US Army Corps of Engineers ®
Chicago District

BUBBLY CREEK, SOUTH BRANCH OF THE CHICAGO RIVER, ILLINOIS INTEGRATED ECOSYSTEM RESTORATION FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX D
GEOTECHNICAL

Bubbly Creek
Ecosystem Restoration Feasibility Study

MARCH 2020

Bubbly Creek, South Branch of the Chicago River, Illinois Ecosystem Restoration Feasibility Study

Appendix D – Geotechnical

March 2020

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Attachment 1:

Geotechnical Appendix

Appendix D. Geotechnical

D-1. Project Plan, Site Selection, Foundation Design, Selection of Structures, and Cost Estimates

D-1.1 References

The geotechnical appendix was prepared following the outline provided in “Content of Engineering Appendix to Feasibility Report” (Appendix C) of “Engineering and Design for Civil Works Projects” (ER 1110-2-1150, 30 Sep 1990).

The settlement analysis (Attachment D-1) was prepared following “Engineering and Design - Settlement Analysis” (EM 1110-1-1904, 30 September 1990). Given the large area and variability of materials, a probabilistic approach was used to vary input parameters to estimate the likelihood of reaching a given settlement value across the entire site. The probabilistic approach used was the point estimate method as described in Reliability-Based Design in Civil Engineering (M.E. Harr, 1987).

The slope stability analysis (Attachment D-2) was prepared following “Engineering and Design - Slope Stability” (EM 1110-2-1902, 31 Oct 2003).

The sand filter layer (Attachment D-3) was prepared following “Filter Design (Appendix D) of Engineering and Design - Seepage Analysis and Control for Dams with CH 1” (EM 1110-2-1901, 30 April 1993).

D-1.2 Project Plan and Site Selections

The rationale for evaluating the existing site is provided in RECONNAISSANCE STUDY Section 905(b) (WRDA 86) Analysis Bubbly Creek, South Branch of the Chicago River (18 August 2006). The structure that is being evaluated in this appendix is geotechnical analysis of a sediment cap. Both a gas vent and sand cap were analyzed. Sloping was evaluated in the turning basin to create a wetland shelf. It is assumed that existing sheetpile and bank support will remain in place and any grading to flatten the creek side slopes will making these slopes more stable. At present there are not plans to remove existing sheetpile or timber cribbing along the banks. The project plan is shown in the Civil Design Appendix (Appendix C). Section drawings showing stationing can be found in the settlement analysis (Attachment D-1) and the slope stability analysis (Attachment D-2).

Two capping scenarios were considered. The first was a sand cap the second a gas vent cap. The designs of these two caps are summarized in Table D-1 and Table D-2. Settlement analyses are provided in Attachment D-1. Slope stability analyses are provided in Attachment D-2. Previous investigations are summarized in Section D-1.2 below and are included in Attachment D-4.

Table D-1. Sand Cap Design

					Specifications					
Layer	Minimum (inches)	Target (inches)	Maximum (inches)	Purpose	D100 (mm)	D50 (mm)	n	Gs	γ'_{sat} (lb/ft^3)	p (lb/ft^2)
Armor	6	8	10	protect against RAPS discharge erosion	63	40	0.35	2.65	66.9	44.6

					Specifications					
Layer	Minimum (inches)	Target (inches)	Maximum (inches)	Purpose	D100 (mm)	D50 (mm)	n	Gs	γ'_{sat} (lb/ft^3)	p (lb/ft^2)
Isolation Mixing Bedding	8	10	12	isolate water column from sediment, accounting for animal burrowing	IDOT FA-2	IDOT FA-2	0.4	2.65	61.8	51.5
	14	18	22							96.1

Description	range (inches)	percentage
Most areas	16 - 20	80%
Some areas	14 - 22	20%

Table D-2. Gas Vent Design

					Specifications					
Layer	Minimum (inches)	Target (inches)	Maximum (inches)	Purpose	D100 (mm)	D50 (mm)	n	Gs	γ'_{sat} (lb/ft^3)	p (lb/ft^2)
Armor	6	8	10	protect against RAPS discharge erosion	63	40	0.35	2.65	66.9	44.6
Filter/Protection	4	6	8	protect gas control from armor layer and animal burrowing	IDOT FA-2	IDOT FA-2	0.4	2.65	61.8	30.9
Gas Control (Aquablok ®)	4	6	8	inhibit vertical gas migration	NA	NA	0.35	1.4	16.2	8.1
Gas Vent	10	12	14	direct gas laterallly	IDOT FA-2	IDOT FA-2	0.35	2.65	66.9	66.9
Bedding/Filter	6	8	10	isolate gas vent from sediment	IDOT FA-2	IDOT FA-2	0.4	2.65	61.8	41.2
	30	40	50							191.7

Description	range (inches)	percentage
Most areas	34-46	80%
Some areas	30-50	20%

Based on the slope stability analyses (Attachment D-2), it was concluded that either a sand cap or a gas vent cap would be stable. However, placing of material would be limited to differential loads as shown in Table D-3 in order to maintain a minimum factor of safety of 1.3.

Table D-3. Maximum allowable differential fill loading

Section	**Maximum Surcharge (Factor of Safety > 1.3)**
Station 14+00	2.5 ft
Station 24+00	1.8 ft
Station 72+00	3 ft

Since placing and spreading presents a risk of sediment slope failure, it is recommended that the cap be placed via broadcast spreading to reduce the risk of excess differential loading.

In the event that excavation is required prior to contouring the slope, for example for gas venting, then maximum differential load is that can be added is quite low. Table D-4 presents a summary of the steps of cap construction for cutting and filling, which would be required in the event of a gas vent cap. The surcharge thicknesses that would be allowable while maintaining a safety factor of at least 1.3 is provided in step (3). The final cap would be stable, as shown in step (4). Therefore, if cutting is required to build the cap, broadcast spreading once again recommended.

Table D-4. Summary of filling steps and safety factors for gas vent construction.

	Factor of Safety (FS)			
Section	**(1) Cut to Required Slope**	**(2) Fill for Cap Base**	**(3) Add Cap, ft (FS)**	**(4) Final Cap in Place (FS)**
Station 14+00	5.668	1.681	0.5 (1.354)	2.122
Station 24+00	4.352	Fill not required here	0.5 (1.630)	1.630
Station 72+00	7.092	1.456	0.25 (1.350)	1.588

A wetland fill section has been considered in the area of the turning basin. The slope for the wetland shelf is estimated to be limited to 8% based on the stability analyses located in Attachment D-2. The factors of safety for given wetland slopes are summarized in Table D-5.

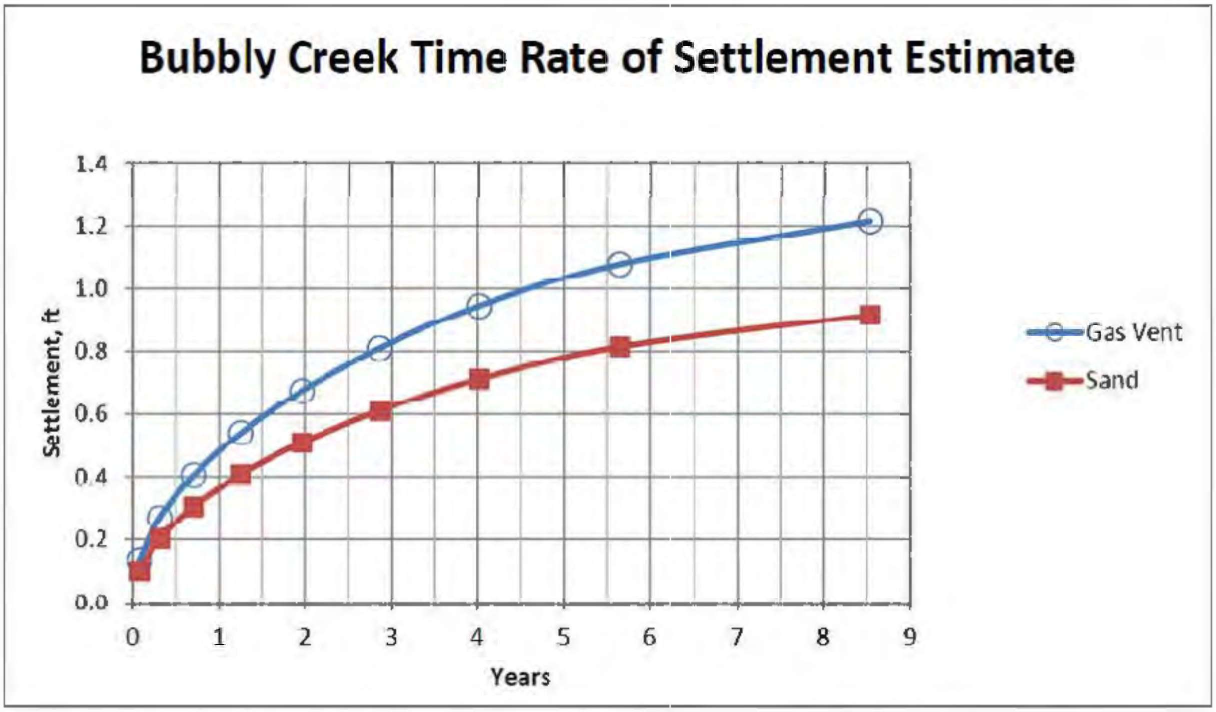
Table D-5. Factors of safety for various wetland fill slopes.

Wetland Shelf at Sta 72+00

Slope	Factor of Safety
10%	1.190
9%	1.275
8%	1.388
7.5%	1.475
5%	2.163

An aggregate rate of settlement over the entire site is estimated in Figure D-2.

Figure D-2.



Based on this analysis, the majority of settlement is expected to occur in 8.5 years, with half of that settlement occurring in the first 2 years.

It is noted that these are average values over the entire site and there will be variability in settlement from point to point. Additionally the time rate of settlement will vary from point to point. Overall the expected settlement for a sand cap is expected to be approximately 1 ft, with standard deviation of +/- 0.7 ft. The expected settlement of a gas vent cap is expected to be 1.3 ft, with a standard deviation of 0.9 ft. These values are summarized in Table D-6. Detailed calculations are provided in Attachment D-1.

Table D-6. Expected settlement and standard deviations for gas vent and sand cap

	Gas Vent	**Sand Cap**
E[settlement]	1.3 ft	1.0 ft
σ[settlement]	0.9 ft	0.7 ft

A probabilistic estimate of reaching a given settlement is provided in Table D-6. Given this estimate, over the entire site, there is a 50% chance that settlement will be greater than 1 ft for a sand cap and only an 8% chance that it will be greater than 2 ft.

Table D-6. Likelihood of reaching 1, 2, or 3 ft of settlement.

Settlement, ft	Gas Vent 1/	Sand 2/

Settlement, ft	Gas Vent 1/	Sand 2/
1	63%	50%
2	22%	8%
3	3%	0%
4	0%	0%
expected value	1.3	1
standard deviation	0.9	0.7

Notes

1/ 172 psf effective submerged loading

2/ 118 psf effective submerged loading

Cost estimates for these alternatives are presented in the cost appendix (Appendix E).

D-1.1. Regional and site geology

The following narrative is based on "The Summary of the Geology of the Chicago Area," Circular 460, H. B. Willman, Illinois State Geological Survey, 1971, 77 pp.

The surface geology of the Chicago Region is dominated by the glaciations of the Quaternary System, which is equivalent to the Pleistocene series. The advances and retreats of the glaciers formed moraines, till, outwash, lacustrine lakes, spits, and scoured valleys. The Pleistocene glaciations in Illinois were the Illinoian and Wisconsin. In the Chicago region the influence of the Illinoian glaciations was wiped out by the Wisconsin glaciations. The subsequent Wisconsin glaciations consisted of five substages: The Altonian advance, Farmdalian retreat, the Woodfordian advance, and the Woodfordian-Valderan substage. These stages are summarized in Figure D-4 and D-5. The Woodfordian was the most significant of the Wisconsin glaciations having ice thicknesses on the order of 3,000 to 5,000 ft thick. During the retreat of the Woodfordian, several moraines were built. These were the Tiskilwa, Malden, Yorkville, Haeger, and Wadsworth Till Members. During the Woodfordian-Valderan substages the Henry and Equality formations formed. The Henry formation consists of the Wasco, Batavia, and Mackinaw members. The Equality formation consists of the Carmi and Dolton members. Bubbly Creek is located in the Carmi member of the Equality formation. The Carmi member of the Equality formation is dominated by silt, generally well bedded or laminated. Much of it is sandy, and it contains bed of tine sand and clay. In most of the lake basins these deposits are only a few feet thick, rarely as much as 20 feet thick. They underlie the flat areas of the lake basin and are the deeper water deposits. In the Chicago area they are exposed at the top of clay pits near Blue Island and Dolton. Major glacial features of the Chicago area are shown in Figure D-5.

Figure D-3. Sequence of events in the glacial history of the Chicago area (1 through 4 cover Illinois, 5 through 12 the area of this report) (ISGS, 1971)

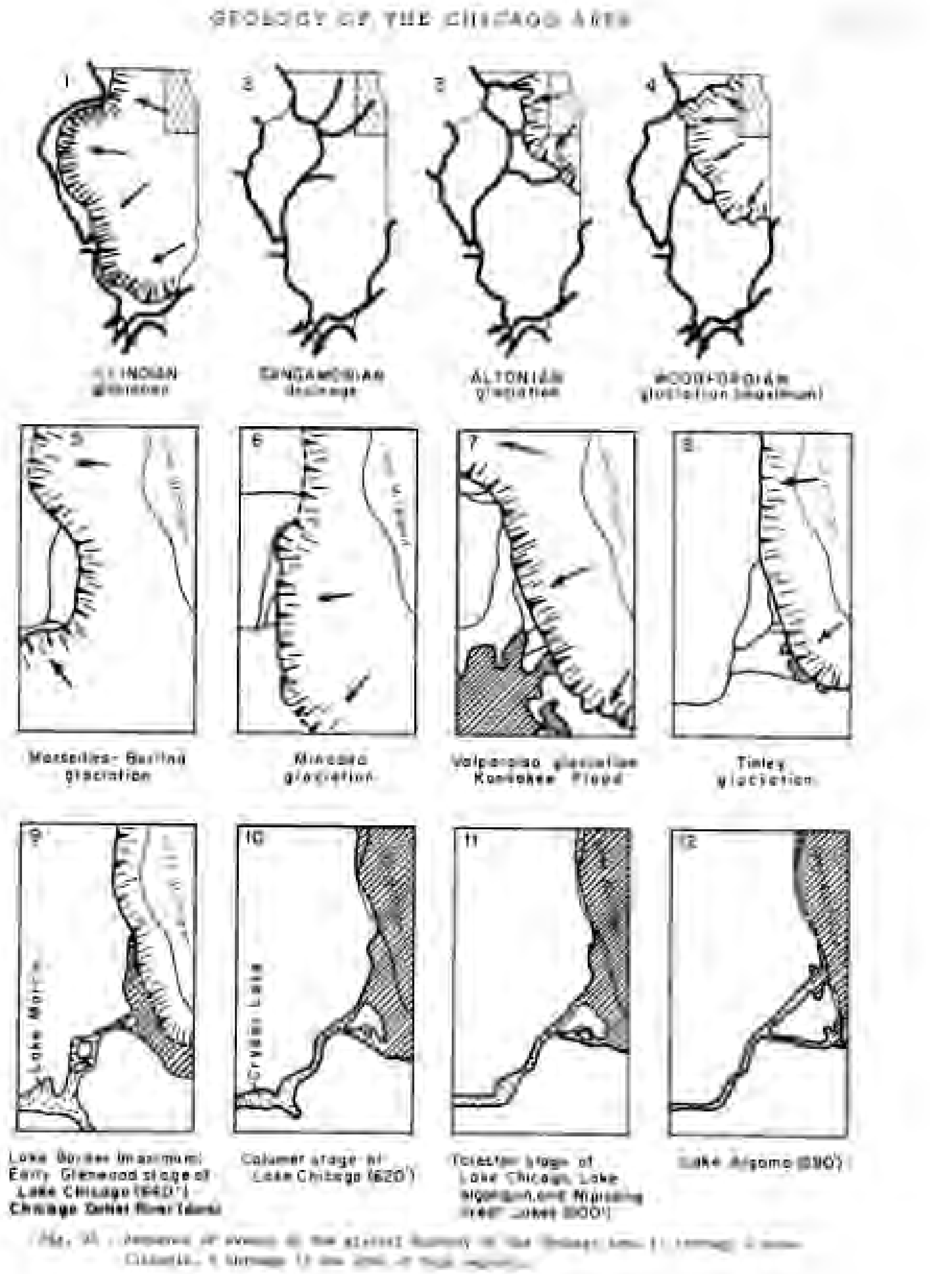


Figure D-4.Classification of the Pleistocene rocks of the Chicago area (after Willman and Frye, 1970) (ISGS, 1971)

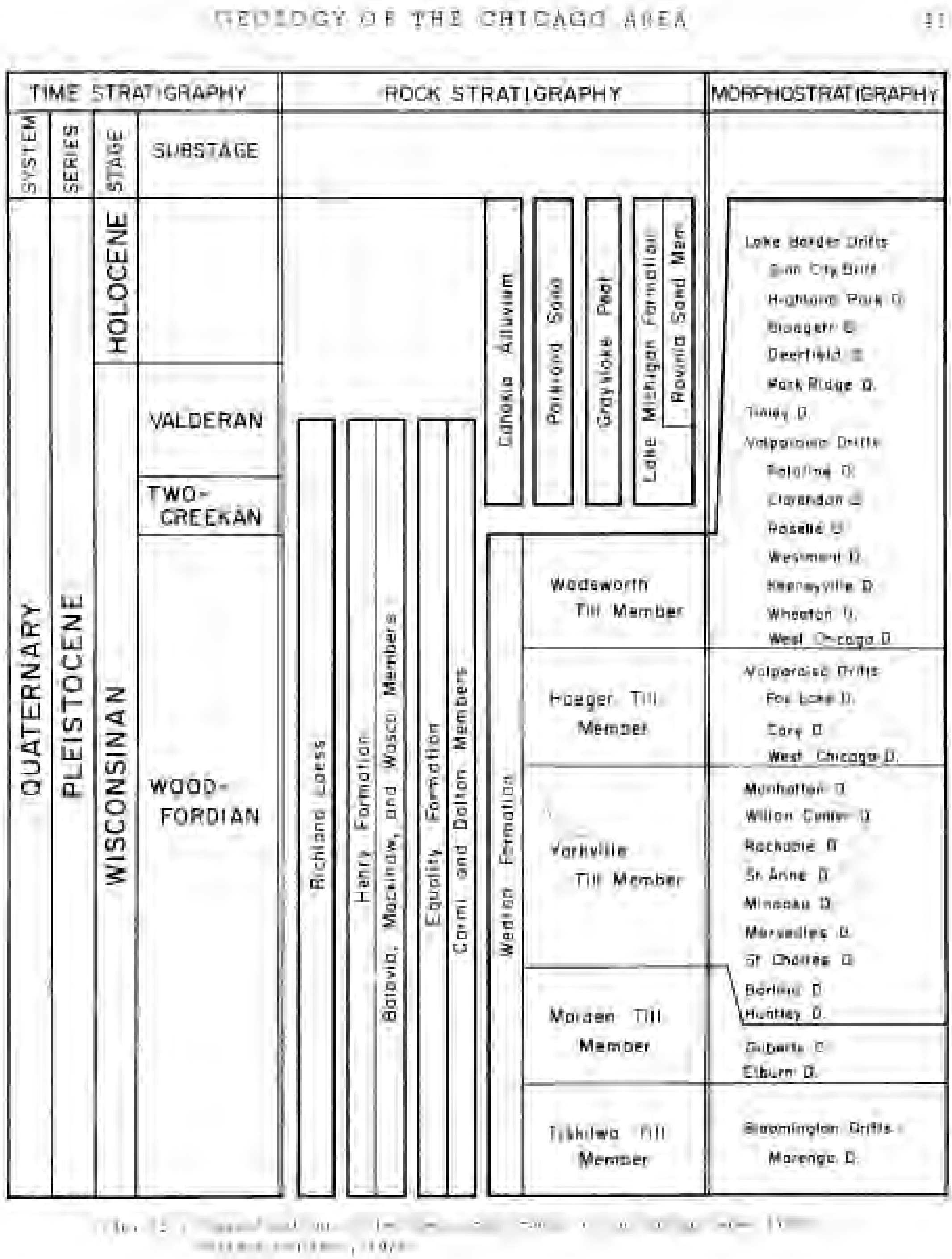


Figure D-5 Major glacial features of the Chicago area (ISGS, 1971)

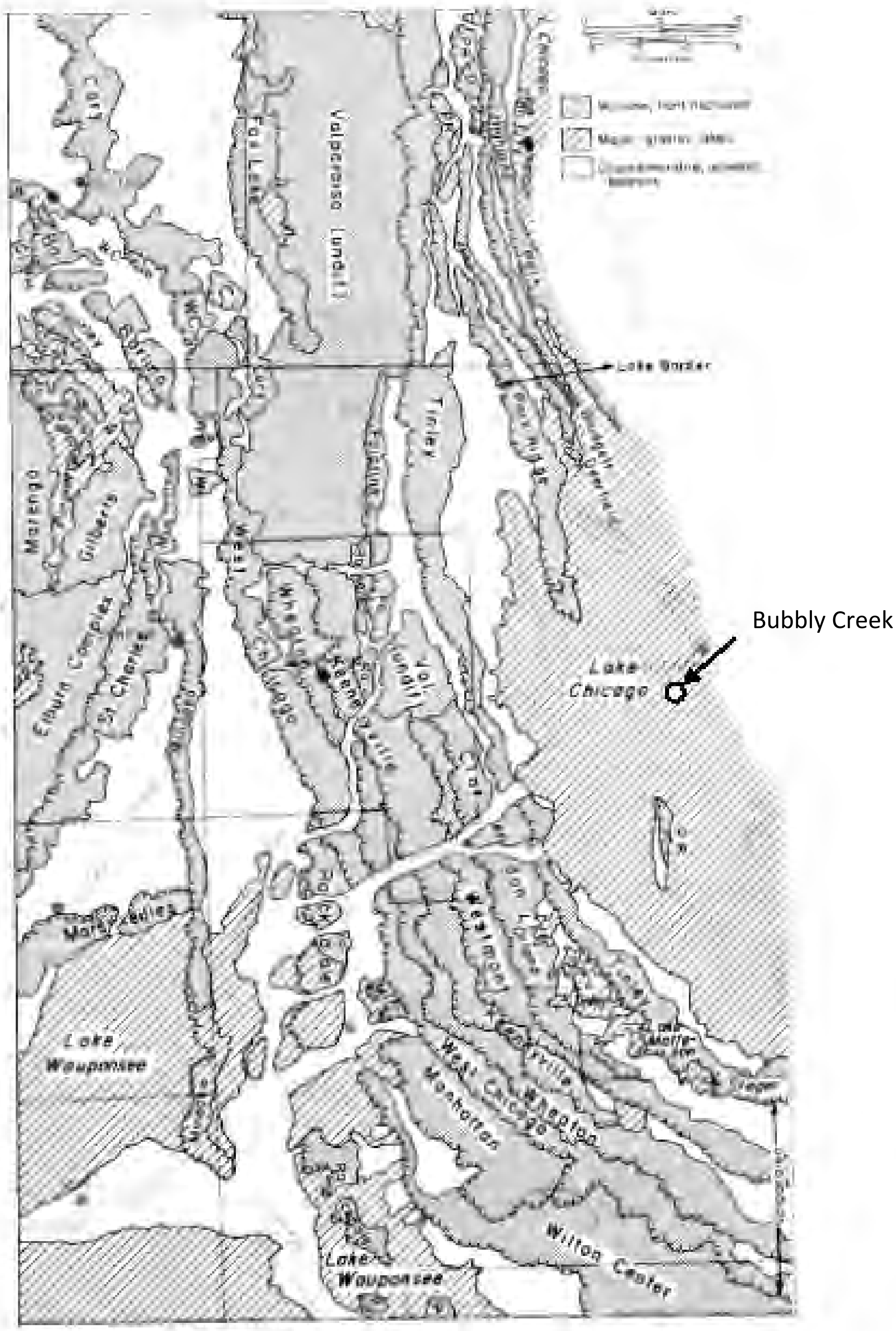


Fig. 30 - Major glacial features of the Chicago area.

Following the melting of the glaciers and continuing to present, the Parkland sand, Grayslake peat, Cahokia alluvium, and Lake Michigan formations were formed. The Holocene age began with the retreat of the Wisconsin glaciations approximately 7,000 radiocarbon years ago, which is roughly 7,000 years ago. At this time the ocean levels were near present levels and most of the glacial ice on the continents from the Wisconsin Ice Age had melted.

Lake levels are presented in Figure D-6. During the advance of the glaciers in Valderan time, the outlets of the lake at the Straits of Mackinac were blocked and Lake Chicago returned to the 620 ft level, discharging through the Chicago outlet. It was during this time that the Rose Hill spit was formed. Spits were also formed into the lake at Riverside and east of Blue Island. Erosion of the outlet led to lowering of the water level to 600 ft, which corresponds to the Toleston stage beach. Continued erosion formed the Graceland spit. When the Valders glacier retreated the Straits of Mackinac and Lake Huron and Michigan were connected. This was the end of Lake Chicago and the beginning of Lake Algonquin. Further retreat of the glaciers opened the North Bay Outlet. Because the area had not rebounded from the depression caused by the weight of the ice, the St. Lawrence extended to the North Bay Outlet. The result was that the lake in the Lake Huron Basin was drained to the north forming Lake Chippewa, which was 230 ft above sea level 9,000 years ago. During the Holocene, the North Bay Outlet into Ontario rebounded from the weight of the ice and water once again discharged through the Chicago and St. Clair outlets. In either Nipissing Great Lakes or Lake Algoma, a complex of low sand bars and tongues of a spit were built southward and successively eastward into the lake south of Jackson Park. Lake Algoma ended when continual downcutting of the St. Clair Outlet toward Lake Erie and lowered the lake to its present level of 580 ft, which is the Lake Michigan stage.

Figure D-6 Elevation and ages of the glacial lakes in the southern part of the Lake Michigan basin (ISGS, 1971)

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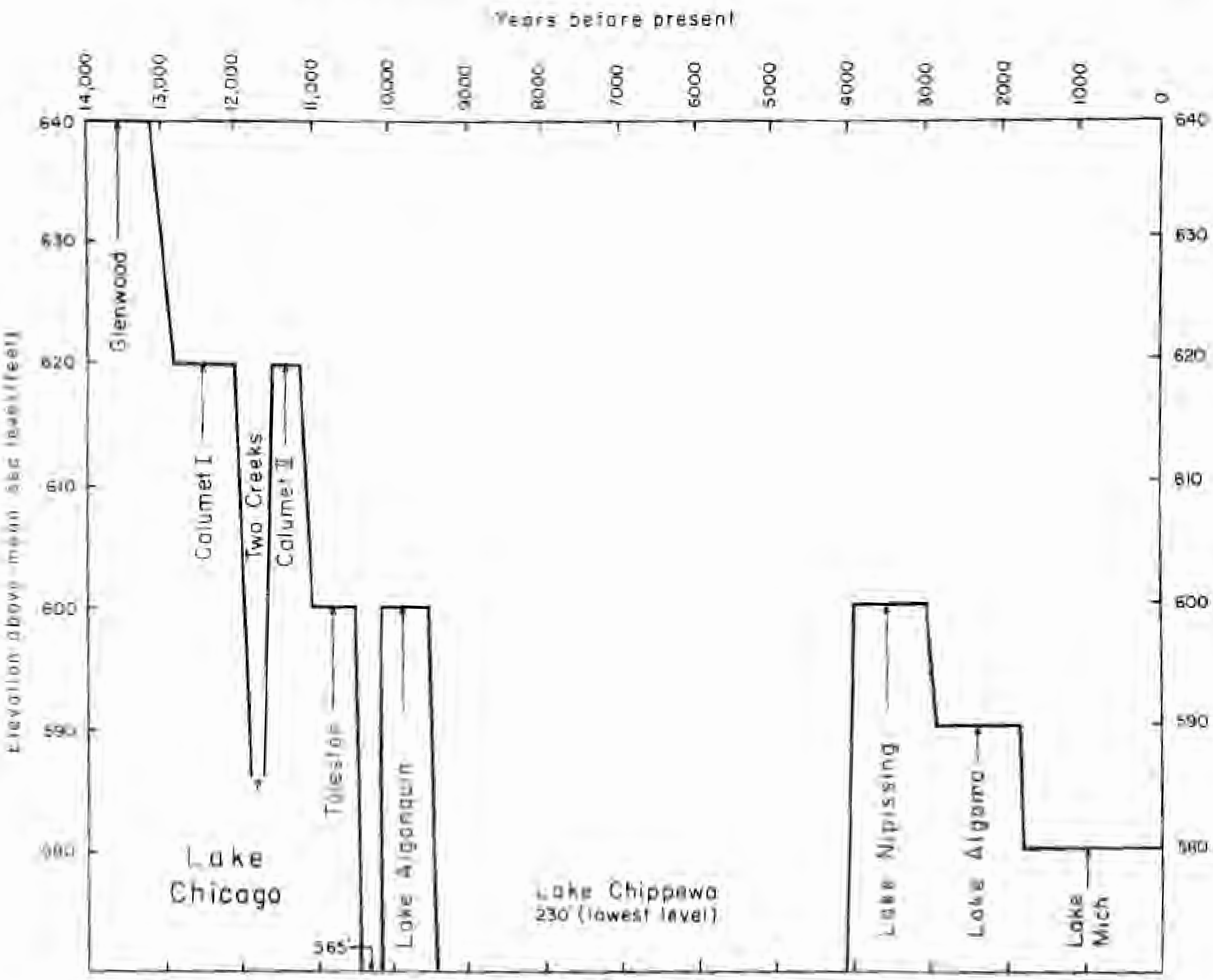


Fig. 19 - Elevation and ages of the glacial lakes in the southern part of the Lake Michigan Basin.

The bedrock contours available in the area are at 50 ft intervals, which is likely to miss many variations from location to location. However, hard till was encountered directly below sediment. This indicates that the bedrock is close to the surface in the vicinity of Bubbly Creek and the el 550 for top of bedrock is likely fairly close. Further research on area bedrock levels could be undertaken by reviewing the Illinois State Geological Survey water well database, or the Chicago District borehole database, should this be necessary. Bedrock topography is presented Figure D-7.

Figure D-7. Bedrock topography of the Chicago area

D-1.2. Summary of Geotechnical Explorations

The geotechnical investigations undertaken were as follows:

1) Bubbly Creek Feasibility Study Chicago, Illinois Subsurface Investigation Report of Findings Delivery Order No. DC 12, Contract No. W912P6-06-D-0001, AECOM Project No. 60090458/200803655. (14 May 2009)

2) Bubbly Creek Turning Basin Chicago, Illinois. Prepared for City of Chicago Department of Environment. Draft Site Investigation Report Patrick Engineering Incorporated. Project Number 20603.115 (Aug 2007)

3) Collection and Analysis of Sediment Samples from the South Fork South Branch, Chicago River (Mar 2005). Final Report. Prepared for United States Army Corps of Engineers – Chicago District. CDM Federal Programs Corporation.

Geotechnical investigations are summarized in Table D-7

Table D-7 Summary of geotechnical investigations at the Bubbly Creek site

Investigation	Number of Borings	Type	Notes	Results
AECOM (14 May 2009)	179	Cone Penetrometer Test (CPT) borings		Representative shear strength and permeability values along the centerline of the creek and at 38 cross sections perpendicular to the centerline. Shear strength was re-analyzed by ERDC and representative c/p’ ratios were developed. (See Slope Stability Analysis)
	3	Standard Penetration Test (SPT) soil borings to approximately twenty (20) feet into the bottom of Bubbly Creek.	Representative split spoon and Shelby Tube soil samples in the three soil borings. Laboratory and index testing on representative samples.	
Patrick Engineering Incorporated (PEI) (Aug 2007)	12	Sediment samples	Continuous samples of the sediment through the entire sediment thickness using a hand-held piston sampler. The hand-held piston sampler retrieves 1" sediment cores in 6.5-foot intervals	
	6	Piezometers	Each boring would be drilled to a depth 10 feet below the groundwater elevation, or a maximum depth of 30 feet, whichever was shallower. Each constructed well was to consist of a 2" diameter slotted PVC screen, with PVC riser piping rising up to the surface where the well would be fit with a flush-mounted well cap. The screen would be extended approximately 5 feet above the groundwater level identified while drilling.	
CDM (Mar 2005)	13	Vibracore	Completed along the length of the project site	Though the CDM report states that the cores were taken to refusal, the CPT investigation by AECOM showed that the depth of the sediment was deeper than predicted by CDM.

No pressure or pumping tests were undertaken. No exploratory excavations were undertaken. Summary and analysis of these data are presented in the Settlement Analysis (Attachment D-1) and Slope Stability Analysis (Attachment D-2).

D-1.3. Selection of preliminary design parameters.

Selection of preliminary design parameters is presented in the settlement Analysis (Attachment D-1), Slope Stability Analysis (Attachment D-2), and Cap Gradation Analysis (Attachment D-3).

D-1.4. Geophysical investigations.

No geophysical investigations were undertaken as part of this work.

D-1.5. Groundwater studies

The project is not expected to impact groundwater flow. Analysis of gradients in the turning basin was performed in the PEI (2007) investigation. Past investigations are provided in Attachment D-4.

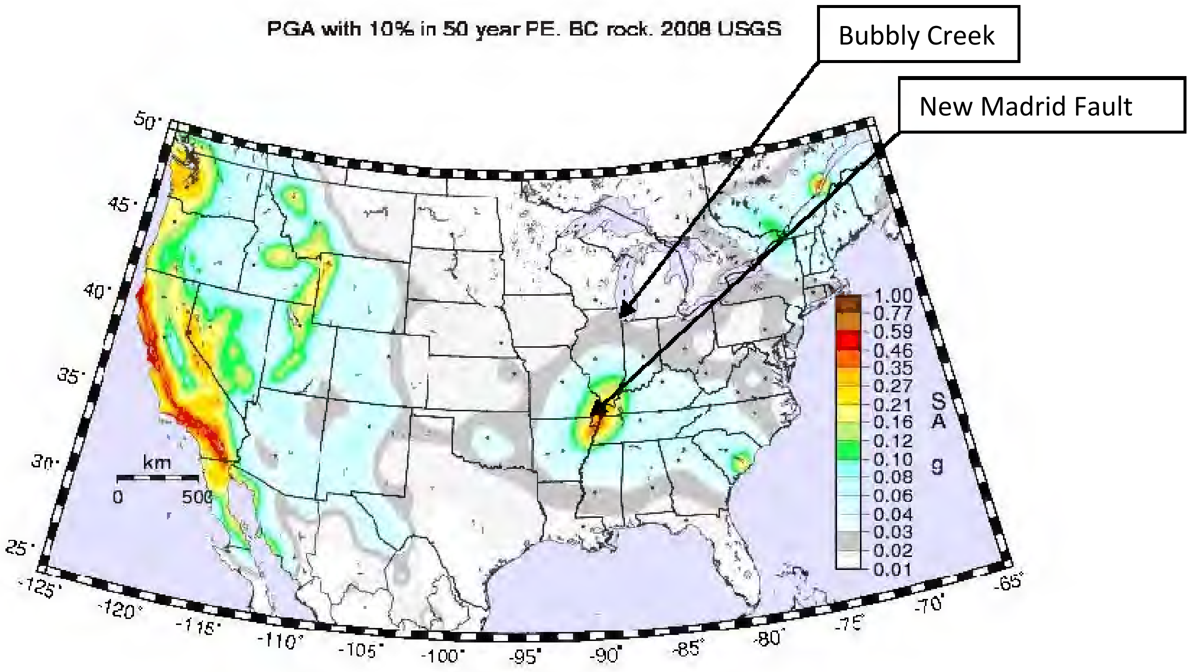
D-1.6. Recommended instrumentation.

We envision 1 - 2 hydrosurveys a year to monitor for scour and settlement. We estimate that the cost of the survey to be $5k per occurrence. We will need to add cost to negotiate and award and post process. We estimate that this will add $5k to each event. Therefore the total cost is $10k x 5 = $50k. Given the uncertainties in this estimate, a factor of safety of 2 is recommended, making the annual monitoring cost $100k. It is unclear at this point whether monitoring will be performed by the Chicago District or the Local Sponsor.

D-1.7. Earthquake studies

The Chicago area is not a seismically active area. The closest significant fault is the New Madrid. A map of peak ground accelerations with a 10% recurrence interval is presented in Figure D-8.

Figure D-8. Peak ground accelerations



Though there is some chance that the project area may experience some shaking, the 0.02 g peak ground acceleration is not expected to lead to significant settlement of the sediment or cap.

D-1.8. Preliminary foundation design and slope stability analysis

Preliminary foundation and slope stability analyses are provided in the Settlement and Slope Stability attachments. See Attachment D-1 and D-2.

D-1.9. Excavatability analysis with possible blasting constraints and controls.

Excavatability analyses are presented in the Slope Stability Analysis (Attachment D-2). No blasting is anticipated for this work.

D-1.10. Anticipated construction techniques, limitations, and problems.

Construction techniques, limitations and problems are discussed in the Slope Stability Analysis (Attachment D-2).

D-1.11. Potential borrow sites and disposal sites

The sand cap is expected to be constructed of sand overlain by rounded cobbles. Commercially in the area only Illinois Department of Transportation FA-02 and FA-06 are available for sand. Of these, only FA-02 meets the filter requirements as described in the Gap Gradation Analysis (Attachment D-3). The selection of rounded cobbles was not investigated in this appendix.

D-1.12. Potential sources of concrete materials and results of materials investigations.

Concrete materials are not anticipated to be needed for this project.

D-1.13. Suitability of concrete materials and plant, earth and rock borrow material, and stone slope protection

Concrete materials are not anticipated to be needed for this project. Stone protection around bridges was not investigated as part of this appendix.

D-2. Physical property testing and discuss selected design values.

Because variability in soils was expected to strongly influence the design and selection of structures and project, extensive physical property testing was performed. Discussion of selected design values is presented in the Settlement Analysis (Attachment D-1) and the Slope Stability Analysis (Attachment D-2). Probabalistic analyses of settlement are performed in the Settlement Analysis (Attachment D-1).

A plan view showing past investigations, geologic sections (with interpretations), exploration records (logs of borings, exploratory excavation maps, etc.), and plans and sections of foundation design (founding elevations, excavation limits) are shown in the settlement analysis (Attachment 1) and the slope stability analysis (Attachment D-2).

D-3. Summary of any additional exploration, testing, and analysis required for preparation of the DDR

ERDC has recommended regarding slope stability that perhaps the best approach at this point (in the absence of recommended additional bathymetry, soil borings, strength testing, and probabilistic strength modeling) is to perform a site demonstration on a selected reach to show that placing 22 inches of sand could be a viable option.

During the design analysis, the settlement analysis should be broken into sub-reaches to achieve a more realistic time-rate of settlement. Additionally, during the design analysis, a large-strain model such as PSDDF will be considered.

D-4. Summary of Laboratory Testing Program

A summary of the laboratory testing program completed and a description of the evaluations made in the selection of the design parameters are provided in the settlement analysis (Attachment D-1) and the slope stability analysis (Attachment D-2).

Attachments

D-1 Settlement Analyses
D-2 Slope Stability Analyses
D-3 Gap Gradation Analyses
D-4 Geotechnical Investigations

Attachment D-1
Settlement Analyses

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **3Sep2013**	SHEET: 1
	COMPUTATION TITLE: **Settlement Analysis**	CHECKED BY:	DATE:	

Bubbly Creek Settlement Analysis (Aug 2013)

SUMMARY
Settlement is predicted to be an average of 1 ft for the sand cap and 1.3 ft for the gas vent cap. This is less than the ERDC prediction, which is an average of 2.5 ft. However, the ERDC prediction is considered an upper bound. The analysis could be improved by breaking up the areas considered into reaches as was performed during the stability analysis. Differential settlement is not expected to impact the cap.

PURPOSE
The purpose of this analysis is to evaluate a proposed cap for the Bubbly Creek feasibility study. The caps under current consideration are either a gas venting cap or a sand cap. Dimensions of these caps shown in Table D-1-1.

Table D-1-1 Summary of gas venting and sand cap designs

Layer	**Gas Venting Cap, inches**	**Sand Cap, inches**
Armor	10 (range 8 – 12)	10 (range 8 – 12)
Filter Protection	4 (range 2 – 6)	
Aquablock ®	6 (range 4 – 8)	
Gas Vent	12 (range 10 – 14)	
Bedding Filter (sand)	4 (range 2 – 6)	
Isolation (sand)		9
Containment (sand)		3 (combined range 10 – 14)
	36 (range 26 – 46)	22 (range 18 – 26)

REFERENCES

1) Bubbly Creek Feasibility Study Chicago, Illinois Subsurface Investigation Report of Findings Delivery Order No. DC 12, Contract No. W912P6-06-D-0001, AECOM Project No. 60090458/200803655. (14 May 2009)
2) Bubbly Creek Turning Basin Chicago, Illinois. Prepared for City of Chicago Department of Environment. Draft Site Investigation Report Patrick Engineering Incorporated. Project Number 20603.115 (Aug 2007)
3) Collection and Analysis of Sediment Samples from the South Fork South Branch, Chicago River (Mar 2005). Final Report. Prepared for United States Army Corps of Engineers – Chicago District. CDM Federal Programs Corporation.
4) Engineering and Design - Settlement Analysis (EM 1110-1-1904, 30 September 1990)
5) McLinn, Eugene L. and Thomas R. Stolzenburg. Ebullition-Facilitated Transport of Manufactured Gas Plant Tar from Contaminated Sediments. Environmental Toxicoloty and Chemistry, Vol. 28, No. 11, pp. 2298-2306, 2009.
6) Harr, M.E., 1987. Reliability-based design in civil engineering. McGraw-Hill., Inc. ISBN 0-07-026697-2.

7) Holtz, R.D., and W.D. Kovacs, 1981. An introduction to geotechnical engineering. Prentice-Hall, Inc. ISBN 0-13-484394-0.

FORMULA

Total settlement is calculated based on the following formula

$$s = Cc \times H / (1 + eo) \times \log [(\sigma' + \Delta\sigma)/\sigma']$$

Where,
S = total settlement,
Cc = compression index,
H = thickness of the layer,
eo = initial void ratio,
σ’ = initial effective stress,
Δσ = change in stress due to the cap

PAST ANALYSES

ERDC performed analysis of cone penetrometer (CPT) data collected by AECOM (2009) to determine soil type, settlement, and shear strength. Settlement values calculated by ERDC are provided in Attachment 1. The settlement values are based on 200 psf loading and a 10 ft assumed layer thickness.

CURRENT ANALYSES

The current analyses consist of determining the total expected settlement, which includes a statistical analysis of the likelihood of a given settlement. Then differential settlement is evaluated based on the expected settlement calculations. Finally at time rate of settlement calculation is performed.

Total Settlement

Calculation of the total settlement in the current analysis is based on the settlement equation identified above. First the method for determining these parameters was developed. Then statistical distributions for these parameters were developed. Finally, the point estimate method was used to evaluate the expected distribution of settlement.

Input Parameter Description

A summary of parameters input into the settlement equation is provided in the following table. A description of the methodology for evaluation of each parameter is presented in Table D-1-2.

Table D-1-2 Summary of settlement analysis input parameters and data sources

Input Values	Source
Cc = compression index	Cc = 0.75 (e_o – 0.5) soils of low plasticity

Input Values	Source
	(summarized by Azzouz, Krizek, and Corotis (1976)
H = thickness of the layer,	AECOM (2009)
e_o = initial void ratio,	Wn and Gs values from AECOM (2009), PEI (2007), and CDM (2005)
σ' = initial effective stress,	Midpoint of layer, unit weight from wn and Gs values (AECOM (2009), PEI (2007), and CDM (2005))
Δσ = change in stress due to the cap	Cap thicknesses, Gs and n provided by ERDC

Where
e_o = initial void ratio = (volume of voids)/(volume of solids) = Vv/Vs
w_n = natural water content = (weight of water)/weight of solids) = Ww/Ws
Gs = specific gravity of solids
n = porosity = (volume of voids)/volume = Vv/V

Compression Index

The compression index is evaluated based on correlations cited by Holtz and Kovacs (1981) as summarized by Azzouz, Krizek, and Corotis (1976) and EM 1110-1-1904. These are summarized in Table D-2-2. The correlations are compared to consolidation data measured on samples taken from the turning basin by PEI. The correlations considered are those based on void ratio (e_o) and natural water content (w_n). These correlations were considered based on index property tests on samples taken in the turning basin by PEI (2007) that show the soils to range from inorganic and organic silts and silty clays of low plasticity; rock flour, silty or clayey fine sands to micaceous or diatomaceous fine sandy and silty soils; elastic silts; organic silts, clays and silty clays. Atterberg limit data based on samples taken along the centerline of Bubbly Creek (CDM, 2005) and in the turning basin (PEI, 2007) are summarized in Figure D-2-1.

Figure D-2-1. Summary of Bubbly Creek Atterberg limit data

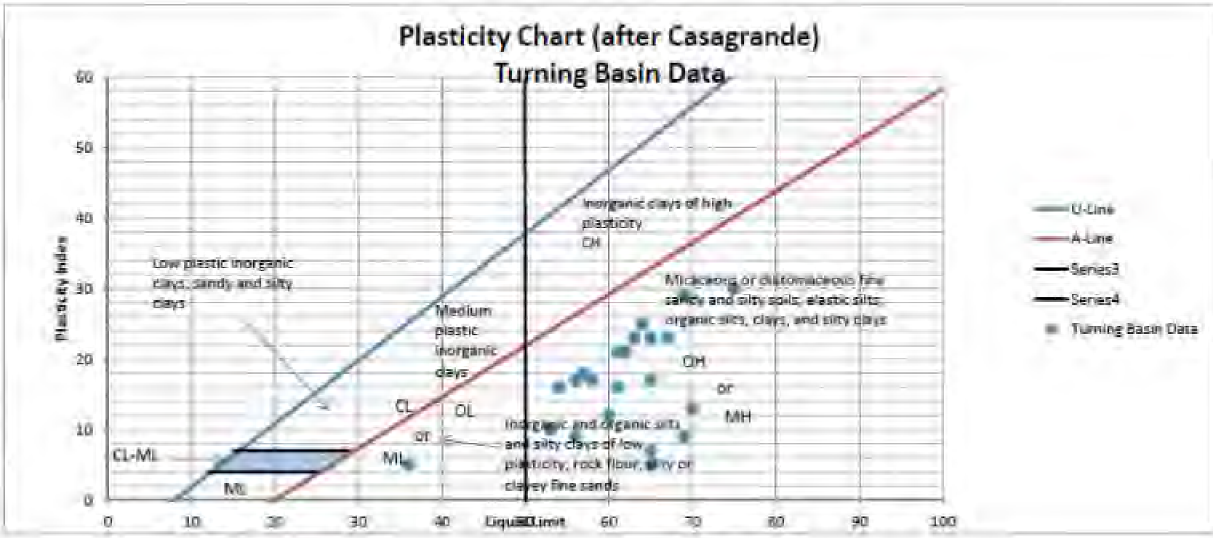


Table D-2-2 Correlations considered for compression index (Cc) estimation

Type	Formula	Description
Void ratio	$0.75\ (e_o - 0.5)$	Soils of low plasticity
	$1.15\ (e_o - 0.35)$	All clays (EM 1110-1-1904)
Water content	$1.15 \times 10^{-2}\ w_n$	Organic soils – meadow mats, peats, and organic silt and clay (EM 1110-1-1904)
	$0.01\ w_n$	Chicago clays

Comparison of turning basin data to these correlations is shown Figure D-2-2 and Figure D-2-3.

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US Army Corps of Engineers, Chicago District	COMPUTATION TITLE: Settlement Analysis	CHECKED BY:	DATE:	

Figure D-2-2.

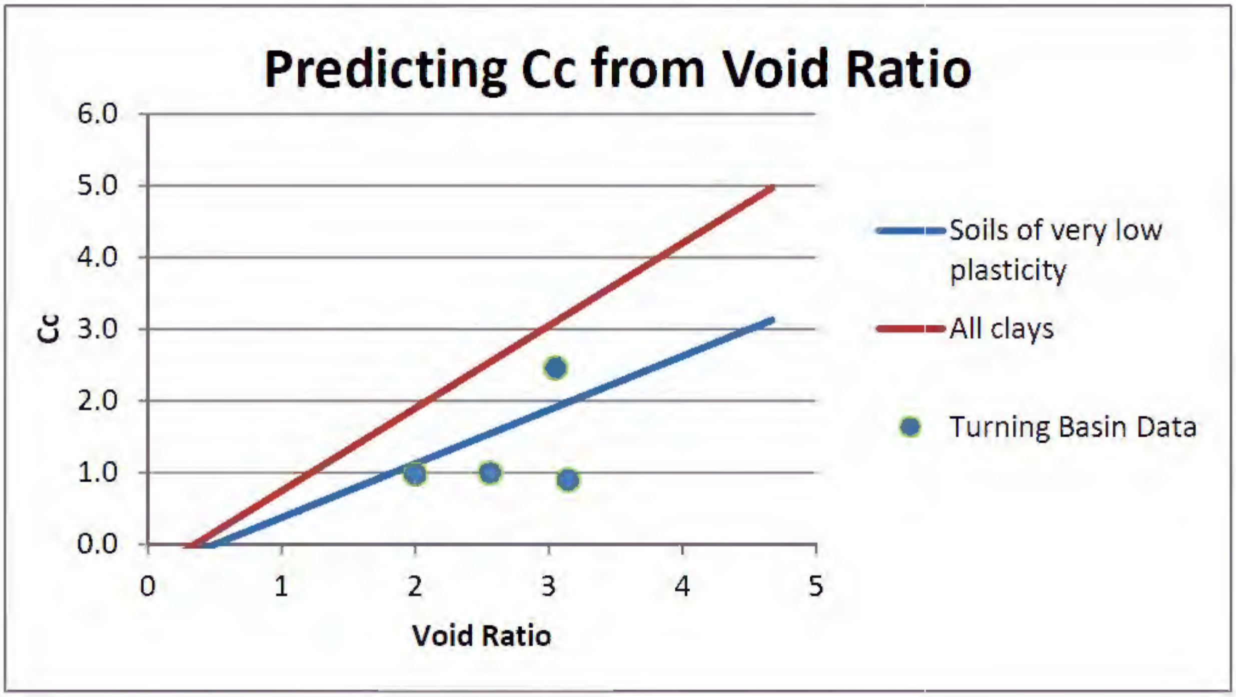
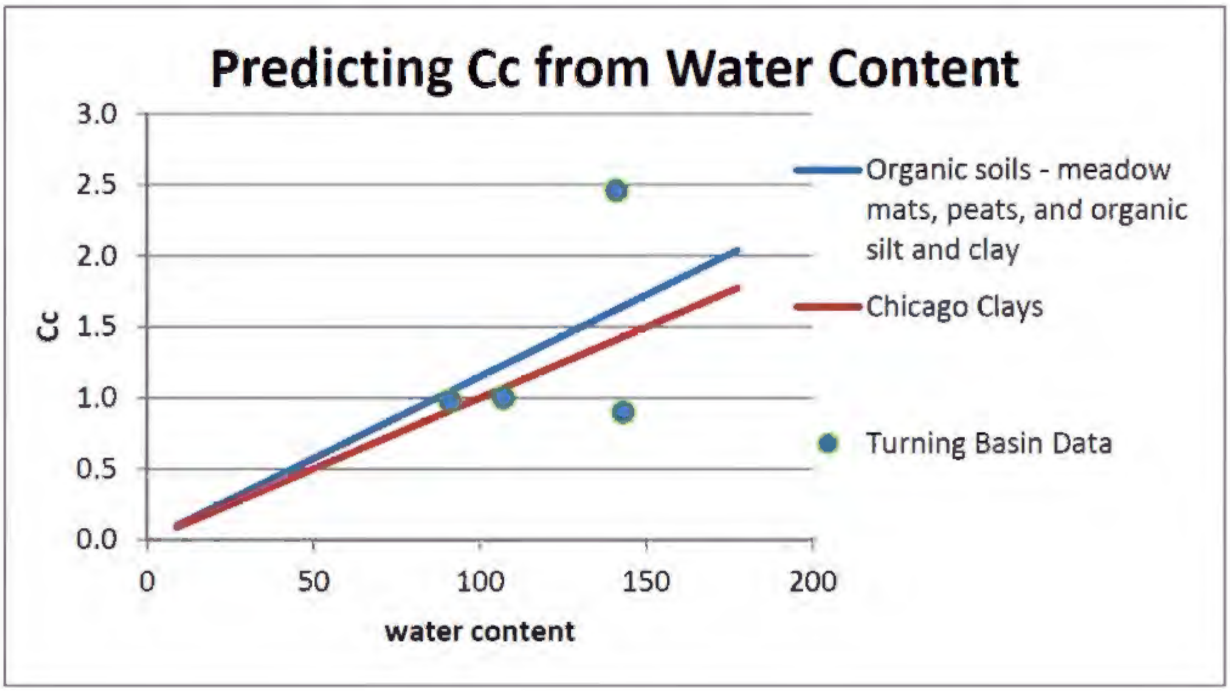


Figure D-2-3.



Because the correlations show a linearly increasing value of Cc with water content, it is expected that Cc should increase with water content or void ratio. This trend is supported by all but the data point corresponding to a natural water content of 143%, void ratio of 3.15 and Cc = 0.9.

Because of this data point does not fit the trend of increasing Cc with water content or void ratio, it is not considered in the fitting comparison.

Overprediction of settlement is not conservative for this project. If the correlation over predicts settlement, then the project team might expect more flow conveyance than actually occurs. If the correlation under predicts settlement, then the project team might expect less flow conveyance than actual. Therefore, the rational for selection of a fit was to find the most predictive correlation.

Based on the above, the correlation between Cc and void ratio for soils of very low plasticity is selected.

Layer Thickness

Though not used directly in the settlement analysis, settlement was calculated at the locations where sediment thickness was measured, the following is a statistical analysis of the sediment layer thickness. It is meant to provide an overall feel for sediment thickness and distribution of sediment thickness. The layer thickness is determined at 179 cone penetrometer locations and 3 standard penetration test boring locations by AECOM (2009). Statistics on the layer thickness are shown in Table D-2-3.

Table D-2-3. Summary statistics on sediment layer thickness

	Value, ft
Average	13.4
Standard Deviation	4.97
Maximum	24.87
Minimum	0

A probability density function (pdf) and cumulative density function (cdf) were developed for the layer thickness by sorting the data and dividing into intervals of 2 ft. The probability density function is a count of the number of samples between a given 2 ft interval and the cumulative density function is the area under the probability density function curve. Using the NormalDist function in Excel, the probability density function and the cumulative distribution function are plotted for normal distribution using the average and standard deviation for the data. The results of this comparison between the data collected and the normal distribution functions are provided in Figure D-2-4 and D-2-5.

Figure D-2-4. Probability density function of sediment thickness

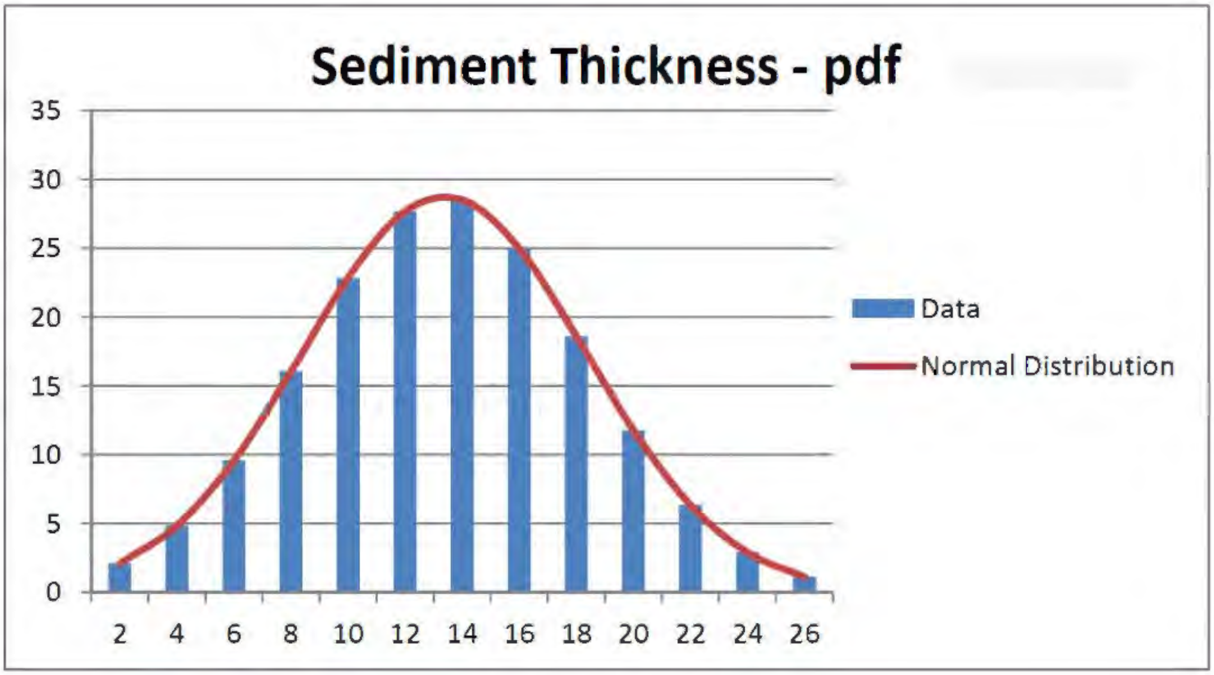
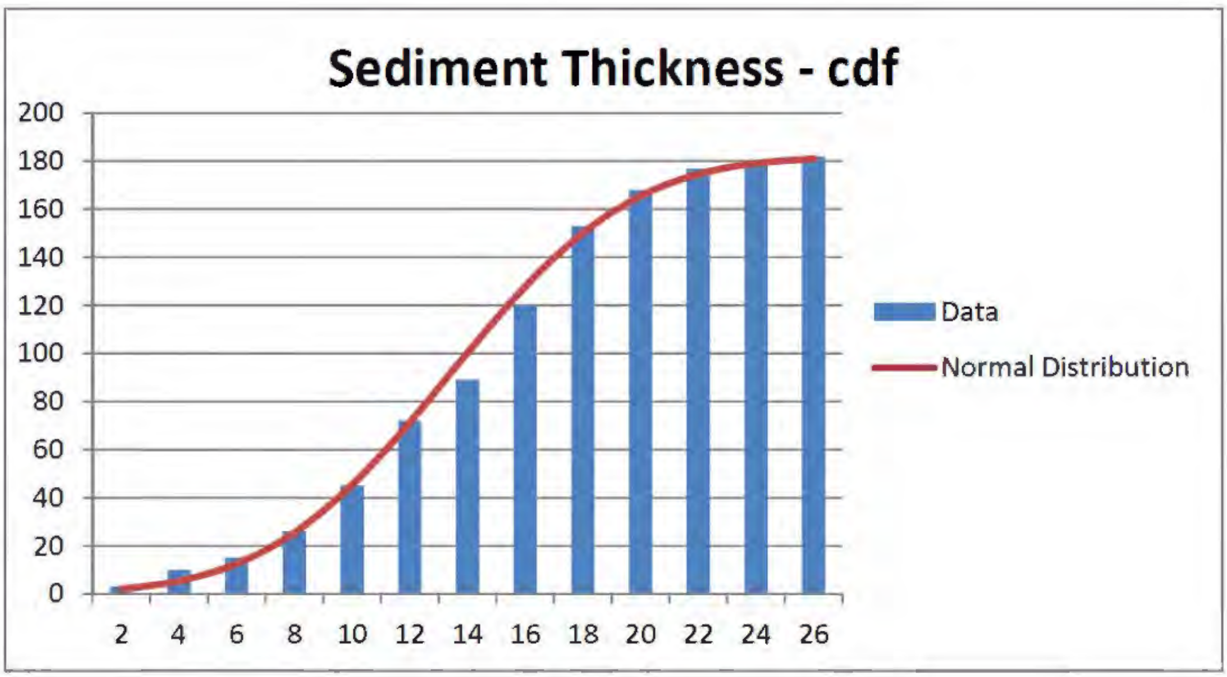


Figure D-2-5. Cumulative density function of sediment thickness



From these data the sediment thickness very closely follows a normal distribution, which provides some support to the validity of a probabilistic settlement analysis approach.

Initial Void Ratio (e_o)

Initial void ratio is calculated based on natural water content and specific gravity based on the following relationship.

$$e_o = w_n \times Gs,$$

Where
e_o = initial void ratio
w_n = natural water content, and
Gs = specific gravity of solids

Natural water content is provided by AECOM (2009) and PEI (2007). CDM (2005) provides percent solids, which, based on their report (p 196/218) is defined as the weight of solids divided by the weight soil weight. Therefore natural water content is calculated for the CDM samples based on the following phase relationship

$$w_n = (1 - S)/S, \text{ where}$$

S = percent solids (Ws/W).

Initial Effective Stress (σ')

The initial effective stress is calculated as the stress at the mid layer based on the following

$$\sigma' = (h / 2) \times \gamma'$$

Where,
σ' = stress at the mid layer
h = thickness of the layer based on CPT tests,
$\gamma' = \gamma - \gamma_w$,
Where,
γ = specific weight calculated based on Gs and w_n

Change in Stress Due to Cap (Δσ)

The cap dimensions were provided by ERDC. At present they are as provided in Table D-2-4 and D-2-5. The thickness of the armor may vary slightly based on the results of hydraulic modeling of Racine Avenue Pump Station (RAPS) discharges.

Table D-2-4 Proposed assumptions and loading for gas vent cap

Material	**Thickness, inches**	**Gs**	**n**	**γ' (pcf)**	**Submerged stress (lb/ft2)**
Armor	10 (range 8 – 12)	2.65	0.35	66.9	44.6 - 66.9
Filter Protection	4 (range 2 – 6)	2.65	0.40	61.8	10.3 - 30.9
Aquablock ®	6 (range 4 –	1.4	0.35	16.2	5.4 - 10.8

Material	Thickness, inches	Gs	n	γ' (pcf)	Submerged stress (lb/ft2)
	8)				
Gas Vent	12 (range 10 – 14)	2.65	0.35	66.9	55.8 - 78.1
Bedding Filter (sand)	4 (range 2 – 6)	2.65	0.40	61.8	10.3 - 30.9
Total	26 - 46				126.4 - 217.6

Average = 172 psf (8.2 kN/m2)

Table D-2-4 Proposed assumptions and loading for sand cap

Material	Thickness, inches	Gs	n	γ' (pcf)	Submerged stress (lb/ft2)
Armor	10 (range 8 – 12)	2.65	0.35	129.3	44.6 – 66.9
Isolation (sand)	9	2.65	0.40	124.2	
Containment (sand)	3 (combined range 10 – 14)	2.65	0.40	124.2	51.5 – 72.1
Total	18 - 26				96.1 – 139.0

Average = 117.6 psf (5.6 kN/m2)

Point Estimate Method

The generalized point estimate method is described by Harr (1987) for a function of three random variables $y = y(x_1, x_2, x_3)$ is as follows

$$y_{\pm\pm\pm} = y(\bar{x}_1 \pm \sigma[x_1], \bar{x}_2 \pm \sigma[x_2], \bar{x}_3 \pm \sigma[x_3])$$

and

$$p_{+++}=p_{---} = 1/2^3(1+\rho_{12} + \rho_{23} + \rho_{31})$$
$$p_{++-}=p_{--+}=1/2^3(1 + \rho_{12} - \rho_{23} - \rho_{31})$$
$$p_{+-+}=p_{-+-}=1/2^3(1 - \rho_{12} - \rho_{23} + \rho_{31})$$
$$p_{+--}=p_{-++}= 1/2^3(1 - \rho_{12} + \rho_{23} - \rho_{31})$$

where ρ_{ij} is the correlation coefficient of the random variables x_i and x_j.

The Mth expected value is obtained from

$$E[y^M] = p_{+++}y^M_{+++} + p_{++-}y^M_{++-} + p_{--+}y^M_{--+} + p_{+-+}y^M_{+-+} + p_{-+-}y^M_{-+-} + p_{+--}y^M_{+--} + p_{-++}y^M_{-++} + p_{---}y^M_{---}$$

The variance V[y] and standard deviation σ can then be calculated for each using

$V[y] = E[y^2] - (E[y])^2$
$\sigma[y] = \text{sqrt}(V[y])$

Distribution of Input Parameters

The site is approximately 140 ft wide and 7200 ft long and consists of sediment that has been deposited by nature and man. The prospect of taking representative samples of this large and varied area is daunting. Therefore a comprehensive CPT investigation was undertaken. From the investigations we have a large number of index property tests along with a selection of undisturbed samples. Based on these data we have developed a settlement analysis based on statistical distributions of input parameters. These analyses have provided an expected settlement value and a standard deviation, which work out to be 1 ft for the sand cap, with a standard deviation of 0.7 ft.

The settlement equation is once again given as

$$s = Cc \times H / (1 + eo) \times \log [(\sigma' + \Delta\sigma)/\sigma']$$

The variables that feed the settlement equation for the point estimate method are described in Table D-2-6.

Table D-2-6. Settlement input variables

Variable	Source
Thickness of sediment (H)	Based on CPT results (AECOM, 2009)
Initial void ratio (e_o)	w x Gs
Initial effective stress (σ')	H/2 x ($\gamma - \gamma_w$)
Sediment unit weight (γ)	(1+w)/(1/Gs+w) x γ_w
Compression Index (Cc)*	Variable, based on e_o → Cc = 0.75 (e_o – 0.5)
Water content (w%)*	Varied based on laboratory measurements of field data
Specific Gravity (Gs)*	Varied based on laboratory measurements of field data

*Varied based on statistical distribution

The variables chosen for variation in the point estimate method are interrelated. The compression index Cc is driven by a correlation with the void ratio, which is a function of water content. Therefore the water content and the compression index are highly correlated. This would lead one to believe that only the water content should be varied. However the water content also impacts the unit weight of the sediment. Therefore the water content and the compression index will impact settlement somewhat independently and therefore both are varied in the analysis.

The specific gravity of solids is chosen as a variable because it impacts the sediment unit weight. Additionally it is measured in the laboratory based on field data.

The distribution of the three input variable are shown as follows: Compression index (Figure D-2-6, D-2-7), water content (Figure D-2-8, D-2,9), and specific gravity (Figure D-2-10, D-2-11).

Compression Index

Figure D-2-6. Probability density function of compression index

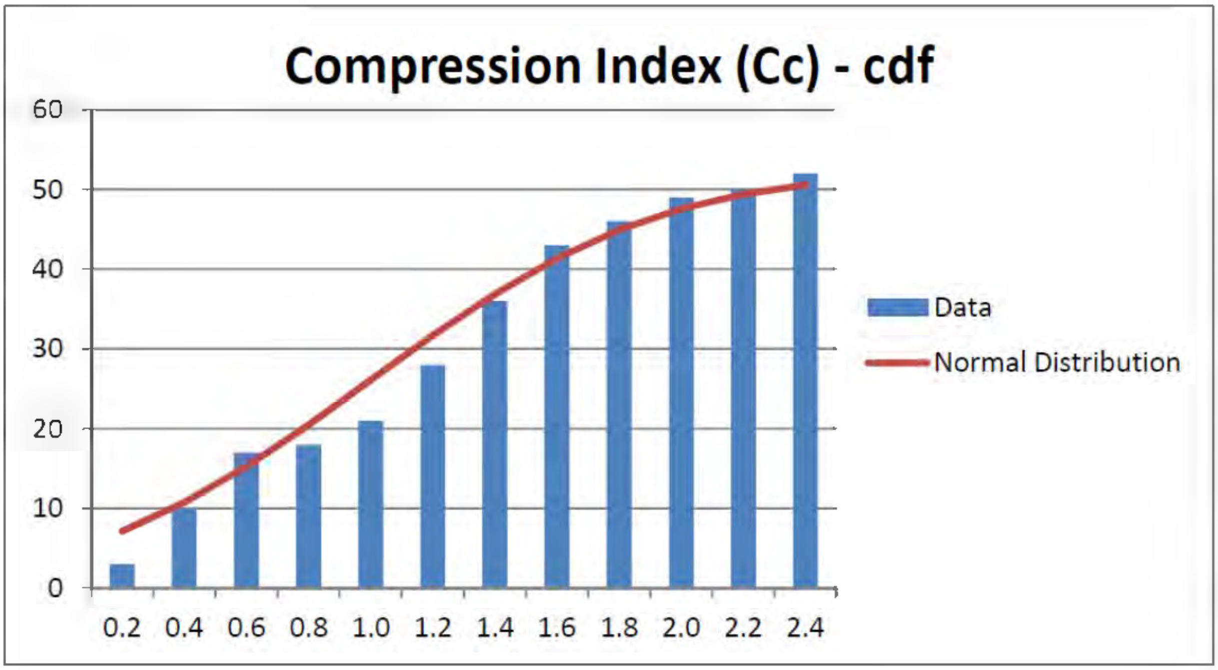


Figure D-2-7. Cumulative density function of compression index

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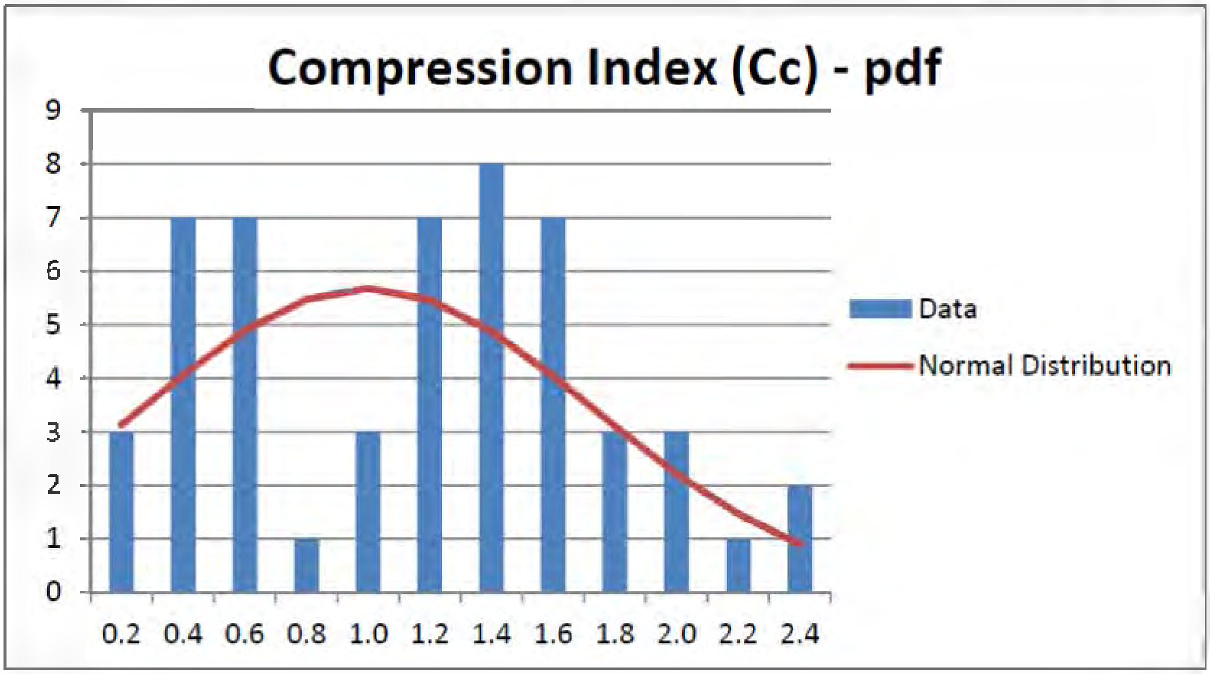


Though the cumulative density function appears to mimic a normal distribution, this masks the bimodal distribution shown in the probability density function. This bi-modal aspect would make breaking up the settlement analysis based on two or more reaches seem reasonable. Given the current extent of the analysis this is not performed, but should be considered for future work. A plan view map of compression index would be useful.

Water Content

Figure D-2-8. Probability density function of water content

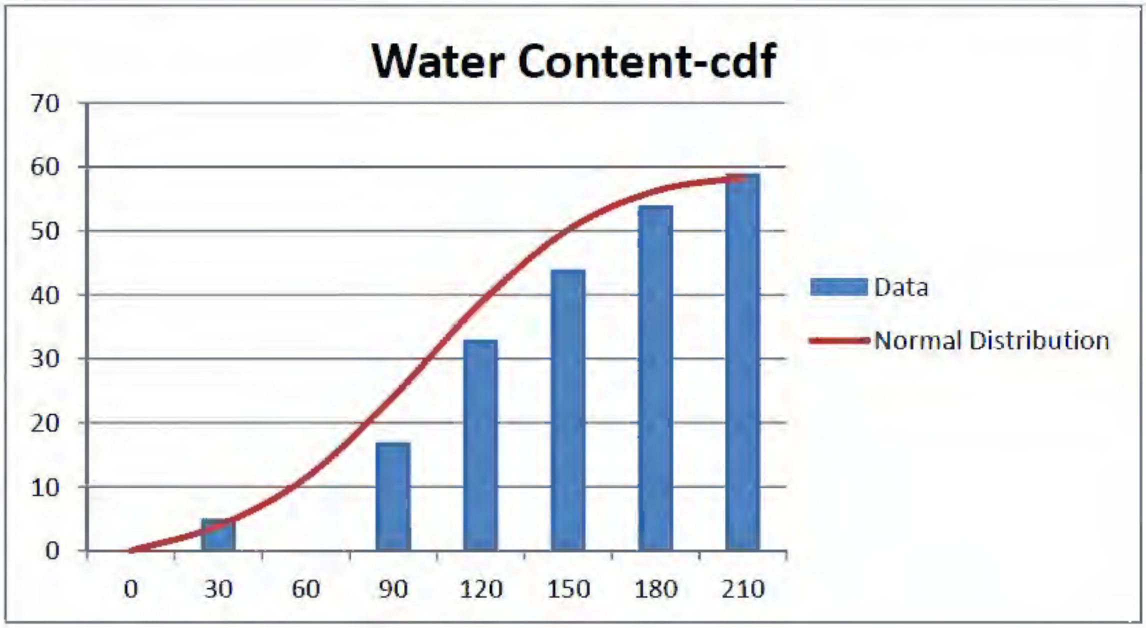
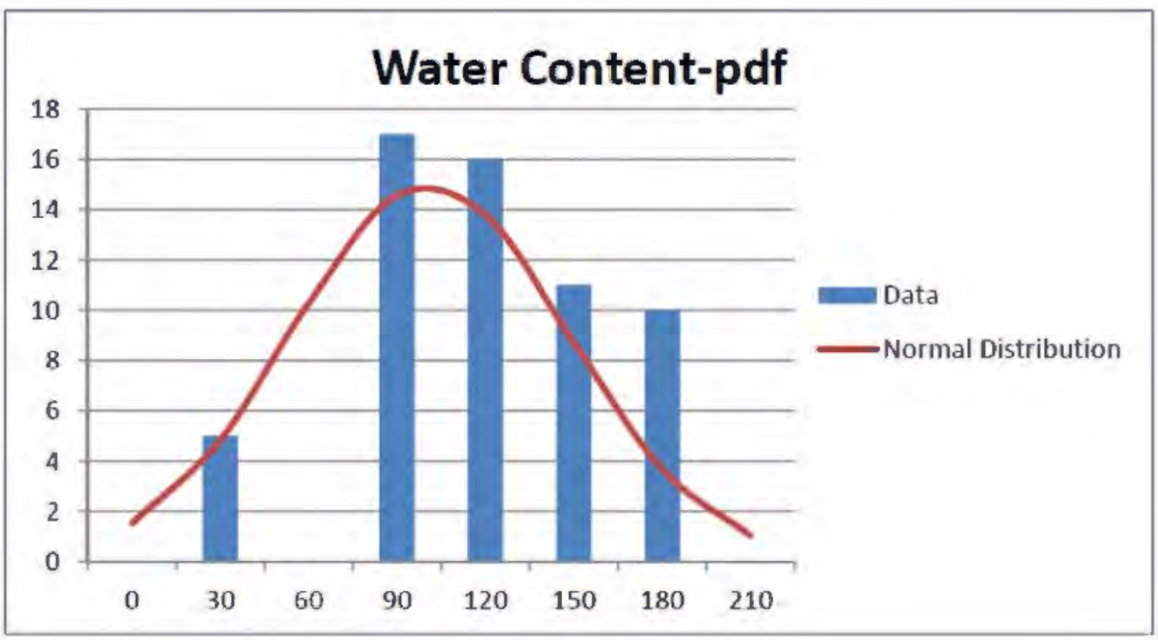


Figure D-2-9. Cumulative density function of water content



Water content appears to be somewhat closely resemble a normal distribution with some data gaps.

