REPORT OF GEOTECHNICAL EXPLORATION

BRIDGE STRUCTURE REPORT

New Wolf Pen Branch Road Bridge and Temporary Diversion Bridge
LSIORBP – Section 4 – KY 841
Louisville, Jefferson County, Kentucky

KSWA Project No. 100-03-0148
KYTC Project No. 5-731.00
Item Number 5-118.00

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July 23, 2009

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Subject: **Report of Geotechnical Exploration**
Bridge Structure Report
New Wolf Pen Branch Bridge & Temporary Diversion Bridge
LSIORBP – Section 4 – KY 841
Louisville, Jefferson County, Kentucky
KSWA Project No. 100-03-0148

Dear Mr. Leslie:

K. S. Ware and Associates, L.L.C. (KSWA) is pleased to submit this report which details the results of our geotechnical exploration for the referenced project. The exploration described in this report was performed in general accordance with the guidelines presented in the Kentucky Transportation Cabinet's Geotechnical Manual and the AASHTO LRFD Bridge Design Specifications.

KSWA has presented the results of the field exploration, laboratory data and our recommendations for the design and construction of the substructure elements proposed for the new bridge. We appreciate this opportunity to be of service to you on this project. Please contact us if you have any questions regarding this report.

Respectfully submitted,

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Enclosures: Report of Geotechnical Exploration

Distribution: KYTC (3) + CD
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TABLE OF CONTENTS

TABLES

APPENDICES

Report of Geotechnical Exploration - Bridge Structure Report
New Wolf Pen Branch Road Bridge & Temporary Diversion Bridge
LSIORBP – Section 4 – KY 841
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1.0 LOCATION AND DESCRIPTION

This project consists of new road and bridge construction along Wolf Pen Branch Road as part of the proposed Louisville – Southern Indiana Ohio River Bridges Project (LSIORBP), Section 4, Kentucky State Route 841 approach project in Louisville, Jefferson County, Kentucky. Based on project information provided by H. W. Lochner, KSWA anticipates cuts of up to 40 feet at the intersection of Wolf Pen Branch Road and KY 841. Currently, a KY 841 bridge crosses over Wolf Pen Branch Road; however, project plans indicate that the elevation of KY 841 will be lowered approximately 40 to 45 feet and a new Wolf Pen Branch Road bridge will be constructed over KY 841. In addition, a temporary diversion bridge, to be utilized during construction of the new Wolf Pen Branch Road Bridge, is planned to be located about 86 feet north of the Wolf Pen Branch Road and Springdale Road intersection. Construction of the approach embankments for the Wolf Pen Branch Road bridge will require about 5 feet of fill at the west abutment and about 2 feet of cut at the east abutment and at the Temporary Diversion Bridge, the grading plans at the abutments indicate about 10 to 12 feet of cut.

The proposed New Wolf Pen Branch Road Bridge begins at Station 48+15.35 and ends at Station 51+50.35 along the Wolf Pen Branch Road alignment. The Temporary Diversion Bridge begins at Station 36+72.57 and ends at Station 38+36.09 along the Diversion Number 1 alignment. The substructure locations for the New Wolf Pen Branch Road Bridge and the Temporary Diversion Bridge are shown in Table 1 below.

Table 1: Bridge Substructure Locations

Element	New Wolf Pen Branch Road - Centerline Station	Temporary Diversion Bridge - Centerline Station
Abutment 1	48+21.02	36+74.28
Pier	50+00.35	*N/A*
Abutment 2	51+44.68	38+34.38

N/A – Not Applicable

This geotechnical report addresses geotechnical recommendations for the New Wolf Pen Branch Road Bridge and Temporary Diversion Bridge. The geotechnical considerations for New Wolf Pen Branch Road and intersecting streets have been addressed in a separate report.

The proposed project structure, location, and details are illustrated in Appendix A. Documents from the Advanced Situation Folder for this bridge are reproduced in Appendix B. A plan and profile drawing which depicts the layout of the proposed substructure elements and the boring locations is included in Appendix C.

2.0 SITE TOPOGRAPHY AND GEOLOGIC CONDITIONS

The physiographic map of Kentucky indicates that this area is located on the southwestern border of the Outer Bluegrass Region. This region is located in the central portion of the state where Ordovician (and some Silurian and Devonian) age rocks are exposed at the surface. The Outer Bluegrass Region is characterized by deep valleys, with little flat land because the bedrock in this area is mostly composed of interbedded Ordovician limestones and shales that are more easily eroded than the limestones of the Inner Bluegrass Region.

The geologic map of parts of the Jeffersonville, New Albany and Charlestown quadrangles, Kentucky-Indiana, describes much of the local geologic conditions in Louisville. This map indicates that the geology at this location is mainly Sellersburg and Jeffersonville Limestones with a segment on the south end around Springdale Road listed as Louisville Limestone.

Sellersburg Limestone is divided into two parts; the Beechwood Limestone Member and the Silver Creek Limestone Member. The Beechwood Limestone formation consist of light-gray to greenish-gray, weathers to yellowish brown to light olive-gray. The limestone contains coarse to very coarse fossil fragments and in matrix of silt-sized lime mud or very finely crystalline calcite. The Silver Creek Limestone is dolomitic and argillaceous and ranges from olive-gray to light-greenish-gray in color and weathers to yellowish-gray. Bedding is laminated to cross laminated with crypto grained to micro grained particle sizes. The thickness of the Beechwood and Silver Creek Limestones range from 3 to 8 feet and 0 to 7 feet, respectfully, with a total thickness ranging from 3 to 15 feet.

The Jeffersonville Limestone formation is olive-gray, brownish-gray or medium to light-gray in color and weathers to a yellowish brown to light yellowish gray material. A limestone matrix of silt to clay sized lime mud or crystalline calcite containing fine to very coarse fossil fragments and larger whole fossils. The thickness of the Jeffersonville Limestone ranges from 20 to 27 feet. The total thickness of the Sellersburg and Jeffersonville Limestones, range from approximately 23 to 42 feet.

Louisville Limestone is a dolomitic limestone with a yellowish-gray to light-olive- gray color. The limestone is bedded in thin to very thin layers near the upper regions and thick bedded near they base of the section. Formation includes fossils in the finely crystalline limestone structure. The thickness of the Louisville Limestone ranges from approximately 40 to 80 feet.

Waldron Shale is a clay shale with a dark greenish gray color that weathers to a medium to light gray or yellowish gray to grayish yellow silt. The formations include dolomite and pyrite with rare pod-like inclusions as large as 3 feet thick and 6 feet wide of dolomite. The thickness of the Waldron Shale ranges from approximately 8 to 15 feet with an average thickness of about 10 feet.

3.0 FIELD EXPLORATION

3.1 SUMMARY

Drilling and sampling operations were performed by American Engineers Inc. and monitored by KSWA personnel. The borehole locations were staked in the field by Hall Harmon Engineers and then adjusted in the field by KSWA based on utility proximity and site conditions. The drilling was performed during the period between March 16 and 24, 2009. Eight (8) test borings, numbered B-1 through B-8 were drilled at the New Wolf Pen Branch Road Bridge site and two (2) test borings, numbered TB-1 and TB-2 were drilled at the Temporary Diversion Bridge site. The borings were backfilled with auger cuttings and the surface patched with asphalt cold patch material where applicable. Table 2 details the borehole location and elevations. Appendix C describes the proposed layout, the borehole locations and the borehole profiles.

Table 2: Summary of Borings

Boring Number	Station/Offset from Center Line	Surface Elevation, ft**	Top of Rock Elevation, ft	Length of Core, ft	Bottom of Boring Elevation, ft
B-1[1]	48+10.5, 18' LT	608.7	591.3	12.2	579.1
B-2[1]	48+19.4, 2' LT	601.5	591.8	13.1	578.7
B-3[1]	48+28.2, 22' RT	602.0	599.0	19.1	579.9
B-4[1]	49+94.2, 8' LT	611.1	597.5	63.5	534.0
B-5[1]	50+02.6, 8' RT	612.3	600.5	65.7	534.8
B-6[1]	51+34.1, 19' LT	616.5	600.0	15.6	584.4
B-7[1]	51+43, 6' LT	618.1	609.1	22.4	586.7
B-8[1]	51+51.9, 13' RT	617.7	605.8	18.7	587.1
TB-1[2]	36+71, 6' LT	609.0	595.2	16.4	578.8
TB-2[2]	38+39.4, 6' RT	621.5	595.0	12.8	582.2

**Location coordinates for each boring can be found in Appendix G on the Coordinate Data Submission Form*
***Surface elevations estimated based on road profiles at or near soil boring locations*
[1]-Stationing from Wolf Pen Branch Road
[2]-Stationing from Temporary Diversion Bridge

Borings associated with both the New Wolf Pen Branch Road Bridge and the Temporary Diversion Bridge encountered auger refusal at depths ranging from 3.0 to 26.5 feet with termination depths ranging from 22.1 to 77.5 feet. Rock coring was completed at each boring location.

3.2 DRILLING AND SAMPLING

Drilling, sampling, and testing were conducted in general accordance with methods of KYTC and the American Society for Testing and Materials (ASTM) or other widely accepted geotechnical engineering standards. A description of the procedures used during this exploration is provided in the following paragraphs.

Ten (10) test borings were drilled at the bridge sites. These borings were drilled into the soil with a track-mounted drill rig using 6-in. continuous-flight hollow-stem power augers in accordance with ASTM D1452. The track mounted drill rig was equipped with an automatic hammer.

Relatively undisturbed samples were obtained at various depths in the borings. The undisturbed soil samples were secured by 3-in. thin-walled Shelby tube samplers (ASTM D1587). The tubes were then identified, sealed air-tight from both ends, and transported to our laboratory for general soil testing.

The relative density and consistency of the *in-situ* soils were measured at discrete depth intervals by penetration tests (ASTM D1586). Standard penetration tests were performed by driving a 1.4-in. I.D., 2-in. O.D. split-barrel sampler into the undisturbed soil by means of a 140-lb weight falling 30 in. The penetration resistance (N-value) in terms of blows per foot of penetration was logged. Samples of soil recovered in the penetration spoon were placed in air-tight containers and transported to our laboratory for evaluation and testing.

3.3 SOIL CONDITIONS

3.3.1 Surface Material

Test Borings B-1, B-6, TB-1 and TB-2 encountered approximately 7 to 12 inches of topsoil and organics. Test Borings B-2 through B-5, B-7 and B-8 encountered approximately 4 to 12 inches of asphalt underlain by 4 to 8 inches of limestone basestone.

3.3.2 Probable Fill Materials

Beneath the surface materials at Test Boring B-5, probable fill materials were encountered to a depth of approximately 3.1 feet. The probable fill material consisted of low plasticity lean clays with limestone gravel. The index-penetration strength test value was 3.5 tons per square foot (tsf).

3.3.3 Lean Clays and Clays

Underlying the fill materials and surface materials, the test borings encountered mostly residuum soils consisting of low and highly plastic clays. The highly plastic clays were encountered beneath the lean clays at Test Borings B-1, B-4, B-5, B-6, B-8, TB-1 and TB-2 at depths ranging from about 4 to 19.5 feet, extending to refusal depths. These soils extended to refusal depths ranging from about 3.0 to 26.5 feet. Index-penetration strength test values ranged between 0.75 and over 4.5 tsf suggesting a firm to hard consistency.

3.3.4 Auger Refusal

Auger refusal conditions were encountered in all of the Test Borings at depths ranging from about 3.0 to 26.5 feet. Refusal conditions varied widely across the site over relatively short distances suggesting that the underlying bedrock is pinnacled with crevices and mounds and valleys. As an example, Test Boring B-1 at abutment 1 encountered auger refusal conditions at approximately 17.4 feet and Test Boring B-3, located about 35 feet south of Test Boring B-1, encountered auger refusal conditions at approximately 3 feet.

Refusal is a designation applied to any material that cannot be penetrated by the power auger and is normally indicative of a very hard or very dense material, such as large boulders or the upper surface of bedrock. In an area of limestone bedrock, refusal can result on slabs of unweathered bedrock suspended in the soil matrix, on rock pinnacles extending above the surrounding bedrock surface, or the upper surface of continuous bedrock.

3.3.5 Bedrock

Rock coring was performed in all of the test borings. The rock core samples consisted of a Rock Disintegration Zone (RDZ), hard, fine to coarse grained, fossiliferious, grey limestone and grey shale. A RDZ layer was encountered in each boring in the upper 2 to 4 feet of the rock cores. The grey shale was encountered at Test Borings B-4 and B-5 at depths of about 69.6 (Elev. 541.5 ft) and 70 feet (Elev. 542.3 ft), respectively, extending to the end of coring depth. Rock recovery ranged between 58 and 100 percent and the Rock Quality Designation (RQD) ranged between 0 and 100 percent indicating a very poor to excellent rock from an engineering standpoint.

3.3.6 Groundwater Conditions

Groundwater measurements were made in the test borings during drilling and at the completion of drilling. Groundwater was not observed in the test borings at the time of drilling or after drilling. At the time of our investigation, the groundwater levels at this site appear to have been below our boring depths, although isolated perched conditions may have existed. Groundwater levels will differ depending on the time of year, climatic conditions and the degree of construction activities.

4.0 LABORATORY TESTING AND RESULTS

4.1 GENERAL

Laboratory tests were performed in accordance with applicable AASHTO or Kentucky Methods of soil testing specifications. The results of the laboratory tests are depicted graphically on the Subsurface Data Sheets presented in Appendix C. Individual laboratory test results are presented in Appendix F.

The test results were used to establish material properties and utilized in subsequent engineering analysis to evaluate foundation alternatives and their respective installation processes.

Undisturbed samples were collected at random depths within the borings. Split spoon sampling continued in cohesionless material (sands and gravel). The testing presented is split into undisturbed and split spoon sampling

4.2 LABORATORY TESTING OF UNDISTURBED (SHELBY) TUBE SAMPLES

Undisturbed (Shelby) tube samples were obtained from each of the borings. Each of the samples was extruded and selected samples were tested. Results are presented on Subsurface Data Sheets in Appendix C.

4.2.1 Moisture Contents

Moisture contest testing was performed on the Shelby tube samples obtained from the borings. The results varied from 18.5 percent to 39.8 percent with an average of approximately 26.5 percent.

4.2.2 Engineering Classification Testing

Classification testing was performed on each of the Shelby tube samples. The samples were classified according to the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) guidelines. The classification results from the Shelby tube samples generally indicated the soils were Clay and Silt consistency with low to high plasticity (CL, CH, ML and MH).

4.2.3 Atterberg Limits Tests

Atterberg limits testing were performed on eight borings for the New Wolf Pen Branch Road Bridge and labeled Borings B-1 through B-8 and two borings for the Temporary Diversion Bridge labeled TB-1 and TB-2. Results from those tests are presented in Table 3 on the following page.

Table 3: Shelby Tube Atterberg Limit Tests and Classification

Boring No.	Sample No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Classification	AASHTO Classification
B-1	ST-1	2.0-4.0	33	22	11	CL	A-6
B-1	ST-2	4.0-6.0	34	21	13	CL	A-6
B-1	ST-4	9.0-11.0	61	30	31	CH	A-7-5
B-1	ST-5	14.0-16.0	73	34	39	CH	A-7-5
B-2	ST-2	4.0-6.0	35	21	14	CL	A-6
B-3	ST-1	2.0-2.5	39	18	21	CL	A-6
B-4	ST-1	2.0-4.0	48	25	23	CL	A-7-6
B-4	ST-2	4.0-6.0	73	29	44	CH	A-7-6
B-4	ST-4	9.0-11.0	67	29	38	CH	A-7-6
B-5	ST-1	2.0-4.0	42	21	21	CL	A-7-6
B-5	ST-2	4.0-6.0	59	30	29	CH	A-7-5
B-5	ST-3	7.0-9.0	54	26	28	CH	A-7-6
B-5	ST-4	9.0-10.5	56	27	29	CH	A-7-6
B-6	ST-1	2.0-4.0	34	21	13	CL	A-6
B-6	ST-2	4.0-6.0	32	21	11	CL	A-6
B-6	ST-3	7.0-9.0	37	22	15	CL	A-6
B-7	ST-1	2.0-4.0	35	20	15	CL	A-6
B-7	ST-3	6.0-6.75	42	21	21	CL	A-7-6
B-8	ST-1	2.0-4.0	29	20	9	CL	A-4
B-8	ST-2	4.0-6.0	36	21	15	CL	A-6
B-8	ST-3	7.0-9.0	59	29	30	CH	A-7-6
B-8	ST-4	9.0-11.0	67	29	38	CH	A-7-6
TB-2	ST-1	2.5-4.5	29	22	7	CL-ML	A-4
TB-2	ST-2	4.5-6.5	31	19	12	CL	A-6
TB-2	ST-4	9.5-11.5	46	23	23	CL	A-7-6
TB-2	ST-6	19.5-21.5	69	32	37	CH	A-7-5
TB-2	ST-7	25.5-26.7	56	27	29	CH	A-7-6

4.2.4 Unconfined Compression Testing

Fifteen unconfined compression tests were performed on the Shelby tube samples. The results are as follows in Table 4 on the next page.

Table 4: Shelby Tube Unconfined Compression Test

Boring No.	Sample No.	Depth (ft)	Unconfined Compression
B-1	ST-2	4.0-6.0	3.1 ksf
B-1	ST-5	14.0-16.0	3.1 ksf
B-2	ST-3	7.0-9.0	2.4 ksf
B-4	ST-2	4.0-6.0	5.1 ksf
B-4	ST-4	9.0-11.0	5.5 ksf
B-5	ST-2	4.0-6.0	4.7 ksf
B-5	ST-3	7.0-9.0	2.3 ksf
B-6	ST-1	2.5-4.5	3.4 ksf
B-6	ST-4	5.0-7.0	2.2 ksf
B-7	ST-2	4.0-6.0	2.7 ksf
B-8	ST-2	4.0-6.0	3.4 ksf
B-8	ST-4	9.0-11.0	5.2 ksf
TB-1	ST-3	7.0-9.0	4.3 ksf
TB-2	ST-2	4.5-6.5	3.0 ksf
TB-2	ST-7	24.5-26.5	4.3 ksf

4.2.5 Consolidation Test

Two consolidation tests were performed: one from Boring B-1, Sample ST-2 and one from Boring TB-1, Sample ST-2. The results are shown below in Table 5:

Table 5: Shelby Tube Consolidation Results

Boring Number	Sample Number	Sample Depth (ft)	Initial Void Ratio	Compressibility Index	Recompression Index
			e_o	(C_c)	(C_r)
B-1	ST-2	4.0-6.0	0.568	0.035	0.0033
TB-1	ST-2	4.0-6.0	0.639	0.040	0.0033

4.3 LABORATORY TESTING OF STANDARD PENETRATION TEST SAMPLES

Standard Penetration Tests (SPT) were generally performed in sample borings where sand was encountered or the previous Shelby tube sample did not recover significant material. The split spoon samples collected generally encountered brown, poorly graded, fine to coarse grained sand, with trace amounts of river gravel.

A total of 4 split spoon samples were collected. Selected samples were tested for moisture content. Results are presented on the Subsurface Data Sheets in Appendix C.

4.3.1 Moisture Contents

Moisture contest testing was performed on the SPT samples obtained from the borings. The results varied from 38.4 percent to 48.8 percent with an average of approximately 42.8 percent.

4.4 ROCK TESTING

All the borings encountered bedrock and were cored to various depths depending on bearing elevations. Unconfined compressive testing was performed on rock cores at approximately bearing elevations depths as well as areas where more brittle rock was encountered. Unconfined Compressive test results are listed below in Table 6.

Table 6: Rock Core Unconfined Compressive Strength

Boring No.	Sample No.	Depth (ft)	Unconfined Compressive Strength
B-1	CORE-1	18.0-18.4	8,840 psi
B-2	CORE-2	13.5-13.9	9,580 psi
B-3	CORE-2	11.6-12.0	10,350 psi
B-4	CORE-9	57.0-57.4	9,840 psi
B-4	CORE-13	75.5-75.9	3,670 psi
B-5	CORE-11	58.5-58.9	15,150 psi
B-5	CORE-14	72.8-73.2	4,520 psi
B-6	CORE-2	20.5-20.9	8,140 psi
B-7	CORE-2	16.0-16.4	8,779 psi
B-8	CORE-2	20.5-20.9	10,812 psi
TB-1	CORE-2	17.5-17.9	9,146 psi
TB-2	CORE-1	27.1-27.5	11,786 psi

5.0 ENGINEERING ANALYSIS

5.1 GENERAL

It is our understanding that the new Wolf Pen Branch Road Bridge will include two approach abutments and one pier group for support. The Temporary Diversion Bridge will consist of a single span bridge. The proposed foundations for both bridges are spread footings supporting an abutment stem wall founded on competent bedrock.

Based on the Advanced Situation Folder for this bridge, the foundation elevations for both the new Wolf Pen Branch Road Bridge and the Temporary Diversion Bridge are in Table 7 below.

Table 7: Bridge Element Elevations

New Wolf Pen Branch Road Bridge		
Bridge Element	**Foundation Elevation, ft**	**Ground Surface Elevation, ft**
Abutment 1	**591**	**602**
Pier	**555**	**612**
Abutment 2	**598**	**617**
Temporary Diversion Bridge		
Bridge Element	**Foundation Elevation, ft**	**Ground Surface Elevation, ft**
Abutment 1	**590**	**609**
Abutment 2	**593**	**621**

The engineering analyses shown are based on this premise and the laboratory data presented. Idealized soil profiles are presented in Appendix H.

KYTC has requested that the proposed project be designed using the AASHTO Load and Resistance Factor Design (LRFD). LRFD is "a reliability-based design methodology in which force effects caused by factored loads are not permitted to exceed the factored resistance of the components." LRFD utilizes load and resistance factors to account for unknowns in loads and load resistance of structural members in lieu of using a Factor of Safety to account for unknowns. The resistance factors of LRFD design were developed using either statistical analysis of load tests together with reliability theory, fitting to allowable stress design (ASD), or both.

5.2 CORRECTION OF STANDARD PENETRATION TEST DATA

Split spoon samples were collected where undisturbed samples provided little recovery. Split spoon samples also provided blow counts (N-values) through soils as a general indicator of the soil strengths.

American Engineers Incorporated (AEI) provided drill rig equipment for the borings including automatic hammer samplers. The automatic hammers were tested and reported to be 80 percent efficient. The generally accepted efficiency of a rope and cathead sampler system on a rig is 60 percent.

The LRFD Bridge Design Specifications (Section 10.4.6.2) indicate that where SPT N-values are used to estimate the shear strength of granular soils, the N-values are corrected for both the estimated efficiency of the sampler system and the effects of the overburden pressure. Granular soils were not encountered within the borings which would require a correction for N-values or overburden pressures.

5.3 SOIL PARAMETER SELECTIONS

KSWA derived subsurface characterizations for the foundation soils along the bridge alignment based upon the results of the drilling and sampling program discussed in Section 3 of this report and the laboratory testing addressed in Section 4. The division of soil horizons was based on visual soil descriptions and laboratory classification data associated with the borings.

A Geotechnical Engineer derived estimated soil parameters for each soil horizon. Strength and settlement parameters for the cohesive materials were estimated based on the results of laboratory classification and unconfined compressive strength. The parameters derived for the cohesive materials are representative of lean and high plasticity clay soils and are typical of clay soils found in this region of the state. Idealized soil profiles are presented in Appendix H.

5.4 ROCK PARAMETER SELECTIONS

KSWA developed rock parameters for bearing capacity for service and strength limit design. The service limit design values are based on typical correlations for a particular bedrock type. The strength limit design uses subsurface characterizations for the underlying limestone and shale bedrock based on the results of the drilling and sampling program discussed in Section 3 of this report and the laboratory testing addressed in Section 4.

Strength and deformation characteristics of bedrock is highly dependent upon the frequency, orientation and condition (weathered versus unweathered) of joints of discontinuities in the rock mass. Therefore, strengths obtained from laboratory testing of intact specimens should be tempered with observation and assessments of the rock mass or core obtained from the field exploration. Sections 10.4.6.4 and 10.4.6.5 of the AASHTO LRFD Design Specifications outline procedures for determination of a Rock Mass Rating (RMR) and development of strength and deformation parameters based on lab testing and visual assessments of the rock mass or representative samples.

Using these procedures, a Geotechnical Engineer can derive strength and deformation parameters for the bedrock mass at the bridge site based on the results of unconfined compression testing of intact rock core specimens and observations of the rock samples obtained from coring operations. As discussed in

Section 4.4 of this report, the unconfined compressive strengths obtained from testing of intact rock specimens range from 264 to 1090 tsf (528 to 2,180 ksf). KSWA selected a design value of 635 tsf (1,270 ksf) for development of strength of deformation parameters of the rock mass. The design value was selected such that two-thirds of the compressive test results at the proposed bearing elevations were equal to or greater than the design value. Table 8 summarizes the bedrock mass parameters derived for the subject bridge structures.

Table 8: Summary of Rock Mass Parameters

Rock Mass Parameter	Symbol	Design Value
Wet Density	γ_{rock}	165.0 pcf
Unconfined Compressive Strength	q_{ui}	1,270 ksf
Shear Strength of Rock Mass	τ	81.2 ksf
Elastic Modulus of Intact Rock	E_i	5,700 ksi
Elastic Modulus of Bedrock Mass	E_m	4,275 ksi
Poisson's Ratio	v	0.23
Shear Modulus	G_m	1,734 ksi

It should be noted that the rock mass parameters outlined above are applicable for limestone bedrock at the bridge sites below the weathered zone and voids observed during drilling operations.

5.4.1 Bearing Capacity of Spread Footings on Bedrock

Based on our understanding of the proposed abutment and pier locations and the subsurface information, we expect the bridge abutment and piers will be supported by spread foundations bearing on bedrock. Bedrock conditions were encountered at depths ranging from about 3.0 and 26.5 feet. Due to the highly to moderately weathered and fractured condition of the bedrock encountered in the upper 2 to 4 feet at most borings, spread foundations will be required to extend to a depth of up to about 4 feet into the bedrock to achieve suitable bearing resistance.

5.4.2 Service Limit State

KSWA has estimated a presumptive bearing resistance for the service limit state from Table C10.6.2.6.1-1 of the AASHTO LRFD Bridge Design Specifications, Fourth Edition. Based on the average RQD value and rock classification, the limestone bedrock should have a presumptive bearing resistance of 219,000 pounds per square foot (psf), below all moderately to highly weathered and fractured bedrock zones. The joint spacing within the limestone at this bridge location is about 3 to 10 feet. Therefore, the presumptive bearing pressure should be reduced by one-quarter. Based on this information, the allowable bearing capacity for the limestone at this site is estimated to be about 50,000 psf.

Section 10.6.2.6.2 indicates that where the presumptive bearing resistance exceeds either the unconfined compression strength of the rock or the nominal resistance of concrete, the lesser of these two should control. In this case, the average unconfined compressive strength of the rock is 1,327 ksf and the nominal resistance of concrete is 576 ksf (4000 psi concrete) are both greater than the recommended rock bearing resistance of 50 ksf.

The recommended bearing resistance is based on a limited foundation settlement of less than one inch and should only be applied at the service limit state. The design of spread footings is frequently controlled by movement at the service limit state. Therefore, it is usually advantageous to proportion spread footings at the service limit state and check for adequate design at the strength and extreme limit states.

5.4.3 Strength Limit State

Based upon the information derived from drilling, sampling, and laboratory testing operations conducted for the subject bridge structures, KSWA has derived nominal bearing estimates for the underlying limestone bedrock. Section 10.6.3.2 of the AASHTO LRFD Bridge Design Specifications, Fourth Edition, provides recommendations for the development of nominal bearing resistance (q_n) using semi-empirical or analytical procedures. KSWA derived the nominal bearing resistance of the limestone bedrock mass using Federal Highway Administration (FHWA) and LRFD methods based on the unconfined compressive strength of intact rock samples, and visual assessments of rock samples obtained from coring operations. An unconfined compressive strength of 635 tsf (1270 ksf) yields a nominal end bearing resistance on the order of 205 tsf (410 ksf) for the limestone bedrock below the weathered zone and voids observed during drilling operations.

This project will be designed using the Load and Resistance Factor Design (LRFD) methodology. LRFD is a design approach in which applicable failure and serviceability conditions can be evaluated considering the uncertainties associated with loads and materials resistances. This design methodology incorporates the sue of load factors and resistance factors to account for uncertainty in applied loads and load resistance of structure elements separately in contrast to the Factor of Safety traditionally applied only to the resistances in Allowable Stress Design (ASD) methodology. Selection of the resistance factors account for the type of loading (axial compression versus uplift) and the variability and reliability of models or methodologies used to determine nominal resistance (R_n) capacities. Table 10.5.5.2.2-1 in the AASHTO LRFD Bridge Design Specifications, Fourth Edition recommends a resistance factor (φ_b) of 0.45 for shallow foundations bearing on rock. Therefore, the factored bearing capacity for spread footings bearing on bedrock at the bridge site is 92 tsf (184 ksf).

5.5 GLOBAL STABILITY ANALYSIS

The factor of safety against rotational failure for the bridge abutment was determined using the Simplified Bishop Method of the STABL for Windows computer software. The soil parameters input for this program were obtained from our laboratory testing and estimated parameters based on unconfined

compressive testing, SPT N-values and soil classification. Global stability analysis was performed for both short term and long term conditions. The KYTC Geotechnical Manual recommends minimum factors of safety of 1.2 and 1.6 for short term and long term analysis, respectively. Short term analysis included little to no cohesive intercept for soft clays and silts (flooded or rapid draw down conditions) and the water table at the 100 year flood level of 450.1 feet. Long term analysis included higher cohesive intercepts and Phi angles for clays and the water table at approximately 420 feet. Our analyses results of the abutments are listed below in Table 9.

Table 9: Summary of Stability Analysis

New Wolf Pen Branch Bridge		
Structure Station	**Long Term**	**Short Term**
48+15.35	4.6	1.4
51+50.35	4.2	1.4
Temporary Diversion Bridge		
Structure Station	**Long Term**	**Short Term**
36+72.57	23.5	4.9
38+36.09	7.0	2.5

Based on the plans provided, the abutments at the Wolf Pen Branch Road Bridge will be constructed as a stem wall. The Temporary Diversion Bridge plans indicate the abutment will have a 2.5(H):1(V) spill-thru slope. The above analyses were based on these configurations. The short and long term values meet or exceed the KYTC target factor of safety values of 1.6 to 1.8 for long term and 1.2 to 1.4 for short term. The results of the stability analysis are depicted graphically on the Stability Analysis Sheets presented in Appendix E.

5.6 SETTLEMENT ANALYSIS

Construction of the approach embankments for the Wolf Pen Branch Road bridge will require about 5 feet of fill at the west abutment and about 2 feet of cut at the east abutment and at the Temporary Diversion Bridge, the grading plans at the abutments indicate about 10 to 12 feet of cut. KSWA anticipates that should fill placement follow KYTC guidelines for placement and compaction, tolerable settlements will occur, with 40 to 60 percent occurring during construction. The settlement analyses indicate that the clay foundation materials at the west abutment, where up to 5 feet of fills will be required, may experience settlement on the order of less than 1 inch.

6.0 GEOTECHNICAL CONSIDERATIONS

6.1 EXISTING FILL MATERIALS

Existing fill materials were encountered in Test Boring B-5 beneath the ground surface to a depth of about 3.1 feet. The evidence of fill in this area included a mixture of limestone gravel and lean clay soils. Existing fill materials may also be present in other areas not investigated, outside of our test boring locations. The samples obtained appeared relatively free of deleterious material. However, information pertaining to the age, placement and compaction of the fill was not available.

6.2 BEDROCK CONDITIONS

Auger refusal conditions were encountered at the test boring locations at elevations ranging from about 591.3 to 609.1 feet above MSL. Based on the boring information, the bedrock surface appears to vary greatly with highs and lows. As an example, Test Borings B-2 and B-3 (separated by about 20 feet) encountered refusal conditions at approximately 591.3 and 599.0 feet above MSL, respectively. As with Test Borings B-6 and B-7 (separated by about 15 feet) encountered refusal conditions at approximately 600.0 and 600.9 feet above MSL, respectively. This illustration is a prime example of a typical karstic landform with relatively large bedrock surface elevation differences over short distances. As previously indicated, RDZ consisting of highly weathered and fractured limestone zones with some voids/soil seams were identified in all of the test borings. The proposed bridge foundations should extend beneath these zones and be founded on competent limestone bedrock.

6.3 SINKHOLE HAZARDS

As previously discussed, the project site is underlain by limestone bedrock that is susceptible to solutioning and karst activity. The depressions and sinkholes in the Louisville, Kentucky area, typically being along fissures, joints or bedding planes and creates channel systems within the bedrock. Generally, ground water flows through these rock channels and removes soil located immediately above the rock line. Ultimately, this process can cause a collapse of the overlying limestone or soil overburden, resulting in a sinkhole. The sinkhole can then allow surface runoff to enter the subsurface passage, further enlarging the sinkhole. The conditions noted on this site are not indicative of an extremely karst region prone to catastrophic sinkhole collapse. Our site reconnaissance did not identify on-site sinkholes at the site or suspect depressions on-site.

The present state-of-the-art of Geotechnical Engineering does not permit accurate prediction of where or when sinkholes will occur. Site grading should be established to provide positive drainage both during and after construction so as to minimize the potential for future sinkhole development. During construction the grading contractor should be alert to any indication of possible sinkhole activity. Any sink features encountered during the site grading should be repaired under the direction of the Geotechnical Engineer.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The design recommendations contained in this report section were developed in consideration of the project information detailed in Section 1.0 of this report. If the information contained in Section 1.0 has been revised, we recommend KSWA be contacted to confirm that our foundation design and construction recommendations are appropriate in consideration of the new available information. The following sections provide recommendations for Spread Foundations.

This project will be designed using the Load and Resistance Factor Design (LRFD) methodology. LRFD is a design approach in which applicable failure and serviceability conditions can be evaluated considering the uncertainties associated with loads and materials resistances. This design methodology incorporates the use of load factors and resistance factors to account for uncertainty in applied loads and load resistance of structure elements separately in contrast to the Factor of Safety traditionally applied only to the resistances in Allowable Stress Design (ASD) methodology.

7.1 APPROACH EMBANKMENT CONSTRUCTION

7.1.1 Based on the drawings downloaded from the Projectwise – KTA website, the Wolf Pen Branch Road Bridge abutments are shown as a stem wall abutment. At the writing of this report, a borrow source for embankment material has not been identified. It is recommended that borrow material to be used for embankment construction meet the following minimum strength parameters.

Embankment Material		**Retained Fill**	
Total Stress	**Effective Stress**	**Total Stress**	**Effective Stress**
c = 1400 psf	c'=200 psf	c = 1400 psf	c'=170 psf
$\varphi = 0°$	$-\varphi = 23°$	$\varphi = 0°$	$-\varphi = 27°$
$\gamma = 120$ pcf	$\gamma = 120$ pcf	$\gamma = 120$ pcf	$\gamma = 120$ pcf

The retained fill material shall be placed in the entire area between the wall and a 1:1 (H:V) line sloping upward and away from the base of the wall to the top of the wall. **Non-durable shales and fat clays (USCS classification of CH) should specifically be excluded from use within this zone.** The Contractor shall perform laboratory testing to confirm that the minimum total stress and effective stress strength parameters are equal to or greater than the above values per material type for each borrow area. The test results shall be submitted to the Engineer for approval.

7.1.2. Backfill behind the wall can consist of retained fill as noted above or non-erodible granular embankment. Coefficients of active earth pressure (K_a) were determined based on Coulomb earth pressure theory using phi angles of 27 and 38 degrees, a vertical back of wall, and friction angles between the back of the wall and backfill of 17 and 29 degrees. Based on a unit weight of 120 pounds per cubic foot for the backfill material, the following equivalent fluid pressures are applicable:

Slope of Backfill	Retained Fill (φ = 27°)		Granular Embankment (φ = 38°)	
	Coefficient of Active Earth Pressure (Ka)	Equivalent Fluid Pressure Per Linear Foot	Coefficient of Active Earth Pressure (Ka)	Equivalent Fluid Pressure Per Linear Foot
Level	0.335	40 psf	0.218	26 psf
3:1 (H:V)	0.464	56 psf	0.274	33 psf
2:1 (H:V)	0.714	86 psf	0.323	39 psf

Drainage systems consisting of free draining material and filter fabric shall be placed directly behind the wall and be minimum thickness of two feet. Use of filter fabric will help reduce the infiltration of fines into the granular material behind the wall and help reduce clogging of the drainage system. In addition, weep holes should also be provided in the design of the walls. If drainage system is not provided, the design should incorporate full hydrostatic forces behind the wall.

7.1.3. Construction of the approach embankments for the Wolf Pen Branch Road bridge will require about 5 feet of fill at the west abutment and about 2 feet of cut at the east abutment and at the Temporary Diversion Bridge, the grading plans at the abutments indicate about 10 to 12 feet of cut. The subsurface exploration program indicates the foundation soils at the abutment locations consist of approximately 3 to 26 feet of clay foundation soils. The settlement analyses presented in Section 5.6 of this report indicate that the clay foundation materials at the west abutment, where up to 5 feet of fills will be required, may experience settlement on the order of less than 1 inch.

7.2 SPREAD FOUNDATION CONSTRUCTION CONSIDERATIONS

Proper foundation construction procedures may enhance long-term foundation performance. KSWA foundation construction recommendations for spread foundations are detailed below:

- Lateral capacity analyses for foundation elements were beyond the scope of services and have not been conducted. KSWA recommends the Designer use the following bedrock material properties for subsequent lateral load studies, as necessary.

Summary of Rock Mass Parameters for Lateral Load Studies

Rock Mass Parameter	Symbol	Design Value
Wet Density	γ_{rock}	165.0 pcf
Unconfined Compressive Strength	q_{ui}	1,270 ksf
Shear Strength of Rock Mass	τ	81.2 ksf
Elastic Modulus of Intact Rock	E_i	5,700 ksi
Elastic Modulus of Bedrock Mass	E_m	4,275 ksi
Poisson's Ratio	v	0.23
Shear Modulus	G_m	1,734 ksi

- Cavities and crevices that are exposed at the bedrock surface should be cleaned of soil and weathered rock and then sealed with concrete before construction foundation is initiated. In

addition, soil exposed in the rock cut area should be undercut to rock and backfilled to the proposed footing subgrade elevation with concrete.

- Foundation support materials that degrade as a result of exposure should be removed from the foundation bearing area prior to concrete placement.
- Foundations should be individually observed by a Geotechnical Engineer to determine the suitability of the bearing material. The observations should be completed prior to placement of steel reinforcement or concrete in the opened excavations. The bottom of each foundation should be level, cleared of loose material or other extraneous matter and dewatered before it is inspected. Inspections should include probing small-diameter test holes to determine the hardness and continuity of the bearing material. Test holes should be installed in the bottom of each foundation to a minimum depth of 6 feet. Additional test holes may be required by the inspector to adequately evaluate the quality of the underlying material.
- The foundation bearing area should be level or suitably benched. The toe of the foundations should also be at a minimum distance of 10 feet from the face of the rock cut.
- KSWA estimates that foundation settlement will be less than 1/4 inch. This settlement should occur during construction of the bridge. The Contractor should be prepared to accommodate this settlement during construction.

8.0 SEISMIC SITE COEFFICIENT

The AASHTO LRFD Bridge Design Specifications, Fourth Edition with the 2008 Interim Revisions provided guidelines for determining the seismic hazard at a bridge site. The seismic hazard for a bridge site is characterized by the acceleration response spectrum and the site factors for the relevant site classification. Based on the results of the drilling and subsequent laboratory testing program, the soil profile in the vicinity of the Wolf Pen Branch Road Bridge and Temporary Diversion Bridge structures should be classified as site classification B. Table 10 presents a summary of the seismic hazard coefficients and the site factors.

Table 10: Seismic Hazard Considerations*

Acceleration Response Spectrum	
Peak Ground Acceleration (PGA)	0.061
Short Period Spectral Acceleration Coefficients (S_S)	0.146
Long Period Spectral Acceleration Coefficients (S_1)	0.060
Site Factors	
Factor at Peak Ground Acceleration Coefficient (F_{pga})	1.0
Factor at Short Period Range of Acceleration Spectrum (F_a)	1.0
Factor at Long Period Range of Acceleration Spectrum (F_v)	1.0

*Based on 2007 U.S. Geological Survey mapping included in AASHTO LRFD Bridge Design Specifications, Fourth Edition with 2008 Interim Revisions, Sections 3.10.2.

Based on the coefficients and factors in Table 10 above, the bridge site classifies as Seismic Performance Zone 1, with a 93 percent probability of not being exceeded in 75 years. It is recommended that the structure be designed based on AASHTO LRFD Bridge Design Specifications, Fourth Edition with 2008 Interim Revisions Sections 3.10.9 and 4.7.4 (for seismic) specifications. Further analyses were beyond the scope of KSWA's work for this project.

9.0 CLOSING

- General soil descriptions and indicated boundaries are based on an engineering interpretation of all available subsurface information and may not necessarily reflect the actual variation in subsurface conditions between borings and samples. Collected data and field interpretation of conditions encountered in individual borings are shown on the attached Subsurface Data Sheets.

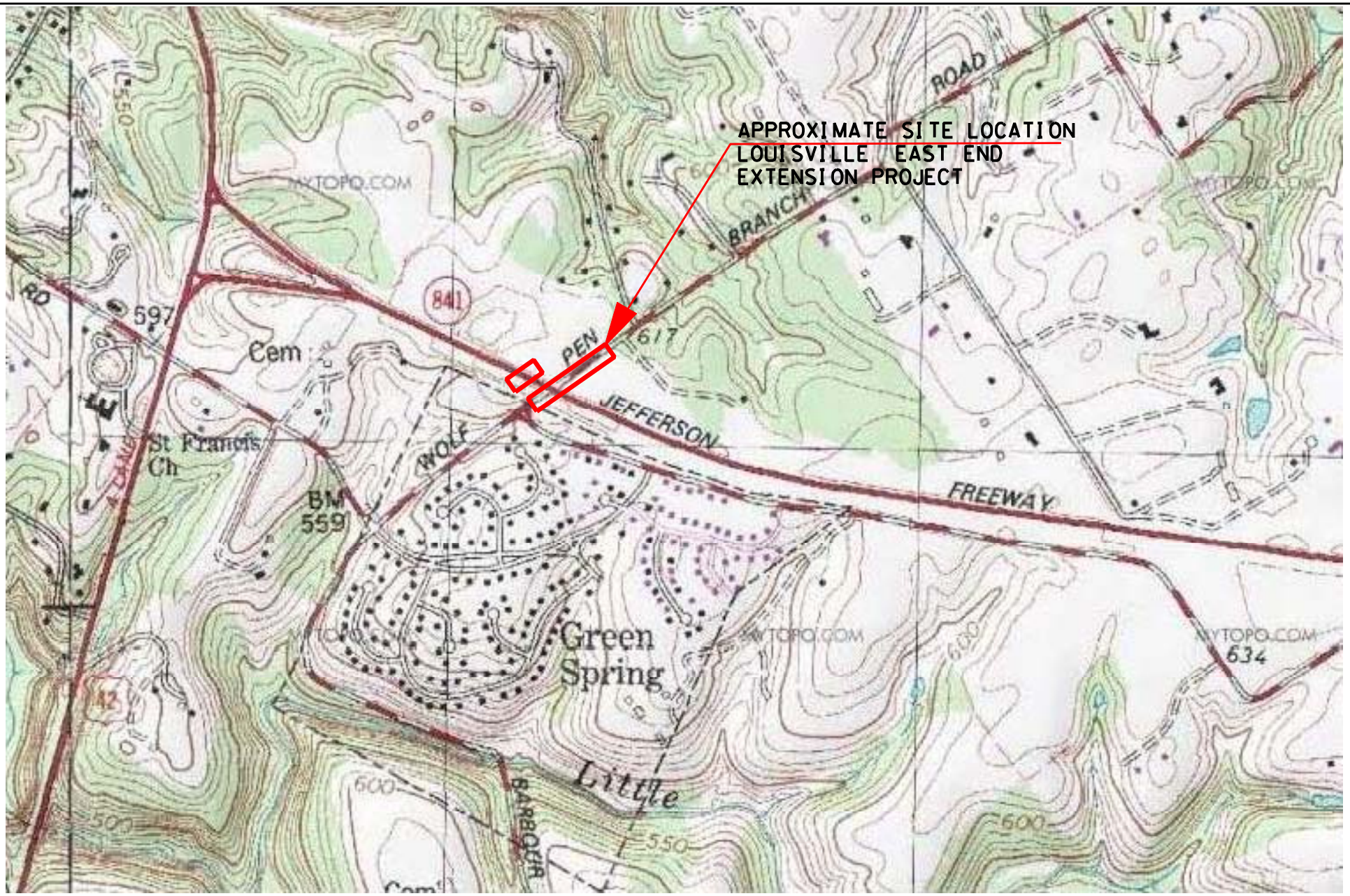
- The observed water levels and/or conditions indicated on the boring logs are as recorded at the time of exploration. These water levels and/or conditions may vary considerably, with time, according to the prevailing climate, rainfall or other factors and are otherwise dependent on the duration of and methods used in the exploration program

- Sound engineering judgment was exercised in preparing the subsurface information presented herein. This information was prepared and is intended for design and estimating purposes. Its presentation on the plans or elsewhere is for the purpose of providing intended users with access to the same information available to the KYTC. This subsurface information interpretation is presented in good faith and is not intended as a substitute for personal investigations, independent interpretations or judgments of the Contractor.

