Report of:

Subsurface Exploration
SR 823 Bridge Over CSXT Railroad
(SCI-823-0214 L & R)
SCI-823-0.00 Portsmouth Bypass (PID 77366)
Scioto County, Ohio

STRUCTURAL ENGINEERING

FEB 29 2008

RECEIVED

Prepared for:

TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, Ohio 43017

Ohio Department of Transportation
District 9

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DLZ Job No. 0121-3070.03

September 13, 2007

Prepared by:

DLZ

REPORT

OF

SUBSURFACE EXPLORATION

FOR

SR 823 BRIDGE OVER CSXT RAILROAD

(BRIDGE NO. SCI-823-0214 L & R)

PROJECT SCI-823-0.00 PORTSMOUTH BYPASS (PID 77366)

SCIOTO COUNTY, OHIO

For:

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1.0 INTRODUCTION

This report includes the findings of evaluations and recommendations for foundations of the proposed SR 823 bridge over CSXT railroad located between approximate stations 112+84 and 117+62. This bridge is planned as part of the Portsmouth Bypass project. Subsurface explorations performed for other features of the project are presented in separate reports.

The purpose of this exploration was to 1) determine the subsurface conditions to the depths of the borings, 2) evaluate the engineering characteristics of the subsurface materials, and 3) provide information to assist in the design of the structure foundations and the roadway approach embankments. The exploration presented in this report was performed essentially in accordance with DLZ Ohio, Inc.'s (DLZ) proposal for the project.

The geotechnical engineer has planned and supervised the performance of the geotechnical engineering services, considered the findings, and prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranties, either expressed or implied, are made as to the professional advice included in this report.

2.0 GENERAL PROJECT INFORMATION

The project consists in part of placing twin structures to carry proposed SR 823 over the CSXT railroad. The two structures, as planned, are three-span structures using spill-through slopes at the abutments.

Based upon comments from ODOT's Office of Structural Engineering (OSE), it is understood that spread footings founded in the embankment fill are preferred to support the abutments of the proposed structures. Also, the use of driven piles is preferred for the support of the two proposed piers. The ODOT Structure Type Study Review Comments are presented in Appendix I.

It is assumed that the maximum height of the embankment at stations 112+84 (rear abutment) and 117+62 (forward abutment) will be approximately 100 and 72 feet, respectively. These heights are based upon the maximum difference between the proposed grade of SR 823 and the existing grade, as indicated on the Structure Site Plan, presented in Appendix I.

The analyses and recommendations presented in this report have been made on the basis of the foregoing information. If the proposed locations or structural concept are changed or differ from that assumed, DLZ should be informed of the changes so that recommendations and conclusions presented in this report may be revised as necessary.

3.0 FIELD EXPLORATION

The field exploration consisted of drilling a total of six borings for the proposed structure. Structure borings TR-39 through TR-42 were drilled for a previous design configuration. These borings were drilled between February 2 and 22, 2005. Borings B-37 and B-38 were drilled for the abutments of the currently proposed structure. These borings were drilled between May 3 and 8, 2007. The boring locations are presented on the Structure Site Plan, presented in Appendix I. Boring logs are presented in Appendix II. Information concerning the drilling procedures is also presented in Appendix II.

The boring locations were determined by representatives of DLZ. The surveyed locations and ground surface elevations of the borings were determined by representatives from Lockwood, Lanier, Mathias & Noland, Inc. (2LMN).

4.0 FINDINGS

4.1 Geology of the Site

The project area in Highland Bend generally has gently rolling terrain and is bounded on either end by steep slopes. The main drainage feature in the valley is the Little Scioto River, located at approximately station 136+00. The ordinary high water elevation is reported to be 498.6 feet. The soil consists primarily of alluvial and lacustrine deposits. The overburden in this area is generally fine-grained soils, which are seventy to ninety feet deep. The area is located in the Shawnee-Mississippian Plateau, and can be found on the Minford 7.5-minute Quadrangle.

Bedrock is of the Mississippian Logan Formation. Generally, this formation consists of primarily sandstone or sandy siltstone with occasional areas of interbedded shale. However, the lithology of the sandstones varies both laterally and vertically. Within this area the Logan Formation typically consists of thick, massive sandstone units.

4.2 Subsurface Conditions

The following sections present the generalized subsurface conditions encountered by the borings. For more detailed information, refer to the boring logs presented in Appendix II. Results of Atterburg Limits and moisture test results are presented on the boring logs and results from strength and consolidation testing are presented in Appendix III.

4.2.1 Soil Conditions

Borings B-37, TR-41, and TR-42 were drilled for the rear abutment and Pier 1 locations, south of the CSXT railroad. Similarly, borings B-38, TR-39, and

TR-40 were drilled for the forward abutment and Pier 2 locations, north of the CSXT railroad.

Borings drilled south of the railroad tracks generally encountered 4 to 9 inches of topsoil at the existing ground surface. Below the surface material, borings generally encountered cohesive soils ranging from clay (A-7-6) to silt and clay (A-6a) to a depth of 20 feet below the ground surface. Below this layer, cohesive silt (A-4b) was generally encountered to a depth of 68 feet below the ground surface. Below this layer, borings generally encountered soils ranging from silt and clay (A-6a) to gravel with sand (A-1-b) to a depth of 84 to 92 feet below the ground surface, at the top of rock.

