.7 (6790)	3.61 (91.7)	11.4 (613)
Z60	.236 (6.00)	8.66 (220)	24.0 (610)	8.26 (53.3)	28.2 (42.0)	14.1 (68.8)	54.2 (7400)	3.62 (91.9)	12.4 (667)
Z65	.256 (6.50)	8.68 (220)	24.0 (610)	8.95 (57.7)	30.6 (45.5)	15.3 (74.7)	58.7 (8010)	3.62 (91.9)	13.4 (720)
Z70	.276 (7.00)	8.70 (221)	24.0 (610)	9.64 (62.2)	33.0 (49.1)	16.5 (80.6)	63.2 (8630)	3.62 (91.9)	14.4 (774)
Z75	.295 (7.50)	8.72 (221)	24.0 (610)	10.3 (66.5)	35.2 (52.4)	17.6 (85.9)	67.7 (9250)	3.63 (92.2)	15.6 (839)

SHEET PILING SPECIFICATIONS

"L" SERIES - ASTM A857 minimum yield strength 36,000 psi • CSA G40.21 Gr.260W minimum yield strength 260 MPa or 37,700 psi • Hot dip galvanizing to ASTM A 123 or CSA G164.

"S" SERIES, "Z" SERIES, "EZ" SERIES, "XZ" SERIES & "JZ" SERIES - ASTM A328 minimum yield strength 38,500 psi • ASTM 572 Gr.50 minimum yield strength 50,000 psi • CSA G40.21 Gr.350W minimum yield strength 350 MPa or 50,800 psi • Hot dip galvanizing to ASTM A 123 or CSA G164.

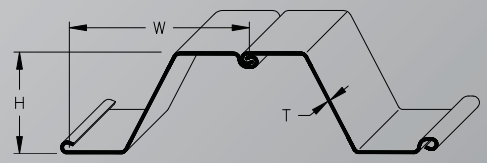
"EZ" SERIES



NOTE: METRIC VALUES IN BRACKETS

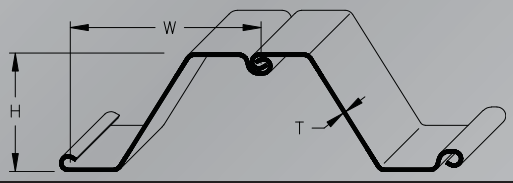
Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
EZ80	.315 (8.00)	10.75 (273)	25.0 (635)	12.1 (77.9)	41.1 (61.2)	19.8 (96.4)	110 (15000)	4.35 (110)	20.5 (1100)
EZ88	.344 (8.75)	10.78 (274)	25.0 (635)	13.2 (85.1)	44.9 (66.8)	21.6 (105)	121 (16500)	4.36 (111)	22.4 (1200)
EZ95	.375 (9.50)	10.81 (275)	25.0 (635)	14.4 (92.7)	48.9 (72.8)	23.5 (115)	131 (17900)	4.36 (111)	24.4 (1310)

"XZ" SERIES



Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
XZ85	.335 (8.50)	14.06 (357)	25.0 (635)	13.6 (87.9)	46.4 (69.0)	22.3 (109)	212 (29000)	5.70 (145)	30.2 (1630)
XZ90	.354 (9.00)	14.09 (358)	25.0 (635)	14.4 (93.0)	48.9 (72.7)	23.5 (115)	225 (30800)	5.70 (145)	31.8 (1710)
XZ95	.375 (9.50)	14.12 (359)	25.0 (635)	15.2 (98.2)	51.7 (76.9)	24.8 (121)	237 (32400)	5.70 (145)	33.5 (1800)
XZ100	.394 (10.0)	14.15 (360)	25.0 (635)	15.9 (103.0)	54.2 (80.7)	26.0 (127)	250 (34200)	5.70 (145)	35.3 (1900)
XZ105	.413 (10.5)	14.17 (360)	25.0 (635)	16.7 (108.0)	56.9 (84.7)	27.3 (133)	263 (35900)	5.70 (145)	37.1 (2000)

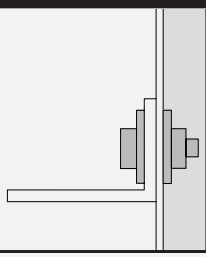
"JZ" SERIES



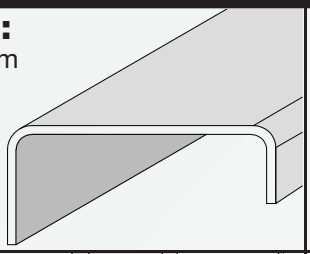
Section	Thickness T in (mm)	Height H in (mm)	Nominal Width W in (mm)	Section Area in² (cm)²	Weight lbs/lin ft. (kg/lin m)	Weight lbs/ft² (kg/m²)	Moment of Inertia in⁴/wall ft (cm⁴/wall m)	Radius of Gyration in (mm)	Section Modulus in³/wall ft (cm³/wall m)
JZ112	.441 (11.2)	16.44 (418)	26.5 (673)	20.1 (129.7)	68.2 (101)	30.9 (151)	374 (51100)	6.41 (163)	45.3 (2430)
JZ120	.472 (12.0)	16.47 (418)	26.5 (673)	21.5 (138.7)	73.0 (109)	33.0 (161)	401 (54700)	6.41 (163)	48.5 (2610)
JZ127	.500 (12.7)	16.50 (419)	26.5 (673)	22.7 (146.5)	77.3 (115)	35.0 (171)	424 (57900)	6.42 (163)	51.4 (2760)