Specific Gravity

Figure D-2-10. Probability density function of specific gravity

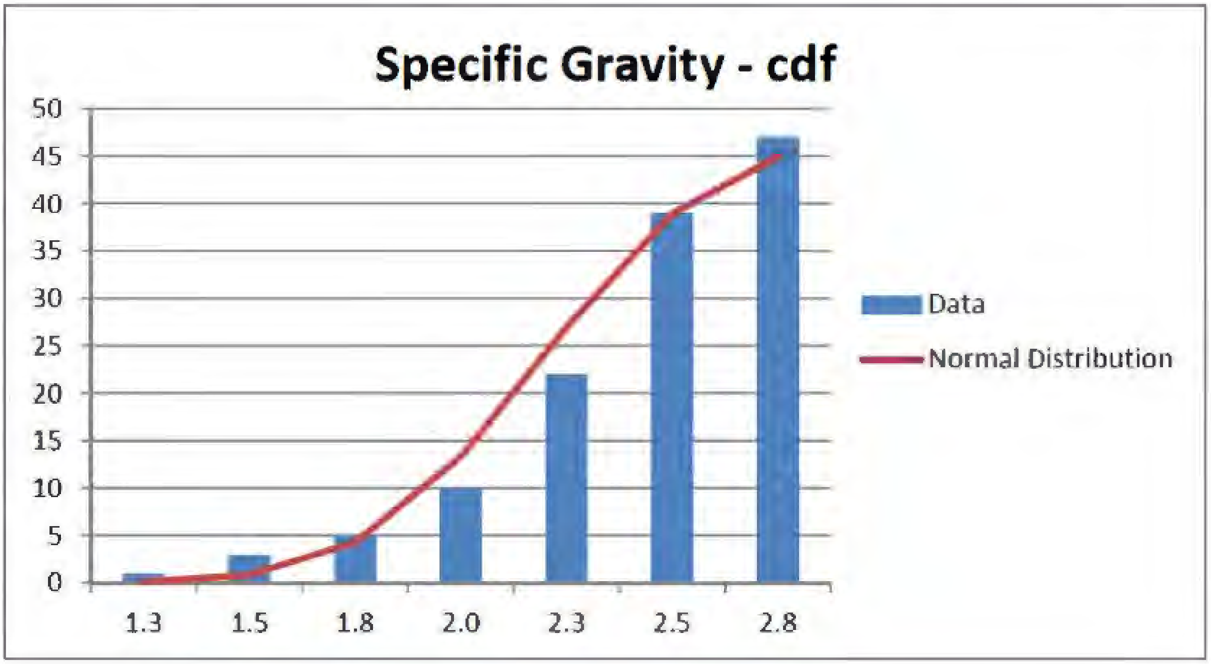
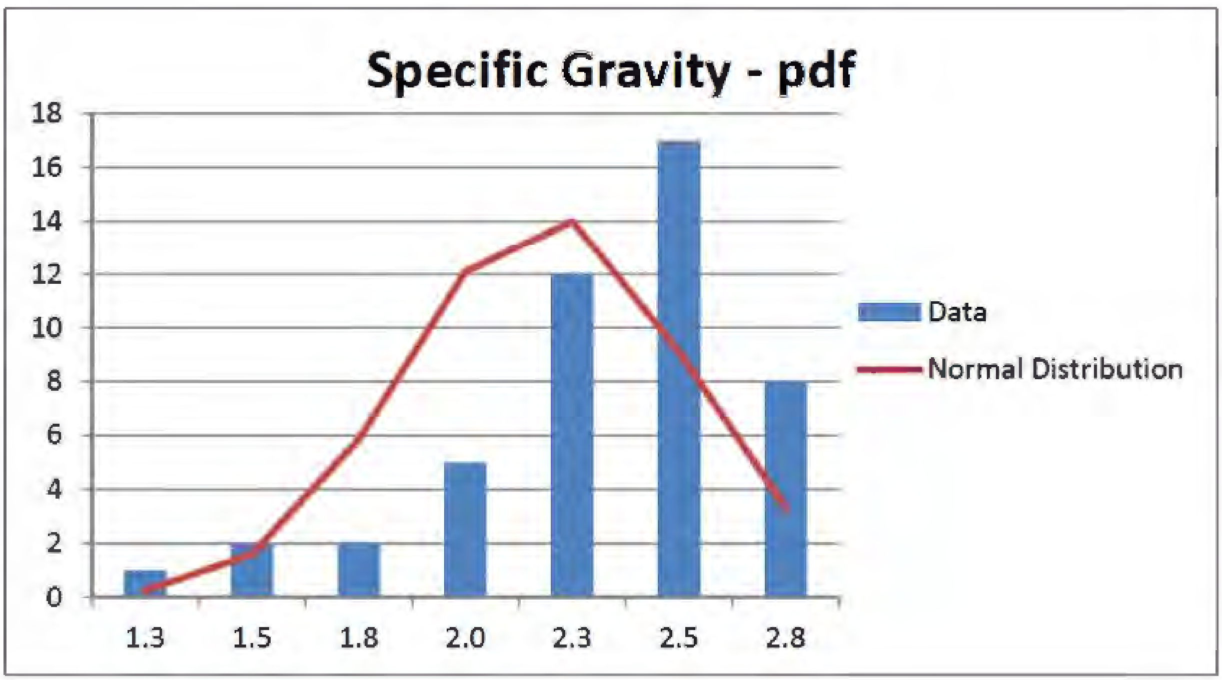


Figure D-2-11. Cumulative density function of specific gravity



The specific gravity distribution is skewed. Analysis that considers this skewing might be worth considering for future work.

Input Values to the Point Estimate Method

The expected value E[x], standard deviation σ[x], and calculation of expected value plus and minus one standard deviation E[x]±σ[x] for the three varied input variables are provided in Table D-1-7.

Table D-1-7 Summary of expected value and standard deviation of varied input variables

	1	2	3
	Cc	**w%**	**Gs**
E[x]	1.3	84.0%	2.2
σ[x]	0.8	41.6%	0.3
E[x]+σ[x]	2.1	125.6%	2.5
E[x]-σ[x]	0.6	42.5%	1.9

The correlation coefficients between the three variables is shown in Table D-1-8

Table D-1-8 Correlation between varied input variables

	value	**description**
ρ12	1.0	Cc and w%
ρ23	-0.08	w% and Gs
ρ31	0.141	Gs and Cc

The compression index (Cc) is perfectly correlated with the water content (w%), which is expected given that the compression index is calculated directly from the void ratio, which is directly related to the water content based on phase relationships. The water content (w%) is not correlated with specific gravity (Gs), which is surprising given that less dense sediments would seem likely to have higher water contents. And the specific gravity (Gs) is not well correlated with the compression index (Cc), which is again surprising given that denser sediments would be expected to be less compressible.

Based on the correlation coefficients, the point weighting p_{ijk} values is shown in Table D-1-9

Table D-1-9. Weighting of variables based on correlation

point weighting	**value**
p+++ = p--- =	0.25
p++1 = p--+ =	0.24
p+-+ = p -+- =	0.03
p+-- = p-++ =	-0.02

Calculation of Expected Settlement and Likelihood of Exceeding a Given Settlement Value

Given these input values, the expected rate of settlement and standard deviations for the gas venting and sand caps are calculated are provided in Table D-1-10

Table D-1-10. Expected settlement and standard deviations for gas vent and sand cap

	Gas Vent	**Sand Cap**
E[settlement]	1.3 ft	1.0 ft
σ[settlement]	0.9 ft	0.7 ft

The likelihood that a given settlement value will be exceeded based on settlement values calculated by ERDC as well as this analysis is provided in Table D-1-11.

Table D-1-11 Likelihood of exceeding 1, 2, 3, and 4 ft of settlement

Settlement, ft	ERDC	Gas Vent 2/	Sand 3/
1	92%	63%	50%
2	68%	22%	8%
3	32%	3%	0%
4	8%	0%	0%
expected value	2.5	1.3	1
standard deviation	1.1	0.9	0.7

Notes
1/ ERDC assumes 200 psf loading
2/ 172 psf effective submerged loading
3/ 118 psf effective submerged loading

The ERDC settlement computation shows more expected settlement than the Gas Vent or Sand cap evaluation. The ERDC analysis assumes a 200 psf loading, which the Gas Vent and Sand cap analyses consider loadings of 172 and 118 psf, respectively. This difference in loading is not expected to explain the difference in settlement between the ERDC and current analyses because the difference in loading between sand and gas vent does not result in a significantly larger settlement for the gas vent cap. What does likely explain the difference is the calculated ratio of Cc / (1 + eo). By choosing the correlation between void ratio (e) and compression index (Cc) for soils of low plasticity the resultant Cc / (1 + eo) is much lower. This means that the soils of low plasticity correlation results in less predicted settlement. If this analysis had chosen the correlation between void ratio (e) and compression index (Cc) for “all clays,” the settlement calculations would have likely matched that performed by ERDC. Given the discussion above a predictive correlation was chosen as opposed to one that would result in an upper bound in the amount of settlement. Therefore the ERDC analysis is considered an upper bound in the predicted settlement and the current analysis is considered more predictive. A comparison of the Cc/(1+eo) values used by ERDC and this analysis is provided in Table D-1-12.

Table D-1-12 Comparison of Cc/(1+eo) between ERDC and this analysis

Cc / (1 + eo)	**ERDC**	**This analysis, void ratio "soils of low plasticity"**	**Void ratio "all clays"**
Expected value	0.57	0.32	0.52
Standard deviation	0.25	0.09	0.24

The distribution of total settlement along the channel alignment for the sand cap, gas vent cap, and ERDC calculated settlement is presented in Figure D-1-12, D-1-13, and D-1-14.

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Figure D-1-12. Distribution of settlement of the sand cap

Figure D-1-13. Distribution of settlement of the gas vent cap

Figure D-1-14. Distribution of cap settlement (ERDC)

TIME RATE OF SETTLEMENT

Given the site variability and limitation on collected coefficient of consolidation data, the time rate of settlement calculations are uncertain. However, we have several CPT pore water pressure dissipation tests that show the permeability of the sediment to be fairly uniform. The average

permeability is estimated to be 4.92x10-7 cm/s. The time rate of settlement calculations are estimates.

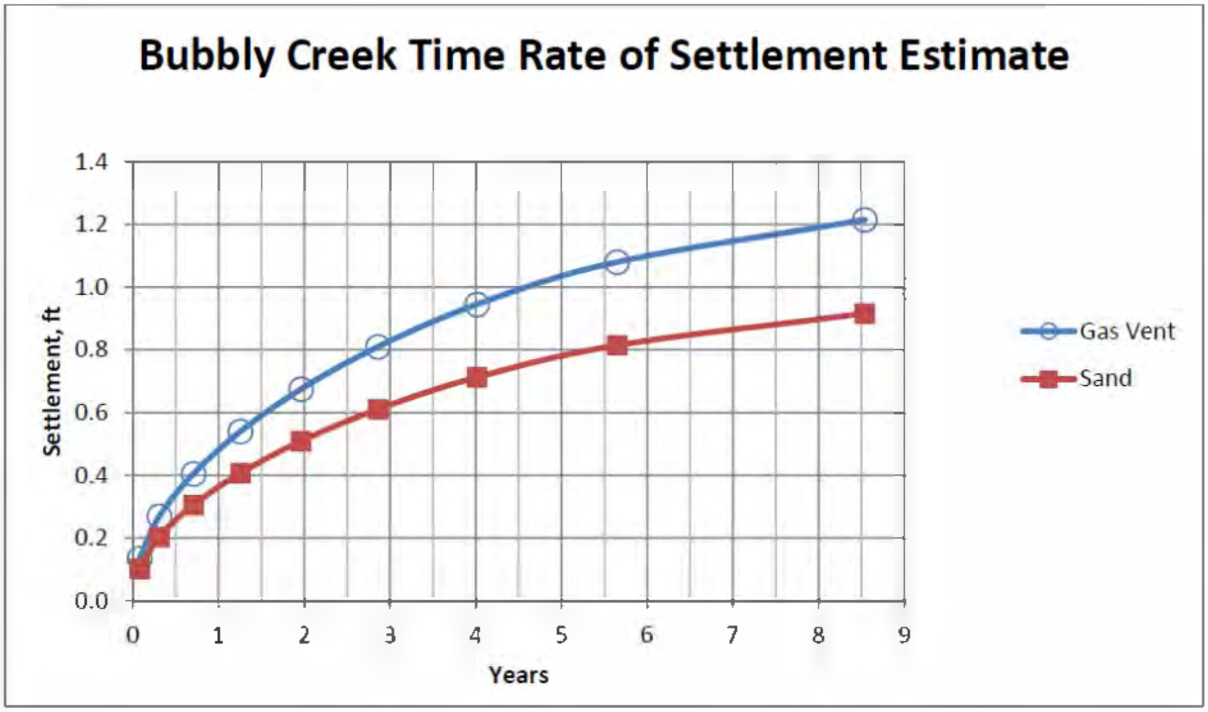
The solution for time rate of settlement is given by the following (Taylor, 1948)

$$t = T\, H_{dr}^2 / c_v$$

Where
t = settlement time, [T]
T = time factor, [d'less]
H_{dr} = drainage distance, [L]
c_v = coefficient of consolidation, [L^2T^{-1}]

The time factor taken is case I, singly drained, as described in EM 1110-1-1904 (30 Sep 1990). This is because the lower clay layer is not expected to drain. The time factors considered were for 10, 20, 30, 40, 50, 60, 70, 80, and 90% consolidation. The drainage distance is therefore taken as the thickness of the sediment layer. The coefficient of consolidation (c_v) is taken for organic silt (OH) based Holtz and Kovacs (1981) after Lowe, Zacchea, and Feldman, 1964. A sample time rate of settlement calculation is provided in Attachment D-1-2. The time rate of settlement results are summarized Figure D-1-15.

Figure D-1-15



Based on this analysis, the majority of settlement is expected to occur in 8.5 years, with half of that settlement occurring in the first 2 years. The values provided in this figure are meant be

averages over the entire site. Therefore there will be locations where more than the stated settlement occurs and others where less than the computed settlement occurs. However the purpose of this figure is to provide a representation of the average settlement to give others a planning understanding for the magnitude of site settlement.

Differential Settlement

The differential settlement analysis was performed because differential settlement has the potential to impact a geosynthetic layer, should one be chosen, or the slope of sediment sloped to vent gases. For the analysis presented herein, only a flat cap was considered both for the sand cap and the gas vent. For the sand cap this is realistic. For the gas cap this is the only analysis that can reasonably run at this time without an estimation of the invert of the sloped cap. This invert is needed based on hydraulic analyses that have yet to be run, but will likely be evaluated at a later time in the design process, should a sloped cap be considered necessary.
Differential settlement is calculated as the change in settlement between two points divided by the distance between these points.

The results of the differential settlement analyses are shown in the Figure D-1-16 and D-1-17. Both cases show very low expected differential settlement, with maximum values being in the range of 0.05%.

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Figure D-1-16

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Figure D-1-17

ERDC Comments

ERDC (Landris T. Lee) provided comments on this report in Apr 2013. Landris retired shortly thereafter and was not able to backcheck his comments. The comments and responses are provided in Attachment D-1-5.

Attachments

D-1-1 Settlement values (ERDC)
D-1-2 Time rate of settlement calculation
D-1-3 Site Data
D-1-4 Point Estimate Calculations
D-1-5 ERDC Comments (4 April 2013)

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ATTACHMENT D-1-1
Settlement values (ERDC)

CPT	lat	long	settlement (ft)	Differential Settlement from average (ft)	bottom depth	Cc/(1+eo) *
01-08x	41.82505	-87.6574	1.4186	1.9039	26.2	0.3206
02-08x	41.82534	-87.6574	4.8025	-1.48	22.8	1.0854
03-08x	41.82563	-87.6575	3.3555	-0.033	23.7	0.7584
04-08x	41.8257	-87.6581	4.6117	-1.2891	27.4	1.0423
05-08x	41.82576	-87.6578	1.3401	1.9824	24.1	0.3029
07-08x	41.82598	-87.6579	0.9554	2.3671	24.2	0.2159
09-08x	41.8259	-87.6574	1.4108	1.9117	19.9	0.3188
10-08A	41.82617	-87.6576	1.1355	2.187	22.8	0.2566
10-08B	41.82617	-87.6575	0.488	2.8345	19.5	0.1103
10-08C	41.82617	-87.6574	0.6333	2.6892	21.8	0.1431
10-08D	41.82618	-87.6573	0.9322	2.3903	21.7	0.2107
10-08E	41.82619	-87.6572	0.8805	2.442	16.8	0.1990
11-08A	41.82671	-87.6576	1.4477	1.8748	20.7	0.3272
11-08C	41.82672	-87.6574	1.303	2.0195	22.2	0.2945
11-08E	41.82674	-87.6573	1.1974	2.1251	23	0.2706
12-08A	41.82726	-87.6577	1.5159	1.8066	22.1	0.3426
12-08B	41.82727	-87.6576	1.4612	1.8614	22.3	0.3302
12-08C	41.82727	-87.6575	1.204	2.1185	22	0.2721
12-08D	41.82727	-87.6574	1.6629	1.6597	22	0.3758
12-08E	41.82728	-87.6573	0.9059	2.4167	22.6	0.2047
13-08A	41.82781	-87.6577	1.3508	1.9717	23	0.3053
13-08C	41.82782	-87.6576	1.1989	2.1236	22	0.2710
13-08E	41.82783	-87.6574	2.0173	1.3052	24.8	0.4559
14-08A	41.82836	-87.6578	1.2014	2.1211	21.3	0.2715
14-08B	41.82836	-87.6577	1.5315	1.791	21.5	0.3461
14-08C	41.82836	-87.6576	1.3169	2.0056	21.4	0.2976
14-08D	41.82837	-87.6575	1.2926	2.0299	22.1	0.2921
14-08E	41.82837	-87.6574	1.9526	1.3699	22	0.4413
15-08A	41.82892	-87.6578	1.5005	1.822	24.6	0.3391
15-08E	41.8289	-87.6574	1.7013	1.6212	24.9	0.3845
16-08A	41.82947	-87.6577	1.9978	1.3247	19.9	0.4515
16-08B	41.82946	-87.6576	1.7379	1.5846	25.2	0.3928
16-08C	41.82946	-87.6575	0.6963	2.6262	24.1	0.1574
16-08D	41.82945	-87.6574	0.9324	2.3901	20.8	0.2107
16-08E	41.82945	-87.6574	1.2126	2.1099	21.6	0.2741
17-08A	41.83001	-87.6577	1.9988	1.3237	21.2	0.4517
17-08B	41.83001	-87.6576	1.5437	1.7788	21.2	0.3489
17-08C	41.83	-87.6575	1.5437	1.7788	21.2	0.3489
17-08E	41.83	-87.6573	0.6632	2.6594	24	0.1499
18-08A	41.83048	-87.6576	1.6628	1.6597	24.1	0.3758
18-08B	41.83048	-87.6575	1.7613	1.5613	23.3	0.3981
18-08C	41.83048	-87.6574	1.4462	1.8763	21.8	0.3269
18-08D	41.83047	-87.6574	1.1072	2.2153	20.9	0.2502
18-08E	41.83048	-87.6572	1.2717	2.0508	22.3	0.2874
19-08A	41.83084	-87.6576	3.4859	-0.1634	23.6	0.7878
19-08C	41.83083	-87.6574	2.7993	0.5232	23.7	0.6327
19-08E	41.83082	-87.6572	2.739	0.5835	17	0.6190
20-08A	41.83111	-87.6576	2.2308	1.0918	19.8	0.5042
20-08B	41.83111	-87.6575	1.909	1.4136	21.6	0.4314
20-08C	41.8311	-87.6574	2.8396	0.4829	21.4	0.6418
20-08D	41.8311	-87.6573	3.0351	0.2874	23.7	0.6860

*Cc/(1+eo) values calculated by LRC
based on values provided by Olsen
200 psf load
10 ft layer thickness

note that the unit weight of sediment is
assumed to be 85 pcf based on
previous LRC computations

column added by LRC

CPT	lat	long	settlement (ft)	Differential Settlement from average (ft)	bottom depth	Cc/(1+eo) *
20-08E	41.83109	-87.6572	2.6649	0.6576	21.3	0.6023
21-08A	41.83149	-87.6578	1.2474	2.0752	18.1	0.2819
21-08C	41.83157	-87.6577	2.3273	0.9952	21.2	0.5260
21-08E	41.83165	-87.6575	2.0471	1.2754	22.9	0.4627
22-08A	41.83194	-87.6583	1.7894	1.5331	24	0.4044
22-08C	41.83202	-87.6581	2.6667	0.6558	20.9	0.6027
22-08D	41.83206	-87.658	3.1767	0.1458	22.7	0.7180
22-08E	41.8321	-87.658	3.7505	-0.428	20.8	0.8476
23-08A	41.83239	-87.6587	1.7952	1.5273	20.3	0.4057
23-08C	41.83248	-87.6585	2.4737	0.8488	19	0.5591
23-08E	41.83257	-87.6584	3.4201	-0.0976	16.9	0.7730
24-08A	41.83285	-87.6591	1.9905	1.332	19.1	0.4499
24-08B	41.83288	-87.659	1.8656	1.4569	19.2	0.4216
24-08C	41.83293	-87.6589	5.0542	-1.7317	22.4	1.1423
24-08D	41.83297	-87.6589	1.8541	1.4684	18.5	0.4190
24-08E	41.83301	-87.6588	2.4523	0.8702	21	0.5542
25-08A	41.8333	-87.6595	2.7839	0.5386	19.3	0.6292
25-08C	41.83338	-87.6594	1.5281	1.7944	15.4	0.3454
25-08E	41.83346	-87.6592	2.0374	1.2852	17.4	0.4605
26-08A	41.83375	-87.6599	1.8617	1.4608	22.4	0.4208
26-08B	41.83379	-87.6598	2.115	1.2075	21.1	0.4780
26-08C	41.83383	-87.6598	1.9188	1.4037	20.6	0.4337
26-08D	41.83387	-87.6597	1.6114	1.7111	17.8	0.3642
26-08E	41.83391	-87.6596	1.8335	1.489	21.5	0.4144
27-08A	41.83416	-87.6603	2.3124	1.0101	23	0.5226
27-08C	41.83427	-87.6602	1.9848	1.3378	23.5	0.4486
27-08E	41.83438	-87.6601	1.8532	1.4693	21.7	0.4188
28-08A	41.83448	-87.6609	2.6581	0.6644	14.1	0.6007
28-08B	41.83454	-87.6609	3.9942	-0.6717	23.4	0.9027
28-08C	41.83459	-87.6608	3.4571	-0.1345	23.1	0.7813
28-08D	41.83465	-87.6607	3.4455	-0.1229	21.9	0.7787
28-08E	41.8347	-87.6607	3.3595	-0.037	22.8	0.7593
29-08A	41.83488	-87.6615	0.9446	2.3779	13	0.2135
29-08C	41.83495	-87.6613	3.6692	-0.3467	22.1	0.8293
29-08E	41.83501	-87.6612	2.48	0.8425	13.3	0.5605
30-08A	41.83533	-87.6619	2.3422	0.9803	11.9	0.5294
30-08B	41.83536	-87.6618	2.7796	0.5429	14.9	0.6282
30-08C	41.83539	-87.6618	4.2906	-0.9681	20.6	0.9697
30-08D	41.83543	-87.6617	3.5527	-0.2302	22.3	0.8029
30-08E	41.83546	-87.6617	4.1053	-0.7828	14.1	0.9278
31-08A	41.83577	-87.6623	2.9276	0.3949	17.8	0.6617
31-08C	41.83584	-87.6622	2.975	0.3476	21.4	0.6724
31-08E	41.83591	-87.6621	3.5102	-0.1877	17.9	0.7933
32-08A	41.83622	-87.6628	0.6306	2.692	10.6	0.1425
32-08B	41.83625	-87.6627	3.4845	-0.1619	20.5	0.7875
32-08C	41.83629	-87.6626	3.3608	-0.0383	21.7	0.7596
32-08D	41.83632	-87.6626	2.6228	0.6997	13.9	0.5928
32-08E	41.83635	-87.6625	2.608	0.7145	18.6	0.5894
33-08A	41.83672	-87.6631	2.7404	0.5821	19	0.6193
33-08C	41.83675	-87.663	4.0716	-0.7491	22.7	0.9202
33-08E	41.83679	-87.6629	3.1439	0.1786	22.3	0.7105
34-08A	41.83724	-87.6634	2.4987	0.8238	14.7	0.5647

CPT	lat	long	settlement (ft)	Differential Settlement from average (ft)	bottom depth	Cc/(1+eo) *
34-08B	41.83726	-87.6633	3.5916	-0.2691	21.1	0.8117
34-08C	41.83728	-87.6632	3.314	0.0085	22.7	0.7490
34-08D	41.8373	-87.6631	4.1624	-0.8399	21.2	0.9407
34-08E	41.83732	-87.663	2.4853	0.8372	17.8	0.5617
35-08A	41.83775	-87.6636	5.383	-2.0605	12	1.2166
35-08C	41.83781	-87.6634	3.4502	-0.1277	22.5	0.7798
35-08E	41.83787	-87.6633	2.1441	1.1784	21.1	0.4846
36-08A	41.83824	-87.6639	3.1072	0.2153	22.3	0.7022
36-08B	41.83827	-87.6638	3.4343	-0.1118	21.4	0.7762
36-08C	41.8383	-87.6637	3.3937	-0.0711	23.1	0.7670
36-08D	41.83833	-87.6636	3.6257	-0.3032	22.3	0.8194
36-08E	41.83836	-87.6636	2.179	1.1435	18.2	0.4925
37-08A	41.83891	-87.6642	1.4759	1.8466	22.3	0.3336
37-08C	41.8388	-87.664	3.8448	-0.5222	22.5	0.8689
37-08E	41.83886	-87.6639	1.8127	1.5099	13.1	0.4097
38-08A	41.83923	-87.6645	1.3632	1.9593	10.5	0.3081
38-08B	41.83927	-87.6644	2.9124	0.4101	20	0.6582
38-08C	41.8393	-87.6644	3.1765	0.146	20.8	0.7179
38-08D	41.83933	-87.6643	2.4947	0.8279	20	0.5638
38-08E	41.83936	-87.6642	1.3709	1.9516	12	0.3098
39-08A	41.83982	-87.6647	3.308	0.0146	20.4	0.7476
39-08C	41.83982	-87.6645	3.2993	0.0232	21.9	0.7457
39-08E	41.83983	-87.6643	3.115	0.2075	19.8	0.7040
40-08A	41.84037	-87.6647	3.7443	-0.4217	20.1	0.8462
40-08B	41.84037	-87.6646	4.3872	-1.0647	23.5	0.9915
40-08C	41.84037	-87.6645	3.8466	-0.5241	23.7	0.8694
40-08D	41.84037	-87.6644	2.8502	0.4723	22.6	0.6442
40-08E	41.84038	-87.6644	2.6229	0.6996	21.1	0.5928
41-08A	41.84085	-87.6648	3.7303	-0.4078	20.5	0.8431
41-08C	41.84091	-87.6647	3.9052	-0.5826	21.6	0.8826
41-08E	41.84096	-87.6645	1.2323	2.0902	9.2	0.2785
42-08A	41.84136	-87.6651	2.5811	0.7414	21.7	0.5833
42-08B	41.84139	-87.665	3.7019	-0.3794	21.7	0.8367
42-08C	41.84142	-87.6649	2.9622	0.3603	21.8	0.6695
42-08D	41.84144	-87.6648	3.7986	-0.4761	17.4	0.8585
42-08E	41.84147	-87.6648	2.3691	0.9534	10.9	0.5354
43-08A	41.84198	-87.665	3.5112	-0.1887	20.7	0.7936
43-08C	41.84192	-87.6648	4.9676	-1.6451	23.4	1.1227
43-08E	41.84187	-87.6646	2.2628	1.0597	18.5	0.5114
44-08B	41.84246	-87.6646	5.349	-2.0264	18.1	1.2089
44-08C	41.84243	-87.6645	4.1193	-0.7967	25.5	0.9310
44-08D	41.8424	-87.6644	3.5345	-0.212	25.5	0.7988
44-08E	41.84237	-87.6644	2.488	0.8345	19.6	0.5623
46-08x	41.84296	-87.6641	3.5477	-0.2252	25.3	0.8018
48-08x	41.84353	-87.6638	3.627	-0.3045	24.5	0.8197
50-08x	41.84407	-87.6639	3.9317	-0.6092	24.1	0.8886
51-08x	41.8441	-87.6636	3.4215	-0.099	24.9	0.7733
52-08x	41.84317	-87.6645	3.2709	0.0516	22.2	0.7392
53-08x	41.84299	-87.665	2.4548	0.8678	21.4	0.5548
55-08x	41.84335	-87.6654	2.6701	0.6524	28.2	0.6035
56-08x	41.84346	-87.6652	2.2037	1.1188	28.8	0.4980
61-08x	41.84377	-87.6653	2.2966	1.0259	28	0.5190

Backing out

$\frac{C_c}{1+e_o}$ from olsen analysis.

Note that this value was requested from Olson but there was no response

assume $\gamma = 85 \; \frac{lb}{ft^2}$

$\Delta\sigma = 200 \; lb/ft^2$

$H = 10 ft$

} based on info provided from Olson via email

$$\delta = \frac{C_c}{1+e_o} H \log\left(\frac{\sigma + \Delta\sigma}{\sigma}\right)$$

$$\sigma = 5ft \times (85 - 62.4 \; lb/ft)$$

$$= 113 \; lb/ft^2$$

$$\frac{C_c}{1+e_o} = \frac{\frac{S}{H}}{\log\left(\frac{\sigma + \Delta\sigma}{\sigma}\right)}$$

Sample calculation

CPT 01-08 $\quad s = 1.4186$

$H = 10\,ft$

$\sigma = 113\ lb/ft^2$

$\Delta\sigma = 200\ lb/ft^2$

$$\frac{C_c}{1+e_0} = \frac{\frac{1.4186}{10}}{\log\left(\frac{200+113}{113}\right)} = 0.3206$$ ✓

ATTACHMENT D-1-2

Time rate of settlement calculation

Project: Bubbly Creek Feasibility Study - Chicago, IL
Horizontal System: Illinois State Plane (NAD 83)
Vertical System: North American Vertical Datum (NAVD 88)
Drilling Firm: STS Exploration (AECOM)

	1	2	3
	Cc	**w%**	**Gs**
E[x]	1.00	84.0%	2.19
σ[x]	0.73	41.6%	0.3
E[x]+σ[x]	1.7	125.6%	2.5
E[x]-σ[x]	0.3	42.5%	1.9

Settlement Calculator

Δσ	118	psf
1 Cc	1.0	
2 w%	84.0%	
3 Gs	2.19	
eo	1.84	
unit wt sediment	89	pcf
Cc/(1+eo)	0.35	

cv 20.4 ft2/yr

	value	description
ρ12	1.0	Cc and w%
ρ23	-0.08	w% and Gs
ρ31	0.141	Gs and Cc

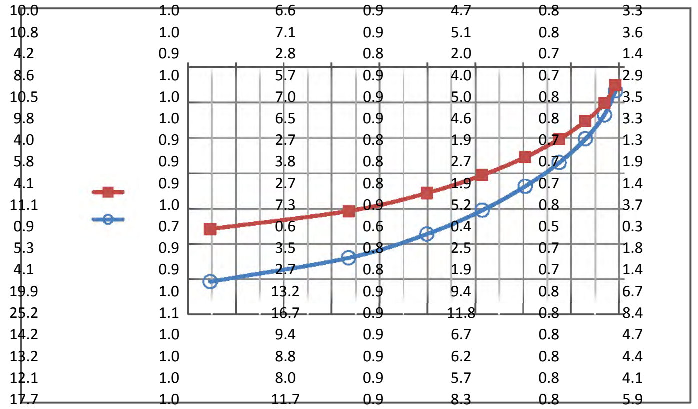
point weighting	value
p+++ = p--- =	0.25
p++1 = p--+ =	0.24
p+-+ = p-+- =	0.03
p+-- = p-++ =	-0.02

Boring/CPT Number	Date Drilled	Hole Depth (ft)	Elevation* (ft)	Depth of Water** (ft)	Northing (ft)	Easting (ft)	Sediment thickness	σ'	σ' + Δσ	s, ft	T 0.857 90%	s, ft	0.567 80%	s, ft	0.403 70%	s, ft	0.287 60%	s, ft	0.197 50%	s, ft	0.126 40%	s, ft	0.071 30%	s, ft	0.031 20%	s, ft	0.008 10%	s, ft
1-08	9/5/2008	26.35	575.43	23.8	1,879,562.60	1,168,490.60	2.55	33.3	151.3	0.59	0.3	0.5	0.2	0.5	0.1	0.4	0.1	0.4	0.1	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.1
2-08	9/5/2008	22.87	575.43	22	1,879,669.30	1,168,470.00	0.87	11.4	129.4	0.32	0.0	0.3	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
3-08	9/5/2008	23.79	575.43	16.1	1,879,775.60	1,168,450.50	7.69	100.5	218.5	0.91	2.5	0.8	1.6	0.7	1.2	0.6	0.8	0.5	0.6	0.5	0.4	0.4	0.2	0.3	0.1	0.2	0.0	0.1
4-08	9/5/2008	27.53	575.43	18.2	1,879,800.20	1,168,293.70	9.33	122.0	240.0	0.97	3.7	0.9	2.4	0.8	1.7	0.7	1.2	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
5-08	9/5/2008	24.21	575.43	3.6	1,879,820.20	1,168,367.10	20.61	269.5	387.5	1.14	17.8	1.0	11.8	0.9	8.4	0.8	6.0	0.7	4.1	0.6	2.6	0.5	1.5	0.3	0.6	0.2	0.2	0.1
7-08	9/5/2008	24.28	575.43	1.7	1,879,899.70	1,168,344.40	22.58	295.2	413.2	1.16	21.4	1.0	14.2	0.9	10.1	0.8	7.2	0.7	4.9	0.6	3.1	0.5	1.8	0.3	0.8	0.2	0.2	0.1
9-08	9/8/2008	20.01	575.62	2.9	1,879,873.70	1,168,469.10	17.11	223.7	341.7	1.11	12.3	1.0	8.1	0.9	5.8	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
10-08A	9/5/2008	22.87	575.43	4.3	1,879,969.40	1,168,427.60	18.57	242.8	360.8	1.12	14.5	1.0	9.6	0.9	6.8	0.8	4.9	0.7	3.3	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
10-08B	9/5/2008	19.59	575.43	3.5	1,879,970.70	1,168,452.60	16.09	210.4	328.4	1.10	10.9	1.0	7.2	0.9	5.1	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
10-08D	9/8/2008	21.82	575.62	2.4	1,879,974.40	1,168,502.80	19.42	253.9	371.9	1.13	15.8	1.0	10.5	0.9	7.5	0.8	5.3	0.7	3.6	0.6	2.3	0.5	1.3	0.3	0.6	0.2	0.1	0.1
10-08E	9/8/2008	16.86	575.62	2.1	1,879,977.50	1,168,528.40	14.76	193.0	311.0	1.08	9.2	1.0	6.1	0.9	4.3	0.8	3.1	0.6	2.1	0.5	1.3	0.4	0.8	0.3	0.3	0.2	0.1	0.1
11-08A	9/8/2008	20.83	575.62	4.5	1,880,166.60	1,168,412.40	16.33	213.5	331.5	1.10	11.2	1.0	7.4	0.9	5.3	0.8	3.8	0.7	2.6	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
11-08C	9/5/2008	22.31	575.43	4	1,880,172.40	1,168,461.90	18.31	239.4	357.4	1.12	14.1	1.0	9.3	0.9	6.6	0.8	4.7	0.7	3.2	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
11-08E	9/8/2008	23.1	575.62	3.1	1,880,178.30	1,168,512.00	20	261.5	379.5	1.14	16.8	1.0	11.1	0.9	7.9	0.8	5.6	0.7	3.9	0.6	2.5	0.5	1.4	0.3	0.6	0.2	0.2	0.1
12-08A	9/3/2008	22.21	575.02	4.2	1,880,367.50	1,168,396.70	18.01	235.5	353.5	1.12	13.6	1.0	9.0	0.9	6.4	0.8	4.6	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
12-08C	9/3/2008	22.15	575.02	5	1,880,371.60	1,168,446.50	17.15	224.2	342.2	1.11	12.4	1.0	8.2	0.9	5.8	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
12-08D	9/3/2008	22.11	575.02	4.6	1,880,372.70	1,168,471.40	17.51	228.9	346.9	1.11	12.9	1.0	8.5	0.9	6.1	0.8	4.3	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
13-08A	9/3/2008	23.1	575.02	3.9	1,880,566.90	1,168,380.40	19.2	251.0	369.0	1.13	15.5	1.0	10.2	0.9	7.3	0.8	5.2	0.7	3.6	0.6	2.3	0.5	1.3	0.3	0.6	0.2	0.1	0.1
13-08C	9/3/2008	22.15	575.02	3.7	1,880,570.80	1,168,430.10	18.45	241.2	359.2	1.12	14.3	1.0	9.5	0.9	6.7	0.8	4.8	0.7	3.3	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
13-08E	9/3/2008	24.9	575.02	5.4	1,880,575.40	1,168,480.20	19.5	255.0	373.0	1.13	16.0	1.0	10.6	0.9	7.5	0.8	5.3	0.7	3.7	0.6	2.3	0.5	1.3	0.3	0.6	0.2	0.1	0.1
14-08A	9/3/2008	21.42	575.02	4.6	1,880,767.90	1,168,365.20	16.82	219.9	337.9	1.10	11.9	1.0	7.9	0.9	5.6	0.8	4.0	0.7	2.7	0.6	1.7	0.4	1.0	0.3	0.4	0.2	0.1	0.1
14-08B	9/2/2008	21.65	575.48	4.5	1,880,768.10	1,168,389.10	17.15	224.2	342.2	1.11	12.4	1.0	8.2	0.9	5.8	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
14-08C	9/3/2008	21.56	575.02	4.3	1,880,770.50	1,168,415.20	17.26	225.7	343.7	1.11	12.5	1.0	8.3	0.9	5.9	0.8	4.2	0.7	2.9	0.6	1.8	0.4	1.0	0.3	0.5	0.2	0.1	0.1
14-08D	9/3/2008	22.21	575.02	4.5	1,880,772.50	1,168,439.80	17.71	231.6	349.6	1.12	13.2	1.0	8.7	0.9	6.2	0.8	4.4	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
14-08E	9/3/2008	22.11	575.02	5.3	1,880,774.40	1,168,464.00	16.81	219.8	337.8	1.10	11.9	1.0	7.9	0.9	5.6	0.8	4.0	0.7	2.7	0.6	1.7	0.4	1.0	0.3	0.4	0.2	0.1	0.1
15-08A	9/2/2008	24.74	575.48	4.6	1,880,972.50	1,168,368.10	20.14	263.3	381.3	1.14	17.0	1.0	11.3	0.9	8.0	0.8	5.7	0.7	3.9	0.6	2.5	0.5	1.4	0.3	0.6	0.2	0.2	0.1
15-08C	9/2/2008	25.16	575.48	5.1	1,880,969.20	1,168,417.80	20.06	262.3	380.3	1.14	16.9	1.0	11.2	0.9	7.9	0.8	5.7	0.7	3.9	0.6	2.5	0.5	1.4	0.3	0.6	0.2	0.2	0.1
15-08E	9/2/2008	25	575.48	4.6	1,880,966.30	1,168,467.40	20.4	266.7	384.7	1.14	17.5	1.0	11.6	0.9	8.2	0.8	5.9	0.7	4.0	0.6	2.6	0.5	1.4	0.3	0.6	0.2	0.2	0.1
16-08A	9/2/2008	20.05	575.48	6	1,881,171.80	1,168,380.00	14.05	183.7	301.7	1.07	8.3	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
16-08B	9/2/2008	25.26	575.48	4.8	1,881,170.90	1,168,406.60	20.46	267.5	385.5	1.14	17.6	1.0	11.6	0.9	8.3	0.8	5.9	0.7	4.0	0.6	2.6	0.5	1.5	0.3	0.6	0.2	0.2	0.1
16-08C	9/2/2008	24.21	575.48	6.3	1,881,168.90	1,168,430.60	17.91	234.2	352.2	1.12	13.5	1.0	8.9	0.9	6.3	0.8	4.5	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
16-08D	9/2/2008	20.9	575.48	5.6	1,881,167.60	1,168,455.80	15.3	200.0	318.0	1.08	9.8	1.0	6.5	0.9	4.6	0.8	3.3	0.7	2.3	0.5	1.4	0.4	0.8	0.3	0.4	0.2	0.1	0.1
17-08A	9/2/2008	21.29	575.48	6.4	1,881,371.30	1,168,394.10	14.89	194.7	312.7	1.08	9.3	1.0	6.2	0.9	4.4	0.8	3.1	0.6	2.1	0.5	1.4	0.4	0.8	0.3	0.3	0.2	0.1	0.1
17-08B	9/2/2008	21.33	575.48	4.8	1,881,370.70	1,168,419.50	16.53	216.1	334.1	1.10	11.5	1.0	7.6	0.9	5.4	0.8	3.8	0.7	2.6	0.6	1.7	0.4	1.0	0.3	0.4	0.2	0.1	0.1
17-08C	9/2/2008	21.33	575.48	4.6	1,881,368.10	1,168,443.90	16.73	218.7	336.7	1.10	11.8	1.0	7.8	0.9	5.5	0.8	3.9	0.7	2.7	0.6	1.7	0.4	1.0	0.3	0.4	0.2	0.1	0.1
17-08E	9/2/2008	24.15	575.48	4.4	1,881,366.10	1,168,494.00	19.75	258.2	376.2	1.14	16.4	1.0	10.8	0.9	7.7	0.8	5.5	0.7	3.8	0.6	2.4	0.5	1.4	0.3	0.6	0.2	0.2	0.1
18-08A	8/29/2008	24.21	575.21	5.9	1,881,540.10	1,168,408.20	18.31	239.4	357.4	1.12	14.1	1.0	9.3	0.9	6.6	0.8	4.7	0.7	3.2	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
18-08B	8/29/2008	23.39	575.21	5.5	1,881,541.80	1,168,437.10	17.89	233.9	351.9	1.12	13.4	1.0	8.9	0.9	6.3	0.8	4.5	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
18-08C	8/29/2008	21.88	575.21	4.9	1,881,540.90	1,168,457.30	16.98	222.0	340.0	1.11	12.1	1.0	8.0	0.9	5.7	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
18-08D	8/29/2008	20.96	575.21	3.5	1,881,539.60	1,168,478.00	17.46	228.3	346.3	1.11	12.8	1.0	8.5	0.9	6.0	0.8	4.3	0.7	2.9	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
18-08E	8/29/2008	22.38	575.21	2.9	1,881,540.90	1,168,507.70	19.48	254.7	372.7	1.13	15.9	1.0	10.5	0.9	7.5	0.8	5.3	0.7	3.7	0.6	2.3	0.5	1.3	0.3	0.6	0.2	0.1	0.1
19-08A	8/28/2008	23.69	575.15	12.2	1,881,671.40	1,168,414.00	11.49	150.2	268.2	1.02	5.5	0.9	3.7	0.8	2.6	0.7	1.9	0.6	1.3	0.5	0.8	0.4	0.5	0.3	0.2	0.2	0.1	0.1
19-08C	8/28/2008	23.85	575.15	10.2	1,881,667.90	1,168,465.00	13.65	178.5	296.5	1.06	7.8	1.0	5.2	0.8	3.7	0.7	2.6	0.6	1.8	0.5	1.2	0.4	0.6	0.3	0.3	0.2	0.1	0.1
19-08E	8/28/2008	17.06	575.15	4.6	1,881,665.70	1,168,515.50	12.46	162.9	280.9	1.04	6.5	0.9	4.3	0.8	3.1	0.7	2.2	0.6	1.5	0.5	1.0	0.4	0.5	0.3	0.2	0.2	0.1	0.1
20-08A	8/28/2008	19.95	575.15	2.7	1,881,770.00	1,168,421.00	17.25	225.5	343.5	1.11	12.5	1.0	8.3	0.9	5.9	0.8	4.2	0.7	2.9	0.6	1.8	0.4	1.0	0.3	0.5	0.2	0.1	0.1
20-08B	8/28/2008	21.72	575.15	4	1,881,770.00	1,168,445.80	17.72	231.7	349.7	1.12	13.2	1.0	8.7	0.9	6.2	0.8	4.4	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
20-08C	8/28/2008	21.46	575.15	8.2	1,881,767.50	1,168,470.60	13.26	173.4	291.4	1.05	7.4	0.9	4.9	0.8	3.5	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1
20-08D	8/28/2008	23.85	575.15	9.8	1,881,766.90	1,168,495.70	14.05	183.7	301.7	1.07	8.3	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
20-08E	8/28/2008	21.36	575.15	7.2	1,881,765.10	1,168,521.20	14.16	185.1	303.1	1.07	8.4	1.0	5.6	0.9	4.0	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
21-08A	8/28/2008	18.24	575.15	2.3	1,881,910.10	1,168,341.20	15.94	208.4	326.4	1.09	10.7	1.0	7.1	0.9	5.0	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
21-08C	8/28/2008	21.33	575.15	6.5	1,881,938.50	1,168,382.30	14.83	193.9	311.9	1.08	9.2	1.0	6.1	0.9	4.3	0.8	3.1	0.6	2.1	0.5	1.4	0.4	0.8	0.3	0.3	0.2	0.1	0.1
21-08E	8/28/2008	22.97	575.15	14.1	1,881,969.20	1,168,422.10	8.87	116.0	234.0	0.95	3.3	0.9	2.2	0.8	1.6	0.7	1.1	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
22-08A	8/28/2008	24.11	575.15	2	1,882,072.80	1,168,227.60	22.11	289.1	407.1	1.16	20.5	1.0	13.6	0.9	9.7	0.8	6.9	0.7	4.7	0.6	3.0	0.5	1.7	0.3	0.7	0.2	0.2	0.1
22-08B	8/28/2008	20.83	575.15	3.7	1,882,087.00	1,168,247.40	17.13	224.0	342.0	1.11	12.3	1.0	8.2	0.9	5.8	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
22-08C	8/27/2008	21	575.6	6.6	1,882,102.80	1,168,267.30	14.4	188.3	306.3	1.07	8.7	1.0	5.8	0.9	4.1	0.8	2.9	0.7	2.0	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
22-08D	8/27/2008	22.8	575.6	8.7	1,882,117.50	1,168,288.70	14.1	184.4	302.4	1.07	8.4	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
22-08E	8/27/2008	20.87	575.6	11.3	1,882,132.50	1,168,308.60	9.57	125.1	243.1	0.97	3.8	0.9	2.5	0.8	1.8	0.7	1.3	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
23-08A	8/27/2008	20.41	575.6	4.6	1,882,236.20	1,168,112.70	15.81	206.7	324.7	1.09	10.5	1.0	6.9	0.9	4.9	0.8	3.5	0.7	2.4	0.5	1.5	0.4	0.9	0.3	0.4	0.2	0.1	0.1
23-08C	8/27/2008	19.09	575.6	5.7	1,882,266.50	1,168,153.40	13.39	175.1	293.1	1.06	7.5	0.9	5.0	0.8	3.5	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1
23-08E	8/27/2008	16.96	575.6	9.6	1,882,301.00	1,168,190.50	7.36	96.2	214.2	0.90	2.3	0.8	1.5	0.7	1.1	0.6	0.8	0.5	0.5	0.5	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.1
24-08A	8/27/2008	19.23	575.6	5	1,882,400.90	1,167,998.20	14.23	186.1	304.1	1.07	8.5	1.0	5.6	0.9	4.0	0.7	2.8	0.6	2.0	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
24-08B	8/27/2008	19.29	575.6	5.3	1,882,414.70	1,168,018.00	13.99	182.9	300.9	1.07	8.2	1.0	5.4	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
24-08C	8/27/2008	22.47	575.6	5.8	1,882,430.30	1,168,037.90	16.67	218.0	336.0	1.10	11.7	1.0	7.7	0.9	5.5	0.8	3.9	0.7	2.7	0.6	1.7	0.4	1.0	0.3	0.4	0.2	0.1	0.1
24-08D	8/27/2008	18.6	575.6	6.2	1,882,446.70	1,168,058.60	12.4	162.1	280.1	1.04	6.5	0.9	4.3	0.8	3.0	0.7	2.2	0.6	1.5	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
24-08E	8/27/2008	21.13	575.6	5.7	1,882,460.10	1,168,078.70	15.43	201.7	319.7	1.09	10.0	1.0	6.6	0.9	4.7	0.8	3.3	0.7	2.3	0.5	1.5	0.4	0.8	0.3	0.4	0.2	0.1	0.1
25-08A	8/27/2008	19.36	575.6	5.9	1,882,563.90	1,167,882.40	13.46	176.0	294.0	1.06	7.6	1.0	5.0	0.8	3.6	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1

Boring/CPT Number	Date Drilled	Hole Depth (ft)	Elevation* (ft)	Depth of Water** (ft)	Northing (ft)	Easting (ft)	Sediment thickness	σ'	σ' + Δσ	s, ft	90%	s, ft	80%	s, ft	70%	s, ft	60%	s, ft	50%	s, ft	40%	s, ft	30%	s, ft	20%	s, ft	10%	s, ft
25-08C	8/27/2008	15.52	575.6	5.4	1,882,594.10	1,167,923.90	10.12	132.3	250.3	0.99	4.3	0.9	2.8	0.8	2.0	0.7	1.4	0.6	1.0	0.5	0.6	0.4	0.4	0.3	0.2	0.2	0.0	0.1
25-08E	8/27/2008	17.52	575.6	4.6	1,882,622.80	1,167,964.80	12.92	168.9	286.9	1.05	7.0	0.9	4.6	0.8	3.3	0.7	2.3	0.6	1.6	0.5	1.0	0.4	0.6	0.3	0.3	0.2	0.1	0.1
26-08A	8/26/2008	22.54	575.07	6.6	1,882,728.20	1,167,768.90	15.94	208.4	326.4	1.09	10.7	1.0	7.1	0.9	5.0	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
26-08B	8/26/2008	21.2	575.07	5.4	1,882,743.10	1,167,789.10	15.8	206.6	324.6	1.09	10.5	1.0	6.9	0.9	4.9	0.8	3.5	0.7	2.4	0.5	1.5	0.4	0.9	0.3	0.4	0.2	0.1	0.1
26-08C	8/26/2008	20.67	575.07	4.6	1,882,758.30	1,167,809.10	16.07	210.1	328.1	1.10	10.8	1.0	7.2	0.9	5.1	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
26-08D	8/26/2008	17.95	575.07	4.7	1,882,773.20	1,167,828.70	13.25	173.2	291.2	1.05	7.4	0.9	4.9	0.8	3.5	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1
26-08E	8/26/2008	21.65	575.07	4.4	1,882,788.10	1,167,849.30	17.25	225.5	343.5	1.11	12.5	1.0	8.3	0.9	5.9	0.8	4.2	0.7	2.9	0.6	1.8	0.4	1.0	0.3	0.5	0.2	0.1	0.1
27-08A	8/26/2008	23.13	575.07	6	1,882,874.80	1,167,658.60	17.13	224.0	342.0	1.11	12.3	1.0	8.2	0.9	5.8	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
27-08C	8/26/2008	23.59	575.07	5.1	1,882,916.00	1,167,688.70	18.49	241.8	359.8	1.12	14.4	1.0	9.5	0.9	6.8	0.8	4.8	0.7	3.3	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
27-08E	8/26/2008	21.82	575.07	4.3	1,882,958.20	1,167,716.60	17.52	229.1	347.1	1.11	12.9	1.0	8.5	0.9	6.1	0.8	4.3	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
28-08A	8/26/2008	14.24	575.07	7.6	1,882,992.00	1,167,497.60	6.64	86.8	204.8	0.87	1.9	0.8	1.2	0.7	0.9	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.3	0.1	0.2	0.0	0.1
28-08B	8/26/2008	23.52	575.07	9.8	1,883,014.20	1,167,512.60	13.72	179.4	297.4	1.06	7.9	1.0	5.2	0.8	3.7	0.7	2.6	0.6	1.8	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
28-08C	8/26/2008	23.23	575.07	12	1,883,033.60	1,167,527.10	11.23	146.8	264.8	1.01	5.3	0.9	3.5	0.8	2.5	0.7	1.8	0.6	1.2	0.5	0.8	0.4	0.4	0.3	0.2	0.2	0.0	0.1
28-08D	8/25/2008	21.98	575.17	11.3	1,883,055.40	1,167,542.70	10.68	139.6	257.6	1.00	4.8	0.9	3.2	0.8	2.3	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
28-08E	8/25/2008	22.93	575.17	8.5	1,883,073.90	1,167,556.60	14.43	188.7	306.7	1.07	8.7	1.0	5.8	0.9	4.1	0.8	2.9	0.6	2.0	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
29-08A	8/25/2008	13.06	575.17	9.7	1,883,137.10	1,167,342.10	3.36	43.9	161.9	0.67	0.5	0.6	0.3	0.5	0.2	0.5	0.2	0.4	0.1	0.3	0.1	0.3	0.0	0.2	0.0	0.1	0.0	0.1
29-08C	8/25/2008	22.24	575.17	12.4	1,883,161.20	1,167,375.50	9.84	128.7	246.7	0.98	4.1	0.9	2.7	0.8	1.9	0.7	1.4	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
29-08E	8/25/2008	13.42	575.17	10.2	1,883,184.60	1,167,407.30	3.22	42.1	160.1	0.66	0.4	0.6	0.3	0.5	0.2	0.5	0.1	0.4	0.1	0.3	0.1	0.3	0.0	0.2	0.0	0.1	0.0	0.1
30-08A	8/25/2008	11.98	575.17	9.6	1,883,299.00	1,167,224.10	2.38	31.1	149.1	0.57	0.2	0.5	0.2	0.5	0.1	0.4	0.1	0.3	0.1	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.1
30-08B	8/25/2008	14.99	575.17	10.2	1,883,310.70	1,167,241.60	4.79	62.6	180.6	0.78	1.0	0.7	0.6	0.6	0.5	0.5	0.3	0.5	0.2	0.4	0.1	0.3	0.1	0.2	0.0	0.2	0.0	0.1
30-08C	8/25/2008	20.67	575.17	13.7	1,883,323.40	1,167,257.10	6.97	91.1	209.1	0.89	2.0	0.8	1.4	0.7	1.0	0.6	0.7	0.5	0.5	0.4	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.1
30-08D	8/25/2008	22.38	575.17	13.4	1,883,334.80	1,167,272.30	8.98	117.4	235.4	0.96	3.4	0.9	2.2	0.8	1.6	0.7	1.1	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
30-08E	8/25/2008	14.24	575.17	9.2	1,883,346.40	1,167,288.30	5.04	65.9	183.9	0.79	1.1	0.7	0.7	0.6	0.5	0.6	0.4	0.5	0.2	0.4	0.2	0.3	0.1	0.2	0.0	0.2	0.0	0.1
31-08A	8/25/2008	17.88	575.17	11	1,883,460.40	1,167,106.40	6.88	90.0	208.0	0.88	2.0	0.8	1.3	0.7	0.9	0.6	0.7	0.5	0.5	0.4	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.1
31-08C	8/25/2008	21.49	575.17	11.2	1,883,483.50	1,167,138.40	10.29	134.5	252.5	0.99	4.4	0.9	2.9	0.8	2.1	0.7	1.5	0.6	1.0	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
31-08E	8/25/2008	18.01	575.17	10.6	1,883,508.80	1,167,170.30	7.41	96.9	214.9	0.90	2.3	0.8	1.5	0.7	1.1	0.6	0.8	0.5	0.5	0.5	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.1
32-08A	8/25/2008	10.73	575.17	7.5	1,883,621.80	1,166,988.00	3.23	42.2	160.2	0.66	0.4	0.6	0.3	0.5	0.2	0.5	0.1	0.4	0.1	0.3	0.1	0.3	0.0	0.2	0.0	0.1	0.0	0.1
32-08B	8/25/2008	20.57	575.17	10.6	1,883,633.40	1,167,005.10	9.97	130.4	248.4	0.98	4.2	0.9	2.8	0.8	2.0	0.7	1.4	0.6	1.0	0.5	0.6	0.4	0.3	0.3	0.2	0.2	0.0	0.1
32-08C	8/22/2008	21.85	574.69	12.2	1,883,646.20	1,167,021.50	9.65	126.2	244.2	0.97	3.9	0.9	2.6	0.8	1.8	0.7	1.3	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
32-08D	8/22/2008	14.04	574.69	12	1,883,657.70	1,167,036.50	2.04	26.7	144.7	0.53	0.2	0.5	0.1	0.4	0.1	0.4	0.1	0.3	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.1
32-08E	8/22/2008	18.7	574.69	10.5	1,883,669.90	1,167,052.60	8.2	107.2	225.2	0.93	2.8	0.8	1.9	0.7	1.3	0.7	0.9	0.6	0.6	0.5	0.4	0.4	0.2	0.3	0.1	0.2	0.0	0.1
33-08A	8/22/2008	19.09	574.69	11.5	1,883,803.50	1,166,883.00	7.59	99.2	217.2	0.91	2.4	0.8	1.6	0.7	1.1	0.6	0.8	0.5	0.6	0.5	0.4	0.4	0.2	0.3	0.1	0.2	0.0	0.1
33-08C	8/22/2008	22.8	574.69	11.9	1,883,816.10	1,166,921.80	10.9	142.5	260.5	1.01	5.0	0.9	3.3	0.8	2.3	0.7	1.7	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
33-08E	8/22/2008	22.38	574.69	11.5	1,883,829.00	1,166,959.80	10.88	142.3	260.3	1.01	5.0	0.9	3.3	0.8	2.3	0.7	1.7	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
34-08A	8/22/2008	14.8	574.69	8.5	1,883,992.20	1,166,815.90	6.3	82.4	200.4	0.86	1.7	0.8	1.1	0.7	0.8	0.6	0.6	0.5	0.4	0.4	0.2	0.3	0.1	0.3	0.1	0.2	0.0	0.1
34-08B	8/22/2008	21.16	574.69	11.4	1,884,001.00	1,166,840.40	9.76	127.6	245.6	0.98	4.0	0.9	2.6	0.8	1.9	0.7	1.3	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
34-08C	8/21/2008	22.8	574.88	10.4	1,884,007.80	1,166,863.50	12.4	162.1	280.1	1.04	6.5	0.9	4.3	0.8	3.0	0.7	2.2	0.6	1.5	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
34-08D	8/21/2008	21.29	574.88	9.1	1,884,016.40	1,166,887.70	12.19	159.4	277.4	1.03	6.2	0.9	4.1	0.8	2.9	0.7	2.1	0.6	1.4	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
34-08E	8/22/2008	17.88	574.69	7	1,884,022.80	1,166,911.50	10.88	142.3	260.3	1.01	5.0	0.9	3.3	0.8	2.3	0.7	1.7	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
35-08A	8/21/2008	12.14	574.88	8.8	1,884,176.40	1,166,759.20	3.34	43.7	161.7	0.67	0.5	0.6	0.3	0.5	0.2	0.5	0.2	0.4	0.1	0.3	0.1	0.3	0.0	0.2	0.0	0.1	0.0	0.1
35-08C	8/21/2008	22.6	574.88	8.9	1,884,199.10	1,166,805.20	13.7	179.1	297.1	1.06	7.9	1.0	5.2	0.8	3.7	0.7	2.6	0.6	1.8	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
35-08E	8/21/2008	21.23	574.88	9.9	1,884,222.20	1,166,848.10	11.33	148.1	266.1	1.02	5.4	0.9	3.6	0.8	2.5	0.7	1.8	0.6	1.2	0.5	0.8	0.4	0.4	0.3	0.2	0.2	0.1	0.1
36-08A	8/21/2008	22.44	574.88	8.4	1,884,355.20	1,166,674.30	14.04	183.6	301.6	1.07	8.3	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
36-08B	8/21/2008	21.56	574.88	11	1,884,367.40	1,166,695.50	10.56	138.1	256.1	1.00	4.7	0.9	3.1	0.8	2.2	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
36-08C	9/12/2008	23.16	575.3	11.3	1,884,379.60	1,166,718.80	11.86	155.1	273.1	1.03	5.9	0.9	3.9	0.8	2.8	0.7	2.0	0.6	1.4	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
36-08D	8/21/2008	22.44	574.88	9	1,884,390.30	1,166,741.50	13.44	175.7	293.7	1.06	7.6	1.0	5.0	0.8	3.6	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1
36-08E	8/21/2008	18.34	574.88	8.3	1,884,401.10	1,166,763.10	10.04	131.3	249.3	0.98	4.2	0.9	2.8	0.8	2.0	0.7	1.4	0.6	1.0	0.5	0.6	0.4	0.4	0.3	0.2	0.2	0.0	0.1
37-08A	8/21/2008	22.44	574.88	7.8	1,884,598.10	1,166,587.60	14.64	191.4	309.4	1.08	9.0	1.0	6.0	0.9	4.2	0.8	3.0	0.6	2.1	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
37-08C	8/21/2008	22.64	574.88	10.9	1,884,560.10	1,166,632.00	11.74	153.5	271.5	1.02	5.8	0.9	3.8	0.8	2.7	0.7	1.9	0.6	1.3	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
37-08E	8/21/2008	13.22	574.88	7.5	1,884,581.80	1,166,678.00	5.72	74.8	192.8	0.83	1.4	0.7	0.9	0.7	0.6	0.6	0.5	0.5	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.2	0.0	0.1
38-08A	8/20/2008	10.6	575.32	3.5	1,884,716.40	1,166,500.70	7.1	92.8	210.8	0.89	2.1	0.8	1.4	0.7	1.0	0.6	0.7	0.5	0.5	0.4	0.3	0.4	0.2	0.3	0.1	0.2	0.0	0.1
38-08B	8/20/2008	20.14	575.32	9.5	1,884,728.90	1,166,524.40	10.64	139.1	257.1	1.00	4.8	0.9	3.1	0.8	2.2	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
38-08C	8/20/2008	20.93	575.32	11.8	1,884,740.50	1,166,545.30	9.13	119.4	237.4	0.96	3.5	0.9	2.3	0.8	1.6	0.7	1.2	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
38-08D	8/21/2008	20.08	574.88	9.5	1,884,750.70	1,166,569.40	10.58	138.3	256.3	1.00	4.7	0.9	3.1	0.8	2.2	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
38-08E	8/20/2008	12.07	575.32	12.1	1,884,762.30	1,166,591.10	0.000001	0.0	118.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-08A	8/20/2008	20.51	575.32	10	1,884,929.70	1,166,450.60	10.51	137.4	255.4	1.00	4.6	0.9	3.1	0.8	2.2	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
39-08C	9/12/2008	21.98	575.3	12.8	1,884,931.60	1,166,499.30	9.18	120.0	238.0	0.96	3.5	0.9	2.3	0.8	1.7	0.7	1.2	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
39-08E	8/20/2008	19.91	575.32	11.2	1,884,934.60	1,166,549.20	8.71	113.9	231.9	0.95	3.2	0.9	2.1	0.8	1.5	0.7	1.1	0.6	0.7	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
40-08A	8/20/2008	20.21	575.32	11.3	1,885,130.00	1,166,440.40	8.91	116.5	234.5	0.95	3.3	0.9	2.2	0.8	1.6	0.7	1.1	0.6	0.8	0.5	0.5	0.4	0.3	0.3	0.1	0.2	0.0	0.1
40-08B	8/20/2008	23.59	575.32	12.1	1,885,129.50	1,166,464.60	11.49	150.2	268.2	1.02	5.5	0.9	3.7	0.8	2.6	0.7	1.9	0.6	1.3	0.5	0.8	0.4	0.5	0.3	0.2	0.2	0.1	0.1
40-08C	8/20/2008	23.79	575.32	11.9	1,885,130.90	1,166,489.70	11.89	155.5	273.5	1.03	5.9	0.9	3.9	0.8	2.8	0.7	2.0	0.6	1.4	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
40-08D	8/20/2008	22.67	575.32	7.5	1,885,132.20	1,166,515.70	15.17	198.3	316.3	1.08	9.7	1.0	6.4	0.9	4.5	0.8	3.2	0.6	2.2	0.5	1.4	0.4	0.8	0.3	0.3	0.2	0.1	0.1
40-08E	8/20/2008	21.16	575.32	4.1	1,885,133.90	1,166,540.10	17.06	223.1	341.1	1.11	12.2	1.0	8.1	0.9	5.7	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
41-08A	8/19/2008	20.64	575.2	10.8	1,885,305.70	1,166,412.60	9.84	128.7	246.7	0.98	4.1	0.9	2.7	0.8	1.9	0.7	1.4	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
41-08C	8/19/2008	21.69	575.2	11.9	1,885,325.60	1,166,458.50	9.79	128.0	246.0	0.98	4.0	0.9	2.7	0.8	1.9	0.7	1.3	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
41-08E	8/19/2008	9.19	575.2	5	1,885,345.40	1,166,504.90	4.19	54.8	172.8	0.74	0.7	0.7	0.5	0.6	0.3	0.5	0.2	0.4	0.2	0.4	0.1	0.3	0.1	0.2	0.0	0.1	0.0	0.1
42-08A	8/19/2008	21.82	575.2	7.7	1,885,491.50	1,166,338.50	14.12	184.6	302.6	1.07	8.4	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
42-08B	8/19/2008	21.82	575.2	10	1,885,501.60	1,166,360.80	11.82	154.5	272.5	1.03	5.9	0.9	3.9	0.8	2.8	0.7	2.0	0.6	1.3	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
42-08C	8/19/2008	21.92	575.2	11.5	1,885,511.10	1,166,383.10	10.42	136.2	254.2	0.99	4.6	0.9	3.0	0.8	2.1	0.7	1.5	0.6	1.0	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
42-08D	8/19/2008	17.55	575.2	11	1,885,520.00	1,166,406.90	6.55	85.6	203.6	0.87	1.8	0.8	1.2	0.7	0.8	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.1	0.3	0.1	0.2	0.0	0.1
42-08E	8/19/2008	10.96	575.2	9	1,885,531.20	1,166,430.00	1.96	25.6	143.6	0.52	0.2	0.5	0.1	0.4	0.1	0.4	0.1	0.3	0.0	0.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	0.1
43-08A	8/19/2008	20.77	575.2	10	1,885,715.80	1,166,366.40	10.77	140.8	258.8	1.00	4.9	0.9	3.2	0.8	2.3	0.7	1.6	0.6	1.1	0.5	0.7	0.4	0.4	0.3	0.2	0.2	0.0	0.1
43-08C	8/19/2008	23.46	575.2	11.7	1,885,696.20	1,166,413.00	11.76	153.8	271.8	1.02	5.8	0.9	3.8	0.8	2.7	0.7	1.9	0.6	1.3	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
43-08E	8/19/2008	18.64	575.2	7.4	1,885,676.80	1,166,459.00	11.24	147.0	265.0	1.01	5.3	0.9	3.5	0.8	2.5	0.7	1.8	0.6	1.2	0.5	0.8	0.4	0.4	0.3	0.2	0.2	0.0	0.1
44-08B	9/12/2008	18.21	575.3	11.7	1,885,891.50	1,166,466.20	6.51	85.1	203.1	0.87	1.8	0.8	1.2	0.7	0.8	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.1	0.3	0.1	0.2	0.0	0.1
44-08C	9/12/2008	25.56	575.3	11.4	1,885,880.80	1,166,490.10	14.16	185.1	303.1	1.07	8.4	1.0	5.6	0.9	4.0	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
44-08D	9/12/2008	25.56	575.3	9.8	1,885,871.20	1,166,512.90	15.76	206.1	324.1	1.09	10.4	1.0	6.9	0.9	4.9	0.8	3.5	0.7	2.4	0.5	1.5	0.4	0.9	0.3	0.4	0.2	0.1	0.1
44-08E	9/12/2008	19.69	575.3	5	1,885,860.50	1,166,535.70	14.69	192.1	310.1	1.08	9.1	1.0	6.0	0.9	4.3	0.8	3.0	0.6	2.1	0.5	1.3	0.4	0.8	0.3	0.3	0.2	0.1	0.1
46-08	9/12/2008	25.36	575.3	10.6	1,886,075.80	1,166,591.40	14.76	193.0	311.0	1.08	9.2	1.0	6.1	0.9	4.3	0.8	3.1	0.6	2.1	0.5	1.3	0.4	0.8	0.3	0.3	0.2	0.1	0.1

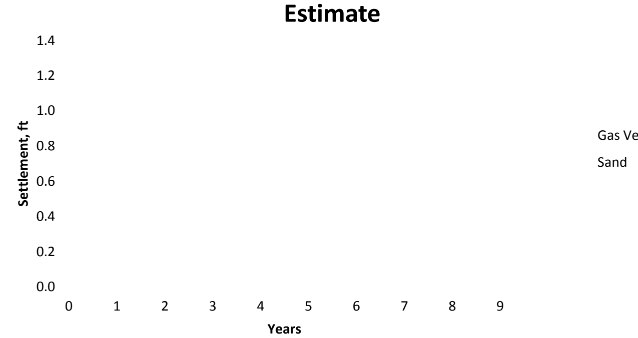
Boring/CPT Number	Date Drilled	Hole Depth (ft)	Elevation* (ft)	Depth of Water** (ft)	Northing (ft)	Easting (ft)	Sediment thickness	σ'	σ' + Δσ	s, ft
48-08	9/17/2008	24.61	575.45	9.2	1,886,283.10	1,166,670.10	15.41	201.5	319.5	1.09
50-08	9/17/2008	24.18	575.45	12.5	1,886,481.90	1,166,650.10	11.68	152.7	270.7	1.02
51-08	9/17/2008	25	575.45	11.1	1,886,492.20	1,166,749.70	13.9	181.7	299.7	1.06
52-08	9/16/2008	22.31	576.2	9.5	1,886,151.00	1,166,488.00	12.81	167.5	285.5	1.04
53-08	9/16/2008	21.46	576.2	5.9	1,886,084.00	1,166,363.00	15.56	203.4	321.4	1.09
56-08	9/16/2008	28.87	576.2	4	1,886,255.00	1,166,291.00	24.87	325.2	443.2	1.18
58-08	9/15/2008	27.1	578.04	13	1,886,318.00	1,166,487.00	14.1	184.4	302.4	1.07
61-08	9/16/2008	28.12	576.2	5.1	1,886,368.00	1,166,277.00	23.02	301.0	419.0	1.16
62-08	9/16/2008	19.29	576.2	3.2	1,886,462.00	1,166,238.00	16.09	210.4	328.4	1.10
63-08	9/16/2008	29.66	576.2	8.4	1,886,536.00	1,166,284.00	21.26	278.0	396.0	1.15
64-08	9/16/2008	25.36	576.2	8.9	1,886,482.00	1,166,442.00	16.46	215.2	333.2	1.10
65-08	9/10/2008	22.83	575.35	4.8	1,882,348.40	1,168,095.60	18.03	235.7	353.7	1.12
66-08	9/12/2008	22.9	575.3	13	1,885,228.20	1,166,474.10	9.9	129.4	247.4	0.98
10-08C	9/5/2008	21.95	575.43	2.6	1,879,972.70	1,168,478.80	19.35	253.0	371.0	1.13
12-08B	9/3/2008	22.41	575.02	4.5	1,880,370.20	1,168,420.00	17.91	234.2	352.2	1.12
12-08E	9/3/2008	22.67	575.02	5.1	1,880,374.70	1,168,496.00	17.57	229.7	347.7	1.11
13-08CC	9/8/2008	17.26	575.62	4	1,880,570.80	1,168,430.10	13.26	173.4	291.4	1.05
16-08E	9/2/2008	21.75	575.48	3.7	1,881,166.20	1,168,481.00	18.05	236.0	354.0	1.12
22-08CC***	9/9/2008	21.42	575.42	6	1,882,102.80	1,168,267.30	15.42	201.6	319.6	1.09
23-08CC	9/10/2008	21.72	575.35	5.7	1,882,266.50	1,168,153.40	16.02	209.5	327.5	1.09
23-08EE,EEE	9/10/2008	19.65	575.35	9.6	1,882,301.00	1,168,190.50	10.05	131.4	249.4	0.98
24-08CC	9/10/2008	20.21	575.35	5.9	1,882,430.30	1,168,037.90	14.31	187.1	305.1	1.07
26-08B	8/26/2008	21.23	575.07	5.4	1,882,743.10	1,167,789.10	15.83	207.0	325.0	1.09
27-08AA	9/11/2008	21.88	575.59	6.6	1,882,874.80	1,167,658.60	15.28	199.8	317.8	1.08
33-08CC	9/11/2008	22.77	575.59	13	1,883,816.10	1,166,921.80	9.77	127.7	245.7	0.98
37-08AA	9/12/2008	22.24	575.3	10.5	1,884,538.30	1,166,587.60	11.74	153.5	271.5	1.02
41-08AA	9/11/2008	19.75	575.59	9.9	1,885,305.70	1,166,412.60	9.85	128.8	246.8	0.98
41-08CC	9/11/2008	23.92	575.59	7.7	1,885,325.60	1,166,458.50	16.22	212.1	330.1	1.10
41-08EE	9/16/2008	11.09	576.2	6.5	1,885,345.40	1,166,504.90	4.59	60.0	178.0	0.76
42-08AA	9/15/2008	24.51	578.04	13.3	1,885,491.50	1,166,338.50	11.21	146.6	264.6	1.01
42-08CC	9/15/2008	24.25	578.04	14.4	1,885,511.10	1,166,383.10	9.85	128.8	246.8	0.98
54-08	9/15/2008	28.28	578.04	6.5	1,886,171.00	1,166,316.00	21.78	284.8	402.8	1.15
55-08	9/16/2008	28.28	576.2	3.8	1,886,215.00	1,166,242.00	24.48	320.1	438.1	1.17
57-08	9/15/2008	27.07	578.04	8.7	1,886,336.00	1,166,372.00	18.37	240.2	358.2	1.12
B-14	9/9/2008	23.75	576.92	6	1,882,102.80	1,168,267.30	17.75	232.1	350.1	1.12
B-15	9/16/2008	23.5	577.7	6.5	1,885,345.40	1,166,504.90	17	222.3	340.3	1.11
B-16	9/9/2008	24.5	576.67	4	1,880,570.80	1,168,430.10	20.5	268.0	386.0	1.14
	182					avg	13.4			1.0
						std dev	5.0			0.2
						max	24.9			1.2
						min	0.0			0.0