Borings drilled north of the railroad tracks generally encountered 4 to 9 inches of topsoil at the existing ground surface. Below the surface material, borings generally encountered cohesive soils ranging from clay (A-7-6) to silt and clay (A-6a) to a depth of 32 feet below the ground surface. Below this layer, cohesive silt (A-4b) was generally encountered to a depth of 46.5 feet below the ground surface. Below this layer, borings generally encountered soils ranging from silt and clay (A-6a) to sandy silt (A-4a) to a depth of 85 to 95 feet below the ground surface, at the top of rock.

4.2.2 Bedrock Conditions

In the area of the proposed structure, bedrock was confirmed by coring in all borings. The bedrock consisted of medium hard, moderately to slightly weathered sandstone. The amount of rock recovered in each core run varied between 80 and 100 percent, with an average of 95 percent. The rock quality designation (RQD) of the bedrock ranged between 50 and 100 percent with an average of 80 percent indicating "good" quality rock.

4.2.3 Groundwater Conditions

Seepage was encountered in all borings drilled at this site. Where seepage was encountered, it was first observed at depths ranging from 17 to 30 feet below the ground surface. Water was used during rock coring and masked any seepage zones that might exist in the rock. A measurable water level in the borings prior to rock coring was only encountered in borings B-37, B-38, TR-38, TR-41, and TR-42. In these borings, water levels prior to coring rock were observed from approximate depths of 20.2 and 60.5 feet below the ground surface. Measurable water levels, upon the completion of coring, were present in all borings from approximate depths of 23.5 and 43.7 feet below the ground surface. It should be noted that the final water levels included drilling water, and consequently, may not be representative of actual groundwater conditions.

It should be noted that groundwater levels may fluctuate with seasonal variations and following periods of heavy or prolonged precipitation, and therefore, the readings indicated on the boring logs may not be representative of the long-term groundwater level. Long-term monitoring would be needed to obtain a more accurate estimate of the groundwater table elevation.

A piezometer was installed in boring R-57, at station 109+17. Readings in the piezometer have shown that the water level is consistently 60 feet below the ground surface, corresponding to an elevation of approximately 501 feet, which is near the ordinary high water elevation in the Little Scioto River, which is reported to be 498.6 feet. However, it should be noted that the water bearing silt (A-4b) layer that was observed throughout much of the valley was not encountered in boring R-57. Therefore the water levels measured in the piezometer may not be representative of other locations throughout the valley.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The Highland Bend area traverses a fairly wide valley with deep, highly compressible soils. A series of three bridges, including the SR 823 Bridge over CSXT railroad, are proposed to be constructed across the valley with three new embankment sections, which will begin at approximate station 105+75 and end at approximate station 130+73. The findings pertaining to the three embankment sections are presented in a report titled "Report of Subsurface Exploration for Proposed Highland Bend Roadway Embankments", dated August 2, 2007, prepared by DLZ. This report will be referred to as "Highland Bend Report" hereafter. The recommendations made pertaining to the adjacent embankment sections were considered in the analyses of the SR 823 bridge over CSXT railroad. Calculations are presented in Appendix IV.

5.1 General Foundation Recommendations

It is understood that the proposed bridges will have three spans and utilize spill-through abutment slopes. It is understood through comments from ODOT's Office of Structural Engineering (OSE) that spread footings are preferred to support the abutments of the proposed structure. Furthermore, it is understood that driven piles are preferred to support the proposed piers of the structure.

A summary of the bridge foundation recommendations is presented in Table 2. It should be noted that the strength characteristics of the soil vary across the project area. The approximate bearing elevations for the piles presented in Table 2 indicate the elevations at the respective boring locations only. If the subsurface conditions encountered while driving piles are different than those assumed, the actual bearing elevations may differ from those cited in Table 2.

Table 2 - Summary of Foundation Recommendations

Structural Element	Structure / Boring	Existing Ground Surface Elevation (Feet)	Foundation Type	Approximate Bearing Elevation (Feet)	Allowable Bearing Capacity
Rear Abutment	Left / B-37	556.2	Spread Footings	635.1+	3.5 ksf
	Right / TR-42	568.0	Spread Footings	635.1+	3.5 ksf
Pier 1	Left / TR-41	569.4	16" dia. CIP piles	497.9	90 tons
			HP 14X73 piles	498.9	95 tons
	Right / TR-41	569.4	16" dia. CIP piles	497.9	90 tons
			HP 14X73 piles	498.9	95 tons
Pier 2	Left / TR-40	567.9	16" dia. CIP piles	491.8	90 tons
			HP 14X73 piles	489.8	95 tons
	Right / TR-40	567.9	16" dia. CIP piles	491.8	90 tons
			HP 14X73 piles	489.8	95 tons
Forward Abutment	Left / B-38	561.7	Spread Footings	615.8+	3.5 ksf
	Right / B-38	561.7	Spread Footings	615.8+	3.5 ksf

+ *Spread footing founded on embankment fill. Elevation taken from Structure Site Plan.*

5.2 Bridge Foundation Recommendations – Rear and Forward Abutments

Although anticipated settlements from the influence of the embankment fill will be very large, it is understood that spread footings are preferred to support the proposed abutments.

For the evaluation of spread footings, it is assumed that the embankment fill material will have a friction angle of at least 30 degrees. It is understood that the loading at the abutments will consist of a dead load of 29 kips per foot and a live load of 5.5 kips per foot (provided by TranSystems Corp). Additionally, the width of the proposed footing is understood to be 10.75 feet. With these parameters, the footings may be designed using allowable bearing capacity of 3.5 kips per square foot (ksf).