ACCESSORIES

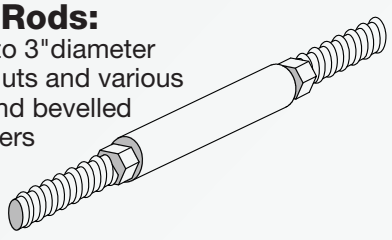
Walers:
available in various shapes and sizes.



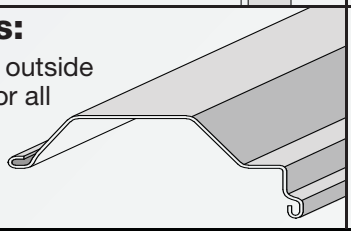
Pile Caps:
various custom designed shapes and sizes.



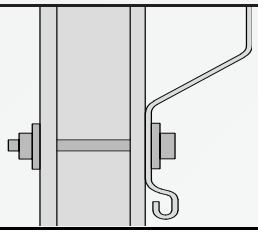
Tie Rods:
3/4" to 3"diameter c/w nuts and various flat and bevelled washers



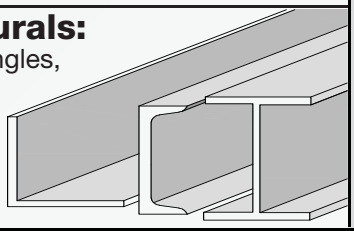
Corners:
inside and outside available for all profiles.



Fasteners:
a full range of bolts, nuts and plate washers.



Structurals:
various angles, channels and beam shapes.



Roll Form Group
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Suite 100 - 6701 Financial Drive,
Mississauga, ON L5N 7J7
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Toll Free: 1-800-233-6228
Fax: (905) 593-3489

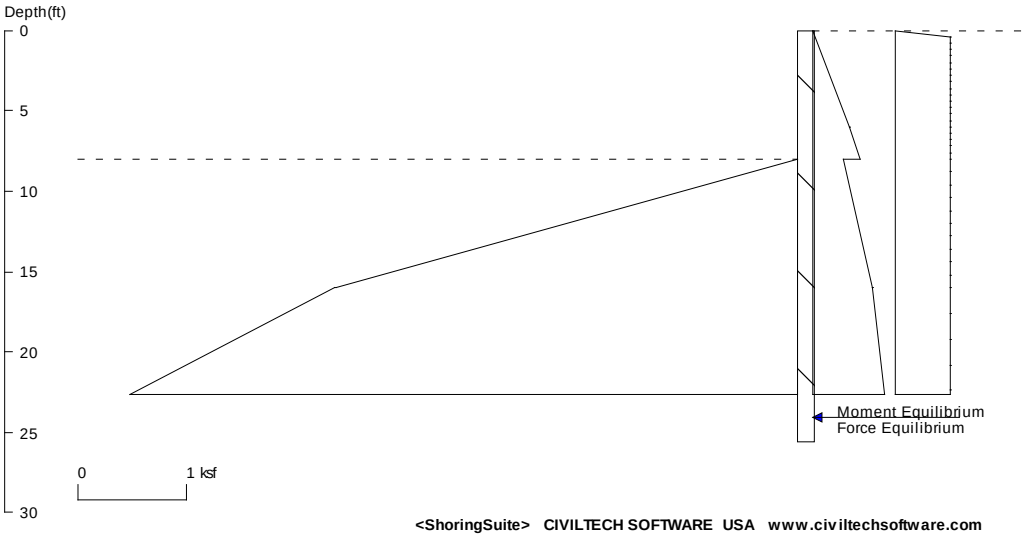
26 County Road 351,
Iuka, Mississippi 38852
Phone: (662) 424- 1460
Toll Free: 1-866-285-7655
Fax: (662) 424-0314

945 Center Street,
Green Cove Springs, Florida 32043
Phone: (904) 287-8000
Fax: (904) 529-7757

ATTACHMENT 4

CT Shoring Output: Section 1-1’

Elmira Sheet Pile Analysis



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File: P:\PRJ1\wpwork\Sean\Elmira\Analysis\Elmira_Shoring_1.sh8

Wall Height=8.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=17.53 Min. Pile Length=25.53
MOMENT IN PILE: Max. Moment=58.36 per Pile Spacing=1.0 at Depth=15.99