All structure details shown herein are for illustrative purposes only and may not be indicative of the final design conditions shown in the contract plans.

APPENDIX A:

SITE LOCATION MAPS



SITE LOCATION PLAN

PROJECT NAME: LOUISVILLE EAST END PROJECT
LOUISVILLE, KENTUCKY

DESIGNED FOR: H.W. LOCHNER,
LEXINGTON, KENTUCKY

DESIGNED BY: KSWA	DATE: 10-1-08	DETAILED BY: JW	DATE: 10-1-08
DRAWN BY:	DATE:	CHECKED BY: JG	DATE: 10-1-08

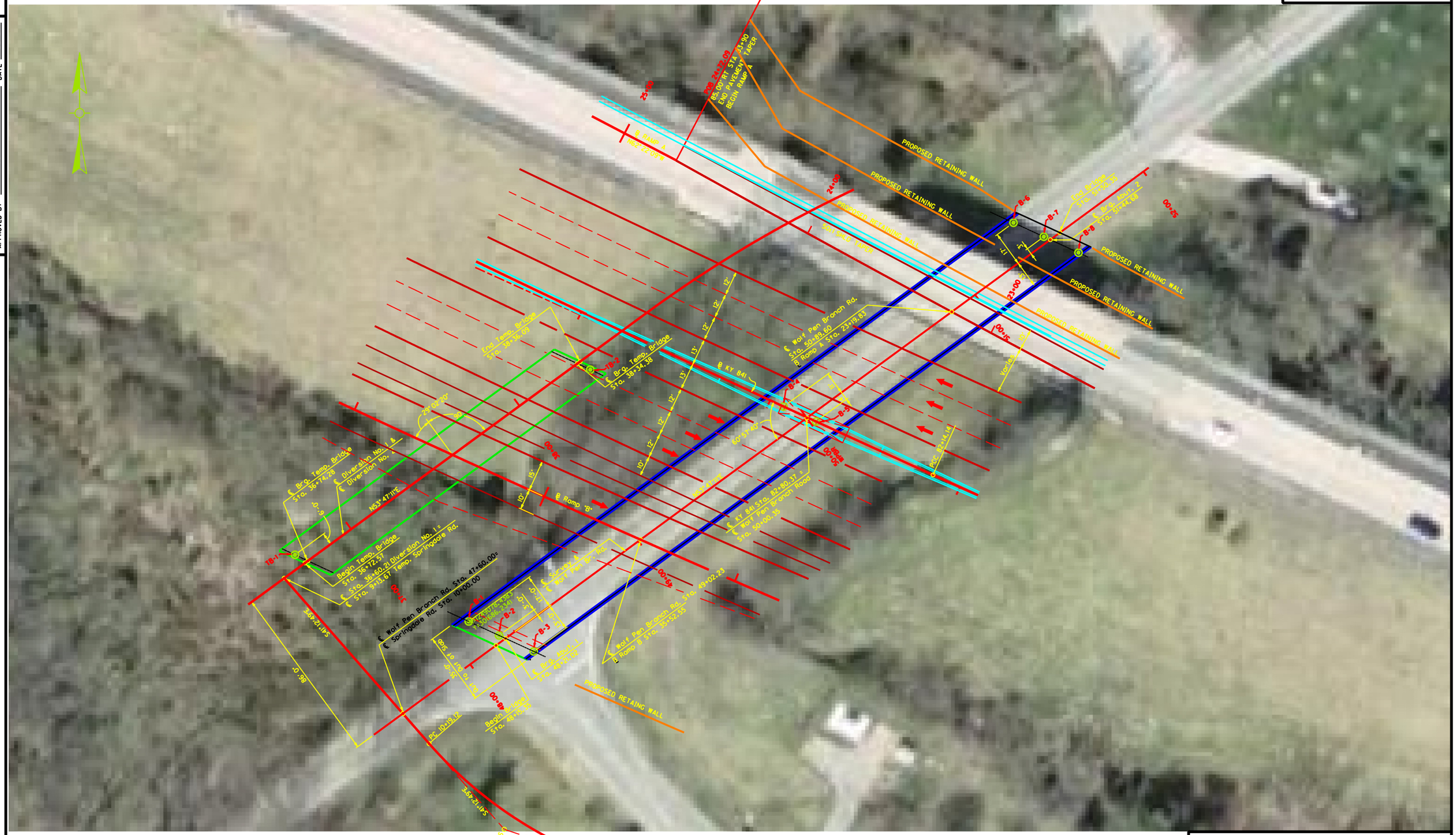
PAGE NO. 000

SCALE: NTS | PROJECT NO. 100-03-0148 | REV. DATE 10-1-2008 | REV. BY JW | SOURCE: MYTOPO.COM | FIG. NO. 1

KSWA
K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

COUNTY OF	ITEM NO.	SHEET NO.
JEFFERSON		----

PREPARED BY	ND	DATE 10-19-2007
CHECKED BY	JW	DATE 10-19-2007
APPROVED BY	JG	DATE 10-22-2007



USER: ND
DATE: 10-19-2007
FILE NAME: WOLFPEN BRANCH RD. AERIEL
E-SHEET NAME: ----------

THE OHIO RIVER BRIDGES
Kentucky Transportation Associates

APPENDIX B:

CLIENT ADVANCED SITUATION DOCUMENTS

COUNTY OF	ITEM NO.	SHEET NO.
JEFFERSON	5-118.00	

℄ Brg. Temp. Bridge
Sta. 36+74.28

℄ Diversion No. 1 &
℄ Diversion No. 2

6'-0"

29°02'20"

90°

End Temp. Bridge
Sta. 38+36.09

TB-1

N53°47'11"E

TB-2

Begin Temp. Bridge
Sta. 36+72.57

℄ Sta. 36+60.21 Diversion No. 1 =
℄ Sta. 9+13.67 Temp. Springdale Rd.

℄ Brg. Temp. Bridge
Sta. 38+34.38

S41°12'49"E

86'-0"

37+00

38+00

10' 15' ℄ Ramp "B"

10' 12' 12' 12' 13' 13' 12' 12' 12' ℄ KY 841

℄ Wolf Pen Branch Rd. Sta. 47+60.00=
℄ Springdale Rd. Sta. 10+00.00

℄ Wolf Pen Branch Rd.
Sta. 50+89.60
℄ Ramp A Sta. 23+19.83

25+00

POB 24+72.09
85.00' RT STA 83+90
END PAVEMENT TAPER
BEGIN RAMP A

℄ Ramp A
N62°22'09"W

24+00

50:1 SHLD TAPER

PROPOSED RETAINING WALL

PROPOSED RETAINING WALL

PROPOSED RETAINING WALL

B-1

B-2

B-3

B-4

B-5

B-6

B-7

B-8

35'-0"
Out to Out of Slab

3'-0"

17'-0"

13'-0"

℄ Survey &
℄ Wolf Pen Br. Rd.

60°57'40"

11'

4'

N53°47'11"E

17'

3'

End Bridge
Sta. 51+50.35

℄ Brg. Abut. 2
Sta. 51+44.68

23+00

13'

48+00

Begin Bridge
Sta. 48+15.35

℄ Brg. Abut. 1
Sta. 48+21.02

49+00

℄ KY 841 Sta. 82+80.37 =
℄ Wolf Pen Branch Road
Sta. 50+00.35

50+00
WPBR

51+00

Varies

10'

PROPOSED RETAINING WALL

PROPOSED RETAINING WALL

PROPOSED RETAINING WALL

52+00

PC 10+19.12

S41°12'49"E

PI 10+73.76

S71°46'37"E

PCC 82+14.14

PROPOSED RETAINING WALL

Name: B-1
Station: 48+10.5
Offset: 13' Left

Name: B-2
Station: 48+19.4
Offset: 3' Left

Name: B-3
Station: 48+28.2
Offset: 19' Right

Name: B-4
Station: 49+94.2
Offset: 11' Left

Name: B-5
Station: 50+02.6
Offset: 4' Right

Name: B-6
Station: 51+34.1
Offset: 19' Left

Name: B-7
Station: 51+43.0
Offset: 3' Left

Name: B-8
Station: 51+51.9
Offset: 13' Right

Name: TB-1
Station: 37+24.2
Offset: 6' Left

Name: TB-2
Station: 38+39.4
Offset: 6' Right

℄ Wolf Pen Branch Rd. Sta. 49+02.23
℄ Ramp B Sta. 35+52.55

SCALE: 1"= 30'

WOLF PEN SOUNDING & TEMP. DIVERSION BRIDGE

COUNTY OF	ITEM NO.	SHEET NO.
JEFFERSON	5-731.00	R42

SCALE: 1" = 50' HORIZONTAL
1" = 5' VERTICAL

WOLF PEN BRANCH ROAD

STA. 43+50 TO 55+00

COUNTY OF	ITEM NO.	SHEET NO.
JEFFERSON	5-731.00	R77

DATE
DATE
CHECKED BY
APPROVED BY

E-SHEET NAME:

DATUM 640 635 630 625 620 615 610 605 600 595 590 585 580 575 570 565 560 555 550

BEGIN CONSTRUCTION
DIVERSION NO. 1
STA. 30+50

VPI 32+00.00
Elev 603.86

PVC 30+50.00
Elev 599.36

PVC 34+00.00
Elev 598.53

PVT 33+50.00
Elev 599.86

300.00' VC
SSD = 340.43'

300.00' VC
HLSD = 211.10'

Existing
Ground line

Proposed
Grade

℄ STA 36+16.34 DIVERSION NO. 1 =
℄ STA 8+98.00 TEMP. SPRINGDALE RD.

STA 36+72.57 TEMP. BRIDGE

PVT 37+00.00
Elev 602.03

STA 38+36.09 TEMP. BRIDGE

V.P.I. 38+75.00
Elev 610.78

VPI 40+35.12
Elev 616.65

48' - 53' - 48'
EX. BRIDGE

END CONSTRUCTION
DIVERSION NO. 1
STA. 40+35.12

163.52' SINGLE SPAN
TEMPORARY BRIDGE
TYPE TO BE DETERMINED
BY CONTRACTOR

3.00%
-2.67%
5.00%
3.66%

SPEC "V" DT LT
@ 1.08%

SPEC "V" DT RT
@ -8.20%

SPEC "V" DT RT
@ -2.21%

24" TEMP PIPE
@ 1.00%

SPEC "V" DT RT
@ 6.64%

SPEC "V" DT LT
@ 2.00%

SPEC "V" DT RT
@ 1.00%

SPEC "V" DT LT
@ 13.00%

SPEC "V" DT LT
@ 4.00%

SPEC "V" DT LT
@ 1.70%

SPEC "V" DT LT
@ 3.25%

EX. GRADE LINE

4 FB OUTLET
DT LT

VPI 35+50.00
Elev594.53

APPROX. RDZ LINE

TEMPORARY RAMP B
CUT LINE

29' 20'

20' FOR CONSTRUCTION & DRAINAGE
THEN BEGIN TEMP. CUT

SCALE: 1" = 50' HORIZONTAL
1" = 5' VERTICAL

597.5	599.4	599.36	600.8	600.63	600.8	601.42	598.6	601.74	596.4	601.59	598.9	600.96	597.9	599.86	591.3	598.53	588.6	597.52	592.2	597.14	595.9	597.40	601.7	598.31	607.3	599.85	611.9	602.03	615.4	604.53	619.0	607.03	622.2	609.53	628.3	611.70	628.4	613.53	615.3	615.36	617.1		618.4
30+00	30+50		31+00		31+50		32+00		32+50		33+00		33+50		34+00		34+50		35+00		35+50		36+00		36+50		37+00		37+50		38+00		38+50		39+00		39+50		40+00		40+50		41+00

41+50

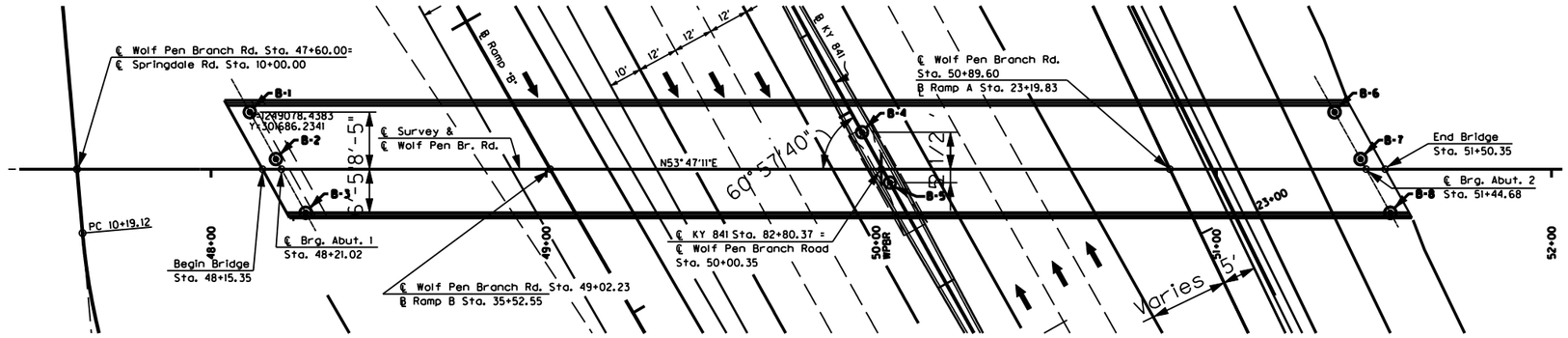
DIVERSION NO. 1 PROFILE
STA. 30+50 TO 40+35.12

APPENDIX C:

SUBSURFACE DATA SHEET

SUBSURFACE DATA

Plan Scale 1" = 40'



Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

Hole No.	B-1	B-2	B-3
Station	48+10.5	48+19.4	48+28.2
Offset	18' LT.	2' LT.	22' RT.
Elev. (Sea level datum)	608.7	601.5	602.0

B-1

Qu (ksf)	200 Wash	w%	LI
		25.3	0.3
3.1		24.0	0.2
		30.8	
		34.0	0.1
3.1		39.8	0.1
		KYROD	REC.
1270		63	100
		96	100
		94	100

A-6,CL,S+C=95.7 (68.0, 27.7)
A-6,CL,S+C=91.6 (55.1, 36.5)
A-7-5,CH,S+C=71.0 (37.3, 33.7)
A-7-5,CH,S+C=84.4 (6.9, 77.5)
LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 591.3
No weathered rock

B-2

Qu (ksf)	200 Wash	w%	LI
		30.1	
		34.2	0.9
2.4		30.7	
		33.9	
		KYROD	REC.
1370		72	100
		79	100
		90	100

A-6,CL,S+C=78.6 (51.2, 27.4)
LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 591.8
No weathered rock

B-3

Qu (ksf)	200 Wash	w%	LI
		18.5	0.0
		KYROD	REC.
1490		37	78
		100	100
		97	100
		92	97

A-6,CL,S+C=72.2 (44.8, 27.9)
LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 599.0
Base of weathered rock elev.= 597.3

Elevation: 610, 600, 590, 580, 570, 560, 550, 540 — Datum

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information

DATE: 24-APRIL-2009	CHECKED BY
DESIGNED BY:	
DETAILED BY: ND	JW, JC

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841 — CROSSING: WOLF PEN BRANCH ROAD

SUBSURFACE DATA

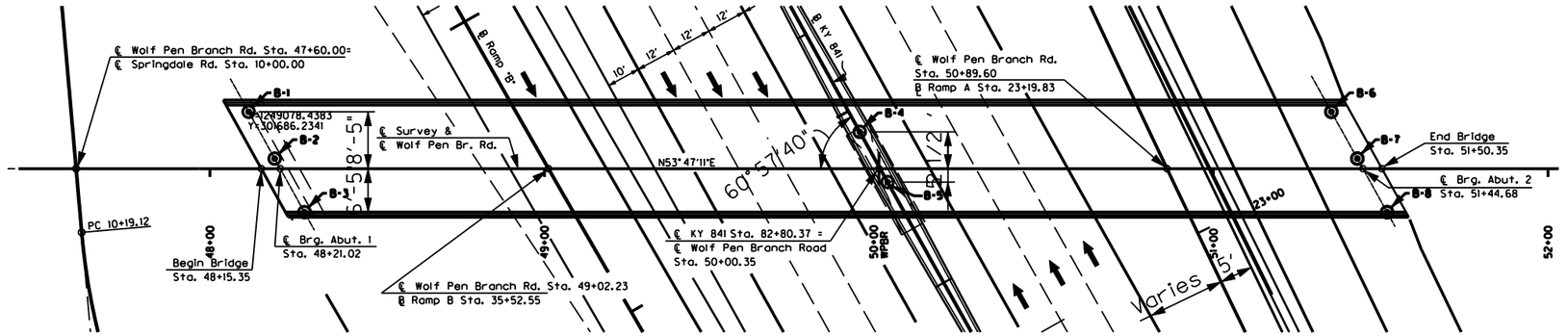
ITEM NUMBER	PREPARED BY	SHEET NO.
5-118.00	The Ohio River Bridges — Kentucky Transportation Associates	DRAWING NO. 0000

SHEET 1 OF 4

SHEET LOCATION:
FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

SUBSURFACE DATA

Plan Scale 1" = 40'



Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

Hole No.	B-4
Station	49+94.2
Offset	8' LT.
Elev. (Sea level datum)	611.1

Qu (ksf)	200 Wash	w%	LI	KYROD	REC.	
		21.1	-0.2			A-7-6, CL, S+C=77.0 (51.5, 25.5)
5.1		27.2	0.0			A-7-6, CH, S+C=90.0 (14.0, 76.0)
		26.4				
5.5		27.3	0.0			A-7-6, CH, S+C=87.9 (19.4, 68.5)
				KYROD	REC.	LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings
				46	96	
				95	100	
				98	100	
				97	100	
				96	100	
				100	100	
				97	97	
				80	100	
1410		100	100			
		92	100			
		100	100			
		17	100			
520		13	100			SHALE: Medium gray with numerious limestone partings

Top of rock elev.= 597.5
No weathered rock

Hole No.	B-5
Station	50+02.6
Offset	8' RT.
Elev. (Sea level datum)	612.3

Qu (ksf)	200 Wash	w%	LI	KYROD	REC.	
		23.1	0.1			A-7-6, CL, S+C=83.5 (52.5, 31.0)
4.7		24.6	-0.2			A-7-5, CH, S+C=90.6 (77.1, 13.5)
2.3		33.9	0.3			A-7-6, CH, S+C=83.3 (68.5, 19.8)
		33.4	0.2			A-7-6, CH, S+C=82.0 (71.0, 11.0)
		41.2				N=12
				KYROD	REC.	LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings
				0	88	
				38	73	
				100	100	
				90	100	
				100	100	
				100	100	
				100	100	
				100	100	
				100	100	
				100	100	
2180		100	100			
		100	100			
		12	100			SHALE: Medium gray with numerious limestone partings
650		23	70			

Top of rock elev.= 600.5
Base of weathered rock elev.= 598.5

620 610 600 590 580 570 560 550 540 530 520

Datum

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information

DATE:	27-APRIL-2009
DESIGNED BY:	
DETAILED BY:	ND
CHECKED BY	JW, JG

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841 | CROSSING: WOLF PEN BRANCH ROAD

SUBSURFACE DATA

PREPARED BY: The Ohio River Bridges — Kentucky Transportation Associates

SHEET NO.

DRAWING NO. 0000

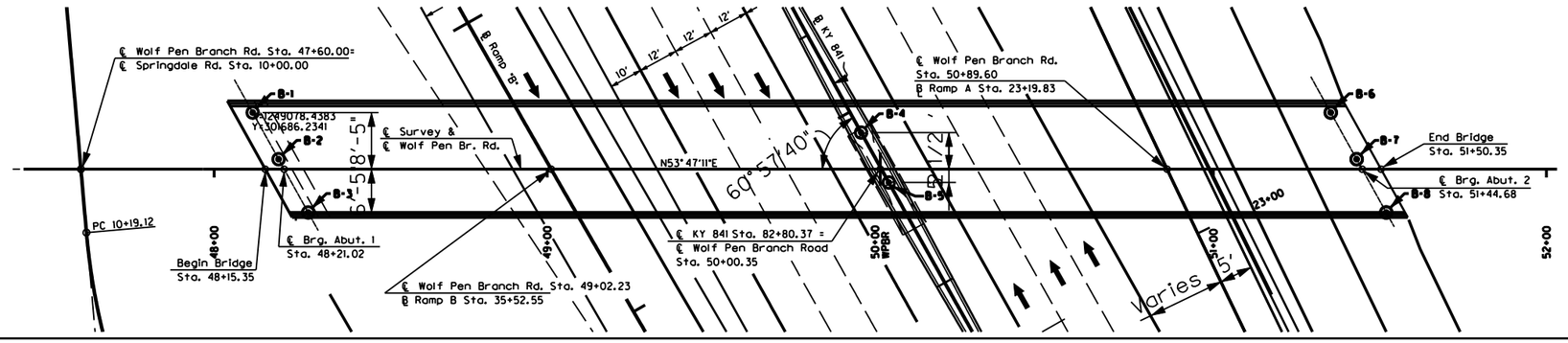
ITEM NUMBER: 5-118.00

SHEET 2 OF 4

SHEET LOCATION:
FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

SUBSURFACE DATA

Plan Scale 1" = 40'



Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

Hole No.
Station
Offset
Elev.
(Sea level datum)

B-6
51+34.1
19' LT.
616.5

Qu (ksf)	200 Wash	w%	LI
3.4		19.6	-0.1
2.2		23.5	0.2
		23.9	0.1
		22.7	

A-6,CL,S+C=92.4 (58.6, 33.8)
A-6,CL,S+C=91.8 (53.6, 38.2)
A-6,CL,S+C=90.8 (56.8, 34.0)

48.8 <

N= 9

KYROD	REC.
0	100
93	97
100	100
100	100

1550

LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 600.00
Base of weathered rock elev.= 599.4

B-7
51+43
6.83' LT.
618.1

Qu (ksf)	200 Wash	w%	LI
		23.0	0.2
2.7		22.8	0.7
		25.7	
		38.4	

A-6,CL,S+C=89.7 (80.8, 8.9)
A-7-6,CL,S+C=93.7 (48.8, 44.9)

N= 38

KYROD	REC.
64	94
83	100
66	89
97	100
97	100

1170

LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 609.1
Base of weathered rock elev.= 608.6

B-8
51+51.9
13' RT.
617.7

Qu (ksf)	200 Wash	w%	LI
		19.8	0.0
3.4		21.9	0.1
		25.6	-0.1
5.2		27.4	0.0

A-4,CL,S+C=94.6 (79.0, 15.6)
A-6,CL,S+C=90.9 (56.2, 34.7)
A-7-6,CH,S+C=84.1 (26.5, 57.6)
A-7-6,CH,S+C=80.7 (28.6, 52.1)

KYROD	REC.
78	96
53	82
100	100
100	100

1260

LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings

Top of rock elev.= 605.8
Base of weathered rock elev.= 605.3

630 620 610 600 590 580 570 560 550 540

Datum

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information

DATE: 27-APRIL-2009	CHECKED BY
DESIGNED BY:	
DETAILED BY: ND	JW, JC

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841 | CROSSING: WOLF PEN BRANCH ROAD

SUBSURFACE DATA

ITEM NUMBER: 5-118.00

PREPARED BY: The Ohio River Bridges — Kentucky Transportation Associates

SHEET NO.

DRAWING NO. 0000

SHEET 3 OF 4

SHEET LOCATION:
FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

SUBSURFACE DATA

Plan Scale 1" = 20'

℄ Brg. Temp. Bridge
Sta. 36+74.28

℄ Diversion No. 1 &
℄ Diversion No. 2

End Temp. Bridge
Sta. 38+36.09

6'-0"

90°

TB-1

N53° 47'11"E

TB-2

Begin Temp. Bridge
Sta. 36+72.57

℄ Brg. Temp. Bridge
Sta. 38+34.38

Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

SHEET LOCATION:

FILE NAME: $$$$design$file$specification$$$$

USERNAME: $$$$USER$$$$

DATE: $$$$DATE$$$$

E-SHEET NAME:

Hole No.	TB-1	TB-2
Station	36+71	38+39.4
Offset	6' LT.	6' RT.
Elev. (Sea level datum)	609.0	621.5

630 620 610 600 590 580 570 560 550 540

Datum

TB-1

Qu (ksf)	200 Wash	w%	LI	KYROD	REC.	
4.3				39	58	N=38 LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings
1310				97	100	
				98	100	
				88	97	

Top of rock elev.= 595.2
Base of weathered rock elev.= 593.4

TB-2

Qu (ksf)	200 Wash	w%	LI	KYROD	REC.	
3.0		21.9	0.0			A-4,CL-ML,S+C=97.6 (70.9, 26.7)
		22.0	0.3			A-6,CL,S+C=95.2 (57.6, 37.6)
		19.3				
		19.5	-0.2			A-7-6,CL,S+C=93.0 (49.0, 44.0)
		21.1				
		28.4	-0.1			A-7-5,CH,S+C=81.0 (21.6, 59.4)
4.3		35.6	0.3			A-7-6,CH,S+C=69.5 (25.7, 43.8)
1690				100	100	LIMESTONE: Gray, fine grained crystaline, fossiliferous with few shale partings
				94	94	
				100	100	
				100	100	

Top of rock elev.= 595.0
No weathered rock

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information

DATE: 27-APRIL-2009	CHECKED BY
DESIGNED BY:	
DETAILED BY: ND	JW, JC

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841

CROSSING: WOLF PEN BRANCH ROAD

SUBSURFACE DATA

ITEM NUMBER: 5-118.00

PREPARED BY: THE OHIO RIVER BRIDGES — Kentucky Transportation Associates

SHEET NO.

DRAWING NO. 0000

SHEET 4 OF 4

APPENDIX D:

BORING LOGS

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-1

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **608.7**

Location: **Sta. 48+10.5, 18' Left**

Depth, feet	Material Description	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
	Topsoil 0.8									
	Light brown, medium stiff to hard, Lean CLAY - with sand and trace chert fragments, moist		92			0.75	25.3	33	22	11
4			83			3	24	34	21	13
8			67			4.5	30.8			
	9.0									
	Light brown, very stiff, Lean CLAY, with sand and trace chert fragments - moist		75			1.5	34	61	30	31
12										
	14.0									
	Yellow brown, stiff, CLAY with silt, sand and trace chert fragments - moist		92			2.5	39.8	73	34	39
16	16.0									
	Dark brown, very stiff, CLAY with silt, sand and trace chert fragments - moist									
	17.4									
	(Auger Refusal at 17.4')									
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, moderately fractured - hard 18.8		100		63					
20										
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly to moderately fractured - hard 22.6									
	23.5									
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly to moderately fractured - hard		100		96					
24										
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 27.6		100		94					
28										
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 29.6									
	(Coring Terminated at 29.6')									
32										
36										
40										

Completion Depth: **29.6**
Date Started: **03/24/09**
Date Completed: **03/24/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

LOG OF BORING-GEOTECH+PP LOUISVILLE EAST END 08-09 BRIDGE STUDY.GPJ KSWARE.GDT 05/15/09

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-2

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **601.5**

Location: **Sta. 48+19.4, 2' Left**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphalt 0.5									
		Basestone 0.8									
		Brown, stiff to very stiff, Lean CLAY - with sand and trace chert fragments, moist 3.2		100			1.75	30.1			
4		Dark reddish brown, very stiff, Lean CLAY - with sand and trace chert fragments, some black mottling, moist		100			2.25	34.2	35	21	14
		7.0									
8		Brown, very stiff, Lean CLAY - with sand and trace chert fragments, moist		92			2	30.7			
		9.7		100			2	33.9			
		(Auger Refusal 9.7') Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, slightly to moderately fractured - hard 12.8		100		72					
12		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly to moderately fractured - hard		100		79					
16		16.5									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 17.8									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		90					
20		22.8									
		(Coring Terminated at 22.8')									
24											
28											
32											
36											
40											

Completion Depth: **22.8**
Date Started: **03/20/09**
Date Completed: **03/19/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-3

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **602.0**

Location: **Sta. 48+28.2, 22' Right**

Depth, feet	Material Description		Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
	Asphalt	0.3									
	Basestone	1.0									
	Reddish brown, stiff, Lean CLAY with sand and trace chert fragments, sulfer residue oder - moist	3.0		150			1.25	18.5	39	18	21
4	(Auger Refusal at 3') Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, highly fractured and moderately weathered - hard	4.7		78		37					
	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard - Void or seam from 5.6' to 6.1'	7.1									
8	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard	12.1		100		100					
12	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard	17.1		100		97					
16	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard	22.1		97		92					
20	(Coring Terminated at 22.1')										
24											
28											
32											
36											
40											

Completion Depth: **22.1**
Date Started: **03/20/09**
Date Completed: **03/20/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-4

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **611.1**

Location: **Sta. 49+94.2, 8' Left**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphalt 0.5									
		Basestone 1.2									
		Light brown, hard, Lean CLAY with sand and trace chert fragments, some black mottling, moist		96			4.5	21.1	48	25	23
4		4.0									
		Light brown, very stiff, CLAY with silt, sand and trace chert fragments, gray mottling, moist		63			3	27.2	73	29	44
		7.0									
8		Dark orangish brown, very stiff to hard, CLAY with silt, sand and trace chert fragments, black mottling - moist		100			4.5	26.4			
				83			3.75	27.3	67	29	38
12		13.6									
		(Auger Refusal at 13.6') Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, highly fractured - hard 15.6		96		46					
16		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 17.6									
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		95					
		22.6									
24		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		98					
		27.6									
28		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		97					
32		32.6									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		96					
36		37.6									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with brachiopod and choral fragments, slightly fractured - hard									
40											

Completion Depth: **77.1**
Date Started: **03/18/09**
Date Completed: **03/18/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-4

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **611.1**

Location: **Sta. 49+94.2, 8' Left**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		42.6									
44		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		97		97					
		47.6									
48		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		80					
52		52.6									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
56		57.6									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings - slightly fractured - hard		100		92					
60		62.6									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings - slightly fractured - hard		100		100					
64		67.6									
68		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings - slightly fractured - hard									
		69.6									
		Medium to dark gray SHALE with numerious fine grained limestone partings - highly fractured - hard		100		17					
72		72.6									
		Medium to dark gray SHALE with numerious fine grained limestone partings - highly fractured - hard		100		13					
76		77.1									
		(Coring Terminated at 77.1)									
80											

Completion Depth: **77.1**
Date Started: **03/18/09**
Date Completed: **03/18/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-5

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **612.3**

Location: **Sta. 50+02.6, 8' Right**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION		Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphalt	0.8									
		Basestone	1.3									
		Dark brown, very stiff, Lean CLAY, with gravel and sand, moist- Probable FILL	3.1		100			3.5	23.1	42	21	21
4		Light brown, very stiff, Lean CLAY with gravel and sand - moist	4.0									
		Light brown to brown, stiff to very stiff, CLAY with silt, sand and trace chert fragments - moist			85			2.25	24.6	59	30	29
8					63			2	33.9	54	26	28
					100			1.75	33.4	56	27	29
					56	5-8-4			41.2			
12		(Auger Refusal at 11.8')	11.8									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard	12.5		88		0					
					73		38					
16		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard	16.5 17.5									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly weathered - hard			100		100					
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard	22.5									
24		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard			100		90					
			27.5									
28		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard			100		100					
32			32.5									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard			100		100					
36			37.5									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with brachiopod and choral fragments, slightly fractured - hard										
40												

Completion Depth: **77.5**
Date Started: **03/19/09**
Date Completed: **03/19/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-5

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **612.3**

Location: **Sta. 50+02.6, 8' Right**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		42.5									
44		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		47.5									
48		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		48.9									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard									
52		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard									
		52.5									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard		100		100					
56											
		57.5									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard		100		100					
60											
		62.5									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard		100		100					
64											
		67.5									
68		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard									
		70.0		100		12					
		Medium to dark gray SHALE with numerious fine grained limestone partings, highly fractured - hard									
72		72.5									
		Medium to dark gray SHALE with numerious fine grained limestone partings, highly fractured - hard		70		23					
76											
		77.5									
		(Coring Terminated at 77.5')									
80											

Completion Depth: **77.5**
Date Started: **03/19/09**
Date Completed: **03/19/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-6

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **616.5**

Location: **Sta. 51+34.1, 19' Left**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Topsoil 0.7									
		Brown, stiff, Lean CLAY - with sandand bitumin specs, moist to wet 3.0									
4		Brown, stiff to very stiff, Lean CLAY - with sand and trace chert fragments, moist		63			3.25	19.6	34	21	13
				100			2	23.5	32	21	11
		7.5									
8		Light brown, stiff to hard, Lean CLAY - with sand and trace chert fragments, moist to wet		83			4.25	23.9	37	22	15
				63			1.75	22.7			
12											
				44	5-6-3			48.8			
16		16.5									
		(Auger Refusal at 16.5') 17.1		100		0					
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard 17.8		97		93					
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard 22.1									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 27.1									
28		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 29.5		100		100					
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard 32.1									
32		(Coring Terminated at 32.1')									
36											
40											

Completion Depth: **32.1**
Date Started: **03/16/09**
Date Completed: **03/16/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-7

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **618.1**

Location: **Sta. 51+43, 6'-10" Left**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphalt 0.6									
		Basestone 1.2									
		Brown, stiff to very stiff, Lean CLAY - with sand and trace chert fragments, moist		83			1.5	23	35	20	15
4				63			1.75	22.8			
				100			2.25	36.7	42	21	21
8				56	6-22-16			38.4			
		9.0 (Auger Refusal at 9') Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard		94		64					
12		12.4 Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, highly fractured and slightly weathered - hard		100		83					
16		16.9									
		17.4 Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly weathered - hard - Void or Seam from 21.5' to 22.4'		89		66					
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 22.4									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		97					
24											
		27.4									
28		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard 30.1		100		97					
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard 31.4									
32		(Coring Terminated at 31.4')									
36											
40											

Completion Depth: **31.4**
Date Started: **03/17/09**
Date Completed: **03/17/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. B-8

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **617.7**

Location: **51+51.9, 13' Right**

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphalt 1.0									
		Basestone 1.4									
		Light brown, hard, Lean CLAY - with sand and trace chert fragments, moist 3.5		100			4	19.8	29	20	9
4		Brown, very stiff, Lean CLAY - with sand and trace chert fragments, moist		88			3	21.9	36	21	15
		7.0									
8		Grey to Light Brown, hard, CLAY with silt, sand and trace chert fragments, black mottling, moist		79			4.25	25.6	59	29	30
		10.0									
		Brown, very stiff, CLAY with silt, sand and trace chert fragments, black mottling, moist 11.9		100			4	27.4	67	29	38
12		(Auger Refusal at 11.9') Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, moderately fractured and weathered - hard		96		78					
16		16.9									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, moderately fractured and weathered - hard 17.4		82		53					
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard - Void or seam from 20.0' to 21.1' 21.9									
24		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		26.9									
28		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
		30.0									
		Medium gray, fine to medium grained crystalline dolomitic LIMESTONE with few shale partings, slightly fractured - hard 30.6									
32		(Coring Terminated at 30.6')									
36											
40											

Completion Depth: **30.6**
Date Started: **03/17/09**
Date Completed: **03/17/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. TB-1

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **609.0**

Location: **Sta. 36+71, 6' Left**
Temporary Diversion Bridge

Depth, feet	Graphic Log	MATERIAL DESCRIPTION	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Topsoil									
		1.0									
		Brown, stiff, Lean CLAY - moist		100			1.5				
4		4.0									
		Reddish brown, very stiff, Lean CLAY with some chert pieces - moist		83			3.5				
8				100			3.5				
		10.0		100			4.5				
		Brown, very stiff to hard, CLAY with silt, black mottling and chert pieces - moist									
12		13.8		0	50/0						
		(Auger Refusal at 13.8')									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with coarse to very coarse brachiopod and horn choral fragments and whole pieces, moderately fractured and weathered - hard - Void or seam from 14.6' to 15.6'		58		39					
16		15.6									
		17.2									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		97					
20		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard									
		22.2									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		98					
24		27.2									
		Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		97		88					
28		30.2									
		(Coring Terminated at 30.2')									
32											
36											
40											

Completion Depth: **30.2**
Date Started: **03/23/09**
Date Completed: **03/24/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

LOG OF BORING-GEOTECH+PP LOUISVILLE EAST END 08-09 BRIDGE STUDY.GPJ KSWARE.GDT 05/15/09

K.S. Ware & Associates, L.L.C.
Engineering & Testing Services

LOG OF BORING NO. TB-2

Project Name: **Louisville East End 08-09 Bridge Study**

Location: **Louisville, Kentucky**

Number: **100-03-0148**

Surface El.: **621.5**

Location: **Sta. 38+39.4 6' Right Temporary Diversion Bridge**

Depth, feet	Material Description	Samples	Recovery %	SPT Values	KY RQD	Pocket Pen (tsf)	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
	Topsoil									
0.8	Light brown, very stiff, SILTY CLAY - with sand and trace chert fragments, moist									
4			96			2.25	21.9	29	22	7
5.0	Orange Tan, hard, Lean CLAY -with sand and trace chert fragments, moist		88			4.5	22	31	19	12
8.0	Red brown, hard, Lean CLAY -with sand and trace chert fragments, moist		100			4.5	19.3			
8			88				19.5	46	23	23
12										
16			100				21.1			
19.5	Dark Brown, hard, CLAY with silt, sand and trace chert fragments - moist		96			4.5	28.4	69	32	37
20										
24			100			4.5	35.6	56	27	29
26.5	(Auger Refusal at 26.5')									
27.3	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
28	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		94		94					
32.3	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with fine to very coarse brachiopod and choral fragments and whole pieces, slightly fractured - hard		100		100					
32										
36										
37.3	Light to medium gray, fine grained crystalline calcite LIMESTONE with few shale partings - fossiliferous with brachiopod and choral fragments, slightly fractured - hard		100		100					
39.3	(Coring Terminated at 39.3)									
40										

Completion Depth: **39.3**
Date Started: **03/23/09**
Date Completed: **03/23/09**
Drilled By: **AEI**
Logged By: **JW**

Remarks: **Groundwater was not encountered during drilling activities.**

LOG OF BORING-GEOTECH+PP LOUISVILLE EAST END 08-09 BRIDGE STUDY.GPJ KSWARE.GDT 05/15/09

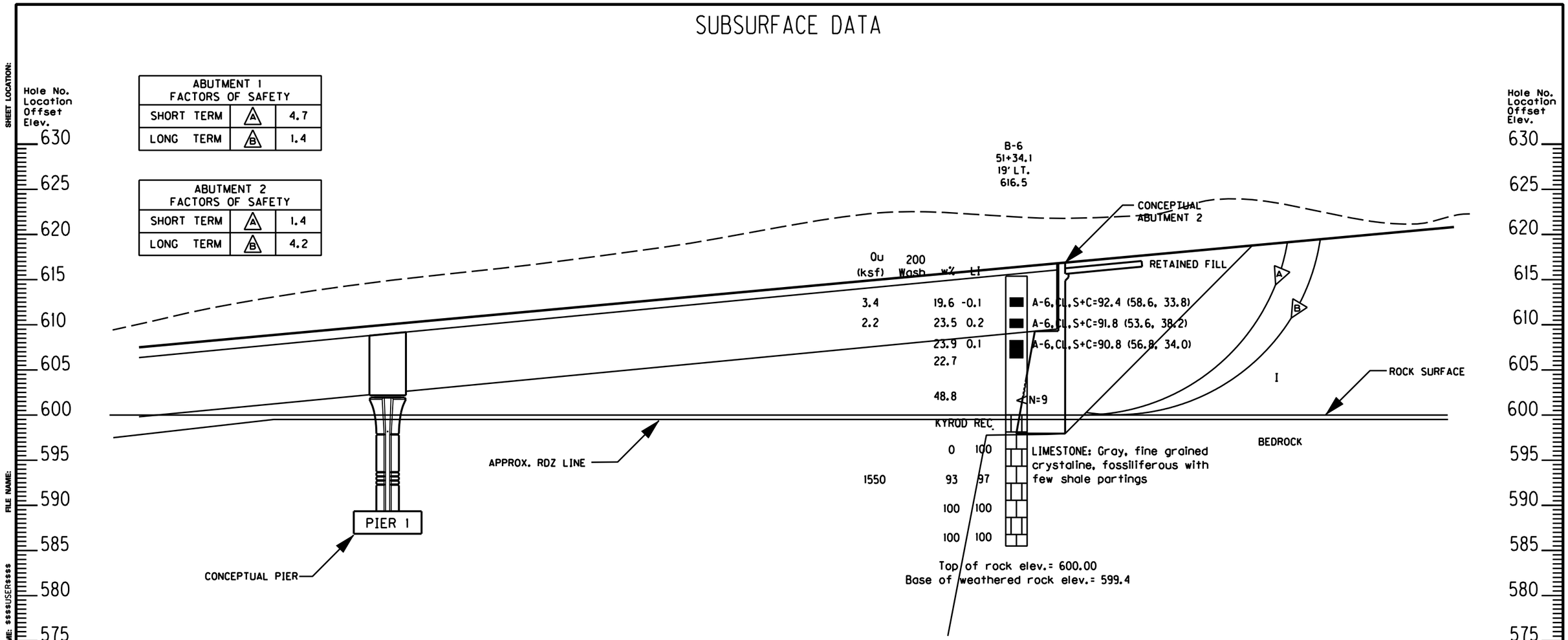
APPENDIX E:

STABILITY SECTION

SUBSURFACE DATA

ABUTMENT 1 FACTORS OF SAFETY		
SHORT TERM	A	4.7
LONG TERM	B	1.4

ABUTMENT 2 FACTORS OF SAFETY		
SHORT TERM	A	1.4
LONG TERM	B	4.2



ABUTMENT 1 and 2 ESTIMATED SOIL STRENGTH PARAMETERS			
SOIL	I	RETAINED FILL	BEDROCK
SHORT TERM	γ = 120 pcf $\bar{c}$ = 1400 psf ϕ = 0°	γ = 120 pcf $\bar{c}$ = 1400 psf ϕ = 0°	γ = 150 pcf $\bar{c}$ = 5000 psf ϕ = 45°
LONG TERM	γ = 120 pcf $\bar{c}$ = 200 psf $\bar{\phi}$ = 23°	γ = 120 pcf $\bar{c}$ = 170 psf $\bar{\phi}$ = 27°	γ = 150 pcf $\bar{c}$ = 5000 psf $\bar{\phi}$ = 45°

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information for the structure elevation used on this drawing was obtained through the Bentley Projectwise Program from the Kentucky Transportation Associates Design Team on June 2, 2007.