Boring/CPT Number	90%	s, ft	80%	s, ft	70%	s, ft	60%	s, ft	50%	s, ft	40%	s, ft	30%	s, ft	20%	s, ft	10%	s, ft
48-08	10.0	1.0	6.6	0.9	4.7	0.8	3.3	0.7	2.3	0.5	1.5	0.4	0.8	0.3	0.4	0.2	0.1	0.1
50-08	5.7	0.9	3.8	0.8	2.7	0.7	1.9	0.6	1.3	0.5	0.8	0.4	0.5	0.3	0.2	0.2	0.1	0.1
51-08	8.1	1.0	5.4	0.9	3.8	0.7	2.7	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
52-08	6.9	0.9	4.6	0.8	3.2	0.7	2.3	0.6	1.6	0.5	1.0	0.4	0.6	0.3	0.2	0.2	0.1	0.1
53-08	10.2	1.0	6.7	0.9	4.8	0.8	3.4	0.7	2.3	0.5	1.5	0.4	0.8	0.3	0.4	0.2	0.1	0.1
56-08	26.0	1.1	17.2	0.9	12.2	0.8	8.7	0.7	6.0	0.6	3.8	0.5	2.2	0.4	0.9	0.2	0.2	0.1
58-08	8.4	1.0	5.5	0.9	3.9	0.7	2.8	0.6	1.9	0.5	1.2	0.4	0.7	0.3	0.3	0.2	0.1	0.1
61-08	22.3	1.0	14.7	0.9	10.5	0.8	7.5	0.7	5.1	0.6	3.3	0.5	1.8	0.3	0.8	0.2	0.2	0.1
62-08	10.9	1.0	7.2	0.9	5.1	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
63-08	19.0	1.0	12.6	0.9	8.9	0.8	6.4	0.7	4.4	0.6	2.8	0.5	1.6	0.3	0.7	0.2	0.2	0.1
64-08	11.4	1.0	7.5	0.9	5.4	0.8	3.8	0.7	2.6	0.6	1.7	0.4	0.9	0.3	0.4	0.2	0.1	0.1
65-08	13.7	1.0	9.0	0.9	6.4	0.8	4.6	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
66-08	4.1	0.9	2.7	0.8	1.9	0.7	1.4	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
10-08C	15.7	1.0	10.4	0.9	7.4	0.8	5.3	0.7	3.6	0.6	2.3	0.5	1.3	0.3	0.6	0.2	0.1	0.1
12-08B	13.5	1.0	8.9	0.9	6.3	0.8	4.5	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
12-08E	13.0	1.0	8.6	0.9	6.1	0.8	4.3	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
13-08CC	7.4	0.9	4.9	0.8	3.5	0.7	2.5	0.6	1.7	0.5	1.1	0.4	0.6	0.3	0.3	0.2	0.1	0.1
16-08E	13.7	1.0	9.1	0.9	6.4	0.8	4.6	0.7	3.1	0.6	2.0	0.4	1.1	0.3	0.5	0.2	0.1	0.1
22-08CC***	10.0	1.0	6.6	0.9	4.7	0.8	3.3	0.7	2.3	0.5	1.5	0.4	0.8	0.3	0.4	0.2	0.1	0.1
23-08CC	10.8	1.0	7.1	0.9	5.1	0.8	3.6	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
23-08EE,EEE	4.2	0.9	2.8	0.8	2.0	0.7	1.4	0.6	1.0	0.5	0.6	0.4	0.4	0.3	0.2	0.2	0.0	0.1
24-08CC	8.6	1.0	5.7	0.9	4.0	0.7	2.9	0.6	2.0	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
26-08B	10.5	1.0	7.0	0.9	5.0	0.8	3.5	0.7	2.4	0.5	1.5	0.4	0.9	0.3	0.4	0.2	0.1	0.1
27-08AA	9.8	1.0	6.5	0.9	4.6	0.8	3.3	0.7	2.3	0.5	1.4	0.4	0.8	0.3	0.4	0.2	0.1	0.1
33-08CC	4.0	0.9	2.7	0.8	1.9	0.7	1.3	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
37-08AA	5.8	0.9	3.8	0.8	2.7	0.7	1.9	0.6	1.3	0.5	0.9	0.4	0.5	0.3	0.2	0.2	0.1	0.1
41-08AA	4.1	0.9	2.7	0.8	1.9	0.7	1.4	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
41-08CC	11.1	1.0	7.3	0.9	5.2	0.8	3.7	0.7	2.5	0.5	1.6	0.4	0.9	0.3	0.4	0.2	0.1	0.1
41-08EE	0.9	0.7	0.6	0.6	0.4	0.5	0.3	0.5	0.2	0.4	0.1	0.3	0.1	0.2	0.0	0.2	0.0	0.1
42-08AA	5.3	0.9	3.5	0.8	2.5	0.7	1.8	0.6	1.2	0.5	0.8	0.4	0.4	0.3	0.2	0.2	0.0	0.1
42-08CC	4.1	0.9	2.7	0.8	1.9	0.7	1.4	0.6	0.9	0.5	0.6	0.4	0.3	0.3	0.1	0.2	0.0	0.1
54-08	19.9	1.0	13.2	0.9	9.4	0.8	6.7	0.7	4.6	0.6	2.9	0.5	1.7	0.3	0.7	0.2	0.2	0.1
55-08	25.2	1.1	16.7	0.9	11.8	0.8	8.4	0.7	5.8	0.6	3.7	0.5	2.1	0.4	0.9	0.2	0.2	0.1
57-08	14.2	1.0	9.4	0.9	6.7	0.8	4.7	0.7	3.3	0.6	2.1	0.4	1.2	0.3	0.5	0.2	0.1	0.1
B-14	13.2	1.0	8.8	0.9	6.2	0.8	4.4	0.7	3.0	0.6	1.9	0.4	1.1	0.3	0.5	0.2	0.1	0.1
B-15	12.1	1.0	8.0	0.9	5.7	0.8	4.1	0.7	2.8	0.6	1.8	0.4	1.0	0.3	0.4	0.2	0.1	0.1
B-16	17.7	1.0	11.7	0.9	8.3	0.8	5.9	0.7	4.1	0.6	2.6	0.5	1.5	0.3	0.6	0.2	0.2	0.1
avg	8.5	0.9	5.6	0.8	4.0	0.7	2.9	0.6	2.0	0.5	1.3	0.4	0.7	0.3	0.3	0.2	0.1	0.1
std dev	5.4	0.1	3.5	0.1	2.5	0.1	1.8	0.1	1.2	0.1	0.8	0.1	0.4	0.0	0.2	0.0	0.0	0.0
max	26.0	1.1	17.2	0.9	12.2	0.8	8.7	0.7	6.0	0.6	3.8	0.5	2.2	0.4	0.9	0.2	0.2	0.1
min	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0



Bubbly Creek Time Rate of Settlement Estimate

time, years	Gas Vent	Sand
8.54	1.2	0.92
5.65	1.08	0.81
4.01	0.94	0.71
2.86	0.81	0.61
1.96	0.67	0.51
1.26	0.54	0.41
0.71	0.40	0.31
0.31	0.27	0.20
0.08	0.13	0.10



US Army Corps of Engineers® Chicago District	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **3Sep2013**	SHEET:
	COMPUTATION TITLE: **Settlement Analysis**	CHECKED BY:	DATE:	

ATTACHMENT D-1-3
Site Data

Laboratory Data Summary

Boring	Easting	Northing	Source	Sample	Depth	w_c (%) /2	γ*	Cc/(1+eo) /7	Cc/(1+eo) /8	LL	PL	PI	e /1	Ash (%)	Organic Carbon (%)	Specific Gravity (G_s)	Specific Gravity (Gs) (data added)	Cc	%fines	%solids	organic soils Cc /3	low plasticity soils Cc /4	Chicago Clays Cc /5	All Clays Cc /6
B-14			AECOM (STS)	4	15'-17'	56	96	0.29	0.45				1.23	72	28	-	2.19							
	1,168,267.30	1,882,102.80																			0.64	0.55	0.56	1.01
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	5	17.5-19.5'	59	93	0.30	0.46				1.24	64	36	2.1	2.1				0.68	0.55	0.59	1.02
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	6	20'-22.5'	43	101	0.25	0.35				0.95	81	19	-	2.19		64.4%		0.49	0.33	0.43	0.69
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	7	22.5'-23.5'	65	69	0.42	0.28				0.78	-	-	1.2	1.2		57.6%		0.75	0.21	0.65	0.49
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	7A	23.5'-23.75'	11	123	0.10	-0.10				0.24	-	-	-	2.19				0.13	-0.19	0.11	-0.12
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	3	12.5'-14.5'	42	101	0.25	0.34				0.92	88	12	-	2.19		31.0%		0.48	0.32	0.42	0.66
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	4	15'-17'	33	106	0.22	0.25				0.73	-	-	-	2.19		19.2%		0.38	0.17	0.33	0.43
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	5	17.5'-19.5'	14	120	0.12	-0.04				0.31	<0.10	<0.10	-	2.19				0.16	-0.14	0.14	-0.05
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	6	20'-22'	18	123	0.14	0.07				0.43	96	4.5	2.4	2.4		34.7%		0.21	-0.05	0.18	0.09
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	7	22.5'-23.5'	9	148	0.08	-0.10				0.24	-	-	2.7	2.7		56.0%		0.10	-0.19	0.09	-0.12
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	4	12.5'-14.5'	32	106	0.22	0.24				0.70	58	42	-	2.19				0.37	0.15	0.32	0.41
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	5	15'-17'	56	79	0.35	0.31				0.84	75	25	1.5	1.5				0.64	0.26	0.56	0.56
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	6	17.5'-19.5'	49	98	0.27	0.40				1.08	71	29	-	2.19				0.56	0.43	0.49	0.84
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	7	20'-22'	54	97	0.28	0.44				1.19	-	-	-	2.19				0.62	0.52	0.54	0.96
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	8	22.5'-24.25'	12	143	0.10	-0.02				0.32	-	-	2.7	2.7		73.1%		0.14	-0.13	0.12	-0.03
B-1-07 ST-1	1,166,237.75	1,886,462.32	PEI		6'-8'	108	86	0.36	0.71	53	43	10	2.49			2.309	2.309		80.4%		1.24	1.50	1.08	2.47
B-1-07 ST-4	1,166,237.75	1,886,462.32	PEI		18'-20'	108	86	0.35	0.71	36	31	5	2.52			2.336	2.336		25.9%		1.24	1.52	1.08	2.50
B-2-07 ST-1	1,166,442.71	1,886,387.39	PEI		11'-13'	157	80	0.39	0.81				3.58			2.279	2.279		54.4%		1.81	2.31	1.57	3.71
B-2-07 ST-3	1,166,442.71	1,886,387.39	PEI		19'-21'	145	80	0.40	0.78	70	57	13	3.19			2.197	2.197		51.4%		1.67	2.01	1.45	3.26
B-3-07 ST1	1,166,363.32	1,886,084.30	PEI		7'-9'	119	84	0.36	0.74	67	44	23	2.78			2.333	2.333		89.8%		1.37	1.71	1.19	2.79
B-3-07 ST-5	1,166,363.32	1,886,084.30	PEI		22'-24'	120	84	0.37	0.73	63	40	23	2.73			2.275	2.275		32.5%		1.38	1.67	1.20	2.74
B-5-07 ST-1	1,166,276.64	1,886,367.87	PEI		8'-10'	107	87	0.35	0.71	56	39	17	2.56			2.391	2.391	1	83.7%		1.23	1.54	1.07	2.54
B-5-07 ST-2	1,166,276.64	1,886,367.87	PEI		12'-14'	108	85	0.36	0.70	54	38	16	2.43			2.252	2.252		32.5%		1.24	1.45	1.08	2.39
B-6-07 ST-1	1,166,372.26	1,886,335.82	PEI		10'-12'	143	80	0.40	0.78	75	45	30	3.14			2.197	2.197	0.9	84.5%		1.64	1.98	1.43	3.21
B-6-07 ST-2	1,166,372.26	1,886,335.82	PEI		14'-16'	91	87	0.35	0.63	56	47	9	2.00			2.197	2.197	0.98	80.5%		1.05	1.12	0.91	1.90
B-6-07 ST-3	1,166,372.26	1,886,335.82	PEI		18'-20'	141	80	0.40	0.77	69	60	9	3.05			2.163	2.163	2.46	67.5%		1.62	1.91	1.41	3.10
B-6-07 ST-4	1,166,372.26	1,886,335.82	PEI		22'-24'	95	88	0.35	0.66	65	58	7	2.17			2.28	2.28		78.1%		1.09	1.25	0.95	2.09
B-7-07 ST-1	1,166,316.31	1,886,171.40	PEI		8'-10'	113	85	0.36	0.72	65	42	23	2.62			2.32	2.32		77.6%		1.30	1.59	1.13	2.61
B-7-07 ST-5	1,166,316.31	1,886,171.40	PEI		24'-26'	68	92	0.32	0.52	58	41	17	1.48			2.172	2.172		64.0%		0.78	0.73	0.68	1.30
B-8-07 ST-1	1,166,242.40	1,886,214.55	PEI		7'-9'	131	83	0.38	0.76	64	39	25	3.02			2.302	2.302		73.3%		1.51	1.89	1.31	3.07
B-8-07 ST-3	1,166,242.40	1,886,214.55	PEI		15'-17'	89	88	0.34	0.63	61	40	21	2.00			2.245	2.245		81.9%		1.02	1.12	0.89	1.90
B-9-07 ST-1	1,166,283.51	1,886,535.56	PEI		11'-13'	87	90	0.33	0.63	57	39	18	2.01			2.311	2.311		46.4%		1.00	1.13	0.87	1.91
B-9-07 ST-3	1,166,283.51	1,886,535.56	PEI		19'-21'	86	89	0.34	0.62	65	48	17	1.91			2.225	2.225		79.4%		0.99	1.06	0.86	1.80
B-10-07 ST-1	1,166,441.97	1,886,482.13	PEI		12'-14'	155	80	0.39	0.81	61	45	16	3.57			2.305	2.305		54.4%		1.78	2.30	1.55	3.71
B-10-07 ST-4	1,166,441.97	1,886,482.13	PEI		24'-26'	100	86	0.36	0.66	62	41	21	2.20			2.198	2.198		78.7%		1.15	1.27	1.00	2.13
B-11-07 ST-2	1,166,486.84	1,886,318.49	PEI		18'-20'	174	81	0.35	0.88	65	60	5	4.67			2.684	2.684		52.3%		2.00	3.13	1.74	4.97
B-12-07 ST-1	1,166,488.15	1,886,150.87	PEI		9'-11'	122	84	0.36	0.75	69	40	29	2.89			2.367	2.367		80.7%		1.40	1.79	1.22	2.92
B-12-07 ST-4	1,166,488.15	1,886,150.87	PEI		21'-23'	94	88	0.34	0.66	60	48	12	2.16			2.293	2.293		66.5%		1.08	1.24	0.94	2.08
SF-2004-B-01A	1,166,334.48	1,886,424.30	CDM			101	79	0.42	0.59				1.75			1.73	1.73		65.2%	49.7%	1.16	0.94	1.01	1.61
SF-2004-B-02	1,166,311.55	1,885,537.78	CDM			72	76	0.41	0.39				1.04			1.44	1.44		82.3%	58.1%	0.83	0.40	0.72	0.79
SF-2004-B03	1,166,495.20	1,885,060.40	CDM			121	79	0.43	0.67				2.23			1.84	1.84		80.2%	45.2%	1.39	1.30	1.21	2.16
SF-2004-B04	1,166,520.49	1,884,806.72	CDM			67	74	0.40	0.34				0.91			1.37	1.37		90.1%	60.0%	0.77	0.31	0.67	0.65
SF-2004-B05	1,166,702.22	1,884,411.32	CDM			103	81	0.40	0.62				1.94			1.88	1.88		58.3%	49.2%	1.19	1.08	1.03	1.83
SF-2004-B05(dup)	1,166,702.22	1,884,411.32	CDM			98	82	0.40	0.60				1.83			1.87	1.87		64.1%	50.6%	1.12	0.99	0.98	1.70
SF-2004-B06	1,167,002.05	1,883,618.62	CDM			37	111	0.22	0.35				0.93			2.5	2.5		15.6%	72.9%	0.43	0.32	0.37	0.67
SF-2004-B07	1,167,708.67	1,882,959.19	CDM			113	83	0.39	0.69				2.37			2.1	2.1		68.5%	47.0%	1.30	1.40	1.13	2.32
SF-2004-B08	1,168,173.31	1,882,289.57	CDM			83	90	0.33	0.61				1.89			2.27	2.27		44.8%	54.6%	0.96	1.04	0.83	1.77
SF-2004-B09	1,166,958.01	1,881,676.13	CDM			120	79	0.43	0.67				2.21			1.84	1.84		71.2%	45.4%	1.38	1.28	1.20	2.14
SF-2004-B10	1,168,474.23	1,881,454.28	CDM			107	83	0.38	0.67				2.22			2.07	2.07		38.1%	48.3%	1.23	1.29	1.07	2.15
SF-2004-B11	1,168,446.17	1,880,323.86	CDM			42	108	0.24	0.40				1.06			2.5	2.5		7.1%	70.2%	0.49	0.42	0.42	0.82
SF-2004-B12	1,168,257.44	1,879,878.29	CDM			106	84	0.37	0.68				2.29			2.16	2.16		66.3%	48.5%	1.22	1.35	1.06	2.24
SF-2004-B13	1,168,490.62	1,879,562.57	CDM			28	119	0.19	0.25				0.72			2.55	2.55		3.5%	78.0%	0.32	0.16	0.28	0.42
SF-2004-G01	1,166,499.75	1,884,874.58	CDM			84	91	0.33	0.63				1.97			2.34	2.34		19.1%	54.3%	0.97	1.10	0.84	1.86
SF-2004-G02	1,166,818.04	1,884,187.71	CDM			128	79	0.42	0.71				2.51			1.96	1.96		32.5%	43.8%	1.48	1.51	1.28	2.49
SF-2004-G03	1,167,794.25	1,882,867.54	CDM			48	101	0.26	0.41				1.10			2.3	2.3		14.0%	67.7%	0.55	0.45	0.48	0.86
SF-2004-G04	1,166,958.01	1,881,676.13	CDM			86	93	0.31	0.66				2.16			2.53	2.53		11.8%	53.9%	0.98	1.25	0.86	2.09
SF-2004-G05	1,168,474.23	1,881,454.28	CDM			31	117	0.20	0.29				0.81			2.57	2.57		4.7%	76.1%	0.36	0.23	0.31	0.53

Laboratory Data Summary

Boring	Easting	Northing	Source	Sample	Depth	w_c (%) /2	γ*	Cc/(1+eo) /7	Cc/(1+eo) /8	LL	PL	PI	e /1	Ash (%)	Organic Carbon (%)	Specific Gravity (G_s)	Specific Gravity (Gs) (data added)	Cc	%fines	%solids	organic soils Cc /3	low plasticity soils Cc /4	Chicago Clays Cc /5	All Clays Cc /6
B-14			AECOM (STS)	4	15'-17'	56	96	0.29	0.45				1.23	72	28	-	2.19							
	1,168,267.30	1,882,102.80																			0.64	0.55	0.56	1.01
avg						84	92	0.32	0.52	61.41	44.77	16.64	1.83			2.19		1.34	54.9%	0.57	0.97	1.00	0.84	1.70
std dev						42	16	0.09	0.24				0.97			0.33		0.75	25.5%	0.11	0.48	0.73	0.42	1.12
max	1168491	1886536				174	148	0.43	0.88				4.67			2.70		2.46	90.1%	0.78	2.00	3.13	1.74	4.97
min	1166238	1879563				9	69	0.08	-0.10				0.24			1.20		0.90	3.5%	0.44	0.10	-0.19	0.09	-0.12

1/ where Gs data not available, assumed to be 2.2

2/ CDM provided percent solids, so w% was calculated for CDM data based on percent solids

3/ Cc = 1.15 x 10^{-2} w_n (For Organic soils - meadow mats, peats, and organic silt and clay)*

4/ Cc = 0.75 (eo - 0.5) (For Soils of low plasticity)*

5/ Cc = 0.01 wn (For Chicago clays)*

6/ Cc = 1.15(eo - 0.35) (For all clays)*

7/ based on Cc correlation for soils of low plasticity

8/ based on Cc correlation for all clays

*; Holtz & Kovacs, 1981; after Azzouz, Krizek, and Corotis (1976)

$\rho 12$	1.0
$\rho 23$	-0.08
$\rho 31$	0.141

Cc/(1+eo) Comparison

	LRC plasticity soils	all clays	Olsen
avg	0.34	0.59	0.57
std dev	0.09	0.25	0.25
max	0.48	0.88	1.22
min	0.08	-0.10	0.11

ERDC's analysis appears to be conservative. The "All Clays" correlation results in higher predicted Cc.

ATTACHMENT D-1-4
Point Estimate Calculations

Sand Cap

ρ12	0.969539	p+++ = p--- =	0.253367
ρ23	-0.08346	p++1 = p--+ =	0.239018
ρ31	0.140863	p+-+ = p -+- =	0.031849
E[y]			
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

with no correlation

Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
1-08	0.3	1.4	0.2	1.0	0.2	1.0	0.1	0.7	0.6	0.6	0.2	0.5
2-08	0.1	0.8	0.1	0.5	0.1	0.6	0.1	0.4	0.3	0.2	0.1	0.3
3-08	0.4	2.2	0.3	1.8	0.3	1.4	0.2	1.2	1.0	1.4	0.5	0.7
4-08	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
5-08	0.5	2.6	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
7-08	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
9-08	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
10-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
10-08B	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.8	0.9
10-08D	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
10-08E	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
11-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
11-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
11-08E	0.5	2.6	0.4	2.3	0.3	1.7	0.3	1.5	1.2	2.2	0.8	0.9
12-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
12-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
12-08D	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
13-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
13-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
13-08E	0.5	2.6	0.4	2.3	0.3	1.7	0.3	1.5	1.2	2.2	0.8	0.9
14-08A	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
14-08B	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
14-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
14-08D	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
14-08E	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
15-08A	0.5	2.6	0.4	2.3	0.3	1.7	0.3	1.5	1.2	2.2	0.8	0.9
15-08C	0.5	2.6	0.4	2.3	0.3	1.7	0.3	1.5	1.2	2.2	0.8	0.9
15-08E	0.5	2.6	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
16-08A	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
16-08B	0.5	2.6	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
16-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
16-08D	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
17-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
17-08B	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
17-08C	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
17-08E	0.5	2.6	0.4	2.3	0.3	1.7	0.3	1.5	1.2	2.2	0.8	0.9
18-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
18-08B	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9

	1	2	3	4	5	6	7	8
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
1-08	0.064313	-0.03486	0.005887	0.250366	0.0428	0.032317	-0.00317	0.187573	0.545233
2-08	0.036152	-0.01959	0.003042	0.129389	0.025519	0.019269	-0.0017	0.100823	0.292898
3-08	0.096484	-0.05229	0.009871	0.419766	0.059977	0.045287	-0.00503	0.297972	0.872034
4-08	0.101487	-0.055	0.01059	0.450378	0.062406	0.047121	-0.00534	0.316534	0.928169
5-08	0.118095	-0.06401	0.013259	0.563856	0.070016	0.052867	-0.00644	0.381597	1.129242
7-08	0.119579	-0.06481	0.013522	0.575056	0.070662	0.053355	-0.00654	0.387698	1.148518
9-08	0.114796	-0.06222	0.012689	0.539648	0.06856	0.051768	-0.00621	0.368213	1.087241
10-08A	0.116294	-0.06303	0.012945	0.550519	0.069224	0.052269	-0.00632	0.374256	1.10616
10-08B	0.113625	-0.06158	0.012492	0.531271	0.068036	0.051372	-0.00614	0.363519	1.072597
10-08D	0.117081	-0.06346	0.013081	0.556316	0.069571	0.052531	-0.00637	0.377457	1.116211
10-08E	0.111912	-0.06066	0.012209	0.519215	0.067264	0.050789	-0.00602	0.356707	1.051421
11-08A	0.113911	-0.06174	0.01254	0.533305	0.068164	0.051469	-0.00615	0.364662	1.076158
11-08C	0.116041	-0.06289	0.012902	0.548671	0.069112	0.052185	-0.0063	0.373233	1.102951
11-08E	0.117588	-0.06373	0.01317	0.56007	0.069794	0.052699	-0.00641	0.379522	1.122705
12-08A	0.115742	-0.06273	0.01285	0.546493	0.06898	0.052085	-0.00628	0.372025	1.099165
12-08C	0.11484	-0.06224	0.012697	0.539963	0.068579	0.051782	-0.00622	0.368389	1.08779
12-08D	0.115226	-0.06245	0.012762	0.54275	0.068751	0.051912	-0.00624	0.369943	1.092649
13-08A	0.116883	-0.06335	0.013047	0.55485	0.069484	0.052465	-0.00636	0.376649	1.113672
13-08C	0.116178	-0.06297	0.012925	0.549671	0.069173	0.05223	-0.00631	0.373787	1.104687
13-08E	0.117153	-0.0635	0.013094	0.556843	0.069603	0.052555	-0.00638	0.377747	1.117123
14-08A	0.114475	-0.06204	0.012635	0.537336	0.068416	0.051659	-0.00619	0.366921	1.083206
14-08B	0.11484	-0.06224	0.012697	0.539963	0.068579	0.051782	-0.00622	0.368389	1.08779
14-08C	0.11496	-0.06231	0.012717	0.540823	0.068632	0.051822	-0.00623	0.368869	1.08929
14-08D	0.115435	-0.06256	0.012798	0.544265	0.068844	0.051982	-0.00626	0.370786	1.095287
14-08E	0.114464	-0.06204	0.012633	0.537256	0.068411	0.051655	-0.00619	0.366876	1.083065
15-08A	0.117706	-0.0638	0.01319	0.560953	0.069846	0.052739	-0.00641	0.380006	1.124231
15-08C	0.117639	-0.06376	0.013179	0.56045	0.069816	0.052716	-0.00641	0.37973	1.123361
15-08E	0.117923	-0.06391	0.013228	0.562571	0.069941	0.05281	-0.00643	0.380893	1.127025
16-08A	0.110897	-0.06011	0.012044	0.512179	0.066803	0.050441	-0.00595	0.3527	1.039007
16-08B	0.117973	-0.06394	0.013237	0.56294	0.069963	0.052827	-0.00643	0.381095	1.127662
16-08C	0.115641	-0.06268	0.012833	0.545756	0.068935	0.052051	-0.00627	0.371615	1.097883
16-08D	0.112635	-0.06105	0.012328	0.524277	0.067591	0.051036	-0.00607	0.359575	1.060326
17-08A	0.11209	-0.06075	0.012238	0.520456	0.067345	0.05085	-0.00603	0.357411	1.053605
17-08B	0.114144	-0.06187	0.012579	0.53497	0.068269	0.051548	-0.00617	0.365596	1.07907
17-08C	0.114373	-0.06199	0.012618	0.536608	0.068371	0.051625	-0.00619	0.366513	1.081933
17-08E	0.117372	-0.06361	0.013132	0.558471	0.069699	0.052628	-0.00639	0.378643	1.11994
18-08A	0.116041	-0.06289	0.012902	0.548671	0.069112	0.052185	-0.0063	0.373233	1.102951
18-08B	0.11562	-0.06267	0.01283	0.545608	0.068926	0.052044	-0.00627	0.371533	1.097625

ρ12	0.969539	p+++ = p--- =	0.253367
ρ23	-0.08346	p++1 = p--+ =	0.239018
ρ31	0.140863	p+-+ = p -+- =	0.031849
E[y]			
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
18-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
18-08D	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
18-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
19-08A	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
19-08C	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
19-08E	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
20-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
20-08B	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
20-08C	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
20-08D	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
20-08E	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
21-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
21-08C	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
21-08E	0.4	2.2	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
22-08A	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
22-08B	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
22-08C	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
22-08D	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
22-08E	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.6	0.6	0.8
23-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
23-08C	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
23-08E	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.2	0.9	1.4	0.5	0.7
24-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
24-08B	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
24-08C	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
24-08D	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
24-08E	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
25-08A	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
25-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
25-08E	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
26-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
26-08B	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
26-08C	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
26-08D	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
26-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
27-08A	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
27-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
27-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
18-08C	0.114653	-0.06214	0.012665	0.538618	0.068496	0.051719	-0.00621	0.367638	1.085444
18-08D	0.115173	-0.06242	0.012753	0.542368	0.068728	0.051894	-0.00624	0.36973	1.091983
18-08E	0.117135	-0.06349	0.013091	0.556712	0.069595	0.052549	-0.00637	0.377675	1.116896
19-08A	0.106487	-0.05772	0.011345	0.482481	0.064771	0.048907	-0.00566	0.335539	0.986152
19-08C	0.11029	-0.05978	0.011946	0.50801	0.066527	0.050232	-0.00591	0.350315	1.031631
19-08E	0.108315	-0.05871	0.011631	0.494626	0.065619	0.049547	-0.00578	0.342606	1.007856
20-08A	0.114949	-0.0623	0.012715	0.540745	0.068628	0.051819	-0.00623	0.368825	1.089154
20-08B	0.115446	-0.06257	0.0128	0.54434	0.068849	0.051986	-0.00626	0.370828	1.095418
20-08C	0.109672	-0.05944	0.011846	0.503791	0.066244	0.050019	-0.00587	0.347894	1.024153
20-08D	0.110897	-0.06011	0.012044	0.512179	0.066803	0.050441	-0.00595	0.3527	1.039007
20-08E	0.111059	-0.06019	0.01207	0.513299	0.066877	0.050497	-0.00596	0.35334	1.040985
21-08A	0.113443	-0.06149	0.012462	0.529979	0.067955	0.05131	-0.00612	0.362792	1.070332
21-08C	0.112008	-0.06071	0.012225	0.519885	0.067308	0.050822	-0.00603	0.357087	1.0526
21-08E	0.10021	-0.05431	0.010403	0.442429	0.061793	0.046658	-0.00526	0.311755	0.913673
22-08A	0.119245	-0.06463	0.013462	0.572516	0.070517	0.053246	-0.00652	0.386319	1.144155
22-08B	0.114818	-0.06223	0.012693	0.539805	0.06857	0.051775	-0.00622	0.368301	1.087515
22-08C	0.111407	-0.06038	0.012126	0.515704	0.067035	0.050616	-0.00599	0.35471	1.045231
22-08D	0.110971	-0.06015	0.012056	0.51269	0.066837	0.050467	-0.00596	0.352992	1.039909
22-08E	0.102119	-0.05535	0.010684	0.454352	0.062709	0.04735	-0.00538	0.318912	0.935394
23-08A	0.113283	-0.0614	0.012435	0.528846	0.067883	0.051256	-0.00611	0.362154	1.068346
23-08C	0.109881	-0.05955	0.01188	0.505215	0.066339	0.050091	-0.00589	0.348712	1.026678
23-08E	0.095306	-0.05165	0.009706	0.412757	0.059395	0.044848	-0.00496	0.293662	0.859062
24-08A	0.111162	-0.06025	0.012087	0.514006	0.066924	0.050532	-0.00597	0.353743	1.042234
24-08B	0.110808	-0.06006	0.012029	0.511564	0.066763	0.050411	-0.00595	0.352349	1.037919
24-08C	0.114305	-0.06195	0.012606	0.53612	0.068341	0.051602	-0.00618	0.36624	1.081079
24-08D	0.108208	-0.05865	0.011614	0.493909	0.06557	0.04951	-0.00578	0.342191	1.006578
24-08E	0.112803	-0.06114	0.012356	0.525461	0.067667	0.051093	-0.00608	0.360244	1.062405
25-08A	0.109992	-0.05961	0.011898	0.505974	0.06639	0.050129	-0.00589	0.349148	1.028024
25-08C	0.103489	-0.05609	0.010888	0.463043	0.063361	0.047842	-0.00547	0.324088	0.95115
25-08E	0.109111	-0.05914	0.011757	0.499983	0.065986	0.049824	-0.00583	0.345702	1.017391
26-08A	0.113443	-0.06149	0.012462	0.529979	0.067955	0.05131	-0.00612	0.362792	1.070332
26-08B	0.113271	-0.06139	0.012433	0.528758	0.067877	0.051252	-0.00611	0.362104	1.068192
26-08C	0.113601	-0.06157	0.012488	0.5311	0.068025	0.051364	-0.00613	0.363422	1.072296
26-08D	0.109656	-0.05943	0.011844	0.503681	0.066236	0.050013	-0.00587	0.347831	1.023958
26-08E	0.114949	-0.0623	0.012715	0.540745	0.068628	0.051819	-0.00623	0.368825	1.089154
27-08A	0.114818	-0.06223	0.012693	0.539805	0.06857	0.051775	-0.00622	0.368301	1.087515
27-08C	0.116216	-0.06299	0.012932	0.549954	0.06919	0.052243	-0.00631	0.373944	1.10518
27-08E	0.115237	-0.06246	0.012764	0.542826	0.068756	0.051916	-0.00624	0.369985	1.092782

ρ12	0.969539	p+++ = p--- =	0.253367
ρ23	-0.08346	p++1 = p--+ =	0.239018
ρ31	0.140863	p+-+ = p -+- =	0.031849
E[y]			
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
28-08A	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.1	0.9	1.3	0.5	0.7
28-08B	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
28-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
28-08D	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
28-08E	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
29-08A	0.3	1.6	0.2	1.2	0.2	1.1	0.1	0.8	0.7	0.8	0.3	0.5
29-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
29-08E	0.3	1.6	0.2	1.2	0.2	1.1	0.1	0.8	0.7	0.8	0.3	0.5
30-08A	0.2	1.4	0.2	1.0	0.2	1.0	0.1	0.7	0.6	0.6	0.2	0.5
30-08B	0.3	1.9	0.3	1.4	0.2	1.3	0.2	1.0	0.8	1.0	0.4	0.6
30-08C	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.1	0.9	1.4	0.5	0.7
30-08D	0.4	2.2	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
30-08E	0.3	1.9	0.3	1.5	0.2	1.3	0.2	1.0	0.8	1.1	0.4	0.6
31-08A	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.1	0.9	1.3	0.5	0.7
31-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
31-08E	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.2	0.9	1.4	0.5	0.7
32-08A	0.3	1.6	0.2	1.2	0.2	1.1	0.1	0.8	0.7	0.8	0.3	0.5
32-08B	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
32-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.6	0.6	0.8
32-08D	0.2	1.3	0.2	0.9	0.2	0.9	0.1	0.7	0.6	0.5	0.2	0.4
32-08E	0.4	2.2	0.3	1.8	0.3	1.4	0.2	1.2	1.0	1.5	0.5	0.7
33-08A	0.4	2.2	0.3	1.7	0.3	1.4	0.2	1.2	1.0	1.4	0.5	0.7
33-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.7	0.6	0.8
33-08E	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.7	0.6	0.8
34-08A	0.4	2.0	0.3	1.6	0.2	1.4	0.2	1.1	0.9	1.3	0.5	0.7
34-08B	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.6	0.6	0.8
34-08C	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
34-08D	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.3	1.1	1.8	0.7	0.8
34-08E	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.7	0.6	0.8
35-08A	0.3	1.6	0.2	1.2	0.2	1.1	0.1	0.8	0.7	0.8	0.3	0.5
35-08C	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
35-08E	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
36-08A	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
36-08B	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
36-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
36-08D	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
36-08E	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
37-08A	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
28-08A	0.092483	-0.05012	0.009318	0.396265	0.057988	0.043785	-0.00478	0.283432	0.828361
28-08B	0.110398	-0.05983	0.011963	0.508751	0.066576	0.05027	-0.00592	0.35074	1.032942
28-08C	0.105959	-0.05743	0.011264	0.479012	0.064524	0.04872	-0.00563	0.333508	0.979929
28-08D	0.104781	-0.05679	0.011083	0.471345	0.063971	0.048303	-0.00555	0.329	0.966139
28-08E	0.11145	-0.0604	0.012133	0.516001	0.067055	0.050631	-0.00599	0.354879	1.045755
29-08A	0.072527	-0.03931	0.006816	0.28985	0.047444	0.035824	-0.00362	0.21446	0.623992
29-08C	0.102805	-0.05572	0.010786	0.458688	0.063036	0.047597	-0.00543	0.321499	0.943264
29-08E	0.071252	-0.03862	0.006668	0.283573	0.046735	0.035288	-0.00355	0.210233	0.611583
30-08A	0.062289	-0.03376	0.005666	0.240969	0.041629	0.031433	-0.00306	0.18107	0.526241
30-08B	0.083107	-0.04504	0.008094	0.344209	0.053164	0.040142	-0.00423	0.250331	0.729779
30-08C	0.093822	-0.05085	0.009501	0.40404	0.058658	0.044291	-0.00487	0.28827	0.842866
30-08D	0.100523	-0.05448	0.010449	0.444371	0.061944	0.046772	-0.00528	0.312925	0.91722
30-08E	0.084601	-0.04585	0.008283	0.352242	0.053948	0.040734	-0.00431	0.255519	0.745161
31-08A	0.093465	-0.05066	0.009452	0.401957	0.05848	0.044156	-0.00484	0.286976	0.838986
31-08C	0.103892	-0.05631	0.010949	0.465619	0.063551	0.047986	-0.0055	0.325615	0.955807
31-08E	0.095488	-0.05175	0.009731	0.41384	0.059486	0.044916	-0.00497	0.294329	0.861069
32-08A	0.071345	-0.03867	0.006679	0.284029	0.046787	0.035327	-0.00355	0.21054	0.612484
32-08B	0.103126	-0.05589	0.010834	0.460727	0.063188	0.047712	-0.00545	0.322712	0.946959
32-08C	0.102325	-0.05546	0.010714	0.455651	0.062807	0.047424	-0.0054	0.319688	0.937754
32-08D	0.057842	-0.03135	0.00519	0.220733	0.039017	0.02946	-0.00282	0.166934	0.48501
32-08E	0.098181	-0.05321	0.010111	0.429994	0.060809	0.045915	-0.00513	0.304221	0.890883
33-08A	0.096134	-0.0521	0.009821	0.417676	0.059805	0.045157	-0.00501	0.296689	0.868171
33-08C	0.105262	-0.05705	0.011157	0.474467	0.064197	0.048474	-0.00558	0.330839	0.971761
33-08E	0.105219	-0.05703	0.01115	0.474186	0.064177	0.048458	-0.00558	0.330674	0.971255
34-08A	0.091014	-0.04933	0.00912	0.387838	0.057247	0.043226	-0.00469	0.278157	0.812577
34-08B	0.102604	-0.05561	0.010756	0.457418	0.06294	0.047525	-0.00541	0.320741	0.94096
34-08C	0.108208	-0.05865	0.011614	0.493909	0.06557	0.04951	-0.00578	0.342191	1.006578
34-08D	0.107828	-0.05844	0.011554	0.491365	0.065394	0.049377	-0.00575	0.340715	1.002041
34-08E	0.105219	-0.05703	0.01115	0.474186	0.064177	0.048458	-0.00558	0.330674	0.971255
35-08A	0.072348	-0.03921	0.006795	0.288966	0.047345	0.035749	-0.00361	0.213866	0.622247
35-08C	0.110367	-0.05982	0.011958	0.50854	0.066562	0.050259	-0.00592	0.350619	1.032569
35-08E	0.106164	-0.05754	0.011295	0.480358	0.06462	0.048793	-0.00564	0.334297	0.982344
36-08A	0.110882	-0.0601	0.012041	0.512077	0.066797	0.050436	-0.00595	0.352642	1.038826
36-08B	0.104512	-0.05664	0.011043	0.46961	0.063844	0.048207	-0.00554	0.327976	0.963011
36-08C	0.10721	-0.05811	0.011458	0.487257	0.065107	0.049161	-0.00571	0.338326	0.994702
36-08D	0.109961	-0.0596	0.011893	0.505758	0.066376	0.050119	-0.00589	0.349024	1.027641
36-08E	0.103296	-0.05599	0.010859	0.461813	0.063269	0.047773	-0.00546	0.323357	0.948925
37-08A	0.111746	-0.06057	0.012182	0.518058	0.067189	0.050732	-0.00601	0.356049	1.049381

ρ12	0.969539	p+++ = p--- =	0.253367
ρ23	-0.08346	p++1 = p--+ =	0.239018
ρ31	0.140863	p+-+ = p -+- =	0.031849
E[y]			
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
37-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
37-08E	0.3	2.0	0.3	1.6	0.2	1.3	0.2	1.1	0.9	1.2	0.4	0.7
38-08A	0.4	2.1	0.3	1.7	0.2	1.4	0.2	1.1	0.9	1.4	0.5	0.7
38-08B	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
38-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
38-08D	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
38-08E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-08A	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
39-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
39-08E	0.4	2.2	0.3	1.8	0.3	1.5	0.2	1.2	1.0	1.5	0.6	0.7
40-08A	0.4	2.2	0.3	1.9	0.3	1.5	0.2	1.2	1.0	1.6	0.6	0.8
40-08B	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
40-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
40-08D	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
40-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
41-08A	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
41-08C	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.6	0.6	0.8
41-08E	0.3	1.8	0.2	1.4	0.2	1.2	0.2	0.9	0.8	0.9	0.3	0.6
42-08A	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
42-08B	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
42-08C	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
42-08D	0.4	2.1	0.3	1.6	0.2	1.4	0.2	1.1	0.9	1.3	0.5	0.7
42-08E	0.2	1.3	0.2	0.9	0.2	0.9	0.1	0.6	0.5	0.5	0.2	0.4
43-08A	0.4	2.3	0.3	2.0	0.3	1.5	0.2	1.3	1.1	1.7	0.6	0.8
43-08C	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
43-08E	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
44-08B	0.4	2.1	0.3	1.6	0.2	1.4	0.2	1.1	0.9	1.3	0.5	0.7
44-08C	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
44-08D	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
44-08E	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
46-08	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.9
48-08	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
50-08	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
51-08	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
52-08	0.4	2.4	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
53-08	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
56-08	0.5	2.7	0.4	2.5	0.3	1.7	0.3	1.6	1.2	2.4	0.9	0.9
58-08	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
	0.106979	-0.05798	0.011422	0.485728	0.065	0.04908	-0.0057	0.337435	0.991967
	0.08827	-0.04784	0.008756	0.372378	0.055848	0.04217	-0.00453	0.268396	0.783447
	0.094328	-0.05113	0.00957	0.407	0.05891	0.044482	-0.0049	0.290105	0.848374
	0.104692	-0.05674	0.01107	0.470769	0.063929	0.048271	-0.00555	0.32866	0.965101
	0.100942	-0.05471	0.01051	0.446977	0.062145	0.046924	-0.00531	0.314493	0.921974
	0.104557	-0.05667	0.011049	0.4699	0.063866	0.048223	-0.00554	0.328147	0.963536
	2.89E-07	-1.6E-07	2.02E-08	8.58E-07	2.33E-07	1.76E-07	-1.2E-08	7.3E-07	2.14E-06
	0.104399	-0.05658	0.011025	0.46888	0.063791	0.048167	-0.00553	0.327544	0.961695
	0.10108	-0.05478	0.010531	0.447835	0.062211	0.046974	-0.00532	0.315008	0.923538
	0.099745	-0.05406	0.010336	0.439556	0.061568	0.046488	-0.00523	0.31002	0.908419
	0.100325	-0.05437	0.01042	0.443139	0.061848	0.046699	-0.00527	0.312182	0.914969
	0.106487	-0.05772	0.011345	0.482481	0.064771	0.048907	-0.00566	0.335539	0.986152
	0.107267	-0.05814	0.011466	0.487636	0.065134	0.049181	-0.00571	0.338547	0.99538
	0.112465	-0.06095	0.0123	0.52308	0.067514	0.050978	-0.00606	0.358898	1.058223
	0.114742	-0.06219	0.01268	0.539253	0.068535	0.051749	-0.00621	0.367992	1.086552
	0.102805	-0.05572	0.010786	0.458688	0.063036	0.047597	-0.00543	0.321499	0.943264
	0.10268	-0.05565	0.010767	0.457895	0.062976	0.047552	-0.00542	0.321026	0.941827
	0.079138	-0.04289	0.007603	0.323315	0.051053	0.038548	-0.004	0.236701	0.689471
	0.111	-0.06016	0.01206	0.512893	0.06685	0.050477	-0.00596	0.353108	1.040268
	0.107134	-0.05807	0.011446	0.48675	0.065072	0.049134	-0.00571	0.338031	0.993794
	0.104193	-0.05647	0.010994	0.467555	0.063694	0.048094	-0.00552	0.326762	0.959305
	0.092103	-0.04992	0.009266	0.394077	0.057797	0.043641	-0.00476	0.282065	0.824269
	0.056707	-0.03073	0.005071	0.21566	0.038342	0.028951	-0.00276	0.163361	0.4746
	0.104979	-0.0569	0.011114	0.472631	0.064065	0.048373	-0.00557	0.329758	0.968456
	0.107018	-0.058	0.011428	0.485984	0.065018	0.049093	-0.0057	0.337585	0.992425
	0.105979	-0.05744	0.011267	0.479147	0.064534	0.048727	-0.00563	0.333587	0.980171
	0.091933	-0.04983	0.009243	0.393094	0.057711	0.043576	-0.00475	0.281451	0.822431
	0.111059	-0.06019	0.01207	0.513299	0.066877	0.050497	-0.00596	0.35334	1.040985
	0.113221	-0.06136	0.012425	0.528406	0.067855	0.051235	-0.00611	0.361906	1.067576
	0.111815	-0.0606	0.012193	0.518542	0.06722	0.050756	-0.00601	0.356324	1.050234
	0.111912	-0.06066	0.012209	0.519215	0.067264	0.050789	-0.00602	0.356707	1.051421
	0.112778	-0.06112	0.012352	0.525279	0.067655	0.051085	-0.00608	0.360142	1.062087
	0.106863	-0.05792	0.011403	0.484957	0.064946	0.049039	-0.00569	0.336985	0.990586
	0.110672	-0.05998	0.012007	0.510634	0.066701	0.050364	-0.00594	0.351817	1.036274
	0.108924	-0.05904	0.011727	0.498724	0.0659	0.049759	-0.00582	0.344975	1.015152
	0.11297	-0.06123	0.012383	0.526631	0.067742	0.05115	-0.00609	0.360905	1.06446
	0.121055	-0.06561	0.013789	0.586402	0.0713	0.053836	-0.00665	0.39382	1.167945
	0.110971	-0.06015	0.012056	0.51269	0.066837	0.050467	-0.00596	0.352992	1.039909

ρ12	0.969539	p+++ = p--- =	0.253367
ρ23	-0.08346	p++1 = p--+ =	0.239018
ρ31	0.140863	p+-+ = p -+- =	0.031849
E[y]			
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
61-08	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.9	0.9
62-08	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.8	0.9
63-08	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
64-08	0.5	2.6	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
65-08	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
66-08	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
10-08C	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
12-08B	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
12-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
13-08CC	0.4	2.5	0.4	2.1	0.3	1.6	0.2	1.4	1.1	1.9	0.7	0.8
16-08E	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
22-08CC***	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
23-08CC	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
23-08EE,EEE	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
24-08CC	0.4	2.5	0.4	2.2	0.3	1.6	0.2	1.4	1.1	2.0	0.7	0.8
26-08B	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.1	0.7	0.9
27-08AA	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.1	2.0	0.7	0.9
33-08CC	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.6	0.6	0.8
37-08AA	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
41-08AA	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
41-08CC	0.4	2.5	0.4	2.2	0.3	1.6	0.3	1.4	1.2	2.1	0.8	0.9
41-08EE	0.3	1.8	0.2	1.4	0.2	1.2	0.2	1.0	0.8	1.0	0.4	0.6
42-08AA	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.6	0.8
42-08CC	0.4	2.3	0.3	1.9	0.3	1.5	0.2	1.3	1.0	1.7	0.6	0.8
54-08	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
55-08	0.5	2.7	0.4	2.4	0.3	1.7	0.3	1.6	1.2	2.4	0.9	0.9
57-08	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.2	0.8	0.9
B-14	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
B-15	0.5	2.6	0.4	2.3	0.3	1.6	0.3	1.5	1.2	2.1	0.8	0.9
B-16	0.5	2.6	0.4	2.4	0.3	1.7	0.3	1.5	1.2	2.3	0.8	0.9
avg	0.4	2.4	0.4	2.0	0.3	1.5	0.2	1.3	1.1	1.8	0.7	0.8
max	0.5	2.7	0.4	2.5	0.3	1.7	0.3	1.6				
min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
std dev	0.1	0.3	0.1	0.4	0.0	0.2	0.0	0.2				

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
61-08	0.119881	-0.06497	0.013576	0.577365	0.070793	0.053454	-0.00656	0.388949	1.152479
62-08	0.113625	-0.06158	0.012492	0.531271	0.068036	0.051372	-0.00614	0.363519	1.072597
63-08	0.11861	-0.06429	0.013349	0.567716	0.070241	0.053037	-0.00648	0.383706	1.135898
64-08	0.114063	-0.06182	0.012566	0.534391	0.068232	0.05152	-0.00617	0.365271	1.078057
65-08	0.115762	-0.06274	0.012854	0.54664	0.068989	0.052092	-0.00628	0.372106	1.099421
66-08	0.102954	-0.0558	0.010808	0.459633	0.063107	0.04765	-0.00544	0.322061	0.944977
10-08C	0.117019	-0.06342	0.01307	0.555852	0.069544	0.052511	-0.00637	0.377201	1.115407
12-08B	0.115641	-0.06268	0.012833	0.545756	0.068935	0.052051	-0.00627	0.371615	1.097883
12-08E	0.115289	-0.06249	0.012773	0.543207	0.068779	0.051933	-0.00625	0.370197	1.093445
13-08CC	0.109672	-0.05944	0.011846	0.503791	0.066244	0.050019	-0.00587	0.347894	1.024153
16-08E	0.115783	-0.06275	0.012857	0.546787	0.068998	0.052098	-0.00628	0.372188	1.099675
22-08CC***	0.112791	-0.06113	0.012354	0.52537	0.067661	0.051089	-0.00608	0.360193	1.062246
23-08CC	0.11354	-0.06154	0.012478	0.53067	0.067998	0.051344	-0.00613	0.363181	1.071544
23-08EE,EEE	0.103321	-0.056	0.010863	0.461967	0.063281	0.047782	-0.00546	0.323449	0.949204
24-08CC	0.111277	-0.06031	0.012105	0.514809	0.066976	0.050572	-0.00598	0.3542	1.04365
26-08B	0.113308	-0.06141	0.01244	0.529021	0.067894	0.051265	-0.00611	0.362252	1.068653
27-08AA	0.112609	-0.06103	0.012324	0.524094	0.067579	0.051027	-0.00607	0.359472	1.060004
33-08CC	0.10263	-0.05562	0.01076	0.457577	0.062952	0.047534	-0.00542	0.320837	0.941249
37-08AA	0.106979	-0.05798	0.011422	0.485728	0.065	0.04908	-0.0057	0.337435	0.991967
41-08AA	0.10283	-0.05573	0.010789	0.458846	0.063048	0.047606	-0.00543	0.321593	0.94355
41-08CC	0.113781	-0.06167	0.012519	0.532378	0.068106	0.051425	-0.00615	0.364141	1.074535
41-08EE	0.081848	-0.04436	0.007936	0.33751	0.052498	0.03964	-0.00415	0.245983	0.716903
42-08AA	0.105917	-0.05741	0.011257	0.478741	0.064505	0.048706	-0.00563	0.333349	0.979442
42-08CC	0.10283	-0.05573	0.010789	0.458846	0.063048	0.047606	-0.00543	0.321593	0.94355
54-08	0.119003	-0.0645	0.013419	0.570685	0.070412	0.053166	-0.0065	0.385324	1.141007
55-08	0.12082	-0.06548	0.013746	0.584582	0.071199	0.05376	-0.00663	0.392842	1.164835
57-08	0.1161	-0.06292	0.012912	0.549101	0.069138	0.052204	-0.0063	0.373471	1.103698
B-14	0.115477	-0.06259	0.012805	0.544565	0.068862	0.051996	-0.00626	0.370953	1.09581
B-15	0.114675	-0.06215	0.012669	0.538777	0.068506	0.051727	-0.00621	0.367727	1.085722
B-16	0.118006	-0.06396	0.013243	0.563185	0.069977	0.052838	-0.00643	0.381229	1.128085
avg									1.0

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
1-08	0.016325	-0.05014	0.001088	0.262254	0.007664	0.032793	-0.00041	0.138864	0.408436	0.111157	0.333402
2-08	0.005158	-0.01584	0.000291	0.070043	0.002725	0.011658	-0.00012	0.04012	0.114032	0.028243	0.168057
3-08	0.036742	-0.11284	0.003059	0.7372	0.01505	0.064396	-0.00104	0.350429	1.092988	0.332544	0.576667
4-08	0.040651	-0.12485	0.003522	0.848642	0.016294	0.069718	-0.00118	0.395448	1.248247	0.386749	0.621891
5-08	0.055045	-0.16906	0.00552	1.330166	0.02051	0.087757	-0.00171	0.574723	1.902951	0.627764	0.792315
7-08	0.056436	-0.17333	0.005741	1.383535	0.02089	0.089384	-0.00177	0.593248	1.974137	0.655044	0.809348
9-08	0.052012	-0.15974	0.005056	1.218404	0.019666	0.084144	-0.00159	0.535115	1.753059	0.570967	0.755623
10-08A	0.053378	-0.16394	0.005262	1.267986	0.020049	0.085783	-0.00165	0.552825	1.819698	0.596107	0.77208
10-08B	0.050956	-0.1565	0.0049	1.180871	0.019366	0.082864	-0.00155	0.521559	1.702462	0.551999	0.742966
10-08D	0.054104	-0.16617	0.005373	1.294831	0.02025	0.086646	-0.00167	0.562321	1.855683	0.609757	0.780869
10-08E	0.049431	-0.15182	0.00468	1.127886	0.018929	0.080994	-0.0015	0.502195	1.630804	0.525318	0.724788
11-08A	0.051213	-0.15729	0.004938	1.189932	0.019439	0.083176	-0.00156	0.524844	1.71469	0.556573	0.746038
11-08C	0.053146	-0.16323	0.005226	1.259489	0.019984	0.085506	-0.00164	0.549806	1.808293	0.591792	0.76928
11-08E	0.054572	-0.16761	0.005446	1.312367	0.02038	0.087201	-0.00169	0.56849	1.879155	0.618688	0.786567
12-08A	0.052873	-0.16239	0.005185	1.24951	0.019908	0.085179	-0.00163	0.546252	1.794893	0.586728	0.765982
12-08C	0.052052	-0.15987	0.005062	1.219825	0.019677	0.084192	-0.0016	0.535626	1.754972	0.571686	0.756099
12-08D	0.052403	-0.16094	0.005114	1.232451	0.019776	0.084615	-0.00161	0.540156	1.771962	0.57808	0.760316
13-08A	0.05392	-0.1656	0.005345	1.288016	0.0202	0.086428	-0.00167	0.559917	1.846554	0.60629	0.778646
13-08C	0.053272	-0.16361	0.005245	1.264082	0.020019	0.085656	-0.00164	0.551439	1.814458	0.594124	0.770794
13-08E	0.054169	-0.16637	0.005383	1.297286	0.020269	0.086724	-0.00168	0.563187	1.858971	0.611007	0.781669
14-08A	0.051721	-0.15885	0.005013	1.207988	0.019584	0.083793	-0.00158	0.531367	1.739032	0.565698	0.752129
14-08B	0.052052	-0.15987	0.005062	1.219825	0.019677	0.084192	-0.0016	0.535626	1.754972	0.571686	0.756099
14-08C	0.05216	-0.1602	0.005078	1.223714	0.019707	0.084323	-0.0016	0.537023	1.760207	0.573655	0.7574
14-08D	0.052593	-0.16153	0.005143	1.23934	0.019829	0.084844	-0.00162	0.542621	1.781225	0.581571	0.762608
14-08E	0.051711	-0.15882	0.005011	1.207626	0.019581	0.08378	-0.00158	0.531236	1.738543	0.565514	0.752007
15-08A	0.054683	-0.16795	0.005463	1.316509	0.02041	0.087331	-0.0017	0.569943	1.884695	0.620799	0.787908
15-08C	0.05462	-0.16775	0.005453	1.314146	0.020393	0.087257	-0.0017	0.569114	1.881535	0.619594	0.787143
15-08E	0.054884	-0.16857	0.005495	1.324111	0.020466	0.087569	-0.00171	0.572606	1.894859	0.624675	0.790364
16-08A	0.048539	-0.14908	0.004554	1.097525	0.018671	0.079888	-0.00146	0.490977	1.589616	0.510081	0.7142
16-08B	0.05493	-0.16871	0.005502	1.325848	0.020479	0.087623	-0.00171	0.573214	1.897182	0.625561	0.790924
16-08C	0.05278	-0.1621	0.005171	1.246142	0.019882	0.085068	-0.00162	0.545051	1.790367	0.58502	0.764866
16-08D	0.050072	-0.15379	0.004772	1.149985	0.019114	0.081783	-0.00152	0.510304	1.660724	0.536432	0.732415
17-08A	0.049589	-0.1523	0.004703	1.133283	0.018975	0.081188	-0.0015	0.50418	1.638114	0.52803	0.726657
17-08B	0.051423	-0.15793	0.004969	1.197373	0.019499	0.083431	-0.00157	0.527535	1.724725	0.560332	0.748553
17-08C	0.05163	-0.15857	0.004999	1.204716	0.019558	0.083682	-0.00158	0.530187	1.734622	0.564043	0.751028
17-08E	0.054373	-0.16699	0.005415	1.304883	0.020325	0.086965	-0.00169	0.56586	1.869141	0.614875	0.78414
18-08A	0.053146	-0.16323	0.005226	1.259489	0.019984	0.085506	-0.00164	0.549806	1.808293	0.591792	0.76928
18-08B	0.052762	-0.16205	0.005168	1.245465	0.019876	0.085046	-0.00162	0.544809	1.789458	0.584677	0.764642

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
18-08C	0.051883	-0.15935	0.005037	1.213759	0.019629	0.083988	-0.00159	0.533445	1.746805	0.568617	0.754067
18-08D	0.052355	-0.1608	0.005107	1.230715	0.019762	0.084557	-0.00161	0.539534	1.769627	0.5772	0.759737
18-08E	0.054153	-0.16632	0.005381	1.296673	0.020264	0.086705	-0.00168	0.562971	1.85815	0.610695	0.78147
19-08A	0.044755	-0.13746	0.004041	0.973936	0.017552	0.075101	-0.00132	0.444361	1.420967	0.448472	0.669681
19-08C	0.048009	-0.14745	0.00448	1.079728	0.018517	0.079227	-0.00144	0.48436	1.56543	0.501168	0.707932
19-08E	0.046305	-0.14222	0.004247	1.023585	0.018015	0.077081	-0.00138	0.463276	1.488914	0.47314	0.687852
20-08A	0.05215	-0.16017	0.005076	1.223362	0.019705	0.084311	-0.0016	0.536896	1.759733	0.573477	0.757282
20-08B	0.052602	-0.16156	0.005144	1.239682	0.019832	0.084855	-0.00162	0.542743	1.781685	0.581745	0.762722
20-08C	0.047472	-0.1458	0.004406	1.061871	0.018359	0.078555	-0.00142	0.477688	1.541128	0.492238	0.701597
20-08D	0.048539	-0.14908	0.004554	1.097525	0.018671	0.079888	-0.00146	0.490977	1.589616	0.510081	0.7142
20-08E	0.048681	-0.14951	0.004574	1.10233	0.018712	0.080065	-0.00147	0.492759	1.59614	0.51249	0.715884
21-08A	0.050793	-0.156	0.004876	1.175133	0.01932	0.082665	-0.00155	0.519475	1.694715	0.549104	0.741016
21-08C	0.049516	-0.15208	0.004692	1.130798	0.018954	0.081099	-0.0015	0.503266	1.634749	0.526781	0.725797
21-08E	0.039634	-0.12173	0.003398	0.818951	0.015975	0.068353	-0.00114	0.383598	1.207038	0.37224	0.610115
22-08A	0.056121	-0.17236	0.00569	1.371339	0.020805	0.089018	-0.00175	0.589037	1.957892	0.648801	0.805482
22-08B	0.052032	-0.15981	0.005059	1.219115	0.019671	0.084168	-0.00159	0.535371	1.754016	0.571327	0.755862
22-08C	0.048986	-0.15045	0.004617	1.112683	0.018801	0.080443	-0.00148	0.496589	1.610191	0.517683	0.719502
22-08D	0.048604	-0.14928	0.004563	1.099714	0.01869	0.079969	-0.00146	0.491789	1.592588	0.511178	0.714967
22-08E	0.041159	-0.12641	0.003584	0.863683	0.016452	0.070396	-0.0012	0.401412	1.269079	0.394117	0.627787
23-08A	0.05065	-0.15556	0.004855	1.170113	0.019279	0.08249	-0.00154	0.517649	1.687935	0.546573	0.739306
23-08C	0.047654	-0.14636	0.004431	1.06788	0.018413	0.078782	-0.00143	0.479937	1.54931	0.495241	0.703734
23-08E	0.03585	-0.1101	0.002958	0.712787	0.01476	0.063153	-0.00101	0.340365	1.058753	0.320765	0.566361
24-08A	0.048771	-0.14979	0.004587	1.105368	0.018738	0.080176	-0.00147	0.493884	1.600264	0.514013	0.716947
24-08B	0.048461	-0.14884	0.004543	1.094888	0.018648	0.079791	-0.00146	0.489999	1.586034	0.50876	0.713274
24-08C	0.051568	-0.15838	0.00499	1.202523	0.01954	0.083607	-0.00158	0.529396	1.731667	0.562934	0.75029
24-08D	0.046214	-0.14194	0.004235	1.02062	0.017988	0.076965	-0.00138	0.462153	1.484863	0.471663	0.686778
24-08E	0.050222	-0.15425	0.004794	1.155183	0.019157	0.081967	-0.00153	0.512204	1.667754	0.539049	0.7342
25-08A	0.04775	-0.14665	0.004445	1.071092	0.018441	0.078903	-0.00143	0.481137	1.553681	0.496847	0.704874
25-08C	0.042271	-0.12982	0.003722	0.897041	0.016796	0.071867	-0.00123	0.414548	1.315185	0.410498	0.640701
25-08E	0.046988	-0.14431	0.00434	1.045878	0.018217	0.077945	-0.0014	0.471686	1.519336	0.484252	0.695883
26-08A	0.050793	-0.156	0.004876	1.175133	0.01932	0.082665	-0.00155	0.519475	1.694715	0.549104	0.741016
26-08B	0.050639	-0.15553	0.004854	1.169725	0.019276	0.082477	-0.00154	0.517508	1.687411	0.546377	0.739173
26-08C	0.050935	-0.15643	0.004897	1.180109	0.01936	0.082838	-0.00155	0.521283	1.701434	0.551615	0.742708
26-08D	0.047458	-0.14576	0.004404	1.061406	0.018355	0.078538	-0.00142	0.477514	1.540495	0.492006	0.701431
26-08E	0.05215	-0.16017	0.005076	1.223362	0.019705	0.084311	-0.0016	0.536896	1.759733	0.573477	0.757282
27-08A	0.052032	-0.15981	0.005059	1.219115	0.019671	0.084168	-0.00159	0.535371	1.754016	0.571327	0.755862
27-08C	0.053307	-0.16372	0.005251	1.265386	0.020029	0.085698	-0.00164	0.551902	1.816209	0.594787	0.771224
27-08E	0.052412	-0.16097	0.005116	1.232798	0.019778	0.084626	-0.00161	0.54028	1.772428	0.578256	0.760431

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
28-08A	0.033758	-0.10368	0.002726	0.656963	0.014068	0.060195	-0.00094	0.317063	0.980149	0.293967	0.542187
28-08B	0.048103	-0.14774	0.004494	1.08288	0.018544	0.079345	-0.00145	0.485534	1.569715	0.502745	0.709045
28-08C	0.044312	-0.1361	0.003984	0.959981	0.017419	0.074529	-0.00131	0.438998	1.40182	0.441559	0.664499
28-08D	0.043332	-0.13309	0.003857	0.929496	0.017121	0.073258	-0.00127	0.427209	1.359916	0.426491	0.653063
28-08E	0.049024	-0.15057	0.004622	1.113965	0.018812	0.08049	-0.00148	0.497063	1.61193	0.518327	0.719949
29-08A	0.020761	-0.06376	0.001459	0.351493	0.009418	0.040295	-0.00054	0.181528	0.540649	0.151283	0.388951
29-08C	0.041714	-0.12811	0.003653	0.880248	0.016624	0.071131	-0.00122	0.407951	1.291992	0.402244	0.634227
29-08E	0.020037	-0.06154	0.001396	0.336435	0.009138	0.039099	-0.00052	0.174442	0.518487	0.144454	0.380071
30-08A	0.015314	-0.04703	0.001008	0.242936	0.00725	0.031023	-0.00039	0.129403	0.379516	0.102587	0.320292
30-08B	0.02726	-0.08372	0.002057	0.495695	0.011825	0.050596	-0.00074	0.247332	0.750305	0.217727	0.466613
30-08C	0.034743	-0.1067	0.002834	0.682996	0.014396	0.061595	-0.00098	0.32798	1.016863	0.30644	0.55357
30-08D	0.039883	-0.12249	0.003428	0.826156	0.016053	0.068688	-0.00115	0.386483	1.217049	0.375757	0.61299
30-08E	0.028249	-0.08676	0.002154	0.5191	0.012176	0.052099	-0.00077	0.257689	0.78394	0.228675	0.4782
31-08A	0.034479	-0.10589	0.002805	0.675973	0.014308	0.061221	-0.00097	0.325044	1.006968	0.303071	0.550519
31-08C	0.0426	-0.13084	0.003764	0.90705	0.016897	0.0723	-0.00125	0.418465	1.328993	0.415425	0.644534
31-08E	0.035987	-0.11053	0.002973	0.716532	0.014805	0.063345	-0.00102	0.341913	1.06401	0.32257	0.567952
32-08A	0.02009	-0.0617	0.001401	0.337516	0.009158	0.039186	-0.00052	0.174952	0.52008	0.144943	0.380714
32-08B	0.041974	-0.12892	0.003685	0.888093	0.016705	0.071476	-0.00122	0.411036	1.30283	0.406098	0.637259
32-08C	0.041325	-0.12692	0.003604	0.86863	0.016504	0.070616	-0.0012	0.403368	1.275925	0.396542	0.629716
32-08D	0.013205	-0.04056	0.000846	0.203848	0.006369	0.027251	-0.00033	0.109987	0.320622	0.085387	0.292211
32-08E	0.038046	-0.11685	0.00321	0.773563	0.01547	0.066193	-0.00109	0.365282	1.143827	0.350154	0.591738
33-08A	0.036476	-0.11203	0.003029	0.729877	0.014964	0.064026	-0.00103	0.347418	1.082728	0.329007	0.573592
33-08C	0.043731	-0.13431	0.003908	0.941851	0.017243	0.073777	-0.00129	0.431999	1.376911	0.432592	0.657717
33-08E	0.043696	-0.1342	0.003904	0.940737	0.017232	0.07373	-0.00129	0.431567	1.375379	0.432042	0.657299
34-08A	0.032694	-0.10041	0.002611	0.629318	0.013711	0.058667	-0.00091	0.305371	0.941051	0.28077	0.529877
34-08B	0.041551	-0.12761	0.003632	0.875378	0.016574	0.070916	-0.00121	0.406032	1.28526	0.399854	0.63234
34-08C	0.046214	-0.14194	0.004235	1.02062	0.017988	0.076965	-0.00138	0.462153	1.484863	0.471663	0.686778
34-08D	0.045889	-0.14094	0.004192	1.010135	0.017891	0.076553	-0.00136	0.458177	1.470533	0.466446	0.682968
34-08E	0.043696	-0.1342	0.003904	0.940737	0.017232	0.07373	-0.00129	0.431567	1.375379	0.432042	0.657299
35-08A	0.020659	-0.06345	0.00145	0.349352	0.009378	0.040127	-0.00054	0.180523	0.537501	0.15031	0.387699
35-08C	0.048076	-0.14766	0.00449	1.081981	0.018536	0.079311	-0.00145	0.485199	1.568493	0.502295	0.708728
35-08E	0.044484	-0.13662	0.004006	0.965382	0.01747	0.074751	-0.00131	0.441076	1.409233	0.444234	0.666509
36-08A	0.048526	-0.14904	0.004552	1.097086	0.018667	0.079872	-0.00146	0.490815	1.58902	0.509861	0.714046
36-08B	0.04311	-0.1324	0.003829	0.922665	0.017054	0.072968	-0.00126	0.424554	1.350511	0.42312	0.650477
36-08C	0.045365	-0.13933	0.004122	0.993314	0.017735	0.075884	-0.00135	0.451774	1.447518	0.458086	0.676821
36-08D	0.047723	-0.14657	0.004441	1.070176	0.018433	0.078869	-0.00143	0.480795	1.552435	0.496389	0.704549
36-08E	0.042113	-0.12934	0.003703	0.892282	0.016748	0.071659	-0.00123	0.412681	1.308616	0.408158	0.638872
37-08A	0.049285	-0.15137	0.004659	1.122862	0.018887	0.080813	-0.00149	0.500345	1.623993	0.522793	0.723045

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
37-08C	0.04517	-0.13873	0.004096	0.98709	0.017677	0.075634	-0.00134	0.449397	1.438995	0.454997	0.674534
37-08E	0.030752	-0.09445	0.002407	0.580148	0.013049	0.055835	-0.00085	0.284315	0.871212	0.257423	0.507369
38-08A	0.035118	-0.10786	0.002876	0.693042	0.01452	0.062125	-0.00099	0.332169	1.031003	0.311264	0.557911
38-08B	0.043259	-0.13286	0.003848	0.927226	0.017099	0.073162	-0.00127	0.426327	1.356791	0.425371	0.652204
38-08C	0.040216	-0.12351	0.003469	0.835875	0.016158	0.069135	-0.00116	0.390365	1.23054	0.380504	0.61685
38-08D	0.043148	-0.13252	0.003833	0.923808	0.017065	0.073017	-0.00127	0.424998	1.352085	0.423684	0.65091
38-08E	3.3E-13	-1E-12	1.28E-14	3.08E-12	2.28E-13	9.76E-13	-6.3E-15	2.1E-12	5.71E-12	1.14E-12	1.07E-06
39-08A	0.043017	-0.13212	0.003817	0.919799	0.017025	0.072846	-0.00126	0.423438	1.346563	0.421707	0.64939
39-08C	0.040326	-0.12385	0.003482	0.839087	0.016192	0.069283	-0.00117	0.391645	1.234997	0.382075	0.618122
39-08E	0.039267	-0.1206	0.003354	0.808348	0.015859	0.067857	-0.00113	0.379341	1.192296	0.367071	0.605864
40-08A	0.039725	-0.12201	0.003409	0.821579	0.016004	0.068475	-0.00115	0.384651	1.21069	0.373522	0.611165
40-08B	0.044755	-0.13746	0.004041	0.973936	0.017552	0.075101	-0.00132	0.444361	1.420967	0.448472	0.669681
40-08C	0.045414	-0.13948	0.004128	0.994861	0.01775	0.075945	-0.00135	0.452364	1.449636	0.458854	0.677388
40-08D	0.049921	-0.15332	0.00475	1.14474	0.01907	0.081597	-0.00151	0.508384	1.653627	0.533793	0.730611
40-08E	0.051963	-0.15959	0.005048	1.216622	0.019652	0.084084	-0.00159	0.534475	1.75066	0.570065	0.755027
41-08A	0.041714	-0.12811	0.003653	0.880248	0.016624	0.071131	-0.00122	0.407951	1.291992	0.402244	0.634227
41-08C	0.041612	-0.1278	0.00364	0.877208	0.016593	0.070997	-0.00121	0.406753	1.28779	0.400752	0.63305
41-08E	0.024719	-0.07592	0.001815	0.437343	0.010904	0.046657	-0.00066	0.221132	0.665994	0.190623	0.436604
42-08A	0.048629	-0.14935	0.004567	1.100587	0.018697	0.080001	-0.00147	0.492113	1.593774	0.511616	0.715273
42-08B	0.0453	-0.13913	0.004113	0.991246	0.017716	0.075801	-0.00134	0.450984	1.444686	0.457059	0.676062
42-08C	0.042848	-0.1316	0.003795	0.914611	0.016973	0.072624	-0.00126	0.421416	1.339416	0.41915	0.647418
42-08D	0.033481	-0.10283	0.002696	0.649728	0.013976	0.059799	-0.00094	0.314013	0.969928	0.290508	0.538988
42-08E	0.012692	-0.03898	0.000807	0.194585	0.006151	0.026317	-0.00031	0.105329	0.306585	0.081341	0.285203
43-08A	0.043497	-0.13359	0.003878	0.934577	0.017171	0.073472	-0.00128	0.429181	1.366907	0.428999	0.65498
43-08C	0.045203	-0.13883	0.0041	0.988131	0.017686	0.075675	-0.00134	0.449795	1.440421	0.455513	0.674917
43-08E	0.04433	-0.13615	0.003986	0.960523	0.017424	0.074552	-0.00131	0.439206	1.402564	0.441828	0.664701
44-08B	0.033357	-0.10245	0.002683	0.646493	0.013934	0.059621	-0.00093	0.312647	0.965356	0.288963	0.537553
44-08C	0.048681	-0.14951	0.004574	1.10233	0.018712	0.080065	-0.00147	0.492759	1.59614	0.51249	0.715884
44-08D	0.050595	-0.15539	0.004847	1.168171	0.019263	0.082423	-0.00154	0.516942	1.685311	0.545593	0.738643
44-08E	0.049346	-0.15156	0.004668	1.12496	0.018905	0.080889	-0.00149	0.501118	1.626838	0.523848	0.723773
46-08	0.049431	-0.15182	0.00468	1.127886	0.018929	0.080994	-0.0015	0.502195	1.630804	0.525318	0.724788
48-08	0.050199	-0.15418	0.00479	1.154386	0.01915	0.081939	-0.00152	0.511913	1.666677	0.538648	0.733926
50-08	0.045072	-0.13843	0.004083	0.983957	0.017647	0.075507	-0.00133	0.448199	1.434702	0.453442	0.673381
51-08	0.048342	-0.14847	0.004527	1.090911	0.018614	0.079644	-0.00146	0.488522	1.580632	0.506767	0.711876
52-08	0.046827	-0.14382	0.004318	1.040617	0.01817	0.077743	-0.0014	0.469706	1.512161	0.481628	0.693994
53-08	0.05037	-0.1547	0.004815	1.160334	0.019199	0.082148	-0.00153	0.514085	1.67472	0.541644	0.735965
56-08	0.057838	-0.17764	0.00597	1.438671	0.021269	0.091004	-0.00182	0.612133	2.047425	0.68333	0.826638
58-08	0.048604	-0.14928	0.004563	1.099714	0.01869	0.079969	-0.00146	0.491789	1.592588	0.511178	0.714967