PILE SELECTION:
Request Min. Section Modulus = 21.2 in3/ft=1140.98 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
User Input I (Moment of Inertia):
Top Deflection = 0.71(in) based on E (ksi)=29000.00 and I (in4)/foot=237.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	6.000	0.333	0.055424
6.000	0.333	8.000	0.434	0.050623
*	Below	Base		
8.000	0.284	16.000	0.548	0.033089
16.000	0.548	40.000	0.977	0.017857
*	Sur-	charge		
0.000	0.000	0.400	0.500	1.249936
0.400	0.500	0.800	0.500	-0.000064
0.800	0.500	1.200	0.500	-0.000064
1.200	0.500	1.600	0.500	-0.000064
1.600	0.500	2.000	0.500	-0.000064
2.000	0.500	2.400	0.500	-0.000064
2.400	0.500	2.800	0.500	-0.000064
2.800	0.500	3.200	0.500	-0.000064
3.200	0.500	3.600	0.500	-0.000064
3.600	0.500	4.000	0.500	-0.000064
4.000	0.500	4.400	0.500	-0.000064

4.400	0.500	4.800	0.500	-0.000064
4.800	0.500	5.200	0.500	-0.000064
5.200	0.500	5.600	0.500	-0.000064
5.600	0.500	6.000	0.500	-0.000064
6.000	0.500	6.400	0.500	-0.000064
6.400	0.500	6.800	0.500	-0.000064
6.800	0.500	7.200	0.500	-0.000064
7.200	0.500	7.600	0.500	-0.000064
7.600	0.500	8.000	0.499	-0.000064
8.000	0.499	8.800	0.499	-0.000064
8.800	0.499	9.600	0.499	-0.000064
9.600	0.499	10.400	0.499	-0.000064
10.400	0.499	11.200	0.499	-0.000064
11.200	0.499	12.000	0.499	-0.000064
12.000	0.499	12.800	0.499	-0.000064
12.800	0.499	13.600	0.499	-0.000064
13.600	0.499	14.400	0.499	-0.000064
14.400	0.499	15.200	0.499	-0.000064
15.200	0.499	16.000	0.499	-0.000064
16.000	0.499	17.600	0.499	-0.000064
17.600	0.499	19.200	0.499	-0.000064
19.200	0.499	20.800	0.499	-0.000064
20.800	0.499	22.400	0.499	-0.000064
22.400	0.499	24.000	0.498	-0.000064
24.000	0.498	25.600	0.498	-0.000064

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.3

Z1	P1	Z2	P2	Slope
8.0	0.00	16.0	4.24	0.530
16.0	4.24	40.0	11.10	0.286

ACTIVE SPACING:

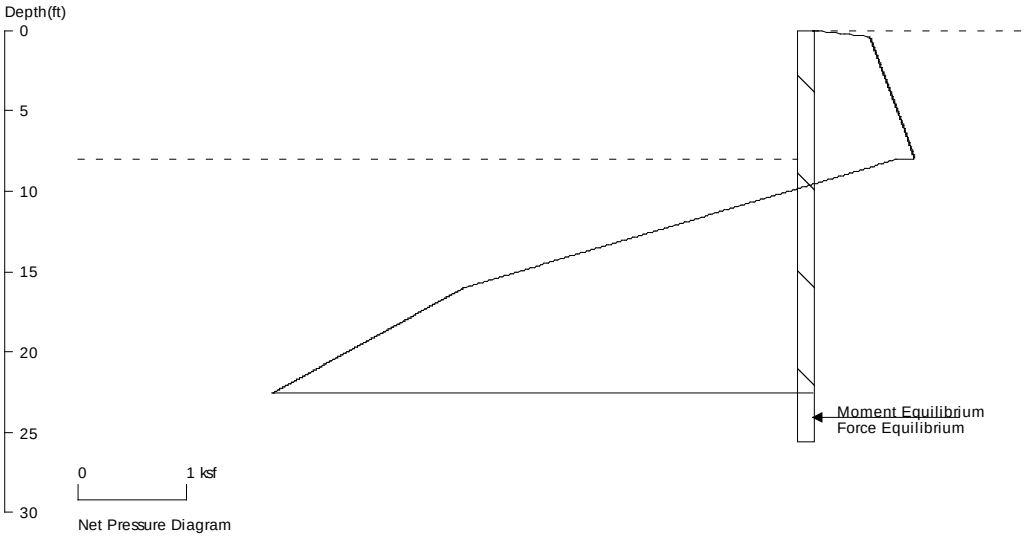
No.	Z depth	Spacing
1	0.00	1.00
2	8.00	1.00