VERTICAL SCALE: 1" = 5'

SHEET 1 OF 2

ITEM NUMBER
5-118.18

DATE: 5-19-2009	CHECKED BY
DESIGNED BY:	
DETAILED BY: ND	JG

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841 | CROSSING: WOLF PEN BRANCH ROAD

WOLF PEN BRANCH ROAD BRIDGE

PREPARED BY: THE OHIO RIVER BRIDGES — Kentucky Transportation Associates

SHEET NO. 1

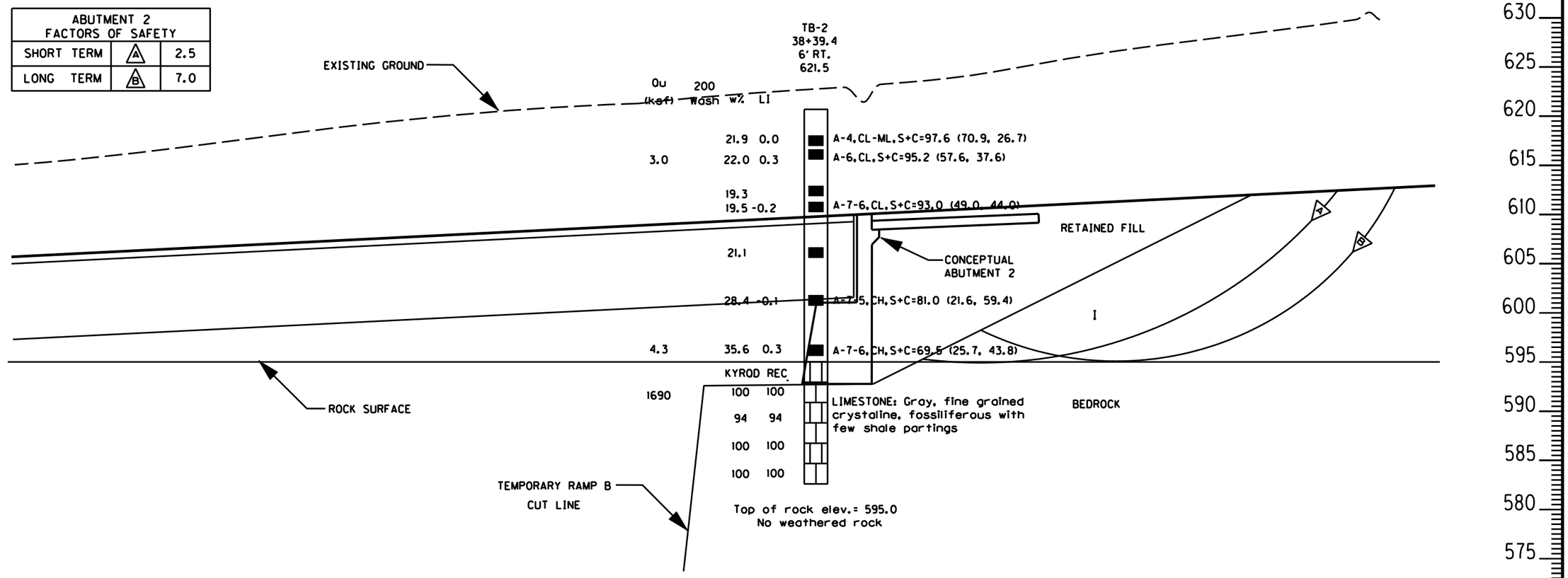
DRAWING NO. 00000

SHEET LOCATION:
FILE NAME:
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

SUBSURFACE DATA

ABUTMENT 1 FACTORS OF SAFETY		
SHORT TERM	A	4.9
LONG TERM	B	23.5

ABUTMENT 2 FACTORS OF SAFETY		
SHORT TERM	A	2.5
LONG TERM	B	7.0



ABUTMENT 1 and 2 ESTIMATED SOIL STRENGTH PARAMETERS			
SOIL	I	RETAINED FILL	BEDROCK
SHORT TERM	γ = 120 pcf $\bar{c}$ = 1400 psf ϕ = 0°	γ = 120 pcf $\bar{c}$ = 1400 psf ϕ = 0°	γ = 150 pcf $\bar{c}$ = 5000 psf ϕ = 45°
LONG TERM	γ = 120 pcf $\bar{c}$ = 200 psf $\bar{\phi}$ = 23°	γ = 120 pcf $\bar{c}$ = 170 psf $\bar{\phi}$ = 27°	γ = 150 pcf $\bar{c}$ = 5000 psf $\bar{\phi}$ = 45°

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.
3. All standard penetration testing performed for structure borings were done utilizing an automatic hammer.
4. The information for the structure elevation used on this drawing was obtained through the Bentley Projectwise Program from the Kentucky Transportation Associates Design Team on June 2, 2007.

VERTICAL SCALE: 1" = 5'

ITEM NUMBER
5-118.18

SHEET 2 OF 2

DATE: 5-18-2009		CHECKED BY
DESIGNED BY:		
DETAILED BY: ND		JG

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: KY 841 | CROSSING: WOLF PEN BRANCH ROAD

TEMPORARY DIVERSION BRIDGE

PREPARED BY: THE OHIO RIVER BRIDGES — Kentucky Transportation Associates

SHEET NO. 2

DRAWING NO. 00000

APPENDIX F:

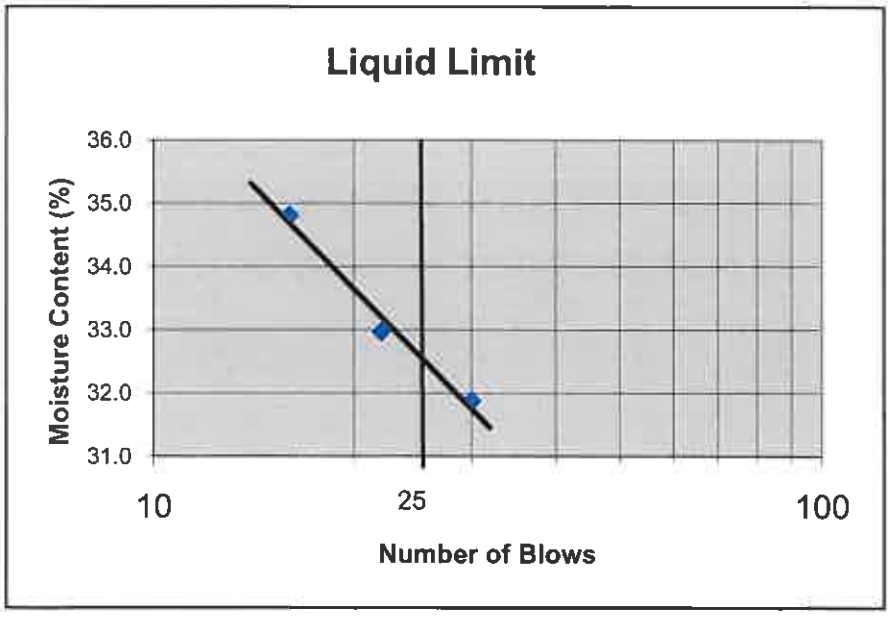
LABORATORY TESTING RESULTS

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-1 ST-1 2-4'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	25.71	26.32	25.85	19.77	22.39
Dry Soil and Tare	22.80	23.30	22.70	18.68	20.84
Wt. of Water	2.91	3.02	3.15	1.09	1.55
Tare Wt.	13.67	14.14	13.65	13.76	13.79
Dry Soil	9.13	9.16	9.05	4.92	7.05
Moisture content%	31.9	33.0	34.8	22.2	22.0
No. Of blows	30	22	16	Average:	22
Required Blows	*25-35*	*20-30*	*15-25*		



Liquid Limit: 33

Plastic Limit: 22

Plasticity Index: 11

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	5/4/2009
Reviewed By:	M. Wolfe	Date:	5/5/2009

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54 Lindsley Ave
Nashville, TN 37210

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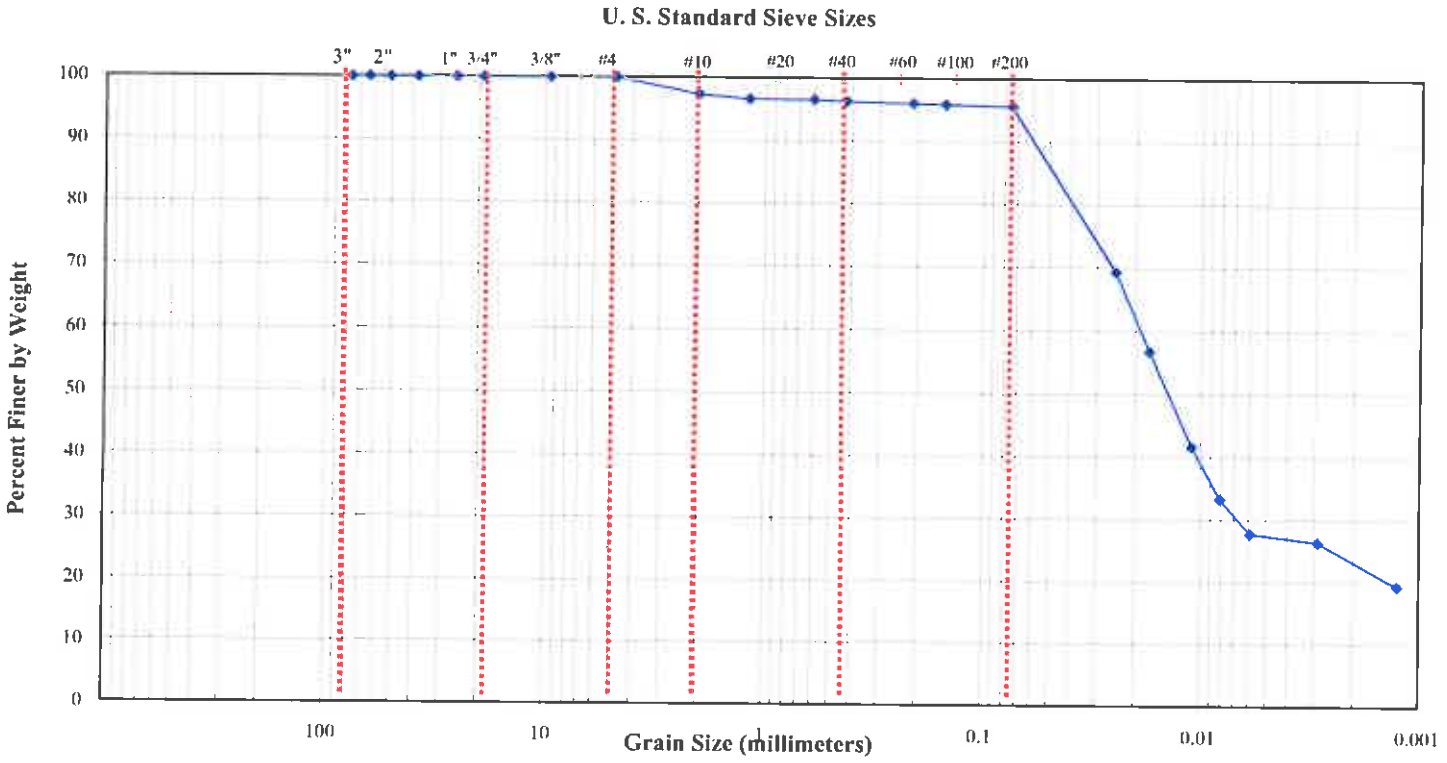
Fax (615) 256-5873

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-1	**Sample Number:**	**ST-1**
Depth:	2-4'	**Date Received:**	**39896**
Soil Description:	Light Brown Lean Clay with trace sand and chert fragments		

K. S. Ware and Associates, LLC
3600 Chamerlain Lane, Suite 610
Louisville, Kentcuky 40241

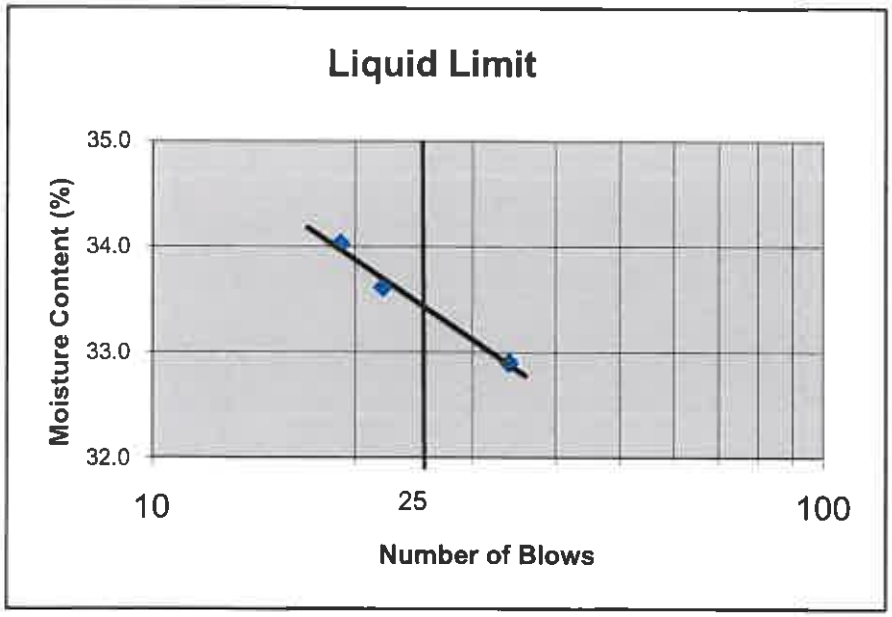
Phone: (502) 326-9023
Fax: (502) 326-9039

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-1 ST-2 4-6'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	23.16	25.12	20.82	24.86	17.18
Dry Soil and Tare	20.88	22.36	19.03	22.95	16.58
Wt. of Water	2.28	2.76	1.79	1.91	0.60
Tare Wt.	13.95	14.15	13.77	13.49	13.78
Dry Soil	6.93	8.21	5.26	9.46	2.80
Moisture content%	32.9	33.6	34.0	20.2	21.4
No. Of blows	34	22	19	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **34**

Plastic Limit: **21**

Plasticity Index: **13**

USCS CLASSIFICATION:

CL

Tested By:	C. Smith	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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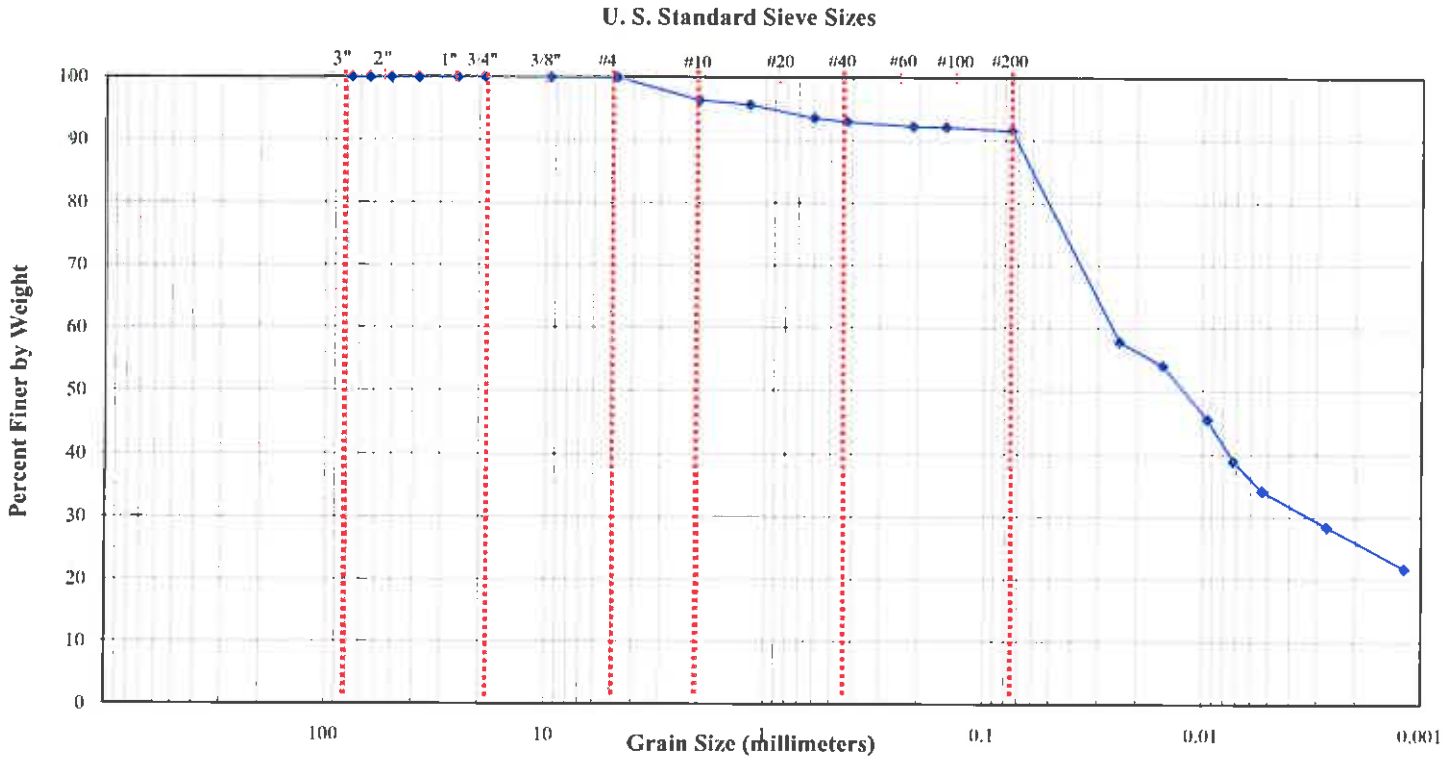
K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-1	**Sample Number:**	ST-2
Depth:	4-6'	**Date Received:**	3/24/2009
Soil Description:	Light Brown Lean Clay with trace sand and chert fragments		

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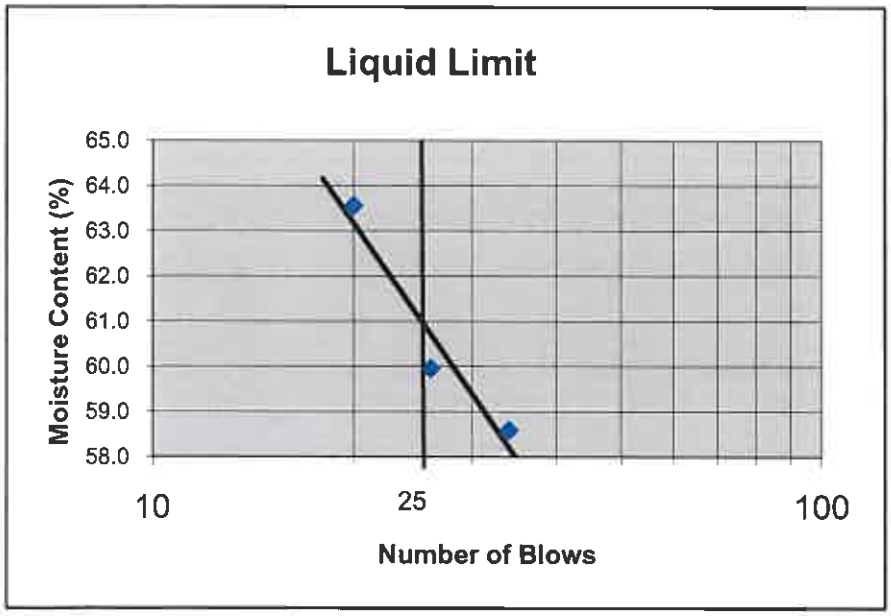
K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-1 ST-4 9-11'
Project Number:	100-03-0148	Test Date:	5/6/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Yellow Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	19.62	17.94	18.33	17.20	21.33
Dry Soil and Tare	16.72	15.20	15.33	15.75	19.11
Wt. of Water	2.90	2.74	3.00	1.45	2.22
Tare Wt.	11.77	10.63	10.61	10.84	11.85
Dry Soil	4.95	4.57	4.72	4.91	7.26
Moisture content%	58.6	60.0	63.6	29.5	30.6
No. Of blows	34	26	20	Average:	30
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 61

Plastic Limit: 30

Plasticity Index: 31

USCS CLASSIFICATION:

CH

Tested By:	C. Smith	Date:	5/6/2009
Reviewed By:	M. Wolfe	Date:	5/7/2009

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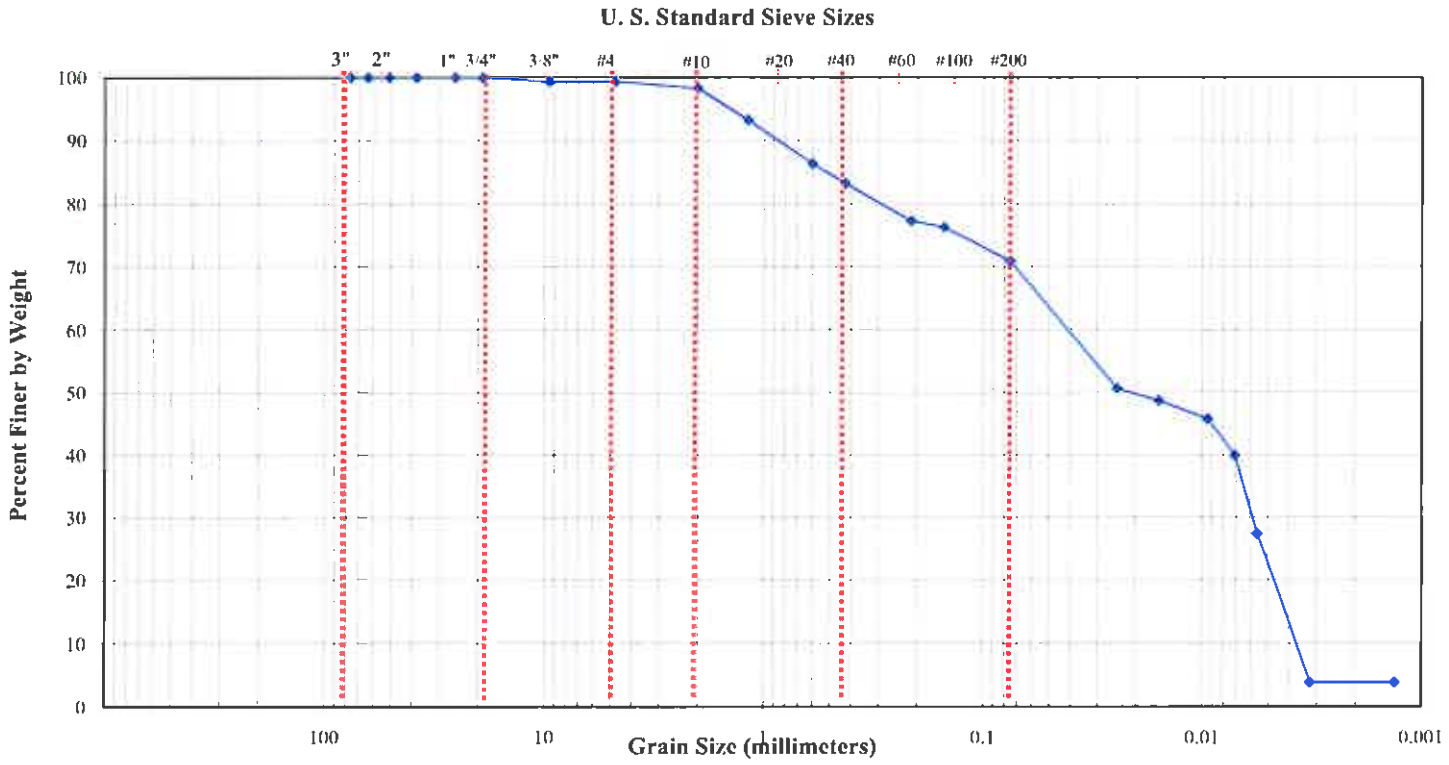
Engineering, Environmental & Information Services

Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	**Wolf Pen Branch Road**	**Project Number:**	100-03-0148
Sample Location:	**B-1**	**Sample Number:**	ST-4
Depth:	**9-11'**	**Date Received:**	3/24/2009
Soil Description:	Yellow Brown Clay with silt, traces and and chert fragments		

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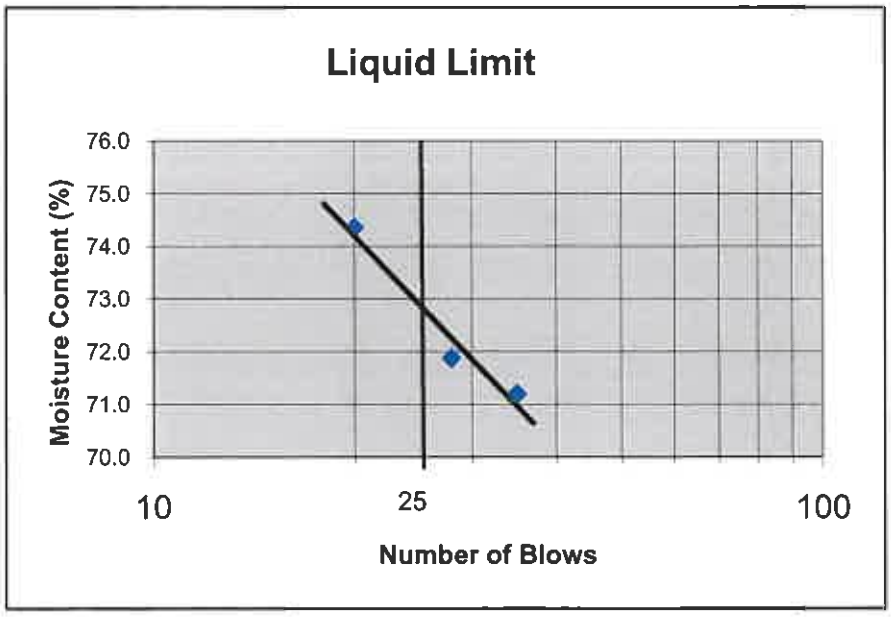
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-1 ST-5 14-16'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Dark Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	24.38	21.97	25.17	21.15	19.88
Dry Soil and Tare	19.98	18.52	20.27	19.27	18.34
Wt. of Water	4.40	3.45	4.90	1.88	1.54
Tare Wt.	13.80	13.72	13.68	13.77	13.83
Dry Soil	6.18	4.80	6.59	5.50	4.51
Moisture content%	71.2	71.9	74.4	34.2	34.1
No. Of blows	35	28	20	Average:	34
Required Blows	*25-35*	*20-30*	*15-25*		



Liquid Limit: 73

Plastic Limit: 34

Plasticity Index: 39

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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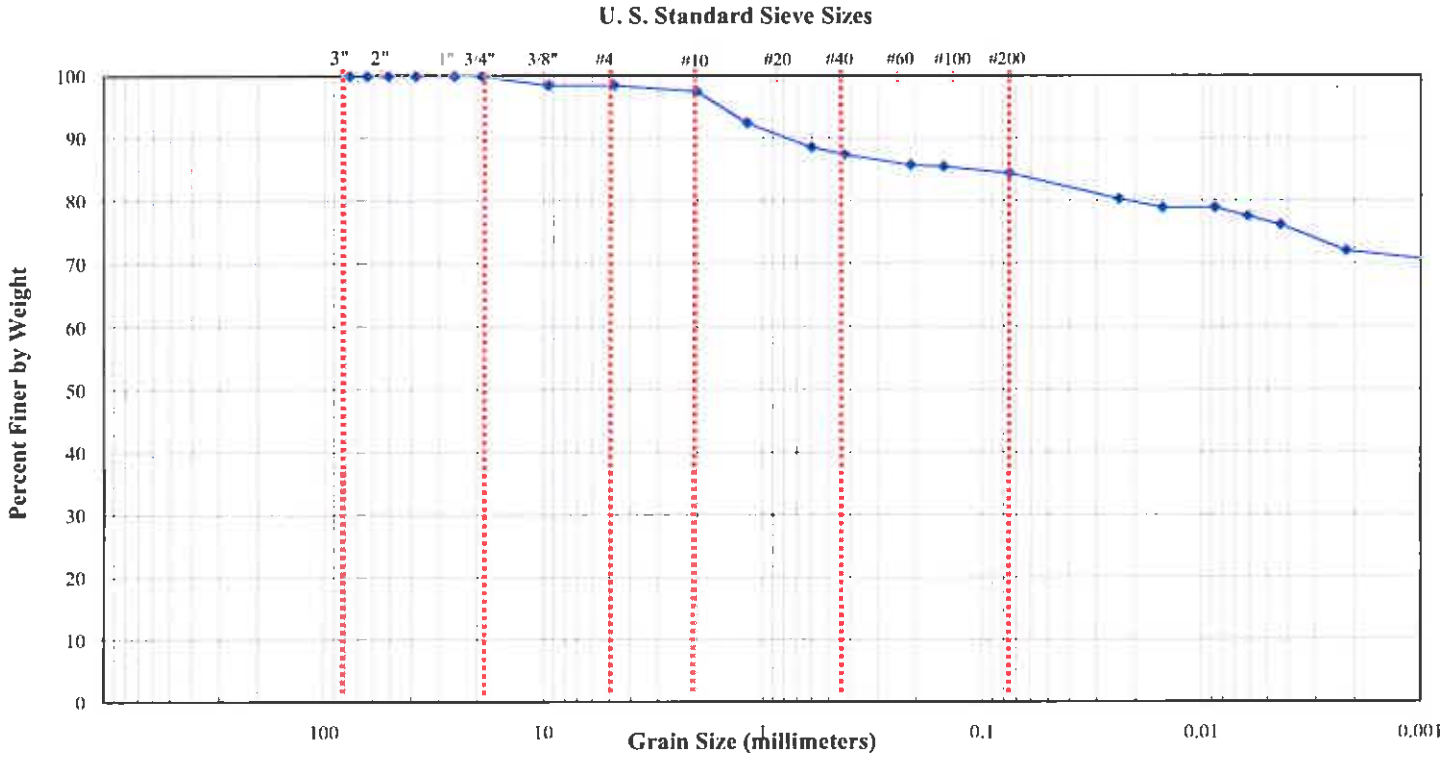
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-1	**Sample Number:**	**ST-5**
Depth:	14-16'	**Date Received:**	**39896**
Soil Description:	Dark Brown Clay with silt, sand and trace chert fragments		

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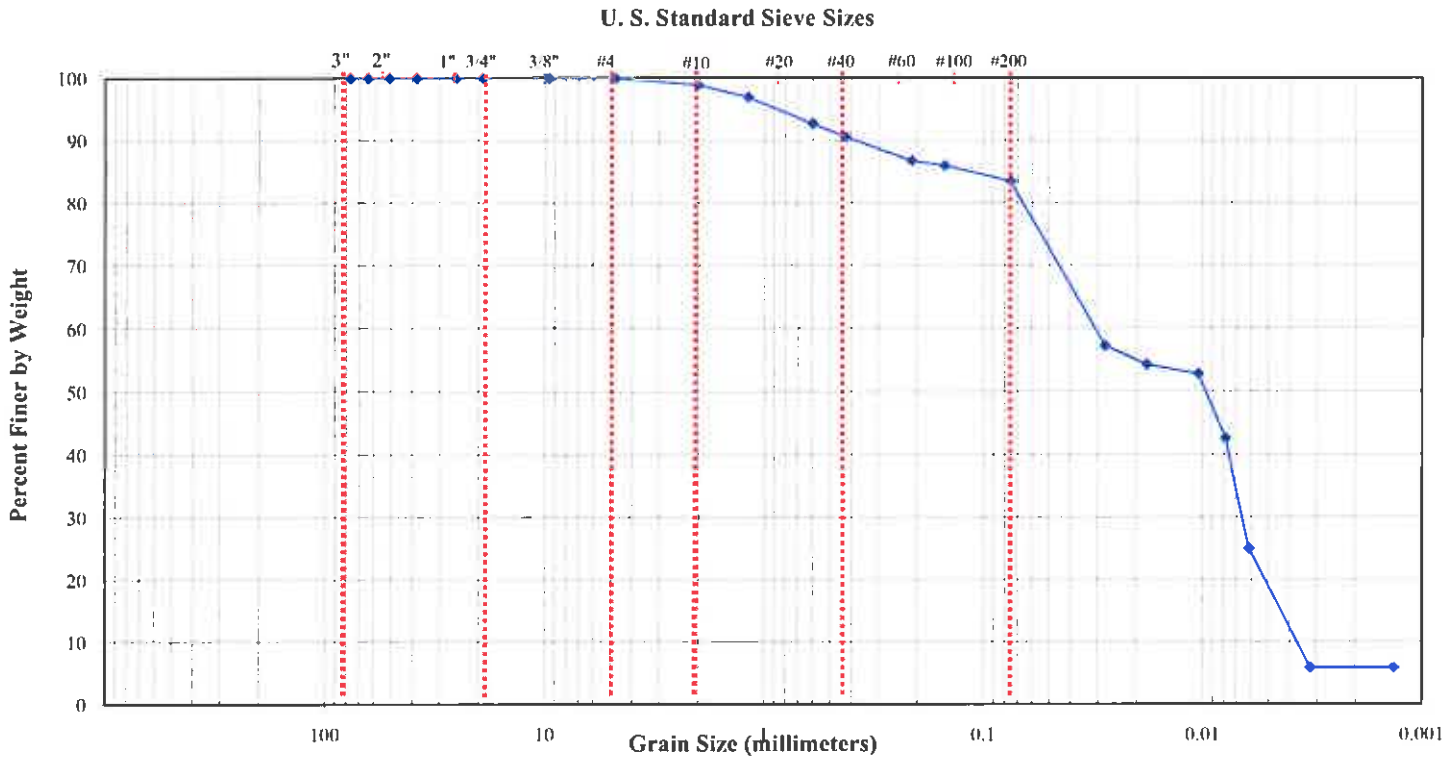
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-2	**Sample Number:**	**ST-1**
Depth:	2-4'	**Date Received:**	**39896**
Soil Description:	Brown **Lean** Clay with trace sand		

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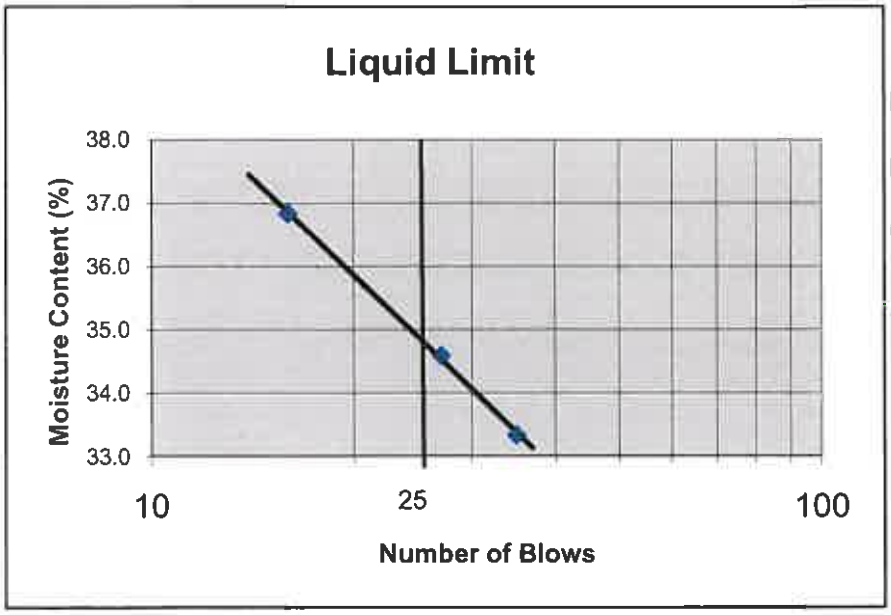
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-2 ST-2 4.0-6.0'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	24.77	24.32	25.82	20.85	19.94
Dry Soil and Tare	21.99	21.57	22.56	19.64	18.84
Wt. of Water	2.78	2.75	3.26	1.21	1.10
Tare Wt.	13.65	13.62	13.71	13.98	13.61
Dry Soil	8.34	7.95	8.85	5.66	5.23
Moisture content%	33.3	34.6	36.8	21.4	21.0
No. Of blows	35	27	16	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **35**

Plastic Limit: **21**

Plasticity Index: **14**

USCS CLASSIFICATION:

CL

Tested By:	C. Smith	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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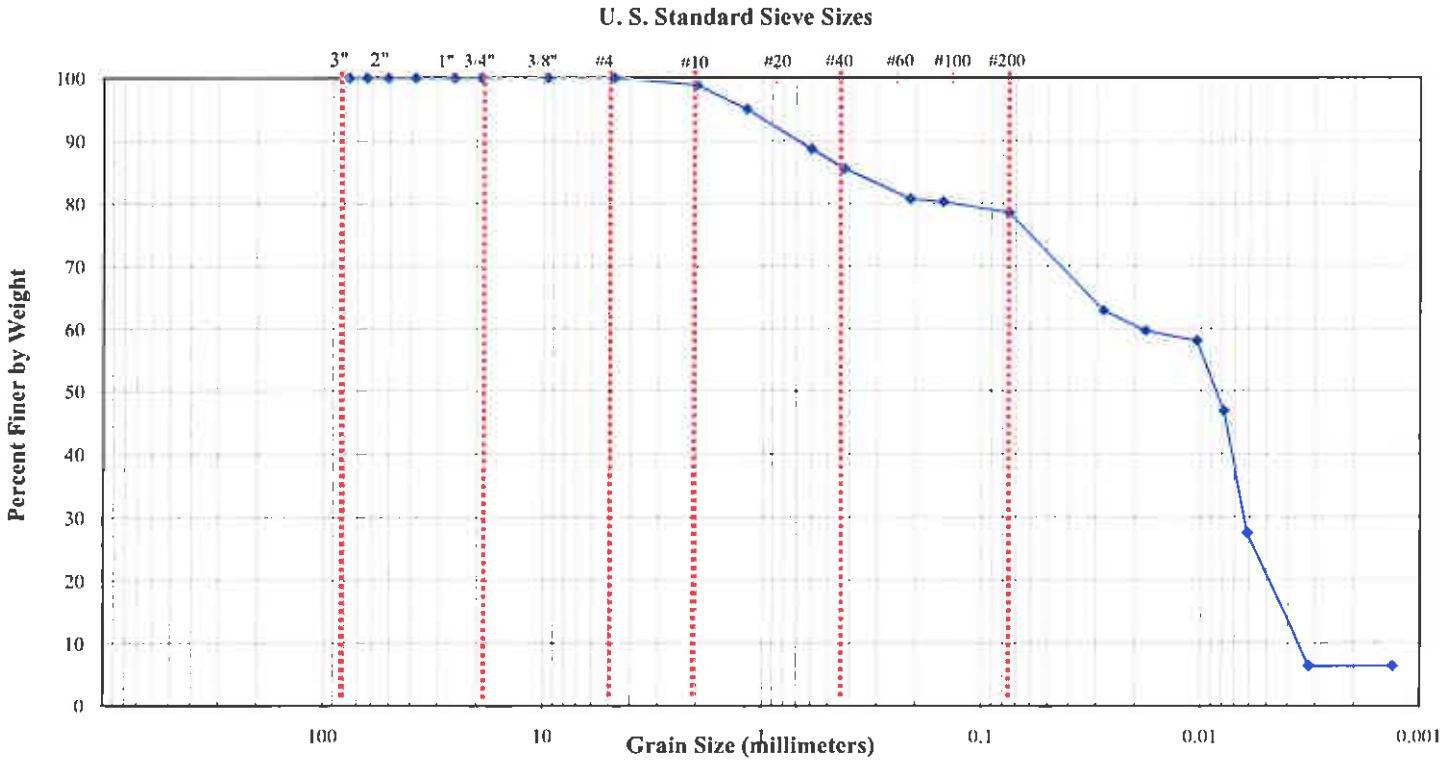
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-2	**Sample Number:**	**ST-2**
Depth:	4-6'	**Date Received:**	**39896**
Soil Description:	Brown Lean Clay with trace sand		

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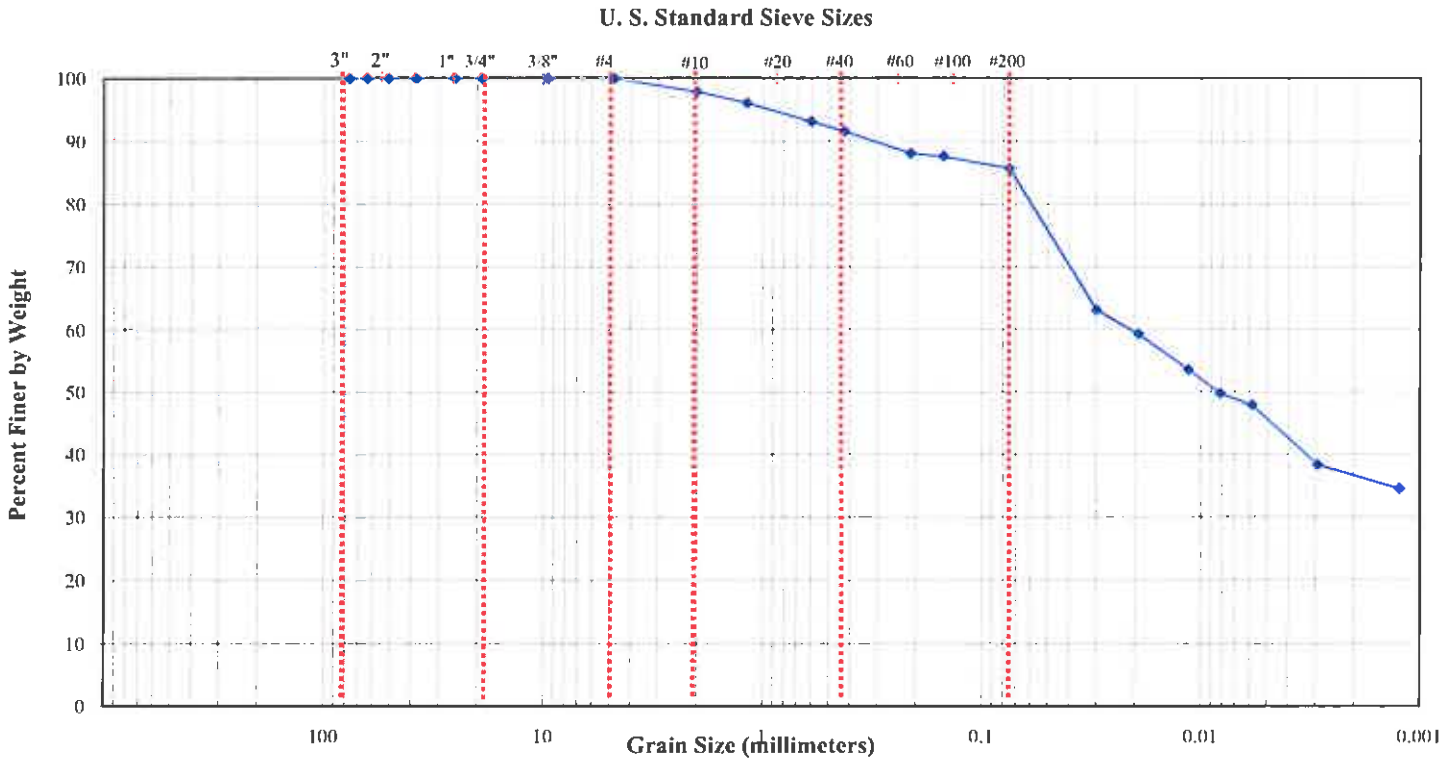
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-2	**Sample Number:**	**ST-4**
Depth:	9-9.7'	**Date Received:**	**3/24/2009**
Soil Description:	Brown Lean Clay with trace sand		