It is assumed that spill-through slopes characterized by 2H:1V slopes will be used. The proposed embankments should be built using staged construction as mentioned in Section 5.4 of this report, and also according to the recommendations cited in the Highland Bend Report. Based upon the provided Structure Site Plans, the maximum height of the embankment at the proposed rear and forward abutments is assumed to be approximately 100 and 72 feet, respectively.

Due to the influence of high embankment fills, large settlements are anticipated at the abutment locations. The amount of settlement/consolidation (embankment loading only) of the foundation soils at the rear and forward abutments was estimated to be approximately 56 and 36 inches, respectively. The influence of the spread footing load will induce elastic settlement of the embankment fill material, as well as additional consolidation of the foundation soils. In order not to exceed the maximum allowable differential settlement between the abutments and adjacent piers, a consolidation period will be required after the construction of the embankment and prior to constructing the spread footings. This consolidation period is designed to ensure that the amount of elastic settlement and consolidation remaining after the construction of the spread footings is below the maximum allowable differential settlement value. Based upon these analyses, the embankment fill should be placed up to the level proposed grade and allowed to consolidate until at least 95 percent of the total primary consolidation (U=95%) has occurred prior to constructing the spread footings. The estimated settlements from the influence of the spread footing loads are presented in Table 3.

Table 3 - Estimated Settlement from Spread Footing Loads*

Location	Settlement (in) Foundation Soils	Settlement (in) Embankment Fill	Total Estimated Settlement (in)
Rear Abutment	0.8	2.1	2.9
Forward Abutment	1.6	2.1	3.7

**Settlement due to spread footing loading only.*

It is understood that ODOT's Office of Structural Engineering (OSE) has specified that the spread footings should not be constructed, and piles (for piers) not be driven until 98 percent of total primary consolidation has occurred. Estimates of the time to 90 and 95 percent consolidation (with wick drains) are presented in Table 4. However, it should be noted that these values are estimates only. Time-rate of consolidation estimates, particularly with the use of wick drains beyond 90 percent are unreliable. Additionally, the staged construction of these embankments further complicates the determination of the time required to reach a specified percentage of consolidation. The ODOT construction representative responsible for monitoring the settlement platforms and pore pressures in the foundation soils should determine when approximately 98 percent consolidation has occurred, and modify the required waiting period accordingly.

Table 4 – Time rate of Consolidation Estimates Using Wick Drains

Location	Total Settlement (in)+	Spacing (ft)*	t_{90} (days)	t_{95} (days)
Rear Abutment / Pier 1	56	5	30	45
		7	60	80
		9	90	130
Forward Abutment / Pier 2	38	5	35	45
		7	60	85
		9	100	140

* *Assumes triangular grid spacing. See Highland Bend Embankment Report (8-2-07) for details.*
\+ *Settlement due to embankment loading only. Representative of settlement at abutments only.*

5.3 Bridge Foundation Recommendations – Piers 1 and 2

Based upon the subsurface conditions encountered by the borings, it is recommended that driven piles be used to support the proposed structure at the pier locations. Recommendations for HP 14x73 piles as well as 16-inch diameter cast-in-place (CIP) reinforced concrete piles are presented here. The results of static analyses indicate that the piles will not encounter bedrock at these locations. Based upon these results, it is recommended that 16-inch diameter cast-in-place (CIP) reinforced concrete piles be used to support the proposed pier. Estimated pile tip elevations are provided in Table 2.

However, if it is preferable to use HP 14x73 piles to support the piers, recommended pile tip elevations for these piles are also provided in Table 2.

Based upon the results of analyses, the allowable uplift was calculated to be 114 and 126 kips for 16-inch CIP and HP 14x73 driven piles, respectively at Pier 1. Similarly, the allowable uplift at Pier 2 was calculated to be 109 and 125 kips for 16-inch CIP and HP 14x73 driven piles, respectively.

To prevent downdrag forces from reducing the allowable capacity of the piles, a consolidation period should be observed after the construction of the embankments and prior to driving piles. The approach embankment should be constructed to the proposed grade level and then foundation soils should be allowed to consolidate to at least 95 percent prior to driving piles. Estimates of consolidation times are provided in Table 4.

It should also be noted that the borings encountered fine sand and silt layers. When saturated, these layers may produce exaggerated blow counts during pile driving which do not reflect the actual load carrying ability of the strata. Therefore, piles should be driven to refusal, and then redriven to refusal after the excess pore pressures near the pile tip have had time to dissipate (usually less than 24 hours).

Due to the subsurface conditions, other foundation types are not being explored at this time. Information for alternative foundation types can be provided upon request.

5.4 Embankment Stability Analysis

Slope stability analyses were performed for the proposed spill-through slopes using the existing and proposed grade elevations indicated on the provided plans. The spill-through slopes being analyzed are characterized by 2H:1V slopes, while the embankment side slopes are assumed to be 2.5H:1V. The analyses for the long-term (drained) condition resulted in an infinite slope-type failure. Deeper, specified failure surfaces were found to have factors of safety of 1.7 and 1.5 for the rear and forward abutment spill-through slopes, respectively. Similarly, the critical factors of safety, assuming the end-of-construction (undrained) condition, were found to be 0.8 and 1.1 for the rear and forward abutment spill-through slopes, respectively. The results of the analyses for the drained condition are acceptable for highway embankments supporting spread footings. However, the critical factors of safety for the undrained condition are well below the minimum required value of 1.5. Analyses performed for the Highland Bend Report indicated that the embankments may be built using staged construction with the use of wick drains. The required waiting periods between stages (depending on wick drain spacing), allowable staged heights, and results of staged construction stability analyses can be found in the cited report. If the proposed spill-through slopes are constructed with 2H:1V slopes as outlined in the cited report they should be considered stable. The results of the stability analyses are presented in Appendix IV.