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
61-08	0.056722	-0.17421	0.005787	1.394667	0.020968	0.089716	-0.00178	0.597082	1.988954	0.660747	0.812863
62-08	0.050956	-0.1565	0.0049	1.180871	0.019366	0.082864	-0.00155	0.521559	1.702462	0.551999	0.742966
63-08	0.055525	-0.17053	0.005595	1.348445	0.020642	0.088321	-0.00173	0.581096	1.92736	0.637096	0.798183
64-08	0.05135	-0.15771	0.004958	1.19478	0.019478	0.083343	-0.00157	0.526598	1.721228	0.559022	0.747677
65-08	0.052891	-0.16244	0.005188	1.250181	0.019913	0.085201	-0.00163	0.546492	1.795794	0.587069	0.766204
66-08	0.041834	-0.12849	0.003668	0.883879	0.016662	0.071291	-0.00122	0.40938	1.297009	0.404028	0.635632
10-08C	0.054046	-0.16599	0.005364	1.292672	0.020234	0.086577	-0.00167	0.56156	1.852792	0.608658	0.780166
12-08B	0.05278	-0.1621	0.005171	1.246142	0.019882	0.085068	-0.00162	0.545051	1.790367	0.58502	0.764866
12-08E	0.05246	-0.16112	0.005123	1.234527	0.019792	0.084684	-0.00161	0.540899	1.774754	0.579132	0.761007
13-08CC	0.047472	-0.1458	0.004406	1.061871	0.018359	0.078555	-0.00142	0.477688	1.541128	0.492238	0.701597
16-08E	0.05291	-0.1625	0.005191	1.250852	0.019918	0.085223	-0.00163	0.546731	1.796695	0.587409	0.766426
22-08CC***	0.050211	-0.15421	0.004792	1.154784	0.019153	0.081953	-0.00153	0.512059	1.667216	0.538849	0.734063
23-08CC	0.05088	-0.15627	0.004889	1.178201	0.019345	0.082772	-0.00155	0.520589	1.698857	0.550652	0.742059
23-08EE,EEE	0.042133	-0.1294	0.003705	0.892879	0.016754	0.071685	-0.00123	0.412915	1.309439	0.408451	0.639102
24-08CC	0.048872	-0.1501	0.004601	1.108821	0.018768	0.080303	-0.00147	0.495162	1.604951	0.515746	0.718154
26-08B	0.050672	-0.15563	0.004859	1.170888	0.019285	0.082517	-0.00154	0.517931	1.688982	0.546963	0.73957
27-08AA	0.050049	-0.15371	0.004769	1.149181	0.019107	0.081755	-0.00152	0.51001	1.659636	0.536027	0.732139
33-08CC	0.041571	-0.12768	0.003635	0.875989	0.01658	0.070943	-0.00121	0.406272	1.286104	0.400153	0.632577
37-08AA	0.04517	-0.13873	0.004096	0.98709	0.017677	0.075634	-0.00134	0.449397	1.438995	0.454997	0.674534
41-08AA	0.041734	-0.12818	0.003655	0.880854	0.016631	0.071158	-0.00122	0.408189	1.29283	0.402542	0.634462
41-08CC	0.051096	-0.15693	0.004921	1.185797	0.019406	0.083034	-0.00156	0.523346	1.709111	0.554485	0.744638
41-08EE	0.02644	-0.08121	0.001978	0.476588	0.011531	0.049337	-0.00071	0.238814	0.722771	0.208822	0.456971
42-08AA	0.044278	-0.13599	0.003979	0.958896	0.017408	0.074485	-0.00131	0.43858	1.40033	0.441022	0.664095
42-08CC	0.041734	-0.12818	0.003655	0.880854	0.016631	0.071158	-0.00122	0.408189	1.29283	0.402542	0.634462
54-08	0.055894	-0.17167	0.005654	1.362582	0.020743	0.088753	-0.00175	0.586004	1.946218	0.644322	0.802697
55-08	0.057614	-0.17695	0.005933	1.429752	0.021209	0.090746	-0.00181	0.609095	2.035587	0.678747	0.823861
57-08	0.0532	-0.16339	0.005235	1.261462	0.019999	0.085571	-0.00164	0.550508	1.810942	0.592794	0.769931
B-14	0.052631	-0.16164	0.005148	1.240707	0.01984	0.084889	-0.00162	0.54311	1.783063	0.582264	0.763062
B-15	0.051903	-0.15941	0.00504	1.214476	0.019635	0.084012	-0.00159	0.533703	1.747771	0.568979	0.754307
B-16	0.054961	-0.1688	0.005507	1.327004	0.020487	0.087659	-0.00171	0.573618	1.898725	0.62615	0.791297
avg										0.5	0.7
max											
min											
std dev											

Point Estimate Method Gas Vent Cap

r12	0.969539	p+++ = p--- =	0.253367
r23	-0.08346	p++1 = p--+ =	0.239018
r31	0.140863	p+-+ = p -+- =	0.031849
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
1-08	0.3	1.7	0.2	1.2	0.2	1.3	0.2	0.9	0.7	0.9	0.3	0.6
2-08	0.2	0.9	0.1	0.6	0.1	0.7	0.1	0.5	0.4	0.3	0.1	0.3
3-08	0.5	2.8	0.3	2.2	0.3	1.9	0.3	1.5	1.2	2.4	0.9	0.9
4-08	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.7	1.0	1.0
5-08	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.2	1.5	1.2
7-08	0.6	3.7	0.5	3.2	0.4	2.3	0.4	2.1	1.7	4.3	1.6	1.3
9-08	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
10-08A	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.5	1.2
10-08B	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
10-08D	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
10-08E	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.1
11-08A	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
11-08C	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.4	1.2
11-08E	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
12-08A	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
12-08C	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
12-08D	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
13-08A	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.0	1.5	1.2
13-08C	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.5	1.2
13-08E	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
14-08A	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
14-08B	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
14-08C	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
14-08D	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
14-08E	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
15-08A	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
15-08C	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
15-08E	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
16-08A	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
16-08B	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.2	1.5	1.2
16-08C	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
16-08D	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.2
17-08A	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.1
17-08B	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.8	1.4	1.2
17-08C	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.8	1.4	1.2
17-08E	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
18-08A	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.4	1.2
18-08B	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2

E[y]

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
1-08	0.078033	-0.04229	0.006221	0.293942	0.05311	0.040102	-0.00378	0.223658	0.648997
2-08	0.041618	-0.02256	0.003082	0.145645	0.029864	0.022549	-0.00194	0.114674	0.33294
3-08	0.125261	-0.06789	0.011089	0.524004	0.079649	0.06014	-0.0064	0.37924	1.105092
4-08	0.133314	-0.07225	0.012042	0.569032	0.083773	0.063255	-0.00688	0.407776	1.190054
5-08	0.161839	-0.08772	0.015828	0.747895	0.097462	0.073591	-0.00869	0.514864	1.515073
7-08	0.164539	-0.08918	0.016226	0.766728	0.098684	0.074514	-0.00887	0.525554	1.548196
9-08	0.155931	-0.08451	0.014983	0.707978	0.094744	0.071538	-0.0083	0.491836	1.444195
10-08A	0.158596	-0.08596	0.015359	0.725774	0.095977	0.07247	-0.00848	0.502164	1.475907
10-08B	0.153864	-0.08339	0.014696	0.694405	0.093778	0.070809	-0.00817	0.483891	1.419883
10-08D	0.160009	-0.08672	0.015562	0.735349	0.096627	0.07296	-0.00857	0.50768	1.492895
10-08E	0.15087	-0.08177	0.014287	0.675078	0.092366	0.069743	-0.00797	0.472479	1.385079
11-08A	0.154367	-0.08367	0.014765	0.69769	0.094014	0.070987	-0.0082	0.485819	1.425778
11-08C	0.158145	-0.08571	0.015295	0.722734	0.095769	0.072313	-0.00845	0.500407	1.470504
11-08E	0.160922	-0.08722	0.015694	0.741583	0.097044	0.073275	-0.00863	0.511256	1.503926
12-08A	0.157612	-0.08542	0.015219	0.71916	0.095523	0.072127	-0.00841	0.498337	1.464142
12-08C	0.156009	-0.08456	0.014994	0.70849	0.09478	0.071565	-0.00831	0.492134	1.44511
12-08D	0.156694	-0.08493	0.01509	0.713035	0.095098	0.071806	-0.00835	0.494781	1.453225
13-08A	0.159652	-0.08653	0.015511	0.732922	0.096463	0.072836	-0.00855	0.506285	1.488594
13-08C	0.158389	-0.08585	0.01533	0.724377	0.095882	0.072398	-0.00846	0.501357	1.473426
13-08E	0.160138	-0.08679	0.015581	0.736223	0.096685	0.073004	-0.00858	0.508182	1.494443
14-08A	0.155362	-0.0842	0.014903	0.704221	0.094479	0.071338	-0.00826	0.489642	1.437476
14-08B	0.156009	-0.08456	0.014994	0.70849	0.09478	0.071565	-0.00831	0.492134	1.44511
14-08C	0.15622	-0.08467	0.015023	0.709891	0.094878	0.07164	-0.00832	0.492951	1.447613
14-08D	0.157065	-0.08513	0.015142	0.71551	0.09527	0.071936	-0.00838	0.496219	1.45764
14-08E	0.155342	-0.08419	0.014901	0.70409	0.094469	0.071331	-0.00826	0.489566	1.437241
15-08A	0.161136	-0.08733	0.015725	0.743054	0.097142	0.073349	-0.00864	0.512098	1.506525
15-08C	0.161014	-0.08727	0.015707	0.742215	0.097086	0.073307	-0.00864	0.511618	1.505043
15-08E	0.161528	-0.08755	0.015782	0.745749	0.09732	0.073484	-0.00867	0.513639	1.511286
16-08A	0.149111	-0.08082	0.01405	0.663909	0.09153	0.069112	-0.00786	0.46583	1.364862
16-08B	0.161617	-0.08759	0.015795	0.746365	0.097361	0.073514	-0.00868	0.513991	1.512374
16-08C	0.157431	-0.08533	0.015194	0.717952	0.095439	0.072064	-0.0084	0.497636	1.46199
16-08D	0.15213	-0.08245	0.014458	0.683164	0.092963	0.070193	-0.00806	0.477267	1.399666
17-08A	0.151179	-0.08194	0.014328	0.677056	0.092513	0.069854	-0.00799	0.473652	1.38865
17-08B	0.154778	-0.08389	0.014822	0.700384	0.094206	0.071132	-0.00823	0.487398	1.430606
17-08C	0.155183	-0.08411	0.014878	0.703039	0.094395	0.071275	-0.00825	0.488951	1.43536
17-08E	0.160533	-0.08701	0.015638	0.738925	0.096866	0.073141	-0.0086	0.509733	1.499225
18-08A	0.158145	-0.08571	0.015295	0.722734	0.095769	0.072313	-0.00845	0.500407	1.470504
18-08B	0.157395	-0.08531	0.015189	0.717709	0.095423	0.072051	-0.0084	0.497496	1.461558

r12	0.969539	p+++ = p--- =	0.253367
r23	-0.08346	p++1 = p--+ =	0.239018
r31	0.140863	p+-+ = p -+- =	0.031849
		p+-- = p-++ =	-0.02423

Point Estimate Method Gas Vent Cap

with no correlation

Boring/CPT Number	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
18-08C	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
18-08D	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
18-08E	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
19-08A	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
19-08C	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.4	1.2	1.1
19-08E	0.6	3.2	0.4	2.7	0.4	2.1	0.3	1.8	1.4	3.2	1.2	1.1
20-08A	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
20-08B	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
20-08C	0.6	3.3	0.4	2.7	0.4	2.1	0.3	1.8	1.5	3.4	1.2	1.1
20-08D	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
20-08E	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
21-08A	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
21-08C	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.1
21-08E	0.5	2.9	0.4	2.3	0.3	2.0	0.3	1.6	1.3	2.6	1.0	1.0
22-08A	0.6	3.7	0.5	3.2	0.4	2.3	0.4	2.1	1.6	4.3	1.6	1.3
22-08B	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
22-08C	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.5	1.3	1.1
22-08D	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
22-08E	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
23-08A	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.3	1.2
23-08C	0.6	3.3	0.4	2.7	0.4	2.2	0.3	1.8	1.5	3.4	1.2	1.1
23-08E	0.5	2.8	0.3	2.1	0.3	1.9	0.3	1.5	1.2	2.3	0.8	0.9
24-08A	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
24-08B	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
24-08C	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.8	1.4	1.2
24-08D	0.6	3.2	0.4	2.7	0.4	2.1	0.3	1.8	1.4	3.2	1.2	1.1
24-08E	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.2
25-08A	0.6	3.3	0.4	2.7	0.4	2.2	0.3	1.8	1.5	3.4	1.2	1.1
25-08C	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.3	2.9	1.0	1.0
25-08E	0.6	3.3	0.4	2.7	0.4	2.1	0.3	1.8	1.4	3.3	1.2	1.1
26-08A	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
26-08B	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.3	1.2
26-08C	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
26-08D	0.6	3.3	0.4	2.7	0.4	2.1	0.3	1.8	1.5	3.4	1.2	1.1
26-08E	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
27-08A	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
27-08C	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.5	1.2
27-08E	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2

E[y]

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
	0.155678	-0.08438	0.014947	0.706303	0.094626	0.071449	-0.00829	0.490859	1.441201
	0.1566	-0.08488	0.015077	0.71241	0.095054	0.071773	-0.00835	0.494418	1.452111
	0.160106	-0.08678	0.015576	0.736005	0.096671	0.072993	-0.00858	0.508057	1.494056
	0.141597	-0.07674	0.013071	0.617616	0.087895	0.066367	-0.00739	0.437856	1.280267
	0.148064	-0.08025	0.013911	0.657327	0.09103	0.068734	-0.0078	0.461894	1.352914
	0.144687	-0.07842	0.013468	0.636384	0.089402	0.067505	-0.00758	0.449278	1.314722
	0.156201	-0.08466	0.015021	0.709764	0.094869	0.071633	-0.00832	0.492877	1.447386
	0.157084	-0.08514	0.015145	0.715633	0.095279	0.071942	-0.00838	0.496291	1.457859
	0.147003	-0.07967	0.013771	0.650696	0.09052	0.068349	-0.00773	0.457914	1.34085
	0.149111	-0.08082	0.01405	0.663909	0.09153	0.069112	-0.00786	0.46583	1.364862
	0.149391	-0.08097	0.014088	0.665681	0.091664	0.069213	-0.00788	0.466888	1.368075
	0.153544	-0.08322	0.014652	0.692322	0.093628	0.070696	-0.00815	0.482667	1.416142
	0.151037	-0.08186	0.014309	0.676146	0.092446	0.069803	-0.00799	0.473112	1.387007
	0.131237	-0.07113	0.011792	0.557222	0.082721	0.06246	-0.00676	0.400352	1.167898
	0.163929	-0.08885	0.016135	0.762436	0.098409	0.074306	-0.00883	0.523128	1.540665
	0.15597	-0.08453	0.014988	0.708234	0.094762	0.071552	-0.0083	0.491985	1.444653
	0.149993	-0.08129	0.014168	0.669494	0.09195	0.069429	-0.00792	0.46916	1.374981
	0.149238	-0.08089	0.014067	0.664716	0.091591	0.069158	-0.00787	0.466312	1.366326
	0.134348	-0.07282	0.012168	0.574968	0.084295	0.063648	-0.00695	0.41149	1.201156
	0.153264	-0.08307	0.014613	0.690497	0.093496	0.070596	-0.00813	0.481593	1.412864
	0.147362	-0.07987	0.013818	0.652931	0.090693	0.068479	-0.00775	0.459257	1.344919
	0.123396	-0.06688	0.010875	0.513862	0.078677	0.059407	-0.00629	0.372726	1.085772
	0.149568	-0.08106	0.014111	0.666801	0.091748	0.069276	-0.00789	0.467555	1.370104
	0.148956	-0.08073	0.01403	0.662935	0.091456	0.069056	-0.00785	0.465248	1.363096
	0.155062	-0.08404	0.014862	0.702246	0.094339	0.071232	-0.00824	0.488488	1.433942
	0.144505	-0.07832	0.013444	0.63527	0.089314	0.067438	-0.00757	0.448603	1.312683
	0.152424	-0.08261	0.014498	0.68506	0.093101	0.070298	-0.00807	0.478388	1.403082
	0.147553	-0.07997	0.013843	0.654124	0.090784	0.068549	-0.00776	0.459973	1.34709
	0.136602	-0.07404	0.012444	0.588026	0.085424	0.064501	-0.00708	0.419623	1.2255
	0.146043	-0.07915	0.013644	0.644734	0.090058	0.068	-0.00767	0.454324	1.329981
	0.153544	-0.08322	0.014652	0.692322	0.093628	0.070696	-0.00815	0.482667	1.416142
	0.153242	-0.08306	0.01461	0.690356	0.093486	0.070589	-0.00813	0.48151	1.41261
	0.153822	-0.08337	0.01469	0.694128	0.093758	0.070794	-0.00816	0.483729	1.419387
	0.146975	-0.07966	0.013767	0.650523	0.090507	0.068339	-0.00773	0.45781	1.340535
	0.156201	-0.08466	0.015021	0.709764	0.094869	0.071633	-0.00832	0.492877	1.447386
	0.15597	-0.08453	0.014988	0.708234	0.094762	0.071552	-0.0083	0.491985	1.444653
	0.158458	-0.08588	0.01534	0.724844	0.095914	0.072422	-0.00847	0.501627	1.474255
	0.156712	-0.08494	0.015093	0.713159	0.095107	0.071812	-0.00835	0.494853	1.453447

Point Estimate Method Gas Vent Cap

r12	0.969539	p+++ = p--- =	0.253367
r23	-0.08346	p++1 = p--+ =	0.239018
r31	0.140863	p+-+ = p -+- =	0.031849
		p+-- = p-++ =	-0.02423

with no correlation

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
28-08A	0.5	2.7	0.3	2.1	0.3	1.8	0.2	1.4	1.2	2.1	0.8	0.9
28-08B	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.4	1.3	1.1
28-08C	0.6	3.1	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
28-08D	0.5	3.1	0.4	2.5	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.0
28-08E	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.5	1.3	1.1
29-08A	0.4	2.0	0.2	1.4	0.3	1.4	0.2	1.0	0.9	1.2	0.4	0.7
29-08C	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
29-08E	0.3	2.0	0.2	1.4	0.2	1.4	0.2	1.0	0.8	1.1	0.4	0.6
30-08A	0.3	1.7	0.2	1.2	0.2	1.2	0.1	0.8	0.7	0.8	0.3	0.6
30-08B	0.4	2.3	0.3	1.7	0.3	1.6	0.2	1.2	1.0	1.6	0.6	0.8
30-08C	0.5	2.7	0.3	2.1	0.3	1.8	0.3	1.4	1.2	2.2	0.8	0.9
30-08D	0.5	2.9	0.4	2.3	0.3	2.0	0.3	1.6	1.3	2.6	1.0	1.0
30-08E	0.4	2.4	0.3	1.8	0.3	1.7	0.2	1.3	1.0	1.7	0.6	0.8
31-08A	0.5	2.7	0.3	2.1	0.3	1.8	0.3	1.4	1.2	2.2	0.8	0.9
31-08C	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	2.9	1.1	1.0
31-08E	0.5	2.8	0.3	2.2	0.3	1.9	0.3	1.5	1.2	2.3	0.8	0.9
32-08A	0.3	2.0	0.2	1.4	0.2	1.4	0.2	1.0	0.8	1.1	0.4	0.6
32-08B	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
32-08C	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
32-08D	0.3	1.6	0.2	1.1	0.2	1.1	0.1	0.8	0.7	0.7	0.3	0.5
32-08E	0.5	2.9	0.4	2.3	0.3	1.9	0.3	1.5	1.3	2.5	0.9	1.0
33-08A	0.5	2.8	0.3	2.2	0.3	1.9	0.3	1.5	1.2	2.4	0.9	0.9
33-08C	0.6	3.1	0.4	2.5	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.0
33-08E	0.6	3.1	0.4	2.5	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.0
34-08A	0.5	2.6	0.3	2.0	0.3	1.8	0.2	1.4	1.1	2.0	0.7	0.9
34-08B	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
34-08C	0.6	3.2	0.4	2.7	0.4	2.1	0.3	1.8	1.4	3.2	1.2	1.1
34-08D	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.8	1.4	3.2	1.2	1.1
34-08E	0.6	3.1	0.4	2.5	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.0
35-08A	0.4	2.0	0.2	1.4	0.2	1.4	0.2	1.0	0.9	1.2	0.4	0.7
35-08C	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.4	1.3	1.1
35-08E	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
36-08A	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
36-08B	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	2.9	1.1	1.0
36-08C	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.2	1.2	1.1
36-08D	0.6	3.3	0.4	2.7	0.4	2.2	0.3	1.8	1.5	3.4	1.2	1.1
36-08E	0.5	3.0	0.4	2.5	0.4	2.0	0.3	1.7	1.3	2.8	1.0	1.0
37-08A	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.5	1.3	1.1

E[y]

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
28-08A	0.118977	-0.06448	0.010375	0.490234	0.076349	0.057649	-0.00603	0.357425	1.040493
28-08B	0.148251	-0.08035	0.013936	0.658495	0.091119	0.068801	-0.00781	0.462593	1.355035
28-08C	0.14071	-0.07626	0.012958	0.612295	0.08746	0.066038	-0.00734	0.434597	1.27046
28-08D	0.138743	-0.0752	0.01271	0.600598	0.086489	0.065305	-0.00721	0.427403	1.248836
28-08E	0.150067	-0.08133	0.014178	0.669966	0.091985	0.069456	-0.00792	0.46944	1.375834
29-08A	0.089437	-0.04847	0.007301	0.344998	0.059889	0.04522	-0.00438	0.259593	0.753583
29-08C	0.135474	-0.07343	0.012306	0.58147	0.08486	0.064075	-0.00701	0.415546	1.213292
29-08E	0.08764	-0.0475	0.007127	0.336787	0.058836	0.044426	-0.00428	0.253868	0.736899
30-08A	0.075284	-0.0408	0.005968	0.281994	0.051441	0.038841	-0.00363	0.215133	0.624226
30-08B	0.104747	-0.05677	0.00884	0.417705	0.068617	0.051811	-0.00522	0.309381	0.899107
30-08C	0.121065	-0.06562	0.01061	0.501332	0.077454	0.058483	-0.00615	0.364634	1.061807
30-08D	0.131746	-0.0714	0.011853	0.5601	0.082979	0.062655	-0.00679	0.402165	1.173305
30-08E	0.10697	-0.05798	0.009073	0.428703	0.069849	0.052741	-0.00535	0.316771	0.920784
31-08A	0.120507	-0.06531	0.010547	0.498352	0.077159	0.058261	-0.00612	0.362702	1.056092
31-08C	0.137267	-0.0744	0.012527	0.591916	0.085756	0.064752	-0.00712	0.422036	1.232732
31-08E	0.123685	-0.06704	0.010908	0.515425	0.078828	0.05952	-0.00631	0.373732	1.088754
32-08A	0.087771	-0.04757	0.00714	0.337381	0.058913	0.044484	-0.00429	0.254283	0.738108
32-08B	0.136003	-0.07371	0.01237	0.584537	0.085124	0.064275	-0.00705	0.417455	1.219007
32-08C	0.134686	-0.073	0.012209	0.576914	0.084464	0.063777	-0.00697	0.412705	1.20479
32-08D	0.069318	-0.03757	0.005429	0.256521	0.04777	0.03607	-0.00332	0.19681	0.571027
32-08E	0.127968	-0.06936	0.011405	0.538914	0.081048	0.061197	-0.00656	0.388759	1.133372
33-08A	0.124706	-0.06759	0.011025	0.520974	0.07936	0.059922	-0.00637	0.377297	1.099326
33-08C	0.139545	-0.07563	0.012811	0.605351	0.086885	0.065605	-0.00726	0.430331	1.257633
33-08E	0.139473	-0.07559	0.012802	0.604923	0.08685	0.065578	-0.00726	0.430068	1.256841
34-08A	0.116702	-0.06325	0.010122	0.478286	0.075138	0.056734	-0.0059	0.349623	1.017452
34-08B	0.135145	-0.07325	0.012265	0.579562	0.084695	0.06395	-0.00699	0.414358	1.209734
34-08C	0.144505	-0.07832	0.013444	0.63527	0.089314	0.067438	-0.00757	0.448603	1.312683
34-08D	0.14386	-0.07797	0.013361	0.631324	0.089	0.067202	-0.00753	0.446209	1.305453
34-08E	0.139473	-0.07559	0.012802	0.604923	0.08685	0.065578	-0.00726	0.430068	1.256841
35-08A	0.089185	-0.04834	0.007277	0.343839	0.059741	0.045109	-0.00437	0.258786	0.751231
35-08C	0.148198	-0.08032	0.013929	0.658162	0.091094	0.068782	-0.0078	0.462393	1.354431
35-08E	0.141054	-0.07645	0.013002	0.614357	0.087629	0.066166	-0.00736	0.435861	1.274262
36-08A	0.149085	-0.0808	0.014047	0.663747	0.091518	0.069102	-0.00786	0.465733	1.364568
36-08B	0.138296	-0.07496	0.012655	0.597962	0.086267	0.065138	-0.00719	0.425776	1.243952
36-08C	0.142815	-0.0774	0.013226	0.62497	0.088491	0.066817	-0.00747	0.442345	1.293794
36-08D	0.147498	-0.07994	0.013836	0.653783	0.090758	0.068529	-0.00776	0.459769	1.346471
36-08E	0.136283	-0.07386	0.012405	0.586172	0.085265	0.064381	-0.00706	0.418471	1.22205
37-08A	0.150581	-0.08161	0.014248	0.673235	0.092229	0.06964	-0.00796	0.471384	1.381747

Point Estimate Method Gas Vent Cap

r12	0.969539	p+++ = p--- =	0.253367
r23	-0.08346	p++1 = p--+ =	0.239018
r31	0.140863	p+-+ = p -+- =	0.031849
		p+-- = p-++ =	-0.02423

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
37-08C	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
37-08E	0.4	2.5	0.3	1.9	0.3	1.7	0.2	1.3	1.1	1.9	0.7	0.8
38-08A	0.5	2.7	0.3	2.1	0.3	1.8	0.3	1.4	1.2	2.2	0.8	0.9
38-08B	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	3.0	1.1	1.0
38-08C	0.5	3.0	0.4	2.4	0.3	2.0	0.3	1.6	1.3	2.7	1.0	1.0
38-08D	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	2.9	1.1	1.0
38-08E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-08A	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	2.9	1.1	1.0
39-08C	0.5	3.0	0.4	2.4	0.3	2.0	0.3	1.6	1.3	2.7	1.0	1.0
39-08E	0.5	2.9	0.4	2.3	0.3	2.0	0.3	1.6	1.3	2.6	0.9	1.0
40-08A	0.5	2.9	0.4	2.3	0.3	2.0	0.3	1.6	1.3	2.6	1.0	1.0
40-08B	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
40-08C	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.2	1.2	1.1
40-08D	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.1
40-08E	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
41-08A	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
41-08C	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
41-08E	0.4	2.2	0.3	1.6	0.3	1.5	0.2	1.1	1.0	1.4	0.5	0.7
42-08A	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
42-08B	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.2	1.1
42-08C	0.5	3.1	0.4	2.5	0.4	2.0	0.3	1.7	1.4	2.9	1.1	1.0
42-08D	0.5	2.6	0.3	2.0	0.3	1.8	0.2	1.4	1.2	2.1	0.8	0.9
42-08E	0.3	1.5	0.2	1.0	0.2	1.1	0.1	0.8	0.6	0.7	0.2	0.5
43-08A	0.5	3.1	0.4	2.5	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.0
43-08C	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
43-08E	0.6	3.1	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
44-08B	0.5	2.6	0.3	2.0	0.3	1.8	0.2	1.4	1.2	2.1	0.8	0.9
44-08C	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
44-08D	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.3	1.2
44-08E	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.5	1.3	1.1
46-08	0.6	3.4	0.4	2.8	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.1
48-08	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.2
50-08	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
51-08	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.4	1.3	1.1
52-08	0.6	3.3	0.4	2.7	0.4	2.1	0.3	1.8	1.4	3.3	1.2	1.1
53-08	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.3	1.2
56-08	0.7	3.7	0.5	3.3	0.4	2.4	0.4	2.1	1.7	4.5	1.6	1.3
58-08	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1

E[y]

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
	0.142426	-0.07719	0.013176	0.622613	0.088301	0.066674	-0.00744	0.440907	1.289461
	0.1125	-0.06097	0.009663	0.456579	0.072875	0.055026	-0.00566	0.335334	0.975343
	0.121858	-0.06605	0.010699	0.505577	0.077871	0.058798	-0.0062	0.36738	1.069938
	0.138595	-0.07512	0.012692	0.599723	0.086415	0.06525	-0.0072	0.426863	1.247215
	0.132427	-0.07177	0.011935	0.563969	0.083324	0.062916	-0.00683	0.404598	1.180567
	0.138371	-0.075	0.012664	0.598403	0.086304	0.065166	-0.00719	0.426048	1.24477
	2.96E-07	-1.6E-07	1.86E-08	8.78E-07	2.39E-07	1.81E-07	-1.3E-08	7.47E-07	2.19E-06
	0.138108	-0.07485	0.012631	0.596854	0.086174	0.065067	-0.00717	0.425091	1.241898
	0.132651	-0.0719	0.011962	0.565245	0.083438	0.063001	-0.00684	0.4054	1.182959
	0.130484	-0.07072	0.011703	0.552974	0.082337	0.06217	-0.00671	0.397671	1.159906
	0.131423	-0.07123	0.011815	0.558273	0.082815	0.062531	-0.00677	0.401014	1.169872
	0.141597	-0.07674	0.013071	0.617616	0.087895	0.066367	-0.00739	0.437856	1.280267
	0.142912	-0.07746	0.013239	0.625556	0.088538	0.066853	-0.00747	0.442701	1.29487
	0.151832	-0.08229	0.014417	0.681248	0.092822	0.070087	-0.00804	0.476135	1.396213
	0.155834	-0.08446	0.014969	0.707336	0.094698	0.071504	-0.0083	0.491461	1.443047
	0.135474	-0.07343	0.012306	0.58147	0.08486	0.064075	-0.00701	0.415546	1.213292
	0.135269	-0.07331	0.01228	0.58028	0.084757	0.063997	-0.007	0.414805	1.211072
	0.098916	-0.05361	0.008241	0.389412	0.065343	0.049339	-0.0049	0.2902	0.842941
	0.149289	-0.08091	0.014074	0.665039	0.091615	0.069176	-0.00787	0.466504	1.36691
	0.142686	-0.07733	0.01321	0.624187	0.088428	0.06677	-0.00746	0.441867	1.292356
	0.137767	-0.07467	0.012589	0.594847	0.086004	0.064939	-0.00715	0.42385	1.238174
	0.118387	-0.06416	0.010309	0.487124	0.076036	0.057413	-0.006	0.355398	1.034504
	0.067813	-0.03675	0.005295	0.250188	0.046834	0.035363	-0.00324	0.192223	0.557717
	0.139073	-0.07538	0.012752	0.602554	0.086652	0.065429	-0.00723	0.428609	1.252459
	0.142491	-0.07723	0.013185	0.623007	0.088333	0.066698	-0.00745	0.441148	1.290187
	0.140745	-0.07628	0.012962	0.612502	0.087477	0.066051	-0.00734	0.434724	1.270842
	0.118122	-0.06402	0.010279	0.485729	0.075895	0.057306	-0.00598	0.354489	1.031818
	0.149391	-0.08097	0.014088	0.665681	0.091664	0.069213	-0.00788	0.466888	1.368075
	0.153155	-0.08301	0.014598	0.689791	0.093445	0.070558	-0.00812	0.481177	1.411594
	0.150701	-0.08168	0.014264	0.674005	0.092287	0.069683	-0.00796	0.471842	1.383139
	0.15087	-0.08177	0.014287	0.675078	0.092366	0.069743	-0.00797	0.472479	1.385079
	0.152379	-0.08259	0.014492	0.68477	0.09308	0.070282	-0.00807	0.478216	1.402559
	0.142229	-0.07709	0.013151	0.621424	0.088205	0.066601	-0.00743	0.440182	1.287275
	0.148723	-0.08061	0.013999	0.661466	0.091345	0.068972	-0.00784	0.46437	1.360431
	0.145724	-0.07898	0.013603	0.642768	0.089904	0.067884	-0.00765	0.453138	1.326391
	0.152715	-0.08277	0.014538	0.686938	0.093238	0.070401	-0.00809	0.479496	1.406462
	0.167254	-0.09065	0.016635	0.786053	0.099901	0.075432	-0.00905	0.536408	1.581979
	0.149238	-0.08089	0.014067	0.664716	0.091591	0.069158	-0.00787	0.466312	1.366326

r12	0.969539	p+++ = p--- =	0.253367
r23	-0.08346	p++1 = p--+ =	0.239018
r31	0.140863	p+-+ = p -+- =	0.031849
		p+-- = p-++ =	-0.02423

Point Estimate Method Gas Vent Cap

	1	2	3	4	5	6	7	8				
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +				
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25				
									with no correlation			
Boring/CPT Number	y---	y+--	y-+-	y++-	y--+	y+-+	y-++	y+++	E[y]	E[y2]	V[y]	s[y]
61-08	0.7	3.7	0.5	3.2	0.4	2.3	0.4	2.1	1.7	4.4	1.6	1.3
62-08	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
63-08	0.6	3.6	0.5	3.2	0.4	2.3	0.4	2.0	1.6	4.2	1.5	1.2
64-08	0.6	3.5	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.8	1.4	1.2
65-08	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
66-08	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
10-08C	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.1	1.5	1.2
12-08B	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
12-08E	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
13-08CC	0.6	3.3	0.4	2.7	0.4	2.1	0.3	1.8	1.5	3.4	1.2	1.1
16-08E	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
22-08CC***	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.2
23-08CC	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
23-08EE,EEE	0.5	3.0	0.4	2.5	0.4	2.0	0.3	1.7	1.3	2.8	1.0	1.0
24-08CC	0.6	3.3	0.4	2.8	0.4	2.2	0.3	1.8	1.5	3.5	1.3	1.1
26-08B	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.3	1.2
27-08AA	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.6	1.3	1.2
33-08CC	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
37-08AA	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.1	1.1	1.1
41-08AA	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
41-08CC	0.6	3.4	0.5	2.9	0.4	2.2	0.3	1.9	1.5	3.7	1.4	1.2
41-08EE	0.4	2.3	0.3	1.7	0.3	1.6	0.2	1.2	1.0	1.6	0.6	0.8
42-08AA	0.6	3.1	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.0	1.1	1.1
42-08CC	0.5	3.0	0.4	2.4	0.4	2.0	0.3	1.6	1.3	2.8	1.0	1.0
54-08	0.6	3.7	0.5	3.2	0.4	2.3	0.4	2.1	1.6	4.3	1.6	1.2
55-08	0.7	3.7	0.5	3.3	0.4	2.4	0.4	2.1	1.7	4.5	1.6	1.3
57-08	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	4.0	1.4	1.2
B-14	0.6	3.5	0.5	3.0	0.4	2.3	0.3	2.0	1.6	3.9	1.4	1.2
B-15	0.6	3.5	0.5	3.0	0.4	2.2	0.3	1.9	1.6	3.8	1.4	1.2
B-16	0.6	3.6	0.5	3.1	0.4	2.3	0.4	2.0	1.6	4.2	1.5	1.2
avg	0.6	3.2	0.4	2.6	0.4	2.1	0.3	1.7	1.4	3.2	1.2	1.1
max	0.7	3.7	0.5	3.3	0.4	2.4	0.4	2.1				
min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
std dev	0.1	0.5	0.1	0.5	0.1	0.3	0.1	0.3				

E[y]

	1	2	3	4	5	6	7	8	
	- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +	
p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25	
	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	E[y]
	0.165093	-0.08948	0.016309	0.77064	0.098934	0.074702	-0.00891	0.527761	1.555052
	0.153864	-0.08339	0.014696	0.694405	0.093778	0.070809	-0.00817	0.483891	1.419883
	0.162772	-0.08822	0.015964	0.75436	0.097886	0.073911	-0.00875	0.518547	1.526466
	0.154635	-0.08381	0.014802	0.699446	0.094139	0.071082	-0.00822	0.486848	1.428925
	0.157648	-0.08544	0.015225	0.7194	0.09554	0.072139	-0.00841	0.498476	1.46457
	0.135719	-0.07356	0.012336	0.582891	0.084983	0.064168	-0.00703	0.416431	1.21594
	0.159896	-0.08666	0.015546	0.734581	0.096575	0.072921	-0.00856	0.507239	1.491534
	0.157431	-0.08533	0.015194	0.717952	0.095439	0.072064	-0.0084	0.497636	1.46199
	0.156806	-0.08499	0.015106	0.713781	0.09515	0.071845	-0.00836	0.495215	1.454556
	0.147003	-0.07967	0.013771	0.650696	0.09052	0.068349	-0.00773	0.457914	1.34085
	0.157683	-0.08546	0.01523	0.71964	0.095556	0.072152	-0.00842	0.498616	1.464998
	0.152401	-0.0826	0.014495	0.684915	0.093091	0.07029	-0.00807	0.478302	1.402821
	0.153716	-0.08331	0.014675	0.693436	0.093709	0.070757	-0.00816	0.483321	1.418143
	0.136323	-0.07389	0.01241	0.586404	0.085285	0.064396	-0.00707	0.418616	1.222483
	0.149769	-0.08117	0.014138	0.668073	0.091844	0.069348	-0.0079	0.468313	1.372408
	0.153307	-0.08309	0.014619	0.690779	0.093517	0.070612	-0.00813	0.481759	1.41337
	0.152084	-0.08243	0.014452	0.68287	0.092941	0.070177	-0.00805	0.477094	1.399137
	0.135186	-0.07327	0.01227	0.579802	0.084715	0.063966	-0.007	0.414507	1.210181
	0.142426	-0.07719	0.013176	0.622613	0.088301	0.066674	-0.00744	0.440907	1.289461
	0.135515	-0.07345	0.012311	0.581708	0.08488	0.064091	-0.00702	0.415694	1.213734
	0.154138	-0.08354	0.014733	0.696192	0.093907	0.070906	-0.00819	0.48494	1.42309
	0.102885	-0.05576	0.008647	0.408585	0.067578	0.051026	-0.00512	0.303225	0.881066
	0.140641	-0.07623	0.012949	0.61188	0.087426	0.066013	-0.00733	0.434343	1.269694
	0.135515	-0.07345	0.012311	0.581708	0.08488	0.064091	-0.00702	0.415694	1.213734
	0.163488	-0.08861	0.01607	0.75935	0.09821	0.074155	-0.0088	0.52138	1.535243
	0.16682	-0.09041	0.016569	0.782935	0.099707	0.075286	-0.00902	0.534665	1.576543
	0.15825	-0.08577	0.01531	0.72344	0.095818	0.072349	-0.00845	0.500815	1.471759
	0.157139	-0.08517	0.015153	0.716001	0.095304	0.071962	-0.00838	0.496505	1.458515
	0.155717	-0.0844	0.014953	0.706562	0.094644	0.071463	-0.00829	0.49101	1.441664
	0.161676	-0.08763	0.015804	0.746775	0.097388	0.073535	-0.00868	0.514224	1.513096
									1.3

Point Estimat

		E[y2]							
		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
1-08	0.024033	-0.07381	0.001215	0.361487	0.011801	0.050494	-0.00059	0.197432	0.572063	0.150865	0.388414
2-08	0.006836	-0.021	0.000298	0.088748	0.003731	0.015965	-0.00015	0.051901	0.14633	0.035481	0.188365
3-08	0.061927	-0.1902	0.003861	1.148788	0.026542	0.113564	-0.00169	0.567646	1.730442	0.509213	0.713592
4-08	0.070146	-0.21544	0.004553	1.354703	0.029362	0.125631	-0.00195	0.656284	2.023286	0.607057	0.779138
5-08	0.103375	-0.31749	0.007866	2.340191	0.039741	0.170042	-0.00312	1.046248	3.386852	1.091407	1.044704
7-08	0.106854	-0.32818	0.008267	2.459532	0.040744	0.174334	-0.00325	1.090147	3.548453	1.151541	1.073099
9-08	0.095966	-0.29474	0.007049	2.097054	0.037555	0.160689	-0.00284	0.95475	3.055482	0.969783	0.984775
10-08A	0.099274	-0.3049	0.007407	2.203802	0.03854	0.164901	-0.00296	0.995269	3.201331	1.023029	1.011449
10-08B	0.093438	-0.28698	0.006781	2.017417	0.036794	0.157431	-0.00275	0.924155	2.946288	0.93022	0.964479
10-08D	0.101051	-0.31036	0.007604	2.262337	0.039063	0.167139	-0.00303	1.017256	3.281064	1.052329	1.025831
10-08E	0.089836	-0.27591	0.006409	1.906683	0.035694	0.152726	-0.00262	0.881078	2.79389	0.875447	0.935653
11-08A	0.09405	-0.28885	0.006845	2.036552	0.036979	0.158223	-0.00277	0.931535	2.972555	0.939713	0.969388
11-08C	0.098709	-0.30316	0.007345	2.185382	0.038373	0.164186	-0.00294	0.988317	3.176205	1.013824	1.006888
11-08E	0.102206	-0.3139	0.007734	2.300859	0.039401	0.168586	-0.00307	1.031636	3.333445	1.07165	1.035205
12-08A	0.098045	-0.30112	0.007273	2.163817	0.038176	0.163343	-0.00292	0.980157	3.146768	1.003056	1.001527
12-08C	0.096061	-0.29503	0.007059	2.10009	0.037584	0.160811	-0.00285	0.95591	3.059637	0.971293	0.985542
12-08D	0.096906	-0.29763	0.00715	2.127118	0.037837	0.161893	-0.00288	0.966218	3.096617	0.984754	0.992348
13-08A	0.100601	-0.30897	0.007554	2.247429	0.038931	0.166574	-0.00301	1.011671	3.260773	1.04486	1.022184
13-08C	0.099015	-0.3041	0.007379	2.195331	0.038463	0.164573	-0.00295	0.992074	3.189778	1.018795	1.009354
13-08E	0.101213	-0.31085	0.007622	2.267717	0.03911	0.167343	-0.00304	1.019268	3.288385	1.055026	1.027145
14-08A	0.095266	-0.29259	0.006974	2.074855	0.037345	0.159791	-0.00282	0.946253	3.025077	0.95874	0.979153
14-08B	0.096061	-0.29503	0.007059	2.10009	0.037584	0.160811	-0.00285	0.95591	3.059637	0.971293	0.985542
14-08C	0.096322	-0.29583	0.007087	2.108403	0.037662	0.161145	-0.00286	0.959084	3.071015	0.975432	0.98764
14-08D	0.097367	-0.29904	0.007199	2.141913	0.037974	0.16248	-0.00289	0.971845	3.116843	0.992129	0.996057
14-08E	0.095242	-0.29251	0.006971	2.074083	0.037338	0.15976	-0.00282	0.945957	3.024019	0.958356	0.978957
15-08A	0.102479	-0.31474	0.007764	2.309991	0.03948	0.168926	-0.00308	1.035035	3.345852	1.076235	1.037417
15-08C	0.102323	-0.31426	0.007747	2.304781	0.039435	0.168732	-0.00308	1.033096	3.338773	1.073618	1.036156
15-08E	0.102978	-0.31627	0.007821	2.326784	0.039626	0.169548	-0.0031	1.041275	3.368656	1.084669	1.041475
16-08A	0.087754	-0.26952	0.006198	1.844111	0.035051	0.149973	-0.00255	0.856454	2.707473	0.844625	0.919035
16-08B	0.103092	-0.31662	0.007834	2.330629	0.039659	0.16969	-0.00311	1.042702	3.373875	1.086601	1.042402
16-08C	0.097821	-0.30043	0.007249	2.156554	0.038109	0.163058	-0.00291	0.977403	3.136848	0.999432	0.999716
16-08D	0.091344	-0.28054	0.006563	1.952628	0.036156	0.154704	-0.00268	0.899028	2.857204	0.898139	0.947702
17-08A	0.090205	-0.27705	0.006446	1.917871	0.035808	0.153211	-0.00264	0.885459	2.809318	0.880968	0.938599
17-08B	0.094552	-0.2904	0.006898	2.052308	0.03713	0.158871	-0.00279	0.937598	2.994169	0.947536	0.973414
17-08C	0.095046	-0.29191	0.006951	2.067895	0.037279	0.159508	-0.00281	0.943584	3.015539	0.95528	0.977384
17-08E	0.101714	-0.31239	0.007678	2.284392	0.039257	0.16797	-0.00305	1.025497	3.311062	1.063387	1.031207
18-08A	0.098709	-0.30316	0.007345	2.185382	0.038373	0.164186	-0.00294	0.988317	3.176205	1.013824	1.006888
18-08B	0.097775	-0.3003	0.007244	2.155097	0.038095	0.163001	-0.00291	0.976851	3.134858	0.998705	0.999352

Point Estimat

		E[y2]							
		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
18-08C	0.095654	-0.29378	0.007015	2.087145	0.037462	0.160289	-0.00283	0.95096	3.041913	0.964852	0.982269
18-08D	0.09679	-0.29727	0.007137	2.123395	0.037802	0.161744	-0.00287	0.9648	3.091525	0.982899	0.991413
18-08E	0.101172	-0.31073	0.007618	2.266374	0.039098	0.167292	-0.00303	1.018766	3.286557	1.054353	1.026817
19-08A	0.079133	-0.24304	0.005364	1.595906	0.032322	0.138299	-0.00225	0.756678	2.362409	0.723325	0.850485
19-08C	0.086527	-0.26575	0.006076	1.807729	0.034669	0.148338	-0.00251	0.842041	2.657123	0.826746	0.909256
19-08E	0.082625	-0.25376	0.005695	1.694373	0.03344	0.143081	-0.00237	0.796672	2.49975	0.771256	0.878212
20-08A	0.096298	-0.29576	0.007084	2.107649	0.037655	0.161115	-0.00286	0.958796	3.069983	0.975056	0.987449
20-08B	0.09739	-0.29911	0.007202	2.142649	0.037981	0.162509	-0.0029	0.972125	3.117849	0.992496	0.996241
20-08C	0.085291	-0.26195	0.005954	1.77144	0.034282	0.146683	-0.00247	0.827594	2.606827	0.808947	0.899415
20-08D	0.087754	-0.26952	0.006198	1.844111	0.035051	0.149973	-0.00255	0.856454	2.707473	0.844625	0.919035
20-08E	0.088084	-0.27053	0.006232	1.853971	0.035153	0.150411	-0.00256	0.860348	2.721105	0.849475	0.92167
21-08A	0.09305	-0.28578	0.00674	2.005331	0.036676	0.156928	-0.00274	0.919483	2.929686	0.924228	0.961368
21-08C	0.090035	-0.27652	0.006429	1.912718	0.035755	0.152988	-0.00263	0.883442	2.802212	0.878425	0.937243
21-08E	0.067977	-0.20878	0.004366	1.299054	0.028628	0.122493	-0.00188	0.632607	1.944464	0.580479	0.761892
22-08A	0.106062	-0.32575	0.008175	2.432073	0.040517	0.173363	-0.00322	1.080104	3.51133	1.137681	1.066621
22-08B	0.096013	-0.29488	0.007054	2.098573	0.03757	0.16075	-0.00285	0.95533	3.05756	0.970538	0.985159
22-08C	0.088795	-0.27272	0.006303	1.875271	0.035373	0.151353	-0.00259	0.868742	2.750535	0.859962	0.927341
22-08D	0.087905	-0.26998	0.006213	1.8486	0.035097	0.150173	-0.00256	0.858228	2.71368	0.846833	0.920235
22-08E	0.071238	-0.21879	0.004649	1.383112	0.029728	0.127199	-0.00199	0.668295	2.063438	0.620662	0.787821
23-08A	0.09271	-0.28474	0.006705	1.994775	0.036573	0.156486	-0.00273	0.915398	2.915181	0.918997	0.958644
23-08C	0.085707	-0.26323	0.005995	1.783627	0.034412	0.147242	-0.00248	0.832454	2.623727	0.814921	0.90273
23-08E	0.060097	-0.18457	0.003713	1.10475	0.025898	0.11081	-0.00163	0.548313	1.667373	0.488473	0.698908
24-08A	0.088293	-0.27117	0.006252	1.860213	0.035218	0.150688	-0.00257	0.862811	2.729733	0.852548	0.923335
24-08B	0.087572	-0.26896	0.00618	1.838706	0.034994	0.149731	-0.00254	0.854318	2.699998	0.841967	0.917587
24-08C	0.094899	-0.29146	0.006935	2.063237	0.037235	0.159318	-0.00281	0.941796	3.009154	0.952965	0.976199
24-08D	0.082417	-0.25313	0.005675	1.688445	0.033374	0.142799	-0.00237	0.79428	2.491499	0.768363	0.876563
24-08E	0.091697	-0.28163	0.0066	1.963485	0.036264	0.155166	-0.00269	0.903253	2.872147	0.903508	0.95053
25-08A	0.08593	-0.26391	0.006017	1.790152	0.034482	0.14754	-0.00249	0.835053	2.632771	0.818121	0.9045
25-08C	0.073648	-0.22619	0.004862	1.446648	0.03053	0.13063	-0.00207	0.694973	2.153027	0.651177	0.806956
25-08E	0.08418	-0.25854	0.005845	1.739127	0.033932	0.145187	-0.00243	0.814669	2.561974	0.793125	0.890576
26-08A	0.09305	-0.28578	0.00674	2.005331	0.036676	0.156928	-0.00274	0.919483	2.929686	0.924228	0.961368
26-08B	0.092684	-0.28466	0.006702	1.99396	0.036565	0.156452	-0.00273	0.915082	2.914061	0.918594	0.958433
26-08C	0.093387	-0.28682	0.006775	2.015811	0.036778	0.157365	-0.00275	0.923535	2.944083	0.929424	0.964066
26-08D	0.085259	-0.26185	0.005951	1.770499	0.034272	0.14664	-0.00246	0.827218	2.605521	0.808486	0.899158
26-08E	0.096298	-0.29576	0.007084	2.107649	0.037655	0.161115	-0.00286	0.958796	3.069983	0.975056	0.987449
27-08A	0.096013	-0.29488	0.007054	2.098573	0.03757	0.16075	-0.00285	0.95533	3.05756	0.970538	0.985159
27-08C	0.099101	-0.30437	0.007388	2.19816	0.038489	0.164683	-0.00296	0.993142	3.193637	1.020209	1.010054
27-08E	0.09693	-0.2977	0.007152	2.127861	0.037843	0.161922	-0.00288	0.966501	3.097633	0.985125	0.992534

Point Estimat

E[y2]

		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
28-08A	0.055869	-0.17159	0.00338	1.005489	0.024388	0.104351	-0.0015	0.50422	1.524606	0.441981	0.664816
28-08B	0.086745	-0.26642	0.006098	1.814156	0.034737	0.148629	-0.00252	0.844593	2.666024	0.829902	0.91099
28-08C	0.078145	-0.24	0.005272	1.568526	0.032003	0.136931	-0.00222	0.745458	2.32411	0.710043	0.842641
28-08D	0.075975	-0.23334	0.005073	1.509167	0.031296	0.133907	-0.00215	0.720981	2.240912	0.681321	0.825422
28-08E	0.088883	-0.27299	0.006312	1.877913	0.0354	0.151469	-0.00259	0.869782	2.754183	0.861264	0.928043
29-08A	0.031571	-0.09696	0.001674	0.49797	0.015006	0.064206	-0.00079	0.265971	0.778643	0.210756	0.459082
29-08C	0.072437	-0.22248	0.004755	1.414572	0.030128	0.128911	-0.00203	0.681536	2.107834	0.635757	0.797344
29-08E	0.030315	-0.09311	0.001595	0.474549	0.014483	0.061969	-0.00076	0.254369	0.743417	0.200396	0.447656
30-08A	0.022369	-0.0687	0.001118	0.332697	0.011071	0.04737	-0.00054	0.182668	0.528047	0.138389	0.372006
30-08B	0.043304	-0.133	0.002454	0.729978	0.019698	0.084284	-0.00113	0.377779	1.123373	0.314979	0.56123
30-08C	0.057848	-0.17767	0.003534	1.05153	0.025099	0.107392	-0.00156	0.524762	1.590935	0.4635	0.680809
30-08D	0.068505	-0.2104	0.004412	1.312506	0.028808	0.12326	-0.0019	0.638349	1.96354	0.586895	0.766091
30-08E	0.045162	-0.13871	0.002584	0.768925	0.020412	0.087339	-0.00118	0.396041	1.180578	0.332735	0.576832
31-08A	0.057316	-0.17603	0.003492	1.039066	0.024908	0.106577	-0.00155	0.519217	1.572997	0.457667	0.676511
31-08C	0.074367	-0.2284	0.004927	1.465854	0.030768	0.131647	-0.00209	0.702988	2.180055	0.660426	0.812666
31-08E	0.060378	-0.18544	0.003736	1.11148	0.025997	0.111235	-0.00164	0.551276	1.677023	0.491638	0.701169
32-08A	0.030405	-0.09338	0.001601	0.476225	0.014521	0.062131	-0.00076	0.255201	0.745941	0.201137	0.448482
32-08B	0.073003	-0.22421	0.004805	1.429533	0.030316	0.129716	-0.00205	0.687811	2.128923	0.642946	0.801839
32-08C	0.071597	-0.21989	0.00468	1.392488	0.029848	0.127712	-0.002	0.672248	2.076677	0.625158	0.790669
32-08D	0.018965	-0.05825	0.000925	0.275307	0.009547	0.040851	-0.00046	0.152877	0.439771	0.1137	0.337194
32-08E	0.064633	-0.19851	0.004084	1.215092	0.027482	0.11759	-0.00178	0.596499	1.825098	0.540566	0.735232
33-08A	0.061379	-0.18851	0.003817	1.135538	0.026349	0.112742	-0.00167	0.561844	1.711483	0.502966	0.709201
33-08C	0.076856	-0.23605	0.005153	1.533149	0.031584	0.135139	-0.00218	0.730896	2.274553	0.692913	0.832414
33-08E	0.076777	-0.2358	0.005146	1.530982	0.031558	0.135028	-0.00217	0.730001	2.271515	0.691865	0.831784
34-08A	0.053754	-0.16509	0.003217	0.957074	0.02362	0.101066	-0.00144	0.482446	1.454647	0.419438	0.64764
34-08B	0.072085	-0.22139	0.004723	1.405305	0.030011	0.12841	-0.00202	0.677642	2.094764	0.631307	0.794549
34-08C	0.082417	-0.25313	0.005675	1.688445	0.033374	0.142799	-0.00237	0.79428	2.491499	0.768363	0.876563
34-08D	0.081683	-0.25087	0.005605	1.667533	0.03314	0.141798	-0.00234	0.785826	2.462374	0.758165	0.870727
34-08E	0.076777	-0.2358	0.005146	1.530982	0.031558	0.135028	-0.00217	0.730001	2.271515	0.691865	0.831784
35-08A	0.031393	-0.09642	0.001663	0.49463	0.014932	0.06389	-0.00079	0.26432	0.773625	0.209277	0.457468
35-08C	0.086682	-0.26623	0.006092	1.812322	0.034717	0.148546	-0.00251	0.843865	2.663485	0.829002	0.910495
35-08E	0.078528	-0.24118	0.005308	1.579108	0.032127	0.137462	-0.00223	0.7498	2.338918	0.715174	0.845679
36-08A	0.087724	-0.26942	0.006195	1.843211	0.035041	0.149933	-0.00255	0.856099	2.706229	0.844182	0.918794
36-08B	0.075487	-0.23184	0.005028	1.49595	0.031136	0.133222	-0.00213	0.715503	2.222354	0.674939	0.821547
36-08C	0.0805	-0.24724	0.005493	1.634139	0.032762	0.14018	-0.0023	0.772273	2.415809	0.741905	0.861339
36-08D	0.085866	-0.26372	0.006011	1.78829	0.034462	0.147455	-0.00249	0.834311	2.630191	0.817208	0.903996
36-08E	0.073305	-0.22514	0.004832	1.43754	0.030417	0.130145	-0.00206	0.691164	2.140202	0.646796	0.804236
37-08A	0.089493	-0.27486	0.006374	1.896283	0.035588	0.152274	-0.00261	0.877	2.779542	0.870318	0.932908

Point Estimat

		E[y2]							
		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
37-08C	0.080062	-0.24589	0.005451	1.621832	0.032621	0.139578	-0.00229	0.767262	2.39863	0.73592	0.857858
37-08E	0.049952	-0.15342	0.002932	0.872172	0.022219	0.09507	-0.00132	0.443817	1.331423	0.38013	0.616547
38-08A	0.058608	-0.18	0.003594	1.069412	0.02537	0.108552	-0.00159	0.532699	1.616647	0.47188	0.686935
38-08B	0.075813	-0.23284	0.005058	1.504773	0.031243	0.13368	-0.00214	0.719161	2.234742	0.679198	0.824135
38-08C	0.069215	-0.21258	0.004473	1.330703	0.029048	0.124288	-0.00192	0.646097	1.989321	0.595583	0.77174
38-08D	0.075568	-0.23209	0.005036	1.49816	0.031163	0.133337	-0.00213	0.716419	2.225458	0.676005	0.822195
38-08E	3.46E-13	-1.1E-12	1.08E-14	3.22E-12	2.39E-13	1.02E-12	-6.6E-15	2.2E-12	5.98E-12	1.2E-12	1.09E-06
39-08A	0.075281	-0.23121	0.00501	1.490414	0.031069	0.132934	-0.00212	0.713205	2.214578	0.672267	0.819919
39-08C	0.069449	-0.2133	0.004493	1.336731	0.029127	0.124627	-0.00193	0.648659	1.997856	0.598463	0.773604
39-08E	0.067199	-0.20639	0.0043	1.279321	0.028363	0.12136	-0.00186	0.624163	1.916459	0.571078	0.755697
40-08A	0.06817	-0.20937	0.004383	1.303956	0.028694	0.122773	-0.00189	0.634701	1.951418	0.582816	0.763424
40-08B	0.079133	-0.24304	0.005364	1.595906	0.032322	0.138299	-0.00225	0.756678	2.362409	0.723325	0.850485
40-08C	0.080609	-0.24757	0.005503	1.637202	0.032797	0.14033	-0.0023	0.773519	2.420083	0.743395	0.862204
40-08D	0.090987	-0.27945	0.006526	1.941694	0.036047	0.154237	-0.00267	0.894766	2.842146	0.892734	0.944846
40-08E	0.095846	-0.29437	0.007036	2.093251	0.037519	0.160536	-0.00284	0.953296	3.050275	0.96789	0.983814
41-08A	0.072437	-0.22248	0.004755	1.414572	0.030128	0.128911	-0.00203	0.681536	2.107834	0.635757	0.797344
41-08C	0.072218	-0.2218	0.004735	1.408786	0.030055	0.128598	-0.00202	0.679105	2.099674	0.632978	0.795599
41-08E	0.038618	-0.11861	0.002132	0.634436	0.017864	0.076433	-0.00099	0.332387	0.982274	0.271726	0.521273
42-08A	0.087965	-0.27016	0.006219	1.850392	0.035116	0.150252	-0.00256	0.858936	2.716158	0.847715	0.920714
42-08B	0.080355	-0.24679	0.005479	1.630047	0.032715	0.13998	-0.0023	0.770608	2.410097	0.739914	0.860183
42-08C	0.07491	-0.23007	0.004976	1.480407	0.030946	0.132411	-0.00211	0.709046	2.200516	0.66744	0.81697
42-08D	0.055317	-0.16989	0.003337	0.99277	0.024189	0.103497	-0.00148	0.498518	1.506249	0.43605	0.660341
42-08E	0.01815	-0.05574	0.00088	0.261881	0.009177	0.039265	-0.00043	0.145835	0.41901	0.107961	0.328574
43-08A	0.076337	-0.23445	0.005106	1.519017	0.031415	0.134414	-0.00216	0.725057	2.254733	0.68608	0.828299
43-08C	0.080135	-0.24612	0.005458	1.62389	0.032645	0.139679	-0.00229	0.768101	2.401502	0.73692	0.85844
43-08E	0.078183	-0.24012	0.005276	1.569587	0.032015	0.136984	-0.00222	0.745894	2.325596	0.710557	0.842946
44-08B	0.05507	-0.16913	0.003318	0.987095	0.024099	0.103114	-0.00148	0.495969	1.498053	0.433406	0.658335
44-08C	0.088084	-0.27053	0.006232	1.853971	0.035153	0.150411	-0.00256	0.860348	2.721105	0.849475	0.92167
44-08D	0.092579	-0.28434	0.006691	1.990695	0.036533	0.156315	-0.00272	0.913817	2.909573	0.916977	0.957589
44-08E	0.089636	-0.2753	0.006388	1.900625	0.035633	0.152463	-0.00262	0.878703	2.785533	0.872459	0.934055
46-08	0.089836	-0.27591	0.006409	1.906683	0.035694	0.152726	-0.00262	0.881078	2.79389	0.875447	0.935653
48-08	0.091643	-0.28146	0.006594	1.96182	0.036248	0.155095	-0.00269	0.902606	2.869856	0.902684	0.950097
50-08	0.079841	-0.24521	0.00543	1.615645	0.03255	0.139274	-0.00228	0.76474	2.38999	0.732912	0.856103
51-08	0.087299	-0.26812	0.006153	1.830565	0.034909	0.149367	-0.00254	0.851096	2.688736	0.837964	0.915404
52-08	0.083813	-0.25741	0.00581	1.728535	0.033817	0.144692	-0.00241	0.81042	2.547258	0.787944	0.887662
53-08	0.092047	-0.2827	0.006636	1.974263	0.036371	0.155623	-0.0027	0.907442	2.886977	0.908841	0.953331
56-08	0.110408	-0.33909	0.008689	2.585078	0.041755	0.178657	-0.00338	1.13564	3.717751	1.215094	1.102313
58-08	0.087905	-0.26998	0.006213	1.8486	0.035097	0.150173	-0.00256	0.858228	2.71368	0.846833	0.920235

Point Estimat

		E[y2]							
		1	2	3	4	5	6	7	8
		- - -	+ - -	- + -	+ + -	- - +	+ - +	- + +	+ + +
p	p	0.25	-0.02	0.03	0.24	0.24	0.03	-0.02	0.25

Boring/CPT Number	p--- y---	p+-- y+--	p-+-y-+-	p++-y++1	p--+y--+	p+-+y+-+	p-++y-++	p+++y+++	$E[y^2]$	V[y]	σ[y]
61-08	0.107574	-0.33039	0.008351	2.484694	0.04095	0.175216	-0.00327	1.099321	3.582441	1.164255	1.079006
62-08	0.093438	-0.28698	0.006781	2.017417	0.036794	0.157431	-0.00275	0.924155	2.946288	0.93022	0.964479
63-08	0.104571	-0.32117	0.008002	2.380826	0.040088	0.171524	-0.00316	1.061268	3.441952	1.111852	1.054444
64-08	0.094377	-0.28986	0.00688	2.046813	0.037078	0.158646	-0.00279	0.935485	2.986632	0.944807	0.972012
65-08	0.09809	-0.30126	0.007278	2.165266	0.038189	0.1634	-0.00292	0.980706	3.148746	1.003779	1.001888
66-08	0.072699	-0.22328	0.004778	1.421492	0.030216	0.129284	-0.00204	0.68444	2.11759	0.639081	0.799425
10-08C	0.100908	-0.30992	0.007588	2.257611	0.039021	0.16696	-0.00302	1.015487	3.274634	1.049961	1.024676
12-08B	0.097821	-0.30043	0.007249	2.156554	0.038109	0.163058	-0.00291	0.977403	3.136848	0.999432	0.999716
12-08E	0.097045	-0.29805	0.007165	2.131573	0.037878	0.16207	-0.00288	0.967913	3.102708	0.986974	0.993466
13-08CC	0.085291	-0.26195	0.005954	1.77144	0.034282	0.146683	-0.00247	0.827594	2.606827	0.808947	0.899415
16-08E	0.098134	-0.3014	0.007283	2.166712	0.038202	0.163457	-0.00292	0.981254	3.150721	1.004501	1.002248
22-08CC***	0.09167	-0.28154	0.006597	1.962652	0.036256	0.155131	-0.00269	0.902929	2.871002	0.903096	0.950314
23-08CC	0.093258	-0.28642	0.006762	2.011789	0.036739	0.157197	-0.00275	0.921981	2.938559	0.927429	0.963031
23-08EE,EEE	0.073348	-0.22527	0.004836	1.438681	0.030431	0.130206	-0.00206	0.691641	2.141809	0.647344	0.804577
24-08CC	0.08853	-0.2719	0.006276	1.867317	0.035291	0.151002	-0.00258	0.865611	2.739548	0.856045	0.925227
26-08B	0.092763	-0.2849	0.00671	1.996404	0.036589	0.156554	-0.00273	0.916029	2.91742	0.919804	0.959064
27-08AA	0.091289	-0.28037	0.006557	1.950951	0.03614	0.154633	-0.00268	0.898375	2.854895	0.89731	0.947264
33-08CC	0.072129	-0.22153	0.004727	1.406466	0.030026	0.128473	-0.00202	0.67813	2.096402	0.631865	0.794899
37-08AA	0.080062	-0.24589	0.005451	1.621832	0.032621	0.139578	-0.00229	0.767262	2.39863	0.73592	0.857858
41-08AA	0.072481	-0.22261	0.004758	1.415727	0.030143	0.128974	-0.00203	0.682021	2.109463	0.636312	0.797691
41-08CC	0.093771	-0.288	0.006816	2.027813	0.036895	0.157862	-0.00276	0.928167	2.960561	0.935376	0.967148
41-08EE	0.041779	-0.12831	0.002348	0.698449	0.019106	0.081752	-0.00108	0.362894	1.076933	0.300657	0.548322
42-08AA	0.078068	-0.23977	0.005265	1.566402	0.031978	0.136824	-0.00222	0.744586	2.321137	0.709014	0.842029
42-08CC	0.072481	-0.22261	0.004758	1.415727	0.030143	0.128974	-0.00203	0.682021	2.109463	0.636312	0.797691
54-08	0.105492	-0.324	0.008109	2.412424	0.040353	0.172662	-0.0032	1.072896	3.484745	1.127772	1.061966
55-08	0.109836	-0.33734	0.00862	2.564613	0.041593	0.177966	-0.00336	1.128272	3.690202	1.204714	1.097595
57-08	0.098841	-0.30357	0.00736	2.189654	0.038411	0.164353	-0.00295	0.989931	3.182035	1.015959	1.007948
B-14	0.097458	-0.29932	0.007209	2.144854	0.038001	0.162596	-0.0029	0.972962	3.120862	0.993595	0.996793
B-15	0.095702	-0.29393	0.00702	2.088674	0.037476	0.160351	-0.00283	0.951545	3.044007	0.965613	0.982656
B-16	0.103168	-0.31686	0.007842	2.333186	0.039681	0.169784	-0.00311	1.04365	3.377346	1.087886	1.043018
avg										0.8	0.9
max											
min											
std dev											

ATTACHMENT D-1-5
ERDC Comments (4 April 2013)

4 April 2013

ERDC Geotechnical Lab Review comments
Documents reviewed: ERDC 's previous review 8 Aug 2012 (Walshire and Wahl), LRC Settlement Analysis 11 Feb 2013 (23 sheets w/ Attach 1 thru 4), LRC Stability Analysis 11 Feb 2013 including Appendices A thru G, LRC Tables and pdf plots.
Reviewer: Landris T. Lee, 601.634.2661

Comments on Settlement Analysis:
LRC addressed the previous (8 Aug 2012) ERDC review comments. LRC attempted to reconcile ERDC's Cc and settlement values using back-calculations; however I suggest disregarding ERDC's CPT-based settlement values and go with LRC input parameter values. ERDC's CPT-based values had an unknown input parameter Cc, a 200 psf incremental load, and 10 ft sediment height values with no statistical deviations.
LRC values for Cc (1 and 1.3 in the time rate and ultimate settlement calculations, respectively) appear reasonable. For example, Bowles (1979) used this correlation for organic soils and peats:

Cc = 0.0115 w%, which gives a value of 0.97 (~1) for expected w% = 84%

Using LRC parameters listed below, an @RISK Monte Carlo simulation got similar settlement values:

	Cc	w%	Gs	H,ft	@RISK Settlement, ft
E(x)	1.3	84	2.2	13.4	1.4
σ(x)	0.8	41.6	0.3	5	1

I also got similar @RISK settlements when including normal distribution functions for e and σ into the settlement equation.

These settlement values are assumed to lump the entire reach of Bubbly Creek. I would suggest breaking it down by sub-reaches or drain pipe outfall locations before plugging the profiles into HEC-Ras or similar models. To achieve a more realistic time-rate of settlement, I would suggest using the large-strain (finite) settlement theory such as the PSDDF model instead of this classical small-strain approach. Gas bubbles and organics suggest a large-strain situation.

RESPONSE:
During the design analysis, the settlement analysis will be broken into sub-reaches to achieve a more realistic time-rate of settlement. Additionally, during the design analysis, a large-strain model such as PSDDF will be considered.

Typo comments:
-The total settlement formula (sheet 9) needs a '+' sign instead of a '-'sign between (σ and Δσ).
-Sheet 9 revise sediment unit weight (γ) = $(1+w)(Gs\gamma_{water})/(1+wGs)$ where w is a decimal (not %)
-Sheet 9 revise e=wGs where w is a decimal (not %)

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	COMPUTATION TITLE: **Settlement Analysis**	CHECKED BY:	DATE:	

-Sheet 7 revise w and solids content relationship to w%=100(100-S%)/S%
where S%=100(Ws/W)

RESPONSE
Typos have been corrected. There were minor disagreements between the reviewer and the original text regarding the percentage nomenclature, where the original text treated 0.50 = 50%.

Attachment D-2
Slope Stability Analyses

<table>
<tr><td rowspan="2">US Army Corps of Engineers®
Chicago District</td><td>PROJECT TITLE:
Bubbly Creek</td><td>COMPUTED BY:
JWS</td><td>DATE:
23Jul2013</td><td rowspan="2">SHEET:
1 of 1</td></tr>
<tr><td>COMPUTATION TITLE:
Description of Analyses</td><td>CHECKED BY:</td><td>DATE:</td></tr>
</table>

There were two types of analysis run for slope stability:

1) Filling on existing sediment, and
2) Cutting sediment, and filling.

Filling on existing sediment doesn't require dredging, and would be the least expensive alternative. However, cutting and filling may be required to achieve the required hydraulic conveyance.

Filling

It was thought that the Contractor might wish to add more than the required cap thickness and spread to create the cap. However, there was likely a limit to how much could be added to the soft sediment before the sediment failed. Therefore this analysis was run to see how much fill the Contractor could add before slope stability would be a concern.

In an effort to reduce the number of stability analyses, only those scenarios that were feasible were run. For example, the fill analyses were only run on the sand cap because hydraulic capacity of the channel limits the fill to about 22 inches, the approximate thickness of the sand cap. Any more fill, for example as would be required by the 40 inch vent cap, would not be acceptable hydraulically.

The following IDNR criteria are meant to explain the hydraulic limitations.

IDNR Criteria:

- Impact of the fill cannot cause the river to go out of bank (not violated),
- Stage cannot increase 0.1 ft (current modeling shows the impact of a 22 inch can increase stage by 0.18 ft), and
- People cannot be impacted (outfalls may be impacted leading to sewer backups).

Cutting and Filling

The cut analyses apply mainly to the vent cap because cutting is not believed to be required for a sand cap. However, these same analyses could be applied to a sand cap where the side slopes were cut to 5%.

	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET: 1 of 1
US Army Corps of Engineers® Chicago District	COMPUTATION TITLE: **Rational for Sections Chosen**	CHECKED BY:	DATE:	

Representative Cross Sections

Bubbly Creek is approximately 7400 ft long from the Racine Avenue Pump Station (RAPS) to the end of the Turning Basin. Bubbly Creek is shown in plan view in Attachment D-2-1. The sediment thickness and properties range over this length. A cross section along the centerline developed based on AECOM and CDM data is shown in Attachment D-2-1.

ERDC served as a technical advisor to the project. ERDC developed sediment classification based on cone penetrometer data is shown in Attachment D-2-1. Normalized sediment shear strength is shown in Figure D-2-1. Because the number of analyses that can be run are limited by time and budget, representative sections were chosen by ERDC.

The reaches chosen by ERDC and rational for selection are as follows:

- Reach 1 – Sta 0+00 to Sta 22+00. Upper layer of silts and silty sands underlain by clayey materials with some organic clays present.
- Reach 2 – Sta 22+00 to Sta 38+00. Similar to Reach 1 with the top layer of silts and silty sands largely scoured away likely due to RAPS discharges.
- Reach 3 – Sta 38+00 to Sta 74+00. One sediment layer of clayey and organic clays similar to the lower sediment in Reach 1 and 2.

Based on representative reaches, ERDC chose the representative cross sections for stability analyses. The sections selected are presented in Table D-2-1.

Table D-2-1 Rationale for sections selected for slope stability analyses

Section	Rationale
14+00	Typical of Reach 1. Upstream of the 35th Street bridge, thus upstream of scour immediately downstream (to the north) of the 35th Street bridge as the RAPS discharges
24+00	Typical of Reach 2. Contains data both from the cone penetrometer (CPT), which does not take samples, as well as a standard penetration test (SPT) boring, which takes samples. Downstream of the 35th Street bridge thus represents the scoured portion.
72+00	Typical of Reach 3. This is an area that is being considered for a wetland shelf. Therefore it may be an area that receives more fill load than other areas in Bubbly Creek

Canal Cross Sections

The canal stratigraphy consists of sediment of varying thickness on top of hard clay. The top of the sediment was estimated with a tape measure with an 8 inch diameter solid plate. This data was supplemented by the actual CPT response. See the AECOM report (Attachment D-4) for more data on the CPT response at the top of the sediment.