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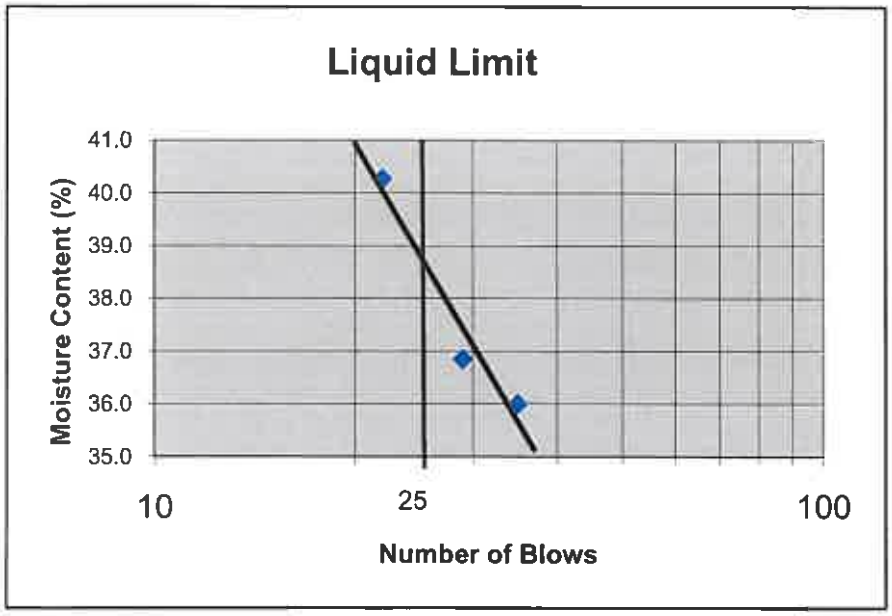
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-3 ST-1 2-2.5'
Project Number:	100-03-0148	Test Date:	4/29/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	20.47	22.39	24.30	19.50	21.16
Dry Soil and Tare	18.67	20.05	21.38	18.58	20.06
Wt. of Water	1.80	2.34	2.92	0.92	1.10
Tare Wt.	13.67	13.70	14.13	13.49	13.91
Dry Soil	5.00	6.35	7.25	5.09	6.15
Moisture content%	36.0	36.9	40.3	18.1	17.9
No. Of blows	35	29	22	Average:	18
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 39

Plastic Limit: 18

Plasticity Index: 21

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	4/29/2009
Reviewed By:	M. Wolfe	Date:	4/30/2009

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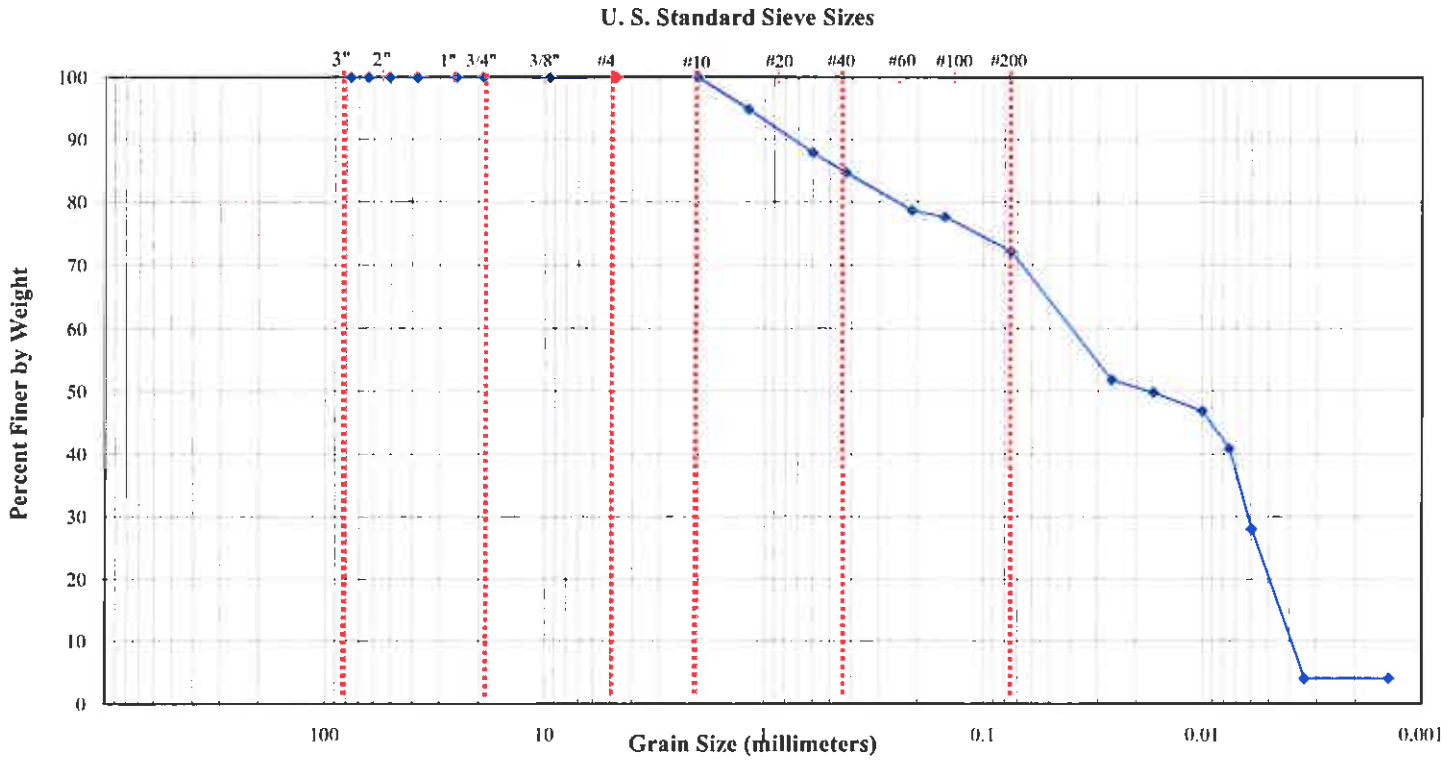
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	**Wolf Pen Branch Road**	**Project Number:**	**100-03-0148**
Sample Location:	**B-3**	**Sample Number:**	**ST-1**
Depth:	**2-2.5'**	**Date Received:**	**3/24/2009**
Soil Description:	Brown Lean Clay with trace sand		

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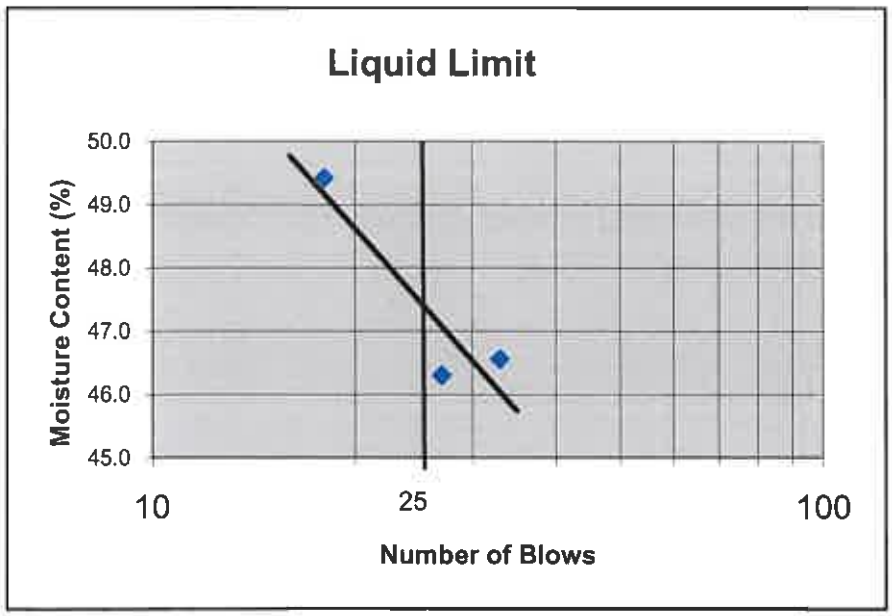
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-4 ST-1 2-4
Project Number:	100-03-0148	Test Date:	5/6/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit				Plastic Content	
Tare No	1	2	3		4	5
Wet Soil and Tare	26.54	22.20	21.67		19.29	23.20
Dry Soil and Tare	23.70	19.51	19.10		18.21	22.18
Wt. of Water	2.84	2.69	2.57		1.08	1.02
Tare Wt.	17.60	13.70	13.90		13.76	18.16
Dry Soil	6.10	5.81	5.20		4.45	4.02
Moisture content%	46.6	46.3	49.4		24.3	25.4
No. Of blows	33	27	18		Average:	25
Required Blows	***25-35***	***20-30***	***15-25***			



Liquid Limit: **48**

Plastic Limit: **25**

Plasticity Index: **23**

USCS CLASSIFICATION:

CL

Tested By:	B. J. Bryant	Date:	5/6/2009
Reviewed By:	M. Wolfe	Date:	5/7/2009

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KSWA

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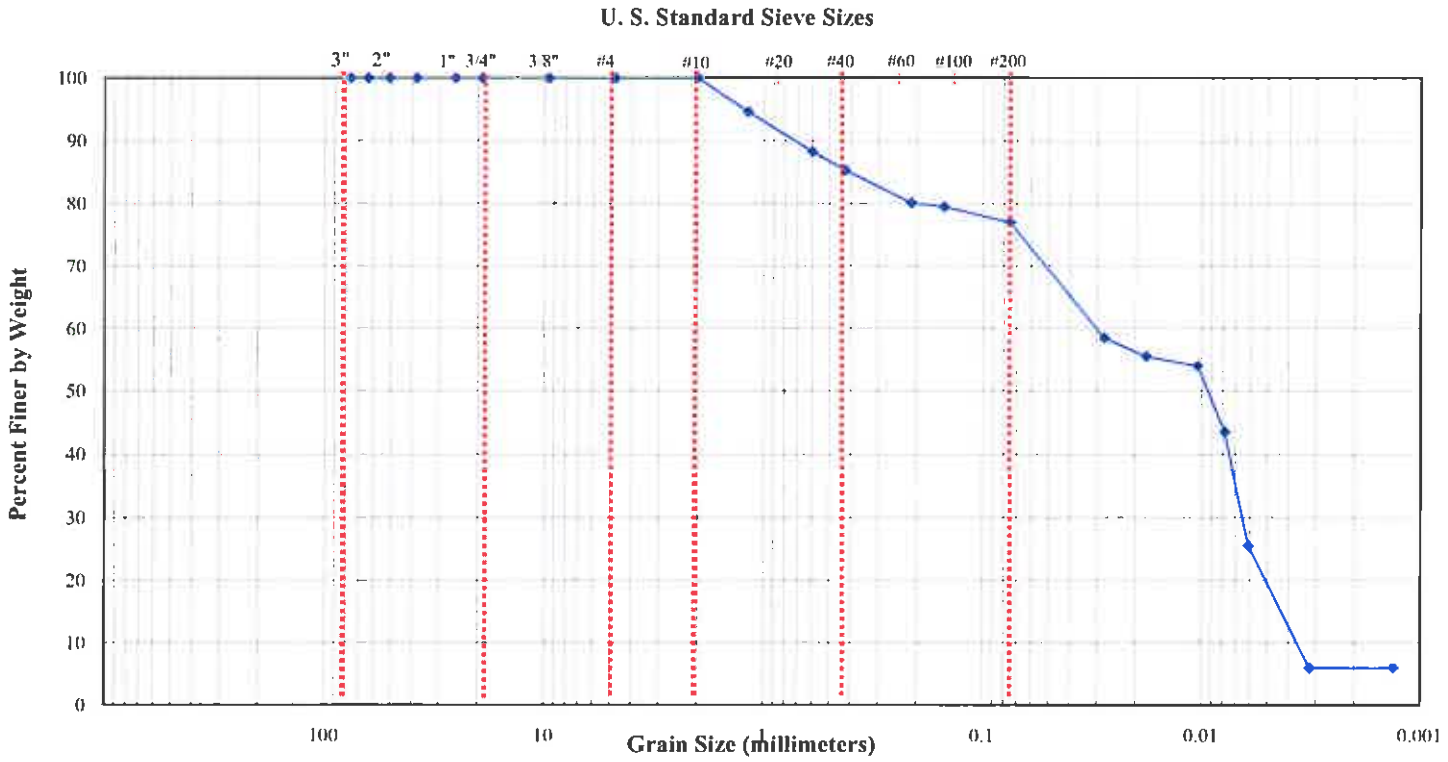
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-4	**Sample Number:**	**ST-1**
Depth:	2-4'	**Date Received:**	**39896**
Soil Description:	Brown Lean Clay with trace sand		

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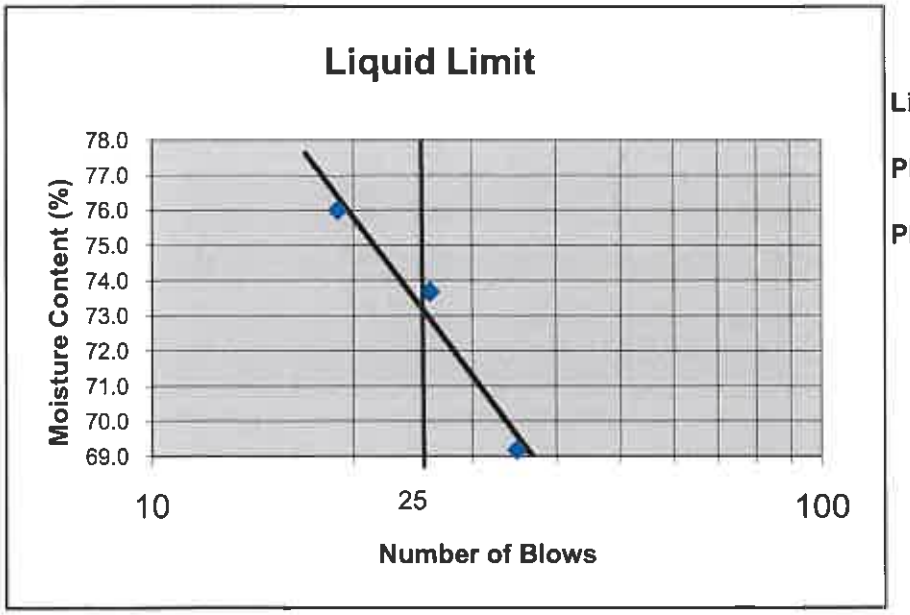
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-4 ST-2 4-6'
Project Number:	100-03-0148	Test Date:	4/27/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Clay with silt and sand		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	24.01	22.87	21.28	19.19	20.28
Dry Soil and Tare	19.88	18.98	18.05	18.03	18.82
Wt. of Water	4.13	3.89	3.23	1.16	1.46
Tare Wt.	13.91	13.70	13.80	13.90	13.82
Dry Soil	5.97	5.28	4.25	4.13	5.00
Moisture content%	69.2	73.7	76.0	28.1	29.2
No. Of blows	35	26	19	Average:	29
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **73**

Plastic Limit: **29**

Plasticity Index: **44**

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	4/27/2009
Reviewed By:	M. Wolfe	Date:	4/28/2009

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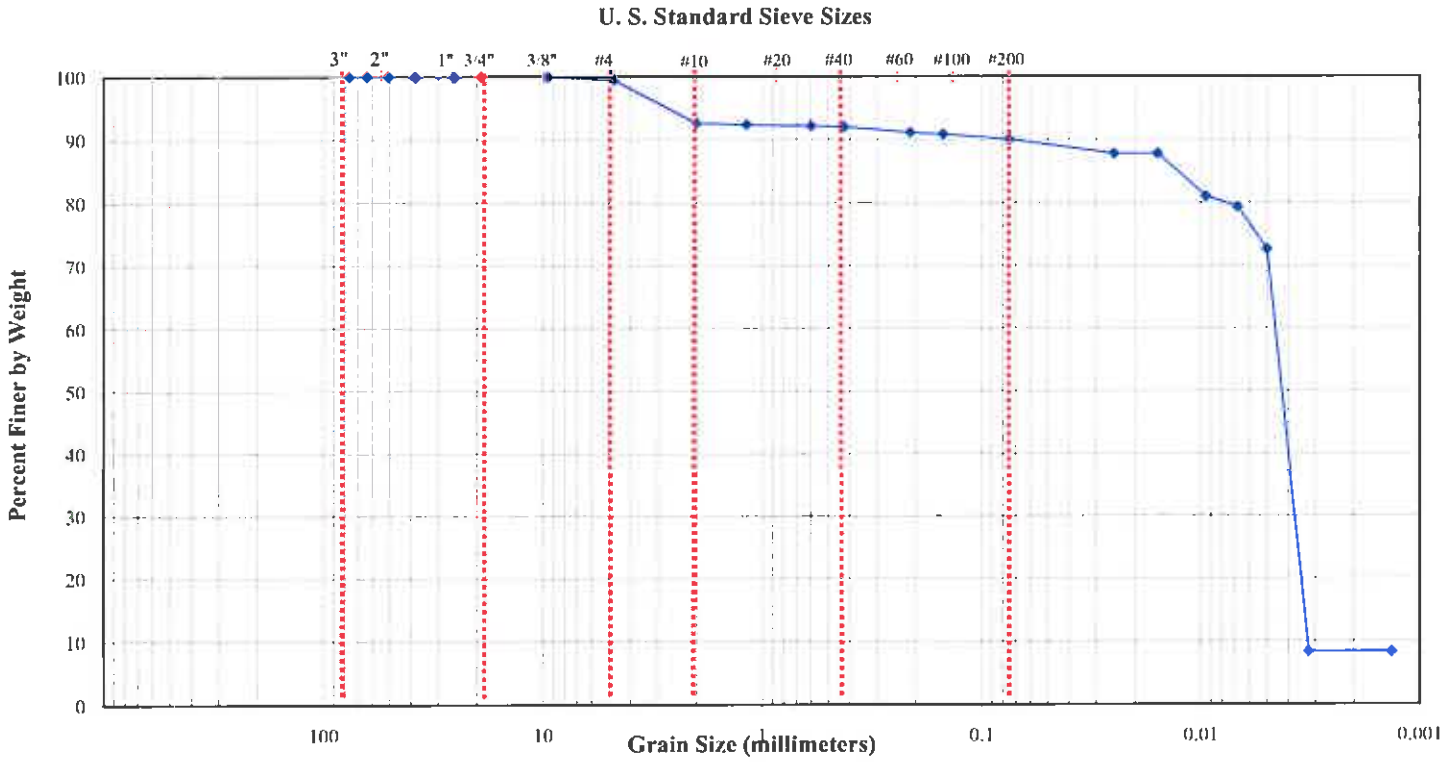
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-4	**Sample Number:**	**ST-2**
Depth:	4-6'	**Date Received:**	**3/24/2009**
Soil Description:	Light Brown Clay with silt, and trace sand		

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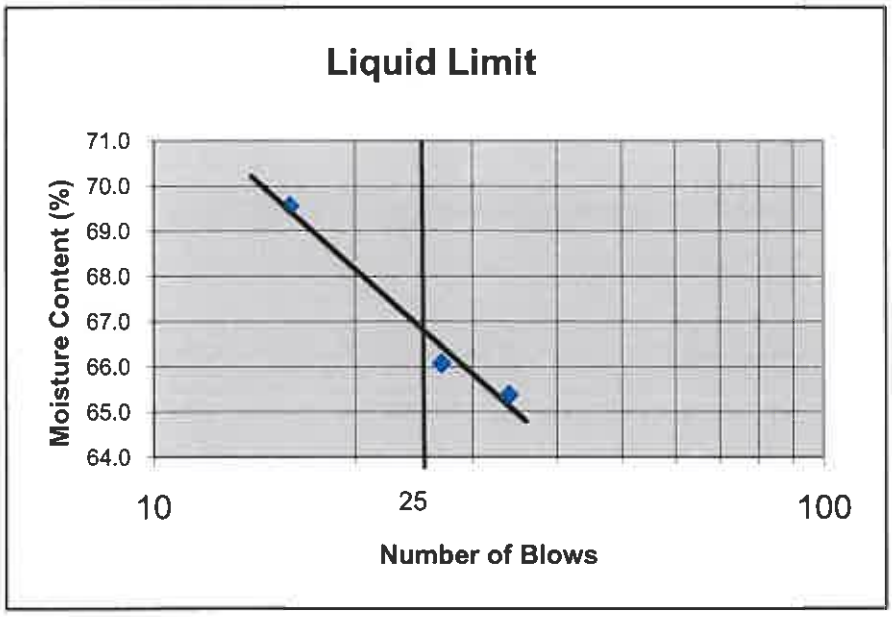
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-4 ST-4 9-11'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	22.41	23.19	23.73	20.30	21.83
Dry Soil and Tare	19.03	19.47	19.64	18.82	20.15
Wt. of Water	3.38	3.72	4.09	1.48	1.68
Tare Wt.	13.86	13.84	13.76	13.72	14.23
Dry Soil	5.17	5.63	5.88	5.10	5.92
Moisture content%	65.4	66.1	69.6	29.0	28.4
No. Of blows	34	27	16	Average:	29
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 67

Plastic Limit: 29

Plasticity Index: 38

USCS CLASSIFICATION:

CH

Tested By: S. Brifkany Date: 5/4/2009

Reviewed By: M. Wolfe Date: 5/5/2009

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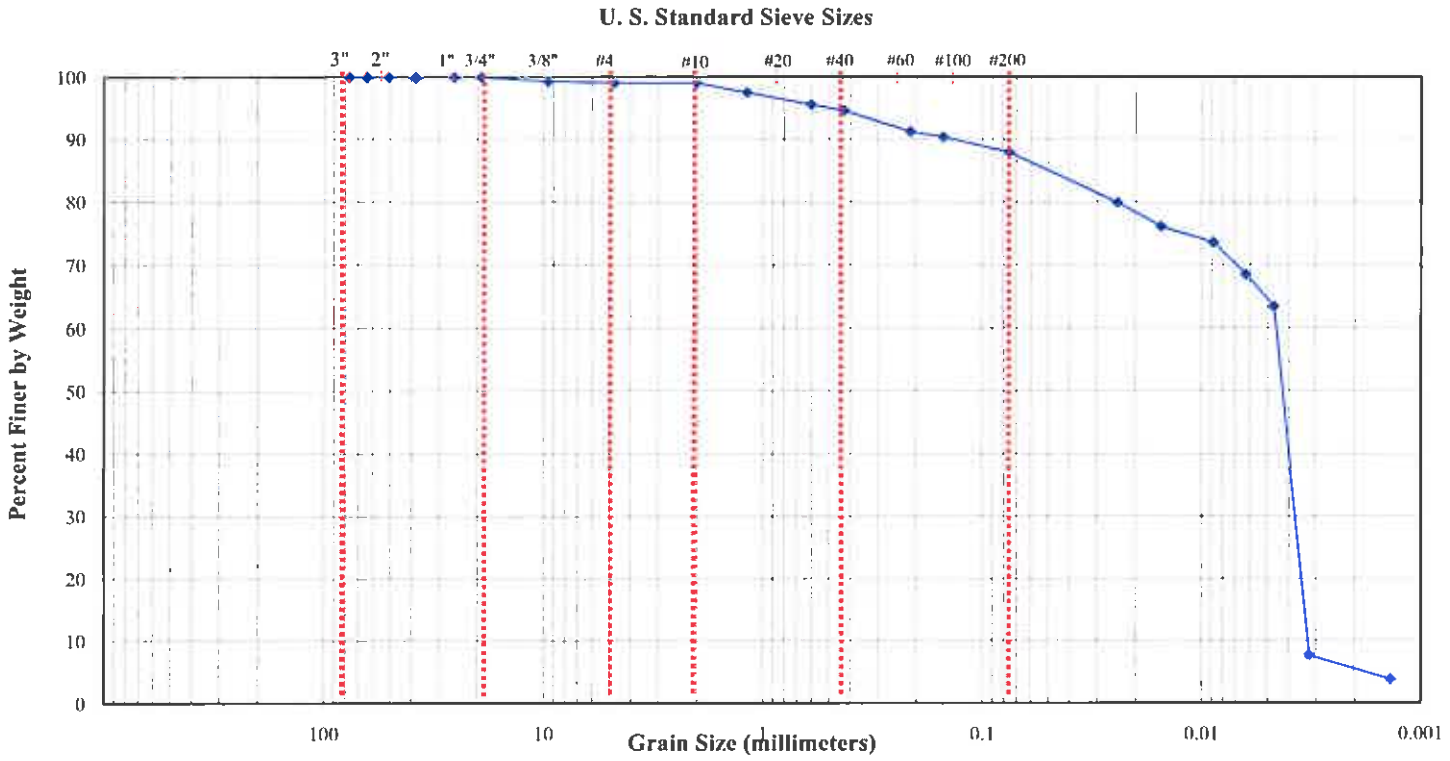
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-4	**Sample Number:**	ST-4
Depth:	9-11'	**Date Received:**	3/24/2009
Soil Description:	Light Brown Clay with silt, trace sand and chert fragments		

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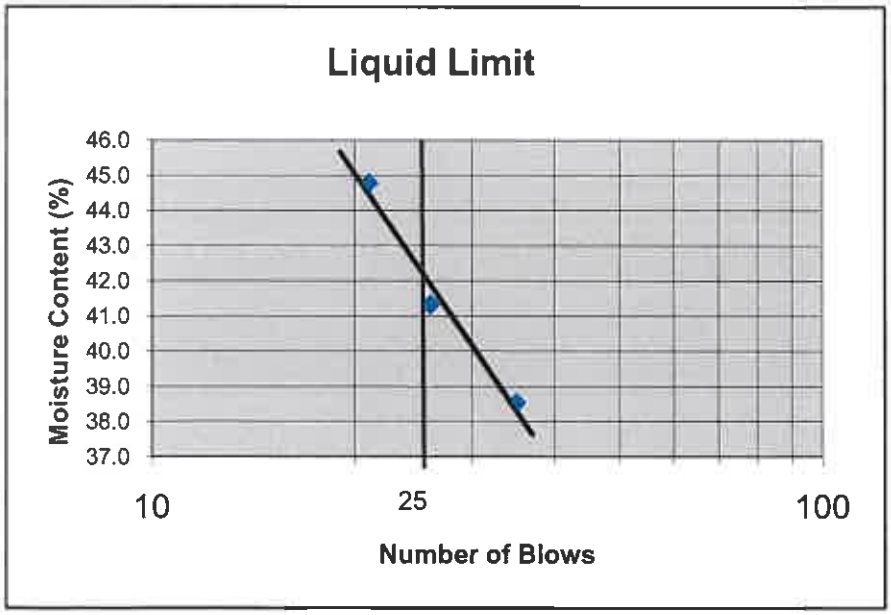
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-5 ST-1 2-4'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with gravel and sand		
Date Received:	3/24/2009		

	Liquid Limit				Plastic Content	
Tare No	1	2	3		4	5
Wet Soil and Tare	19.34	18.91	21.23		14.63	13.28
Dry Soil and Tare	17.24	16.55	18.31		13.89	12.84
Wt. of Water	2.10	2.36	2.92		0.74	0.44
Tare Wt.	11.79	10.84	11.79		10.61	10.62
Dry Soil	5.45	5.71	6.52		3.28	2.22
Moisture content%	38.5	41.3	44.8		22.6	19.8
No. Of blows	35	26	21		Average:	21
Required Blows	***25-35***	***20-30***	***15-25***			



Liquid Limit: **42**

Plastic Limit: **21**

Plasticity Index: **21**

USCS CLASSIFICATION:

CL

Tested By:	C. Smith	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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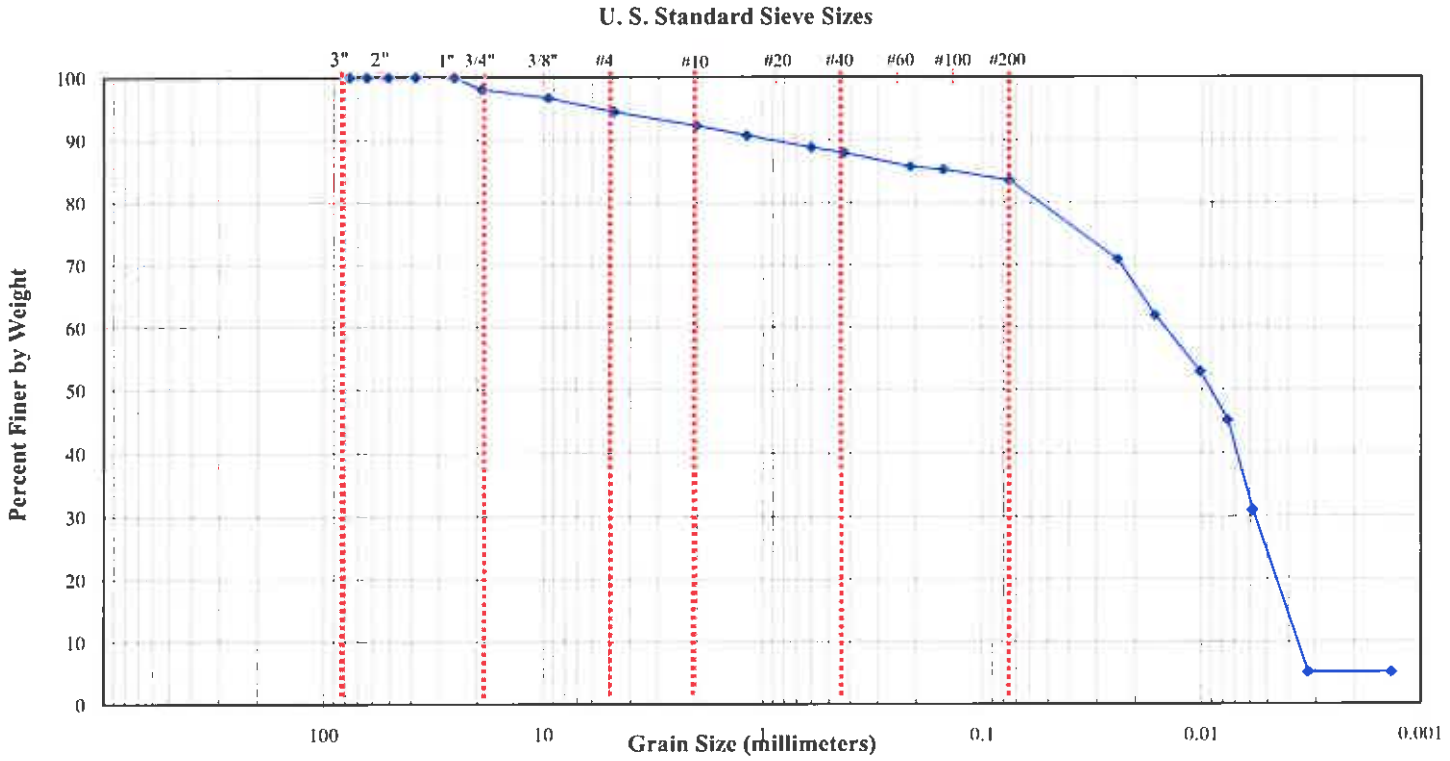
Engineering, Environmental & Information Services

Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-5	**Sample Number:**	ST-1
Depth:	2-4'	**Date Received:**	3/24/2009
Soil Description:	Light Brown Lean Clay with trace gravel and sand		

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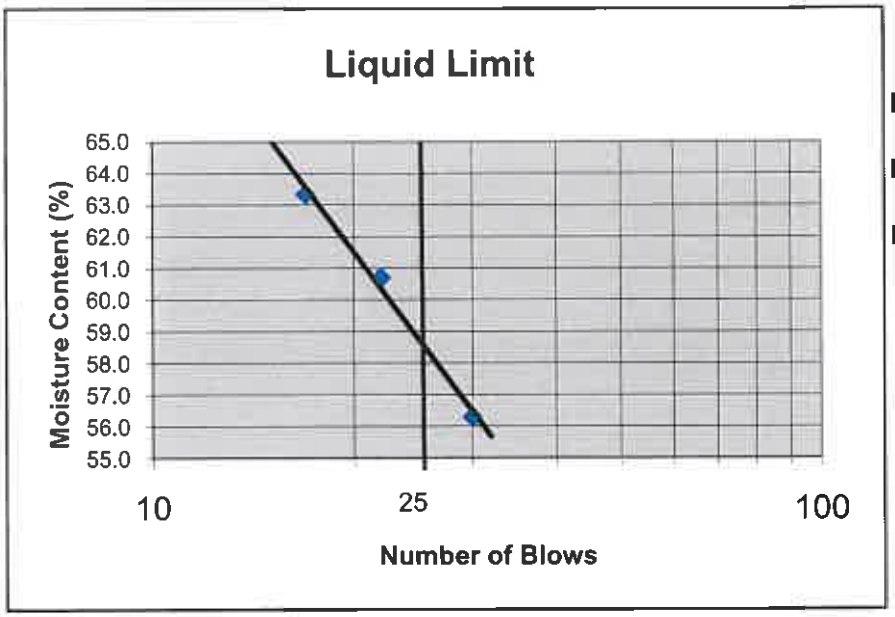
Engineering, Environmental & Information Services

Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-5 ST-2 4-6'
Project Number:	100-03-0148	Test Date:	5/6/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	19.90	20.94	20.52	17.40	17.88
Dry Soil and Tare	17.71	18.22	17.91	16.55	16.94
Wt. of Water	2.19	2.72	2.61	0.85	0.94
Tare Wt.	13.82	13.74	13.79	13.64	13.81
Dry Soil	3.89	4.48	4.12	2.91	3.13
Moisture content%	56.3	60.7	63.3	29.2	30.0
No. Of blows	30	22	17	Average:	30
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 59

Plastic Limit: 30

Plasticity Index: 29

USCS CLASSIFICATION:

CH

Tested By: B. J. Bryant Date: 5/6/2009

Reviewed By: M. Wolfe Date: 5/7/2009

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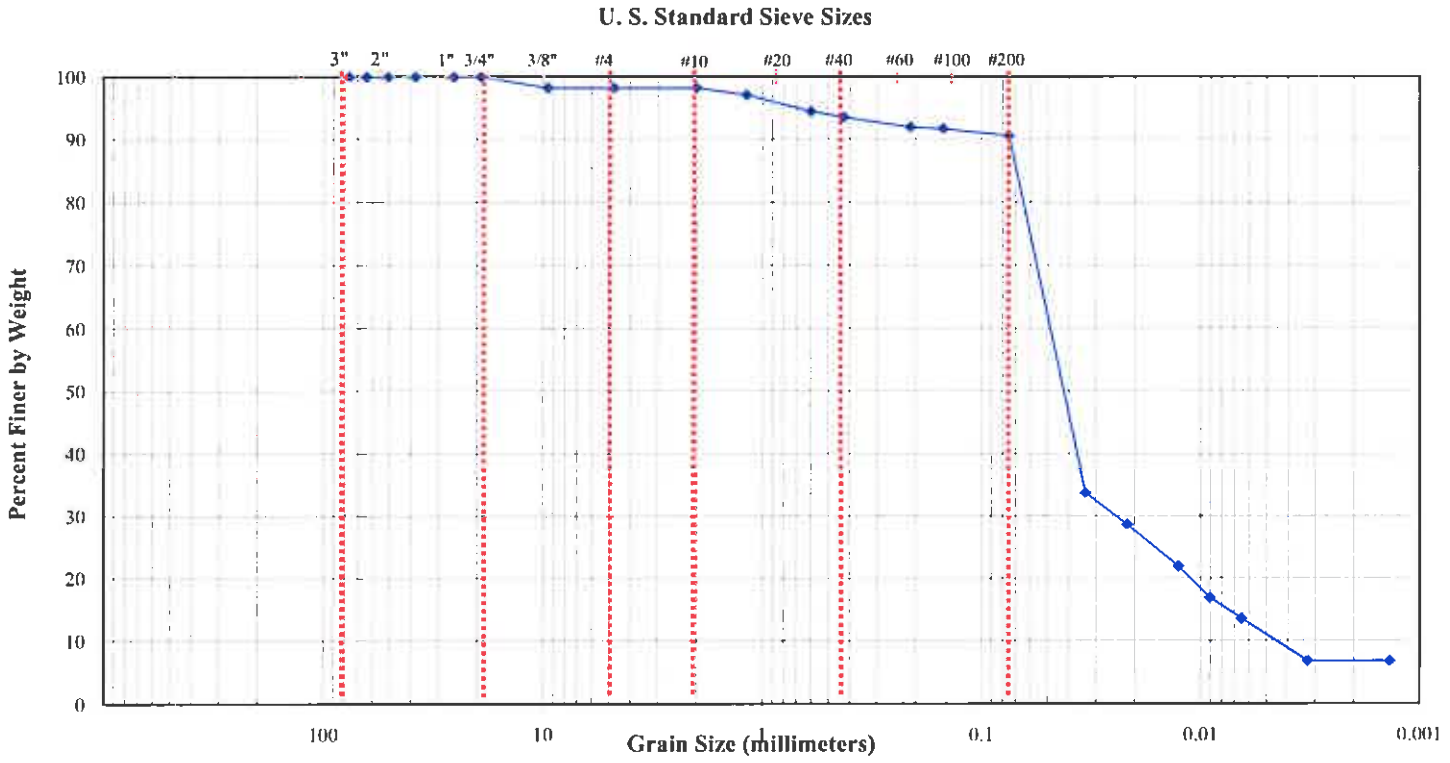
Grain Size Distribution

		Gravel		Sand			Fines	
Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-5	**Sample Number:**	**ST-2**
Depth:	4-6'	**Date Received:**	**3/24/2009**
Soil Description:	Brown Clay with silt, trace sand and chert fragments		

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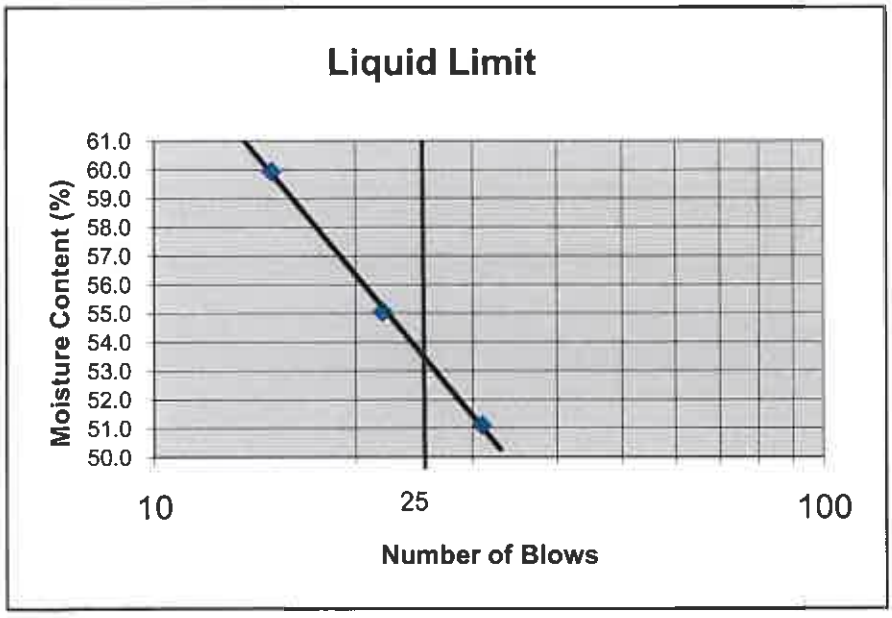
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolfpen Branch Road	Sample ID:	B-5 ST-3 7-9'
Project Number:	100-03-0148	Test Date:	5/1/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	22.52	23.74	24.03	20.17	20.31
Dry Soil and Tare	19.52	20.20	20.08	18.84	18.95
Wt. of Water	3.00	3.54	3.95	1.33	1.36
Tare Wt.	13.65	13.77	13.49	13.72	13.80
Dry Soil	5.87	6.43	6.59	5.12	5.15
Moisture content%	51.1	55.1	59.9	26.0	26.4
No. Of blows	31	22	15	Average:	26
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **54**

Plastic Limit: **26**

Plasticity Index: **28**

USCS CLASSIFICATION:

CH

Tested By: S. Brifkany Date: 5/1/2009

Reviewed By: M. Wolfe Date: 5/4/2009

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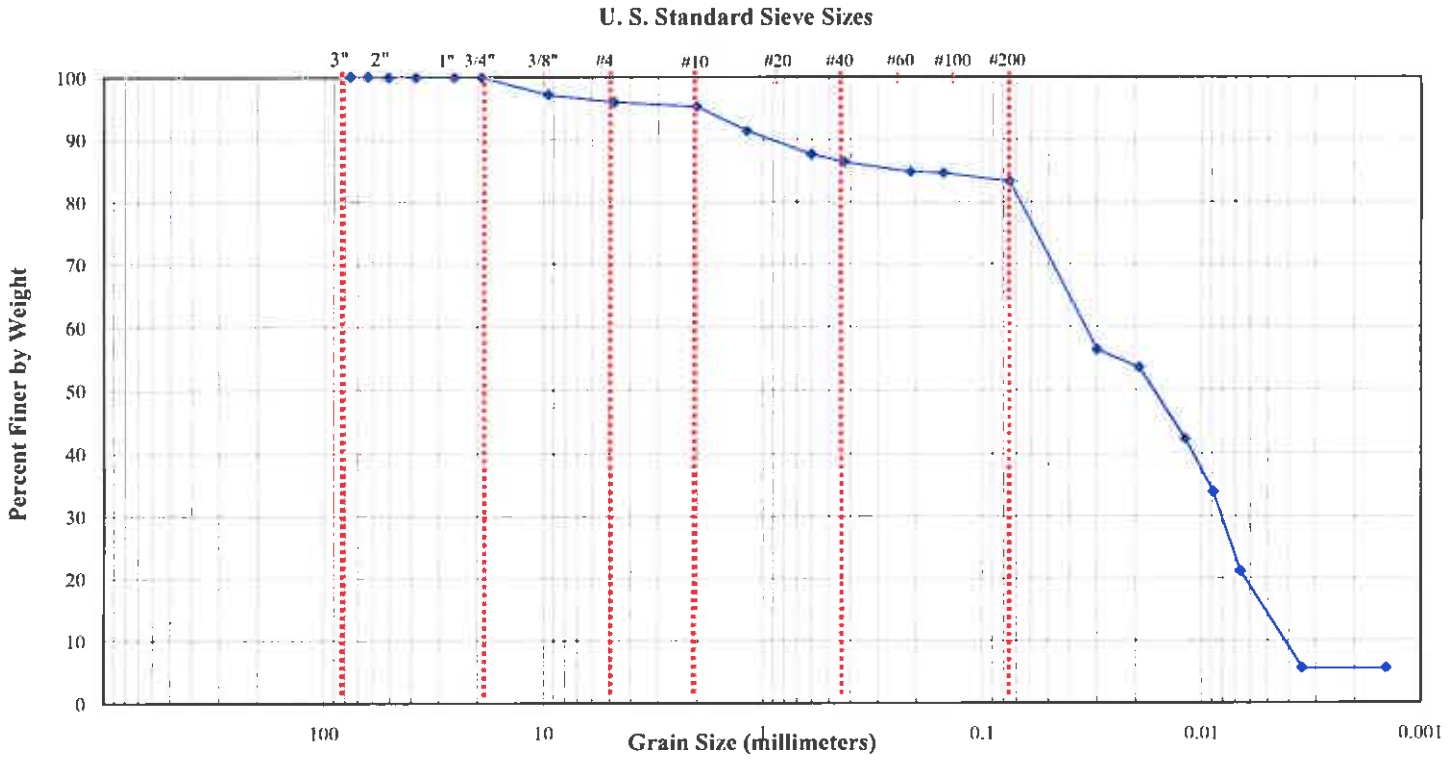
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-5	**Sample Number:**	ST-3
Depth:	7-9'	**Date Received:**	39896
Soil Description:	Dark to Light Brown Clay with silt, trace sand and chert fragments		