It is recommended that pore pressures and settlements be monitored via vibrating wire piezometers and settlement platforms. An Instrumentation plan and associated details are presented in the Highland Bend Report. Please refer to this document for additional information.

5.5 Groundwater Considerations

Seepage was encountered in all borings drilled at this site and it was first observed at depths ranging from 17 to 30 feet below the ground surface. A measurable water level in the borings prior to rock coring was only encountered in borings B-37, B-38, TR-38, TR-41, and TR-42. In these borings, water levels prior to coring rock were observed from approximate depths of 20.2 and 60.5 feet below the ground surface. Water was used during rock coring and masked any seepage zones that might exist in the rock. Measurable water levels, upon the completion of coring, were present in all borings at depths ranging from approximate depths of 23.5 and 43.7 feet below the ground surface. It should be noted that the final water levels included drilling water, and consequently, may not be representative of actual groundwater conditions.

Excavations for the pier foundations are anticipated to be approximately 7.0 to 9.0 feet deep. At these depths, it is anticipated that excavations will encounter only minor seepage. The contractor should be prepared to deal with any unexpected seepage, water flow, and precipitation that may enter any excavations.

5.6 General Earthwork Recommendations

The proposed alignment of SR 823 over CSXT Railroad traverses a gently to moderately sloping area. Consequently, the placement of fill will be required to construct the approach embankments for the bridges. The maximum fill anticipated is approximately 100 feet, near the proposed rear abutment.

Between 4.0 and 9.0 inches of topsoil were encountered at the ground surface. All topsoil and vegetation within the footprint of the new embankment and roadway should be removed prior to new fill placement. All pavement, and organic soil within three feet of subgrade level should also be removed prior to placing fill or pavement materials.

Organic soils were not encountered in any of the borings. However, organic or very soft soils may be encountered at locations other than where the borings were drilled. Consequently, the contractor should be prepared to perform overexcavation of any poor soils at other locations and replace the overexcavated soil with compacted engineered fill as needed.

Excavations for foundations should be prepared in accordance with ODOT Item 503, "Excavation for Structures." Excavations deeper than 5.0 feet must be sloped or shored to protect workers entering the excavations. Refer to OSHA regulations (29CFR Part 1926) concerning sloping and shoring requirements for excavations.

Relative to the footing excavations, the following additional recommendations are presented:

1. All footings should be founded deep enough for frost protection, considered to be 36 inches in this area.

2. Excavation bottoms should be examined by the geotechnical engineer prior to placement of reinforcing steel and concrete in order to determine the suitability of the supporting soils.

3. Excavations should be undercut to suitable bearing material if such material is not encountered at the planned footing level. Such undercuts may be backfilled with a lean mix concrete (1,500 psi @ 28 days) or footing concrete.

4. All footing excavations should be cut to stable side walls and flat bottoms with the bottoms comprised of firm soil undisturbed by the method of excavation or softened by standing water. Concrete should be placed the same day that the footings are excavated.

6.0 CLOSING REMARKS

We appreciate having the opportunity to be of service to you on this project. Please do not hesitate to call if you have any questions concerning our report.

Respectfully submitted,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

Dorothy A. Adams

Dorothy A. Adams, P.E.
Senior Geotechnical Engineer

sjr

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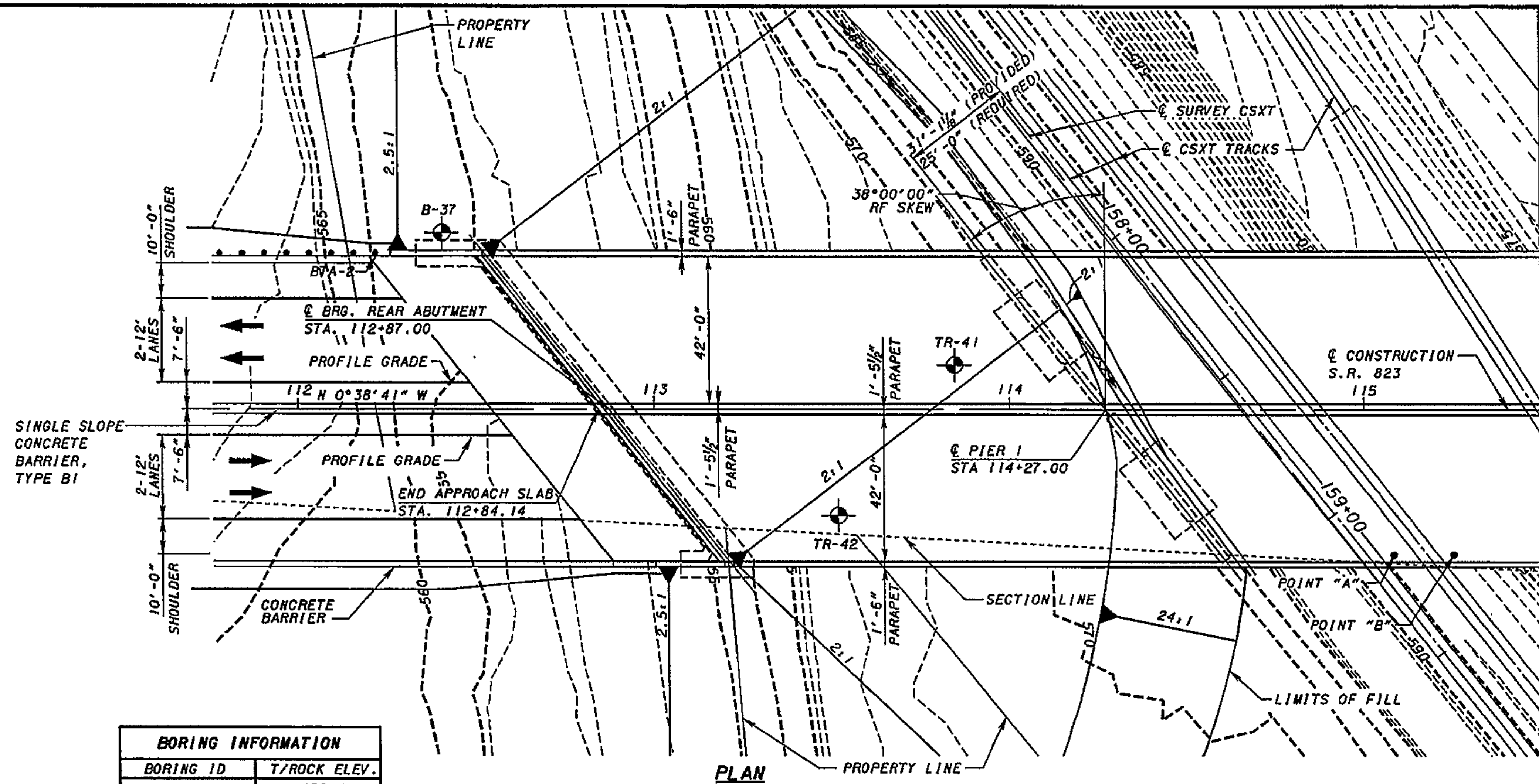
APPENDIX I