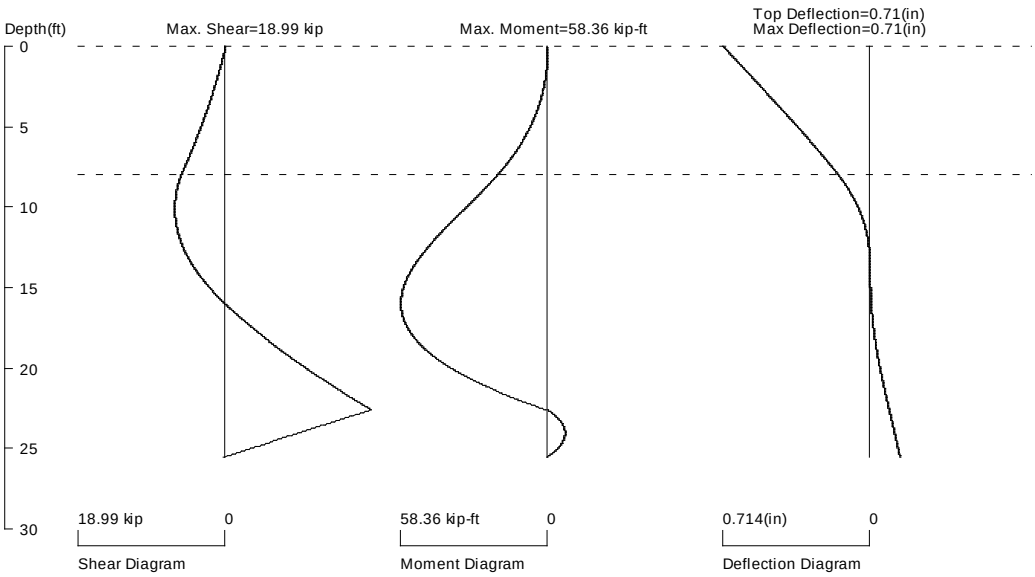
PASSIVE SPACING:

No.	Z depth	Spacing
1	8.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Elmira Sheet Pile Analysis





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 1.0 foot or meter

User Input I: E (ksi)=29000.0, I (in4)/foot=237.0

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****

SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltechsoftware.com

****
ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. AASHTO HB-17, American Association of State and Highway Transportation Officials, 2 September 2002

UNITS: Width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in
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Date: 3/15/2018 File: P:\PRJ1\wpwork\Sean\Elmira\Analysis\Elmira_Shoring_1.sh8

Title: Elmira Sheet Pile Analysis
Subtitle:

**********INPUT DATA**********
Wall Type: 1. Sheet Pile
Wall Height: 8.00
Pile Diameter: 1.00
Pile Spacing: 1.00
Factor of Safety (F.S.): 1.30
Lateral Support Type (Braces): 1. No
Top Brace Increase (Multi-Bracing): Add 15%*
Embedment Option: 1. Yes
Friction at Pile Tip: No
Pile Properties:
Steel Strength, Fy: 50 ksi = 345 MPa
Allowable Fb/Fy: 0.66
Elastic Module, E: 29000.00
Moment of Inertia, I: 237
User Input Pile: Rollform X

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	*	Above	Base		
2	0.000	0.000	6.000	0.333	0.055424
3	6.000	0.333	8.000	0.434	0.050623
4	*	Below	Base		
5	8.000	0.284	16.000	0.548	0.033089
6	16.000	0.548	40.000	0.977	0.017857
7	*	Sur-	charge		
8	0.000	0.000	0.400	0.500	1.249936
9	0.400	0.500	0.800	0.500	-0.000064
10	0.800	0.500	1.200	0.500	-0.000064
11	1.200	0.500	1.600	0.500	-0.000064
12	1.600	0.500	2.000	0.500	-0.000064
13	2.000	0.500	2.400	0.500	-0.000064
14	2.400	0.500	2.800	0.500	-0.000064
15	2.800	0.500	3.200	0.500	-0.000064
16	3.200	0.500	3.600	0.500	-0.000064
17	3.600	0.500	4.000	0.500	-0.000064
18	4.000	0.500	4.400	0.500	-0.000064
19	4.400	0.500	4.800	0.500	-0.000064
20	4.800	0.500	5.200	0.500	-0.000064
21	5.200	0.500	5.600	0.500	-0.000064
22	5.600	0.500	6.000	0.500	-0.000064
23	6.000	0.500	6.400	0.500	-0.000064
24	6.400	0.500	6.800	0.500	-0.000064
25	6.800	0.500	7.200	0.500	-0.000064
26	7.200	0.500	7.600	0.500	-0.000064
27	7.600	0.500	8.000	0.499	-0.000064
28	8.000	0.499	8.800	0.499	-0.000064
29	8.800	0.499	9.600	0.499	-0.000064
30	9.600	0.499	10.400	0.499	-0.000064
31	10.400	0.499	11.200	0.499	-0.000064
32	11.200	0.499	12.000	0.499	-0.000064
33	12.000	0.499	12.800	0.499	-0.000064
34	12.800	0.499	13.600	0.499	-0.000064
35	13.600	0.499	14.400	0.499	-0.000064
36	14.400	0.499	15.200	0.499	-0.000064
37	15.200	0.499	16.000	0.499	-0.000064
38	16.000	0.499	17.600	0.499	-0.000064
39	17.600	0.499	19.200	0.499	-0.000064
40	19.200	0.499	20.800	0.499	-0.000064
41	20.800	0.499	22.400	0.499	-0.000064
42	22.400	0.499	24.000	0.498	-0.000064
43	24.000	0.498	25.600	0.498	-0.000064
44	25.600	0.498	27.200	0.498	-0.000064
45	27.200	0.498	28.800	0.498	-0.000064