The sides are reinforced with wood sheeting, steel sheeting, or concrete. Data for sediment depth was only available along the centerline of the channel +/- a given distance. Data for the sediment depth was not available to the shoreline. Therefore the depth of the sediment had to be extrapolated to the shoreline. Because banks are reinforced and subject to high velocity flows from the Racine Avenue Pump Station (RAPS), the top of the sediment were not pulled up to the water surface as might be the case for natural banks. Rather, the top of the sediment was extrapolated to the shore assuming that the slope continued to the shoreline. Because the channel was likely dredged, the bottom of the sediment was also extrapolated from the existing information to the shore. Development of canal cross sections is presented in Attachment D-2-1.

Strength and Unit Weight

Shear strength is critically important when evaluating the stability of the sediment to support construction loading due to a cap or a wetland shelf. Analysis of the data shows that the ERDC analyzed data provided reasonable strength values and the PEI vane tests to provided inflated values. Therefore the ERDC strength values are used in these analyses.

The strength of the sediment was estimated based on normalized strengths provided by ERDC. These normalized strengths can be found in Figure D-2-1. For the stations selected, the normalized strength ratios are as provided in Table D-2-2.

Table D-2-2 Normalized shear strength parameters for slope stability sections

Section	**c/p’**
Station 14+00	0.4
Station 24+00	0.34 – 0.4 → analyzed with 0.35
Station 72+00	0.26-0.32 →Analyzed with 0.3

The data provided by AECOM (May 2009) was judged to be of poor quality by ERDC. However, ERDC was able to make standard adjustments and provide reasonable strength values. The adjustments were to add 0.5 to the cone resistance (q_c) and 0.018 to the sleeve resistance (f_s) and develop these ratios for the entire channel based on the AECOM provided data.

The PEI vane test data in the turning basin is not believed to accurately reflect the strength of the sediment in the channel. This is because the back calculated overconsolidation ratios for the PEI data are on the order of 2.5 to 14. The consolidation test data provided by PEI show the sediment to be normally consolidated to slightly overconsolidated. The reason for the high PEI vane test data may be trash located in the canal.

The back calculated OCR ratios for PEI vane test data are presented in Table D-2-3.

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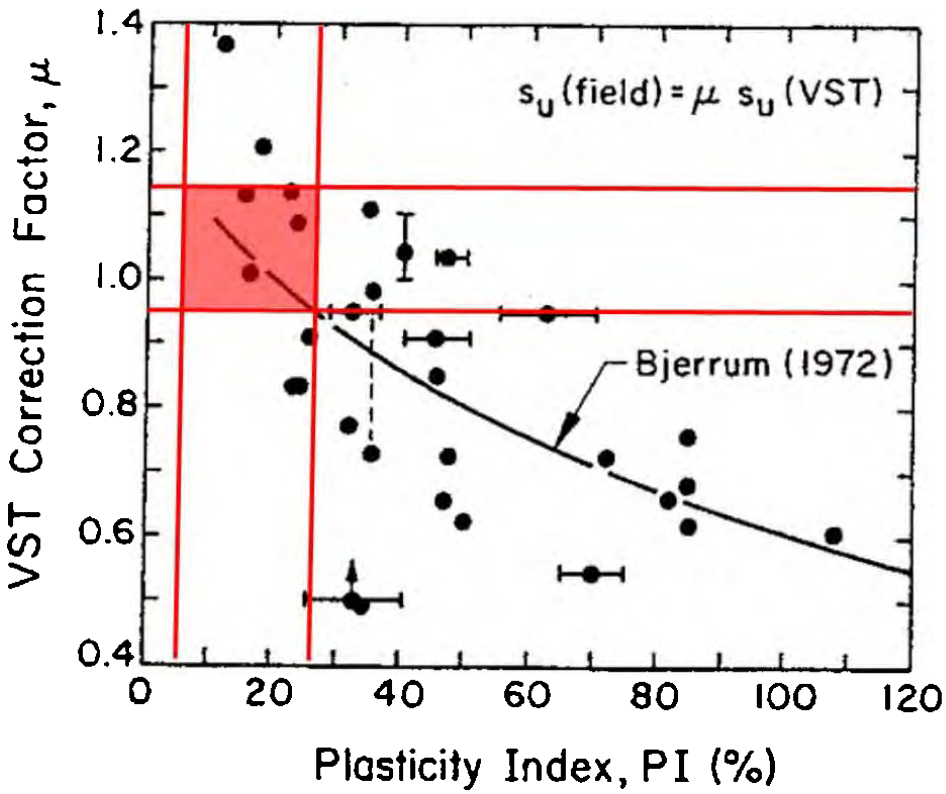
US Army Corps of Engineers® Chicago District	COMPUTATION TITLE: **Input Parameters**	CHECKED BY:	DATE:	

Table D-2-3

Back Calculated values of c/p' and OCR fro Fiel Vane tests performd by PEI in Boring B1A				
Depth, ft	Field Vane c, tsf	p', tsf	c/p'	OCR from Equation 1 using c/p' from Field Vane Tests
5	0.036	0.0565	0.64	2.58
9	0.104	0.1017	1.0	4.61
13	0.301	0.1469	2.0	11.05
17	0.472	0.1921	2.5	13.87

The Bjerrum correction factor was considered and found to be nearly one for the plasticity index of the material, which means that it need not be applied to the PEI vane data. Comparison of site plasticity index test data to Bjerrum's 1972 vane test correction figure is presented in Figure D-2-1.

Figure D-2-1. Comparison of site plasticity data to Bejerrum's 1972 vane test correction figure



Soil tests are summarized in Attachment D-2-3. These are plasticity tests run by PEI that show the range to be 5 – 30%. Site Atterberg limit data are presented in Figure D-2-2.

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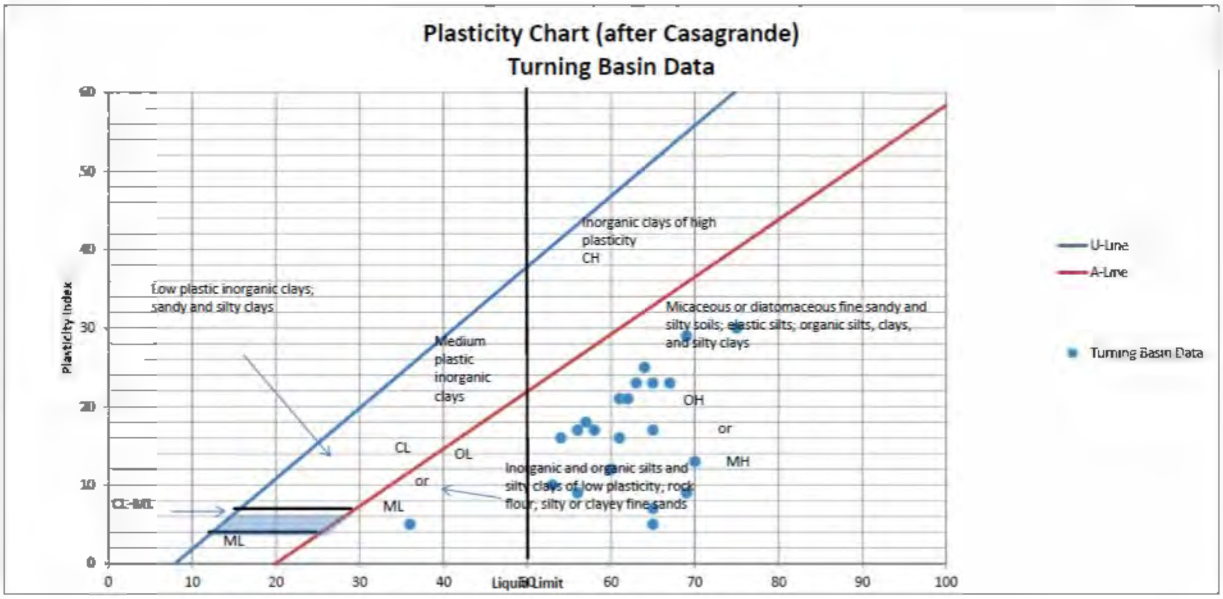
Figure D-2-2. Site Atterberg limit data



This is the Ladd and Foote (1974) relation to calculate normalized shear strength for soils with overconsolidation (OCR) ratios greater than one (1).

Equation 1
$$\left(\frac{Su}{\sigma_v'}\right)_{OCR>1} = \left(\frac{Su}{\sigma_v'}\right)_{OCR=1} OCR^{\lambda}$$

The input parameters for this equation are:

s_u = the undrained shear strength,
σ_v' = effective overburden stress,
OCR = overconsolidation ratio,
λ = fitting parameter (taken to be 0.8).

In the ERDC analysis c/p is reported as the normalized strength ratio. Where c is the cohesion and p is the effective consolidation stress. Foot and Ladd (1974) report the normalized strength ratio as s_u/σ_v'. These two relations are the same. To clarify, for these analyses, the primed symbol ‘ is added to indicate that the consolidation stress is effective rather than total. Therefore the consolidation stress is described as p’.

Standard charts of overconsolidation ratio (OCR) versus normalized shear strength such as that provided in Holtz and Kovacs (1981) show for normally consolidated soils the ratio should be on the order of 0.3, which is what ERDC calculated for the turning basin. If the c/p’ ratio for normally consolidated soils was taken to be 0.3, then the overconsolidation ratio could be calculated in Table D-2-3.

Table D-2-3. Computation of overconsolidation ratios based on ERDC provided c/p’

Section	**c/p’**	**OCR**
Station 14+00	0.4	(.4/.3)^(1/0.8) = 1.4
Station 24+00	0.34 – 0.4 → analyzed with 0.35	(.35/.3)^(1/.8) = 1.2
Station 72+00	0.26-0.33 →Analyzed with 0.3	(.3/.3)^(1/.8) = 1.0

These calculations show for the sections considered that the overconsolidation ratio is on the order of 1 – 1.4, which is much closer to the overconsolidation ratios provided by PEI based on their consolidation tests. Therefore the c/p’ ratios provided by ERDC are considered more reasonable than the vane shear strength data provided by PEI.

The sediment unit weight was taken to be 80 pcf, which is less than the average of 89 pcf. This was done to add conservativism in the analysis and because earlier in the analysis process the composite unit weight of the sediment was not calculated. At this point in the analysis re-doing the numerous runs would add time to the analysis process. However, for design computations, re-running the analysis with a more representative unit weight may be considered.

Comparing the c/p’ ratios chosen for analysis with those based on the PEI data are provided in Figure D-2-3.

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	COMPUTATION TITLE: **Input Parameters**	CHECKED BY:	DATE:	

Figure D-2-3. Comparing Undrained shear strength ratios chosen versus those calculated from the PEI data

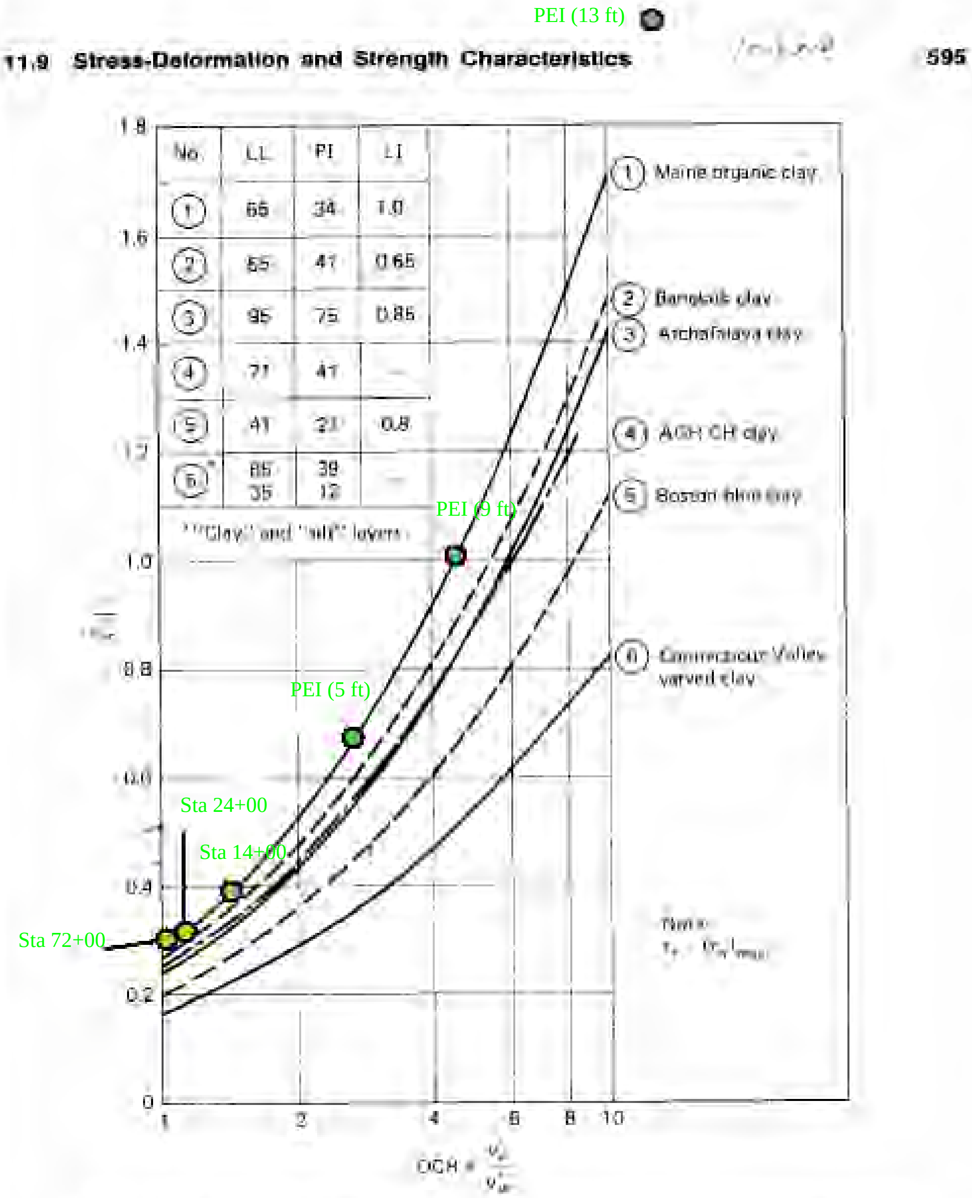

Fig. 11.63 Undrained strength ratio versus overconsolidation ratio from direct-simple shear tests on six clays (after Ladd and Edgers, 1972, and Ladd, et al., 1977).

Figure D-2-3 illustrates the high over consolidation ratios that would be associated with the ratios of strength to confining pressure. Based on the consolidation tests on material taken from the turning basin, it is believed that the stress history in Bubbly Creek is likely to have created a normally consolidated material rather than a heavily over consolidated material. Therefore it is believed that the c/p' ratios chosen are more predictive than those that would result from using the PEI data.

Application of the c/p' ratios to SlopeW are presented in Attachment D-2-2.

Sand Cap Constructability

The cap surcharge is input using a unit weight of 125 pcf – 62.4 pcf = 62.6 pcf. This assumes that the cap is sand with a unit weight of 125 pcf and that the cap is fully submerged. Though this differs slightly with values provided in the settlement analysis, re-running all the stability analyses at this time would add time to this portion of the project and is not warranted given all the uncertainties in unit weights. The value chosen is considered reasonable and representative.

Cut/Fill

A rough analysis was made to balance the cut and fill. This is based on the idea that if the A x $R^{2/3}$ terms in the Manning equation are equivalent for both the current and future conditions, the conveyance will be roughly the same. A is the area of the channel and R is the hydraulic radius. The hydraulic radius is the area divided by the wetted perimeter.

The limitations of this analysis are that changes in the elevation of the channel and the water surface are not considered. In actuality, the water elevation and the bottom of the channel will vary from location to location affecting the velocities and flow rate. Additionally, the geometry of the conveyance channel will change once the water level rises during Racine Avenue Pump Station discharges. Therefore a more sophisticated analysis such as that which is possible using software such as Hydraulic Engineering Center River Analysis System (HEC-RAS) developed by USACE should be performed.

However, this analysis is performed to provide an approximation before the full HEC-RAS analysis can be run.

The details for these calculations are provided in the Attachment D-2-4.

Slope Stability Checks

To check the consistency of the solutions, we have run lambda plot graphs for Sta 14 fill 1.5 ft and Sta 14 cut/fill step 2. These plots show that the force and moment equilibrium converge and agree with the Spencer solution. Therefore, we do not suspect the validity of these analyses. Because Spencer balances force and moment equilibrium, and all stability analyses in this package were run using the Spencer method, we expect the other analyses to also be valid. These plots and a brief explanation have been added to the report. In reviewing the GeoSlope Slope Stability literature, the lambda plots are part of the General Limit Equilibrium analysis developed by Fredlund and Krahn 1977; Fredlund et al. 1981. The GeoSlope Slope Stability documentation states, "The GLE formulation is very useful for understanding what is happening behind the scenes and understanding the reasons for differences between the various methods. It is not necessarily a method for routine analyses in practice, but it is an effective supplementary method useful for enhancing your confidence in the selection and use of the other more common methods." These the GLE formulation should be checked periodically for future analyses..

Note that ehere is no reference to lambda plots in Engineering and Design - Slope Stability (EM 1110-2-1902, 31 Oct 2003). However there is reference to using multiple software tools. Given the relatively small loading (1 - 3 ft), only one tool was used. Additionally, only circular failure analyses were run, a wedge analysis could also be run. It is recommended that a wedge analysis be run in the design phase.

Sand Cap Constructability.
The amount of fill that would be allowable while still maintaining a factor of safety of 1.3 is provided in Table D-2-4.

Table D-2-4. Amount of fill that would be allowable while still maintaining a factor of safety of 1.3

Section	Maximum Surcharge (Factor of Safety > 1.3)
Station 14+00	2.5 ft
Station 24+00	1.8 ft
Station 72+00	3 ft

Before spreading, only 2.5, 1.8, and 3 ft may be placed at stations 14+00, 24+00, and 72+00 respectively. Though this can be accomplished by very careful placement of cap, broadcast spreading is preferred to reduce uncertainties in non-uniform loading. Plots of stability are located in Attachment D-2-5.

Gas Vent Cap. The steps considered were:
1) Cut to required grade (10%)
2) Fill to complete the slope (where necessary)
3) Fill for cap: cap constructability
4) Final cap in place

The results of these stability analyses are presented in Table D-2-5.

Table D-2-5 Summary of construction steps and factors of safety for cutting and filling

	Factor of Safety (FS)			
Section	**(1) Cut to Required Slope**	**(2) Fill for Cap Base**	**(3) Add Cap, ft (FS)**	**(4) Final Cap in Place (FS)**
Station 14+00	5.668	1.681	0.5 (1.354)	2.122
Station 24+00	4.352	Fill not required here	0.5 (1.630)	1.630
Station 72+00	7.092	1.456	0.25 (1.350)	1.588

Based on these analyses, though cutting and filling to grade (steps 1 and 2) appear to be stable, only a small amount of fill (step 3) can lead to instability. Once the cap is applied (step 4) the slope is again stable. The instability is caused by the lack of load uniformity. By adding only a small amount of fill on the slope a failure can result. Therefore, all loading should be as evenly as possible, avoiding differences of six inches or greater for Station 14+00 and Station 24+00 and less than three inches for Station 72+00. This can be accomplished by placing the cap material using a broadcast spreader or similar technique. Plots of slope stability are located in Attachment D-2-6.

Wetland Shelf

Stability is evaluated using sand fill and slopes ranging from 5 – 10%. The results are as presented in Table D-2-6.

Table D-2-6 Summary of factors of safety for wetland shelf slopes of 5 – 10%

Wetland Shelf at Sta 72+00

Slope	Factor of Safety
10%	1.190
9%	1.275
8%	1.388
7.5%	1.475
5%	2.163

From this analysis, the maximum permissible slope to achieve a factor of safety of 1.3 or greater is 8%. It is again recommended that the wetland shelf material be built using broadcast spreading rather than dumping and spreading. Additionally, the slopes should be built from the toe up rather than from the crest down to reduce the likelihood of sliding. A geotextile may be of use in this area to further assure stability of the wetland shelf slope. Stability output is provided in Attachment D-2-7.

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET:
	COMPUTATION TITLE: **Stability Comments**	CHECKED BY:	DATE:	

ERDC Comments

ERDC (Landris T. Lee) provided comments on this report in Apr 2013. Landris retired shortly thereafter and was not able to backcheck his comments. The comments and responses are provided in Attachment D-2-8.

ATTACHMENTS

- D-2-1 Centerline Cross Section (AECOM and CDM data)
- D-2-2 c/p' ratios
- D-2-3 Soil Tests Summary
- D-2-4 Cut-Fill Calculations
- D-2-5 Sand Cap Slope Stability Output
- D-2-6 Sand Cap Constructability Stability Output
- D-2-7 Wetland Shelf Stability Output
- D-2-8 ERDC Comments/Responses

US Army Corps of Engineers Chicago District	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET:
	COMPUTATION TITLE: **Stability Attachments**	CHECKED BY:	DATE:	

ATTACHMENT

D-2-1 Centerline Cross Section (AECOM and CDM data)

SCALE: 200 ft = 1 in

200' 0 200' 400'

LEGEND

01-08 CONE PENETROMETER TEST LOCATION (BY STS|AECOM – 2008)
B-14 SOIL BORING LOCATION (BY STS|AECOM – 2008)
B-01-07 SOIL BORING LOCATION (BY OTHERS – 2007)
G01 SOIL BORING LOCATION (BY OTHERS)

RIVER PROFILE ALIGNMENT AND BORING LOCATIONS - PLAN (STATION 0+00 THROUGH STA. 37+60)
Scale: 1"=200'

RIVER PROFILE ALIGNMENT AND BORING LOCATIONS - PLAN (STA. 37+60 THROUGH STATION 75+28)
Scale: 1"=200'

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Chicago District

MARK	DESCRIPTION	DATE	APPR.

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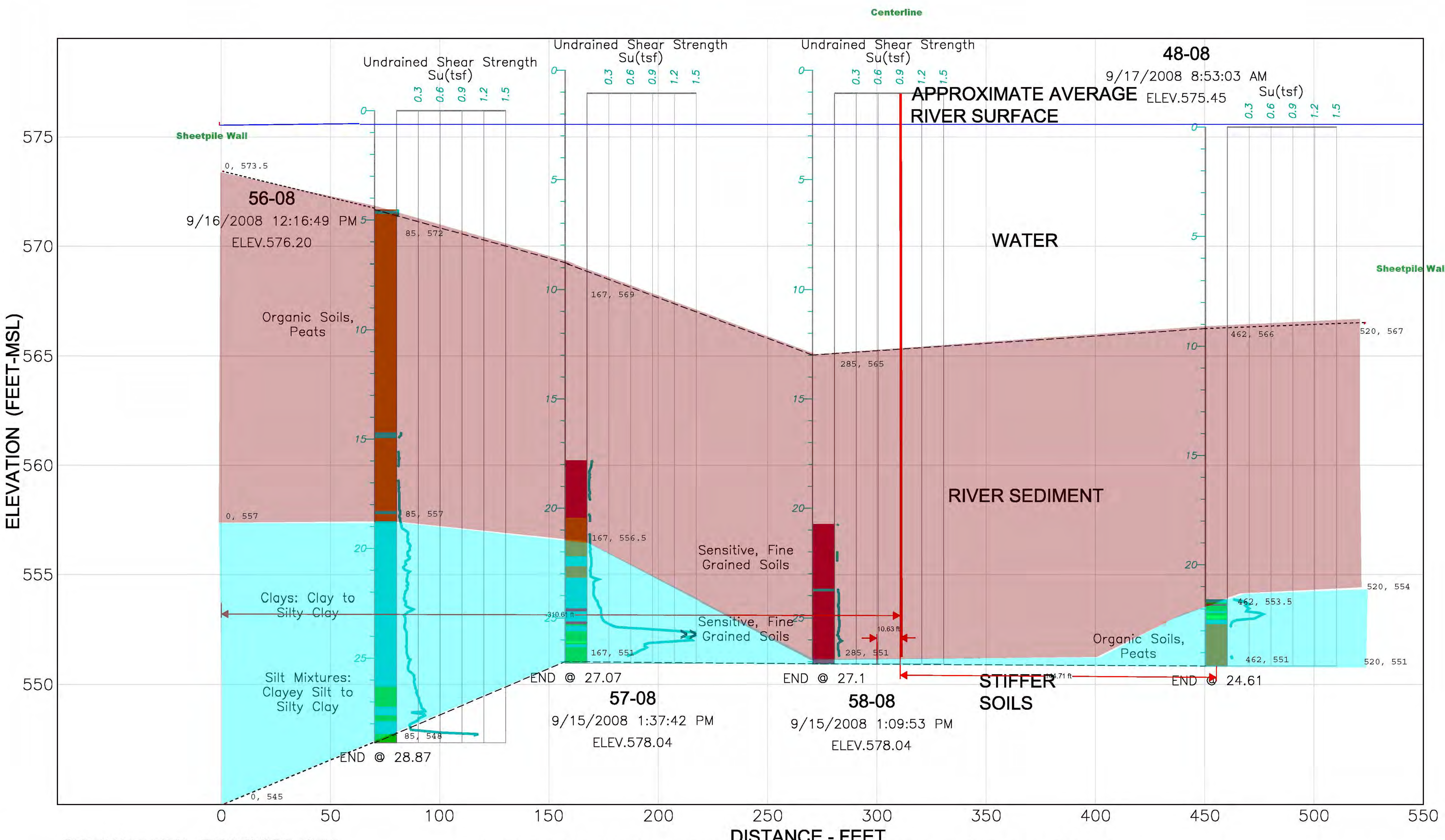
DESIGNED BY: AMH		DATE: 04/03/2009
DWN BY: CJD	CKD BY: RLE	DELIVERY ORDER NO.: DC 12
SUBMITTED BY: STS|AECOM		CONTRACT NO.: W912P6-06-D-0001
PLOT SCALE: 1:1	PLOT DATE: 04/03/2009	FILE NUMBER: 200803655
SIZE: ANSI D	FILE NAME: G200803655-001.dgn	

SOUTH FORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION

RIVER PROFILE ALIGNMENT AND BORING LOCATIONS - PLAN STATION 0+00 THROUGH STATION 75+28

SHEET IDENTIFICATION
C-001

X:\PROJECTS\200803655\G200803655-001.dwg; 4/1/2009 3:59:59 PM; DOYLE, CONAN



GENERALIZED GEOTECHNICAL RIVER CROSS SECTION @ STATION 72+00

CPT MATERIAL GRAPHICS KEY

- Sensitive, Fine Grained Soils
- Organic Soils, Peats
- Clays: Clay to Silty Clay
- Silt Mixtures: Clayey Silt to Silty Clay
- Sand Mixtures: Silty Sand to Sandy Silt
- Sands: Clean Sand to Silty Sand
- Gravelly Sand to Sand
- Very Stiff Clay to Clayey Sand
- Very Stiff Fine Grained Soils
- Very Stiff Clay to Clayey Sand

Note: given the scale of the drawing the slopes appear steeper than they are.

Robertson et al (1990) Qt vs. Fr – MAI = 1

NOTE: Refer to boring logs for detailed descriptions. Top of river sediment is estimated from a combination of CPT data and soundings (field measurements) performed by STS|AECOM personnel.

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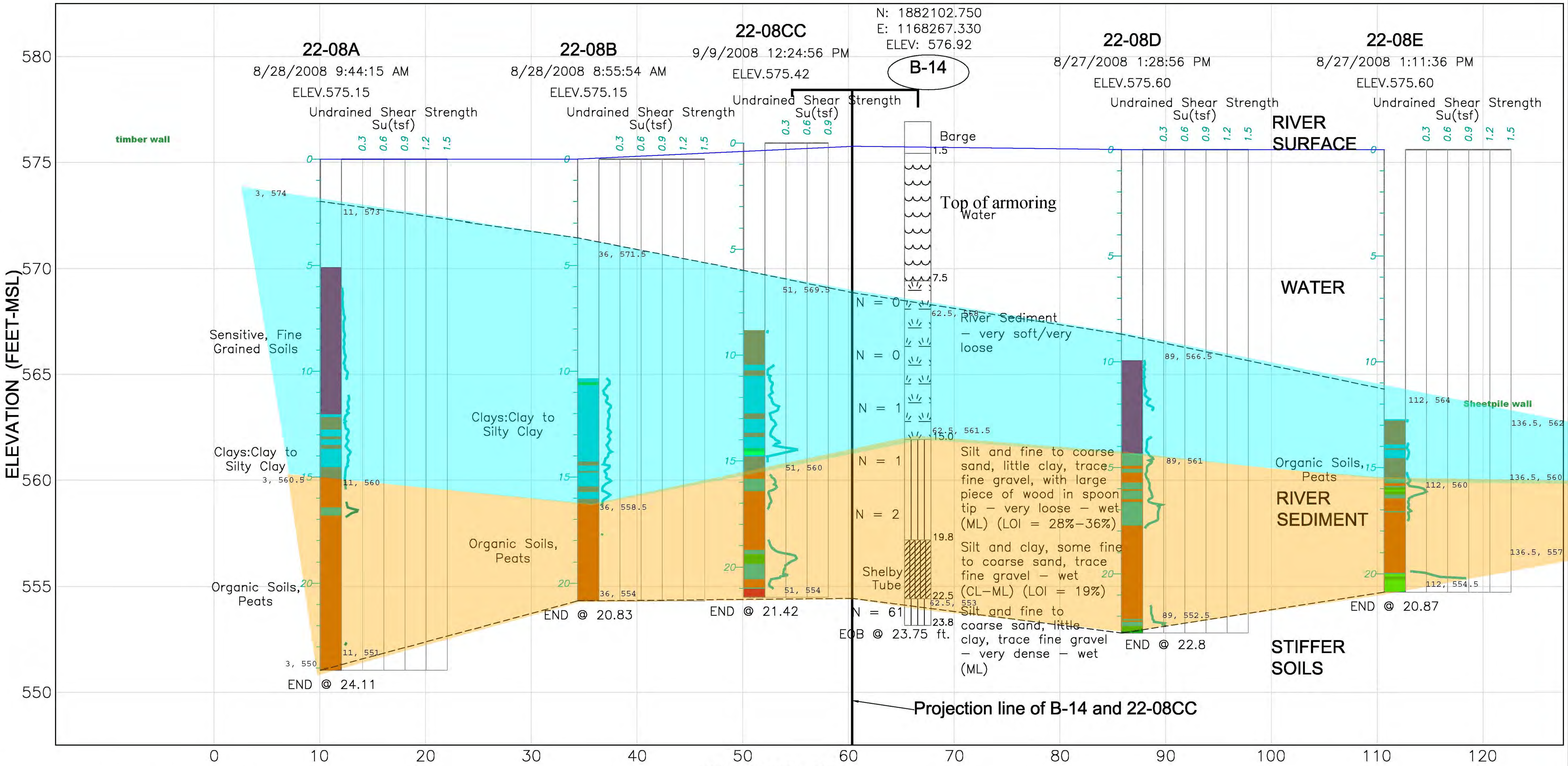
STS | AECOM

SOUTH FORK SOUTH BRANCH CHICAGO RIVER - BUBBLY CREEK FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION
GENERALIZED GEOTECHNICAL RIVER CROSS SECTION @ STATION 72+00

SHEET IDENTIFICATION
C-048

X:\PROJECTS\200803655\G200803655-004.dwg; 4/1/2009 4:23:21 PM; DOYLE, CONAN



GENERALIZED GEOTECHNICAL RIVER CROSS SECTION @ STATION 24+00

CPT MATERIAL GRAPHICS KEY

- Sensitive, Fine Grained Soils
- Organic Soils, Peats
- Clays: Clay to Silty Clay
- Silt Mixtures: Clayey Silt to Silty Clay
- Sand Mixtures: Silty Sand to Sandy Silt
- Sands: Clean Sand to Silty Sand
- Gravelly Sand to Sand
- Very Stiff Clay to Clayey Sand
- Very Stiff Fine Grained Soils
- Very Stiff Clay to Clayey Sand

Robertson et al (1990) Qt vs. Fr – MAI = 1

NOTE: Refer to boring logs for detailed descriptions. Top of river sediment is estimated from a combination of CPT data and soundings (field measurements) performed by STS|AECOM personnel.

section looking upstream from low to higher station

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SOUTH FORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION

GENERALIZED GEOTECHNICAL
RIVER CROSS SECTION
@ STATION 24+00

SHEET IDENTIFICATION
C-024

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Gas Venting
Goal slope of 5 degrees - required for venting
Options
Fill - allow sediment to settle
Cut/fill - reduce the amount of material needed to fill and maintain conveyance

Section 14 Geotechnical Cross Section
chosen due to weaker material on the left

GENERALIZED GEOTECHNICAL RIVER CROSS SECTION @ STATION 14+00

CPT MATERIAL GRAPHICS KEY

- Sensitive, Fine Grained Soils
- Organic Soils, Peats
- Clays: Clay to Silty Clay
- Silt Mixtures: Clayey Silt to Silty Clay
- Sand Mixtures: Silty Sand to Sandy Silt
- Sands: Clean Sand to Silty Sand
- Gravelly Sand to Sand
- Very Stiff Clay to Clayey Sand
- Very Stiff Fine Grained Soils
- Very Stiff Clay to Clayey Sand

strength estimated based on Olsen developed c/p

For design - use Olson developed strengths except for organic peat. For organic peat use su =

Robertson et al (1990) Qt vs. Fr — MAI = 1

NOTE: Refer to boring logs for detailed descriptions. Top of river sediment is estimated from a combination of CPT data and soundings (field measurements) performed by STS|AECOM personnel.

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SOUTH FORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION
GENERALIZED GEOTECHNICAL RIVER CROSS SECTION @ STATION 14+00

SHEET IDENTIFICATION
C-018

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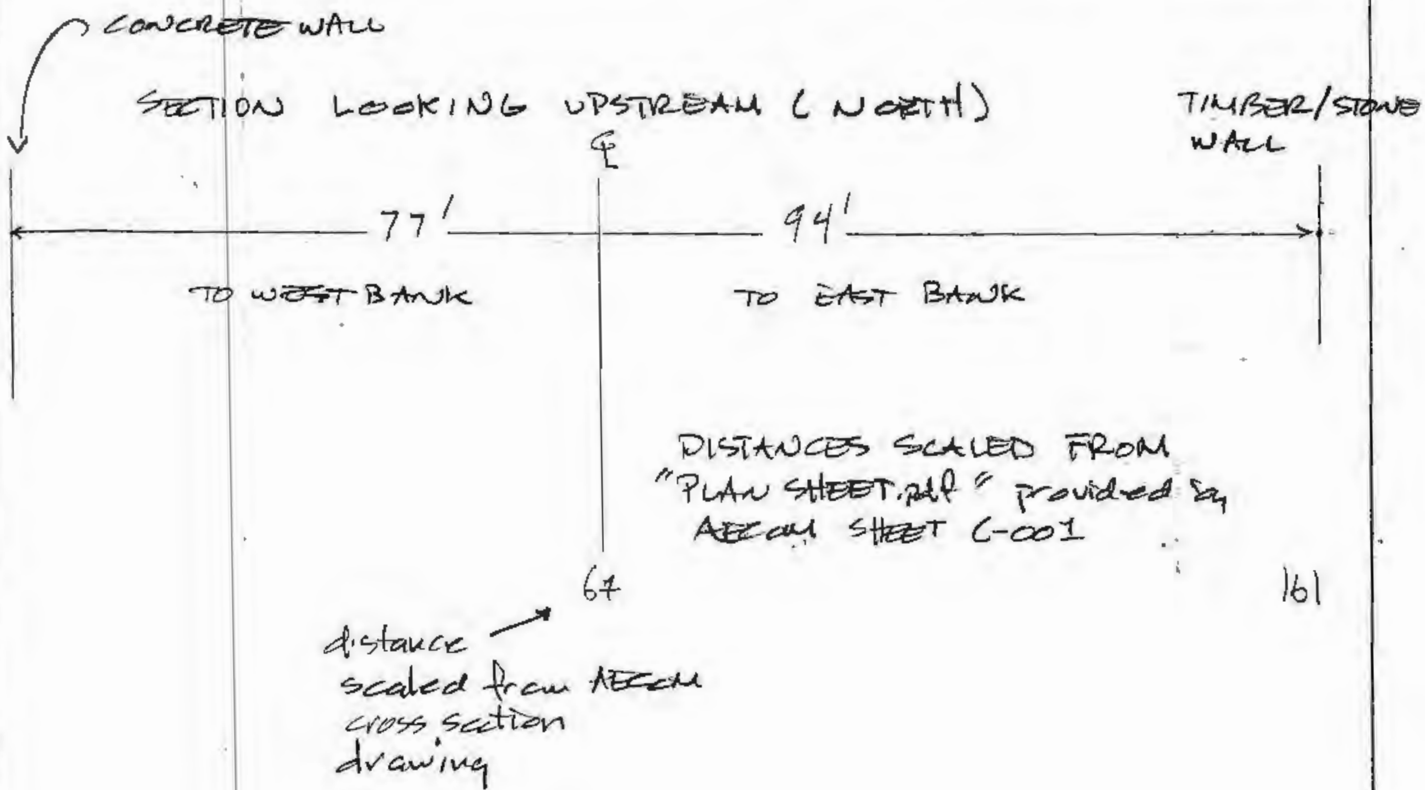
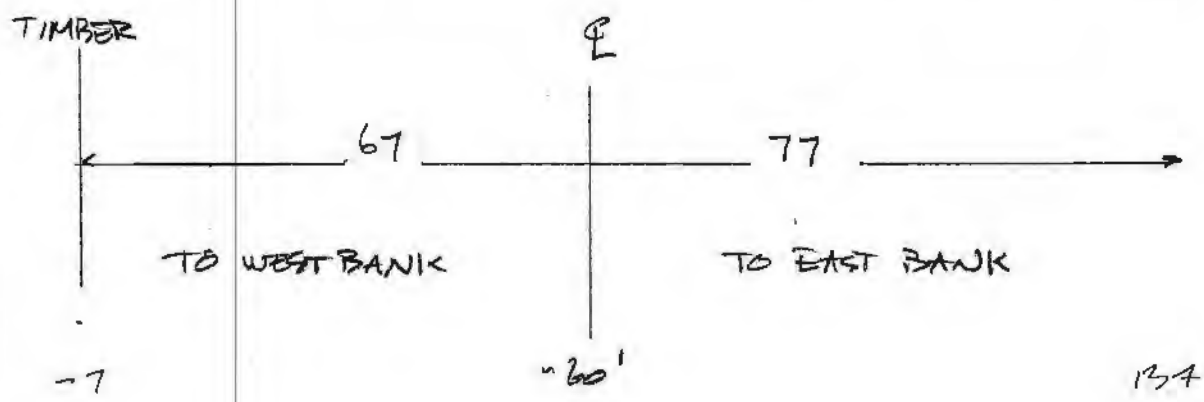
US Army Corps of Engineers Chicago District	PROJECT TITLE: Bubbly Creek	COMPUTED BY: JWS	DATE: 29 May 2012	SHEET: 1	3
	STRUCTURE TITLE: Section 14	CHECKED BY:	DATE:	CONTRACT NO:	



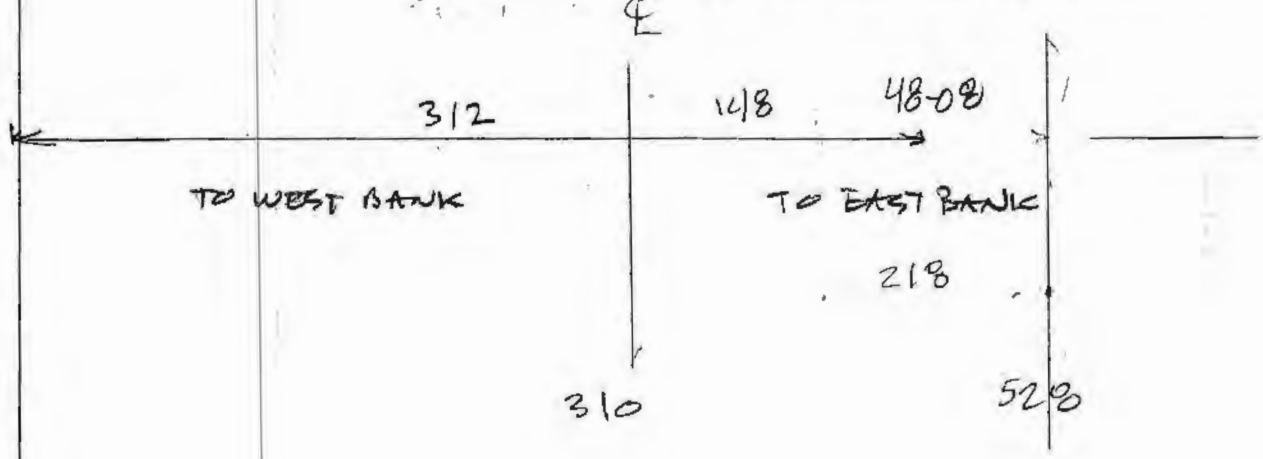
US Army Corps of Engineers Chicago District	PROJECT TITLE: Bubbly Creek	COMPUTED BY: JWS	DATE: 29 May 2012	SHEET: 2	3
	STRUCTURE TITLE: Section 24	CHECKED BY:	DATE:	CONTRACT NO:	

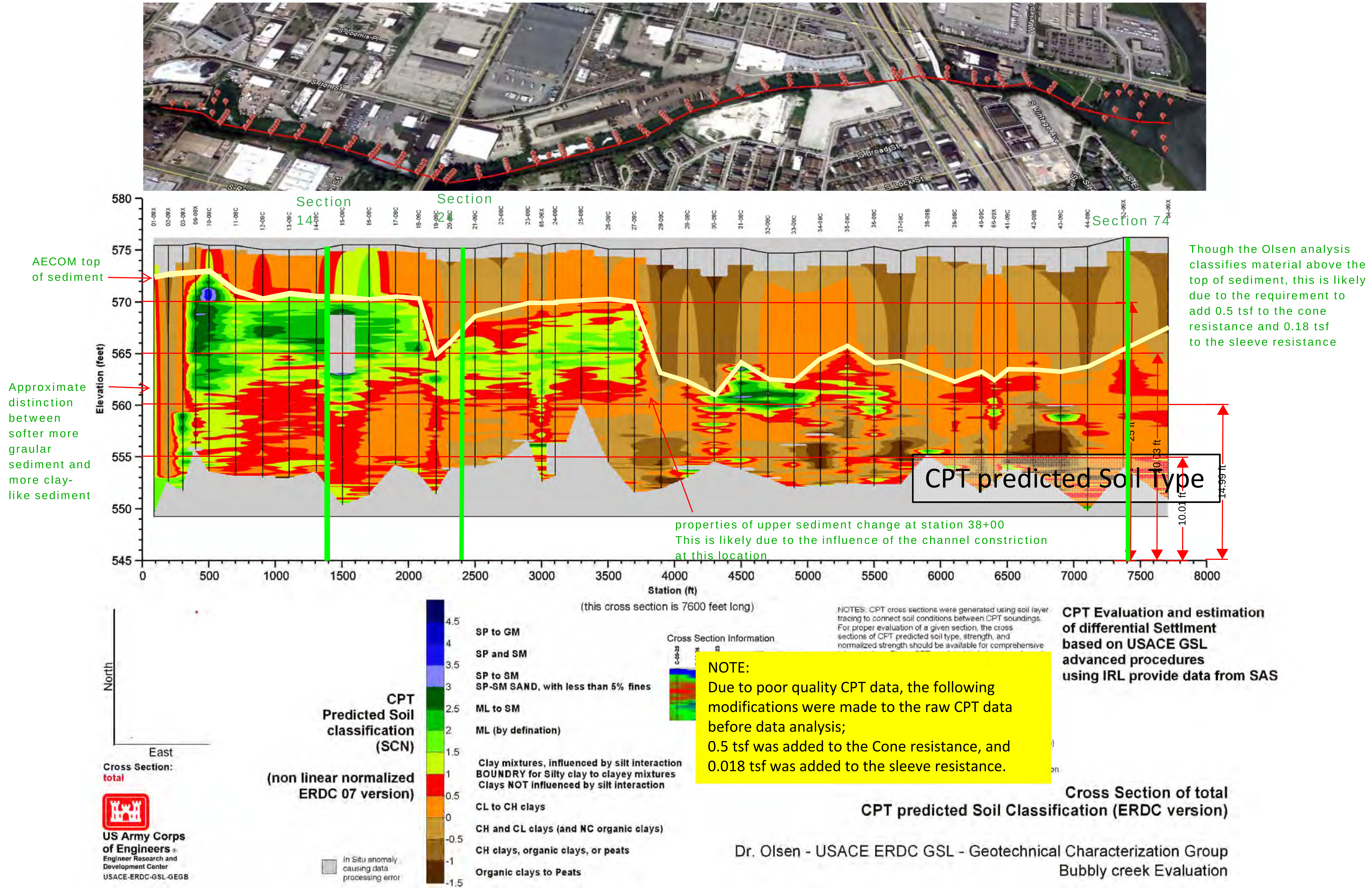
SECTION LOOKING UPSTREAM (NORTH)

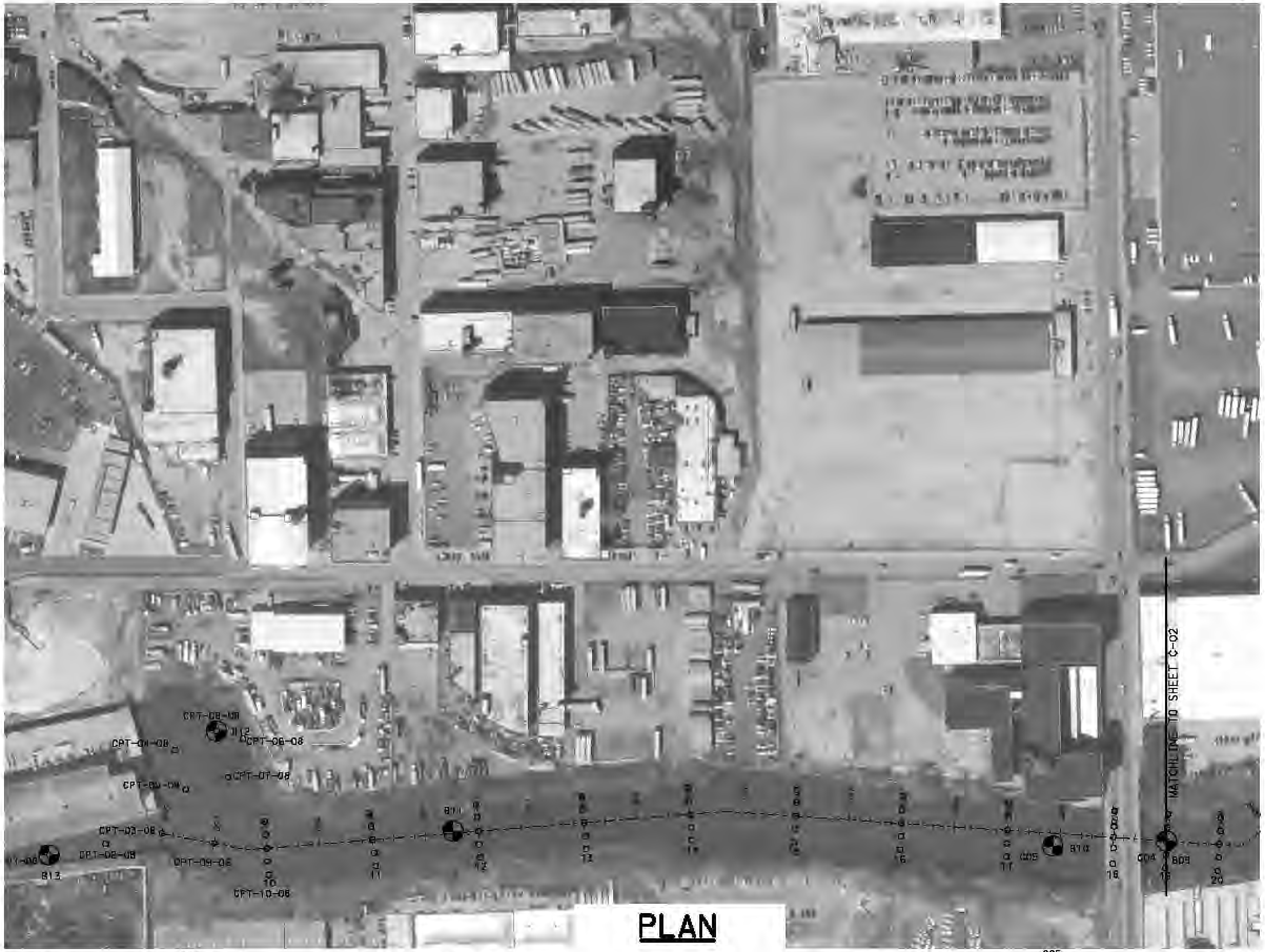


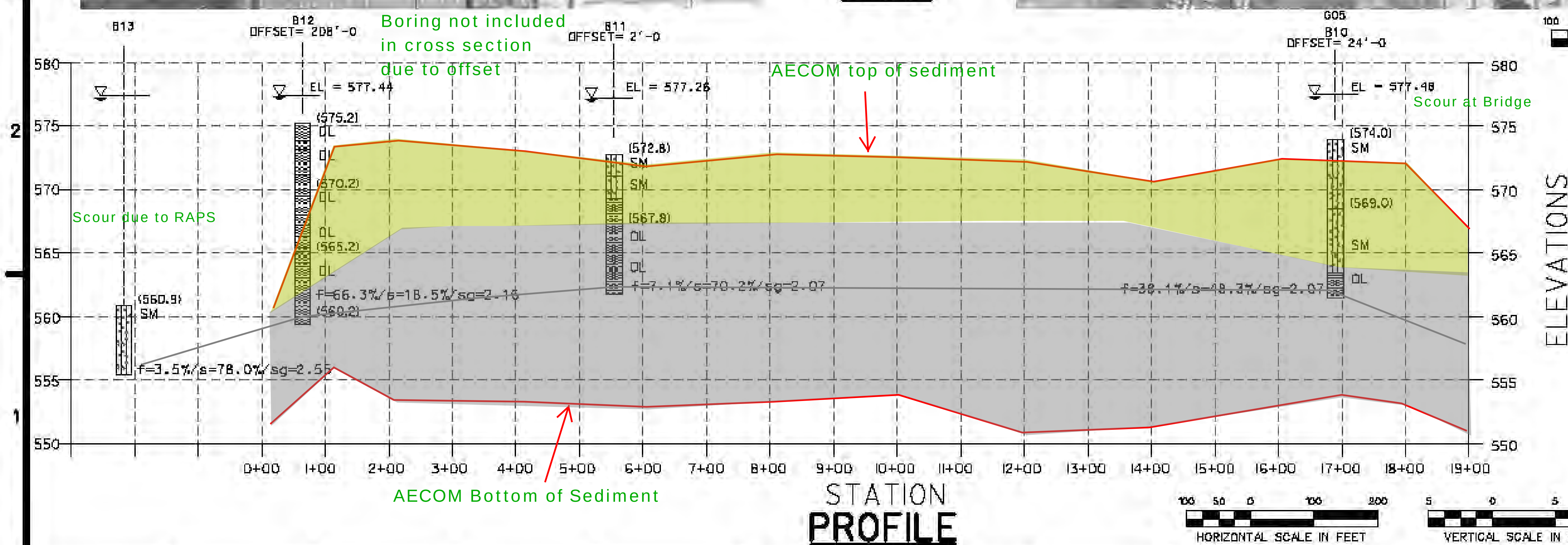
US Army Corps of Engineers Chicago District	PROJECT TITLE: Bubbly Creek	COMPUTED BY: JWS	DATE: 29 May 2012	SHEET: 3	3
	STRUCTURE TITLE: Section 72	CHECKED BY:	DATE:	CONTRACT NO:	

SECTION LOOKING UPSTREAM (NORTH)




S Loomis Pl
S Iron St
S Broad St
S Lock St
S Vintage Ave
Section 14
Section 24
Section 74
AECOM top of sediment
Approximate distinction between softer more graular sediment and more clay-like sediment
Though the Olsen analysis classifies material above the top of sediment, this is likely due to the requirement to add 0.5 tsf to the cone resistance and 0.18 tsf to the sleeve resistance
properties of upper sediment change at station 38+00
This is likely due to the influence of the channel constriction at this location
CPT predicted Soil Type
Elevation (feet)
580
575
570
565
560
555
550
545
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
Station (ft)
(this cross section is 7600 feet long)
14.99 ft
10.01 ft
10.03 ft
North
East
Cross Section:
total
US Army Corps of Engineers
Engineer Research and Development Center
USACE-ERDC-GSL-GEGB
In Situ anomaly causing data processing error
CPT Predicted Soil classification (SCN)
(non linear normalized ERDC 07 version)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
SP to GM
SP and SM
SP to SM
SP-SM SAND, with less than 5% fines
ML to SM
ML (by defination)
Clay mixtures, influenced by silt interaction
BOUNDRY for Silty clay to clayey mixtures
Clays NOT influenced by silt interaction
CL to CH clays
CH and CL clays (and NC organic clays)
CH clays, organic clays, or peats
Organic clays to Peats
Cross Section Information
NOTES: CPT cross sections were generated using soil layer tracing to connect soil conditions between CPT soundings. For proper evaluation of a given section, the cross sections of CPT predicted soil type, strength, and normalized strength should be available for comprehensive
NOTE:
Due to poor quality CPT data, the following modifications were made to the raw CPT data before data analysis;
0.5 tsf was added to the Cone resistance, and
0.018 tsf was added to the sleeve resistance.
CPT Evaluation and estimation of differential Settlment based on USACE GSL advanced procedures using IRL provide data from SAS
Cross Section of total
CPT predicted Soil Classification (ERDC version)
Dr. Olsen - USACE ERDC GSL - Geotechnical Characterization Group
Bubbly creek Evaluation





NOTES: SUMMARY OF CPT POINT LOCATIONS SPECIFIED BELOW

- POINTS NEAR RACINE AVENUE PUMP STATION SLIP:

POINT ID	CORRESPONDING BORING LOCATION
CPT-01-08	B13
CPT-02-08	–
CPT-03-08	–
CPT-04-08	–
CPT-05-08	–
CPT-06-08	–
CPT-07-08	–
CPT-08-08	B12
CPT-09-08	–

- POINTS ALONG BUBBLY CREEK CHANNEL:

POINT ID	STATION	OFFSETS				
		LEFT		CENTER	RIGHT	
		A	B	C	D	E
CPT-10-08	2+00	50'	25'	0'	25'	50'
CPT-11-08	4+00	50'	25'	0'	25'	50'
CPT-12-08	6+00	50'	25'	0'	25'	50'
CPT-13-08	8+00	50'	25'	0'	25'	50'
CPT-14-08	10+00	50'	25'	0'	25'	50'
CPT-15-08	12+00	50'	25'	0'	25'	50'
CPT-16-08	14+00	50'	25'	0'	25'	50'
CPT-17-08	16+00	50'	25'	0'	25'	50'
CPT-18-08	18+00	50'	25'	0'	25'	50'
CPT-19-08	19+00	50'	25'	0'	25'	50'
CPT-20-08	20+00	50'	25'	0'	25'	50'
CPT-21-08	22+00	50'	25'	0'	25'	50'
CPT-22-08	24+00	50'	25'	0'	25'	50'
CPT-23-08	26+00	50'	25'	0'	25'	50'
CPT-24-08	28+00	50'	25'	0'	25'	50'
CPT-25-08	30+00	50'	25'	0'	25'	50'
CPT-26-08	32+00	50'	25'	0'	25'	50'
CPT-27-08	34+00	50'	25'	0'	25'	50'
CPT-28-08	36+00	50'	25'	0'	25'	50'
CPT-29-08	38+00	40'	20'	0'	20'	40'
CPT-30-08	40+00	40'	20'	0'	20'	40'
CPT-31-08	42+00	40'	20'	0'	20'	40'
CPT-32-08	44+00	40'	20'	0'	20'	40'
CPT-33-08	46+00	40'	20'	0'	20'	40'
CPT-34-08	48+00	50'	25'	0'	25'	50'
CPT-35-08	50+00	50'	25'	0'	25'	50'
CPT-36-08	52+00	50'	25'	0'	25'	50'
CPT-37-08	54+00	50'	25'	0'	25'	50'
CPT-38-08	56+00	50'	25'	0'	25'	50'
CPT-39-08	58+00	50'	25'	0'	25'	50'
CPT-40-08	60+00	50'	25'	0'	25'	50'
CPT-41-08	62+00	50'	25'	0'	25'	50'
CPT-42-08	64+00	50'	25'	0'	25'	50'
CPT-43-08	66+00	50'	25'	0'	25'	50'
CPT-44-08	68+00	50'	25'	0'	25'	50'

- POINTS OPPOSITE TURNING BASIN:

POINT ID	CORRESPONDING BORING LOCATION
CPT-45-08	–
CPT-46-08	–
CPT-47-08	–
CPT-48-08	–
CPT-49-08	–
CPT-50-08	–
CPT-51-08	–

- POINTS WITHIN TURNING BASIN:

POINT ID	CORRESPONDING BORING LOCATION
CPT-52-08	B-12-07
CPT-53-08	B-03-07
CPT-54-08	B-07-07
CPT-55-08	B-08-07
CPT-56-08	B-04-07
CPT-57-08	B-06-07
CPT-58-08	B-11-07
CPT-59-08	B-02-07
CPT-60-08	B01A
CPT-61-08	B-05-07
CPT-62-08	B-01-07
CPT-63-08	B-09-07
CPT-64-08	B-10-07

station 70+00

station 72+00

station 74+00

SCALE IN FEET

notes:
1) CPT-56-08 not performed
2) no vane test data for B-04-07
3) B01A performed by CDM, no vane test data
4) CPT-54-08, -55-08, -59-08 -61-08, and -63-08 do not fall on cross sections. Individual logs are compared

US Army Corps of Engineers Chicago District

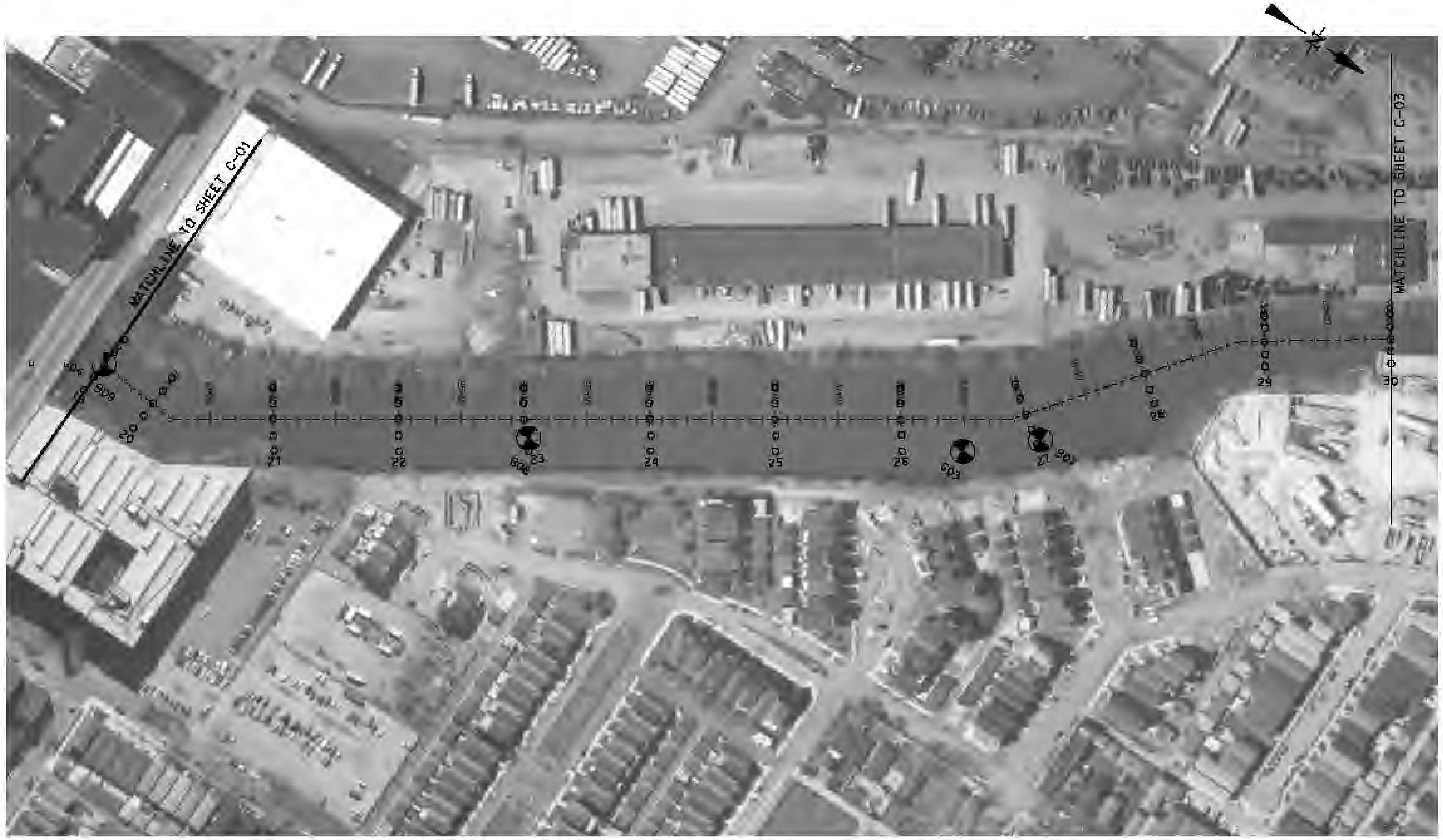
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS CHICAGO, ILLINOIS

DESIGNED BY: JWS
DRAWN BY: OJ
CHECKED BY: DFB
SUBMITTED BY:
DATE: MARCH 2008
SCALE: AS SHOWN
SOLICITATION NUMBER:

SOUTHFORK SOUTH BRANCH CHICAGO RIVER - BUBBLY CREEK FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION

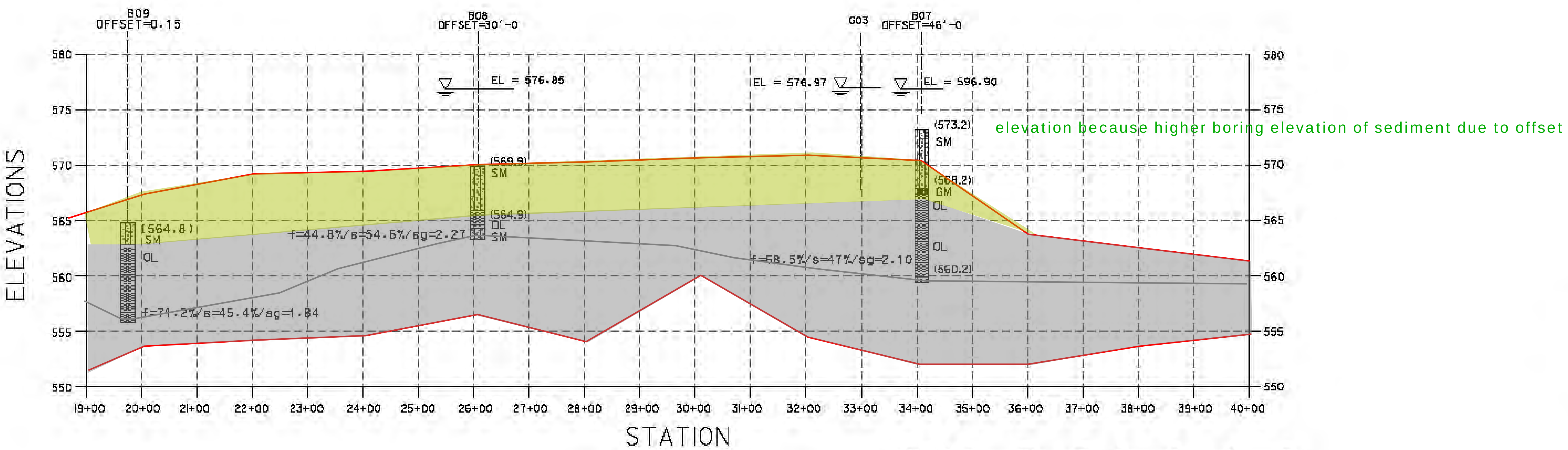
PLAN AND PROFILE

SHEET REFERENCE NUMBER: C-01



PLAN

100 50 0 100 200
SCALE IN FEET



PROFILE

100 50 0 100 200
HORIZONTAL SCALE IN FEET

5 0 5 10
VERTICAL SCALE IN FEET

ABBREVIATIONS
f = fines
s = percent solids
sg = specific gravity

US Army Corps of Engineers Chicago District

DESIGNED BY: JWS
DRAWN BY: DJ
CHECKED BY: DFB
SUBMITTED BY:
DATE: MARCH 2008
SCALE: AS SHOWN
SOLICITATION NUMBER:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

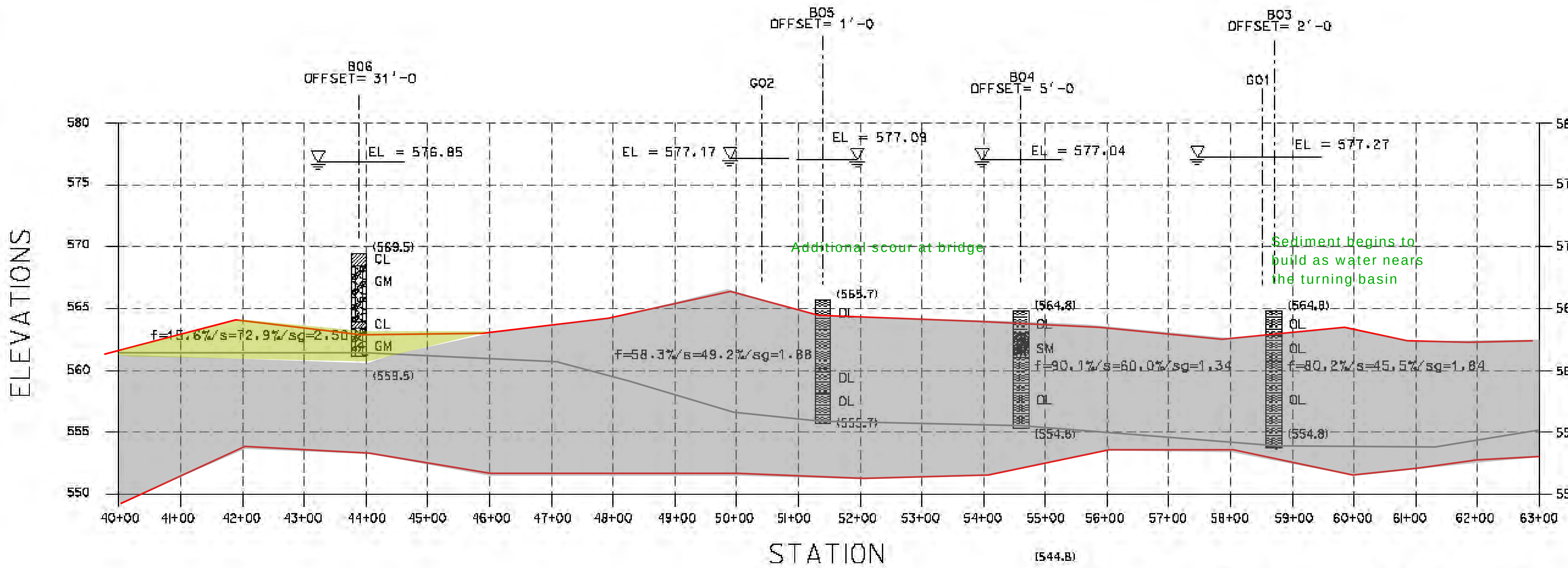
SOUTHFORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION

PLAN AND PROFILE

SHEET REFERENCE NUMBER:
C-02

PLAN

SCALE IN FEET



PROFILE

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET

ABBREVIATIONS

f = fines
s = percent solids
sg = specific gravity

US Army Corps of Engineers Chicago District

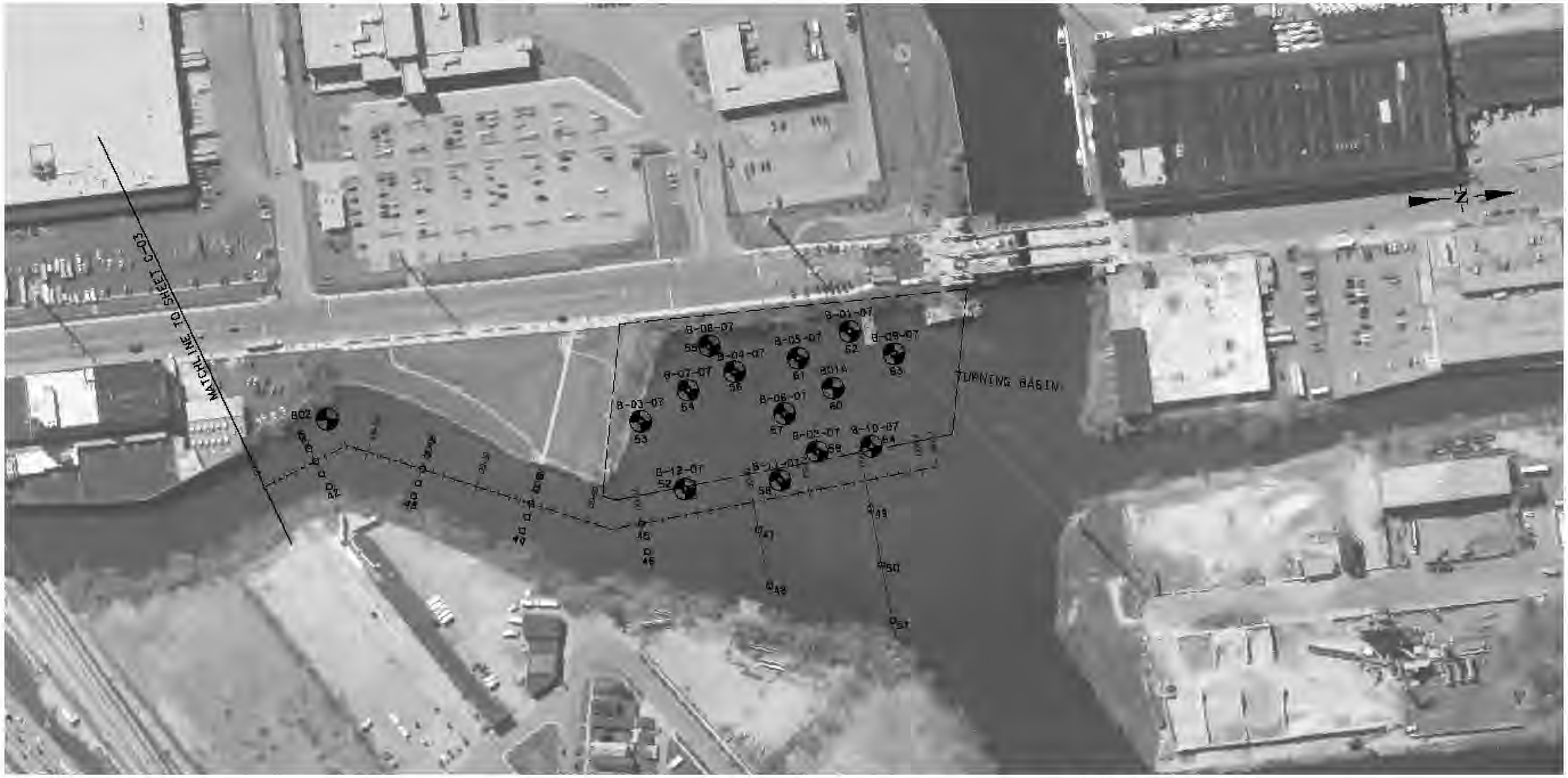
DESIGNED BY: JWS
DRAWN BY: DJ
CHECKED BY: DFB
SUBMITTED BY:
DATE: MARCH 2008
SCALE: AS SHOWN
SOLICITATION NUMBER:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

SOUTHFORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION

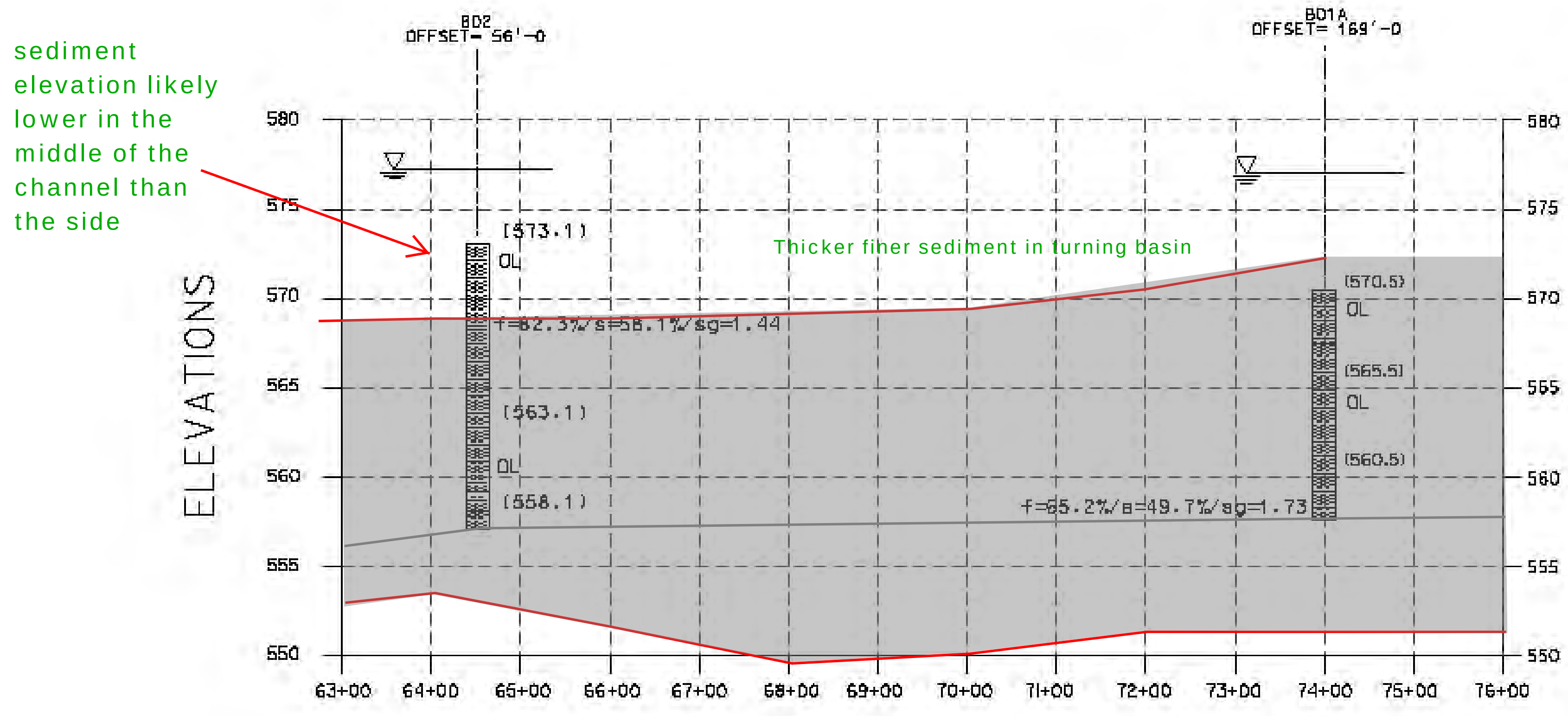
PLAN AND PROFILE

SHEET REFERENCE NUMBER:
C-03



PLAN

SCALE IN FEET



PROFILE

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET

NOTE:

TURNING BASIN CPT'S WILL BE LOCATED AT SAME LOCATIONS AS PEI BORINGS W/VANE TESTS FOR STRATIGRAPHY AND ENGINEERING PROPERTY CORRELATION.