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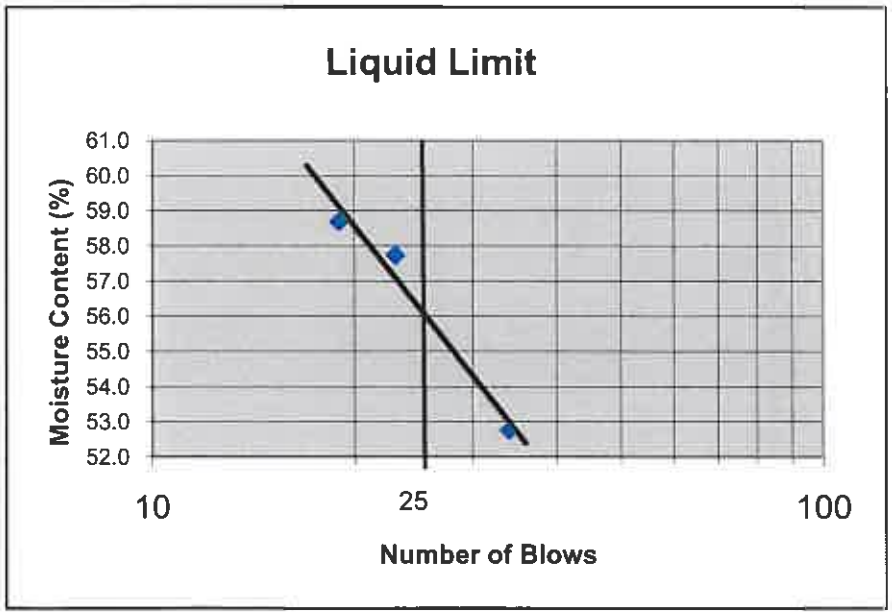
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-5 ST-4 9-10.5'
Project Number:	100-03-0148	Test Date:	5/6/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	19.57	26.93	22.24	19.79	19.12
Dry Soil and Tare	16.90	22.19	18.39	18.55	17.98
Wt. of Water	2.67	4.74	3.85	1.24	1.14
Tare Wt.	11.84	13.98	11.83	13.82	13.73
Dry Soil	5.06	8.21	6.56	4.73	4.25
Moisture content%	52.8	57.7	58.7	26.2	26.8
No. Of blows	34	23	19	Average:	27
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 56

Plastic Limit: 27

Plasticity Index: 29

USCS CLASSIFICATION:

CH

Tested By:	B. J. Bryant	Date:	5/6/2009
Reviewed By:	M. Wolfe	Date:	5/7/2009

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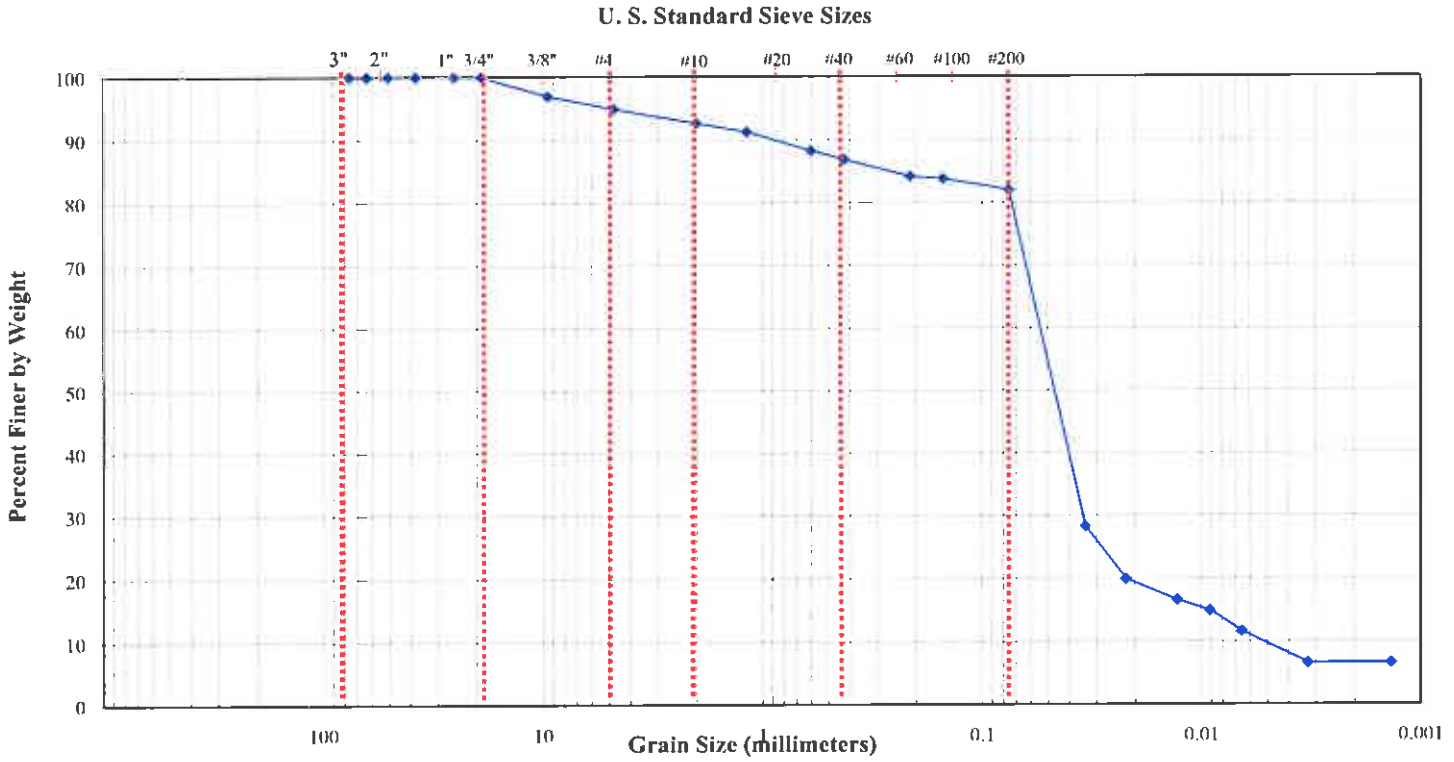
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-5	**Sample Number:**	ST-4
Depth:	9-10.5'	**Date Received:**	3/24/2009
Soil Description:	Brown Clay with Silt, trace sand and chert fragments		

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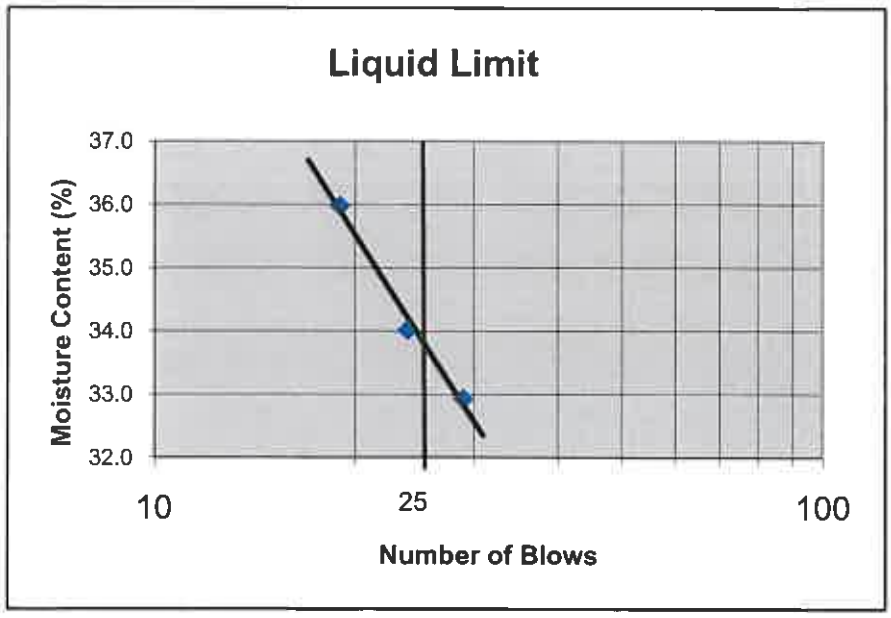
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-6 ST-1 2.5-4.5'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with tace sand		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	24.78	21.62	25.21	21.51	21.01
Dry Soil and Tare	22.08	19.63	22.17	20.19	19.74
Wt. of Water	2.70	1.99	3.04	1.32	1.27
Tare Wt.	13.88	13.78	13.72	13.62	13.67
Dry Soil	8.20	5.85	8.45	6.57	6.07
Moisture content%	32.9	34.0	36.0	20.1	20.9
No. Of blows	29	24	19	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **34**

Plastic Limit: **21**

Plasticity Index: **13**

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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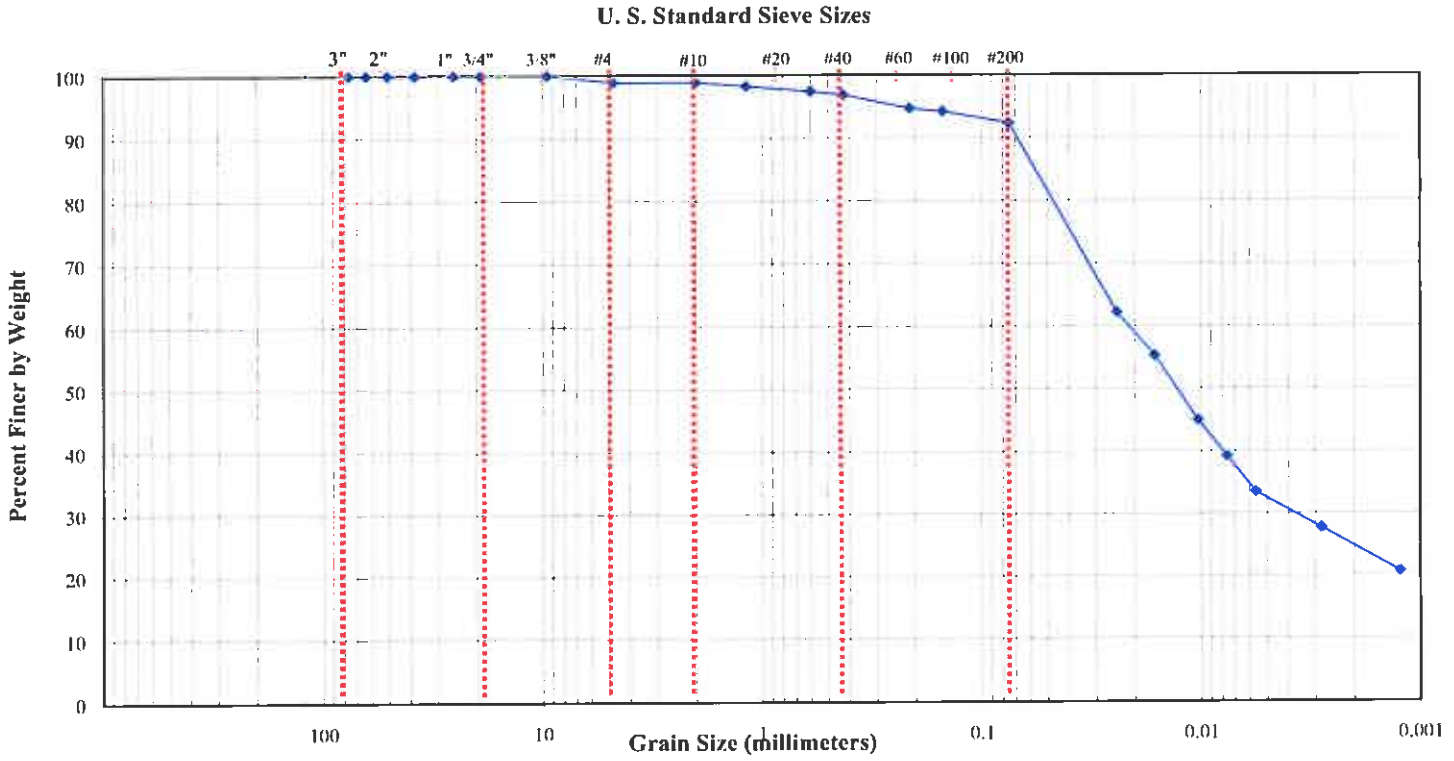
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-6	**Sample Number:**	**ST-1**
Depth:	2.5-4.5'	**Date Received:**	**3/24/2009**
Soil Description:	Light Brown Lean Clay with trace sand		

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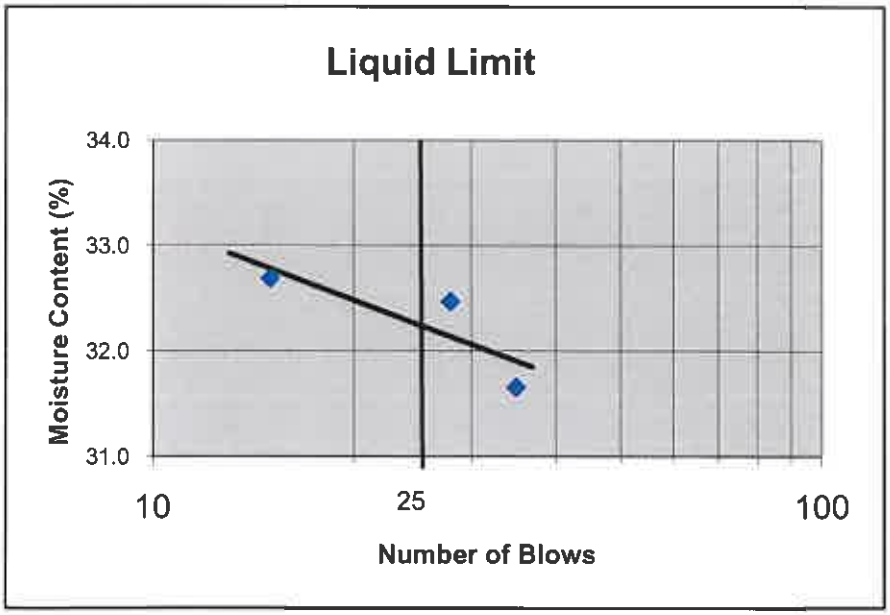
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-6 ST-2 5-7'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	25.40	23.96	24.81	23.99	20.75
Dry Soil and Tare	22.63	21.45	22.09	22.21	19.52
Wt. of Water	2.77	2.51	2.72	1.78	1.23
Tare Wt.	13.88	13.72	13.77	13.61	13.65
Dry Soil	8.75	7.73	8.32	8.60	5.87
Moisture content%	31.7	32.5	32.7	20.7	21.0
No. Of blows	35	28	15	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 32

Plastic Limit: 21

Plasticity Index: 11

USCS CLASSIFICATION:

CL

Tested By: S. Brifkany Date: 5/4/2009

Reviewed By: M. Wolfe Date: 5/5/2009

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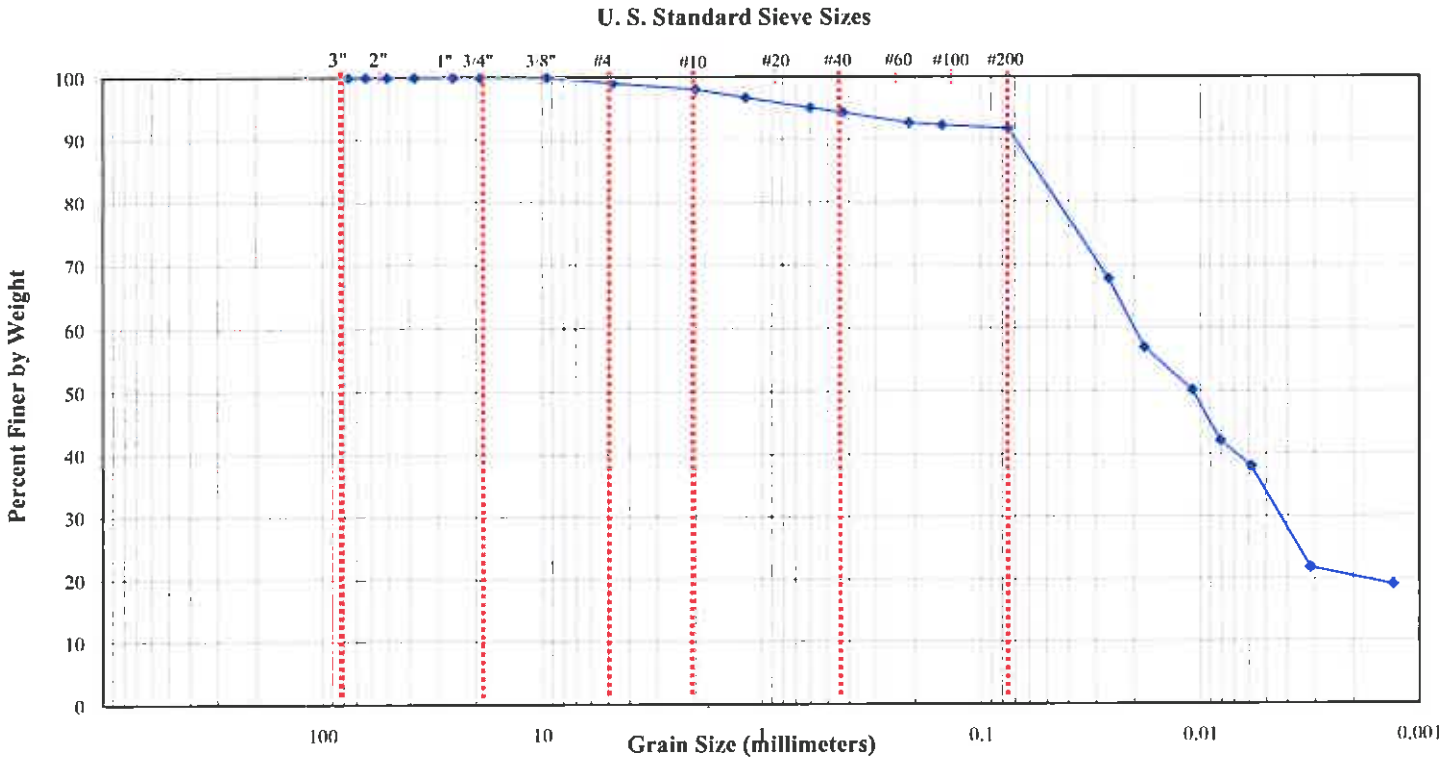
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-6	**Sample Number:**	ST-2
Depth:	5-7'	**Date Received:**	3/24/2009
Soil Description:	Brown Lean Clay with trace sand		

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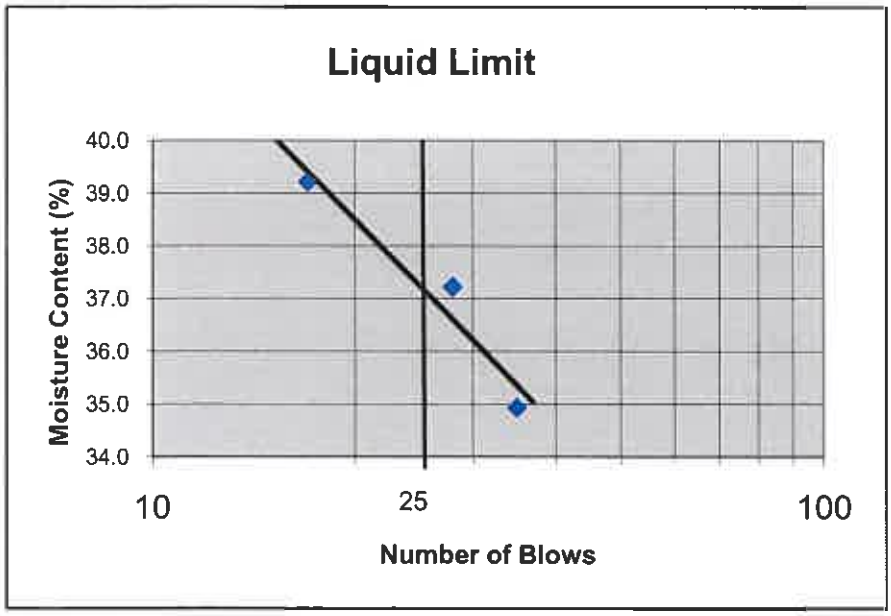
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-6 ST-3 7.5-9'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	23.16	22.99	25.06	20.52	21.56
Dry Soil and Tare	20.76	20.47	21.84	19.36	20.17
Wt. of Water	2.40	2.52	3.22	1.16	1.39
Tare Wt.	13.89	13.70	13.63	13.94	13.79
Dry Soil	6.87	6.77	8.21	5.42	6.38
Moisture content%	34.9	37.2	39.2	21.4	21.8
No. Of blows	35	28	17	Average:	22
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 37

Plastic Limit: 22

Plasticity Index: 15

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	5/5/2009
Reviewed By:	M. Wolfe	Date:	5/6/2009

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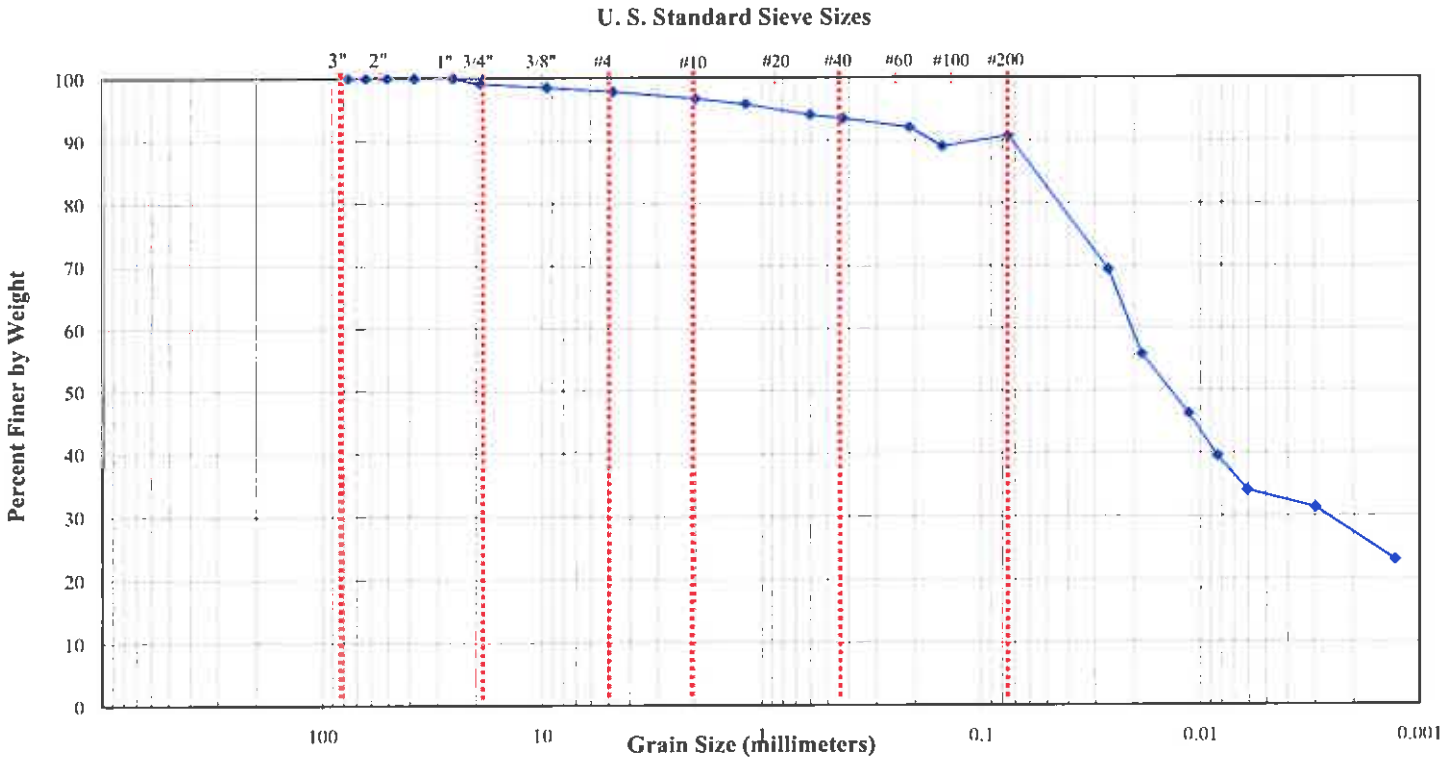
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-6	**Sample Number:**	**ST-3**
Depth:	7.5' - 9.0'	**Date Received:**	**39896**
Soil Description:	Light Brown Lean Clay with trace sand and chert fragments		

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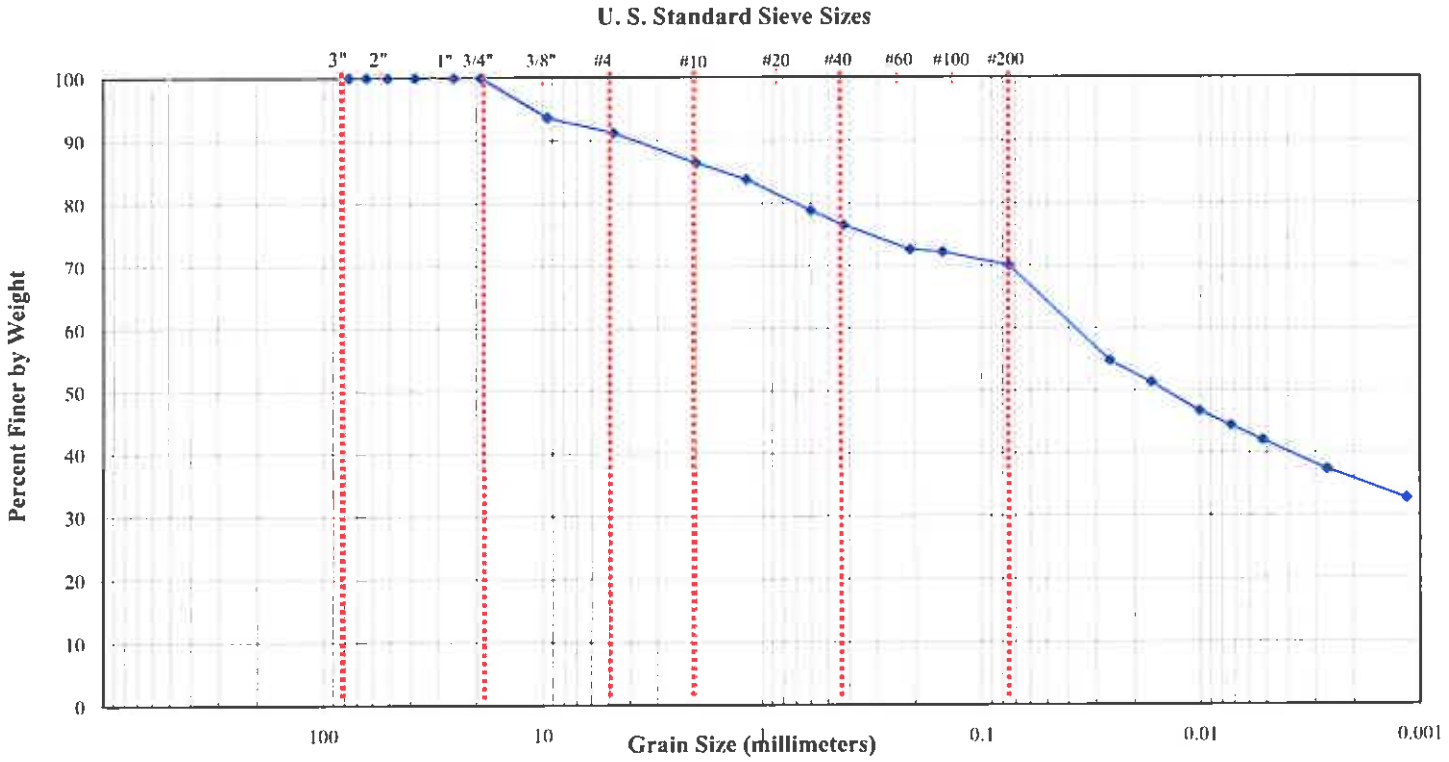
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-6	**Sample Number:**	SS-1
Depth:	14-15.5'	**Date Received:**	39896
Soil Description:	Light Brown Clay with silt, trace sand and chert		

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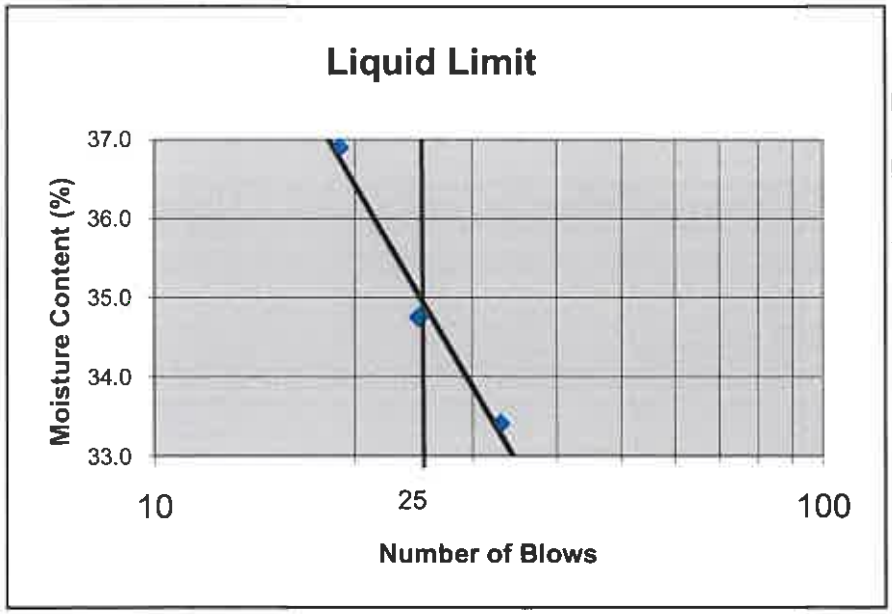
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-7 ST-1 2-4'
Project Number:	100-03-0148	Test Date:	4/29/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit				Plastic Content	
Tare No	1	2	3		4	5
Wet Soil and Tare	25.65	23.87	24.44		20.20	22.17
Dry Soil and Tare	22.65	21.26	21.58		19.16	20.82
Wt. of Water	3.00	2.61	2.86		1.04	1.35
Tare Wt.	13.67	13.75	13.83		13.90	13.98
Dry Soil	8.98	7.51	7.75		5.26	6.84
Moisture content%	33.4	34.8	36.9		19.8	19.7
No. Of blows	33	25	19		Average:	20
Required Blows	***25-35***	***20-30***	***15-25***			



Liquid Limit: **35**

Plastic Limit: **20**

Plasticity Index: **15**

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	4/29/2009
Reviewed By:	M. Wolfe	Date:	4/30/2009

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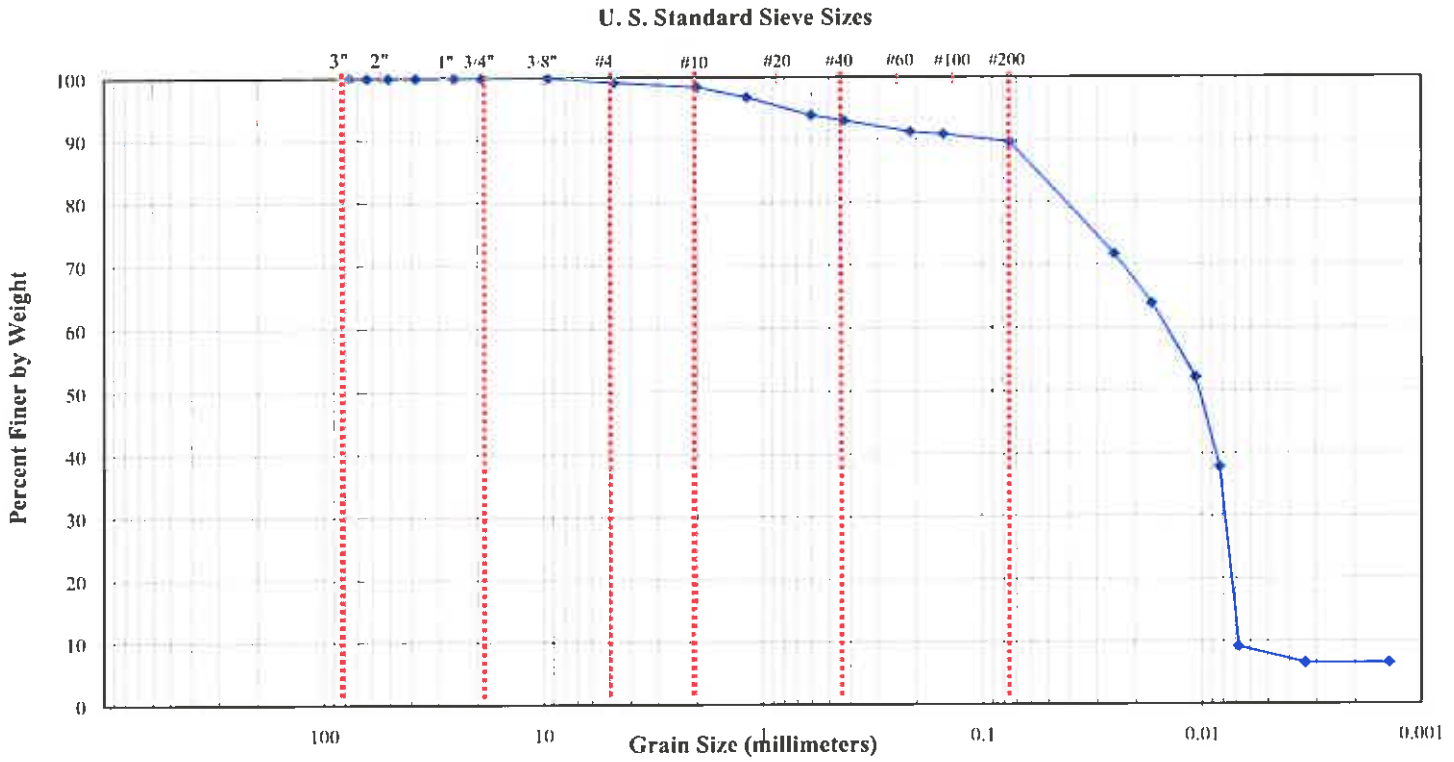
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-7	**Sample Number:**	**ST-1**
Depth:	2-4'	**Date Received:**	**3/24/2009**
Soil Description:	Brown Lean Clay with trace sand		

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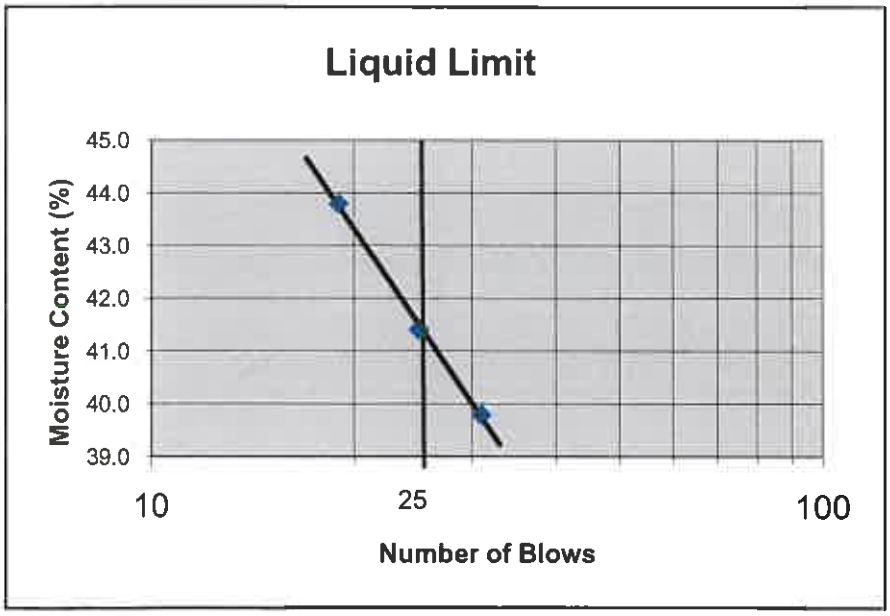
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-7 ST-3 6-6.75'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	25.51	25.82	24.50	19.52	21.42
Dry Soil and Tare	22.18	22.30	21.29	18.54	20.11
Wt. of Water	3.33	3.52	3.21	0.98	1.31
Tare Wt.	13.81	13.80	13.96	13.89	13.76
Dry Soil	8.37	8.50	7.33	4.65	6.35
Moisture content%	39.8	41.4	43.8	21.1	20.6
No. Of blows	31	25	19	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 42

Plastic Limit: 21

Plasticity Index: 21

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	5/4/2009
Reviewed By:	M. Wolfe	Date:	5/5/2009

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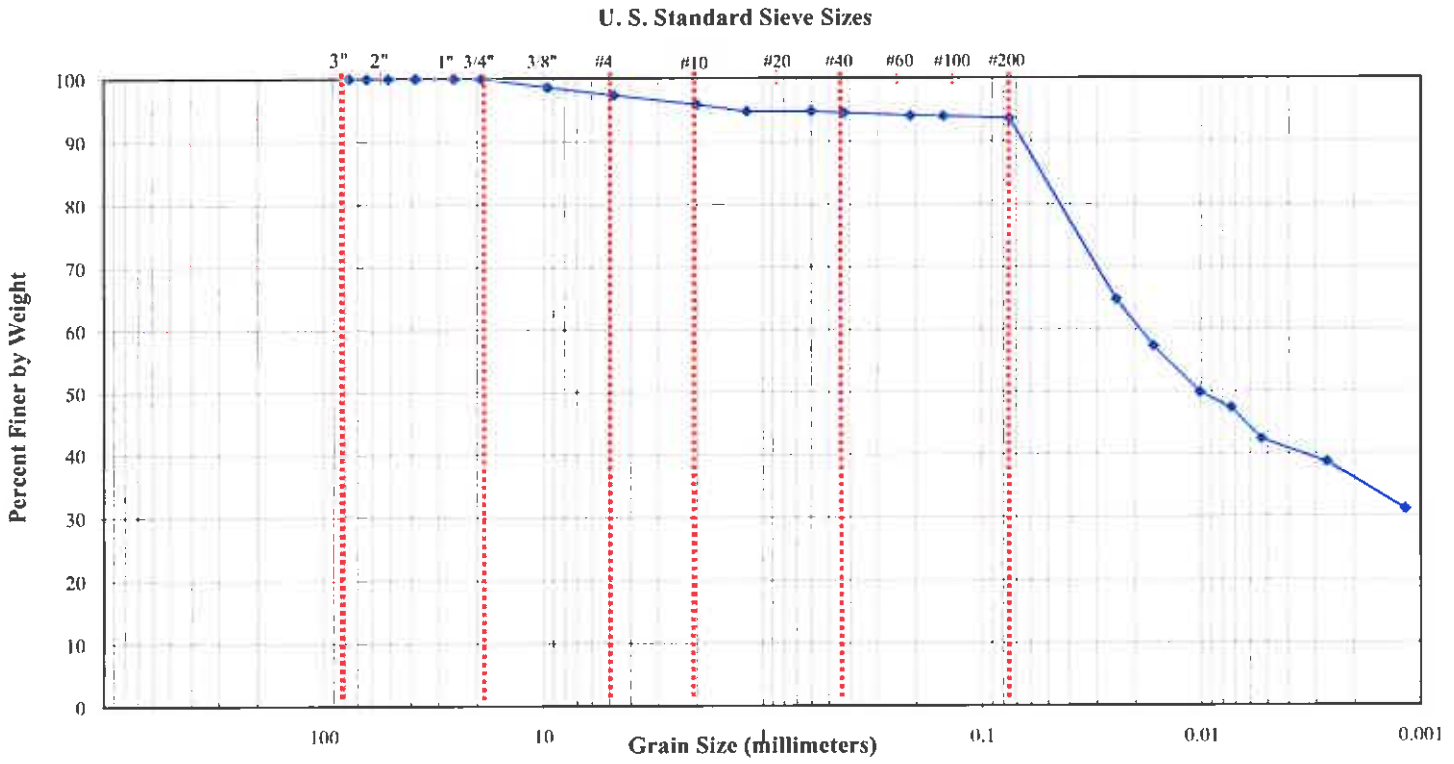
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-7	**Sample Number:**	**ST-3**
Depth:	6-6.75'	**Date Received:**	**39896**
Soil Description:	Brown Lean Clay with trace sand		

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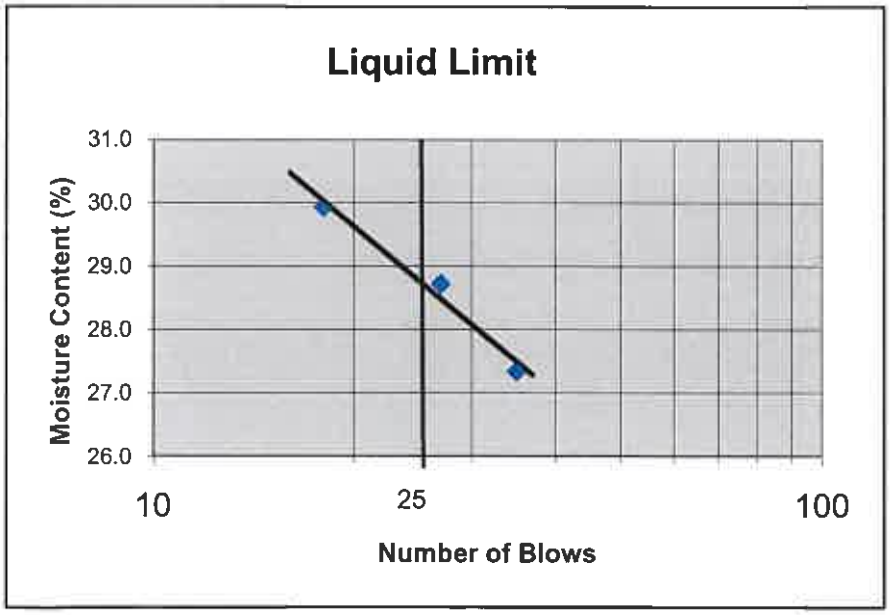
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-8 ST-1 2-4'
Project Number:	100-03-0148	Test Date:	4/27/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	26.76	23.28	24.83	20.68	20.93
Dry Soil and Tare	23.99	21.14	22.33	19.52	19.77
Wt. of Water	2.77	2.14	2.50	1.16	1.16
Tare Wt.	13.86	13.69	13.98	13.65	13.78
Dry Soil	10.13	7.45	8.35	5.87	5.99
Moisture content%	27.3	28.7	29.9	19.8	19.4
No. Of blows	35	27	18	Average:	20
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 29