46	28.800	0.498	30.400	0.498	-0.000064
47	30.400	0.498	32.000	0.000	-0.311291

* PASSIVE PRESSURE *
The pressures below will be divided by a Factor of Safety =1.3

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	8.00	0.00	16.00	4.24	0.5297
2	16.00	4.24	40.00	11.10	0.2858

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	1.00
2	8.00	1.00

* PASSIVE SPACE *

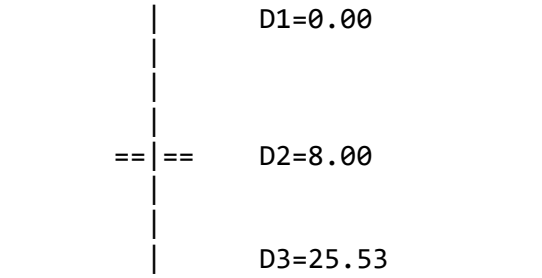
No.	Z depth	Spacing
1	8.00	1.00

*For Tieback: Input1 = Diameter; Input2 = Bond Stength
*For Plate: Input1 = Diameter; Input2 = Allowable Pressure
*For Deaman: Input1 = Horz. Width; Input2 = Allowable Pressure; Angle = 0

**********CALCULATION**********

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
D2 - EXCAVATION BASE

D3 - PILE TIP (20% increased, see EMBEDMENT Notes below)

MOMENT BALANCE: M=0.00 AT DEPTH=22.61 WITH EMBEDMENT OF 14.61
FORCE BALANCE: F=0.00 AT DEPTH=25.53 WITH EMBEDMENT OF 17.53

The program calculates an embedment for moment equilibrium, then increase the embedment by 20% to reach force equilibrium.
A Balance Force=19.10 is developed from depth=22.61 to depth=25.53
Total Passive Pressure = Total Active Pressure, OK!

**********RESULTS**********

* EMBEDMENT Notes *
Based on USS Design Manual, fist calculate embedment for moment equilibrium, then increased by 20 to 40 % to reach force equilibrium.
The embedment for moment equilibrium is 14.61
* The 20% increased embedment for force equilibrium is 17.53 (Used by Program)
The 30% increased embedment for force equilibrium is 18.99
The 40% increased embedment for force equilibrium is 20.45

Based on AASHTO 2002 Standard Specifications, fist calculate embedment for moment equilibrium, then add safety factor of 30% for temporary shoring; add safety factor of 50% for permanent shoring.
The embedment for moment equilibrium is 14.61
Add 30% embedment for temporary shoring is 18.99
Add 50% embedment for permanent shoring is 21.91

* BASED ON USS DESIGN MANUAL (20% increased), PROGRAM CALCULATED MINIMUM EMBEDMENT = 17.53
TOTAL MINIMUM PILE LENGTH = 25.53

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 58.36 at 15.99
Maximum Shear = 18.99
Moment and Shear are per pile spacing: 1.0 foot or meter

* VERTICAL LOADING *
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

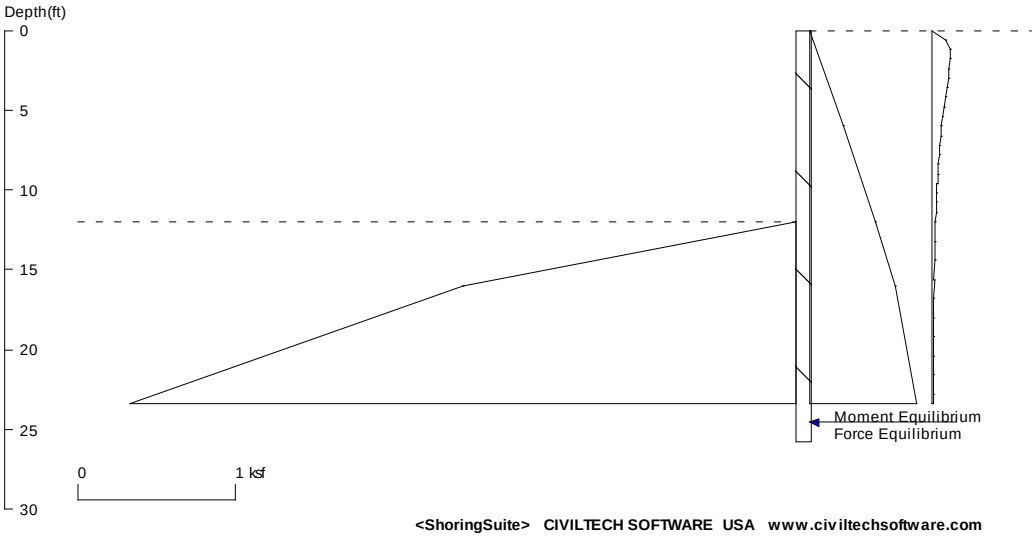
* DEFLECTION *
I (in4)/foot=237.00
Top deflection = 0.714(in)