ABBREVIATIONS

f = fines
s = percent solids
sg = specific gravity

US Army Corps of Engineers Chicago District

DESIGNED BY: JWS | DATE: MARCH 2008
DRAWN BY: OJ | SCALE: AS SHOWN
CHECKED BY: DFB | SOLICITATION NUMBER:
SUBMITTED BY: | DATE:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

SOUTHFORK SOUTH BRANCH
CHICAGO RIVER - BUBBLY CREEK
FEASIBILITY STUDY
GEOTECHNICAL INVESTIGATION

PLAN AND PROFILE

SHEET REFERENCE NUMBER:

C-04

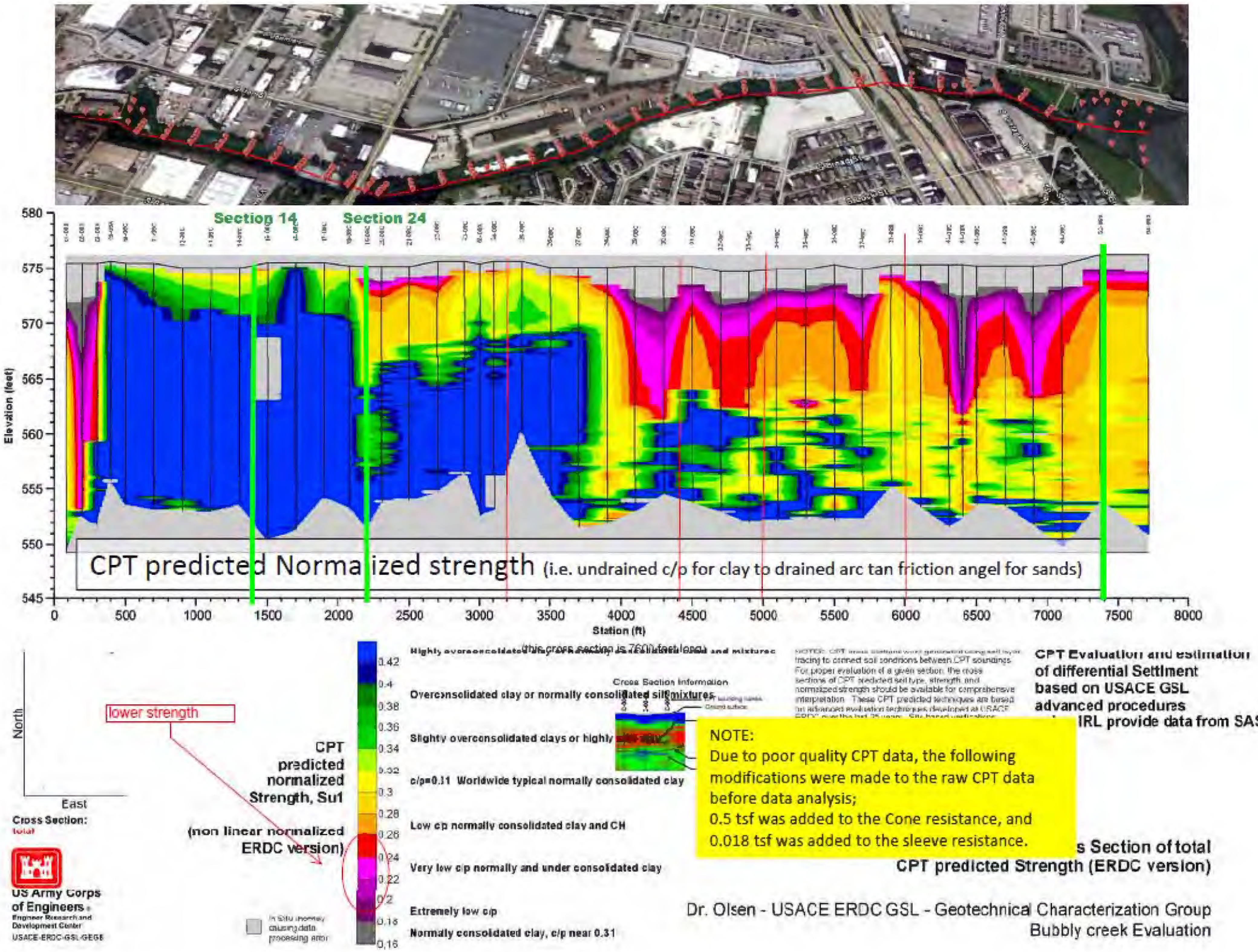
SHEET OF 99

PLOT DATE: 3/20/2008

US Army Corps of Engineers® Chicago District	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET:
	COMPUTATION TITLE: **Stability Attachments**	CHECKED BY:	DATE:	

ATTACHMENT

D-2-2 c/p' ratios



Section 14
Section 24
Elevation (feet)
580
575
570
565
560
555
550
545
CPT predicted Normalized strength (i.e. undrained c/p for clay to drained arc tan friction angel for sands)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
Station (ft)
(this cross section is 7600 feet long)
North
East
lower strength
Cross Section:
total
CPT predicted normalized Strength, Su1
(non linear normalized ERDC version)
0.42
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
Highly overconsolidated clay or normally consolidated sand and mixtures
Overconsolidated clay or normally consolidated silt mixtures
Slighty overconsolidated clays or highly
c/p=0.31 Worldwide typical normally consolidated clay
Low c/p normally consolidated clay and CH
Very low c/p normally and under consolidated clay
Extremely low c/p
Normally consolidated clay, c/p near 0.31
Cross Section information
tracing to connect soil conditions between CPT soundings. For proper evaluation of a given section, the cross sections of CPT predicted soil type, strength, and normalized strength should be available for comprehensive interpretation. These CPT predicted techniques are based on advanced evaluation techniques developed at USACE
NOTE:
Due to poor quality CPT data, the following modifications were made to the raw CPT data before data analysis;
0.5 tsf was added to the Cone resistance, and
0.018 tsf was added to the sleeve resistance.
CPT Evaluation and estimation of differential Settlment based on USACE GSL advanced procedures
IRL provide data from SAS
s Section of total CPT predicted Strength (ERDC version)
Dr. Olsen - USACE ERDC GSL - Geotechnical Characterization Group
Bubbly creek Evaluation
US Army Corps of Engineers
Engineer Research and Development Center
USACE-ERDC-GSL-GEGE

	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET:
US Army Corps of Engineers® Chicago District	COMPUTATION TITLE: **Stability Attachments**	CHECKED BY:	DATE:	

ATTACHMENT

D-2-3 Soil Tests Summary

Laboratory Data Summary

Boring	Easting	Northing	Source	Sample	Depth	w_c (%) /2	γ*	Cc/(1+eo) /7	Cc/(1+eo) /8	LL	PL	PI	e /1	Ash (%)	Organic Carbon (%)	Specific Gravity (G_s)	Specific Gravity (Gs) (data added)	Cc	%fines	%solids	organic soils Cc /3	low plasticity soils Cc /4	Chicago Clays Cc /5	All Clays Cc /6
B-14			AECOM (STS)	4	15'-17'	56	96	0.29	0.45				1.23	72	28	-	2.19							
	1,168,267.30	1,882,102.80																			0.64	0.55	0.56	1.01
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	5	17.5-19.5'	59	93	0.30	0.46				1.24	64	36	2.1	2.1				0.68	0.55	0.59	1.02
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	6	20'-22.5'	43	101	0.25	0.35				0.95	81	19	-	2.19		64.4%		0.49	0.33	0.43	0.69
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	7	22.5'-23.5'	65	69	0.42	0.28				0.78	-	-	1.2	1.2		57.6%		0.75	0.21	0.65	0.49
B-14	1,168,267.30	1,882,102.80	AECOM (STS)	7A	23.5'-23.75'	11	123	0.10	-0.10				0.24	-	-	-	2.19				0.13	-0.19	0.11	-0.12
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	3	12.5'-14.5'	42	101	0.25	0.34				0.92	88	12	-	2.19		31.0%		0.48	0.32	0.42	0.66
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	4	15'-17'	33	106	0.22	0.25				0.73	-	-	-	2.19		19.2%		0.38	0.17	0.33	0.43
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	5	17.5'-19.5'	14	120	0.12	-0.04				0.31	<0.10	<0.10	-	2.19				0.16	-0.14	0.14	-0.05
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	6	20'-22'	18	123	0.14	0.07				0.43	96	4.5	2.4	2.4		34.7%		0.21	-0.05	0.18	0.09
B-15	1,166,504.90	1,885,345.40	AECOM (STS)	7	22.5'-23.5'	9	148	0.08	-0.10				0.24	-	-	2.7	2.7		56.0%		0.10	-0.19	0.09	-0.12
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	4	12.5'-14.5'	32	106	0.22	0.24				0.70	58	42	-	2.19				0.37	0.15	0.32	0.41
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	5	15'-17'	56	79	0.35	0.31				0.84	75	25	1.5	1.5				0.64	0.26	0.56	0.56
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	6	17.5'-19.5'	49	98	0.27	0.40				1.08	71	29	-	2.19				0.56	0.43	0.49	0.84
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	7	20'-22'	54	97	0.28	0.44				1.19	-	-	-	2.19				0.62	0.52	0.54	0.96
B-16	1,168,430.10	1,880,570.80	AECOM (STS)	8	22.5'-24.25'	12	143	0.10	-0.02				0.32	-	-	2.7	2.7		73.1%		0.14	-0.13	0.12	-0.03
B-1-07 ST-1	1,166,237.75	1,886,462.32	PEI		6'-8'	108	86	0.36	0.71	53	43	10	2.49			2.309	2.309		80.4%		1.24	1.50	1.08	2.47
B-1-07 ST-4	1,166,237.75	1,886,462.32	PEI		18'-20'	108	86	0.35	0.71	36	31	5	2.52			2.336	2.336		25.9%		1.24	1.52	1.08	2.50
B-2-07 ST-1	1,166,442.71	1,886,387.39	PEI		11'-13'	157	80	0.39	0.81				3.58			2.279	2.279		54.4%		1.81	2.31	1.57	3.71
B-2-07 ST-3	1,166,442.71	1,886,387.39	PEI		19'-21'	145	80	0.40	0.78	70	57	13	3.19			2.197	2.197		51.4%		1.67	2.01	1.45	3.26
B-3-07 ST1	1,166,363.32	1,886,084.30	PEI		7'-9'	119	84	0.36	0.74	67	44	23	2.78			2.333	2.333		89.8%		1.37	1.71	1.19	2.79
B-3-07 ST-5	1,166,363.32	1,886,084.30	PEI		22'-24'	120	84	0.37	0.73	63	40	23	2.73			2.275	2.275		32.5%		1.38	1.67	1.20	2.74
B-5-07 ST-1	1,166,276.64	1,886,367.87	PEI		8'-10'	107	87	0.35	0.71	56	39	17	2.56			2.391	2.391	1	83.7%		1.23	1.54	1.07	2.54
B-5-07 ST-2	1,166,276.64	1,886,367.87	PEI		12'-14'	108	85	0.36	0.70	54	38	16	2.43			2.252	2.252		32.5%		1.24	1.45	1.08	2.39
B-6-07 ST-1	1,166,372.26	1,886,335.82	PEI		10'-12'	143	80	0.40	0.78	75	45	30	3.14			2.197	2.197	0.9	84.5%		1.64	1.98	1.43	3.21
B-6-07 ST-2	1,166,372.26	1,886,335.82	PEI		14'-16'	91	87	0.35	0.63	56	47	9	2.00			2.197	2.197	0.98	80.5%		1.05	1.12	0.91	1.90
B-6-07 ST-3	1,166,372.26	1,886,335.82	PEI		18'-20'	141	80	0.40	0.77	69	60	9	3.05			2.163	2.163	2.46	67.5%		1.62	1.91	1.41	3.10
B-6-07 ST-4	1,166,372.26	1,886,335.82	PEI		22'-24'	95	88	0.35	0.66	65	58	7	2.17			2.28	2.28		78.1%		1.09	1.25	0.95	2.09
B-7-07 ST-1	1,166,316.31	1,886,171.40	PEI		8'-10'	113	85	0.36	0.72	65	42	23	2.62			2.32	2.32		77.6%		1.30	1.59	1.13	2.61
B-7-07 ST-5	1,166,316.31	1,886,171.40	PEI		24'-26'	68	92	0.32	0.52	58	41	17	1.48			2.172	2.172		64.0%		0.78	0.73	0.68	1.30
B-8-07 ST-1	1,166,242.40	1,886,214.55	PEI		7'-9'	131	83	0.38	0.76	64	39	25	3.02			2.302	2.302		73.3%		1.51	1.89	1.31	3.07
B-8-07 ST-3	1,166,242.40	1,886,214.55	PEI		15'-17'	89	88	0.34	0.63	61	40	21	2.00			2.245	2.245		81.9%		1.02	1.12	0.89	1.90
B-9-07 ST-1	1,166,283.51	1,886,535.56	PEI		11'-13'	87	90	0.33	0.63	57	39	18	2.01			2.311	2.311		46.4%		1.00	1.13	0.87	1.91
B-9-07 ST-3	1,166,283.51	1,886,535.56	PEI		19'-21'	86	89	0.34	0.62	65	48	17	1.91			2.225	2.225		79.4%		0.99	1.06	0.86	1.80
B-10-07 ST-1	1,166,441.97	1,886,482.13	PEI		12'-14'	155	80	0.39	0.81	61	45	16	3.57			2.305	2.305		54.4%		1.78	2.30	1.55	3.71
B-10-07 ST-4	1,166,441.97	1,886,482.13	PEI		24'-26'	100	86	0.36	0.66	62	41	21	2.20			2.198	2.198		78.7%		1.15	1.27	1.00	2.13
B-11-07 ST-2	1,166,486.84	1,886,318.49	PEI		18'-20'	174	81	0.35	0.88	65	60	5	4.67			2.684	2.684		52.3%		2.00	3.13	1.74	4.97
B-12-07 ST-1	1,166,488.15	1,886,150.87	PEI		9'-11'	122	84	0.36	0.75	69	40	29	2.89			2.367	2.367		80.7%		1.40	1.79	1.22	2.92
B-12-07 ST-4	1,166,488.15	1,886,150.87	PEI		21'-23'	94	88	0.34	0.66	60	48	12	2.16			2.293	2.293		66.5%		1.08	1.24	0.94	2.08
SF-2004-B-01A	1,166,334.48	1,886,424.30	CDM			101	79	0.42	0.59				1.75			1.73	1.73		65.2%	49.7%	1.16	0.94	1.01	1.61
SF-2004-B-02	1,166,311.55	1,885,537.78	CDM			72	76	0.41	0.39				1.04			1.44	1.44		82.3%	58.1%	0.83	0.40	0.72	0.79
SF-2004-B03	1,166,495.20	1,885,060.40	CDM			121	79	0.43	0.67				2.23			1.84	1.84		80.2%	45.2%	1.39	1.30	1.21	2.16
SF-2004-B04	1,166,520.49	1,884,806.72	CDM			67	74	0.40	0.34				0.91			1.37	1.37		90.1%	60.0%	0.77	0.31	0.67	0.65
SF-2004-B05	1,166,702.22	1,884,411.32	CDM			103	81	0.40	0.62				1.94			1.88	1.88		58.3%	49.2%	1.19	1.08	1.03	1.83
SF-2004-B05(dup)	1,166,702.22	1,884,411.32	CDM			98	82	0.40	0.60				1.83			1.87	1.87		64.1%	50.6%	1.12	0.99	0.98	1.70
SF-2004-B06	1,167,002.05	1,883,618.62	CDM			37	111	0.22	0.35				0.93			2.5	2.5		15.6%	72.9%	0.43	0.32	0.37	0.67
SF-2004-B07	1,167,708.67	1,882,959.19	CDM			113	83	0.39	0.69				2.37			2.1	2.1		68.5%	47.0%	1.30	1.40	1.13	2.32
SF-2004-B08	1,168,173.31	1,882,289.57	CDM			83	90	0.33	0.61				1.89			2.27	2.27		44.8%	54.6%	0.96	1.04	0.83	1.77
SF-2004-B09	1,166,958.01	1,881,676.13	CDM			120	79	0.43	0.67				2.21			1.84	1.84		71.2%	45.4%	1.38	1.28	1.20	2.14
SF-2004-B10	1,168,474.23	1,881,454.28	CDM			107	83	0.38	0.67				2.22			2.07	2.07		38.1%	48.3%	1.23	1.29	1.07	2.15
SF-2004-B11	1,168,446.17	1,880,323.86	CDM			42	108	0.24	0.40				1.06			2.5	2.5		7.1%	70.2%	0.49	0.42	0.42	0.82
SF-2004-B12	1,168,257.44	1,879,878.29	CDM			106	84	0.37	0.68				2.29			2.16	2.16		66.3%	48.5%	1.22	1.35	1.06	2.24
SF-2004-B13	1,168,490.62	1,879,562.57	CDM			28	119	0.19	0.25				0.72			2.55	2.55		3.5%	78.0%	0.32	0.16	0.28	0.42
SF-2004-G01	1,166,499.75	1,884,874.58	CDM			84	91	0.33	0.63				1.97			2.34	2.34		19.1%	54.3%	0.97	1.10	0.84	1.86
SF-2004-G02	1,166,818.04	1,884,187.71	CDM			128	79	0.42	0.71				2.51			1.96	1.96		32.5%	43.8%	1.48	1.51	1.28	2.49
SF-2004-G03	1,167,794.25	1,882,867.54	CDM			48	101	0.26	0.41				1.10			2.3	2.3		14.0%	67.7%	0.55	0.45	0.48	0.86
SF-2004-G04	1,166,958.01	1,881,676.13	CDM			86	93	0.31	0.66				2.16			2.53	2.53		11.8%	53.9%	0.98	1.25	0.86	2.09
SF-2004-G05	1,168,474.23	1,881,454.28	CDM			31	117	0.20	0.29				0.81			2.57	2.57		4.7%	76.1%	0.36	0.23	0.31	0.53

Laboratory Data Summary

Boring	Easting	Northing	Source	Sample	Depth	w_c (%) /2	γ*	Cc/(1+eo) /7	Cc/(1+eo) /8	LL	PL	PI	e /1	Ash (%)	Organic Carbon (%)	Specific Gravity (G_s)	Specific Gravity (Gs) (data added)	Cc	%fines	%solids	organic soils Cc /3	low plasticity soils Cc /4	Chicago Clays Cc /5	All Clays Cc /6
B-14			AECOM (STS)	4	15'-17'	56	96	0.29	0.45				1.23	72	28	-	2.19							
	1,168,267.30	1,882,102.80																			0.64	0.55	0.56	1.01
avg						84	92	0.32	0.52	61.41	44.77	16.64	1.83			2.19		1.34	54.9%	0.57	0.97	1.00	0.84	1.70
std dev						42	16	0.09	0.24				0.97			0.33		0.75	25.5%	0.11	0.48	0.73	0.42	1.12
max	1168491	1886536				174	148	0.43	0.88				4.67			2.70		2.46	90.1%	0.78	2.00	3.13	1.74	4.97
min	1166238	1879563				9	69	0.08	-0.10				0.24			1.20		0.90	3.5%	0.44	0.10	-0.19	0.09	-0.12

1/ where Gs data not available, assumed to be 2.2
2/ CDM provided percent solids, so w% was calculated for CDM data based on percent solids
3/ Cc = 1.15 x 10^{-2} w_n (For Organic soils - meadow mats, peats, and organic silt and clay)*
4/ Cc = 0.75 (eo - 0.5) (For Soils of low plasticity)*
5/ Cc = 0.01 wn (For Chicago clays)*
6/ Cc = 1.15(eo - 0.35) (For all clays)*
7/ based on Cc correlation for soils of low plasticity
8/ based on Cc correlation for all clays
*; Holtz & Kovacs, 1981; after Azzouz, Krizek, and Corotis (1976)

ρ12	1.0
ρ23	-0.08
ρ31	0.141

Cc/(1+eo) Comparison

	LRC plasticity soils	all clays	Olsen
avg	0.34	0.59	0.57
std dev	0.09	0.25	0.25
max	0.48	0.88	1.22
min	0.08	-0.10	0.11

ERDC's analysis appears to be conservative.
The "All Clays" correlation results in higher predicted Cc.

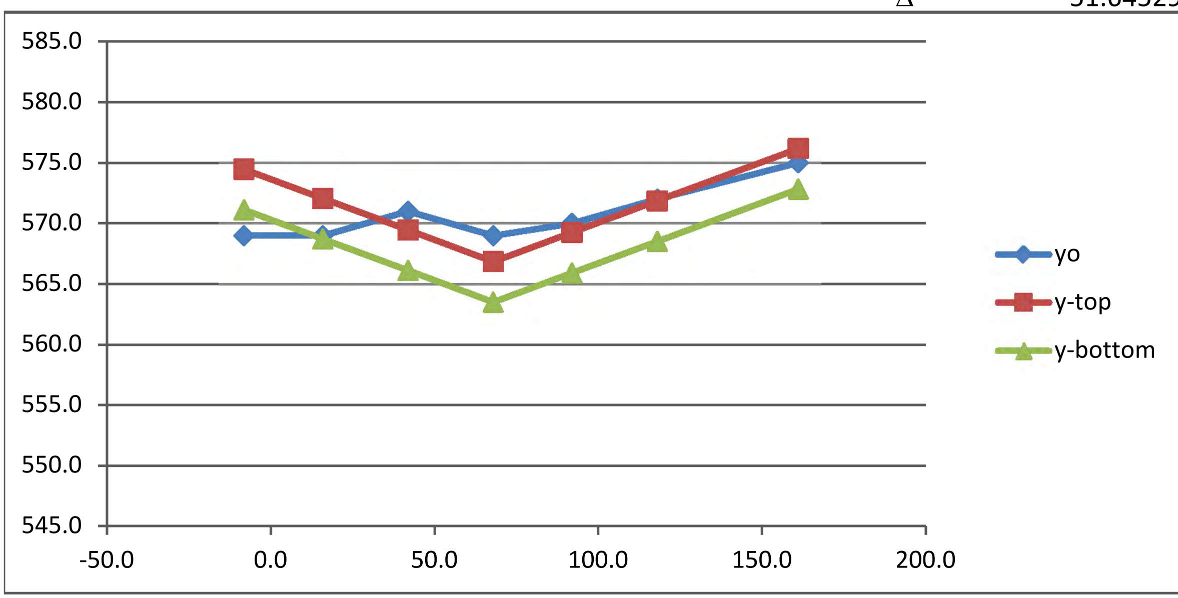
ATTACHMENT

D-2-4 Cut-Fill Calculations

Section 14 Cut/Fill Analysis

Cap	
invert top of cap	566.8692029
cap thickness	40 in	3.33 ft
slope	10%
top of water	575

Point	x	yo	y-top	y-bottom	hc	Ac	ediment are	cap area
1	-8.0	569.0	574.5	571.1	6.0	144.0	13656	13758.46
2	16.0	569.0	572.1	568.7	6.0	130.0	14820	14840
3	42.0	571.0	569.5	566.1	4.0	130.0	14820	14772.4
4	68.0	569.0	566.9	563.5	6.0	132.0	13668	13633.66
5	92.0	570.0	569.3	565.9	5.0	104.0	14846	14834.8
6	118.0	572.0	571.9	568.5	3.0	64.5	24660.5	24682.83
7	161.0	575.0	576.2	572.8	0.0			
				Σ		704.5	96470.5	96522.15
				Δ	51.64529085			



Calculator

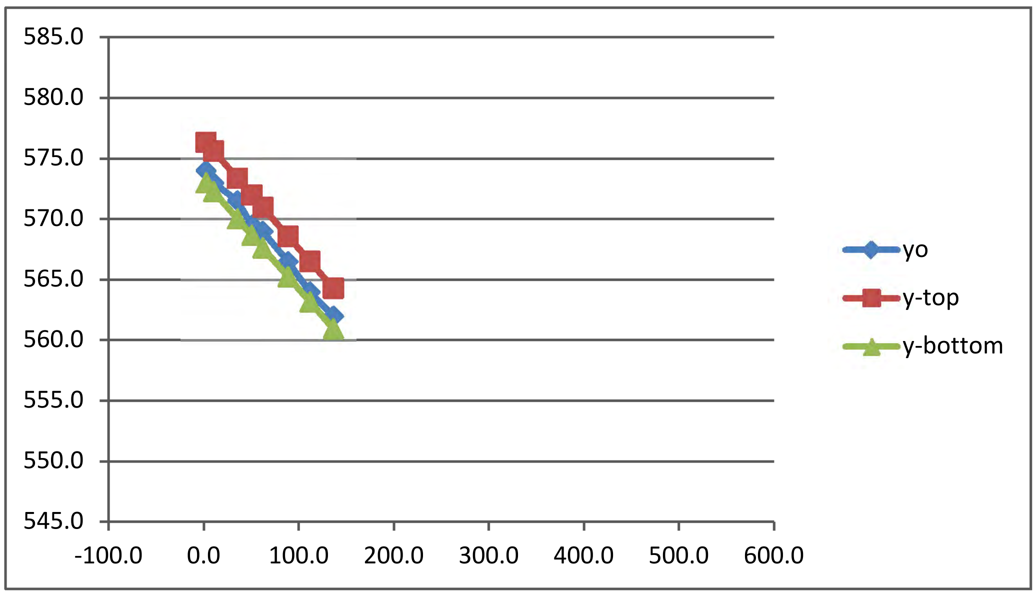
z	10
y	8.130797
A	661.0986
R	4.045223
term	1678.396
goal term	1678.396
Δ	4.87E-06
top of water	575
invert calculation	566.8692

Section 24 Cut/Fill Analysis

Cap			
invert top of cap	564.3191		
cap thickness	40	in	3.33 ft
slope	9%		

Point	x	yo	y-top	y-bottom	sediment area	cap area	notes
1	3.0	574.0	576.3	573.0	4588	4607.792964	
2	11.0	573.0	575.6	572.3	14306.25	14362.22801	
3	36.0	571.5	573.4	570.0	8557.5	8590.336808	
3	51.0	569.5	572.0	568.7	6546.375	6572.211136	
4	62.5	569.0	571.0	567.6	15045.375	15099.34544	centerline
5	89.0	566.5	568.6	565.3	13000.75	13053.85977	
6	112.0	564.0	566.5	563.2	13793.5	13852.8297	
7	136.5	562.0	564.3	561.0			
				Σ	75837.75	76138.60384	

Δ 300.8538446



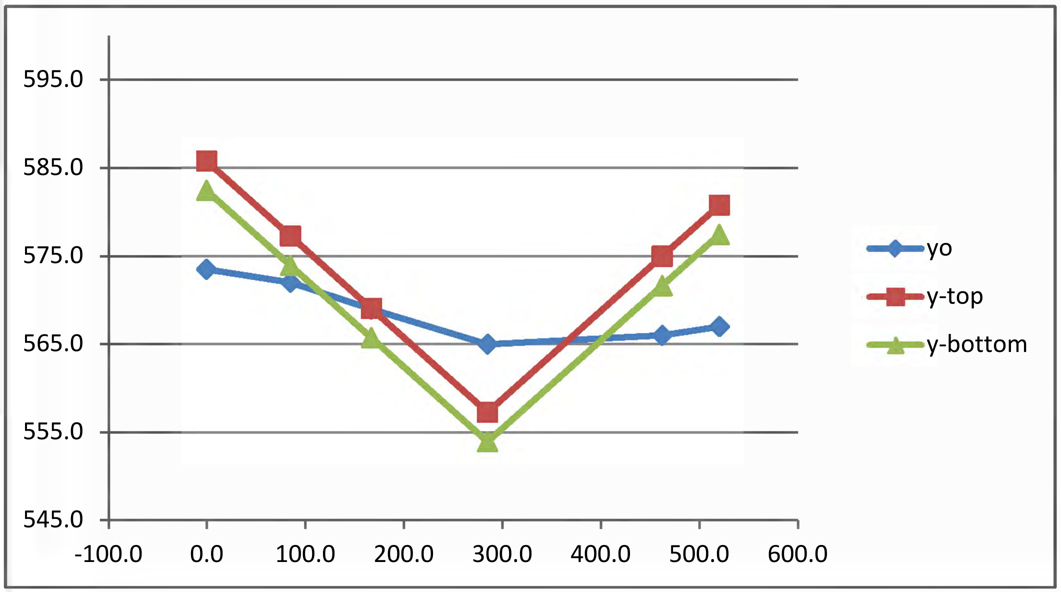
Calculator

z	10
y	10.68087944
A	1140.811856
R	5.313936134
term	3473.960796
goal term	3473.960796
Δ	8.31543E-07
top of water	575
invert calculation	564.3191206

Section 14 Cut/Fill Analysis Cap

invert top of cap	557.3
cap thickness	40 in	3.333333333 ft
slope	10%

Point	x	yo	y-top	y-bottom	sediment area	cap area	notes
1	0.0	573.5	585.8	582.5	48683.75	49430.39164	
2	85.0	572.0	577.3	574.0	46781	47001.08959	
3	167.0	569.0	569.1	565.8	66906	66455.71428	
4	285.0	565.0	557.3	554.0	100093.5	100205.7214	centerline
5	462.0	566.0	575.0	571.7	32857	33517.27312	
6	520.0	567.0	580.8	577.5			
				Σ	295321.25	296610.1901	
				Δ	1288.9401		



Calculator

z	10
y	17.71598065
A	3138.559705
R	8.814029805
term	13392.04
goal term	13392.04
Δ	-2.41271E-07
top of water	575
invert calculatior	557.2840193

US Army Corps of Engineers Chicago District	PROJECT TITLE: Cut/Fill Analysis Station 14+00	COMPUTED BY: MBP	DATE: 30 MAY 2012	SHEET: 1 of 2
	STRUCTURE TITLE: Bubbly Creek	CHECKED BY:	DATE:	CONTRACT NO:

Manning Eq.

$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$ → assume Q, n, S are equal.

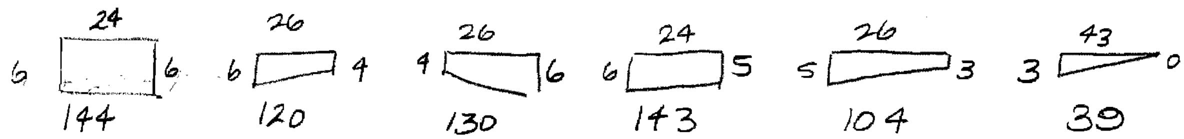
must equate New $AR^{2/3}$ and current $AR^{2/3}$.

Station 14+00

breaking into 6 segments

Wetted Perimeter WP = 24 + 26.08 + 26.08 + 24.02 + 26.08 + 43.10 + 6 (vert.) = 175.36

Area ↳



A = 680

$R = \frac{A}{WP} = \frac{680}{175.36} = 3.8777$ $AR^{2/3} = 680(3.878)^{2/3} = 1678.3964$

current →

$R = \frac{zy}{2\sqrt{1+z^2}}$ using 10% slope z = .10 using excel to vary y to achieve duplicate mannings term

where $A = zy^2$

$R = WP = 2y\sqrt{1+z^2}$

US Army Corps of Engineers Chicago District	PROJECT TITLE: Cut/Fill Analysis stations { 24+00, 72+00	COMPUTED BY: MBP	DATE: 30 MAY 2012	SHEET: 2 of 2
	STRUCTURE TITLE: Bubbly Creek	CHECKED BY:	DATE:	CONTRACT NO:

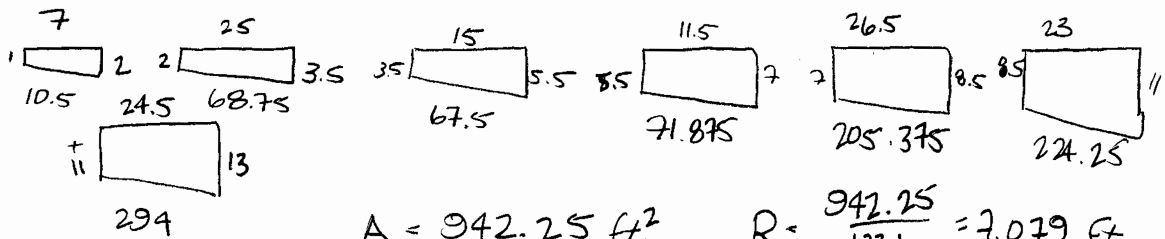
Station 24+00

breaking into 7 segments.

Wetted Perimeter

↳ WP = 7.07 + 25.04 + 15.13 + 11.60 + 26.54 + 23.14 + 24.58 = 133.1 ft

Area
↳



$A = 942.25\ ft^2$ $R = \frac{942.25}{133.1} = 7.079\ ft$

$AR^{2/3} = 3473.9607955$

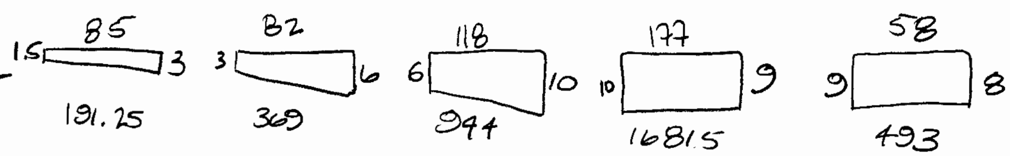
Station 72+00

breaking into 5 segments.

Wetted Perimeter

↳ WP = 85.01 + 82.05 + 118.07 + 177 + 58.01 + 1.5 + 8 = 529.64 ft (vert: 1.5 + 8)

Area
↳



$A = 3678.75\ ft^2$

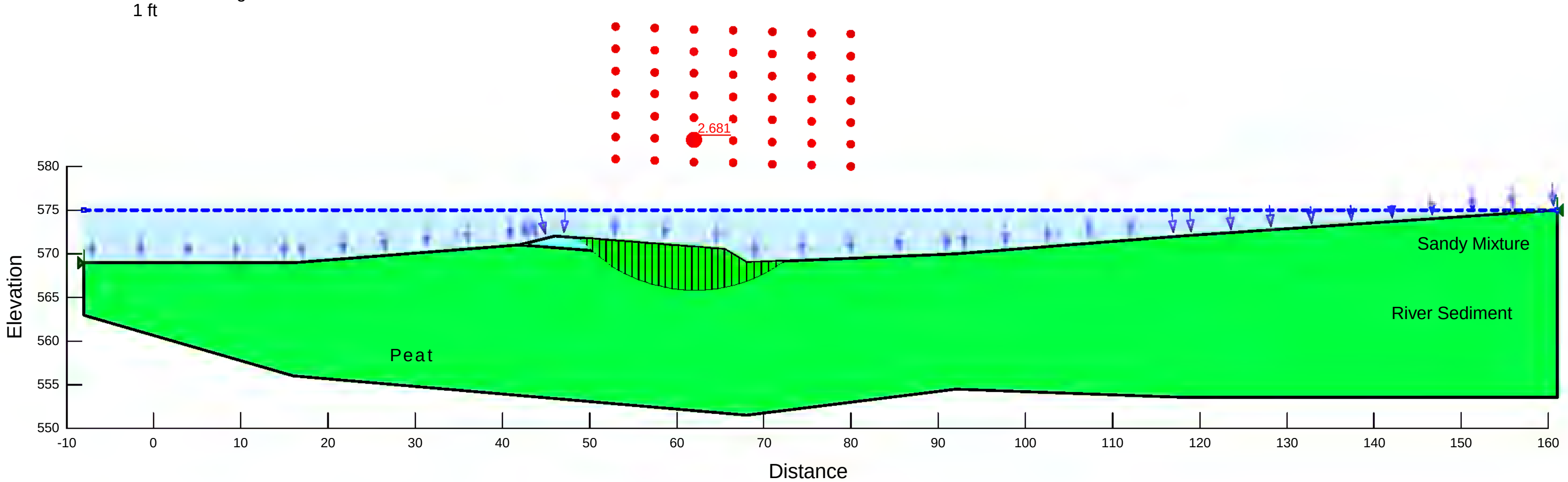
$R = \frac{3678.75}{529.64} = 6.95\ ft$

$AR^{2/3} = 13392.04$

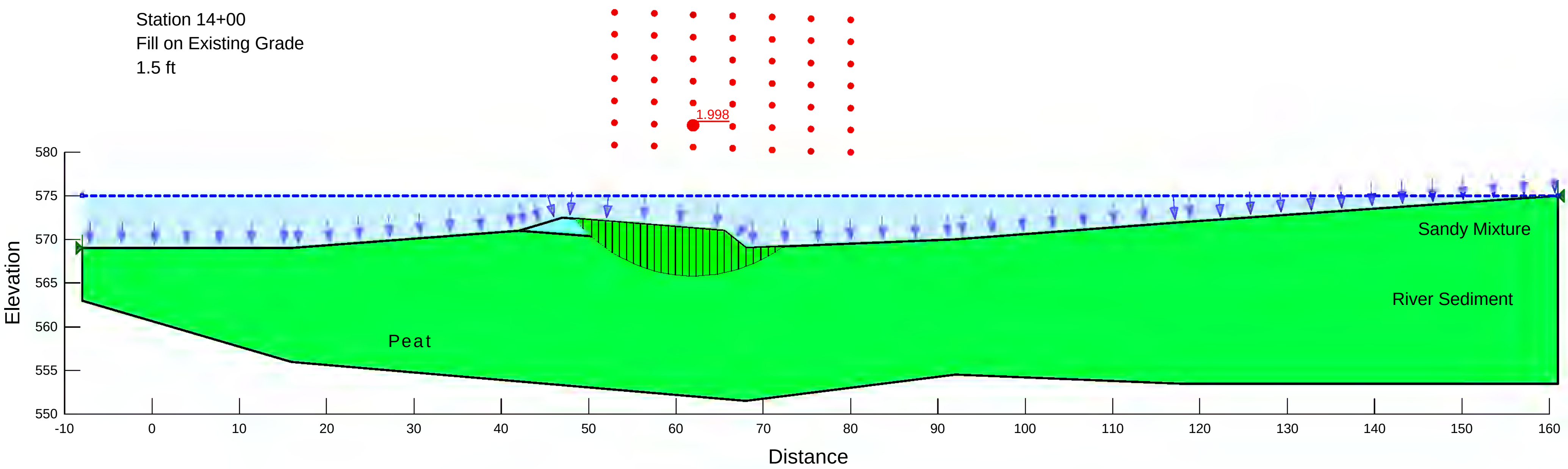
ATTACHMENT

D-2-5 Sand Cap Slope Stability Output

Station 14+00
Fill on Existing Grade
1 ft

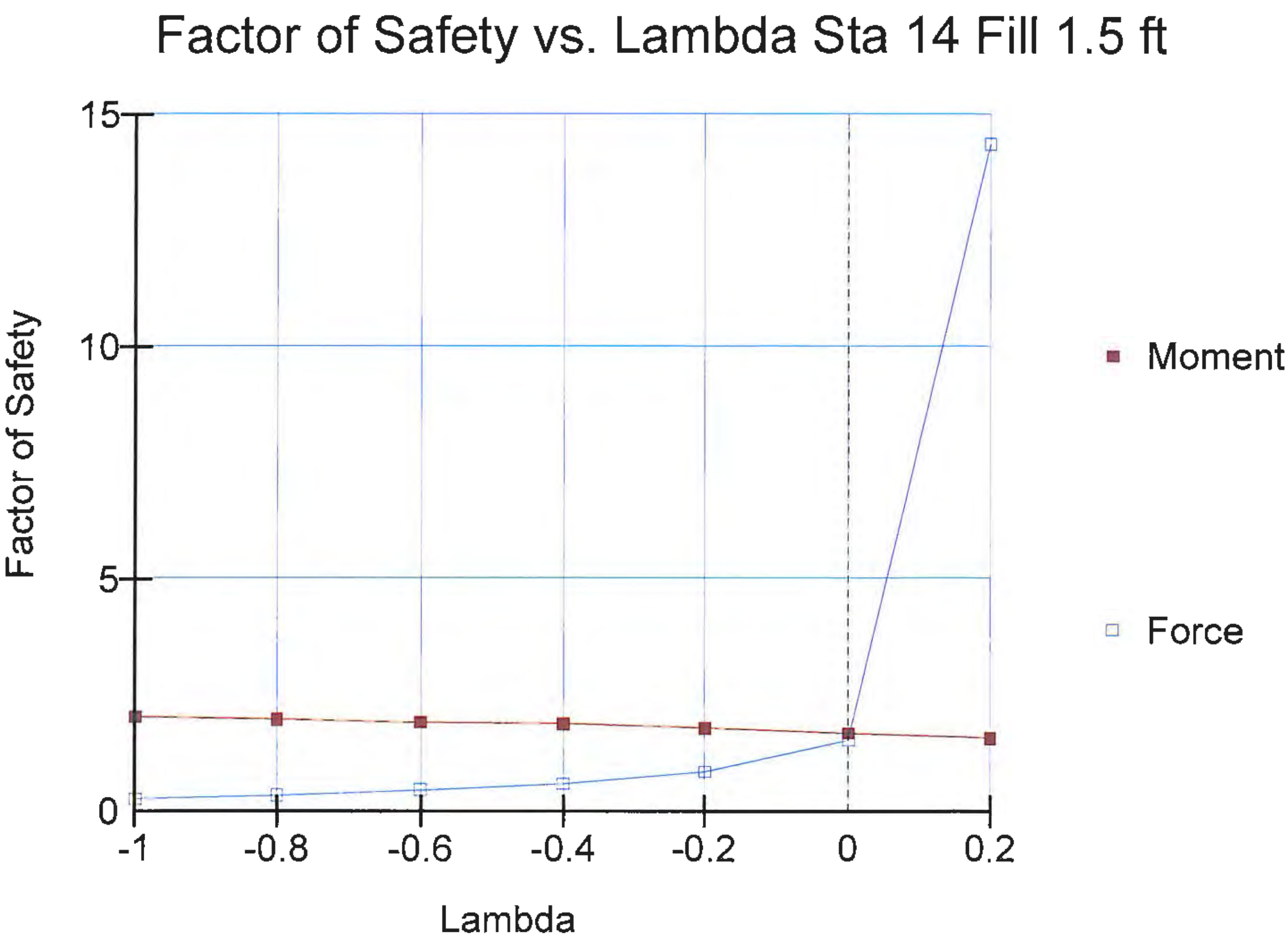


Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

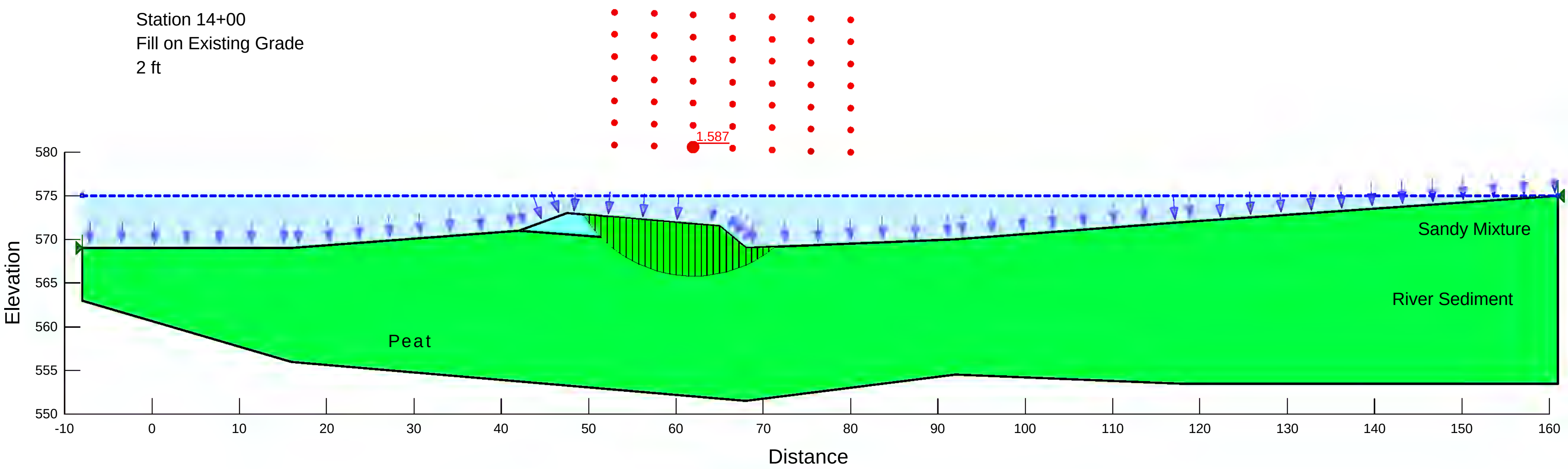


Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

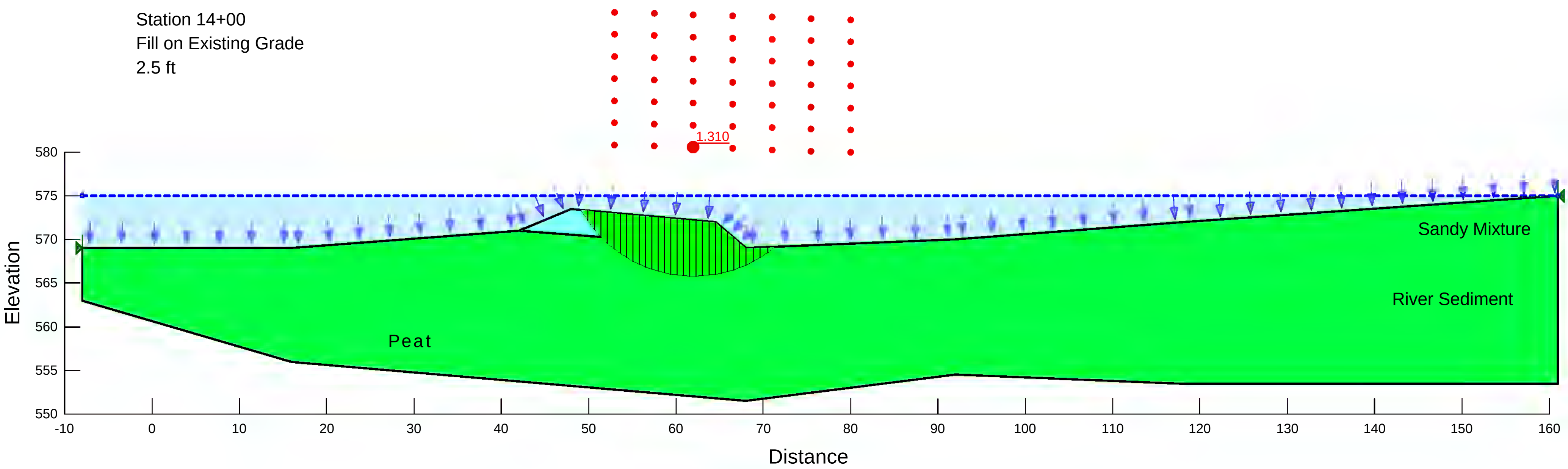


Factor of Safety vs. Lambda Sta 14 Fill 1.5 ft
Factor of Safety
15
10
5
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
Lambda
Moment
Force



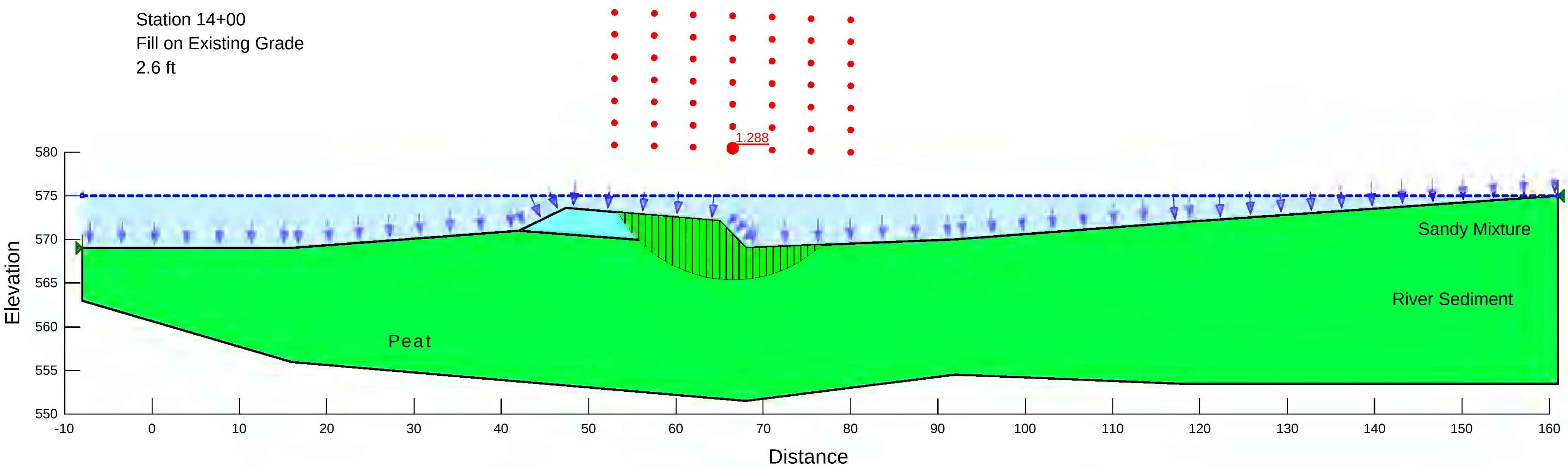
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



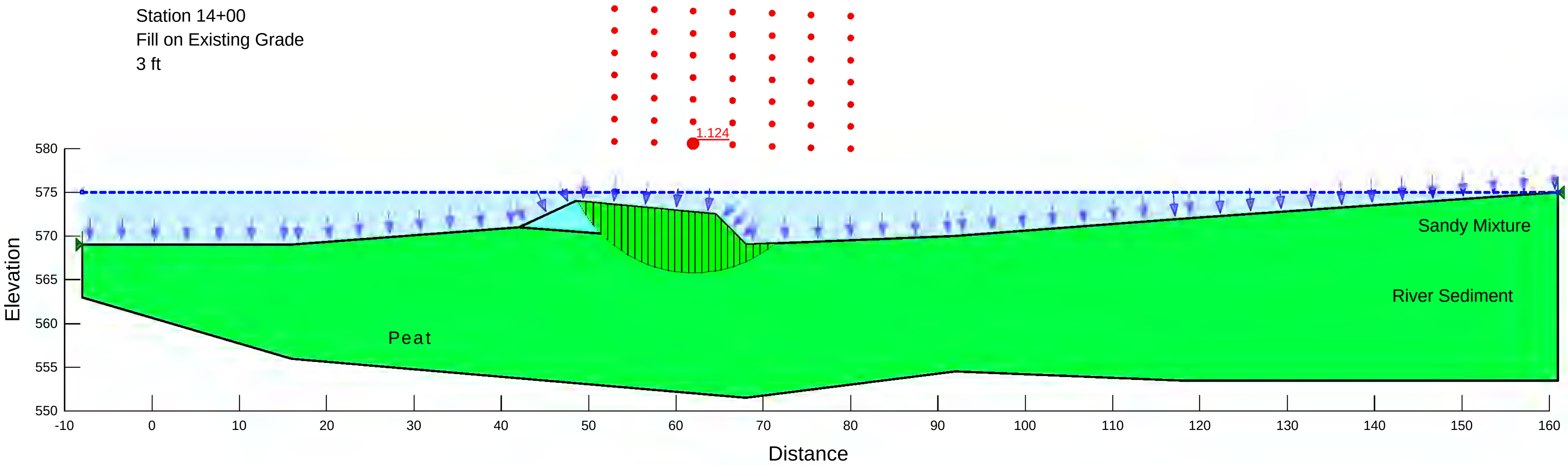
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



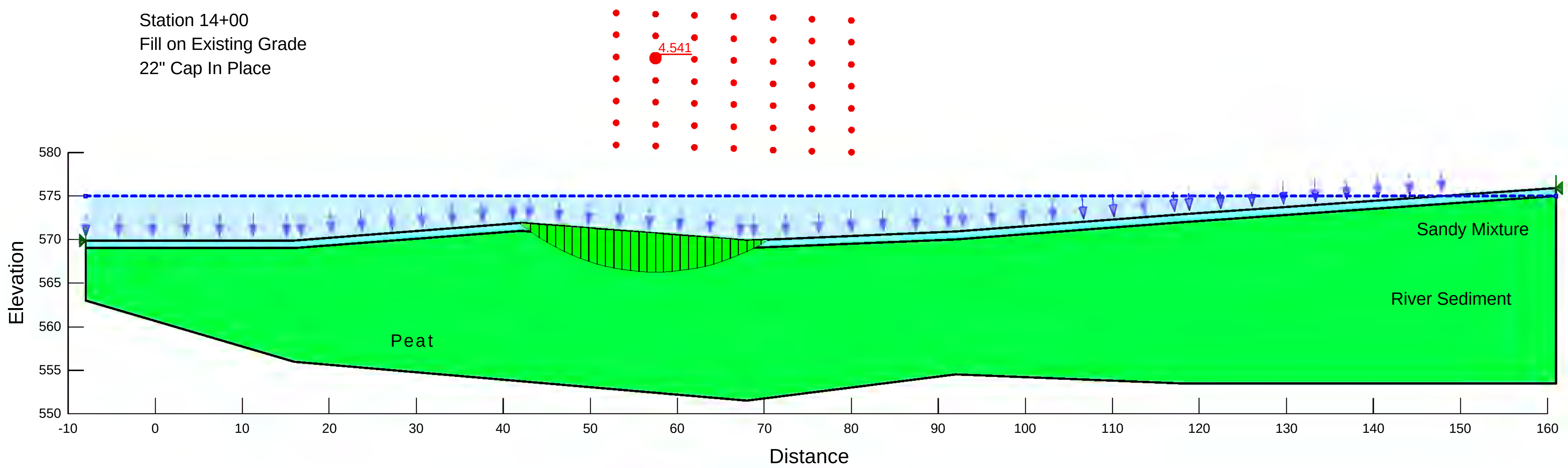
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

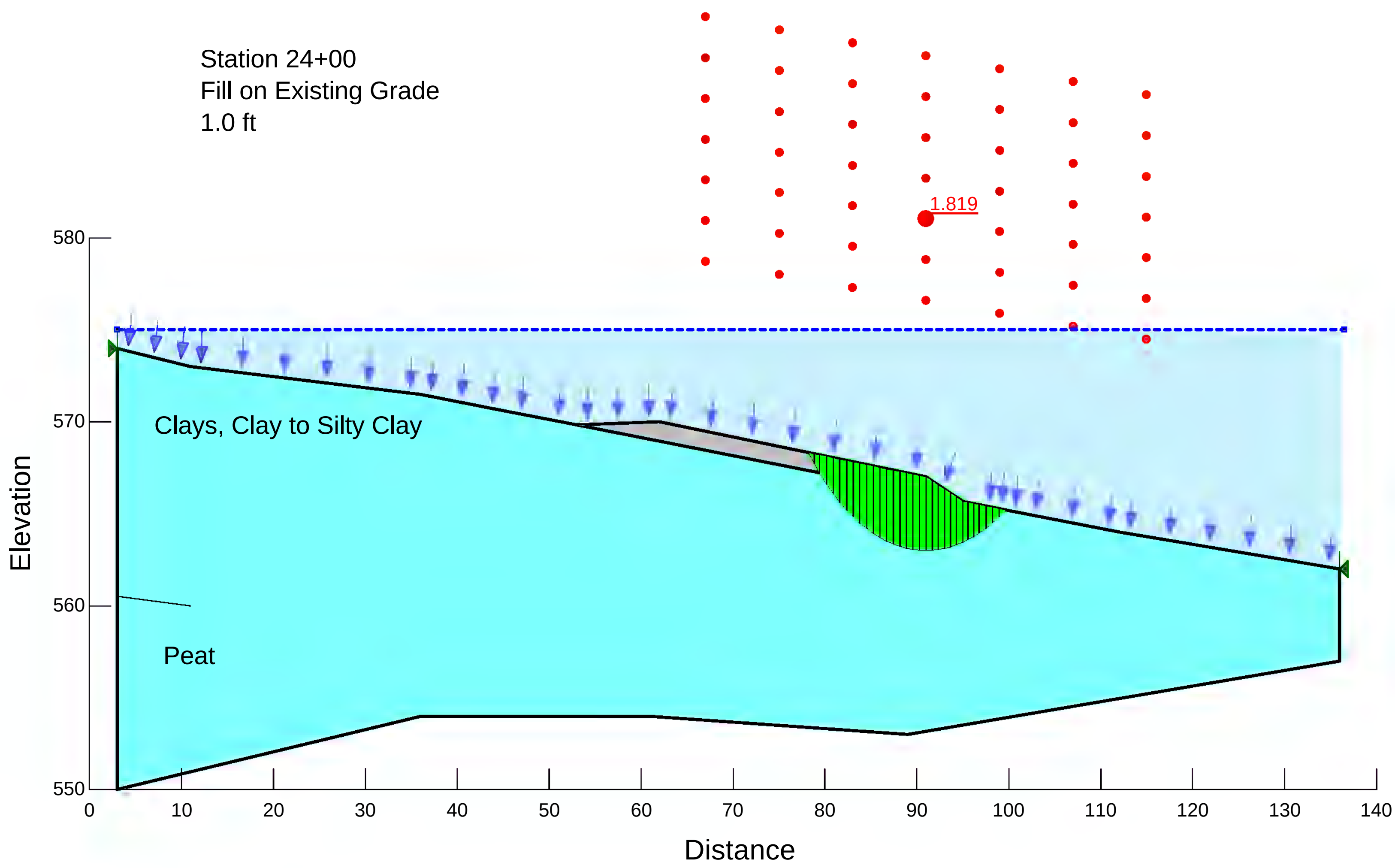


Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 10.6 psf/ft Limiting C: 600 psf Piezometric Line: 1

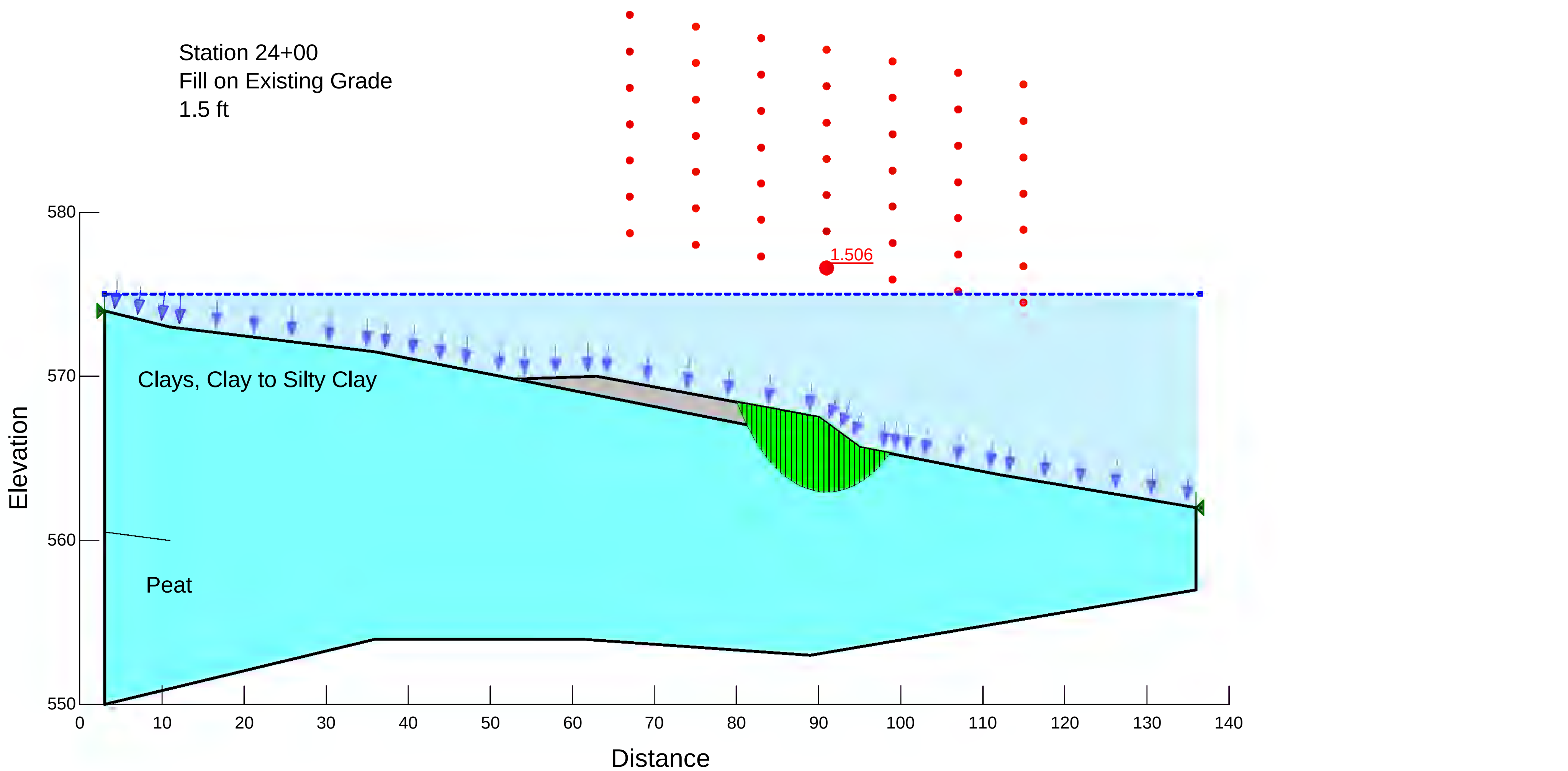
Name: cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



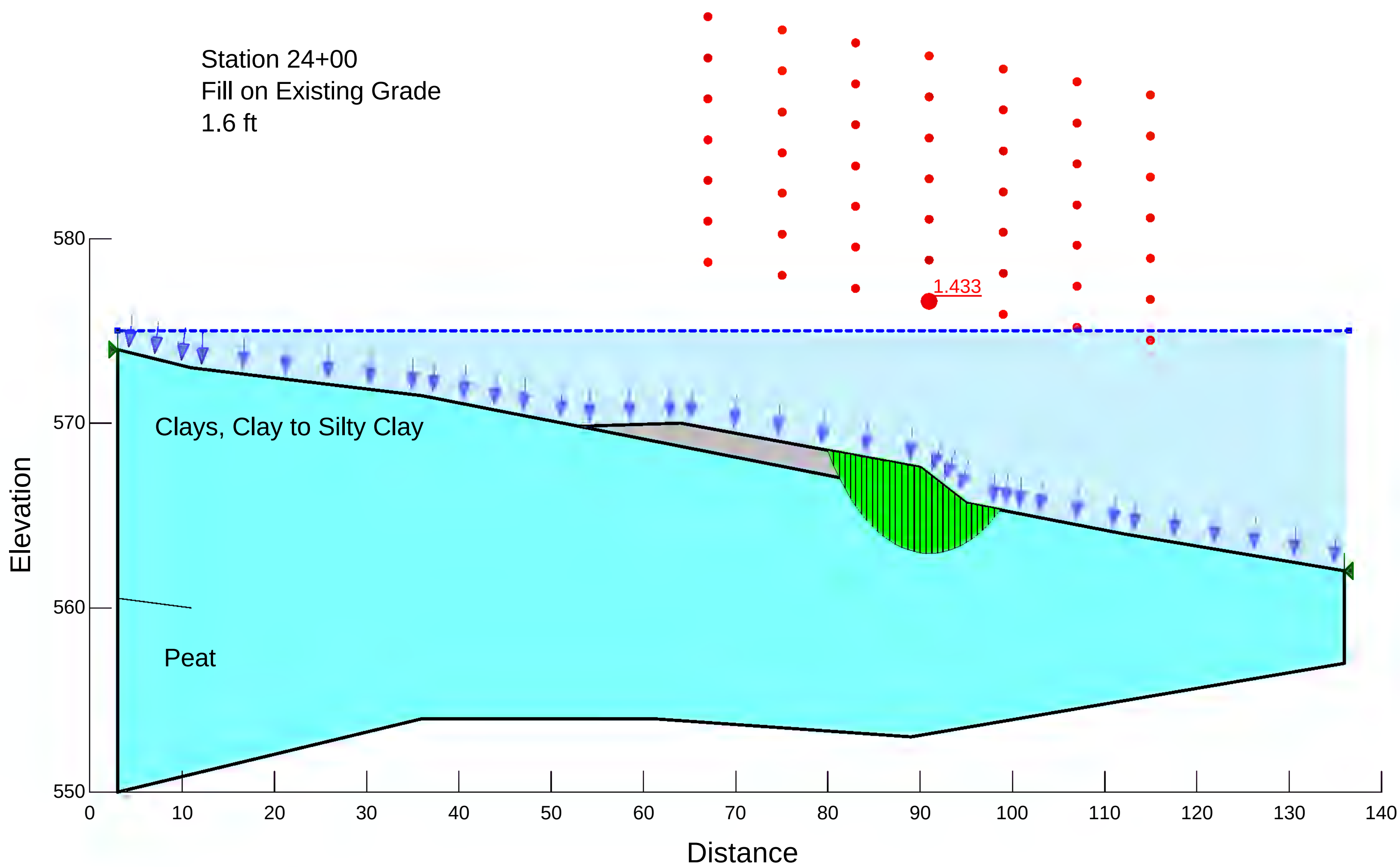
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1



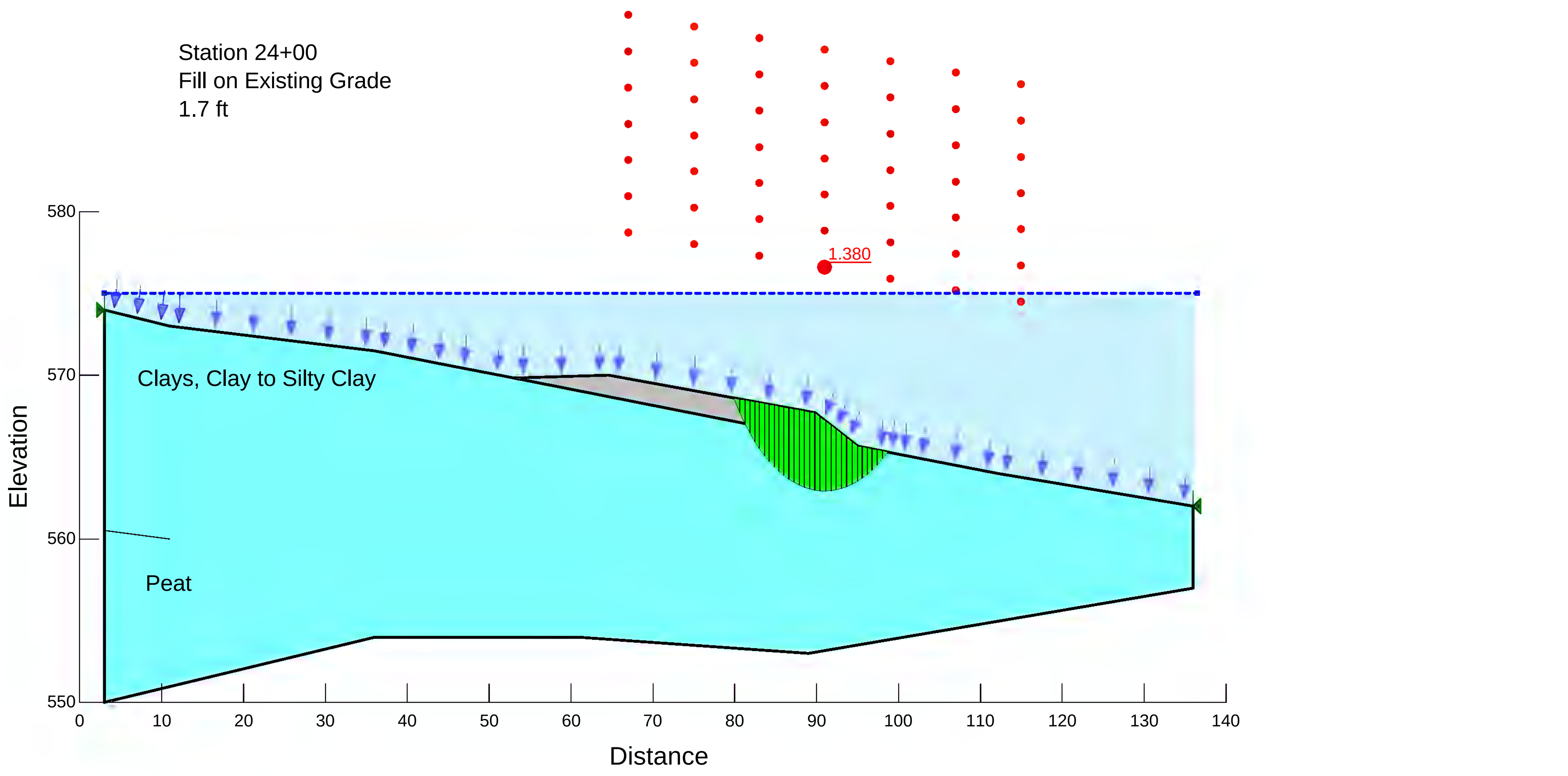
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



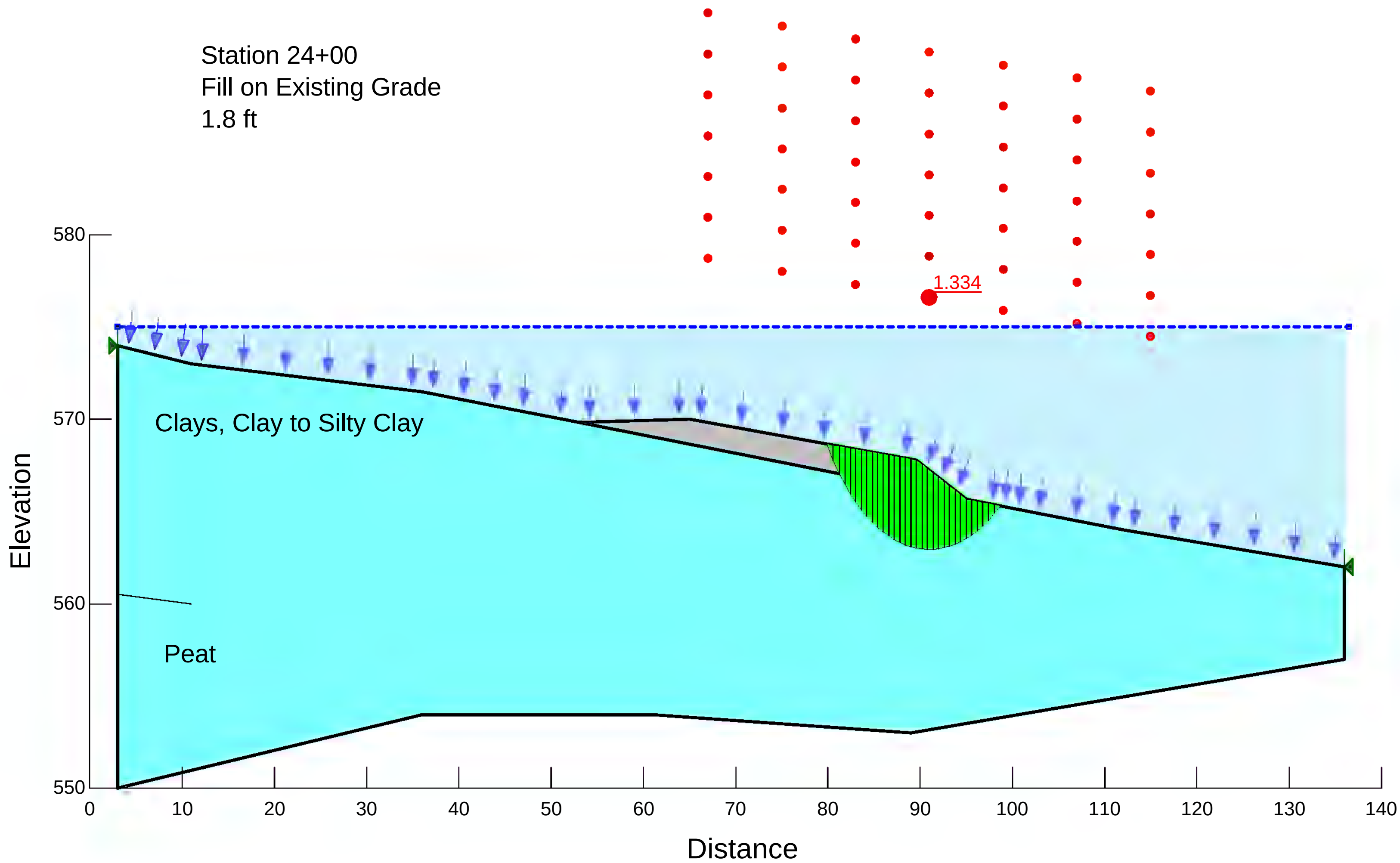
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