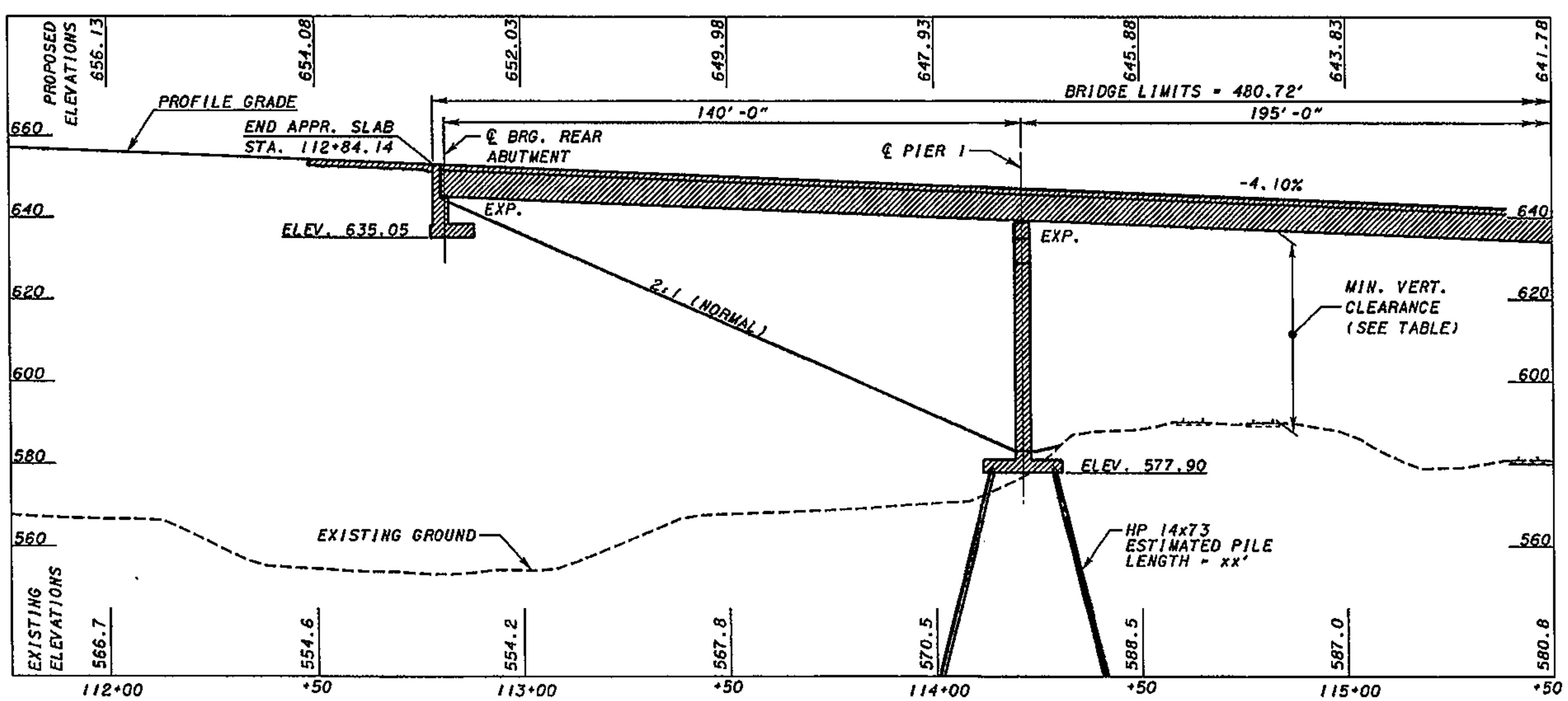
Structure Plan and Profile Drawing – 11"x17"
Structure Type Study Review Comments, dated December 15, 2006



PLAN

BORING INFORMATION

BORING ID	T/ROCK ELEV.
TR-41	482.4
TR-42	476.0
B-37	472.2



PROFILE ALONG PROFILE GRADE S.R. 823 LEFT BRIDGE

FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS

LOCATION	STATION	OFFSET
REAR ABUT.	112+96.11	43.50 LT.
FWD. ABUT.	117+48.14	43.50 LT.

TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"
PROPOSED	44.69'	44.15'
REQUIRED	23.0'	23.0'

BENCHMARK 1	BENCHMARK 2
(TO BE PROVIDED LATER)	(TO BE PROVIDED LATER)

TRAFFIC DATA

S.R. 823
CURRENT YEAR ADT (2010) = 21,200
DESIGN YEAR ADT (2030) = 31,200
CURRENT YEAR ADTT (2010) = 2,968
DESIGN YEAR ADTT (2030) = 4,368

LEGEND

BTA-1 = BRIDGE TERMINAL ASSEMBLY TYPE 1
BTA-2 = BRIDGE TERMINAL ASSEMBLY TYPE 2
⊕ = BORING LOCATION

NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

PROPOSED STRUCTURE

TYPE: 3 SPAN CONTINUOUS A709 GRADE 50W STEEL PLATE GIRDER WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY REINFORCED CONCRETE T-TYPE PIERS AND STUB TYPE ABUTMENTS.
SPANS: 140'-0" - 195'-0" - 140'-0" C/C BRGS
ROADWAY: 2 - 42'-0" T/T OF PARAPETS
LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING, FUTURE WEARING SURFACE = 60 PSF
SKEW: 38°00'00" RF
CROWN: 0.016 FT/FT
ALIGNMENT: TANGENT
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (30' LONG)
LATITUDE: 38°46'06" N
LONGITUDE: 82°52'36" W

DESIGN AGENCY: Systems
DESIGNED PJP | CHECKED MSL | DRAWN PJP | REVISED | REVIEWED JRC | DATE 2/14/07 | STRUCTURE FILE NUMBER 7306326