Plastic Limit: 20

Plasticity Index: 9

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	4/27/2009
Reviewed By:	M. Wolfe	Date:	4/28/2009

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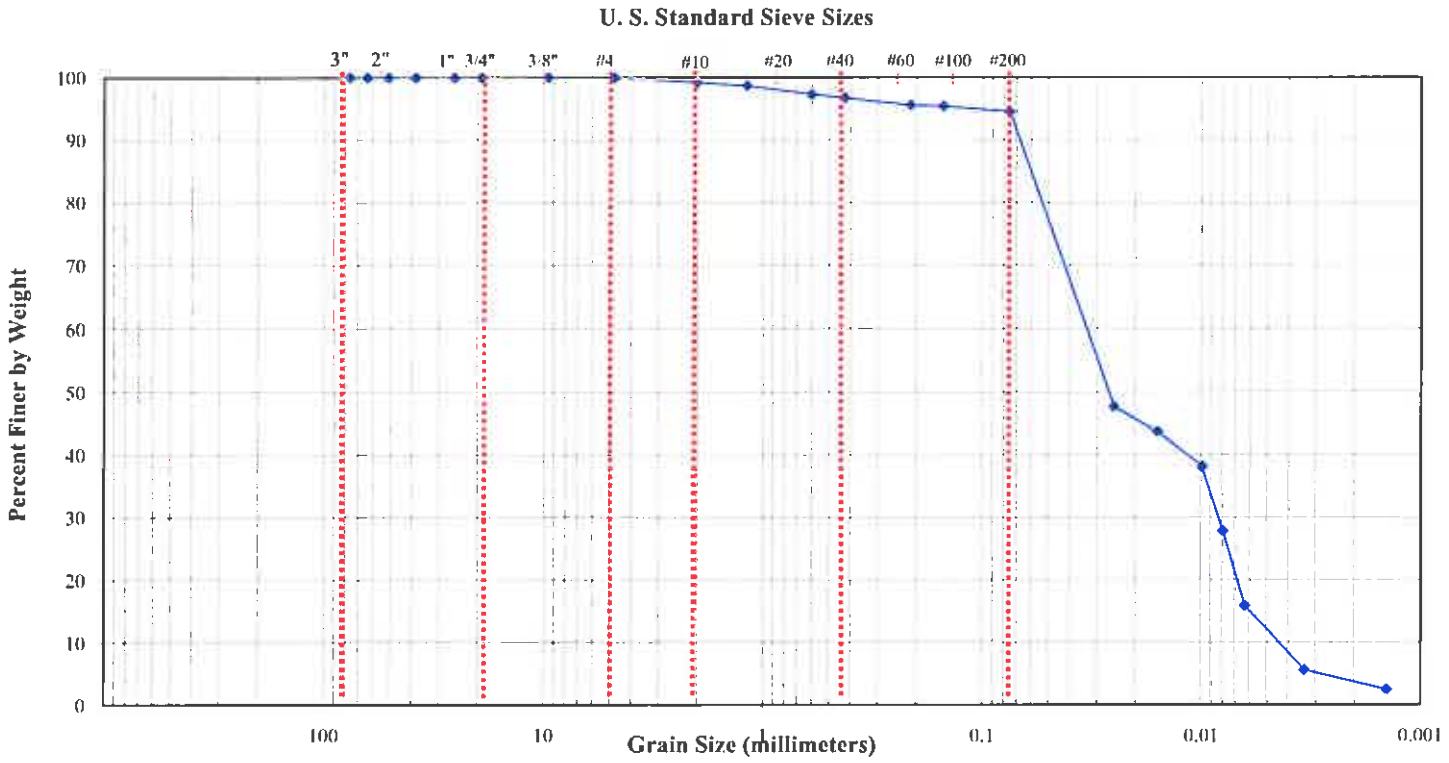
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-8	**Sample Number:**	**ST-1**
Depth:	2-4'	**Date Received:**	**3/24/2009**
Soil Description:	Light Brown Lean Clay with trace **sand**		

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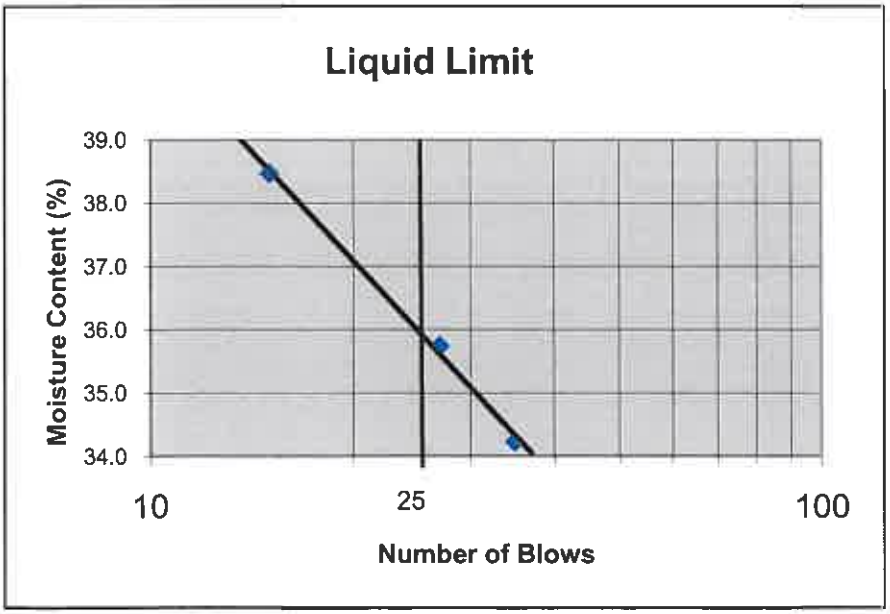
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-8 ST-2 4-6'
Project Number:	100-03-0148	Test Date:	4/28/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	24.88	23.53	24.21	20.86	20.38
Dry Soil and Tare	22.08	21.80	21.29	19.62	19.22
Wt. of Water	2.80	1.73	2.92	1.24	1.16
Tare Wt.	13.90	16.96	13.70	13.69	13.77
Dry Soil	8.18	4.84	7.59	5.93	5.45
Moisture content%	34.2	35.7	38.5	20.9	21.3
No. Of blows	35	27	15	Average:	21
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **36**

Plastic Limit: **21**

Plasticity Index: **15**

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	4/28/2009
Reviewed By:	M. Wolfe	Date:	5/1/2009

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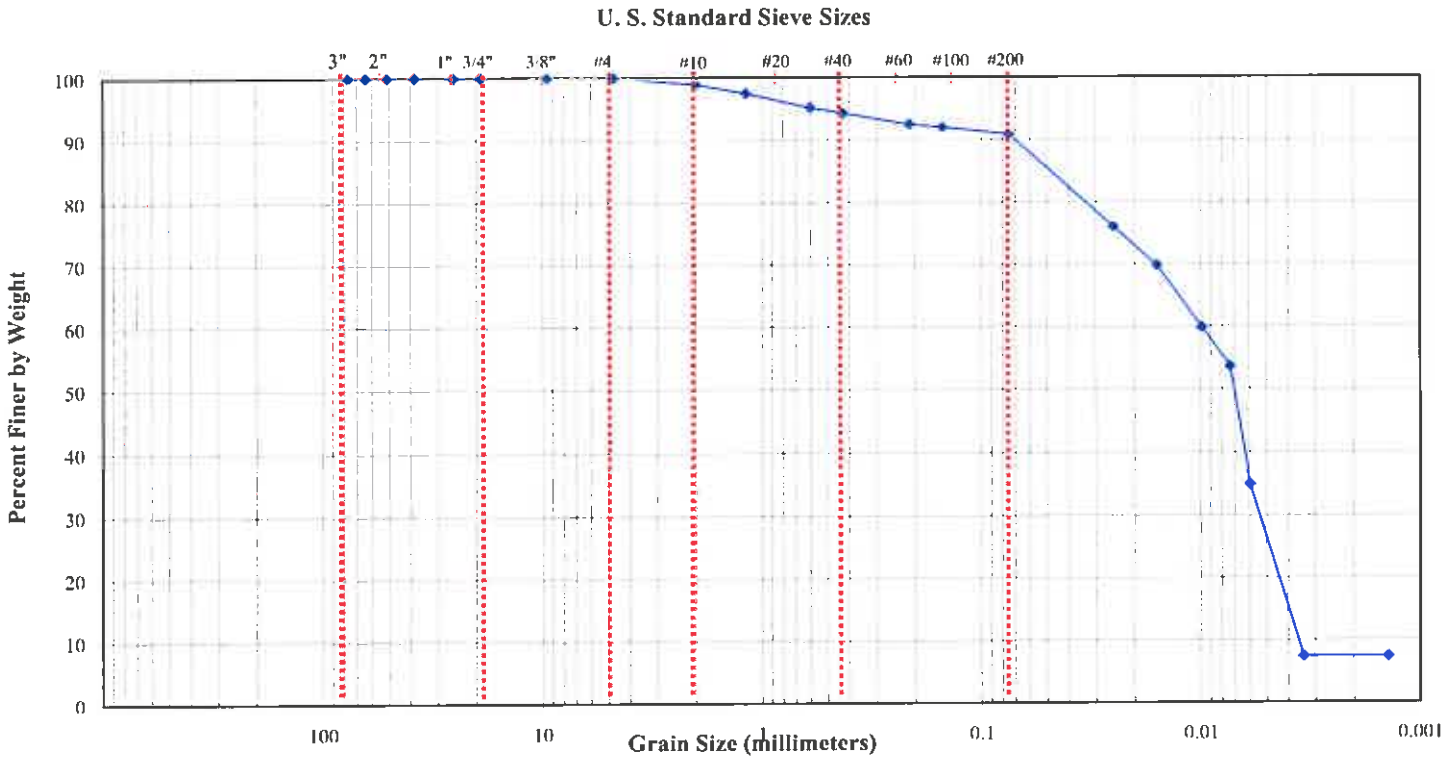
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	B-8	**Sample Number:**	**ST-2**
Depth:	4-6'	**Date Received:**	**3/24/2009**
Soil Description:	Brown Lean Clay with trace sand		

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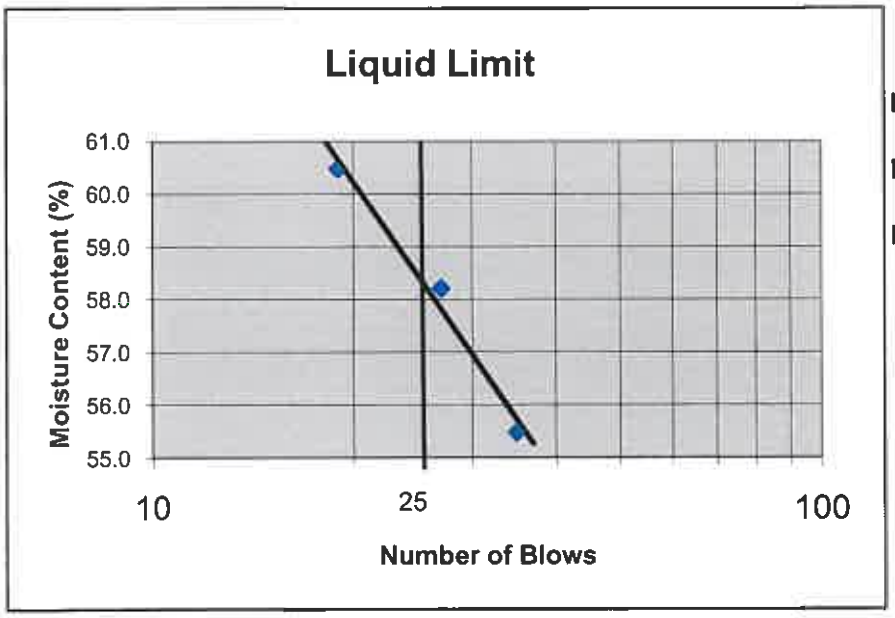
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-8 ST-3 7-9'
Project Number:	100-03-0148	Test Date:	4/29/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Grey to Light Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	22.74	25.58	21.65	20.13	20.04
Dry Soil and Tare	19.50	21.22	18.65	18.67	18.67
Wt. of Water	3.24	4.36	3.00	1.46	1.37
Tare Wt.	13.66	13.73	13.69	13.84	13.76
Dry Soil	5.84	7.49	4.96	4.83	4.91
Moisture content%	55.5	58.2	60.5	30.2	27.9
No. Of blows	35	27	19	Average:	29
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 59

Plastic Limit: 29

Plasticity Index: 30

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	4/29/2009
Reviewed By:	M. Wolfe	Date:	4/30/2009

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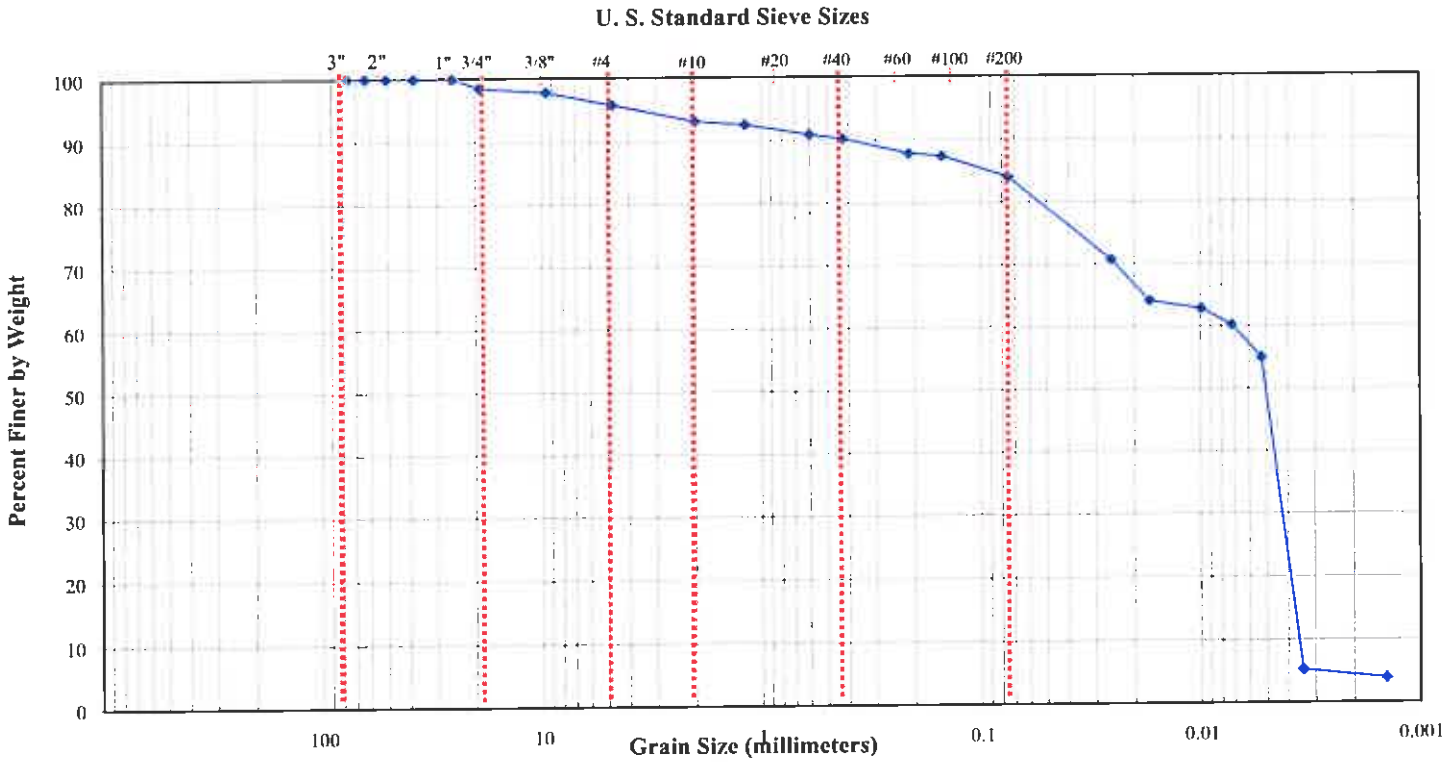
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-8	**Sample Number:**	ST-3
Depth:	7-9'	**Date Received:**	3/24/2009
Soil Description:	Grey to Light Brown Clay, with silt, sand and trace chert fragments		

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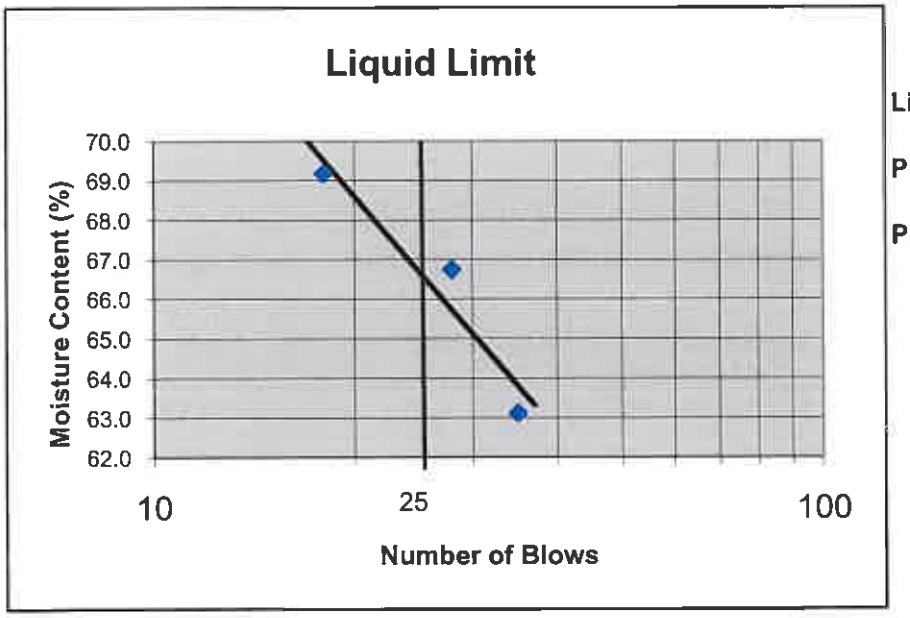
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	B-8 ST-4 9-11'
Project Number:	100-03-0148	Test Date:	4/28/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	21.81	23.12	21.13	18.69	19.25
Dry Soil and Tare	18.73	20.27	18.19	17.62	18.02
Wt. of Water	3.08	2.85	2.94	1.07	1.23
Tare Wt.	13.85	16.00	13.94	13.94	13.70
Dry Soil	4.88	4.27	4.25	3.68	4.32
Moisture content%	63.1	66.7	69.2	29.1	28.5
No. Of blows	35	28	18	Average:	29
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 67

Plastic Limit: 29

Plasticity Index: 38

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	4/28/2009
Reviewed By:	M. Wolfe	Date:	5/1/2009

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KSWA

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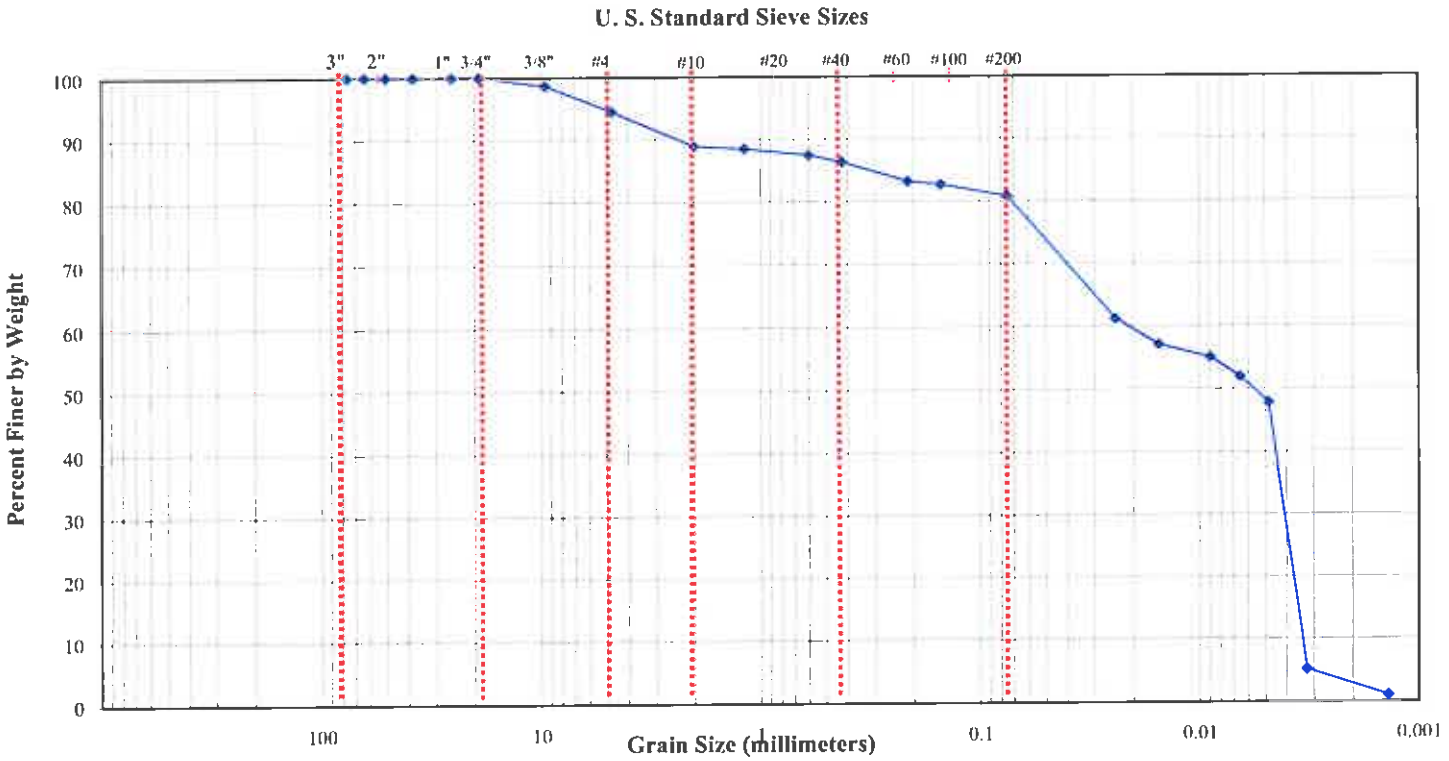
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	B-8	**Sample Number:**	ST-4
Depth:	9-11'	**Date Received:**	3/24/2009
Soil Description:	Brown Clay, with silt, trace sand and chert fragments		

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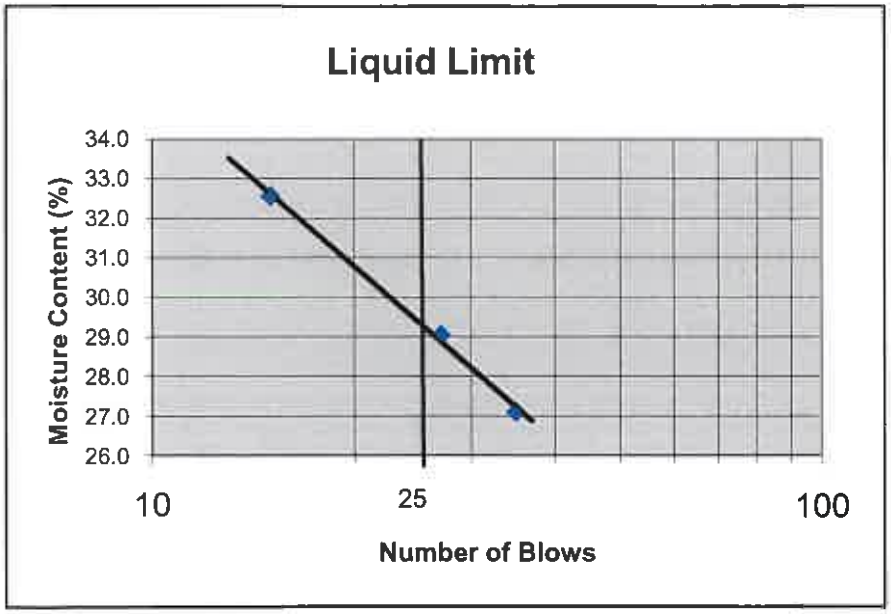
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	TB-2 ST-1 2.5-4.5'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Light Brown Silty Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	22.88	23.69	26.15	22.16	19.95
Dry Soil and Tare	20.98	21.43	23.04	20.66	18.82
Wt. of Water	1.90	2.26	3.11	1.50	1.13
Tare Wt.	13.97	13.65	13.49	13.68	13.73
Dry Soil	7.01	7.78	9.55	6.98	5.09
Moisture content%	27.1	29.0	32.6	21.5	22.2
No. Of blows	35	27	15	Average:	22
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 29

Plastic Limit: 22

Plasticity Index: 7

USCS CLASSIFICATION:

CL-ML

Tested By:	S. Brifkany	Date:	5/4/2009
Reviewed By:	M. Wolfe	Date:	5/5/2009

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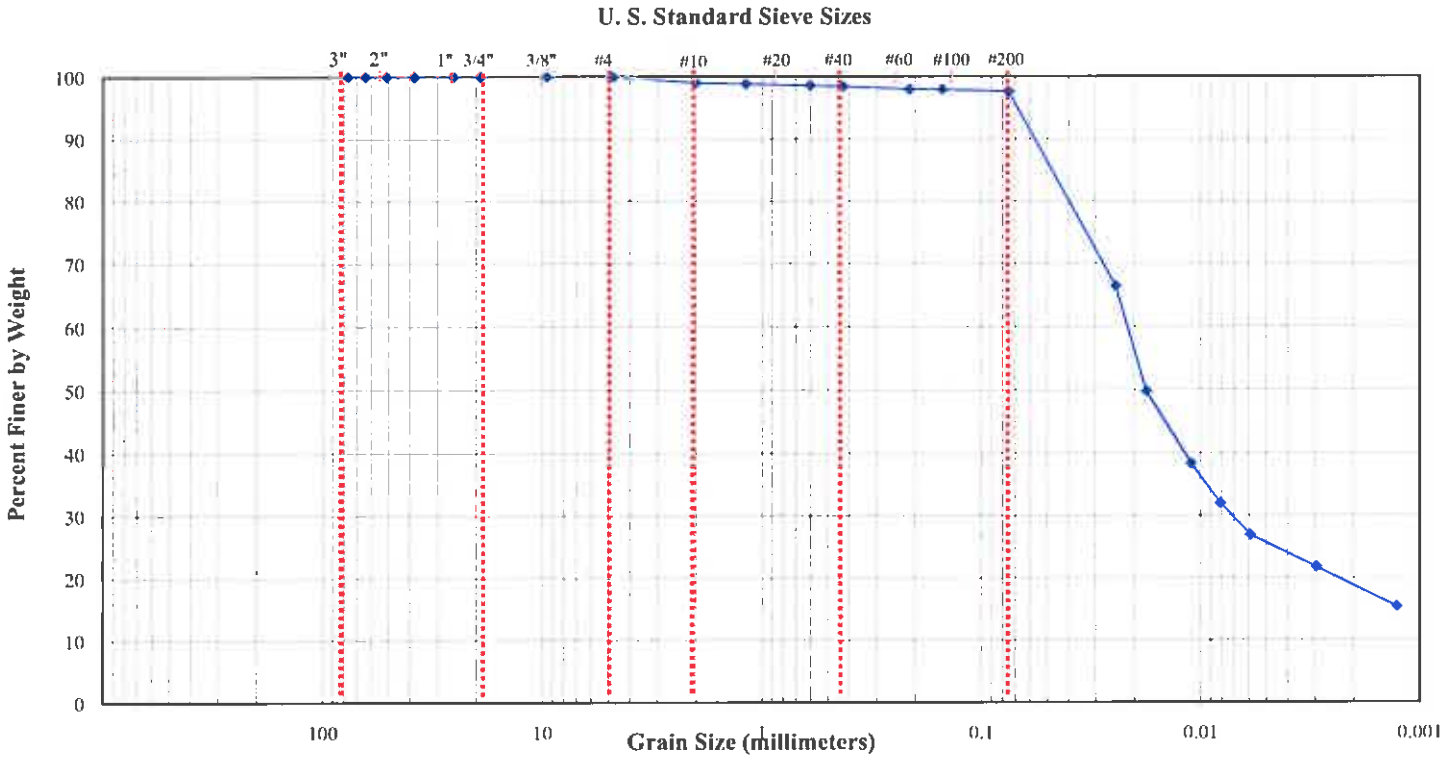
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	TB-2	**Sample Number:**	**ST-1**
Depth:	2.5-4.5'	**Date Received:**	**3/24/2009**
Soil Description:	Light Brown Silty Clay with trace sand		

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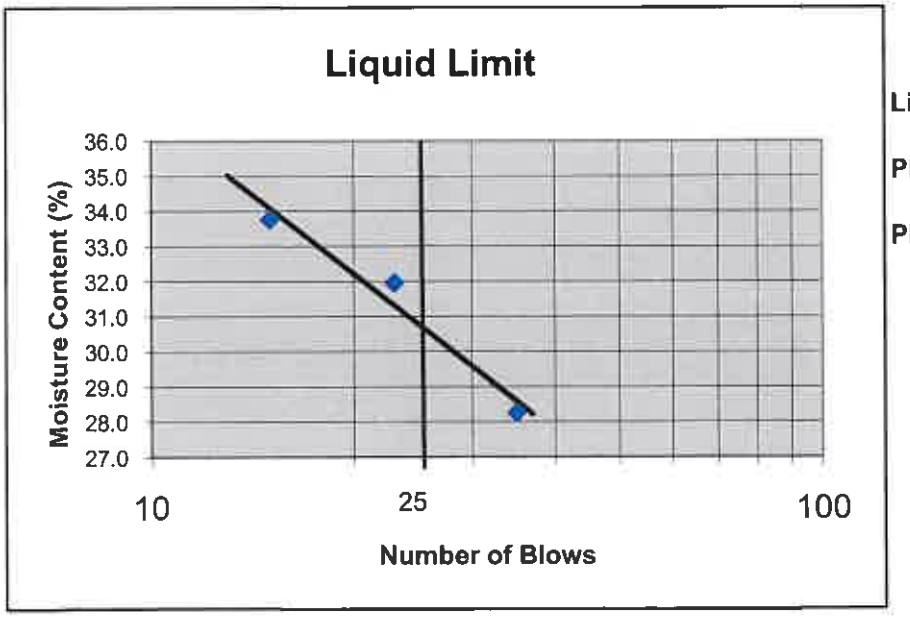
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	TB-2 ST-2 4-6'
Project Number:	100-03-0148	Test Date:	5/5/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Orange Tan Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	22.32	21.98	19.95	15.62	18.80
Dry Soil and Tare	19.65	19.26	17.88	14.99	17.68
Wt. of Water	2.67	2.72	2.07	0.63	1.12
Tare Wt.	10.20	10.75	11.75	11.78	11.85
Dry Soil	9.45	8.51	6.13	3.21	5.83
Moisture content%	28.3	32.0	33.8	19.6	19.2
No. Of blows	35	23	15	Average:	19
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 31

Plastic Limit: 19

Plasticity Index: 12

USCS CLASSIFICATION:

CL

Tested By: C. Smith Date: 5/5/2009

Reviewed By: M. Wolfe Date: 5/6/2009

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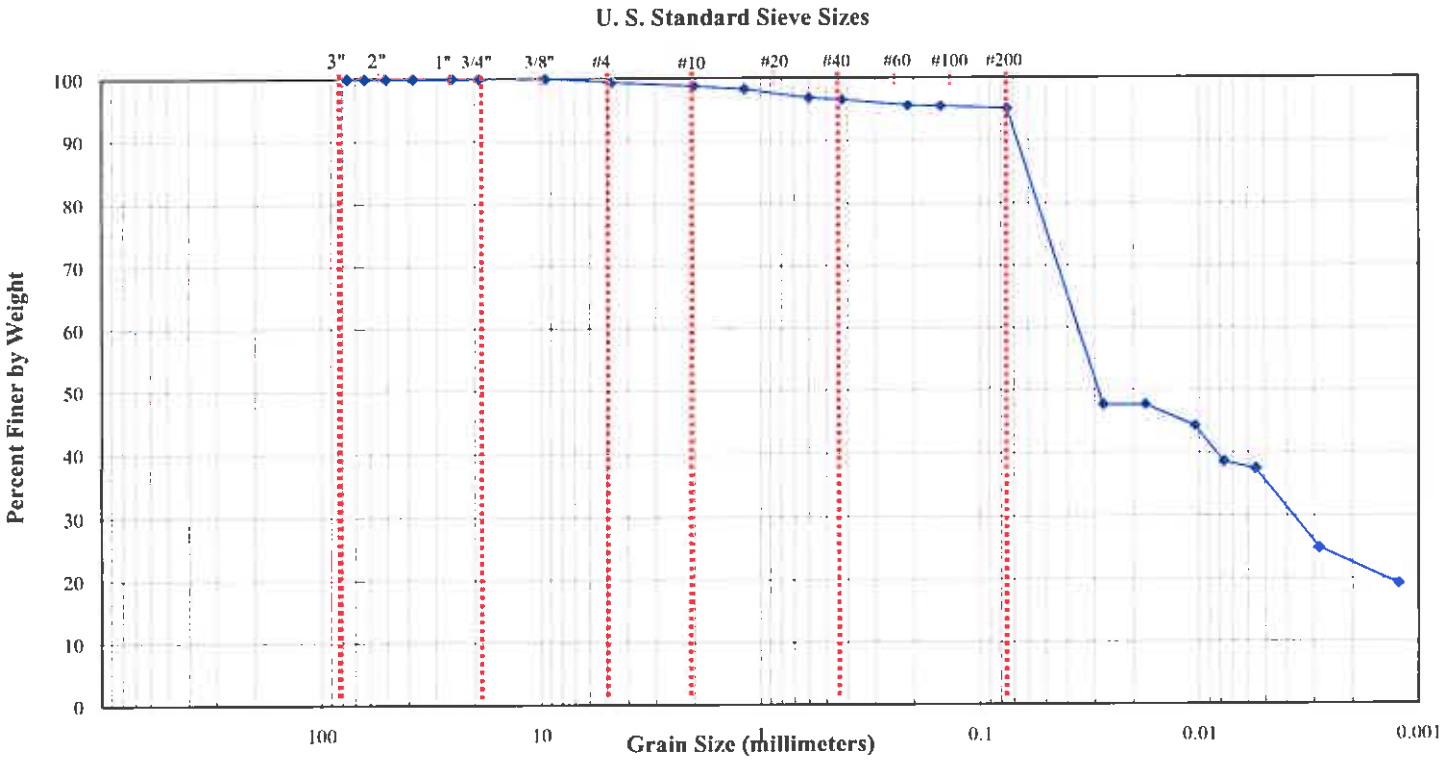
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	TB-2	**Sample Number:**	**ST-2**
Depth:	4.5-6.5'	**Date Received:**	**3/24/2009**
Soil Description:	Orange Tan Lean Clay with trace sand		

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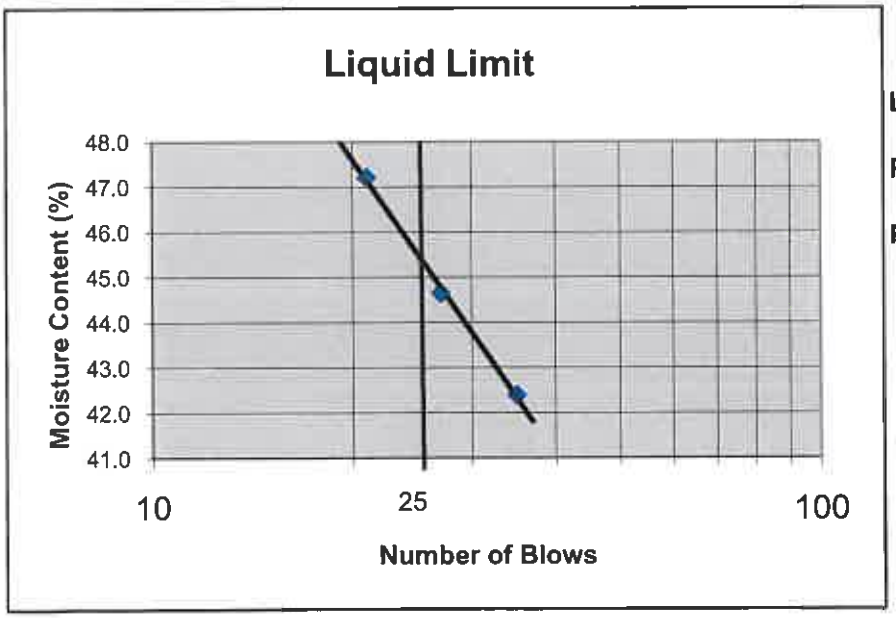
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	TB-2 ST-4 9.5-11.5'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Red Brown Lean Clay with sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	21.84	23.97	24.19	22.03	22.32
Dry Soil and Tare	19.39	20.80	20.89	20.52	20.71
Wt. of Water	2.45	3.17	3.30	1.51	1.61
Tare Wt.	13.61	13.70	13.90	13.80	13.62
Dry Soil	5.78	7.10	6.99	6.72	7.09
Moisture content%	42.4	44.6	47.2	22.5	22.7
No. Of blows	35	27	21	Average:	23
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 46

Plastic Limit: 23

Plasticity Index: 23

USCS CLASSIFICATION:

CL

Tested By:	S. Brifkany	Date:	5/4/2009
Reviewed By:	M. Wolfe	Date:	5/5/2009

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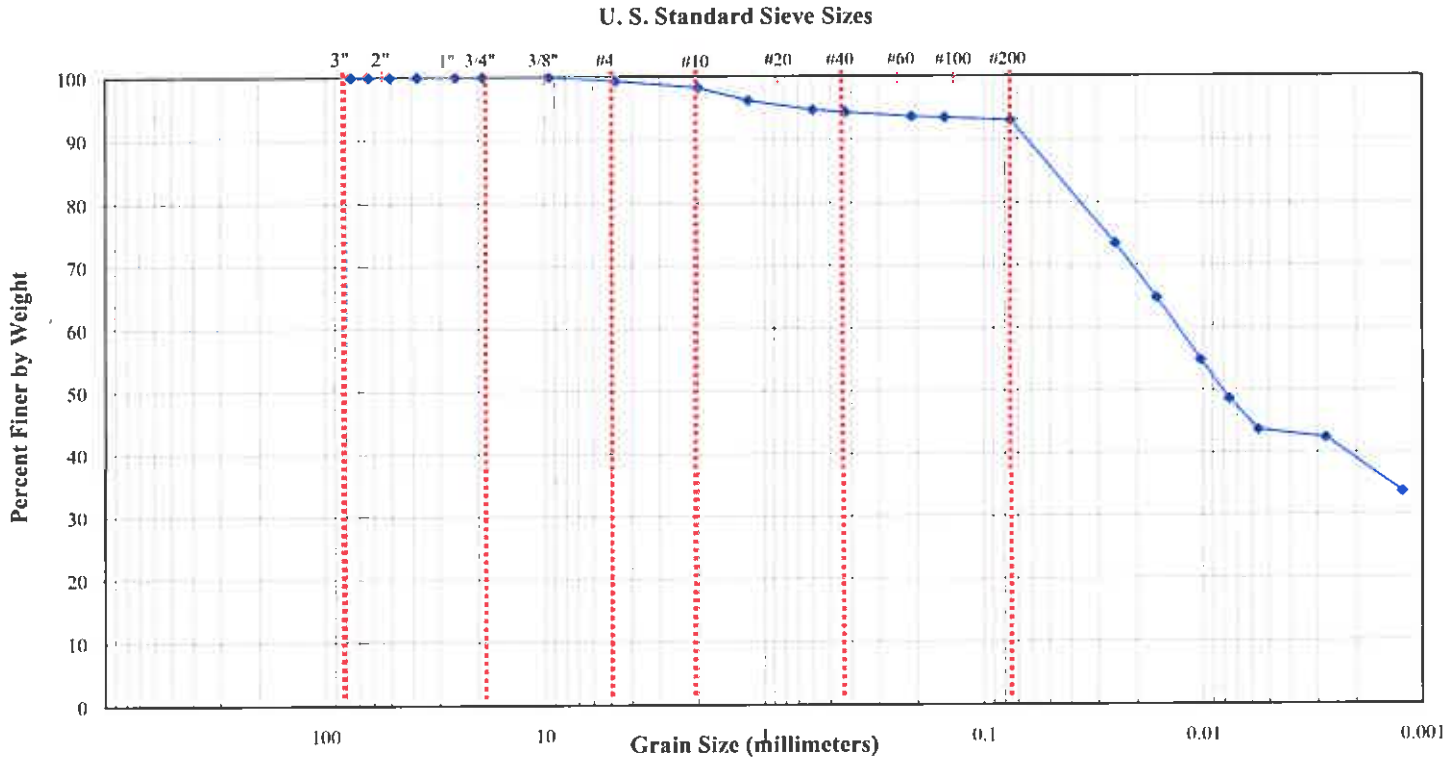
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	TB-2	**Sample Number:**	**ST-4**
Depth:	9.5-11.5'	**Date Received:**	**39896**
Soil Description:	Red Brown Lean Clay with trace sand		

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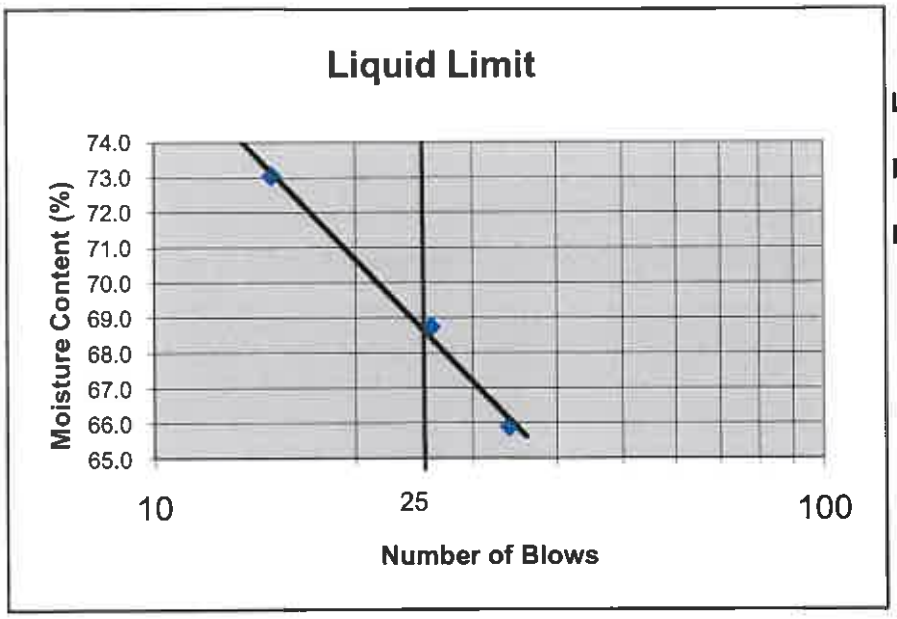
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolf Pen Branch Road	Sample ID:	TB-2 ST-6 19.5-21.5'
Project Number:	100-03-0148	Test Date:	5/4/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Dark Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit			Plastic Content	
Tare No	1	2	3	4	5
Wet Soil and Tare	23.90	23.03	26.12	20.80	21.50
Dry Soil and Tare	19.90	19.27	21.00	19.11	19.61
Wt. of Water	4.00	3.76	5.12	1.69	1.89
Tare Wt.	13.83	13.80	13.99	13.77	13.71
Dry Soil	6.07	5.47	7.01	5.34	5.90
Moisture content%	65.9	68.7	73.0	31.6	32.0
No. Of blows	34	26	15	Average:	32
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: 69