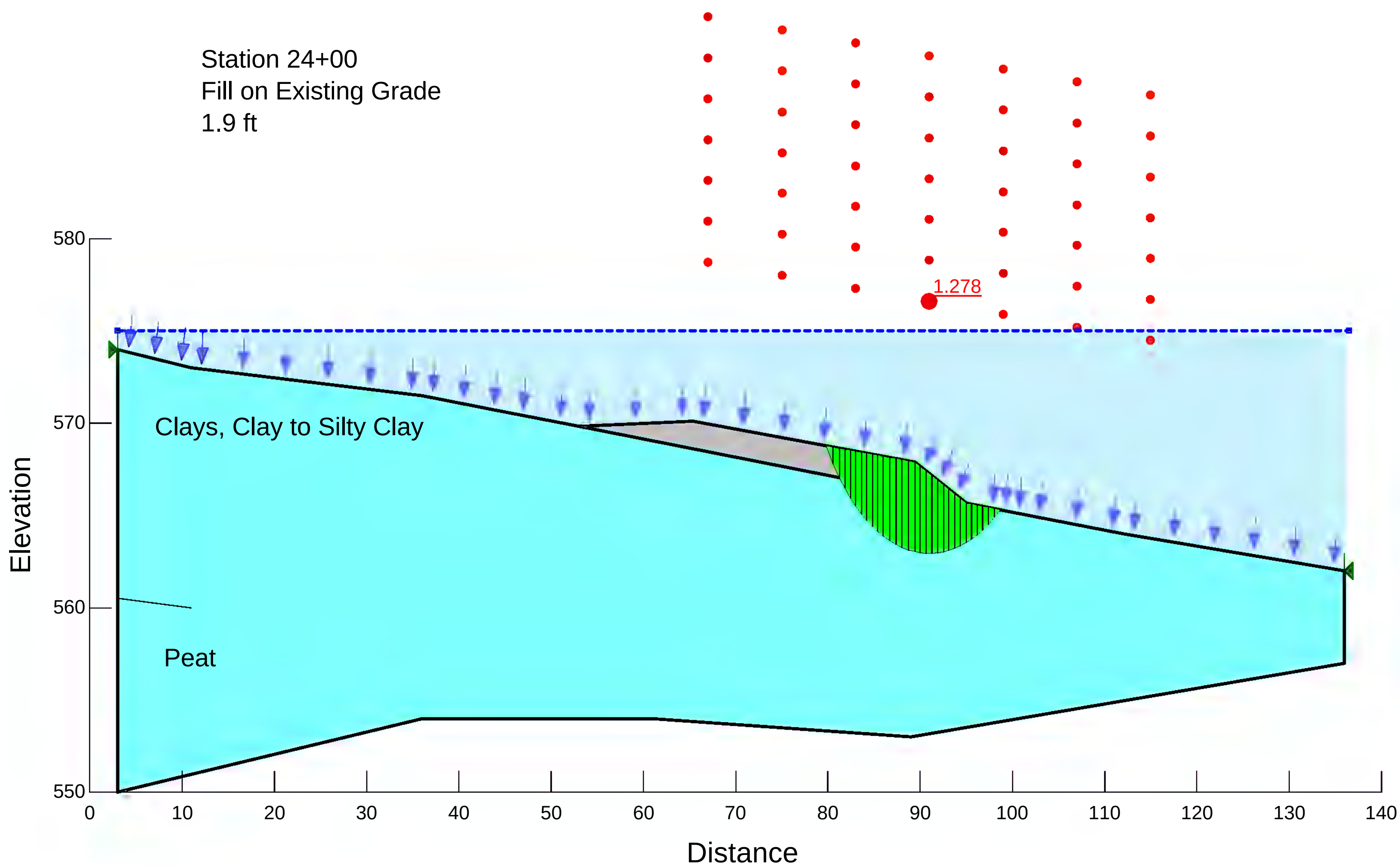
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



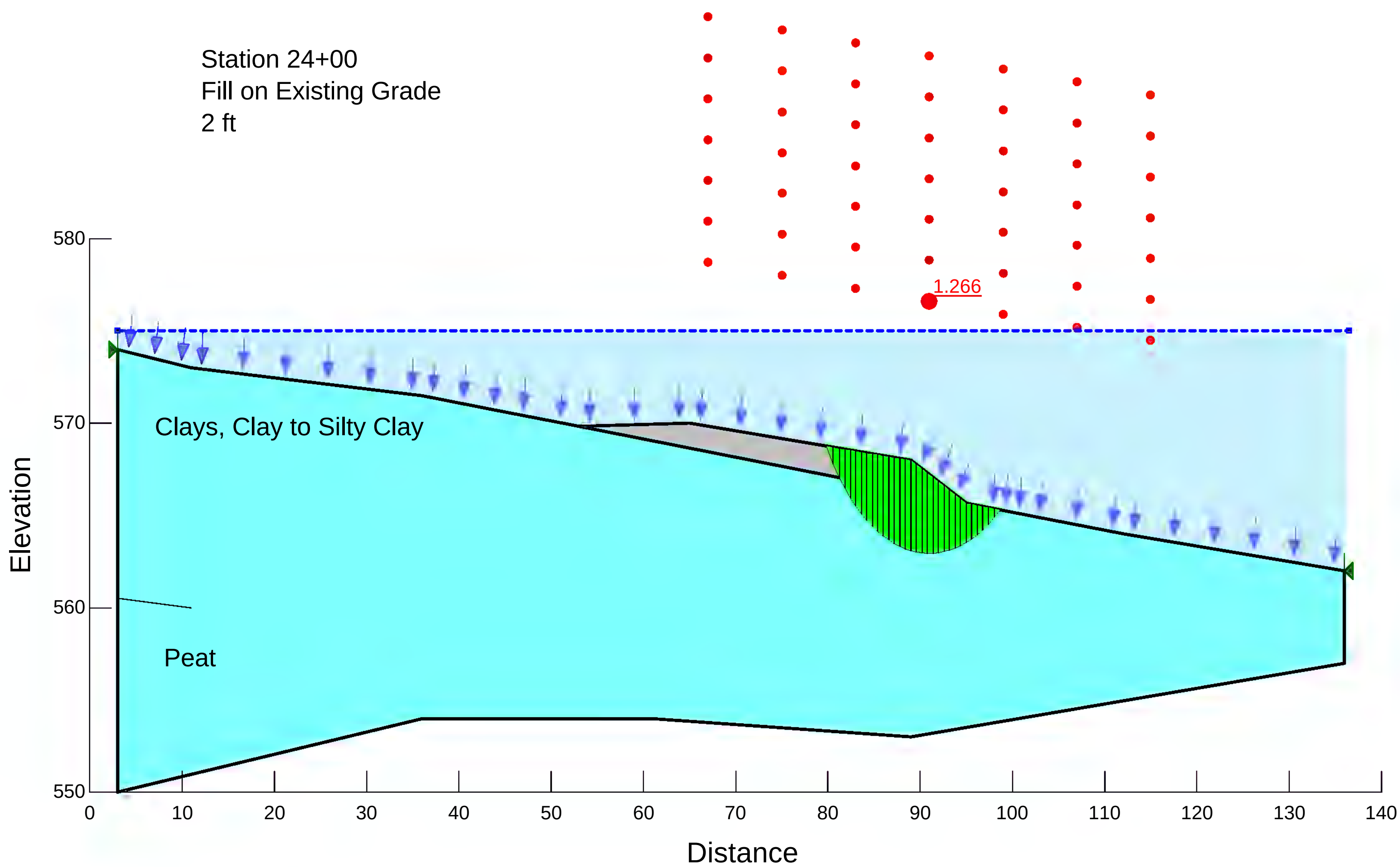
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

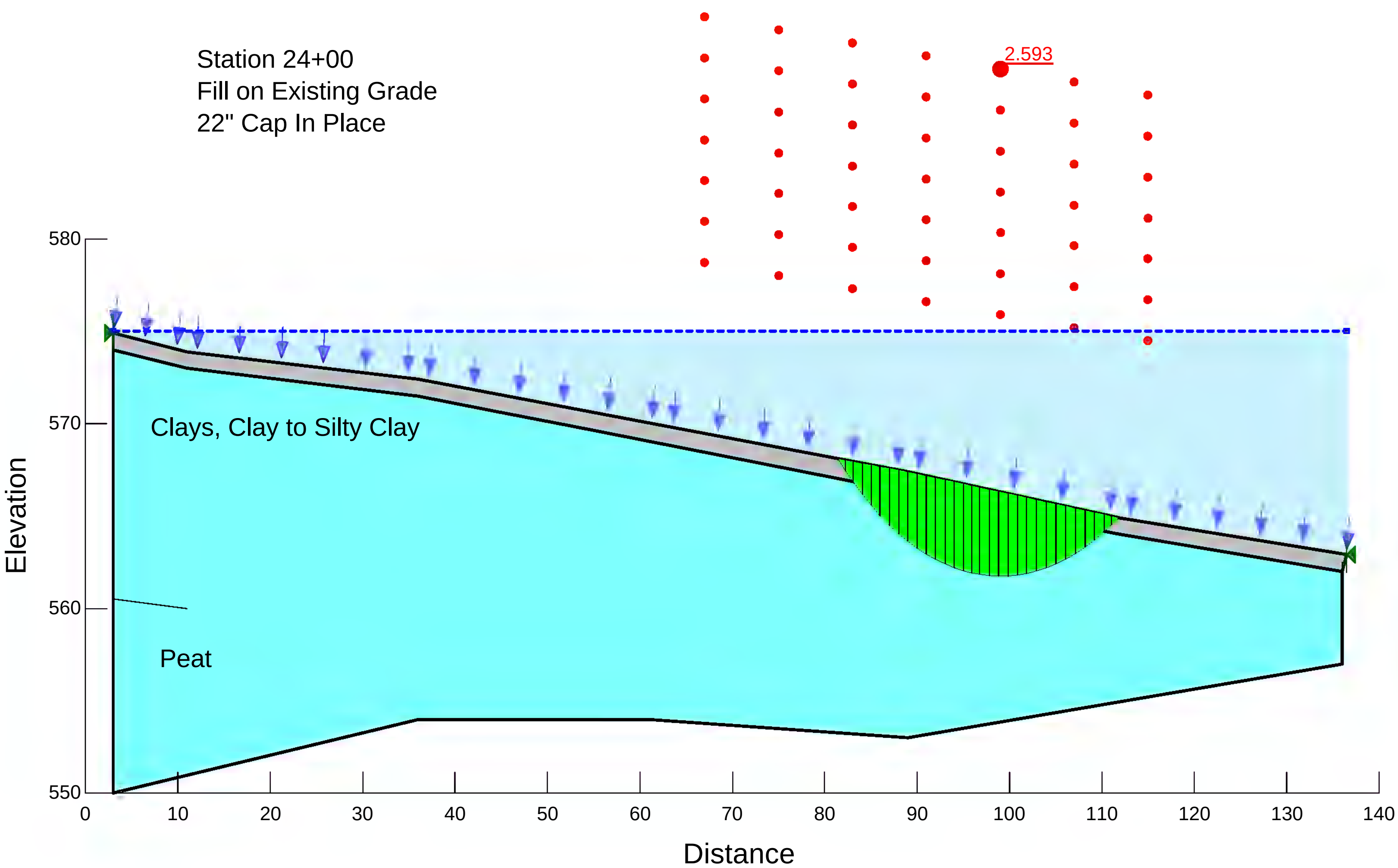


Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



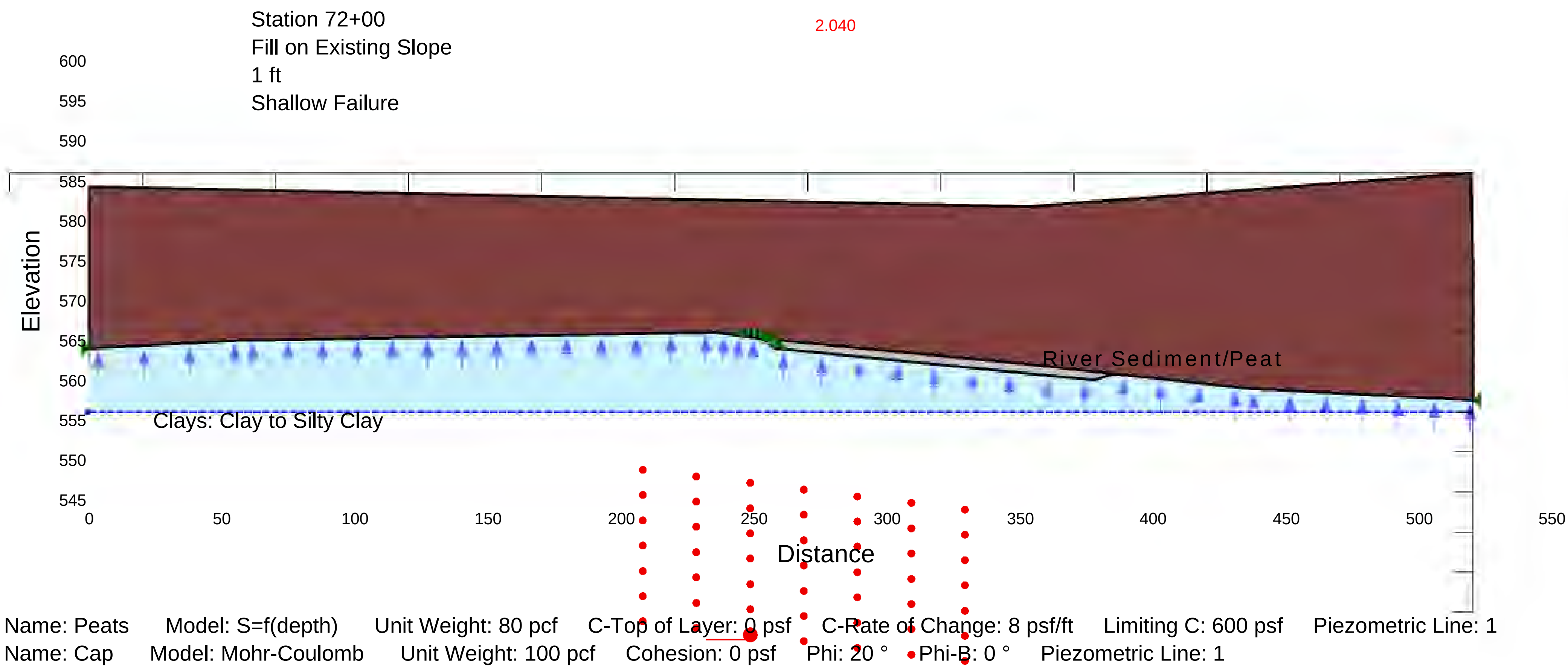
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

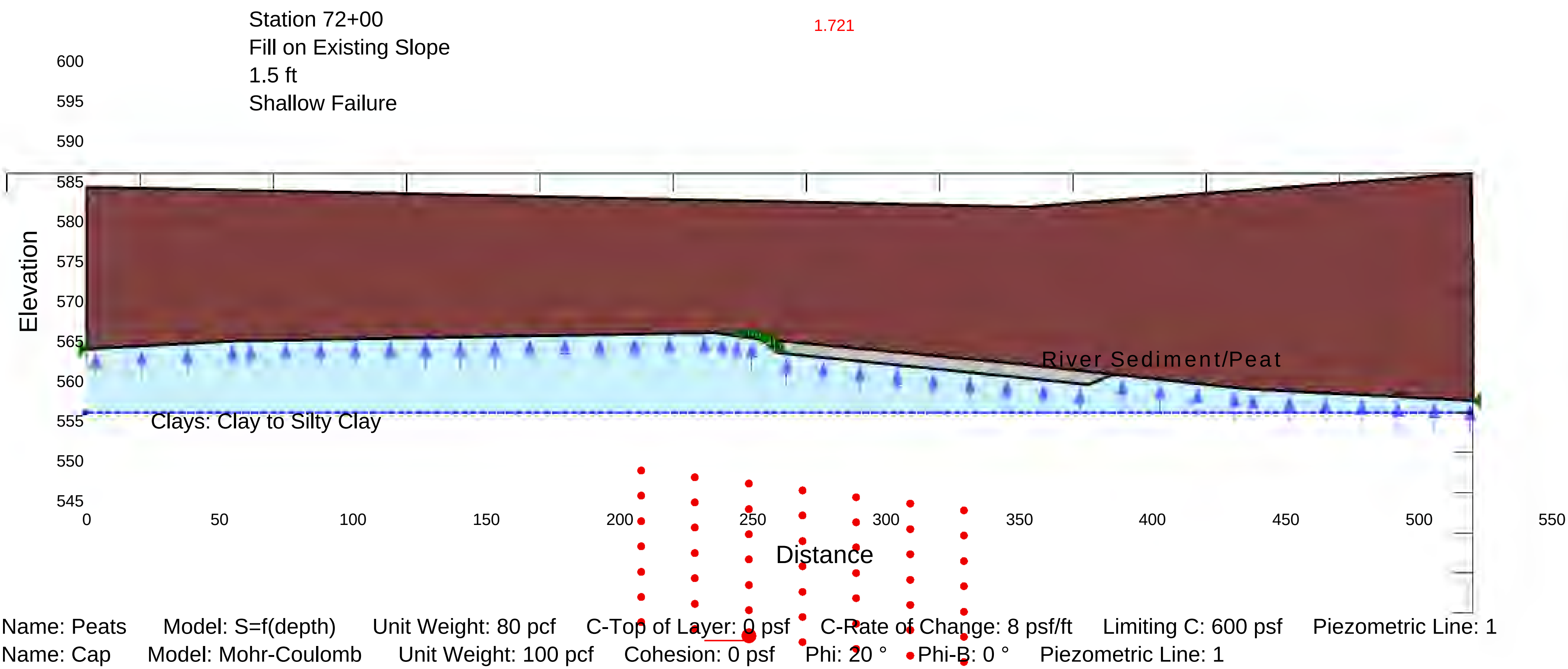


Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Increase: 9.3 Limiting C: 560 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

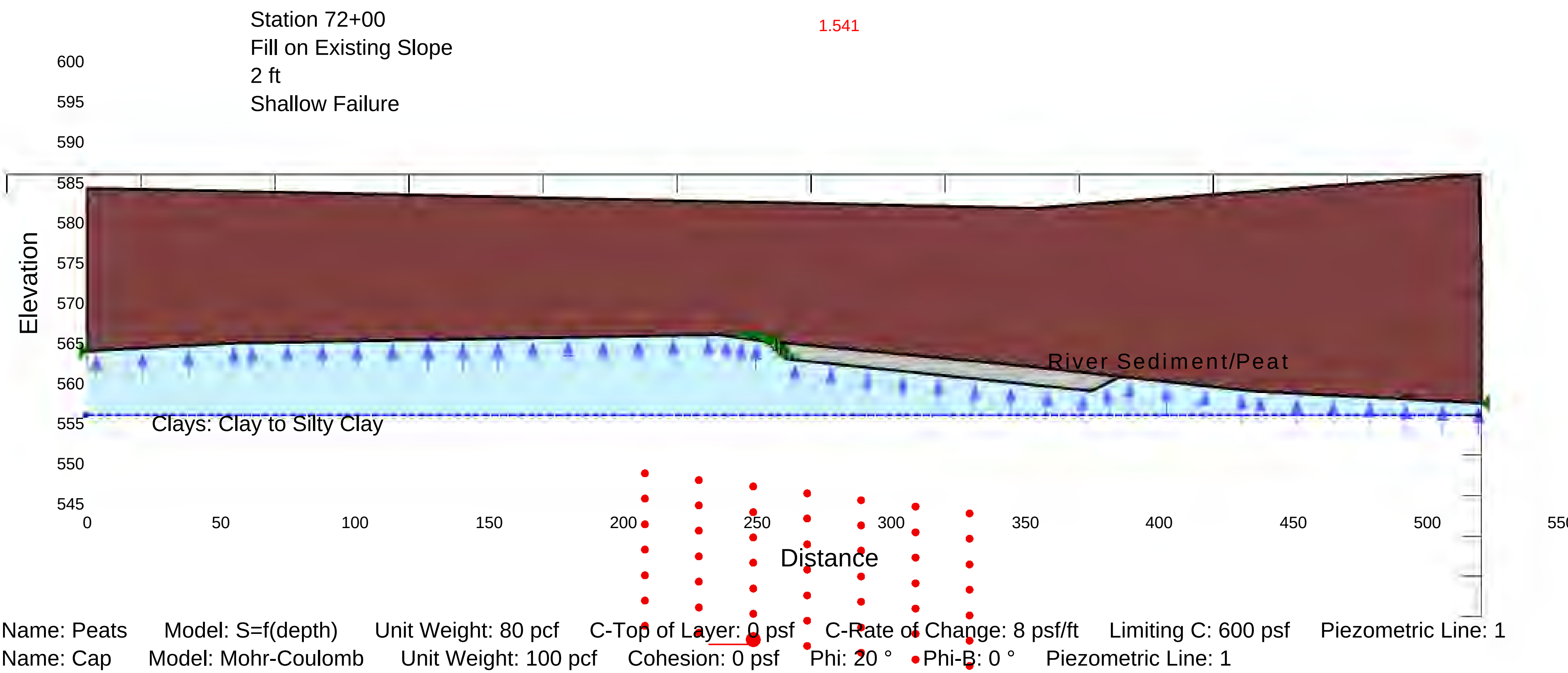


Station 72+00
Fill on Existing Slope
1 ft
Shallow Failure
2.040
600
595
590
585
580
575
570
565
560
555
550
545
Elevation
River Sediment/Peat
Clays: Clay to Silty Clay
0
50
100
150
200
250
300
350
400
450
500
550
Distance
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



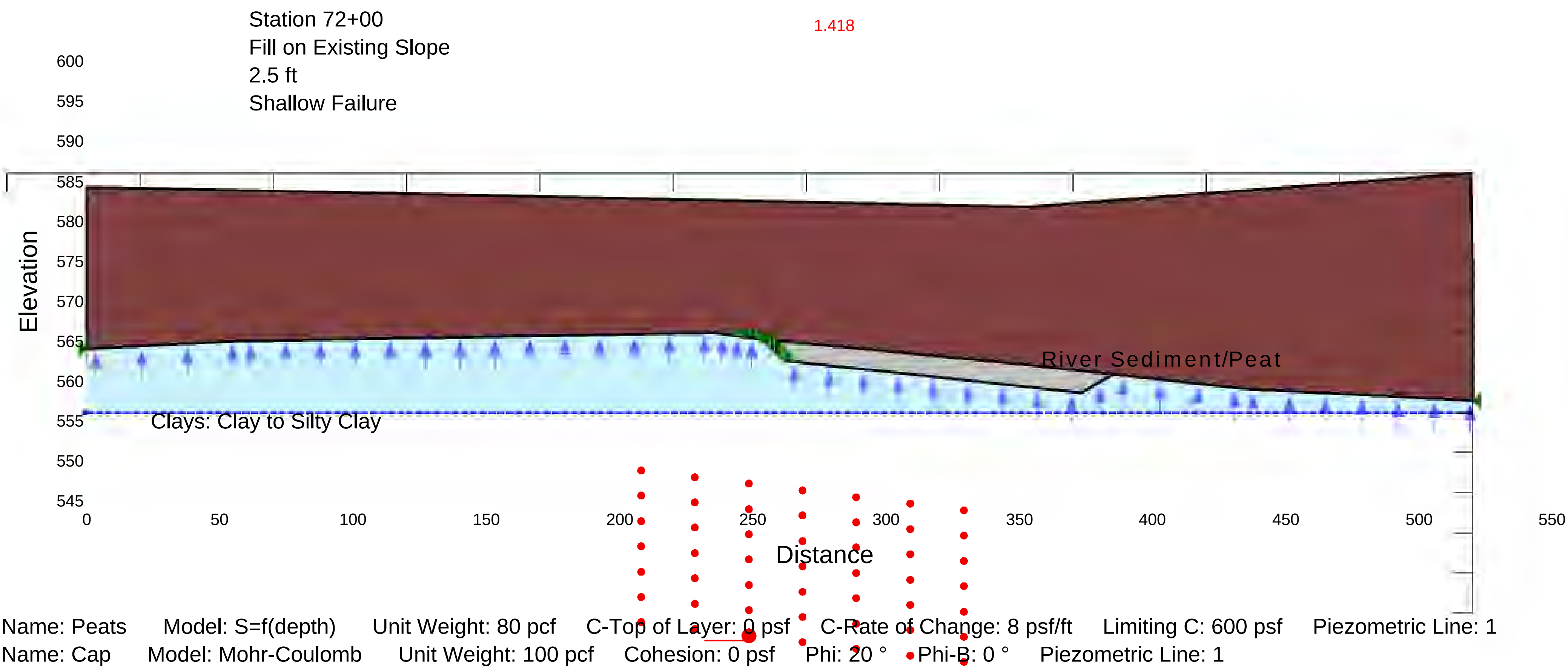
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

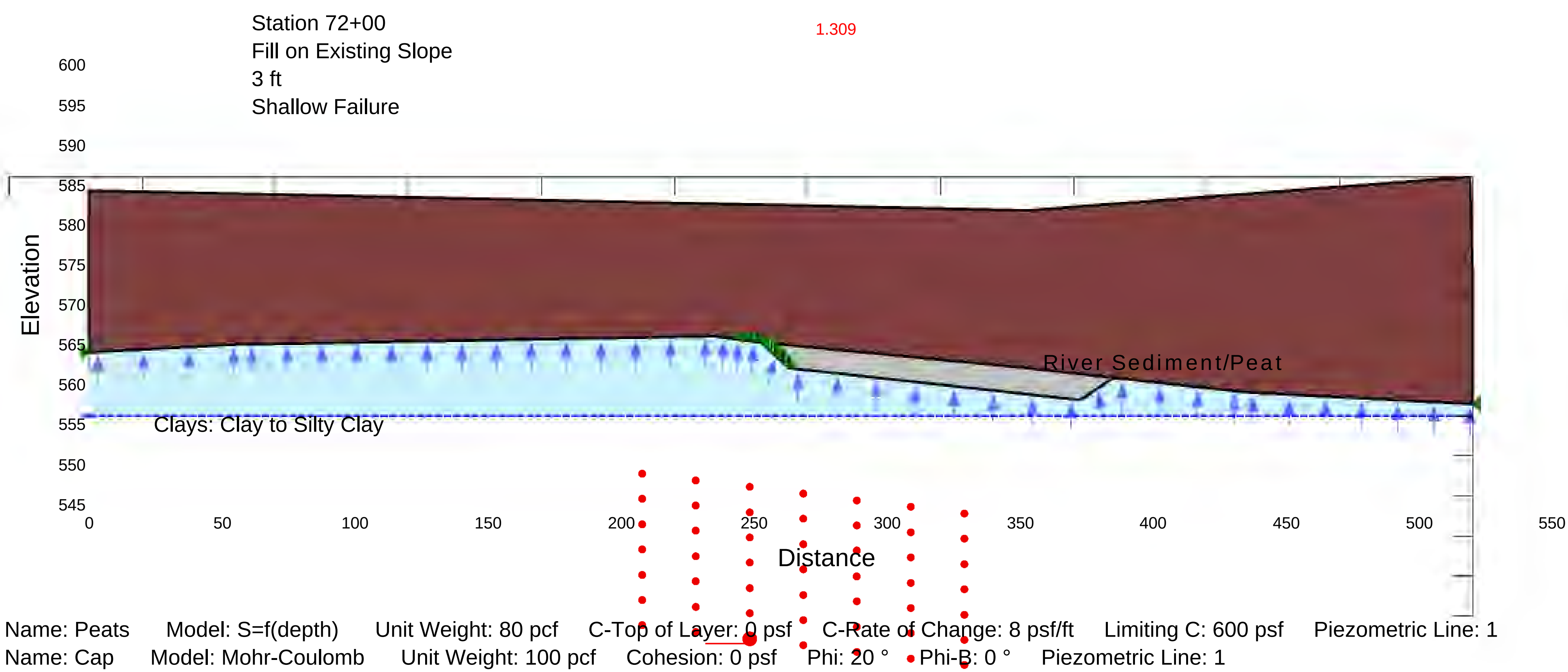


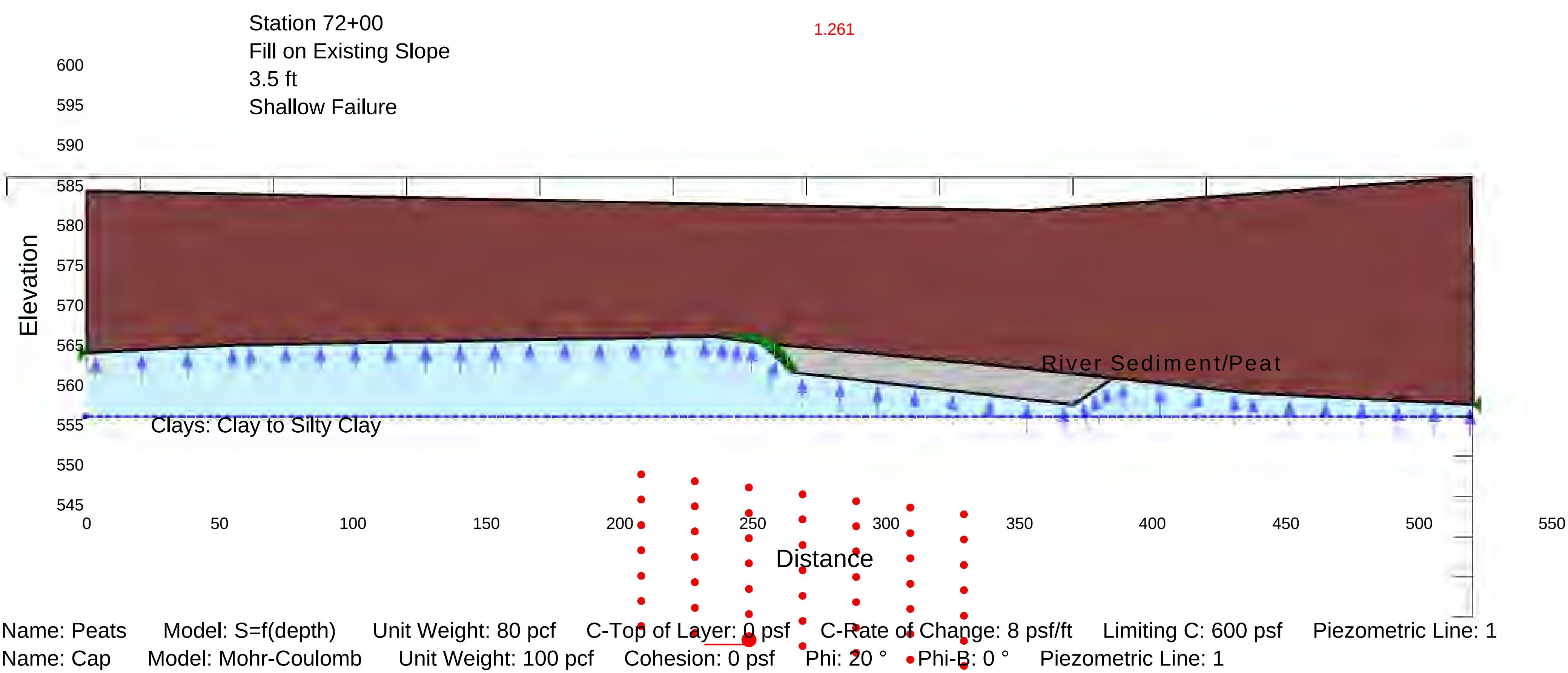
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



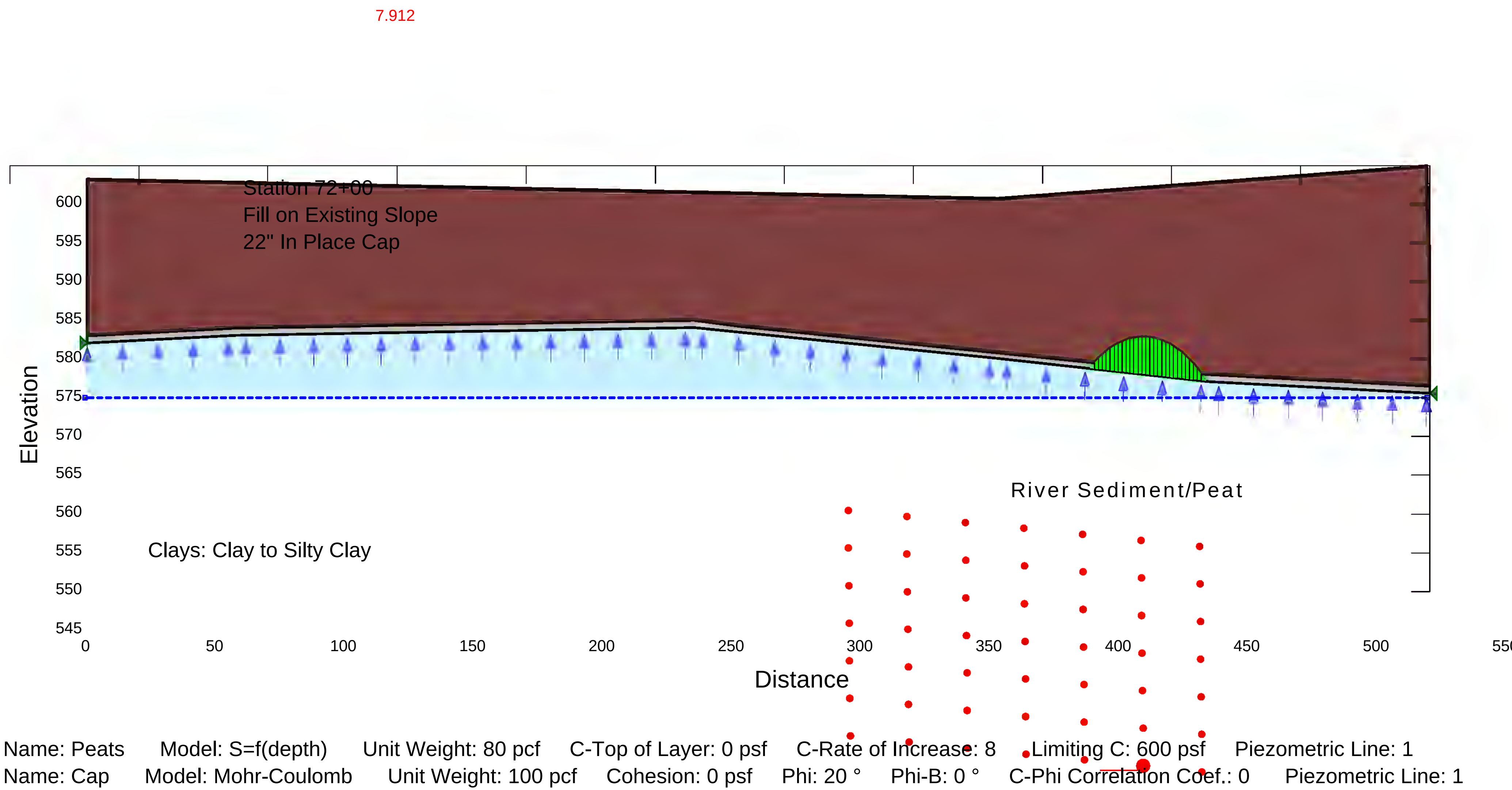
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1


Station 72+00
Fill on Existing Slope
3 ft
Shallow Failure
1.309
Elevation
600
595
590
585
580
575
570
565
560
555
550
545
0
50
100
150
200
250
300
350
400
450
500
550
Distance
River Sediment/Peat
Clays: Clay to Silty Clay
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

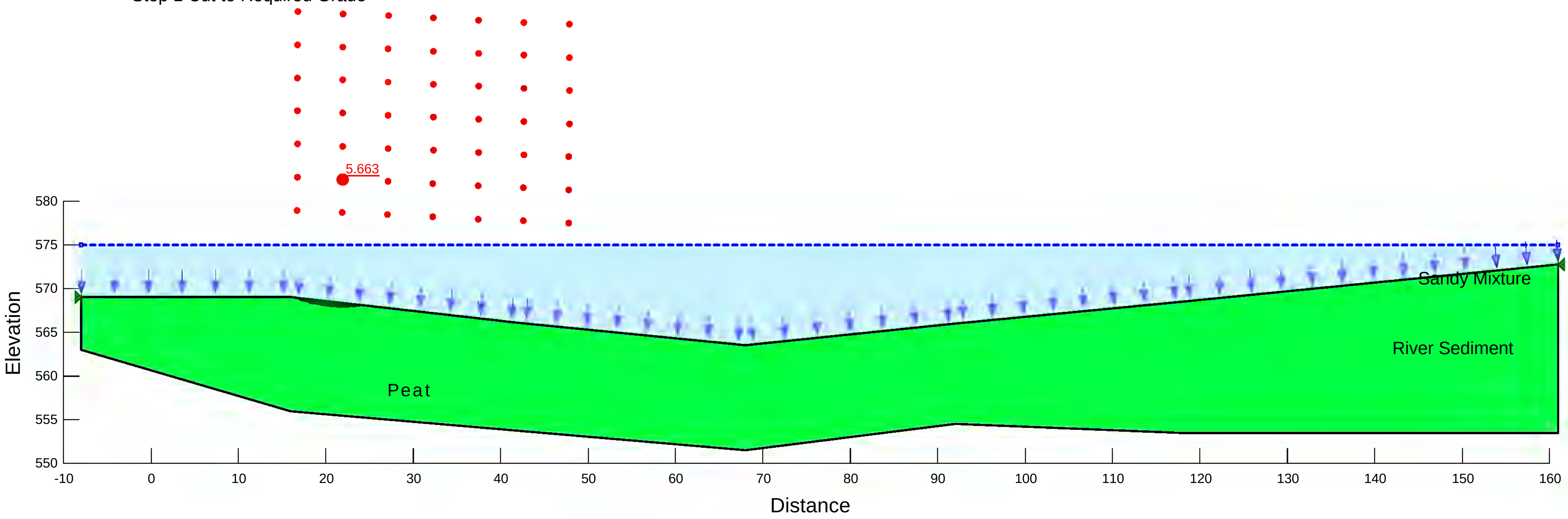
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1


7.912
Station 72+00
Fill on Existing Slope
22" In Place Cap
River Sediment/Peat
Clays: Clay to Silty Clay
Elevation
600
595
590
585
580
575
570
565
560
555
550
545
Distance
0
50
100
150
200
250
300
350
400
450
500
550
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 8 Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

ATTACHMENT

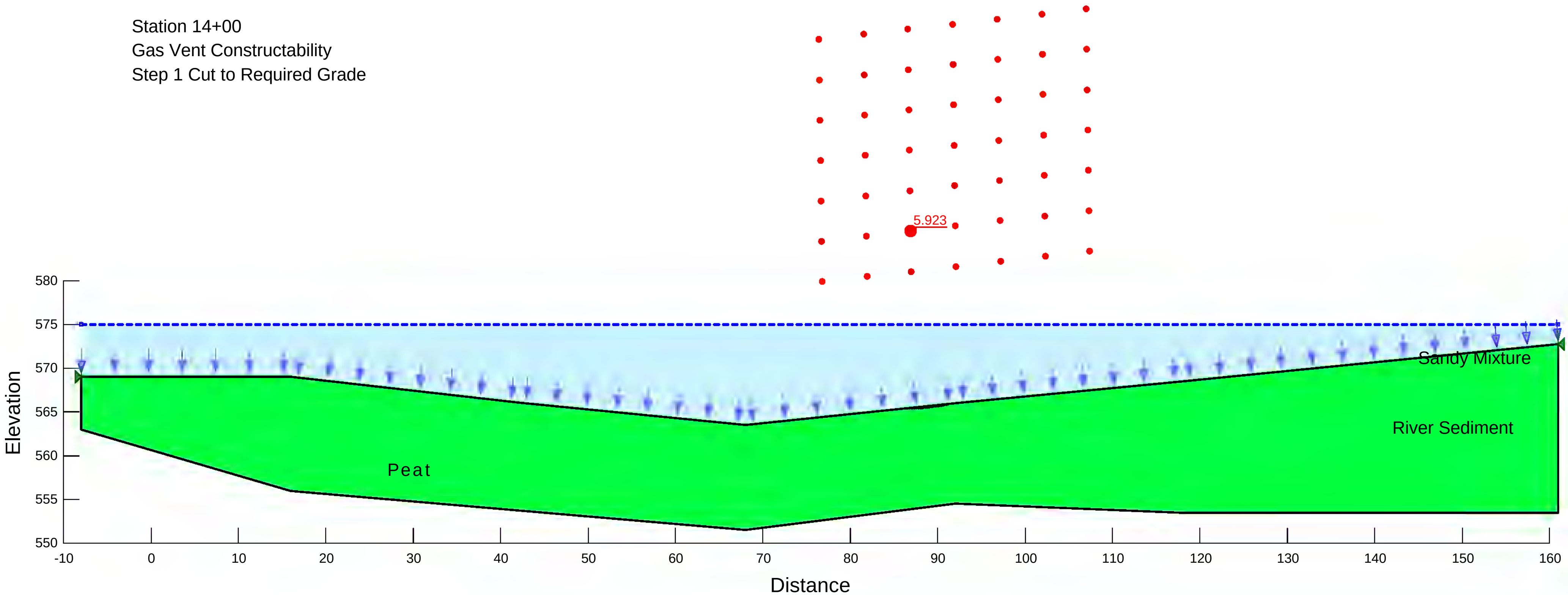
D-2-6 Sand Cap Constructability Stability Output

Station 14+00
Gas Vent Constructability
Step 1 Cut to Required Grade



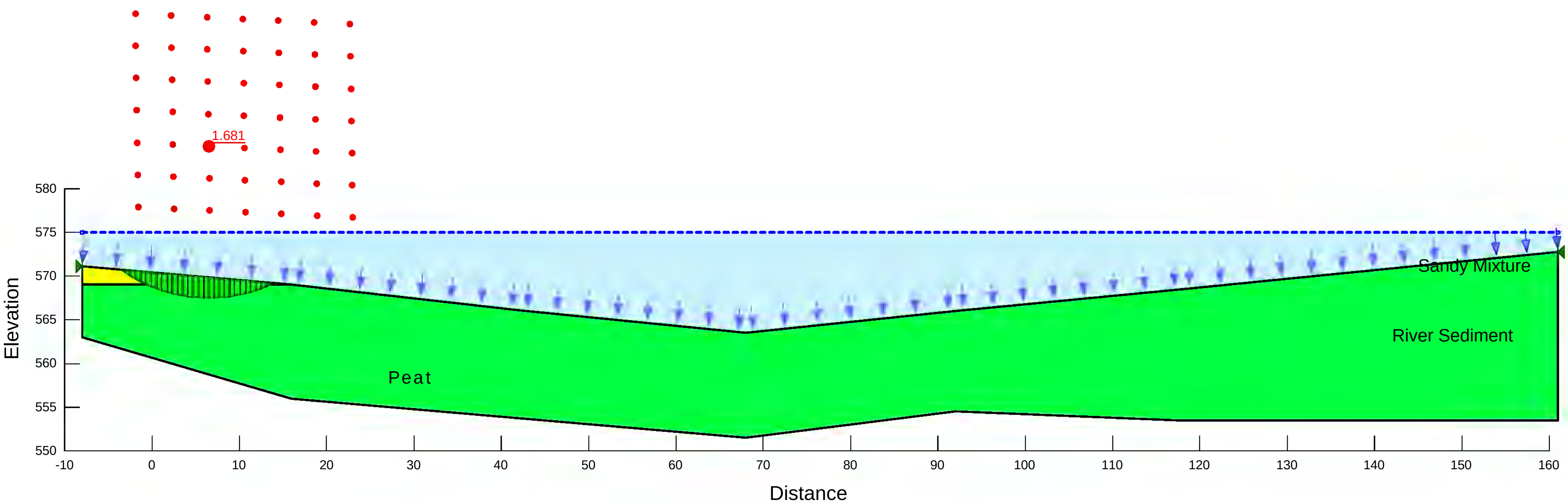
Name: SandyMixture   Model: S=f(depth)   Unit Weight: 80 pcf   C-Top of Layer: 0 psf   C-Rate of Increase: 10.6   Limiting C: 600 psf   Piezometric Line: 1

Station 14+00
Gas Vent Constructability
Step 1 Cut to Required Grade



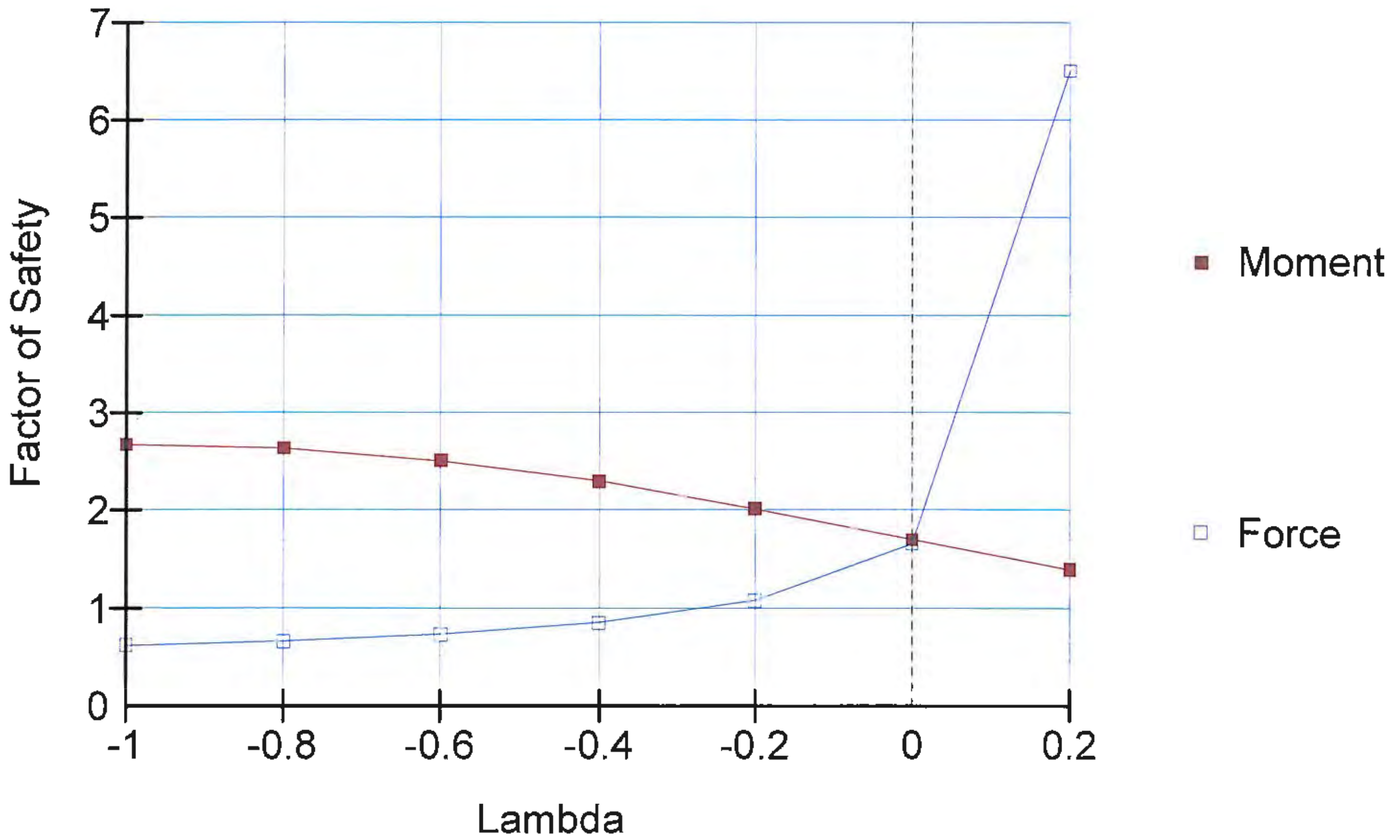
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1

Station 14+00
Gas Vent Constructability
Step 2 Fill to Required Grade

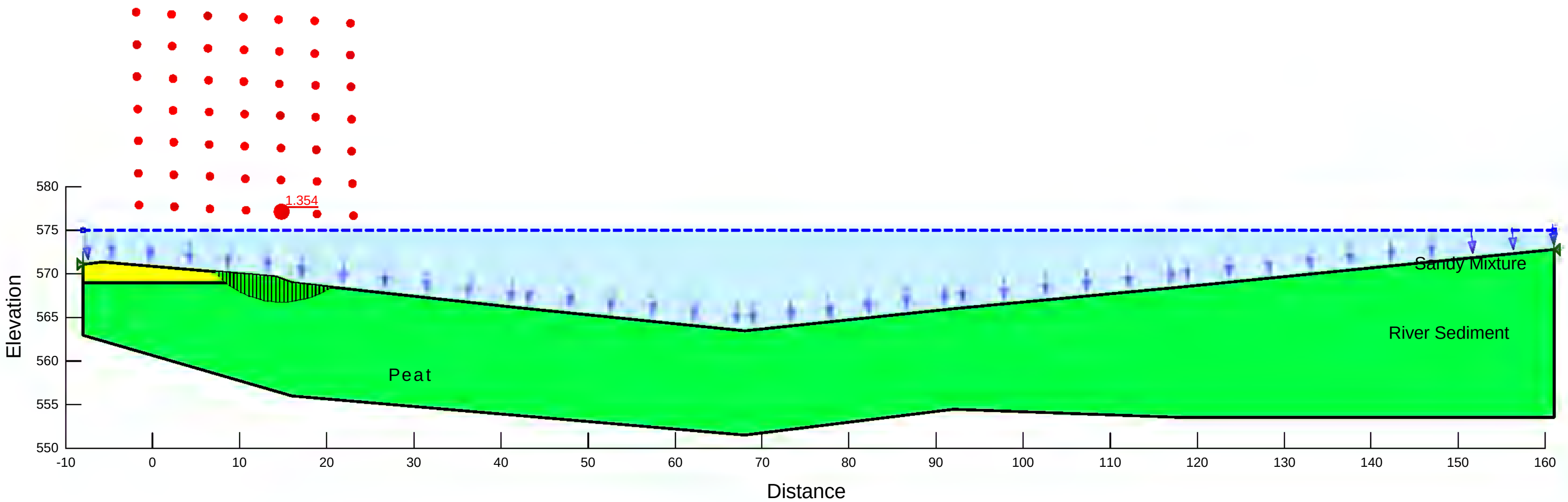


Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

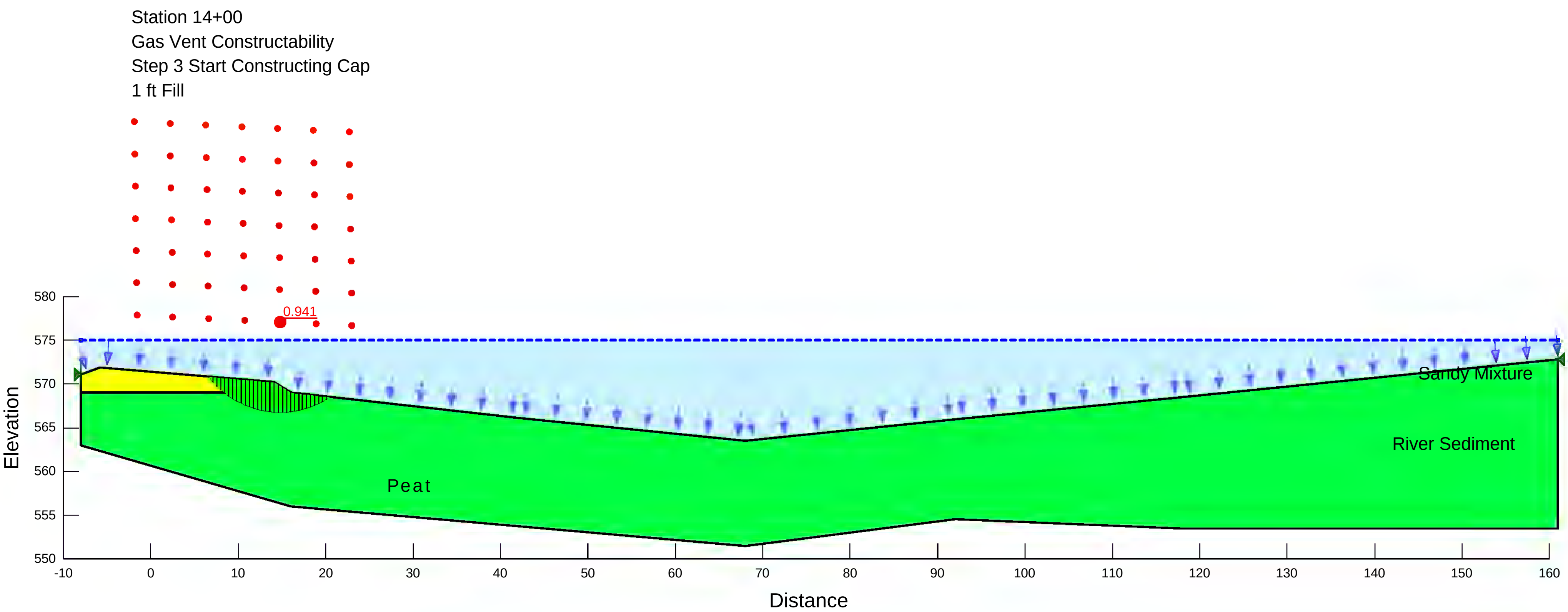
Factor of Safety vs. Lambda Sta 14 Cut/Fill Step 2



Station 14+00
Gas Vent Constructability
Step 3 Start Constructing Cap
6 in Fill



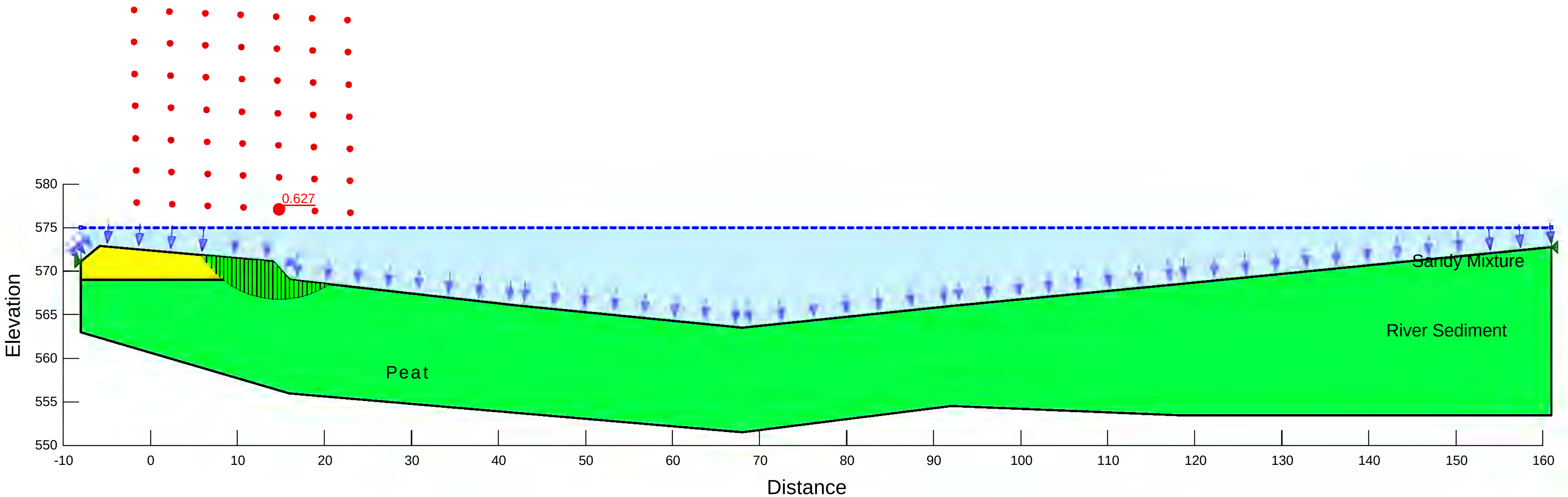
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1



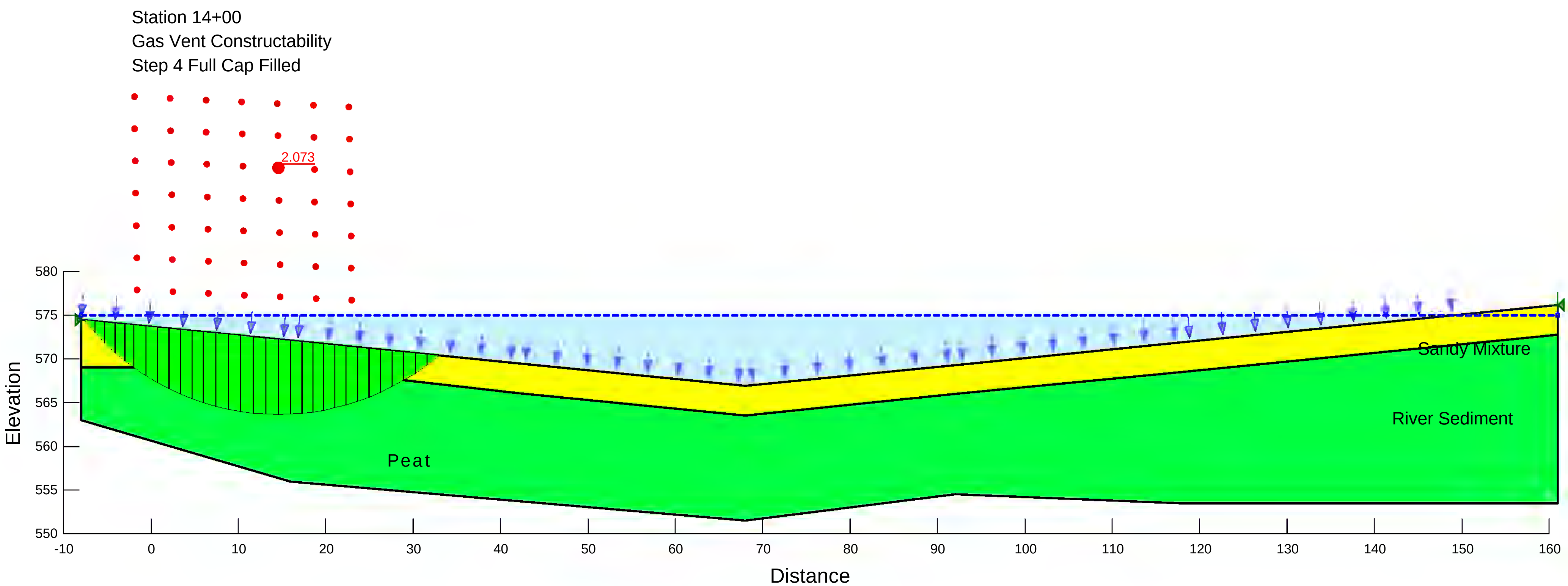
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

Station 14+00
Gas Vent Constructability
Step 3 Start Constructing Cap
2 ft Fill



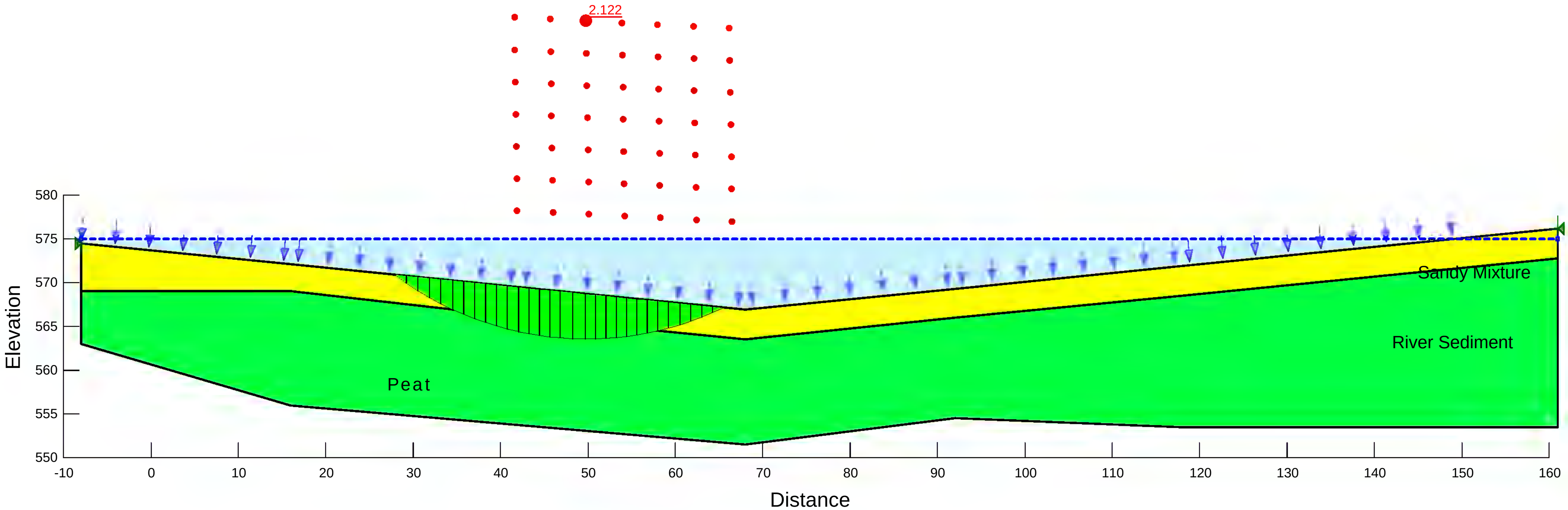
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1



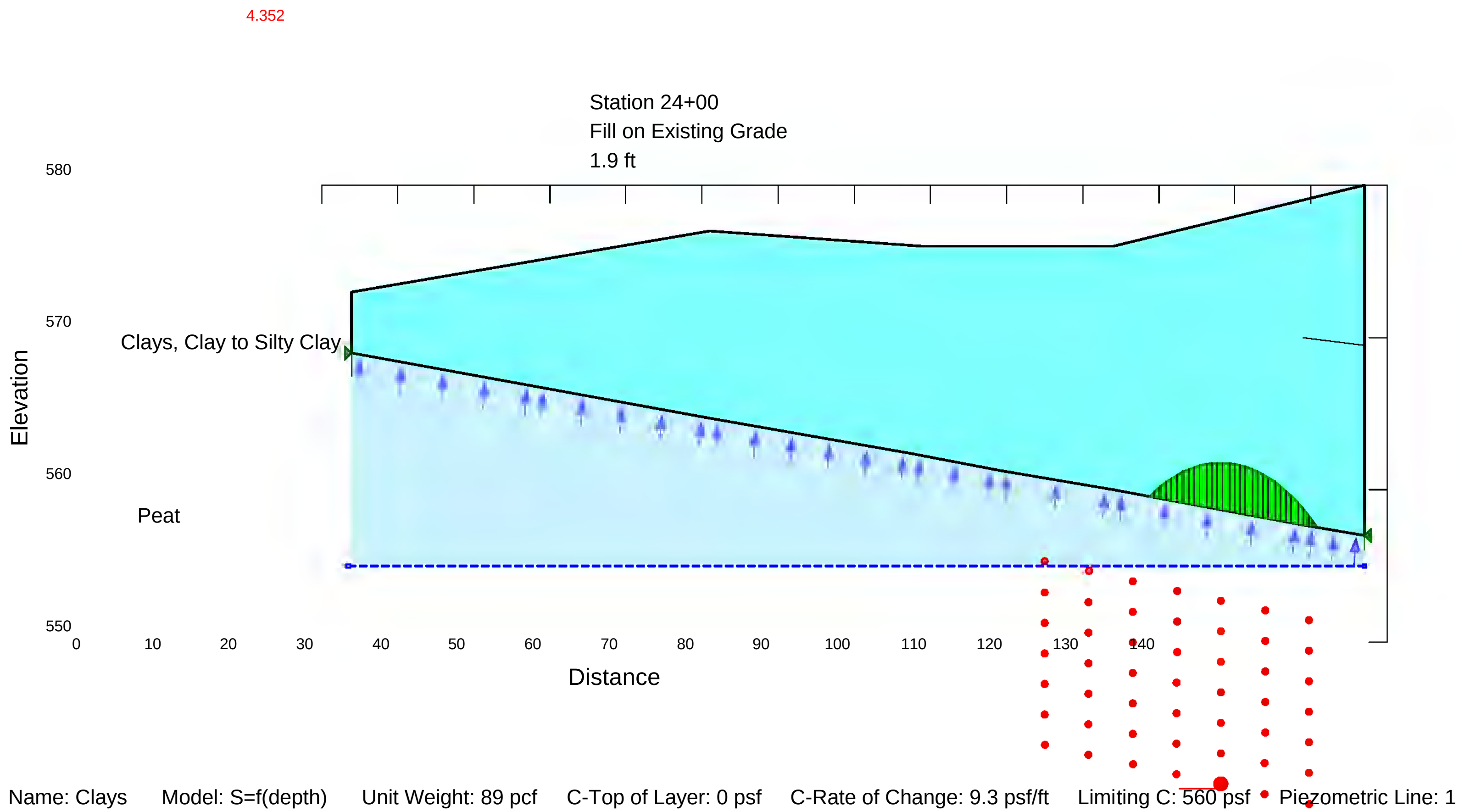
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1

Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

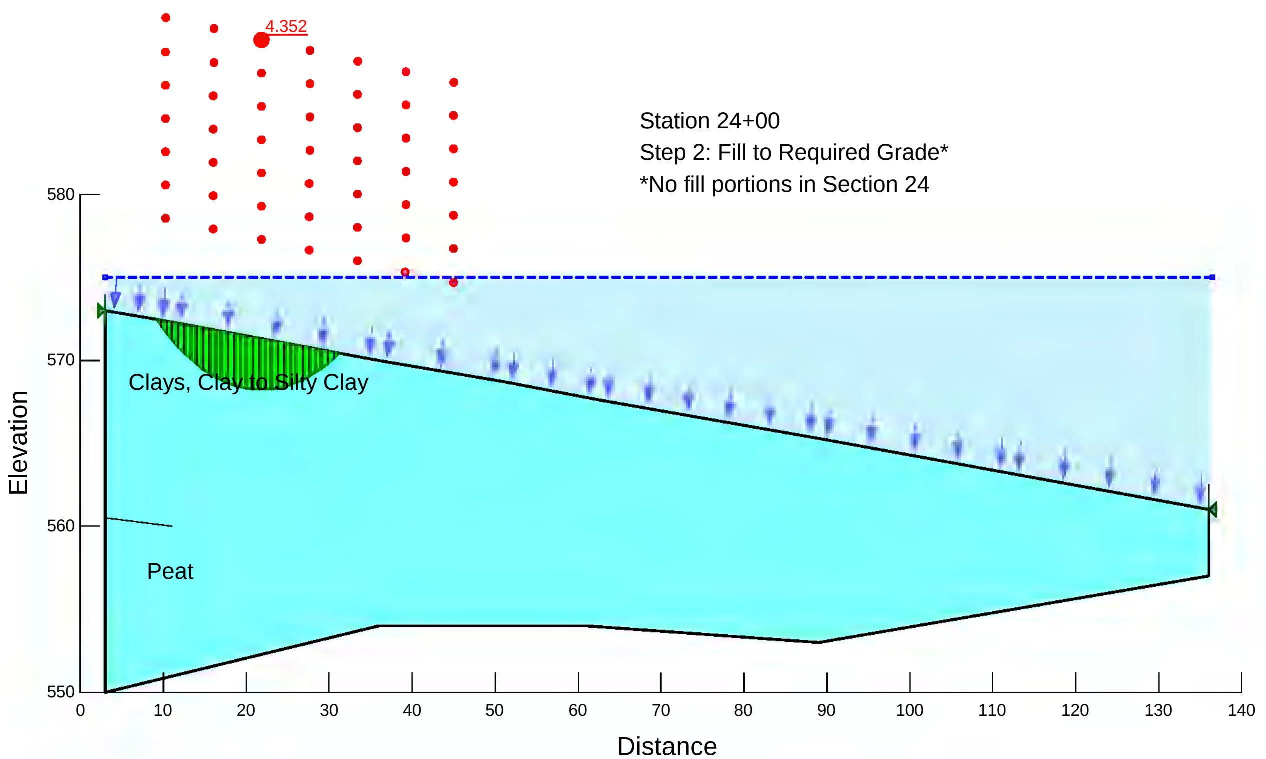
Station 14+00
Gas Vent Constructability
Step 4 Full Cap Filled



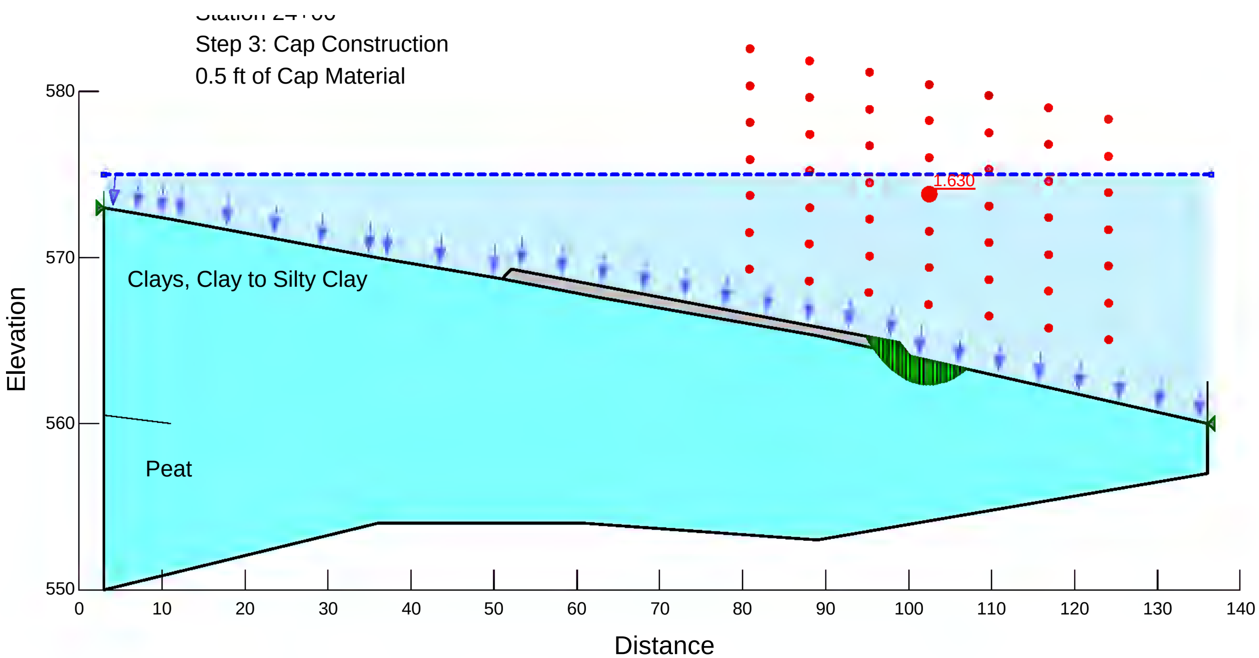
Name: SandyMixture Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 10.6 Limiting C: 600 psf Piezometric Line: 1
Name: cap Model: Mohr-Coulomb Unit Weight: 124 pcf Cohesion: 0 psf Phi: 30 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1



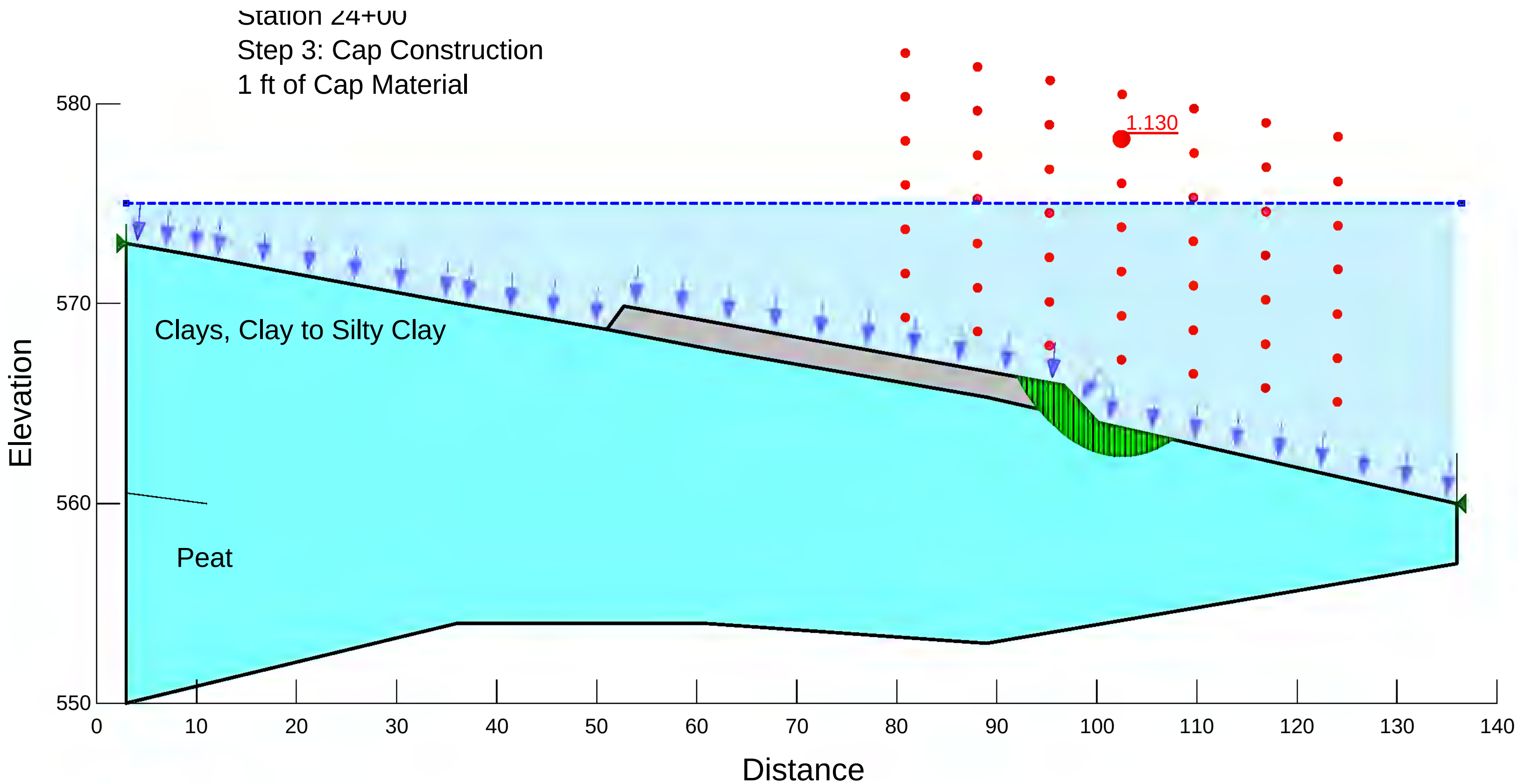
4.352
Station 24+00
Fill on Existing Grade
1.9 ft
580
570
560
550
Elevation
Clays, Clay to Silty Clay
Peat
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Distance
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1



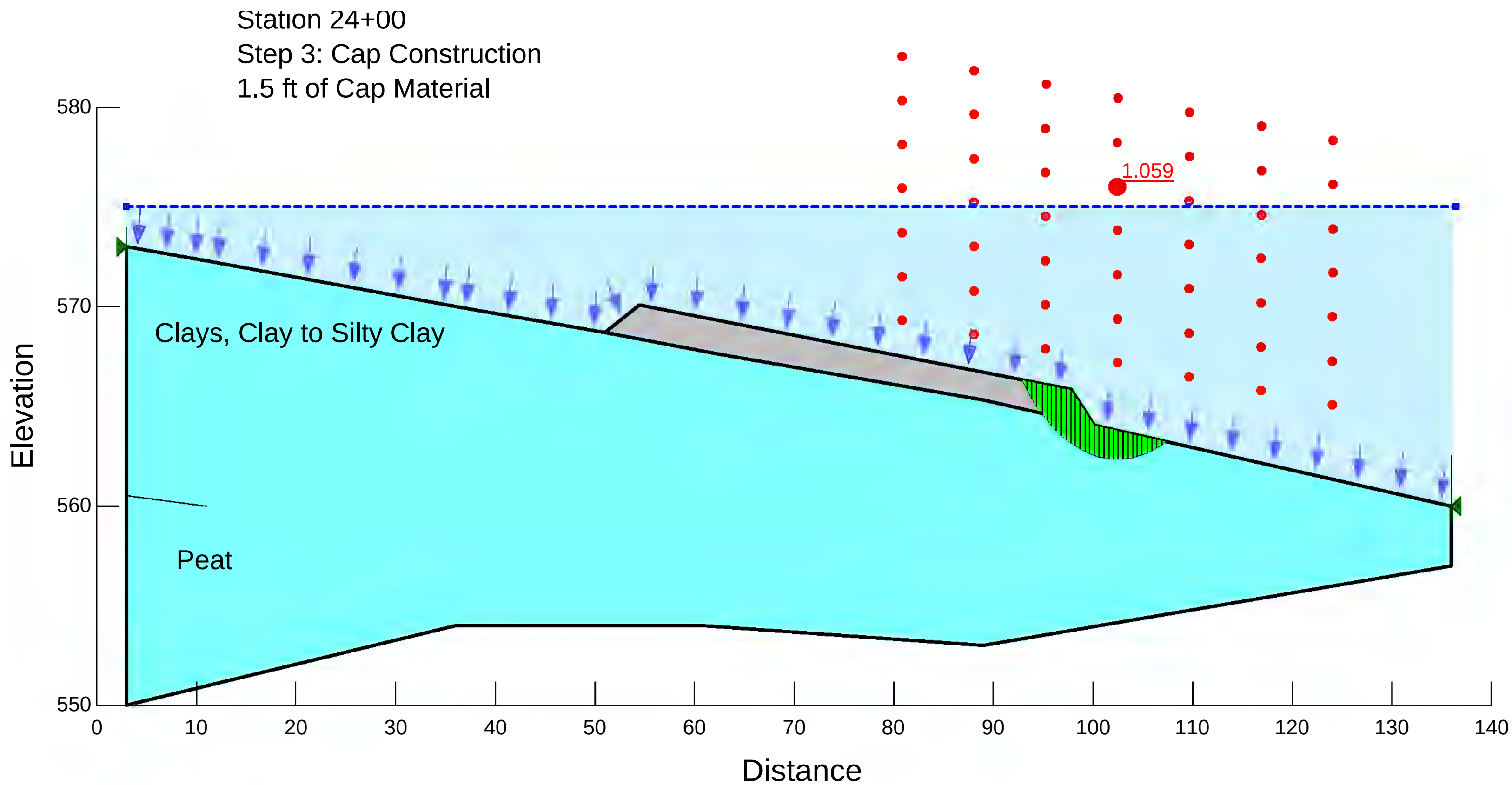
Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1