SCIOTO COUNTY
STA. 112+84.14
STA. 117+64.86

SITE PLAN
BRIDGE NO. SCI-823-0214 L
S.R. 823 OVER CSXT RAILROAD

SCI-823-0.00
PID 77366

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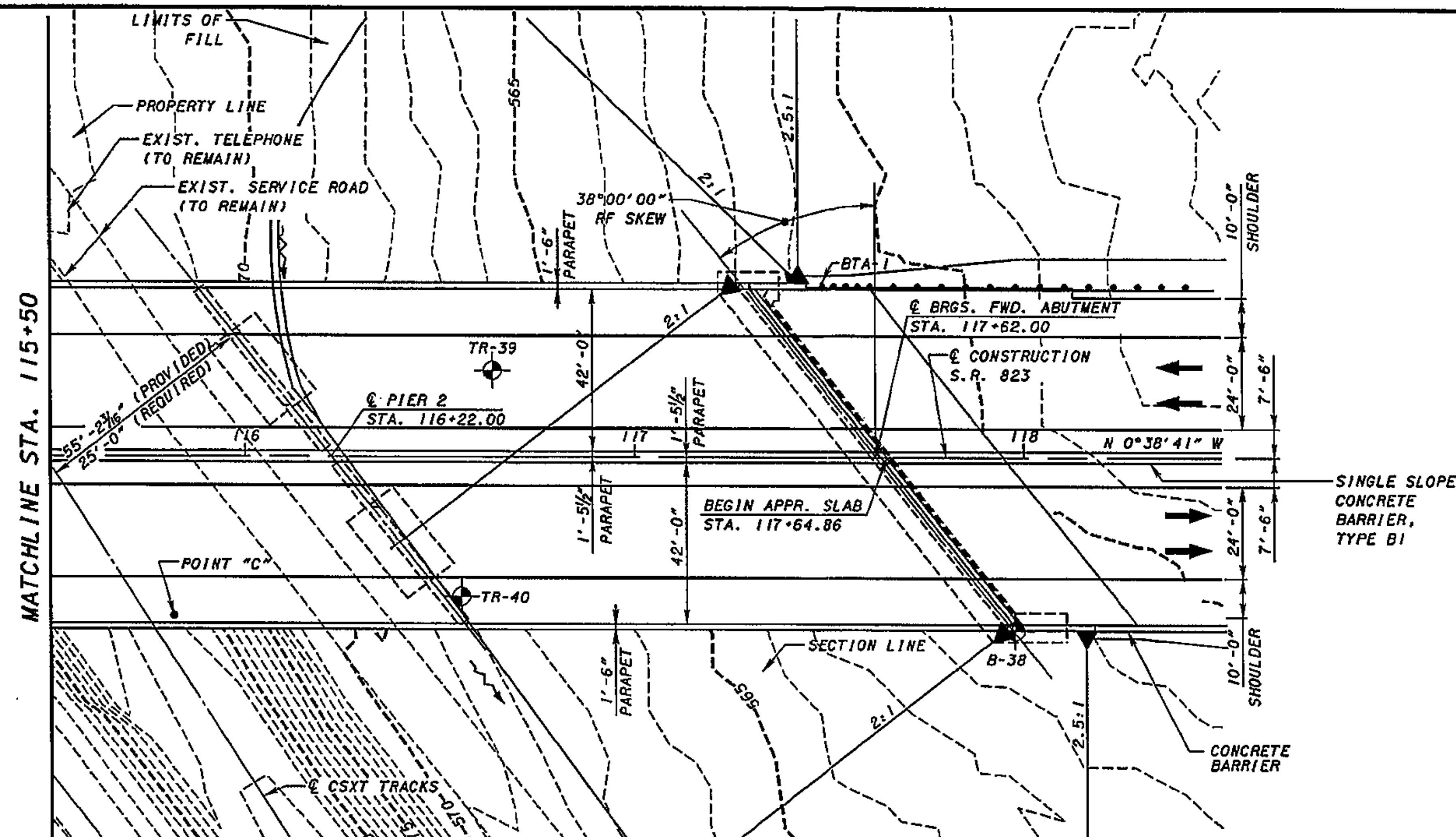
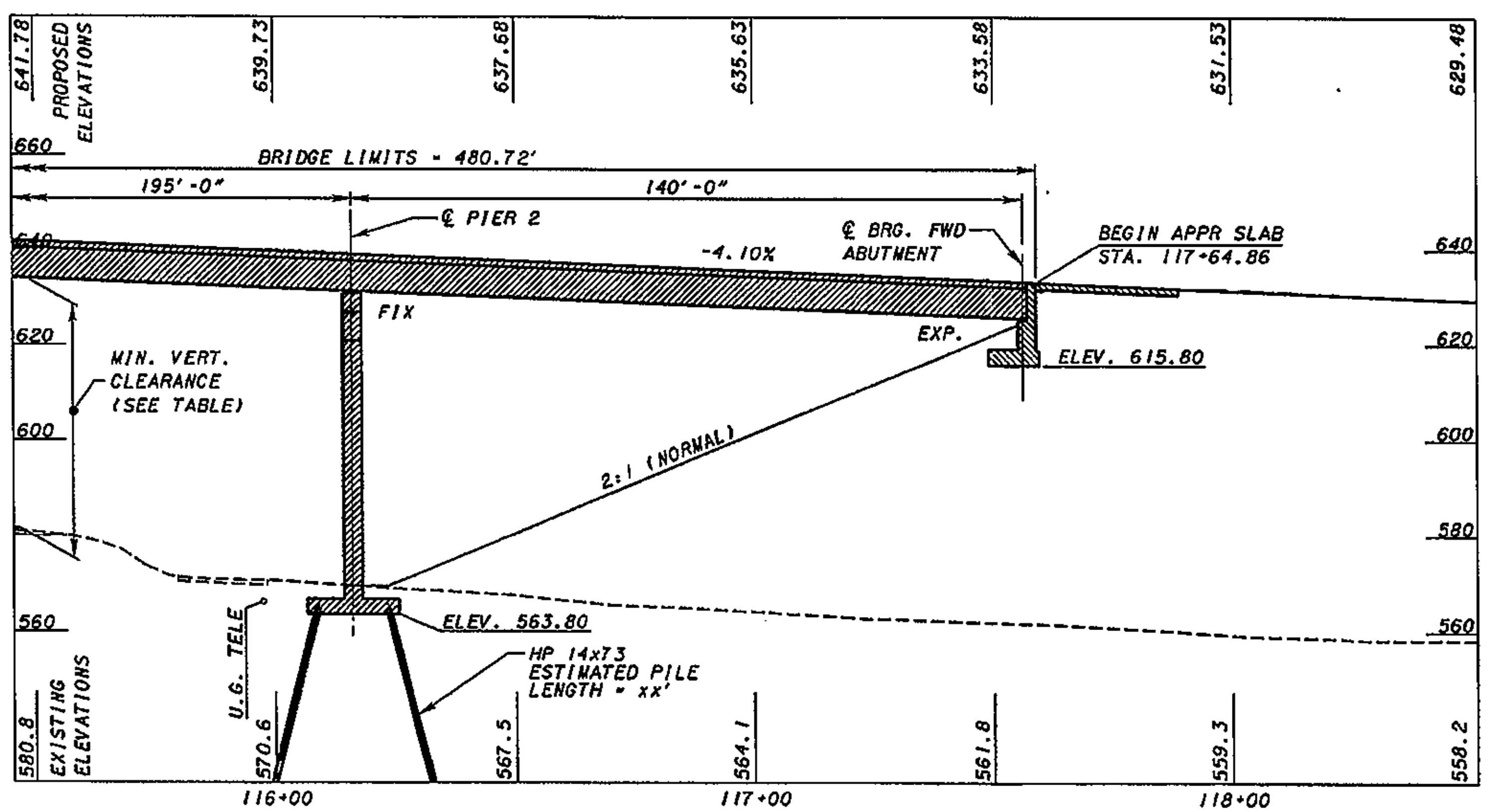


PLAN



PROFILE ALONG PROFILE GRADE S.R. 823 LEFT BRIDGE

BORING INFORMATION

BORING ID	T/ROCK ELEV.
TR-39	479.2
TR-40	472.9
B-38	476.2

TABLE OF VERTICAL CLEARANCES

LOCATION	"C"	
PROPOSED	49.62'	
REQUIRED	23.0'	

NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS..