Plastic Limit: 32

Plasticity Index: 37

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	5/4/2009
Reviewed By:	M. Wolfe	Date:	5/5/2009

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Nashville, TN 37210

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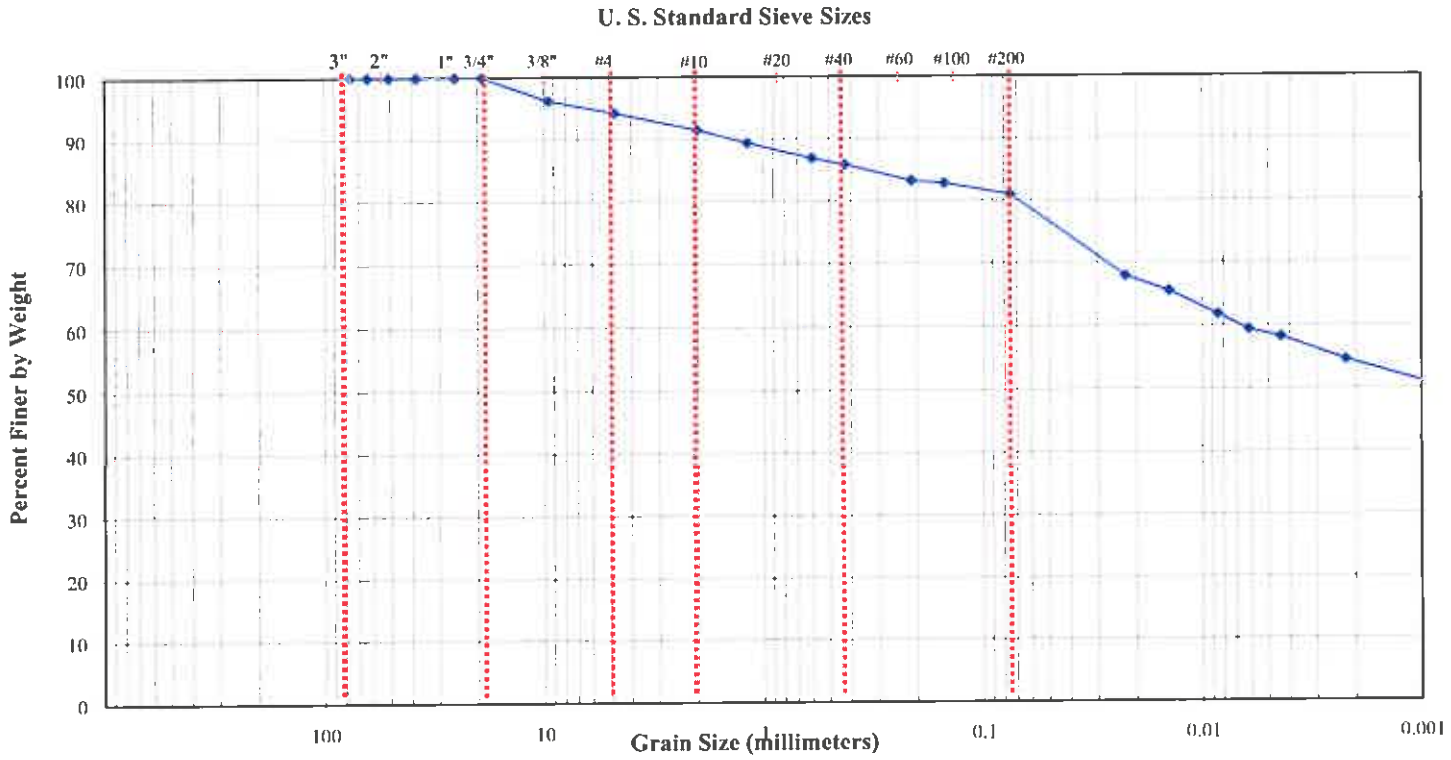
Engineering, Environmental & Information Services

Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	100-03-0148
Sample Location:	TB-2	**Sample Number:**	ST-6
Depth:	19.5-21.5'	**Date Received:**	39896
Soil Description:	Dark Brown Clay, with Silt and trace sand and chert fragments		

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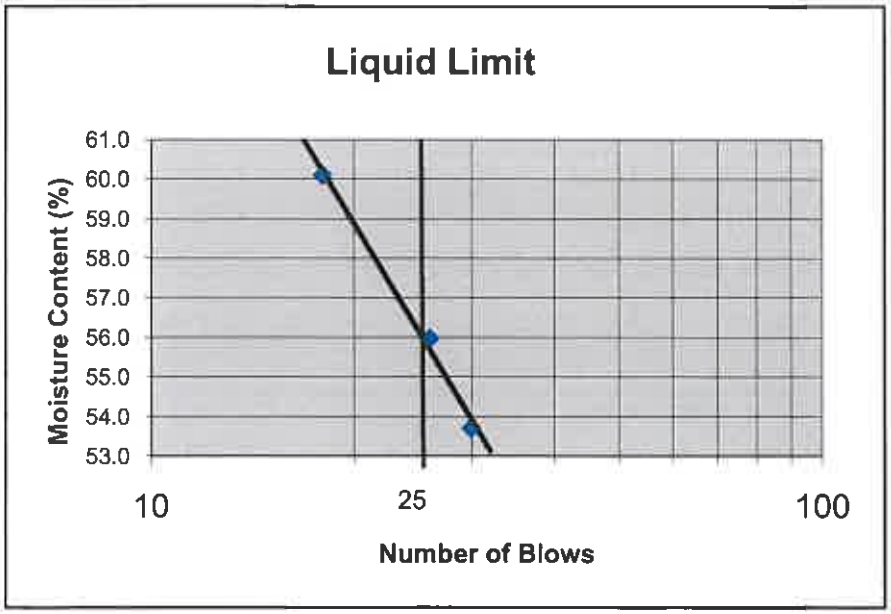
Report of Liquid Limit, Plastic Limit & Plasticity Index ASTM D4318

Project Name:	Wolfpen Branch Road	Sample ID:	TB-2 ST-7 25.5-26.7'
Project Number:	100-03-0148	Test Date:	5/1/2009
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestel, Spatula, Grooving Tool		
Sample Description:	Brown Clay with silt, sand and trace chert fragments		
Date Received:	3/24/2009		

	Liquid Limit				Plastic Content	
Tare No	1	2	3		4	5
Wet Soil and Tare	23.90	22.84	25.89		20.08	21.24
Dry Soil and Tare	20.49	19.56	21.31		18.73	19.71
Wt. of Water	3.41	3.28	4.58		1.35	1.53
Tare Wt.	14.14	13.70	13.69		13.69	13.99
Dry Soil	6.35	5.86	7.62		5.04	5.72
Moisture content%	53.7	56.0	60.1		26.8	26.7
No. Of blows	30	26	18		Average:	27
Required Blows	***25-35***	***20-30***	***15-25***			



Liquid Limit: **56**

Plastic Limit: **27**

Plasticity Index: **29**

USCS CLASSIFICATION:

CH

Tested By:	S. Brifkany	Date:	5/1/2009
Reviewed By:	M. Wolfe	Date:	5/4/2009

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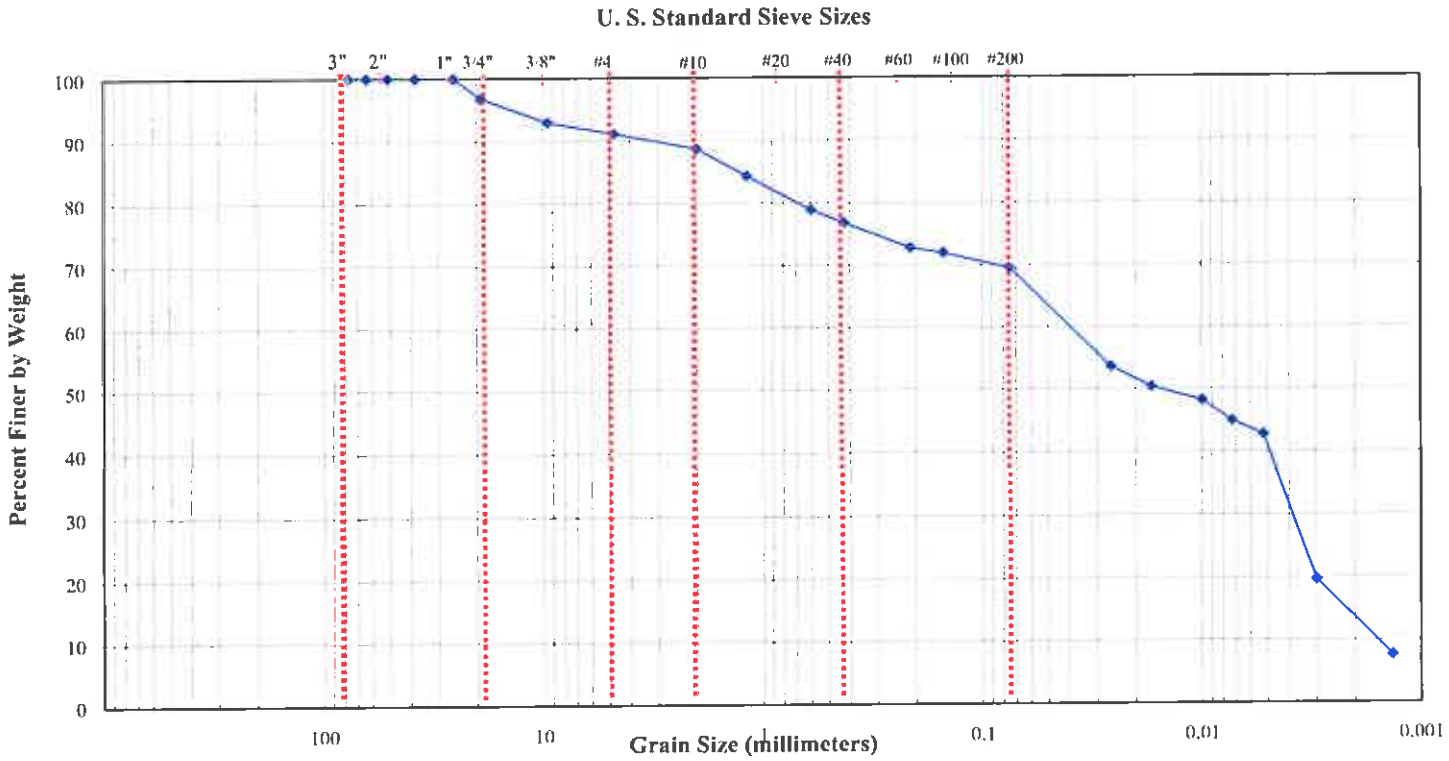
Grain Size Distribution

Boulders	Cobbles	Gravel		Sand			Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clays



Project Name:	Wolf Pen Branch Road	**Project Number:**	**100-03-0148**
Sample Location:	TB-2	**Sample Number:**	**ST-7**
Depth:	24.5-26.5'	**Date Received:**	**39896**
Soil Description:	Brown Clay, with silt, trace sand and chert fragments		

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UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORES (ASTM D2938)

Project Name: Wolfpen Branch Road
Project Number: 100-03-0148.001
Client: H.W. Lochner, Inc.
Client Job Number :
Contractor:
Core Description: Limestone
Date Sampled :
Date Received: 3/24/2009

Boring No.	Depth	Average Dia.(in)	Average Length (in.)	Surface area(sq.in)	L/D Ratio	Load (lb)	Corrected Strength (psi)
B-1 Run 1	18.0-18.4	2.00	4.15	3.14	2.08	27760	**8840**
B-2 Run 2	13.5-13.9	1.98	4.41	3.08	2.23	29490	**9580**
B-3 Run 2	11.6-12.0	1.99	4.14	3.11	2.08	32200	**10350**
B-4 Run 9	57.0-57.4	1.99	4.36	3.11	2.19	30610	**9840**
B-4 Run 13	75.5-75.9	1.99	4.08	3.11	2.05	11400	**3670**
B-5 Run 14	72.8-73.2	1.99	4.25	3.11	2.14	14070	**4520**
B-5 Run 11	58.5-58.9	2.00	4.15	3.14	2.08	47590	**15150**
B-7 Run 2	16.0-16.4	1.98	4.37	3.08	2.21	25060	**8140**
B-7 Run 2	20.5-20.9	1.98	4.21	3.08	2.13	33290	**10812**
B-8 Run 2	21.5-21.9	1.98	4.16	3.08	2.10	27030	**8779**
TB-1 Run 2	17.5-17.9	1.98	4.21	3.08	2.13	28160	**9146**
TB-2 Run 1	27.1-27.5	1.98	4.13	3.08	2.09	36290	**11786**

Remarks:

Submitted By: M. Wolfe **Date:** 5/4/2009
Reviewed By: **Date:**

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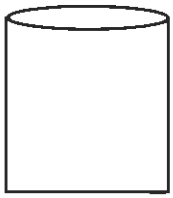
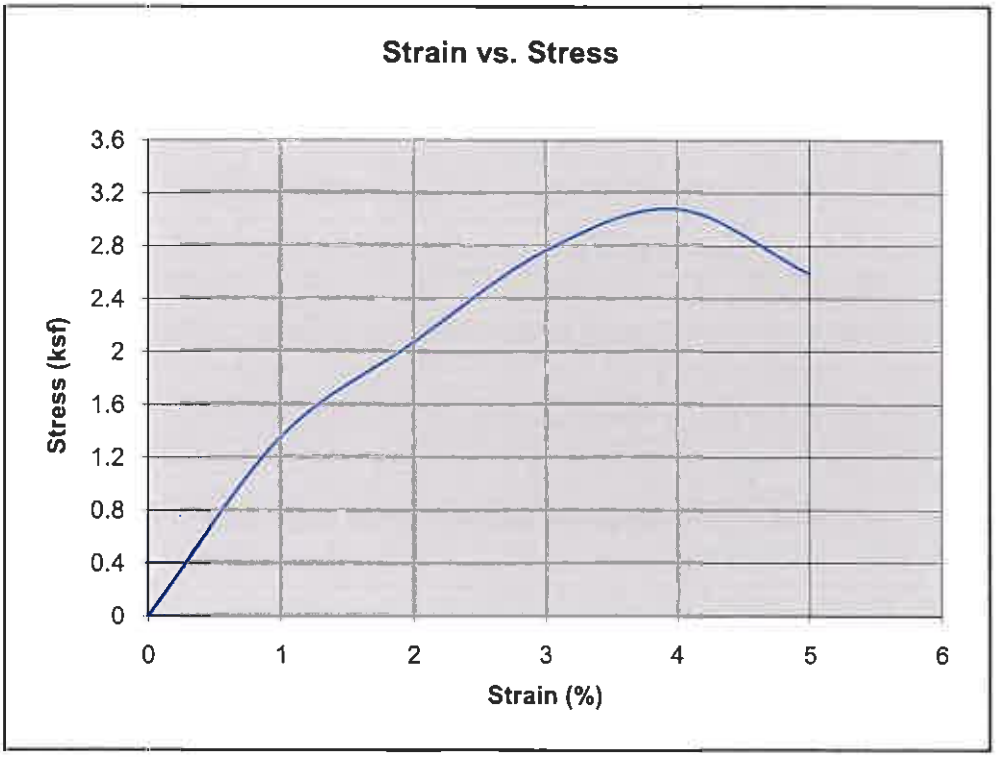
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #	B-1	**Sample #**	ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/20/2009			**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube				
Sample Description:	Light Brown Silty Clay with sand and trace chert fragments				
Testing apparatus:	Model 7691 S/N 2147				
Wet Density:	109.8				
Dry Density:	51.3	**Initial Height:**	5.72		
Moisture Content:	114.1%	**Initial Diameter:**	2.84		
Deg of Sat.:		**Specific Gravity:**			





Qu = 3.1 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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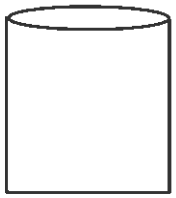
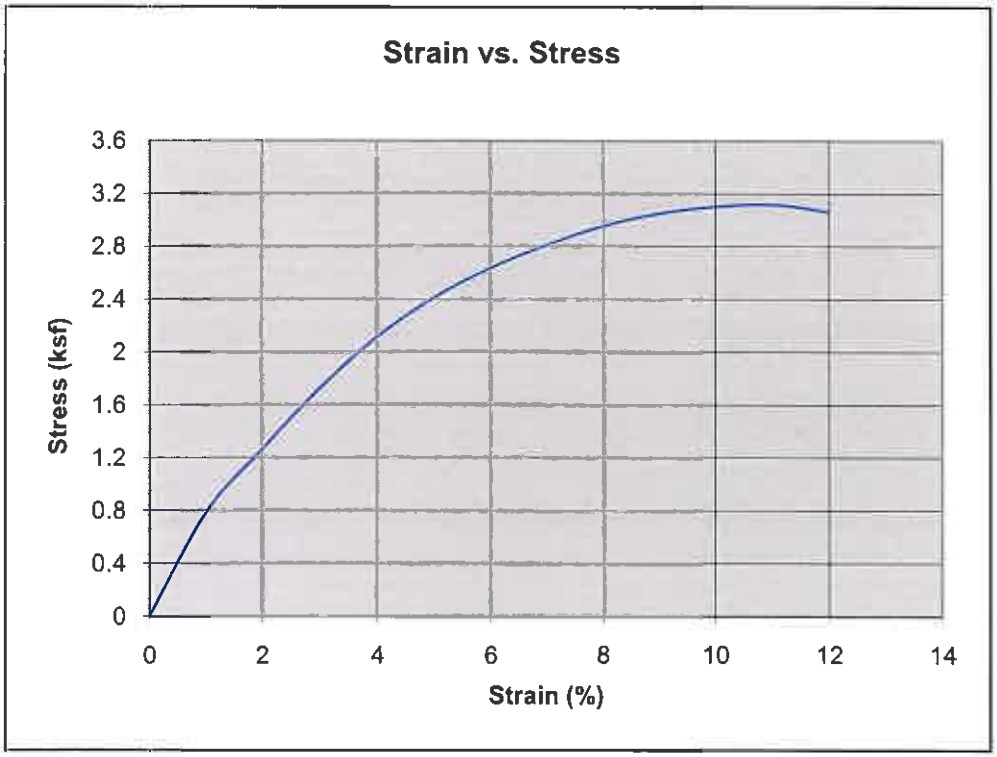
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	B-1	**Sample #:**	ST-5	**Depth:**	14.0'-16.0'
Date Tested:	4/20/2009			**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube				
Sample Description:	Dark Brown Elastic Silt with sand and trace chert fragments				

Testing apparatus: Model 7691 S/N 2147

Wet Density:	128.3		
Dry Density:	104.6	**Initial Height:**	5.64
Moisture Content:	22.7%	**Initial Diameter:**	2.82
Deg of Sat.:		**Specific Gravity:**	





Qu = 3.1 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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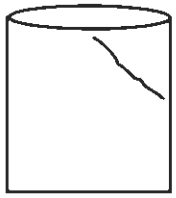
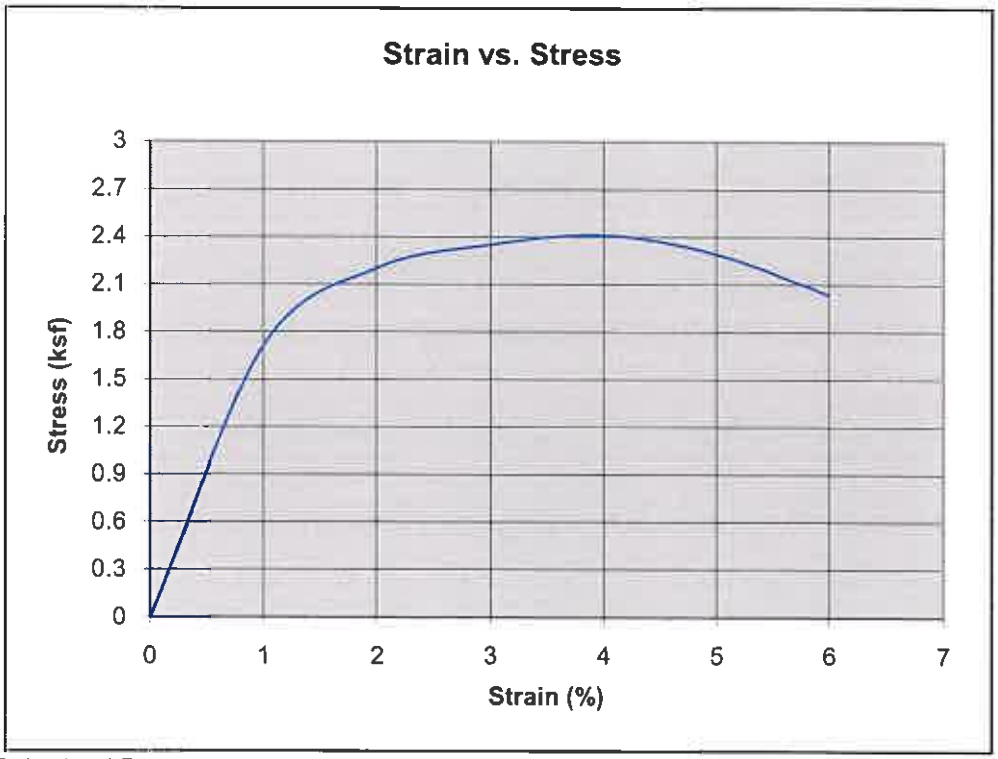
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road	**Job number:**	100-03-0148
Boring #	B-2	**Sample #**	ST-3	**Depth:**	7.0'-9.0'
Date Tested:	4/29/2009	**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube		
Sample Description:	Brown Silty Clay with sand and trace chert fragments		

Testing apparatus: Model 7691 S/N 2147

Wet Density:	113.5		
Dry Density:	86.4	**Initial Height:**	5.56
Moisture Content:	31.4%	**Initial Diameter:**	2.88
Deg of Sat.:		**Specific Gravity:**	





Qu =2.4 ksf

Submitted By: M. Wolfe Date: 4/30/2009

Reviewed By: J. Wilson Date: 5/1/2009

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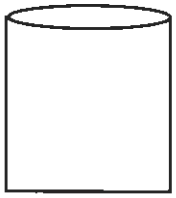
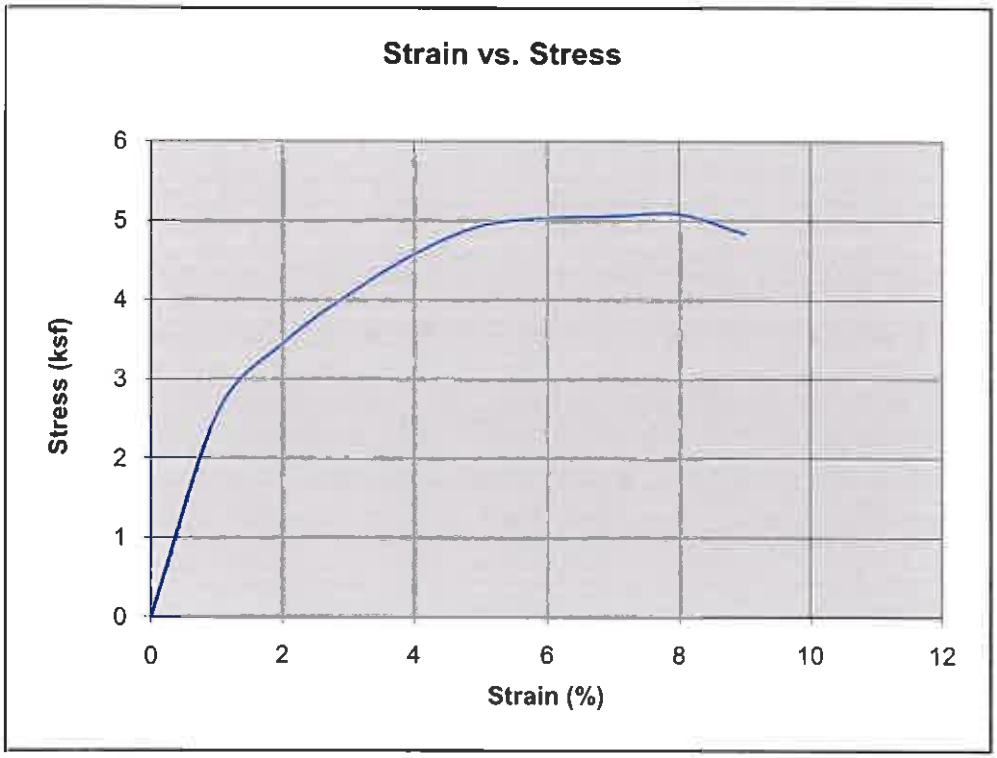
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road	**Job number:**	100-03-0148
Boring #:	B-4	**Sample #:**	ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/20/2009	**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube		
Sample Description:	Light Brown Silty Clay with sand		
Testing apparatus:	Model 7691 S/N 2147		

Wet Density:	123.1		
Dry Density:	101.2	**Initial Height:**	5.73
Moisture Content:	21.6%	**Initial Diameter:**	2.86
Deg of Sat.:		**Specific Gravity:**	





Qu =5.1 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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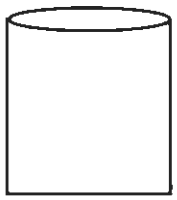
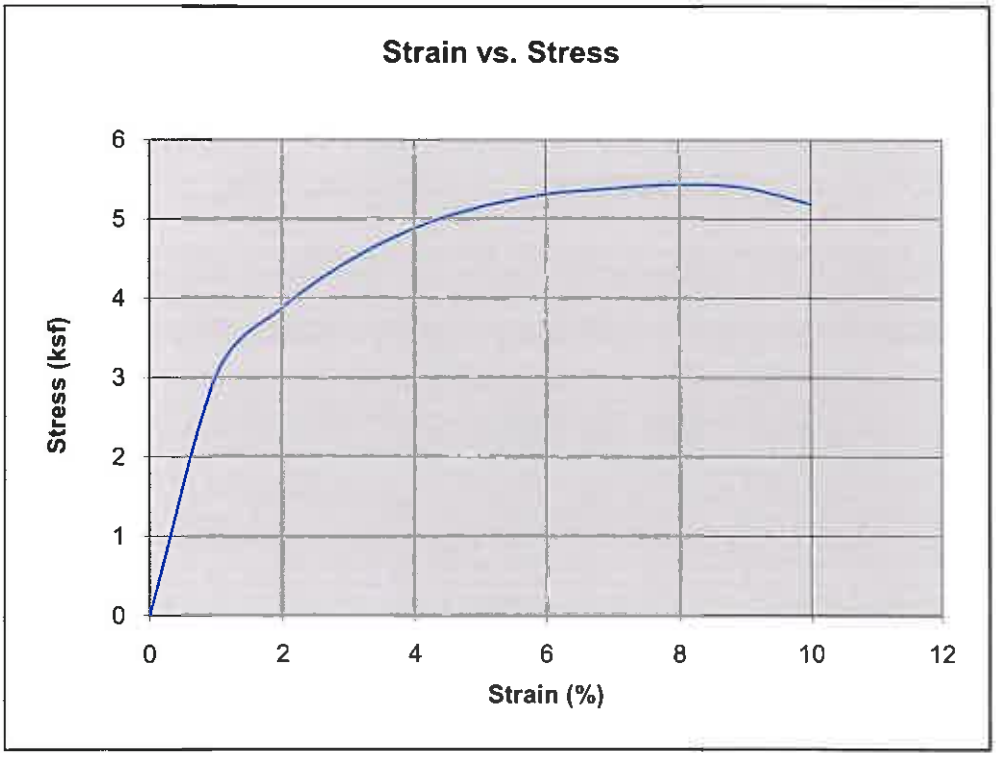
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	B-4	**Sample #:**	ST-4	**Depth:**	9.0'-11.0'
Date Tested:	4/20/2009			**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube				
Sample Description:	Light Brown Silty Clay with sand and trace chert fragments				

Testing apparatus: Model 7691 S/N 2147

Wet Density:	124.5		
Dry Density:	101.0	**Initial Height:**	5.72
Moisture Content:	23.3%	**Initial Diameter:**	2.84
Deg of Sat.:		**Specific Gravity:**	





Qu = 5.5 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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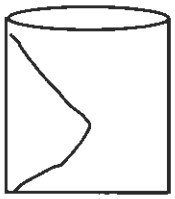
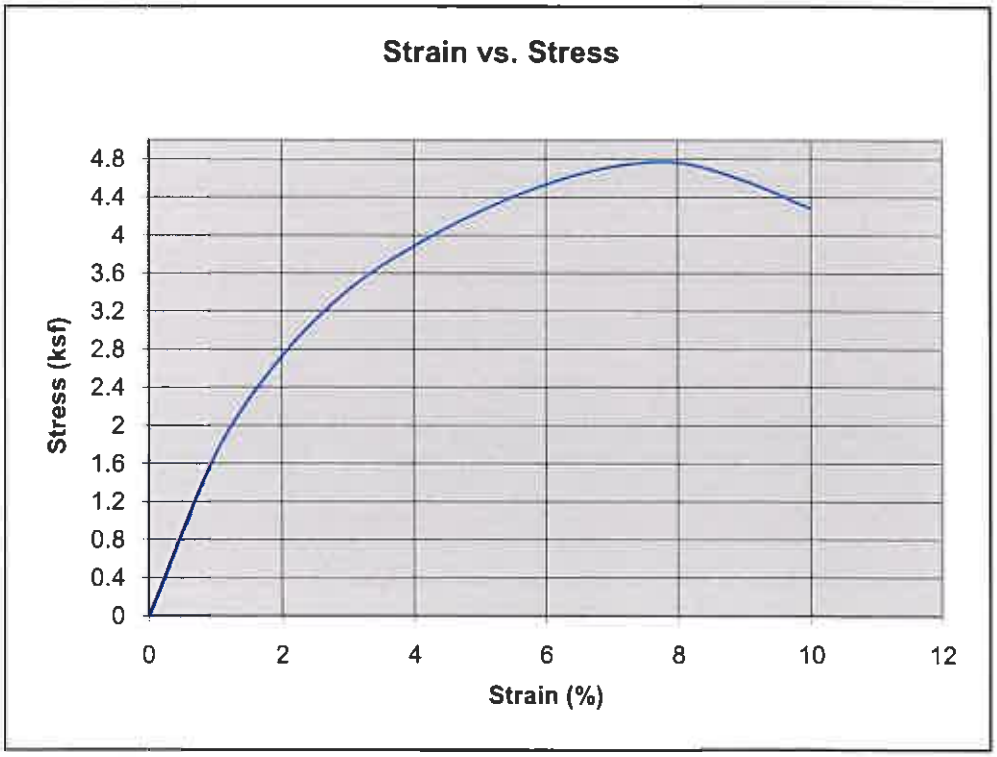
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	B-5	**Sample #:**	ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/29/2009			**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube				
Sample Description:	Light Brown Elastic Silt with sand and trace chert fragments				
Testing apparatus:	Model 7691 S/N 2147				
Wet Density:	124.5				
Dry Density:	101.4	**Initial Height:**	5.59		
Moisture Content:	22.9%	**Initial Diameter:**	2.85		
Deg of Sat.:		**Specific Gravity:**			





Qu = 4.7 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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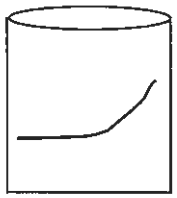
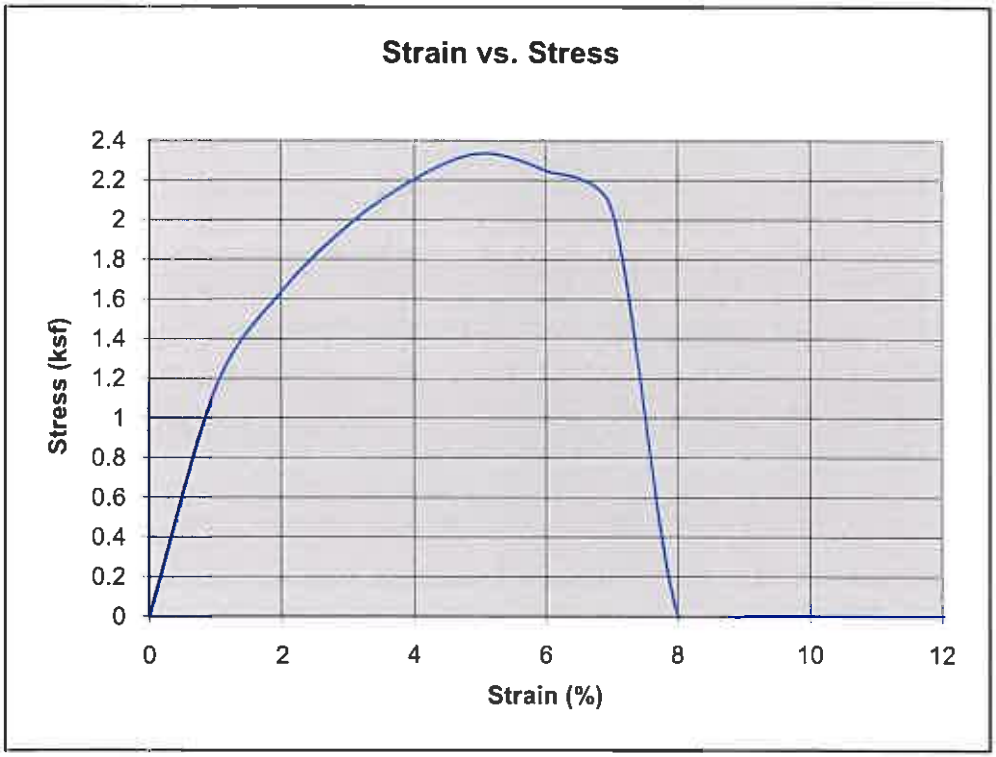
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Brach Road	**Job number:**	100-03-0148
Boring #:	B-5 **Sample #:** ST-3	**Depth:**	7.0'-9.0'
Date Tested:	4/29/2009	**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube		
Sample Description:	Brown Silty Clay with sand and trace chert fragments		

Testing apparatus: Model 7691 S/N 2147

Wet Density:	111.8		
Dry Density:	81.2	**Initial Height:**	5.61
Moisture Content:	37.6%	**Initial Diameter:**	2.85
Deg of Sat.:		**Specific Gravity:**	





Qu =2.3 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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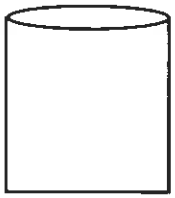
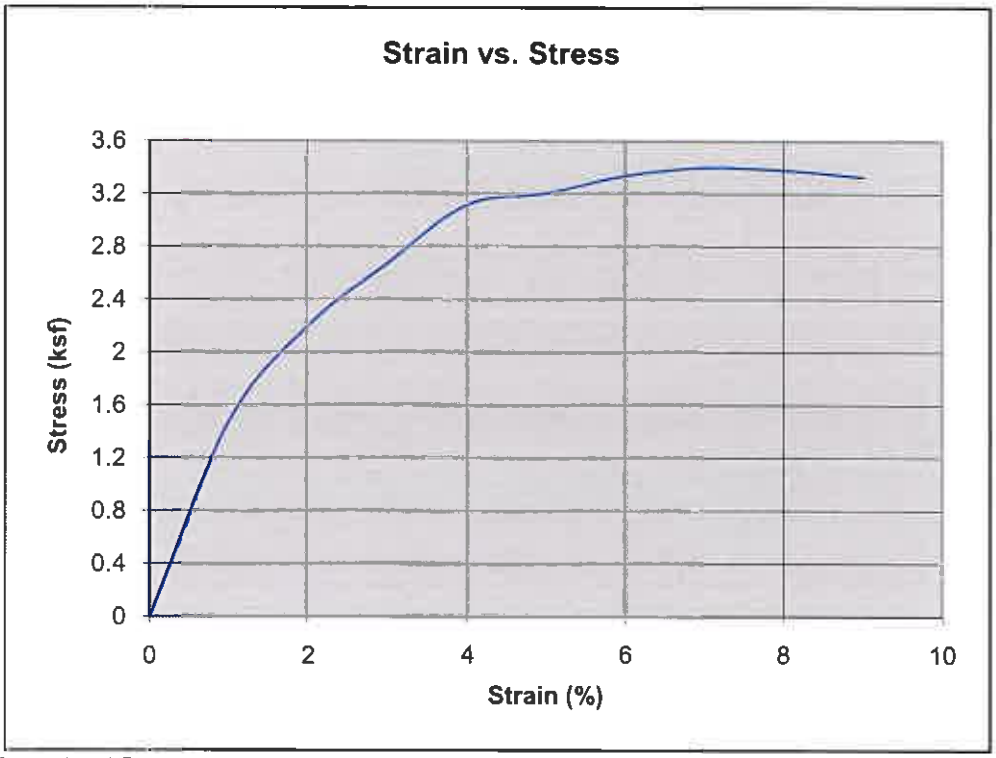
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road	**Job number:**	100-03-0148
Boring #:	B-6 **Sample #:** ST-1	**Depth:**	2.5'-4.5'
Date Tested:	4/20/2009	**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube		
Sample Description:	Light Brown Silty Clay with sand		
Testing apparatus:	Model 7691 S/N 2147		

Wet Density:	131.0		
Dry Density:	108.6	**Initial Height:**	5.63
Moisture Content:	20.6%	**Initial Diameter:**	2.84
Deg of Sat.:		**Specific Gravity:**	





Qu =3.4 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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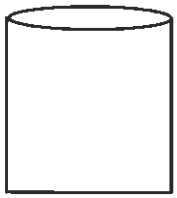
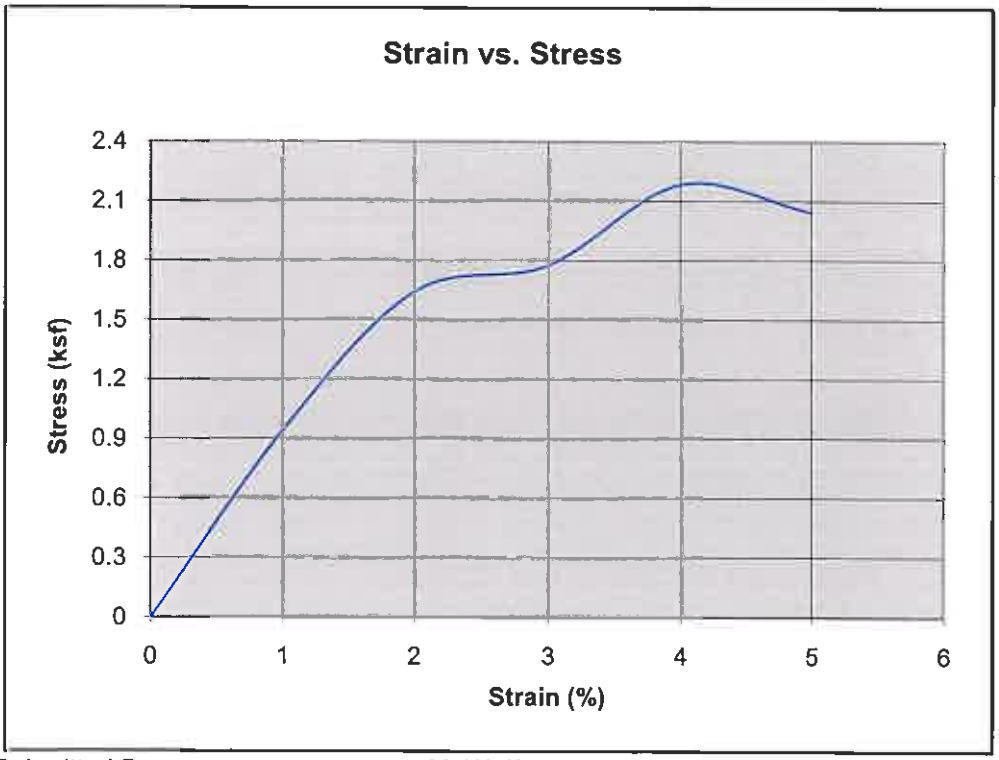
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Brach Road			**Job number:**	100-03-0148
Boring #:	B-6	**Sample #:**	ST-3	**Depth:**	5.0'-7.0'
Date Tested:	4/20/2009			**Date Received:**	3/24/2009
Specimen Type:	Shelby Tube				
Sample Description:	Light Brown Silty Clay with sand and trace chert fragments				
Testing apparatus:	Model 7691 S/N 2147				
Wet Density:	127.9				
Dry Density:	103.3	**Initial Height:**	5.53		
Moisture Content:	23.8%	**Initial Diameter:**	2.85		
Deg of Sat.:		**Specific Gravity:**			





Qu =2.2 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
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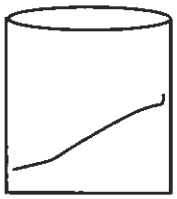
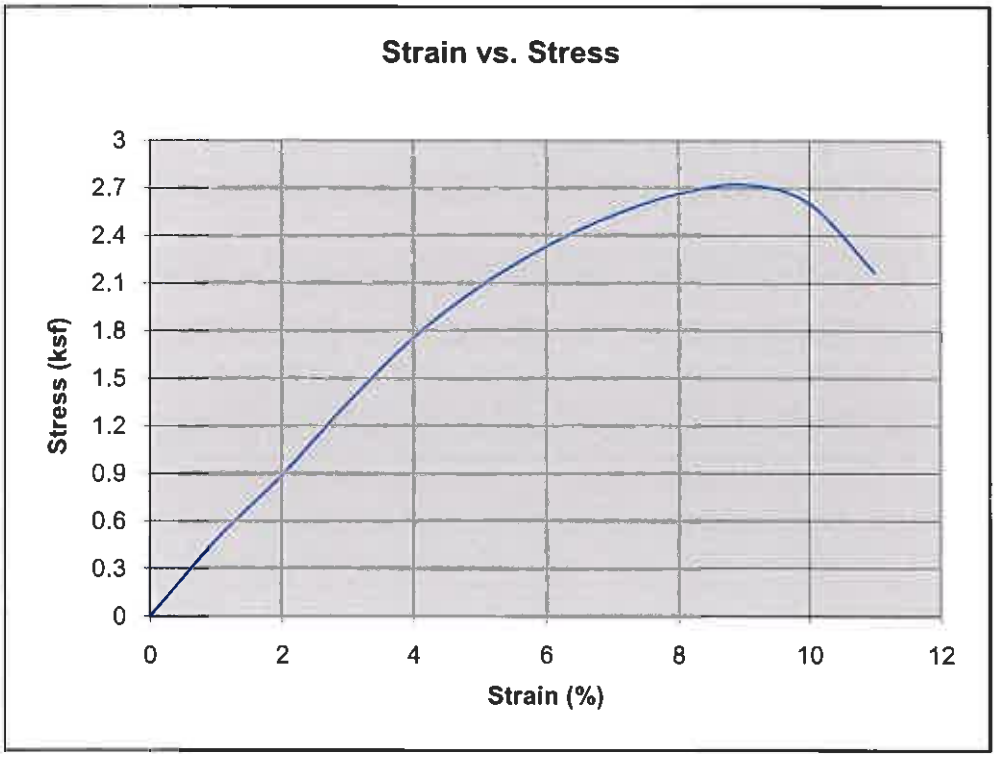
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	B-7	**Sampel #:**	ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/29/2009			**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube				
Sample Description:	Brown Silty Clay with sand and trace chert fragments				
Testing apparatus:	Model 7691 S/N 2147				
Wet Density:	122.5				
Dry Density:	98.5	**Initial Height:**	5.57		
Moisture Content:	24.5%	**Initial Diameter:**	2.87		
Deg of Sat.:		**Specific Gravity:**			