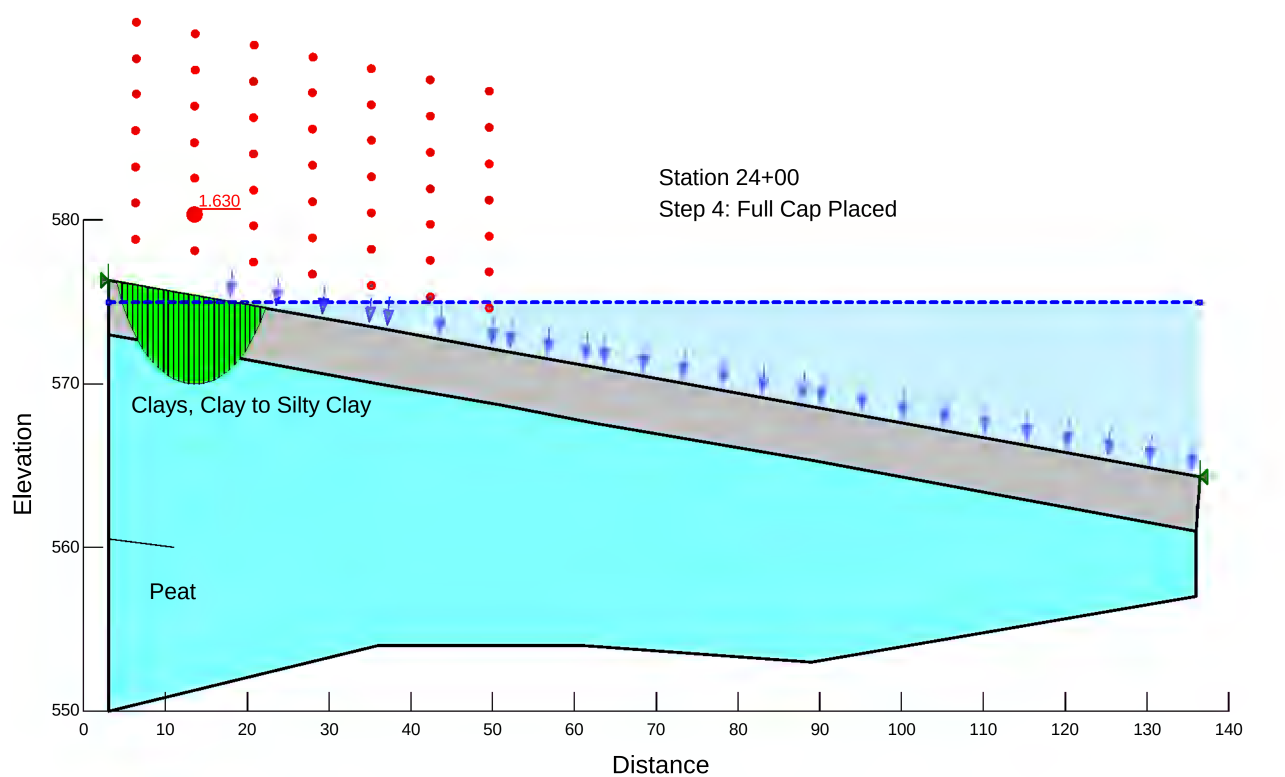
Name: Clays   Model: S=f(depth)   Unit Weight: 89 pcf   C-Top of Layer: 0 psf   C-Rate of Change: 9.3 psf/ft   Limiting C: 560 psf   Piezometric Line: 1
Name: Cap   Model: Mohr-Coulomb   Unit Weight: 100 pcf   Cohesion: 15 psf   Phi: 20 °   Phi-B: 0 °   Piezometric Line: 1



Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

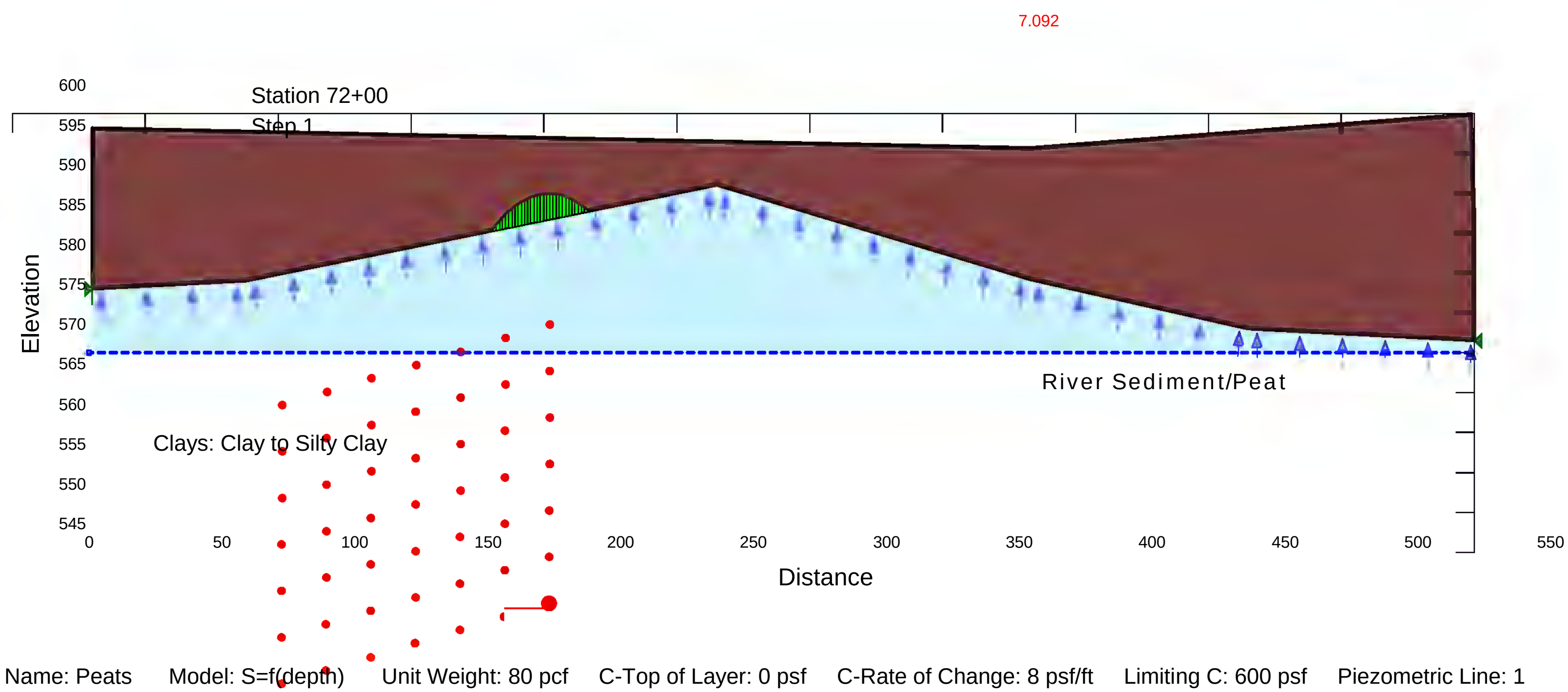


Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

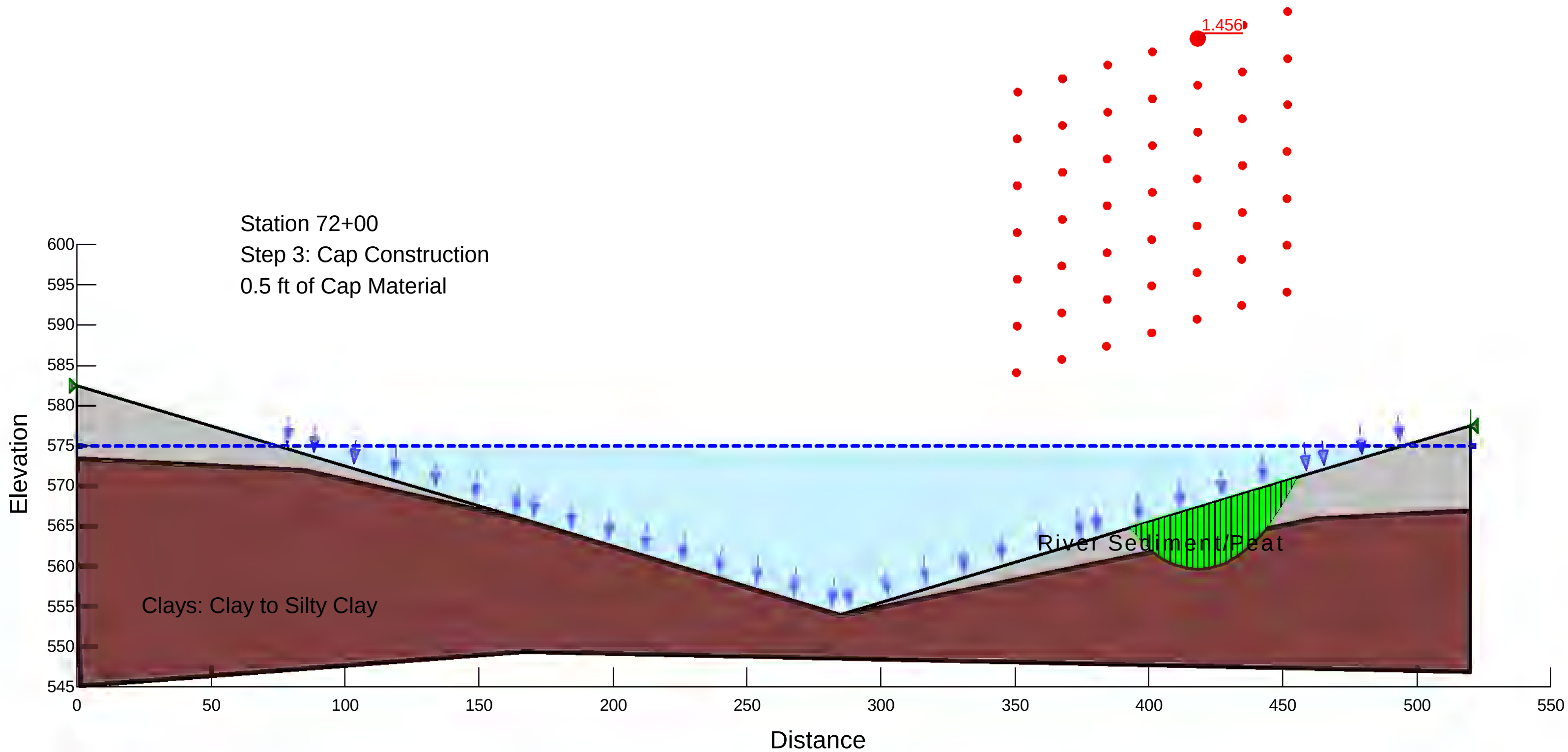


Name: Clays Model: S=f(depth) Unit Weight: 89 pcf C-Top of Layer: 0 psf C-Rate of Change: 9.3 psf/ft Limiting C: 560 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 15 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

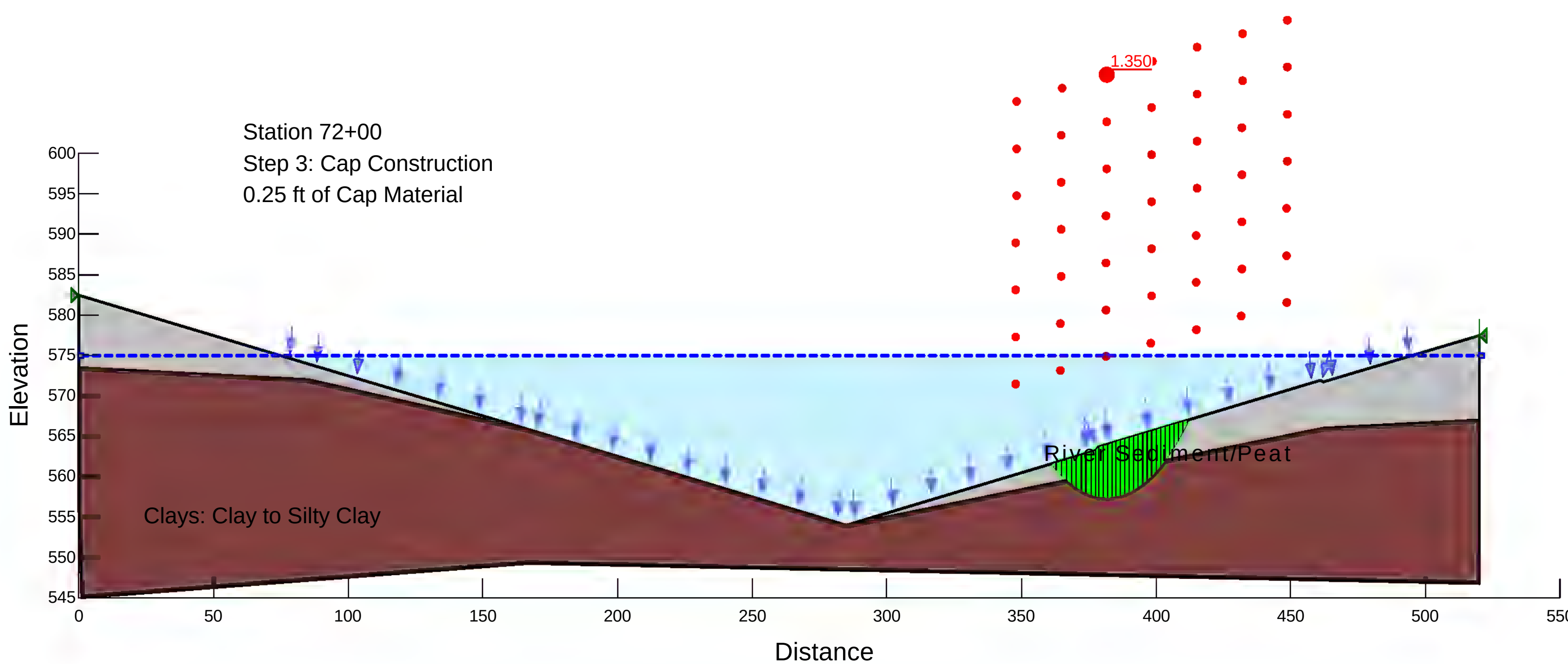


Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

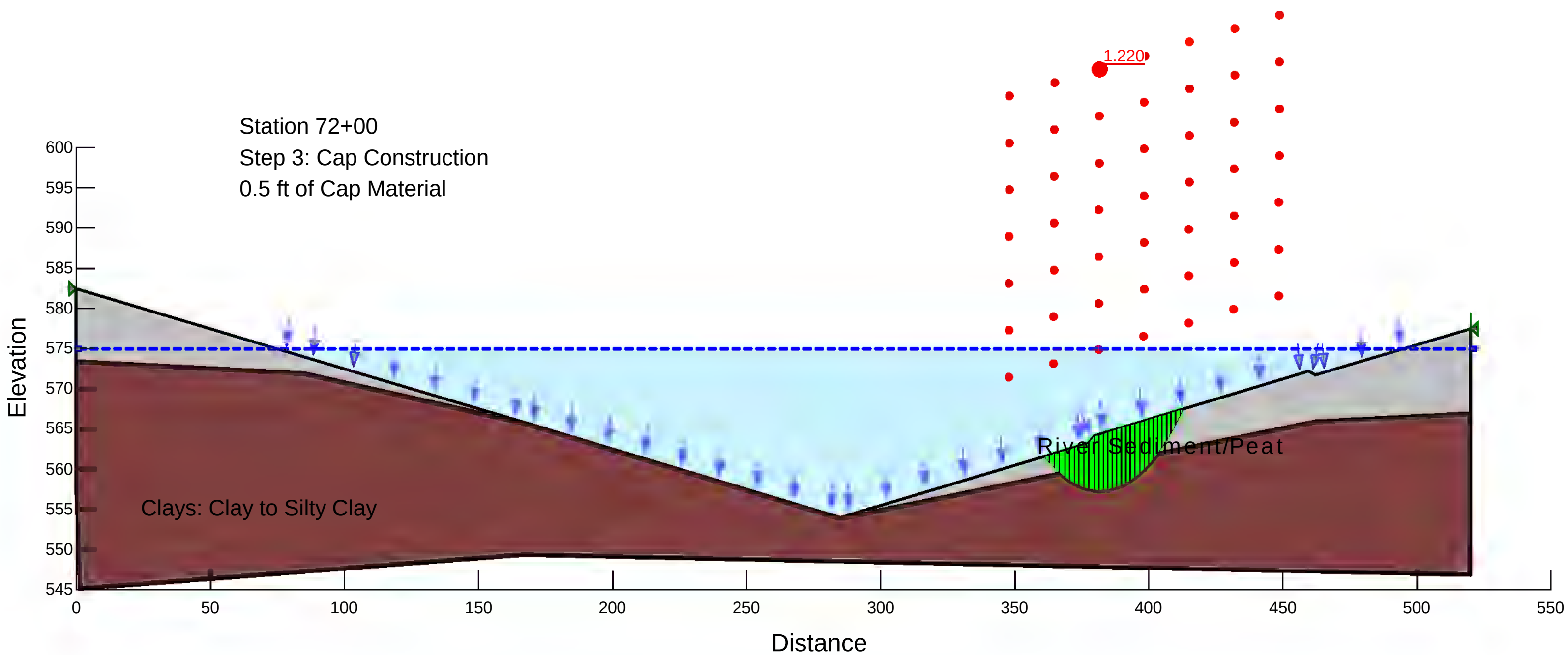


Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 8 Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

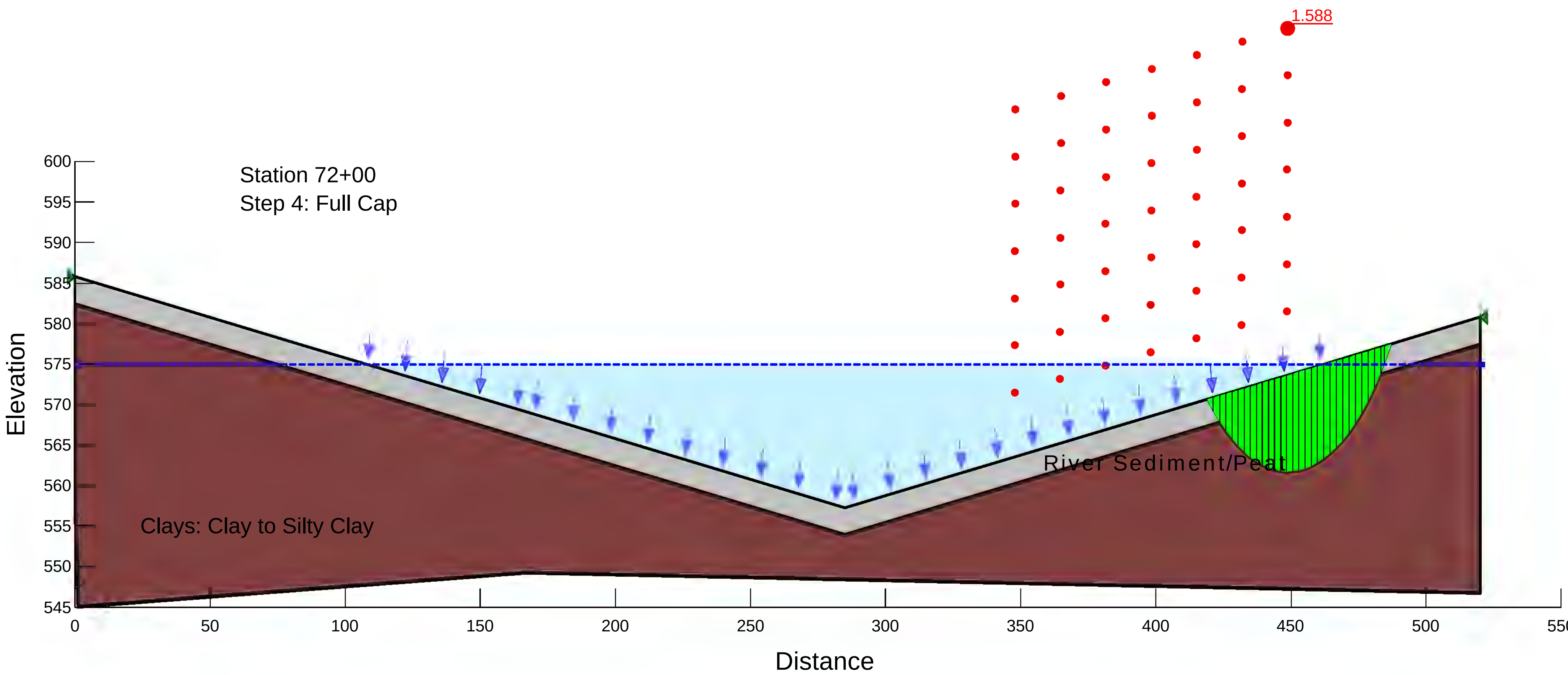


Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

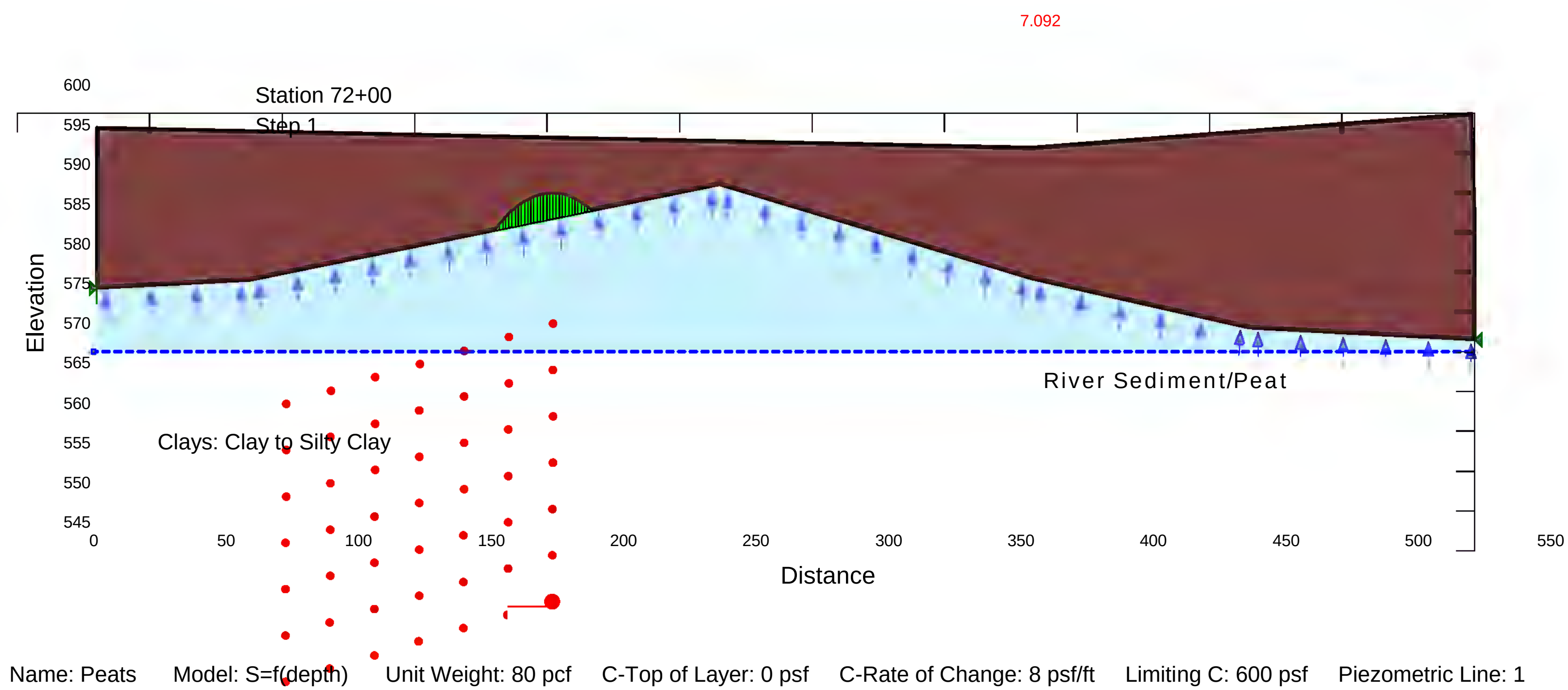


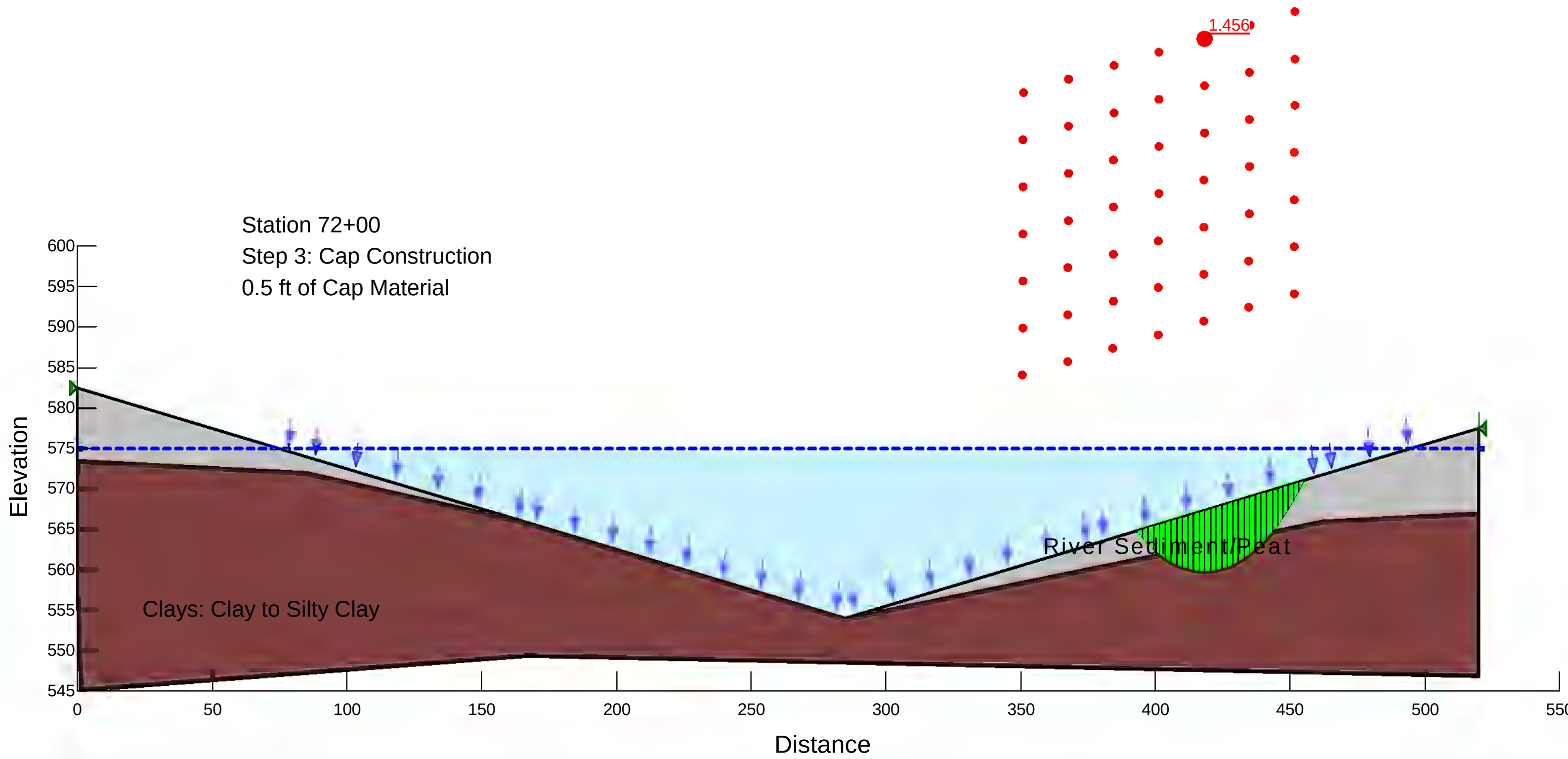
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

ATTACHMENT

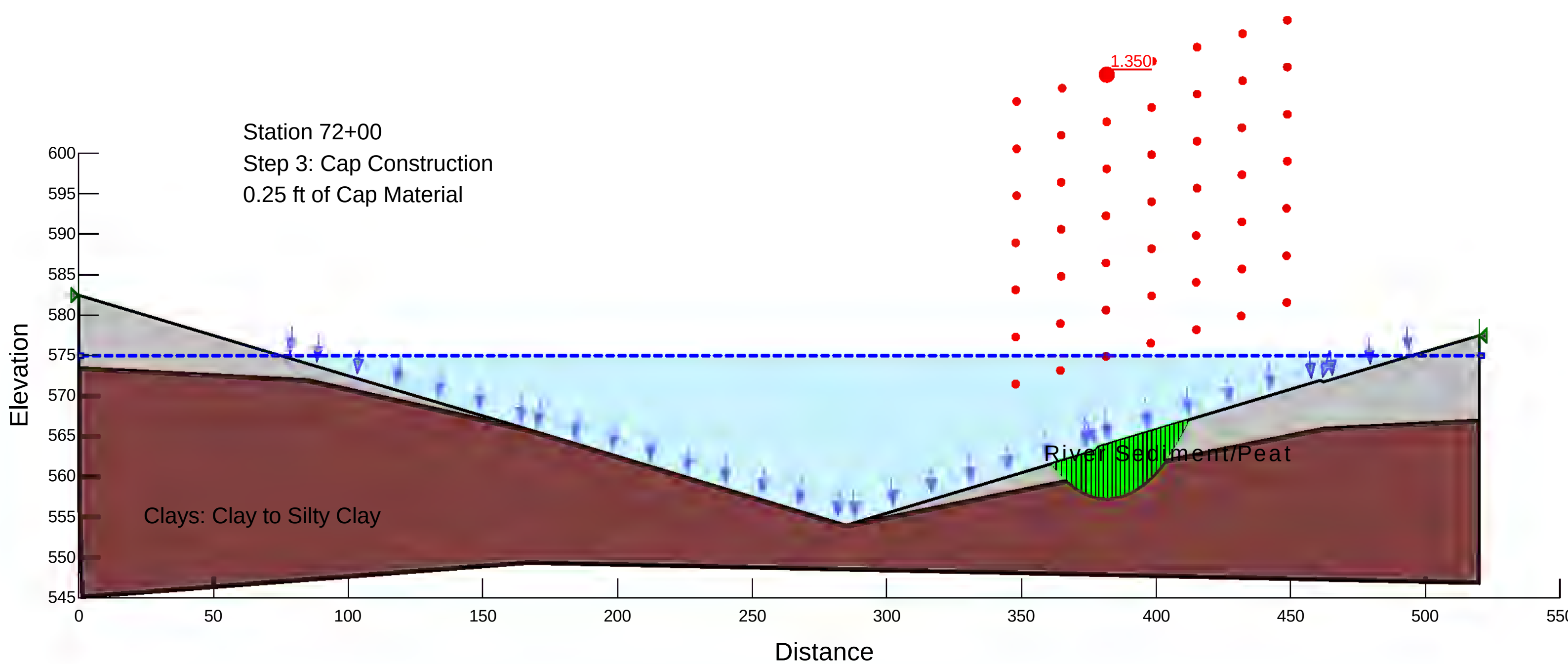
D-2-7 Wetland Shelf Stability Output


7.092
Station 72+00
Step 1
River Sediment/Peat
Clays: Clay to Silty Clay
Elevation
Distance
600
595
590
585
580
575
570
565
560
555
550
545
0
50
100
150
200
250
300
350
400
450
500
550
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1



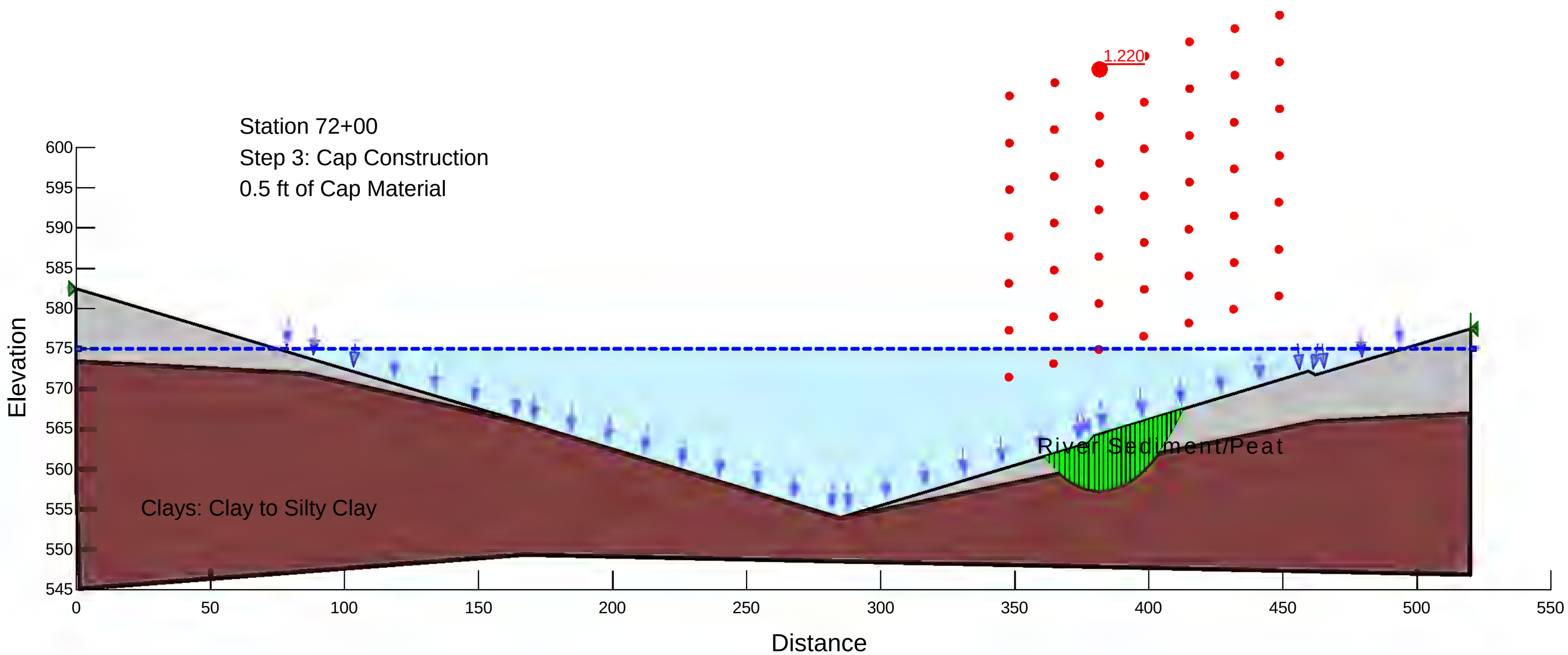
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 8 Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1



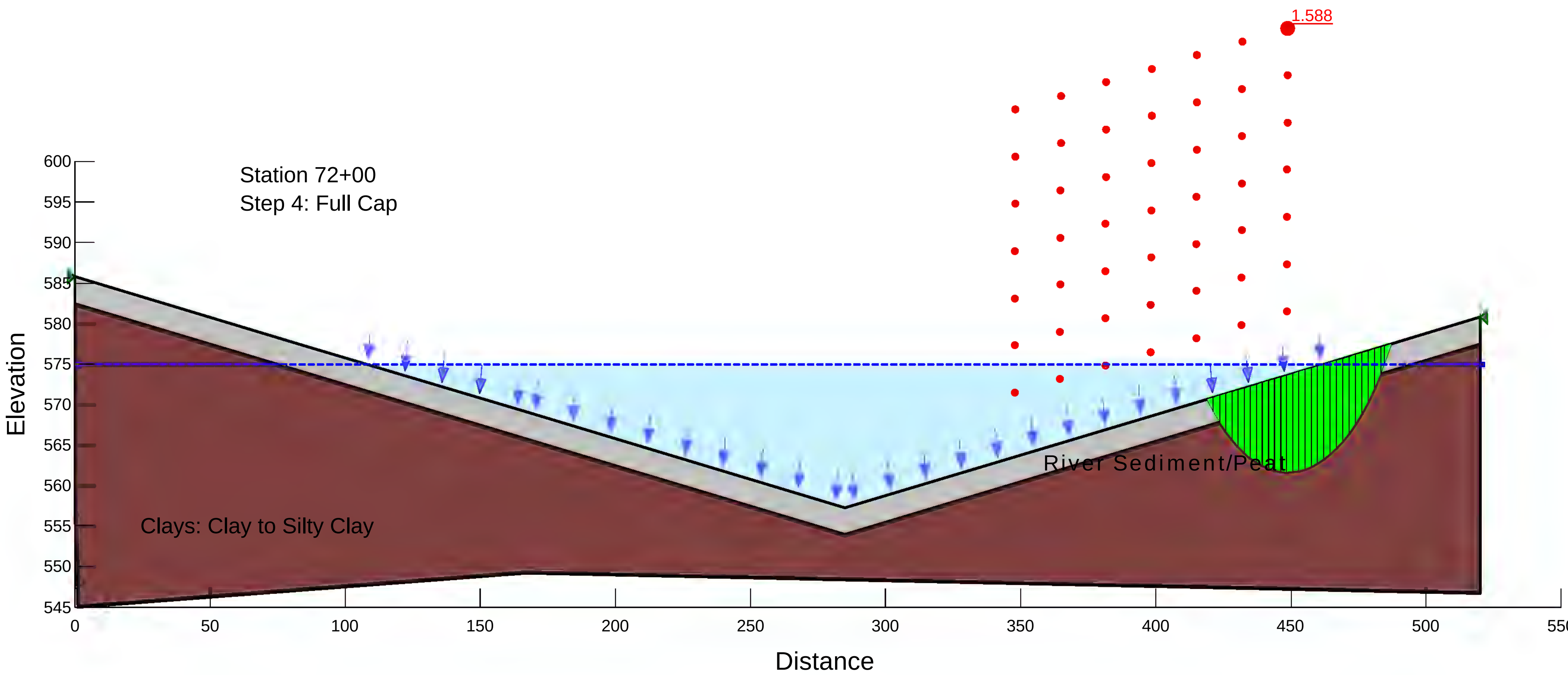
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1

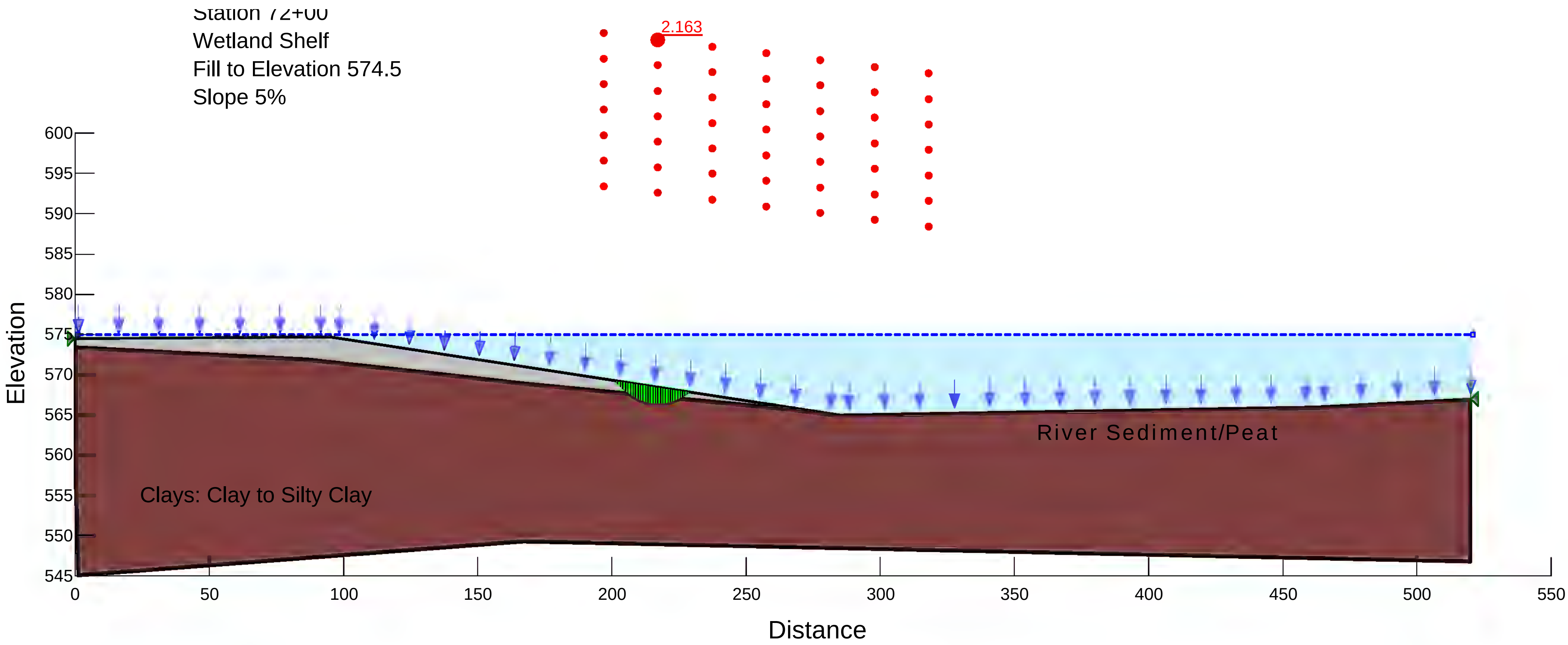


Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



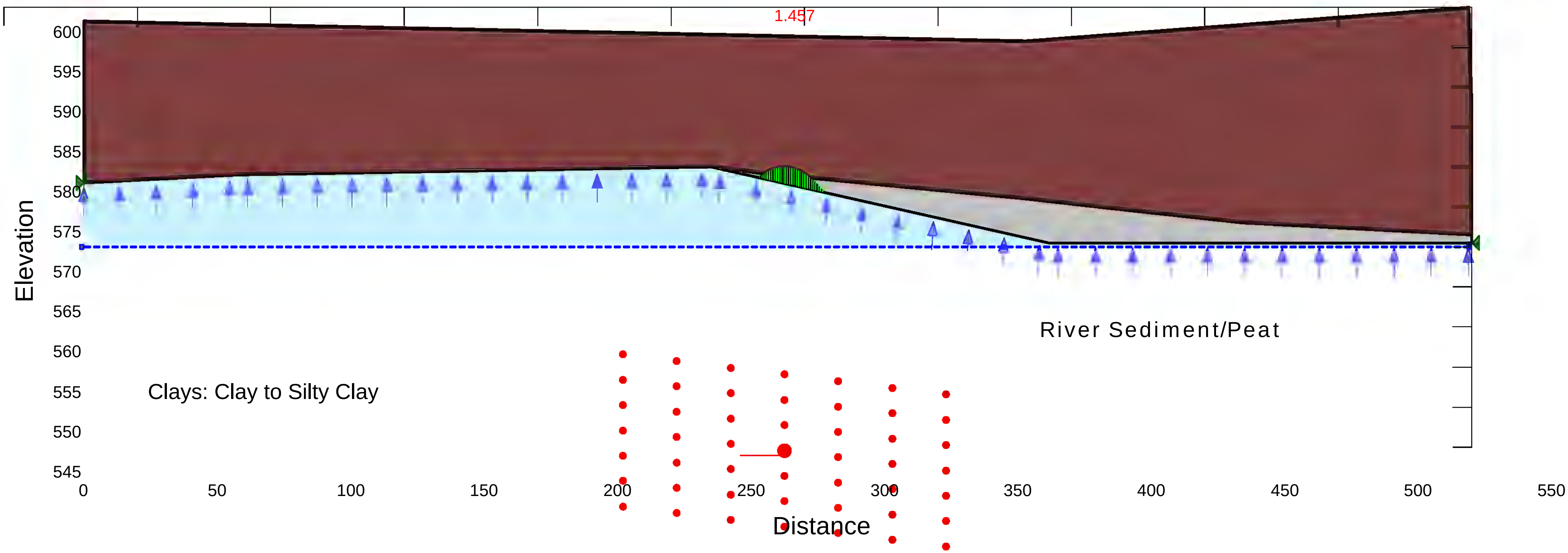
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Change: 8 psf/ft Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° Piezometric Line: 1



Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 5.3 Limiting C: 600 psf Piezometric Line: 1

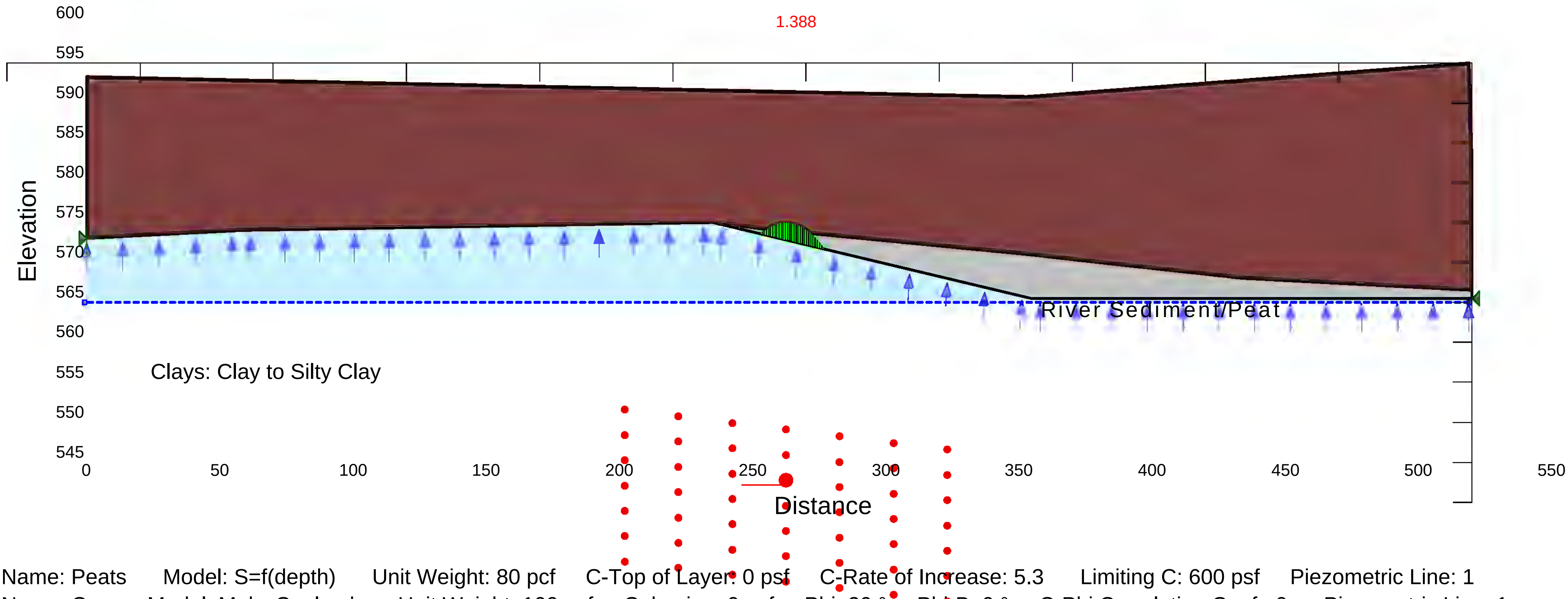
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

Station 72+00
Wetland Shelf
Fill to Elevation 574.5
Slope 7.5%



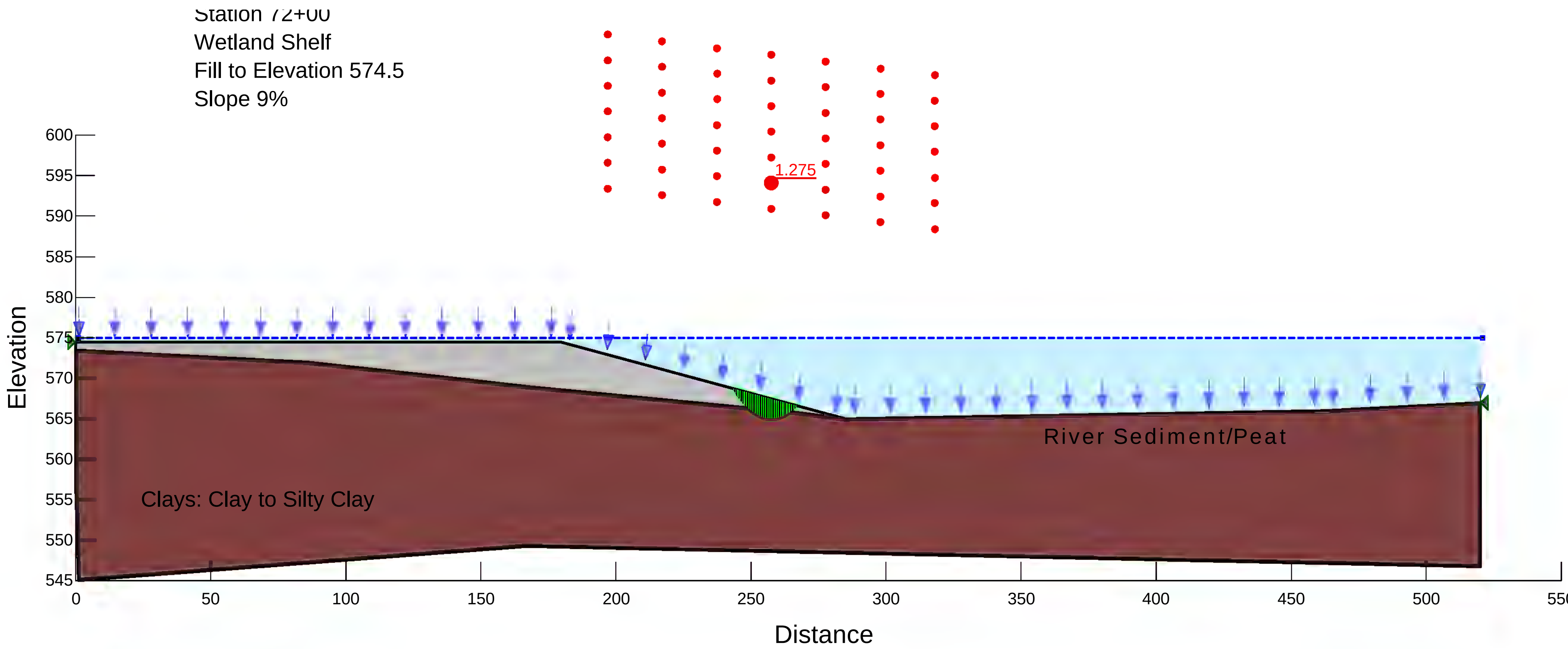
Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 5.3 Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

Station 72+00
Wetland Shelf
Fill to Elevation 574.5
Slope 8%



Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 5.3 Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

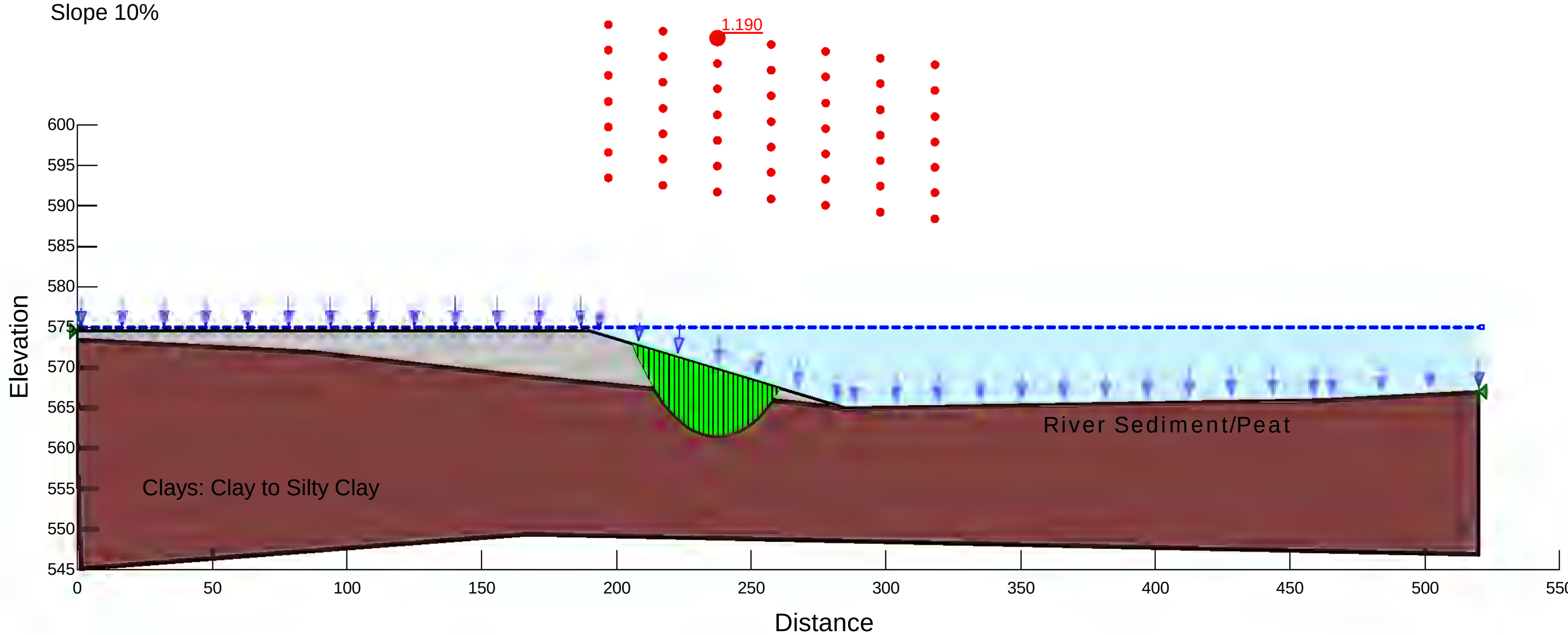


Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 5.3 Limiting C: 600 psf Piezometric Line: 1
Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

Wetland Shelf

Fill to Elevation 574.5

Slope 10%



Name: Peats Model: S=f(depth) Unit Weight: 80 pcf C-Top of Layer: 0 psf C-Rate of Increase: 5.3 Limiting C: 600 psf Piezometric Line: 1

Name: Cap Model: Mohr-Coulomb Unit Weight: 100 pcf Cohesion: 0 psf Phi: 20 ° Phi-B: 0 ° C-Phi Correlation Coef.: 0 Piezometric Line: 1

	PROJECT TITLE: **Bubbly Creek**	COMPUTED BY: **JWS**	DATE: **23Jul2013**	SHEET:
US Army Corps of Engineers® Chicago District	COMPUTATION TITLE: **Stability Attachments**	CHECKED BY:	DATE:	

ATTACHMENT

D-2-8 ERDC Comments/Responses

4 April 2013

ERDC Geotechnical Lab Review comments

Documents reviewed: ERDC 's previous review 8 Aug 2012 (Walshire and Wahl), LRC Settlement Analysis 11 Feb 2013 (23 sheets w/ Attach 1 thru 4), LRC Stability Analysis 11 Feb 2013 including Appendices A thru G, LRC Tables and pdf plots.

Reviewer: Landris T. Lee, 601.634.2661

Comments on Stability Analysis:

LRC addressed the previous (8 Aug 2012) stability comments, and narrowed the analysis to sand fill-only and dredge cut-sand fill situations.

Using the CPT-based c/p' values for soft organic soils may or may not reasonable after having to 'adjust' the cone resistance and sleeve friction data. Throwing out the turning basin field vane data because of their back-calculated high OCR values may or may not be reasonable. What's left is a best-guess of the site strength values as modeled herein using Slope/W. Additionally, the bottom surface elevations and slopes were extrapolated to the shorelines in some cases. There is a large amount of uncertainty involved in this modeling effort. Perhaps the best approach at this point (in the absence of recommended additional bathymetry, soil borings, strength testing, and probabilistic strength modeling) is to perform a site demonstration on a selected reach to show that cutting and dumping 22" of sand could be a viable option.

RESPONSE

This test could be performed during the design phase.

Bowles, J.E. (1979). *Physical and Geotechnical Properties of Soils*, McGraw-Hill Book Co., Inc. New York, NY

Attachment D-3
Gap Gradation Analyses

Below are AECOM collected grain size data

Date 14-Aug
Sample 4
Depth 15 ft

sieve		Weight retained	Sieve tare	Percent finer
12.5	mm	0	0	0
9.5	mm	0	0	100
4.75	mm	751.26	751.1	99.7
2	mm	487.81	487.69	99.4
0.85	mm	416.58	416.25	98.8
0.425	mm	381.22	380.33	97
0.18	mm	359.89	353.82	85
0.15	mm	353.34	349.95	78.3
0.075	mm	342.85	335.6	63.9
0.053	mm	336	332.94	57.8

Date 14-Aug
Sample 6 ft
Depth 20

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	781.4	779.7	96.6
4.75	mm	752.09	751.1	94.6
2	mm	489.22	487.69	91.6
0.85	mm	418.03	416.25	88
0.425	mm	381.96	380.33	84.8
0.18	mm	357.6	353.82	77.2
0.15	mm	351.47	349.95	74.2
0.075	mm	339.28	335.6	66.8
0.053	mm	334.16	332.94	64.4

15-Aug
3 ft
12.5

retained	tare	finer
0	0	100
785.93	779.7	87.6
753.77	751.1	82.3
489.49	487.69	78.7
417.09	416.25	77
381.01	380.33	75.7
356.15	353.82	71.1
352.49	349.95	66
350.48	335.6	36.4
335.68	332.94	31

Date 15-Aug
Sample 6
Depth 20

		Weight	Sieve	Percent
12.5	mm	0	0	100
9.5	mm	781.85	779.7	95.7
4.75	mm	761.14	751.1	75.8
2	mm	499.42	487.69	52.5
0.85	mm	419.66	416.25	45.7
0.425	mm	381.46	380.33	43.4
0.18	mm	356.7	353.82	37.7
0.15	mm	351.74	349.95	34.2
0.075	mm	341.96	335.6	21.5
0.053	mm	335.2	332.94	17

Date 14-Aug
Sample 5 ft
Depth 17.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.42	751.1	99.4
2	mm	488.27	487.69	98.2
0.85	mm	418.15	416.25	94.4
0.425	mm	382.37	380.33	90.4
0.18	mm	357.85	353.82	82.3
0.15	mm	352.65	349.95	76.9
0.075	mm	338.6	335.6	71
0.053	mm	336.59	332.94	63.7

Date 14-Aug
Sample 7 ft
Depth 22.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	780.61	779.7	98.2
4.75	mm	752.59	751.1	95.2
2	mm	489.42	487.69	91.8
0.85	mm	417.7	416.25	88.9
0.425	mm	381.17	380.33	87.2
0.18	mm	358.1	353.82	78.7
0.15	mm	352.92	349.95	72.8
0.075	mm	341.03	335.6	62
0.053	mm	335.17	332.94	57.6

15-Aug
4 ft
15

retained	tare	finer
0	0	100
800.06	779.7	59.8
756.48	751.1	49.2
490.93	487.69	42.8
418.39	416.25	38.6
381.82	380.33	35.7
356.31	353.82	30.7
351.02	349.95	28.6
339.28	335.6	21.4
334.04	332.94	19.2

Date 15-Aug
Sample 7
Depth 22.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.28	751.1	99.6
2	mm	489.42	487.69	96.2
0.85	mm	418.48	416.25	91.8
0.425	mm	382.39	380.33	87.6
0.18	mm	357.05	353.82	81.2
0.15	mm	350.74	349.95	79.6
0.075	mm	337.87	335.6	75.1
0.053	mm	333.9	332.94	73.2

Below are AECOM collected grain size data

Date
Sample

Depth
sieve

12.5	mm
9.5	mm
4.75	mm
2	mm
0.85	mm
0.425	mm
0.18	mm
0.15	mm
0.075	mm
0.053	mm

Date 16-Aug
Sample 4 ft
Depth 12.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	780.19	779.7	99
4.75	mm	753.05	751.1	95.2
2	mm	489.46	487.69	91.7
0.85	mm	419.3	416.25	85.6
0.425	mm	382.93	380.33	80.5
0.18	mm	363.19	353.82	61.9
0.15	mm	357.36	349.95	47.2
0.075	mm	349.27	335.6	20.2
0.053	mm	334.21	332.94	17.6

Date 16-Aug
Sample 6 ft
Depth 17.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.95	751.1	98.3
2	mm	488.3	487.69	97.1
0.85	mm	417.69	416.25	94.2
0.425	mm	381.83	380.33	91.2
0.18	mm	358.64	353.82	81.7
0.15	mm	354.11	349.95	73.4
0.075	mm	351.86	335.6	41
0.053	mm	336.14	332.94	34.7

Date 16-Aug
Sample 8 ft
Depth 22.5

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.49	751.1	99.2
2	mm	489.53	487.69	95.6
0.85	mm	418.51	416.25	91.1
0.425	mm	382.25	380.33	87.3
0.18	mm	356.92	353.82	81.2
0.15	mm	350.71	349.95	79.7
0.075	mm	337.91	335.6	75.2
0.053	mm	333.97	332.94	73.1

Date
Sample
Depth
sieve

12.5	mm
9.5	mm
4.75	mm
2	mm
0.85	mm
0.425	mm
0.18	mm
0.15	mm
0.075	mm
0.053	mm

Date 16-Aug
Sample 5 ft
Depth 15

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.57	751.1	99.1
2	mm	487.96	487.69	98.5
0.85	mm	417.15	416.25	96.7
0.425	mm	381.81	380.33	93.8
0.18	mm	357.4	353.82	86.7
0.15	mm	353.01	349.95	80.6
0.075	mm	348.57	335.6	54.8
0.053	mm	336.72	332.94	47.3

Date 16-Aug
Sample 7 ft
Depth 20

sieve		retained	tare	finer
12.5	mm	0	0	100
9.5	mm	0	0	100
4.75	mm	751.12	751.1	100
2	mm	487.86	487.69	99.6
0.85	mm	416.63	416.25	98.9
0.425	mm	380.99	380.33	97.6
0.18	mm	357.27	353.82	90.7
0.15	mm	352.8	349.95	85
0.075	mm	346.13	335.6	64
0.053	mm	336.97	332.94	56

These are IDOT Fine Aggregate Gradation Limits

	FA1 high	FA 1 low	FA2 high	FA 2 low	FA3 high	FA3 low	FA4 high	FA4 low	FA5 high	FA5 low	FA6 high	FA6 low	FA20 high	FA20 low	FA21 high	FA 21 low
9.5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
4.75	100%	95%	100%	94%	100%	94%			100%	84%	100%	84%	100%	94%	100%	94%
2.36													100%	60%	100%	60%
2					95%	65%										
1.18	85%	45%	85%	45%			10%	0%					65%	35%	75%	49%
0.6																
0.425					70%	30%										
0.3	29%	3%	30%	10%									30%	8%	40%	20%
0.18					40%	10%										
0.15	15%	0%	10%	0%					40%	0%	40%	0%	17%	3%	30%	10%
0.075					6%	0%			30%	0%	12%	0%	8%	0%	18%	0%

	FA1 high	FA 1 low	FA2 high	FA 2 low	FA3 high	FA3 low	FA4 high	FA4 low	FA5 high	FA5 low	FA6 high	FA6 low	FA20 high	FA20 low	FA21 high	FA 21 low
9.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.75	0.01	0.0095	0.01	0.0094	0.01	0.0094			0.01	0.0084	0.01	0.0084	0.01	0.0094	0.01	0.0094
2.36													0.01	0.006	0.01	0.006
2					0.0095	0.0065										
1.18	0.0085	0.0045	0.0085	0.0045			0.001						0.0065	0.0035	0.0075	0.0049
0.6																
0.425					0.007	0.003										
0.3	0.0029	0.0003	0.003	0.001	0	0							0.003	0.0008	0.004	0.002
0.18					0.004	0.001										
0.15	0.0015		0.001		0	0			40%	0%	40%	0%	0.0017	0.0003	0.003	0.001
0.075					0.0006	0			30%	0%	12%	0%	0.0008		0.0018	

This is a compilation of AECOM collected grain sizes

Date	14-Aug	14-Aug	14-Aug	14-Aug	15-Aug	15-Aug	15-Aug	15-Aug	16-Aug	16-Aug	16-Aug	16-Aug	16-Aug		
Sample	4	5	6	7	3	4	6	7	4	5	6	7	8		
Depth	15	17.5	20	22.5	12.5	15	20	22.5	12.5	15	17.5	20	22.5		
sieve	finer	finer	finer	finer	finer	finer	Percent	finer	finer	finer	finer	finer	finer	max	min
12.5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9.5	100	100	96.6	98.2	87.6	59.8	95.7	100	99	100	100	100	100	100	59.8
4.75	99.7	99.4	94.6	95.2	82.3	49.2	75.8	99.6	95.2	99.1	98.3	100	99.2	100	49.2
2	99.4	98.2	91.6	91.8	78.7	42.8	52.5	96.2	91.7	98.5	97.1	99.6	95.6	99.6	42.8
0.85	98.8	94.4	88	88.9	77	38.6	45.7	91.8	85.6	96.7	94.2	98.9	91.1	98.9	38.6
0.425	97	90.4	84.8	87.2	75.7	35.7	43.4	87.6	80.5	93.8	91.2	97.6	87.3	97.6	35.7
0.18	85	82.3	77.2	78.7	71.1	30.7	37.7	81.2	61.9	86.7	81.7	90.7	81.2	90.7	30.7
0.15	78.3	76.9	74.2	72.8	66	28.6	34.2	79.6	47.2	80.6	73.4	85	79.7	85	28.6
0.075	63.9	71	66.8	62	36.4	21.4	21.5	75.1	20.2	54.8	41	64	75.2	75.2	20.2
0.053	57.8	63.7	64.4	57.6	31	19.2	17	73.2	17.6	47.3	34.7	56	73.1	73.2	17

These are the AECOM Collected Grain Size Limits Used in the Plot

Sieve	Particle size	Base soil (original), % passing	
#	(mm)	(upper bound)	(lower bound)
4	4.75	100.0%	49.2%
10	2.00	99.6%	42.8%
20	0.85	98.9%	38.6%
40	0.425	97.6%	35.7%
80	0.180	90.7%	30.7%
100	0.150	85.0%	28.6%
170	0.090	75.2%	20.2%
200	0.075	74.0%	18.5%
270	0.053	73.2%	17.0%
-	0.0001	0.0%	0.0%

Armor Layer

Percent Passing	Size (mm)
1	63
0.5	40

These are the Filter Material Limits calculated by a TS-DG filter criteria calculating spreadsheet

*Required entry values for base soil & candidate filter gradations:

Filter criteria required by the USBR as published in Design Standards - Embankment Dams No. 13 (1994):

D85B used in filter design	#N/A
Average Passing #200 sieve of base soil	46.3%
Base soil category	2
Base soil description	Sands, silts, clays, and silty and clayey sands
Filter criteria (mm)	Maximum: D15F £ 0.70 To ensure sufficient permeability: Minimum: D15F ³ 0.10
Maximum particle size of filter (mm)	50
Maximum % passing # 200 sieve	5%
PI of material passing #40	0 when tested in accordace with USBR 5360, Earth Manual, on material passing #40

USBR filter gradation limits:

Maximum limit	
Grain size (mm)	% Passing
50.00	100.0%
0.70	15.0%

Minimum limit	
Grain size (mm)	% Passing
0.10	15.0%
0.075	5.0%

Filter criteria required by the US Army Corps of Engineers as published in EM 1110-2-2300 (31 Jul 94):

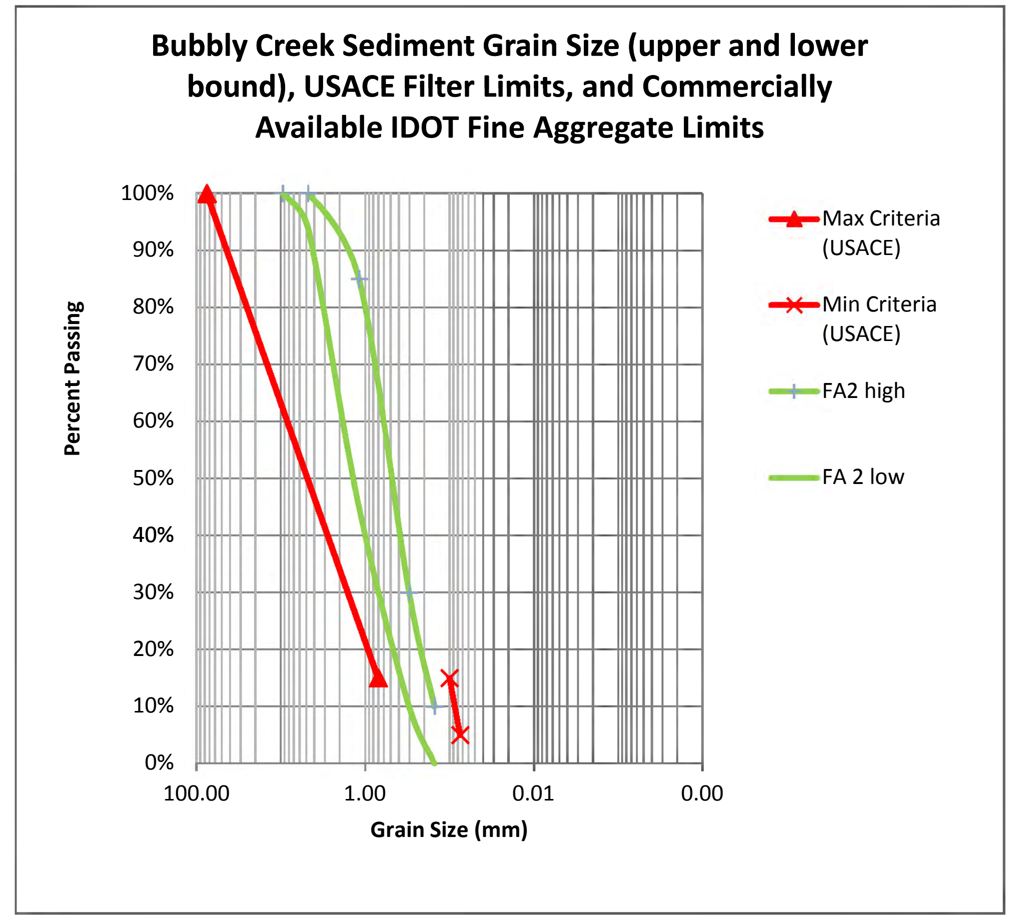
D85B used in filter design	#N/A
Average Passing #200 sieve of base soil	46.3%
Base soil category	2
Filter criteria (mm)	Maximum: D15F £ 0.70 to 0.70 To ensure sufficient permeability: Minimum: D15F ³ 0.10 to 0.10
Maximum particle size of filter (mm)	75
Maximum % passing # 200 sieve	5%
PI of material passing #40	0 when tested in accordance with EM 1110-2-1906

USACE filter gradation limits:

Maximum limit	
Grain size (mm)	% Passing
75.00	100.0%
0.70	15.0%
0.70	15.0%

Minimum limit	
Grain size (mm)	% Passing
0.10	15.0%
0.10	15.0%
0.075	5.0%

**If the base soil is in category 4, use the lower of the two 'max. D15F' values when the filter is beneath riprap subject to wave action or beneath drains which may be subject to violent surging and/or vibration.



Attachment D-4
Geotechnical Investigations

Attachment 2:

Impact from Adopted VE Study Measures Memorandum

CELRC-TS-DG April 15, 2014

MEMORANDUM FOR CELRC-PM-PM

SUBJECT: Impacts from Adopted VE Study Measures

1. References

- USACE, Chicago District. Nov 2013. Bubbly Creek, South Branch of the Chicago River, Illinois Ecosystem Restoration Feasibility Study and Integrated Environmental Assessment, Alternative Formulation Briefing (AFB) Document
- USACE, Chicago District. Mar 2014. Value Engineering Study: Bubbly Creek South Branch of the Chicago River Ecosystem Restoration.VE Study Final Report.

Background

2. The feasibility design for Bubbly Creek was for nominally ten (10) inches of sand overlying eight (8) inches of rounded river stone (USACE, 2013). During the Value Engineering Study (USACE, 2014) it was proposed that the sand thickness be reduced to six (6) inches and the rounded river stone be reduced to six (6) inches. The net loading impact would then be from eighteen (18) to twelve (12) inches of fill. The geotechnical section was asked how these changes would affect the geotechnical analysis of the cap.

3. In the geotechnical analysis the settlement was estimated to be an average of 1 ft for the eighteen (18) inch cap. Half of the settlement was expected to occur within the first two (2) years and the remainder of the settlement was expected to be substantially complete within eight and a half (8.5) years of construction.

4. If less material is added then less settlement would be expected. Since the fill and the resultant settlement roughly offset one another for the previous analysis, that is 1.5 ft of material was added resulting in nearly that amount (1 ft) of settlement, a similar result is expected when 1 ft of material is added. That is approximately ¾ ft or 9 inches of settlement would be expected for placement of 1 ft of material. Additional analyses could be run to confirm this settlement. However, given the various uncertainties, the present level of analysis should be sufficient to evaluate the feasibility of the design.

5. Settlement is a function of coefficient of consolidation (c_v) and the length of the drainage path. Adding less granular material will not affect either of these parameters. Therefore the time to reach consolidation should not be affected by adding less material granular material.

6. The existing concerns regarding placement of the cap on the soft sediment remain. Therefore the recommendation to broadcast spread the cap material to avoid differential loading.

7. Any questions can be addressed to the undersigned.

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