Max. deflection = 0.714(in)

ATTACHMENT 5

CT Shoring Output – Section 2-2’

Elmira Sheet Pile Analysis



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File: P:\PRJ1\wpwork\Sean\Elmira\Analysis\Elmira_Shoring_1.sh8

Wall Height=12.0 Pile Diameter=1.0 Pile Spacing=1.0 Wall Type: 1. Sheet Pile

PILE LENGTH: Min. Embedment=13.72 Min. Pile Length=25.72
MOMENT IN PILE: Max. Moment=30.22 per Pile Spacing=1.0 at Depth=17.65

PILE SELECTION:
Request Min. Section Modulus = 11.0 in3/ft=590.86 cm3/m, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
User Input I (Moment of Inertia):
Top Deflection = 0.57(in) based on E (ksi)=29000.00 and I (in4)/foot=237.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
*	Above	Base		
0.000	0.000	6.000	0.217	0.036227
6.000	0.217	12.000	0.416	0.033089
*	Below	Base		
12.000	0.416	16.000	0.548	0.033089
16.000	0.548	41.000	0.995	0.017857
*	Sur-	charge		
0.000	0.000	0.600	0.088	0.146318
0.600	0.088	1.200	0.115	0.045540
1.200	0.115	1.800	0.116	0.000959
1.800	0.116	2.400	0.109	-0.011412
2.400	0.109	3.000	0.100	-0.014634
3.000	0.100	3.600	0.091	-0.015089
3.600	0.091	4.200	0.082	-0.014558
4.200	0.082	4.800	0.074	-0.013631
4.800	0.074	5.400	0.067	-0.012549
5.400	0.067	6.000	0.060	-0.011425
6.000	0.060	6.600	0.054	-0.010319

6.600	0.054	7.200	0.048	-0.009267
7.200	0.048	7.800	0.043	-0.008286
7.800	0.043	8.400	0.039	-0.007385
8.400	0.039	9.000	0.035	-0.006569
9.000	0.035	9.600	0.031	-0.005834
9.600	0.031	10.200	0.028	-0.005178
10.200	0.028	10.800	0.025	-0.004595
10.800	0.025	11.400	0.023	-0.004078
11.400	0.023	12.000	0.021	-0.003622
12.000	0.021	13.200	0.017	-0.003042
13.200	0.017	14.400	0.014	-0.002415
14.400	0.014	15.600	0.012	-0.001929
15.600	0.012	16.800	0.010	-0.001551
16.800	0.010	18.000	0.008	-0.001256
18.000	0.008	19.200	0.007	-0.001025
19.200	0.007	20.400	0.006	-0.000842
20.400	0.006	21.600	0.005	-0.000696
21.600	0.005	22.800	0.005	-0.000580
22.800	0.005	24.000	0.004	-0.000486
24.000	0.004	26.400	0.003	-0.000379

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.3

Z1	P1	Z2	P2	Slope
12.0	0.00	16.0	2.12	0.530
16.0	2.12	41.0	9.27	0.286
41.0	8.36	60.0	12.54	0.220

ACTIVE SPACING:

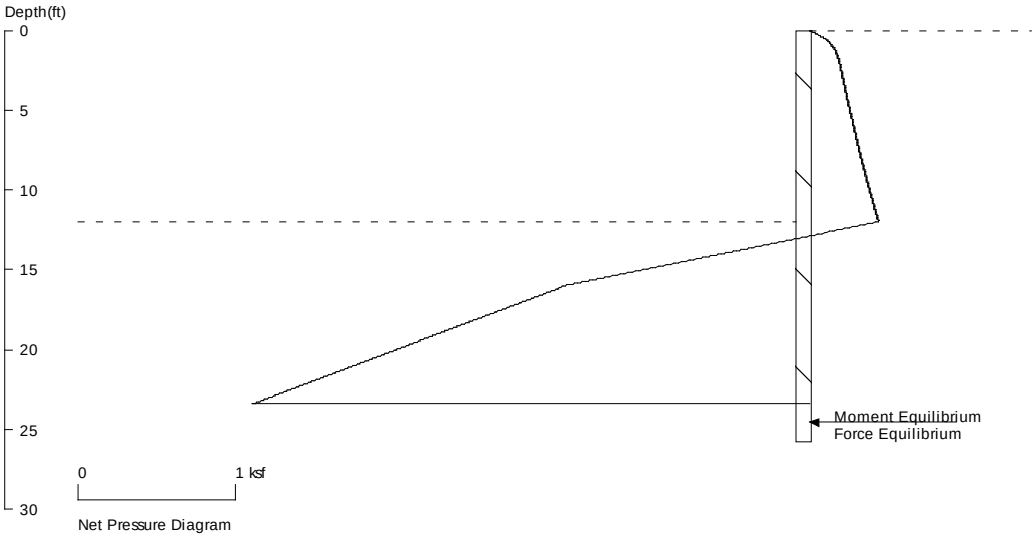
No.	Z depth	Spacing
1	0.00	1.00
2	12.00	1.00