Qu =2.7 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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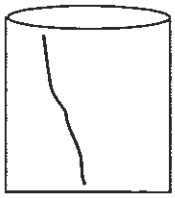
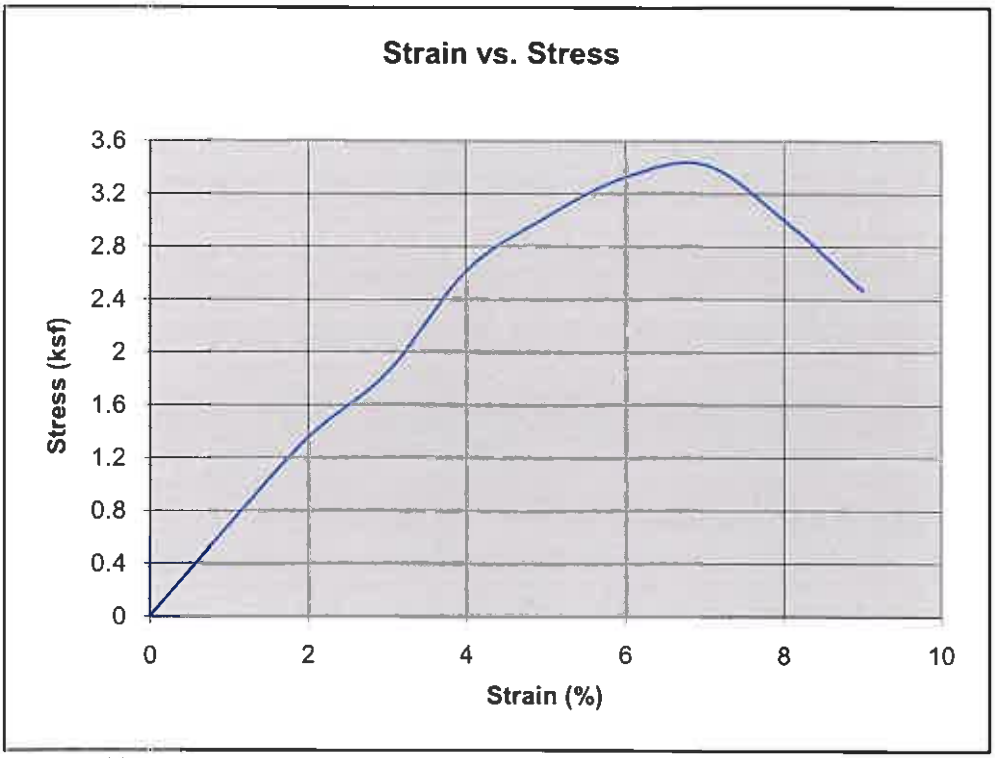
Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Brach Road	**Job number:**	100-03-0148
Boring #:	B-8 **Sample #:** ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/29/2009	**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube		
Sample Description:	Brown Silty Clay with and sand and trace chert fragments		
Testing apparatus:	Model 7691 S/N 2147		

Wet Density:	126.8		
Dry Density:	104.5	**Initial Height:**	5.22
Moisture Content:	21.2%	**Initial Diameter:**	2.87
Deg of Sat.:		**Specific Gravity:**	





Qu =3.4 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

K.S. Ware & Associates, LLC
54 Lindsley Avenue
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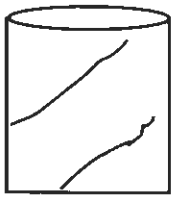
Fax (615) 256-5873

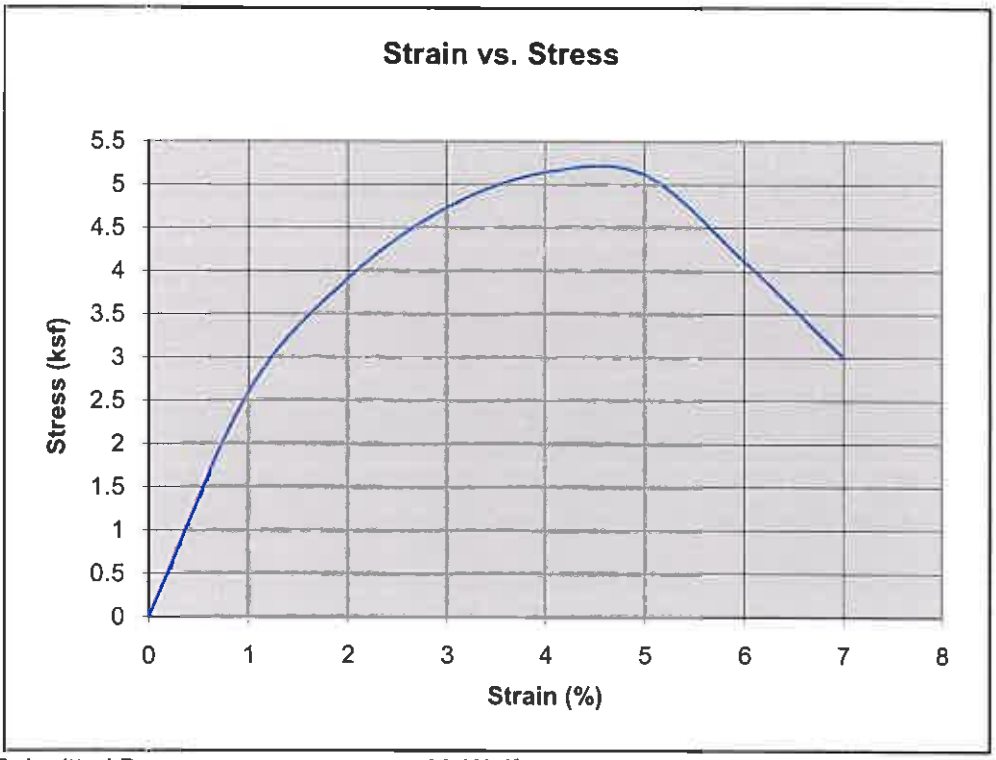
KSWA

Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road	**Job number:**	100-03-0148
Boring #:	B-8 **Sample #:** ST-4	**Depth:**	9.0'-11.0'
Date Tested:	4/29/2009	**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube		
Sample Description:	Brown Silty Clay with sand and trace chert fragments		
Testing apparatus:	Model 7691 S/N 2147		

Wet Density:	125.6		
Dry Density:	99.5	**Initial Height:**	5.57
Moisture Content:	26.2%	**Initial Diameter:**	2.84
Deg of Sat.:		**Specific Gravity:**	





Qu = 5.2 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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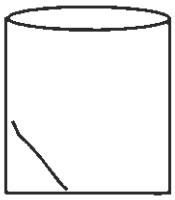
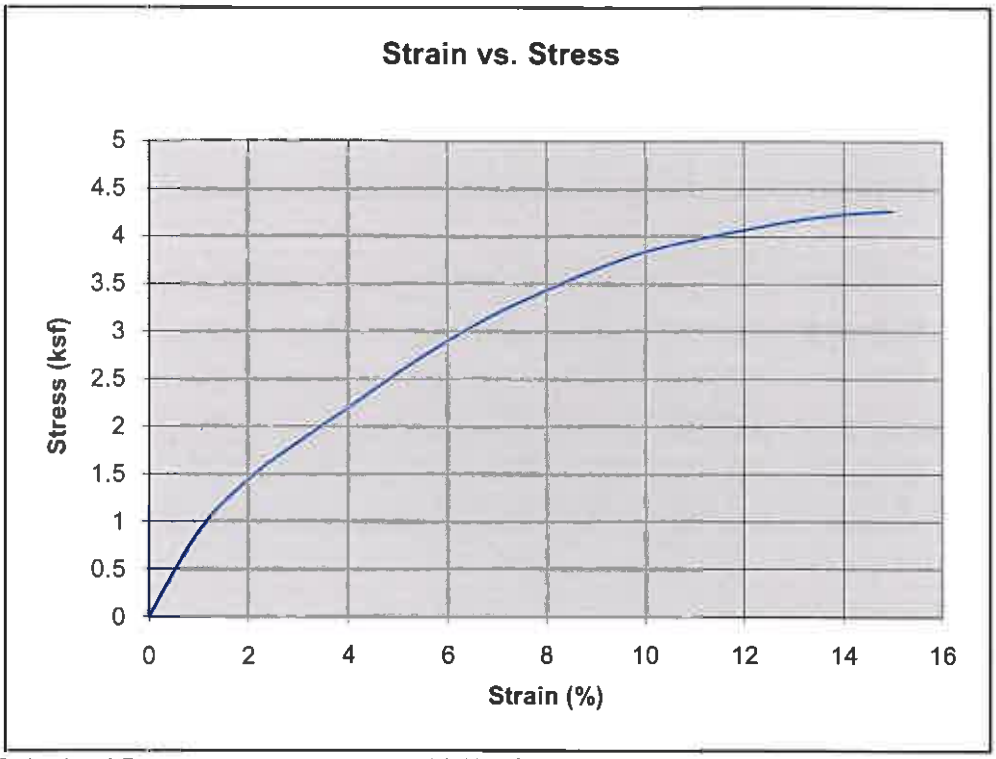
KSWA

Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	TB-1	**Sample #:**	ST-3	**Depth:**	7.0'-9.0'
Date Tested:	4/29/2009			**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube				
Sample Description:	Brown Silty Clay with White Gravel				
Testing apparatus:	Model 7691 S/N 2147				
Wet Density:	120.1				
Dry Density:	97.6	**Initial Height:**	5.58		
Moisture Content:	23.1%	**Initial Diameter:**	2.88		
Deg of Sat.:		**Specific Gravity:**			





Qu =4.3 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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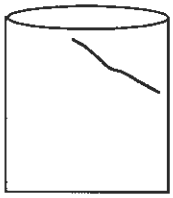
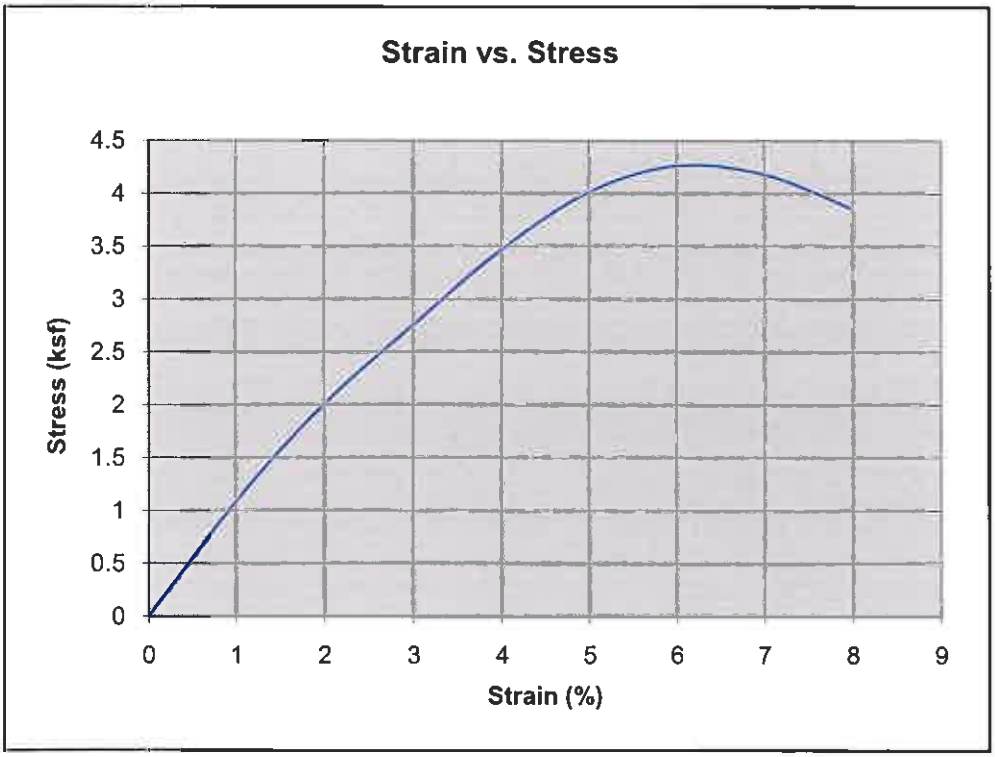
KSWA

Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road			**Job number:**	100-03-0148
Boring #:	TB-2	**Sample #:**	ST-7	**Depth:**	24.5'-26.5'
Date Tested:	4/29/2009			**Date Received:**	3/24/2009
Specimen Type:	Undisturbed Shelby Tube				
Sample Description:	Brown Silty Clay with sand and trace chert fragments				
Testing apparatus:	Model 7691 S/N 2147				

Wet Density:	110.6		
Dry Density:	87.0	**Initial Height:**	5.64
Moisture Content:	27.1%	**Initial Diameter:**	2.79
Deg of Sat.:		**Specific Gravity:**	





Qu =4.3 ksf

Submitted By:	M. Wolfe	Date:	4/30/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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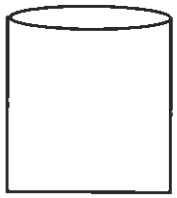
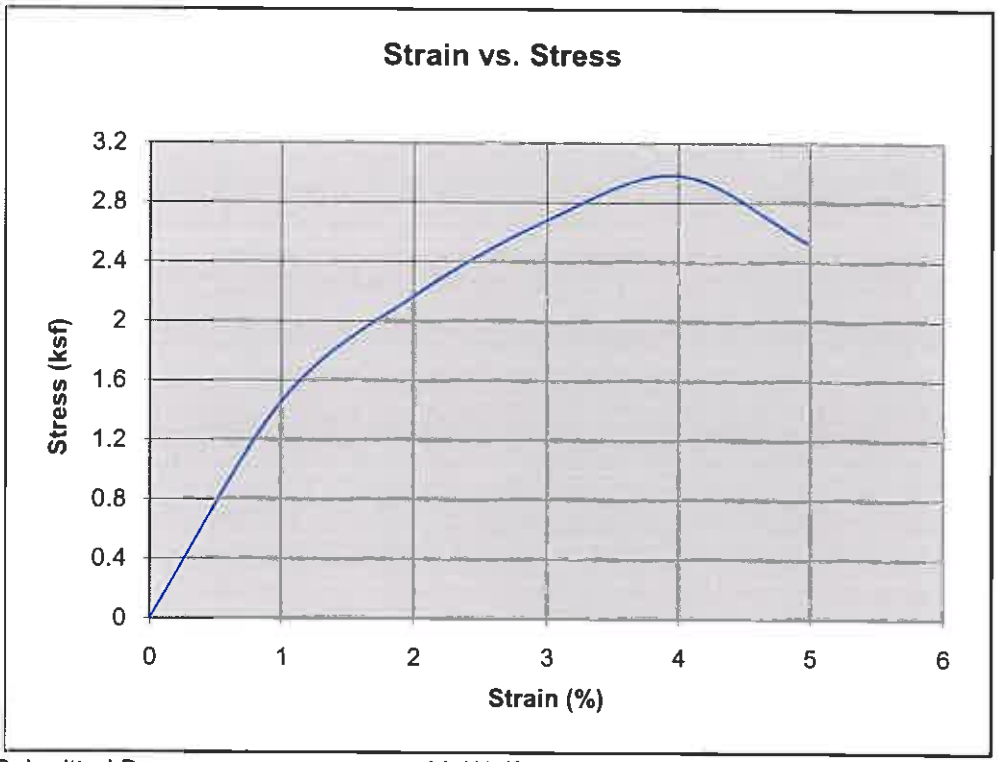
KSWA

Unconfined Compression Test
AASHTO T-208

Job Name:	Wolf Pen Branch Road	**Job number:**	100-03-0148
Boring #:	TB-2 **Sample #:** ST-2	**Depth:**	4.0'-6.0'
Date Tested:	4/20/2009	**Date Received:**	3/24/2009
Specimen Type:	Shelby		
Sample Description:	Orange Tan Silty Clay with sand and trace chert fragments		
Testing apparatus:	Model 7691 S/N 2147		

Wet Density:	125.6		
Dry Density:	102.5	**Initial Height:**	5.63
Moisture Content:	22.5%	**Initial Diameter:**	2.85
Deg of Sat.:	NP	**Specific Gravity:**	





Qu = 3.0 ksf

Submitted By:	M. Wolfe	Date:	4/20/2009
Reviewed By:	J. Wilson	Date:	4/27/2009

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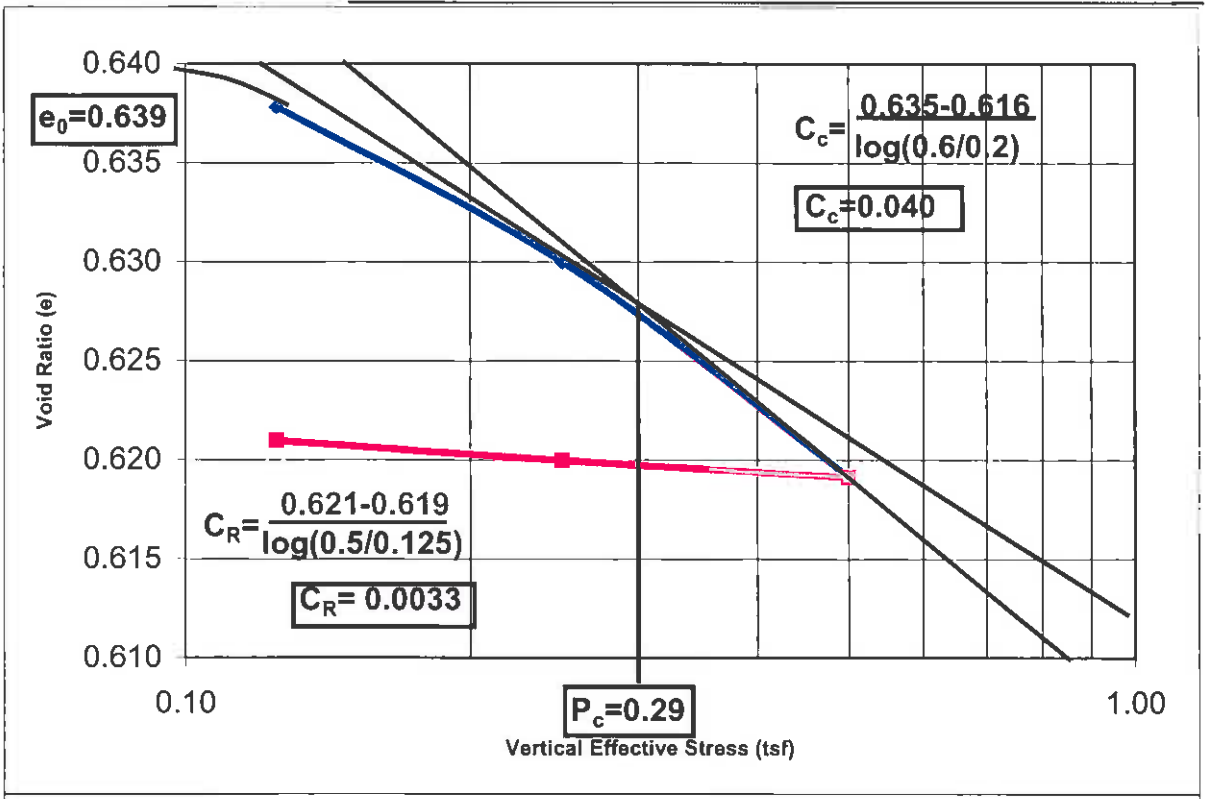
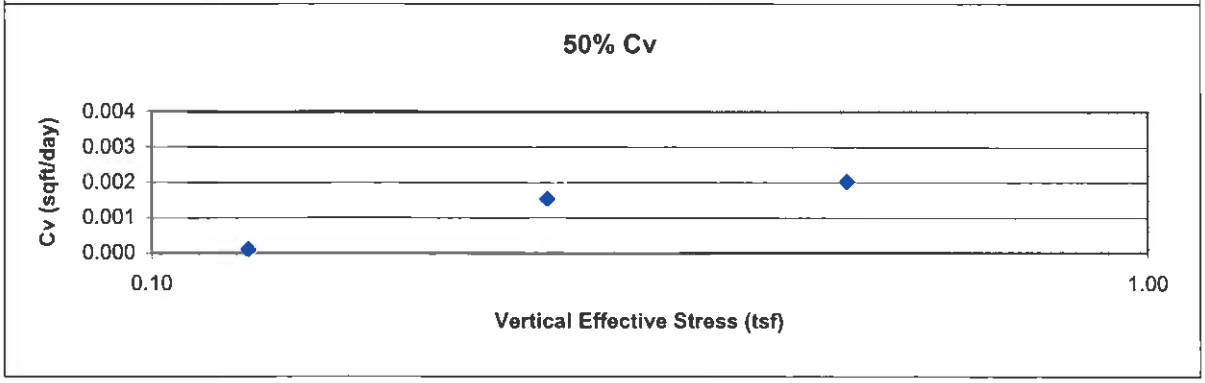
KSWA

ASTM D 2435 / AASHTO T 216
One-Dimensional Consolidation of Soils

Job Name:	Louisville East End			**Job number:**	100-03-0148
Boring #:	TB-1	**Sample #:**	ST-1	**Depth:**	2.0'-4.0'
Specimen Type:	Shelby Tube				
Sample Description:	Brown Clay				
Equipment:	CLF-1, Ohaus 3kg Scale, Micrometers				





Submitted By:	M. Wolfe	Date:	4/28/2009
Reviewed By:	J. Wilson	Date:	5/1/2009

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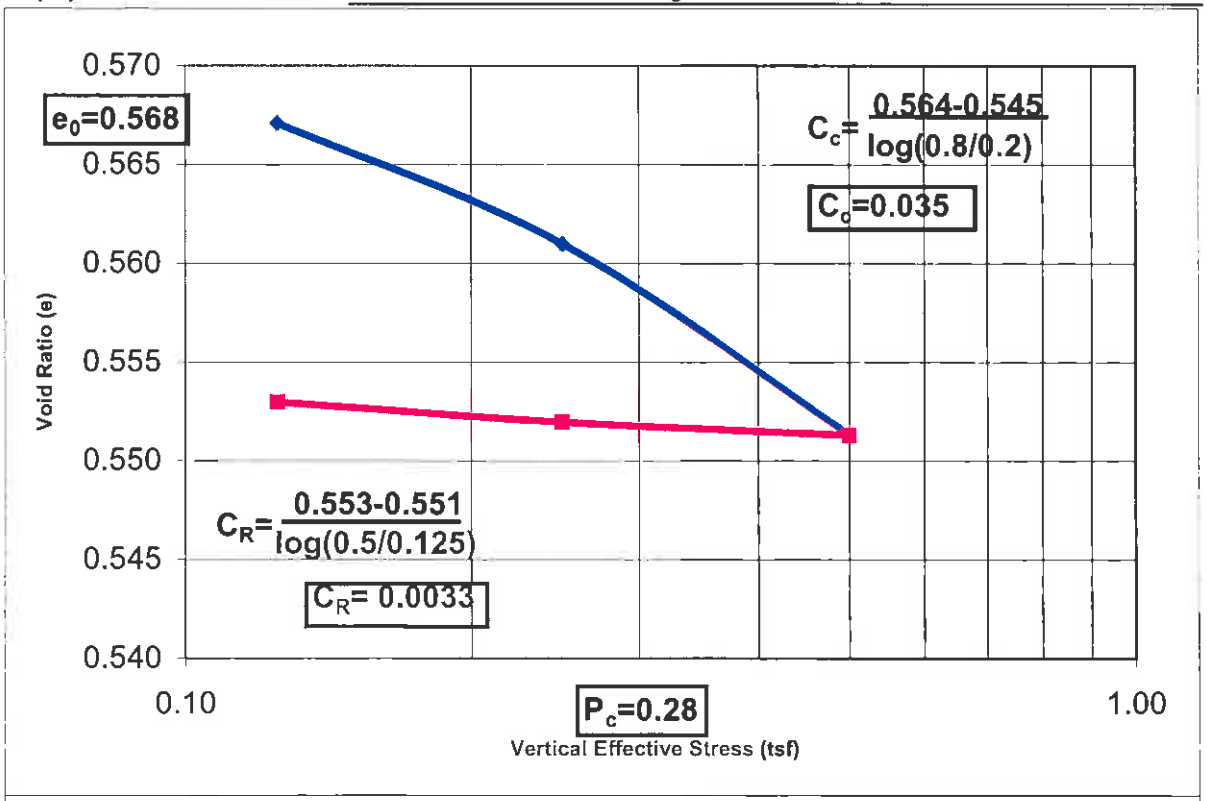
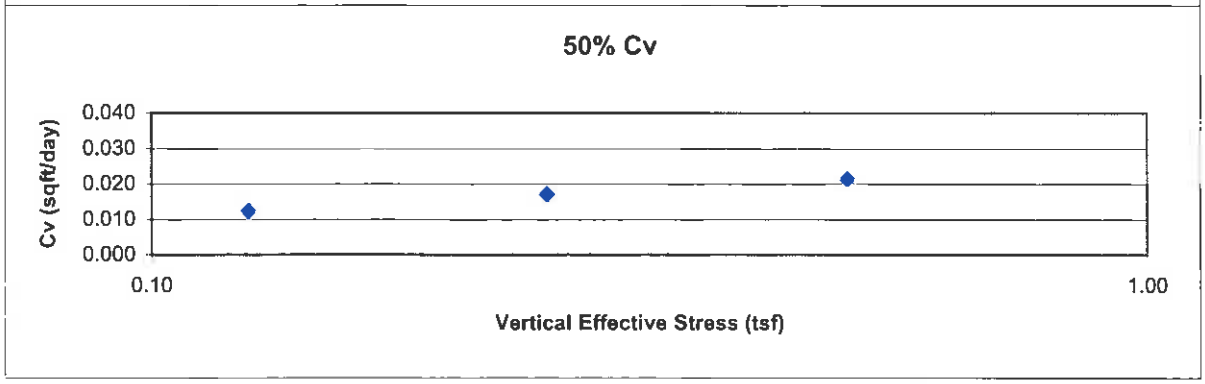
KSWA

ASTM D 2435 / AASHTO T 216
One-Dimensional Consolidation of Soils

Job Name:	Louisville East End			**Job number:**	100-03-0148
Boring #:	B-1	**Sample #:**	ST-2	**Depth:**	4.0'-6.0'
Specimen Type:	Shelby Tube				
Sample Description:	Brown Lean Clay				
Equipment:	CLF-1, Ohaus 3kg Scale, Micrometers				





Submitted By:	M. Wolfe	Date:	5/7/2009
Reviewed By:	J. Wilson	Date:	5/11/2009

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54 Lindsley Avenue
Phone (615) 255-9702
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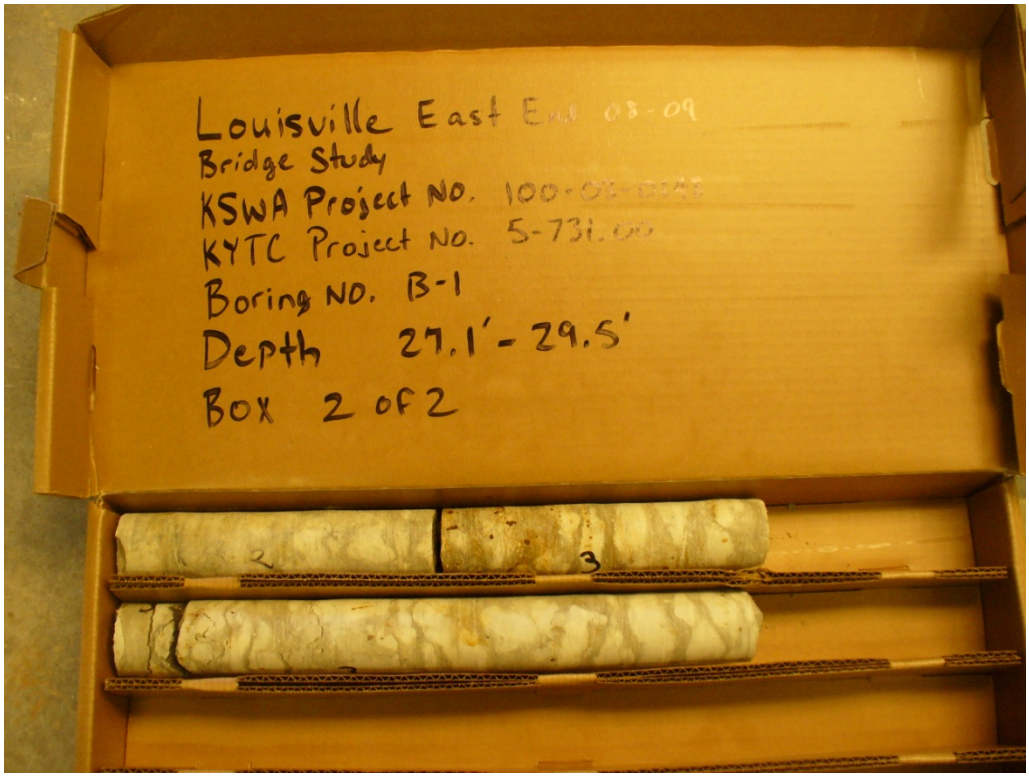
APPENDIX G:

ROCK CORE PHOTOS

B-1 Rock Core Samples: 17.4’ to 27.1’.



B-1 Rock Core Samples: 27.1’ to 29.5’.

B-2 Rock Core Samples: 9.7’ to 19.2’.

B-2 Rock Core Samples: 19.2’ to 22.8’.

B-3 Rock Core Samples: 3.0’ to 12.1’

B-3 Rock Core Samples: 12.1’ to 22.1’.

B-4 Rock Core Samples: 13.6’ to 23.6’.

B-4 Rock Core Samples: 23.6’ to 33.6’.

B-4 Rock Core Samples: 33.6’ to 44.0’.

B-4 Rock Core Samples: 44.0’ to 52.1’.

B-4 Rock Core Samples: 52.1’ to 62.0’.

B-4 Rock Core Samples: 62.0’ to 71.5’.

B-4 Rock Core Samples: 71.5’ to 77.1’.

B-5 Rock Core Samples: 11.9’ to 22.7’.

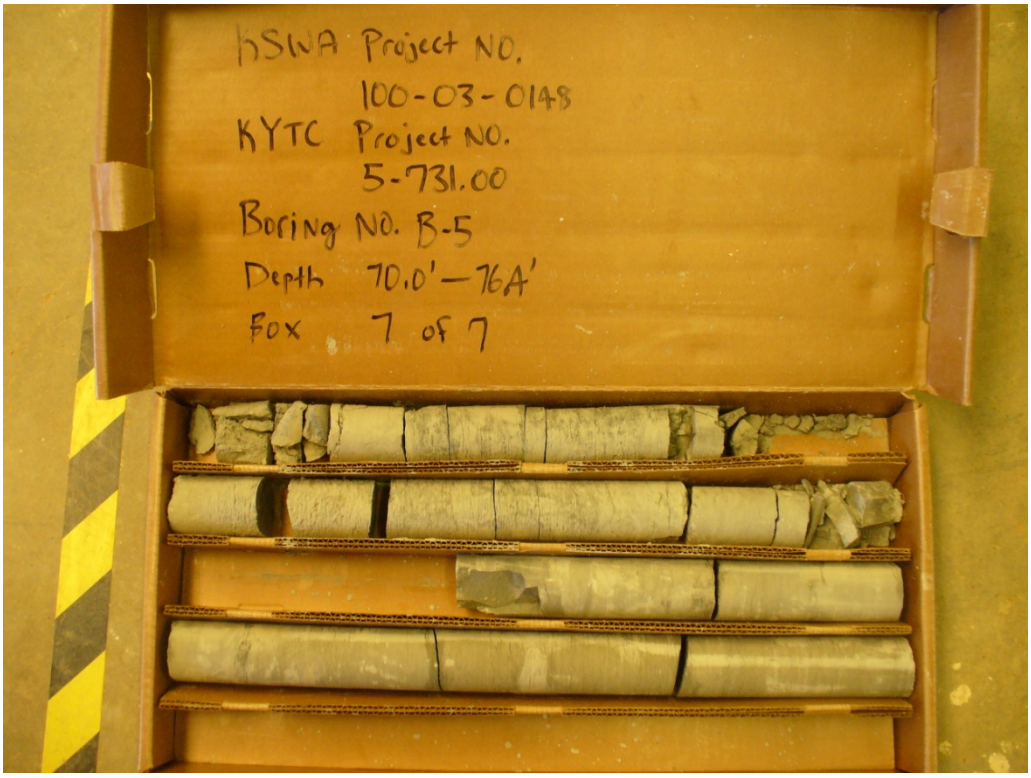
B-5 Rock Core Samples: 22.7’ to 32.0’.

B-5 Rock Core Samples: 32.0’ to 41.2’.

B-5 Rock Core Samples: 41.2’ to 50.7’.

B-5 Rock Core Samples: 50.7’ to 61.3’.

B-5 Rock Core Samples: 61.3’ to 70.0’.



B-5 Rock Core Samples: 70.0’ to 76.4’.

B-6 Rock Core Samples: 16.5’ to 25.5’.

B-6 Rock Core Samples: 25.5’ to 31.5’.

B-7 Rock Core Samples: 9.0’ to 18.5’.

B-7 Rock Core Samples: 18.5’ to 28.6’.

B-7 Rock Core Samples: 28.6’ to 31.4’.

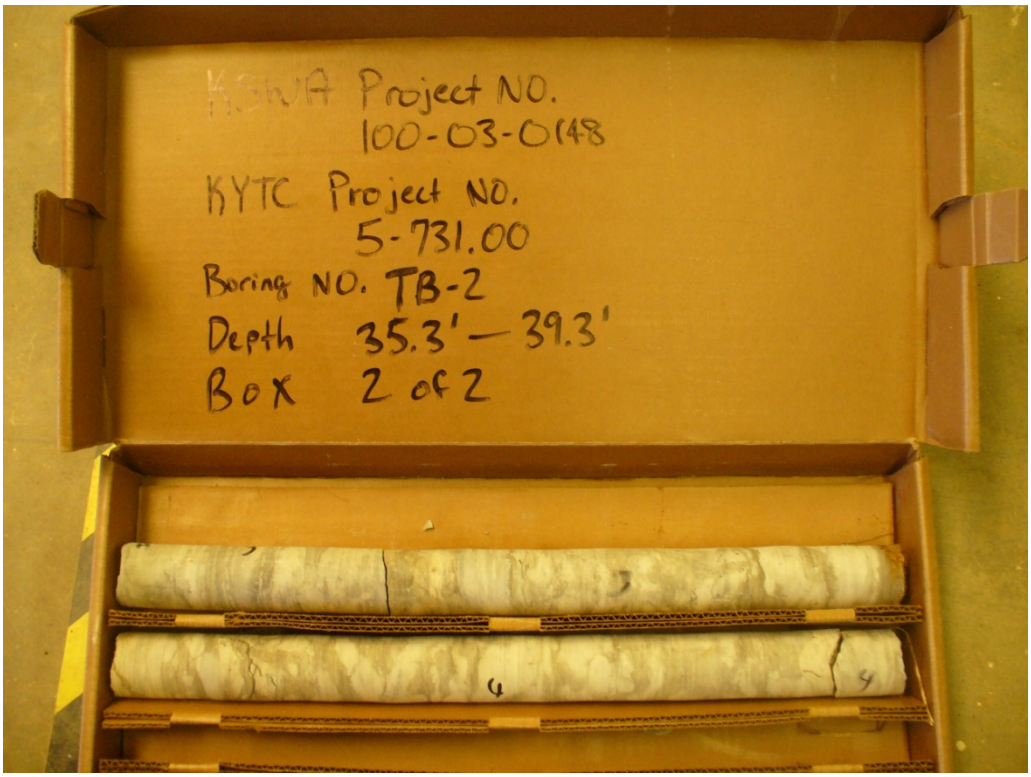
B-8 Rock Core Samples: 11.9’ to 21.9’.

B-8 Rock Core Samples: 21.9’ to 30.6’.

TB-1 Rock Core Samples: 13.8’ to 24.0’.

TB-1 Rock Core Samples: 24.0’ to 30.2’.

TB-2 Rock Core Samples: 26.5’ to 35.3’.



TB-2 Rock Core Samples: 35.3’ to 39.3’.

APPENDIX H:

IDEALIZED SOIL PROFILES

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

SUBSURFACE PROFILE

Kennedy Interchange
Wolf Pen Branch Road Bridge

Borings B-1 through B-3

Stratigraphy

Approximate Elevation (ft.)	Approximate Depth (ft.)	Description	Parameters
601.5 - 608.7	**0.0**		
		Surface Materials (Topsoil or Asphalt and Basestone)	
600.7 - 607.9	**0.8 - 1.0**		
		Medium Stiff to Very Stiff Lean Clay (CL, ML and CL-ML)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400
			P-Y Curve Reference Number 2
		Auger Refusal	
591.3 - 599.0	**3.0 - 17.4**	**Core Started**	
		Weathered Limestone	
			P-Y Curve Reference Number 6
		RDZ Zone	
585.0 - 597.3	**4.7 - 18.8**		
		Limestone	
			P-Y Curve Reference Number 6
578.7 - 579.9	**22.1 - 29.6**	**Boring Terminated**	

γ_t (lb/ft^3) = Unit Density (Above Water Table) C_u(tsf) = Undrained Shear Strength

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

SUBSURFACE PROFILE

Kennedy Interchange
Wolf Pen Branch Road Bridge

Borings B-4 and B-5

Stratigraphy

Approximate Elevation (ft.)	Approximate Depth (ft.)	Description	Parameters
611.1 - 612.3	**0.0**		
		Surface Materials (Asphalt and Basestone)	
609.9 - 611.0	**1.2 - 1.3**		
		Medium Stiff to Very Stiff Lean Clay (CL, ML and CL-ML)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400 P-Y Curve Reference Number 2
607.1 - 608.3	**4.0**		
		Medium Stiff to Very Stiff Clay with Silt (CH)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400 P-Y Curve Reference Number 2
597.5 - 600.5	**11.8 - 13.6**	**Auger Refusal** **Core Started**	
		Weathered Limestone	P-Y Curve Reference Number 6
594.8 - 595.5	**15.6 - 17.5**	**RDZ Zone**	
		Limestone	P-Y Curve Reference Number 6
541.5 - 542.3	**69.6 - 70.0**		
		Shale	
534.0 - 534.8	**77.1 - 77.5**	**Boring Terminated**	

γ_t (lb/ft^3) = Unit Density (Above Water Table) C_u(tsf) = Undrained Shear Strength

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

SUBSURFACE PROFILE

Kennedy Interchange
Wolf Pen Branch Road Bridge

Borings B-6 through B-8

Stratigraphy

Approximate Elevation (ft.)	Approximate Depth (ft.)	Description	Parameters
616.5 - 618.1	**0.0**		
		Surface Materials (Topsoil or Asphalt and Basestone)	
615.8 - 616.9	**0.7 - 1.4**		
		Medium Stiff to Very Stiff Lean Clay (CL, ML and CL-ML)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400
			P-Y Curve Reference Number 2
		Auger Refusal	
600.0 - 609.1	**9.0 - 16.5**	**Core Started**	
		Weathered Limestone	
			P-Y Curve Reference Number 6
		RDZ Zone	
598.7 - 601.2	**16.9 - 17.8**		
		Limestone	
			P-Y Curve Reference Number 6
584.4 - 586.7	**30.6 - 32.1**	**Boring Terminated**	

γ_t (lb/ft^3) = Unit Density (Above Water Table) C_u(tsf) = Undrained Shear Strength

K.S. Ware & Associates, L.L.C.
Engineering, Environmental & Information Services

SUBSURFACE PROFILE

Kennedy Interchange
Wolf Pen Branch Road Temporary Diversion Bridge

Borings TB-1 and TB-2

Stratigraphy

Approximate Elevation (ft.)	Approximate Depth (ft.)	Description	Parameters
609.0 - 621.5	**0.0**	Surface Materials (Topsoil)	
608.0 - 620.7	**0.8 - 1.0**	Medium Stiff to Very Stiff Lean Clay (CL, ML and CL-ML)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400 P-Y Curve Reference Number 2
599.0 - 602.0	**10.0 - 19.5**	Medium Stiff to Very Stiff Clay with Silt (CH)	γ_t (lb/ft^3) = 120 C_u(psf) = 1400 P-Y Curve Reference Number 2
595.0 - 595.2	**13.8 - 26.5**	**Auger Refusal** **Core Started**	
593.4 - 595.0	**15.6 - 26.5**	Weathered Limestone **RDZ Zone**	P-Y Curve Reference Number 6
578.8 - 582.2	**30.2 - 39.3**	Limestone **Boring Terminated**	P-Y Curve Reference Number 6

γ_t (lb/ft^3) = Unit Density (Above Water Table) C_u(tsf) = Undrained Shear Strength

APPENDIX I:

COORDINATE DATA SUBMISSION FORM

COORDINATE DATA SUBMISSION FORM
KYTC DIVISION OF STRUCTURAL DESIGN -- GEOTECHNICAL BRANCH

County	Jefferson	Date	5/1/2009
Road Number	Wolf Pen Branch Road		
Survey Crew / Consultant	K. S. Ware & Associates, LLC		Notes:
Contact Person	John D. Godfrey Jr., P.E.		All coordinates should be NAD-83 Latitude,
Item #	5-118.18		Longitude in Decimal Degrees
MARS #	C-04224166		
Project #	5-731.00		

(Please Mark one)
Elevation Datum **[Sea Level]** Assumed

HOLE NUMBER	STATION	OFFSET	ELEVATION (ft)*	LATITUDE	LONGITUDE
B-1[1]	48+10.5	18' LT	608.7	38.320506	85.614097
B-2[1]	48+19.4	2' LT	601.5	38.320486	85.614011
B-3[1]	48+28.2	22' RT	602.0	38.320472	85.613906
B-4[1]	49+94.2	8' LT	611.1	38.320811	85.613492
B-5[1]	50+02.6	8' RT	612.3	38.320797	85.613436
B-6[1]	51+34.1	19' LT	616.5	38.321100	85.613122
B-7[1]	51+43.0	6' LT	618.1	38.321075	85.613042
B-8[1]	51+51.9	13' RT	617.7	38.321061	85.613992
TB-1[2]	36+71.0	6' LT	609.0	38.320567	85.614358
TB-2[2]	38+39.4	6' RT	621.5	38.320847	85.613833
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HOLE NUMBER	STATION	OFFSET	ELEVATION (ft)	LATITUDE	LONGITUDE
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[1] - Stationing from Wolf Pen Branch Road
[2] - Stationing from Diversion No. 1