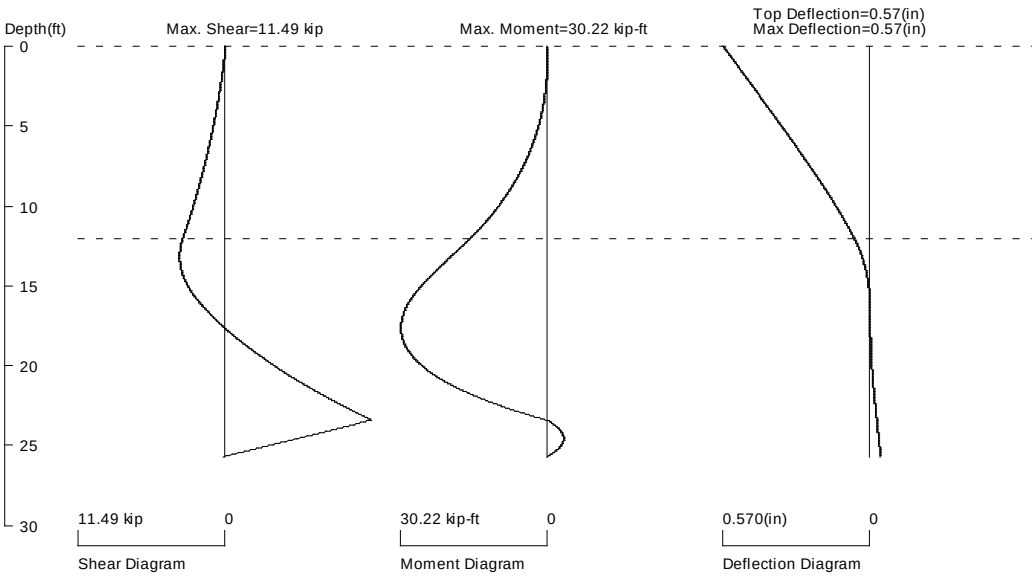
PASSIVE SPACING:

No.	Z depth	Spacing
1	12.00	1.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

Elmira Sheet Pile Analysis





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 1.0 foot or meter

User Input I: E (ksi)=29000.0, I (in4)/foot=237.0

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SHORING WALL CALCULATION SUMMARY
The leading shoring design and calculation software

www.civiltechsoftware.com

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ShoringSuite Software is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
6. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 2002
5. DESIGN OF SHEET PILE WALLS, EM 1110-2-2504, U.S. Army Corps of Engineers, 31 March 1994
7. EARTH RETENTION SYSTEMS HANDBOOK, Alan Macnab, McGraw-Hill. 2002
8. AASHTO HB-17, American Association of State and Highway Transportation Officials, 2 September 2002

UNITS: Width/Spacing/Diameter/Length/Depth - ft, Force - kip, Moment - kip-ft, Friction/Bearing/Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

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Title: Elmira Sheet Pile Analysis
Subtitle:

**********INPUT DATA**********
Wall Type: 1. Sheet Pile
Wall Height: 12.00
Pile Diameter: 1.00
Pile Spacing: 1.00
Factor of Safety (F.S.): 1.30
Lateral Support Type (Braces): 1. No
Top Brace Increase (Multi-Bracing): Add 15%*
Embedment Option: 1. Yes
Friction at Pile Tip: No
Pile Properties:
Steel Strength, Fy: 50 ksi = 345 MPa
Allowable Fb/Fy: 0.66
Elastic Module, E: 29000.00
Moment of Inertia, I: 237
User Input Pile: Rollform X

* DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) *

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	*	Above	Base		
2	0.000	0.000	6.000	0.217	0.036227
3	6.000	0.217	12.000	0.416	0.033089
4	*	Below	Base		
5	12.000	0.416	16.000	0.548	0.033089
6	16.000	0.548	41.000	0.995	0.017857
7	41.000	1.075	60.000	1.383	0.016233
8	*	Sur-	charge		
9	0.000	0.000	0.600	0.088	0.146318
10	0.600	0.088	1.200	0.115	0.045540
11	1.200	0.115	1.800	0.116	0.000959
12	1.800	0.116	2.400	0.109	-0.011412
13	2.400	0.109	3.000	0.100	-0.014634
14	3.000	0.100	3.600	0.091	-0.015089
15	3.600	0.091	4.200	0.082	-0.014558
16	4.200	0.082	4.800	0.074	-0.013631
17	4.800	0.074	5.400	0.067	-0.012549
18	5.400	0.067	6.000	0.060	-0.011425
19	6.000	0.060	6.600	0.054	-0.010319
20	6.600	0.054	7.200	0.048	-0.009267
21	7.200	0.048	7.800	0.043	-0.008286
22	7.800	0.043	8.400	0.039	-0.007385
23	8.400	0.039	9.000	0.035	-0.006569
24	9.000	0.035	9.600	0.031	-0.005834
25	9.600	0.031	10.200	0.028	-0.005178
26	10.200	0.028	10.800	0.025	-0.004595
27	10.800	0.025	11.400	0.023	-0.004078
28	11.400	0.023	12.000	0.021	-0.003622
29	12.000	0.021	13.200	0.017	-0.003042
30	13.200	0.017	14.400	0.014	-0.002415
31	14.400	0.014	15.600	0.012	-0.001929
32	15.600	0.012	16.800	0.010	-0.001551
33	16.800	0.010	18.000	0.008	-0.001256
34	18.000	0.008	19.200	0.007	-0.001025
35	19.200	0.007	20.400	0.006	-0.000842
36	20.400	0.006	21.600	0.005	-0.000696
37	21.600	0.005	22.800	0.005	-0.000580
38	22.800	0.005	24.000	0.004	-0.000486
39	24.000	0.004	26.400	0.003	-0.000379
40	26.400	0.003	28.800	0.002	-0.000275
41	28.800	0.002	31.200	0.002	-0.000204
42	31.200	0.002	33.600	0.002	-0.000154
43	33.600	0.002	36.000	0.001	-0.000119
44	36.000	0.001	38.400	0.001	-0.000093
45	38.400	0.001	40.800	0.001	-0.000073

46	40.800	0.001	43.200	0.001	-0.000059
47	43.200	0.001	45.600	0.001	-0.000048
48	45.600	0.001	48.000	0.000	-0.000282

* PASSIVE PRESSURE *
The pressures below will be divided by a Factor of Safety =1.3

No.	Z1 top	Top Pres.	Z2 bottom	Bottom Pres.	Slope
1	12.00	0.00	16.00	2.12	0.5297
2	16.00	2.12	41.00	9.27	0.2858
3	41.00	8.36	60.00	12.54	0.2201

* ACTIVE SPACE *

No.	Z depth	Spacing
1	0.00	1.00
2	12.00	1.00

* PASSIVE SPACE *

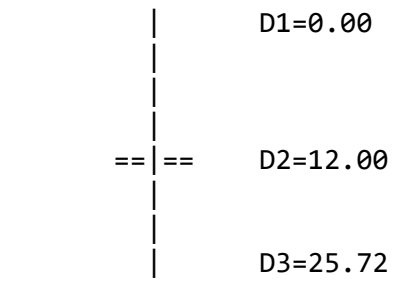
No.	Z depth	Spacing
1	12.00	1.00

*For Tieback: Input1 = Diameter; Input2 = Bond Stength
*For Plate: Input1 = Diameter; Input2 = Allowable Pressure
*For Deaman: Input1 = Horz. Width; Input2 = Allowable Pressure; Angle = 0

**********CALCULATION**********

The calculated moment and shear are per pile spacing. Sheet piles are per one foot or meter; Soldier piles are per pile.

Top Pressures start at depth = 0.00



D1 - TOP DEPTH
D2 - EXCAVATION BASE
D3 - PILE TIP (20% increased, see EMBEDMENT Notes below)

MOMENT BALANCE: M=0.00 AT DEPTH=23.44 WITH EMBEDMENT OF 11.44
FORCE BALANCE: F=0.00 AT DEPTH=25.72 WITH EMBEDMENT OF 13.72

The program calculates an embedment for moment equilibrium, then increase the embedment by 20% to reach force equilibrium.
A Balance Force=11.57 is developed from depth=23.44 to depth=25.72
Total Passive Pressure = Total Active Pressure, OK!

**********RESULTS**********

* EMBEDMENT Notes *
Based on USS Design Manual, fist calculate embedment for moment equilibrium, then increased by 20 to 40 % to reach force equilibrium.
The embedment for moment equilibrium is 11.44
* The 20% increased embedment for force equilibrium is 13.72 (Used by Program)
The 30% increased embedment for force equilibrium is 14.87
The 40% increased embedment for force equilibrium is 16.01

Based on AASHTO 2002 Standard Specifications, fist calculate embedment for moment equilibrium, then add safety factor of 30% for temporary shoring; add safety factor of 50% for permanent shoring.
The embedment for moment equilibrium is 11.44
Add 30% embedment for temporary shoring is 14.87
Add 50% embedment for permanent shoring is 17.15

* BASED ON USS DESIGN MANUAL (20% increased), PROGRAM CALCULATED MINIMUM EMBEDMENT = 13.72
TOTAL MINIMUM PILE LENGTH = 25.72

* MOMENT IN PILE (per pile spacing)*
Pile Spacing: sheet piles are one foot or one meter; soldier piles are one pile.
Overall Maximum Moment = 30.22 at 17.65
Maximum Shear = 11.49
Moment and Shear are per pile spacing: 1.0 foot or meter

* VERTICAL LOADING *
Vertical Loading from Braces = 0.00
Vertical Loading from External Load = 0.00
Total Vertical Loading = 0.00

* DEFLECTION *

I (in4)/foot=237.00
Top deflection = 0.570(in)
Max. deflection = 0.570(in)