DESIGN AGENCY: Systems

DESIGNED PJP · DRAWN PJP · REVIEWED JRC · DATE 2/14/07 · CHECKED MSL · REVISED · STRUCTURE FILE NUMBER 7306326

SCIOTO COUNTY
STA. 112+84.14
STA. 117+64.86

SITE PLAN
BRIDGE NO. SCI-823-0214 L
S.R. 823 OVER CSXT RAILROAD

SCI-823-0.00
PID 77366

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inter-office communication

to: Harry Fry, District 9 Deputy Director **date:** December 15, 2006

from: Tim Keller, Administrator, Office of Structural Engineering By: Jeff Crace, P. E.

subject: SCI-823-0214 over CSXT Railroad; PID 19415,77366; Preliminary Design Submittal

We have performed a cursory review of the information furnished in the Structure Type Study Submittal by TranSystems Corporation for the subject bridge and offer the following comments:

1. In the quest for the most economical structure an alternate with the shortest feasible bridge length and/or most economical span arrangement should be investigated.

2. Following are three alternates that could possibly address the economy/efficiency of the structure:

   a) Is the set of tracks that veer off to the right when looking to the west a spur? If so, please investigate placing a pier (T-type) between the two sets of tracks. A T-type pier (which meets the requirements for a crashwall) should fit between the tracks and still meet the required minimum offset (for a crashwall) to both sets of tracks. CSXT should be made aware of that cost savings may be possible for both the construction and long term maintenance of the structure.

   b) What is the minimum required section for a service road? Investigate how much fill can be added adjacent to the railroad. This would allow the pier and or the service road to be relocated closer to the tracks, thereby allowing the pier to be located so that the center span can be shortened. If relocating the service road is not feasible can the pier be located closer to the service road?

   c) Is it possible to eliminate the skew of the structure/substructures? We understand this will cause the spans to increase beyond whatever thee minimum are determined to be. However we are will to pay a small premium to obtain a structure with a better construction, operation and long term maintenance history. The vertical clearance should not be a concern do to the height of the piers.

3. Revise the inside shoulder width to match the roadway typical section as per the District 9 request.

4. After further review and deliberation, we recommend that the abutments be supported by spread footings. The following issues were contemplated prior to making the final recommendation.

   a) The difficulty in providing a prebored hole that is in excess of 80 feet.

b) The fact that battered pile should be avoided when negative skin friction (down drag) is expected, AASHTO Standard Specifications for Highway Bridges, section 4.5.2.4.

c) The fact that the length of the end span is conducive to allowing settlement of the abutments without causing an overstress in the girders.

5. Revise note 22a in the bridge design manual to include that the piles cannot be driven until after 95 percent of the primary consolidation has occurred. Please include this item in the Structure Type Study so that the consultant preparing the detail design will have the

6. Prior to driving piles, construct the spill through slope and the bridge approach embankment behind the rear abutment up to the level of the subgrade elevation for a minimum distance of 200 feet behind the rear abutment. Do not begin excavation for the rear abutment footing and the installation of the rear abutment piles until after the above required embankment has been constructed and a __ calendar day waiting period has elapsed. The Engineer may adjust the waiting period based on the settlement platform readings.

   The consultant should provide the minimum waiting period required based on an evaluation of the in-situ souls, the consolidation rate and the embankment required.

7. When first looking at the Site Plan, the estimated pile length did not appear to be correct, only after checking the boring logs and realizing that the actual top of rock was located off the sheet did we realize that the actual top of rock elevations were shown above the Plan view. Please give the top of rock elevations next to the top of rock designation or remove the top of rock designations off of the Site Plan.

8. Please include the following note in the plans.

ITEM SPECIAL--SETTLEMENT PLATFORMS

Description: This item consists of furnishing, constructing, and maintaining settlement platforms and obtaining settlement readings as required by the plans or as directed by the Engineer. At the option and expense of the Contractor, additional settlement platforms may be installed at locations approved by the Engineer. Settlement readings shall be taken weekly during construction and during any specified waiting period. The readings shall be plotted on graph paper presenting deformation (on the negative y-axis) and fill height (on the positive y-axis) versus time (on the x-axis). A copy of each cumulative plot shall be sent to the Office of Geotechnical Engineering, Attention: Geotechnical Design Coordinator, after each settlement reading is recorded.

Materials: Sound lumber such as 19mm (3/4-inch) exterior grade plywood shall be used for the base. The pipe shall be 64mm (2-1/2-inch) standard black pipe with threaded fittings as shown on the plans. A steel plate 915mm x 915mm x 3.2mm (36" x 36" x 1/8") may be substituted for the lumber for the platforms, at the Contractor's option.

Construction Methods: The platform shall conform to the details shown on the plans. The platform shall be set on a level surface. The pipe shall be firmly secured to the platform and shall be maintained in a plumb position during the placement of the embankment. The pipe shall be marked at intervals to facilitate measurement of the depth of fill. The Contractor shall stop work in any location where the settlement platform has been disturbed or damaged. Platforms or pipes damaged or displaced during construction shall be restored to their proper condition at the Contractor's expense.

Prior to paving, the top of the settlement platform pipe shall be cut off 600mm (two feet) below the finished surface of the subgrade or finished ground surface, whichever is applicable.

Method of Measurement: The number of settlement platforms to be paid for shall be the actual number of settlement platforms completed, maintained, and accepted by the Engineer.

Basis of Payment: Payment shall be made at the contract unit price each for "Item Special – Settlement Platforms" which is compensation for constructing maintaining, and monitoring the settlement platforms including furnishing all labor, equipment, materials, and incidentals necessary to complete the work. Payment shall not be made for settlement platforms which become useless due to damage caused by the Contractor's operations.

(Note: The following plan detail must accompany this note.)

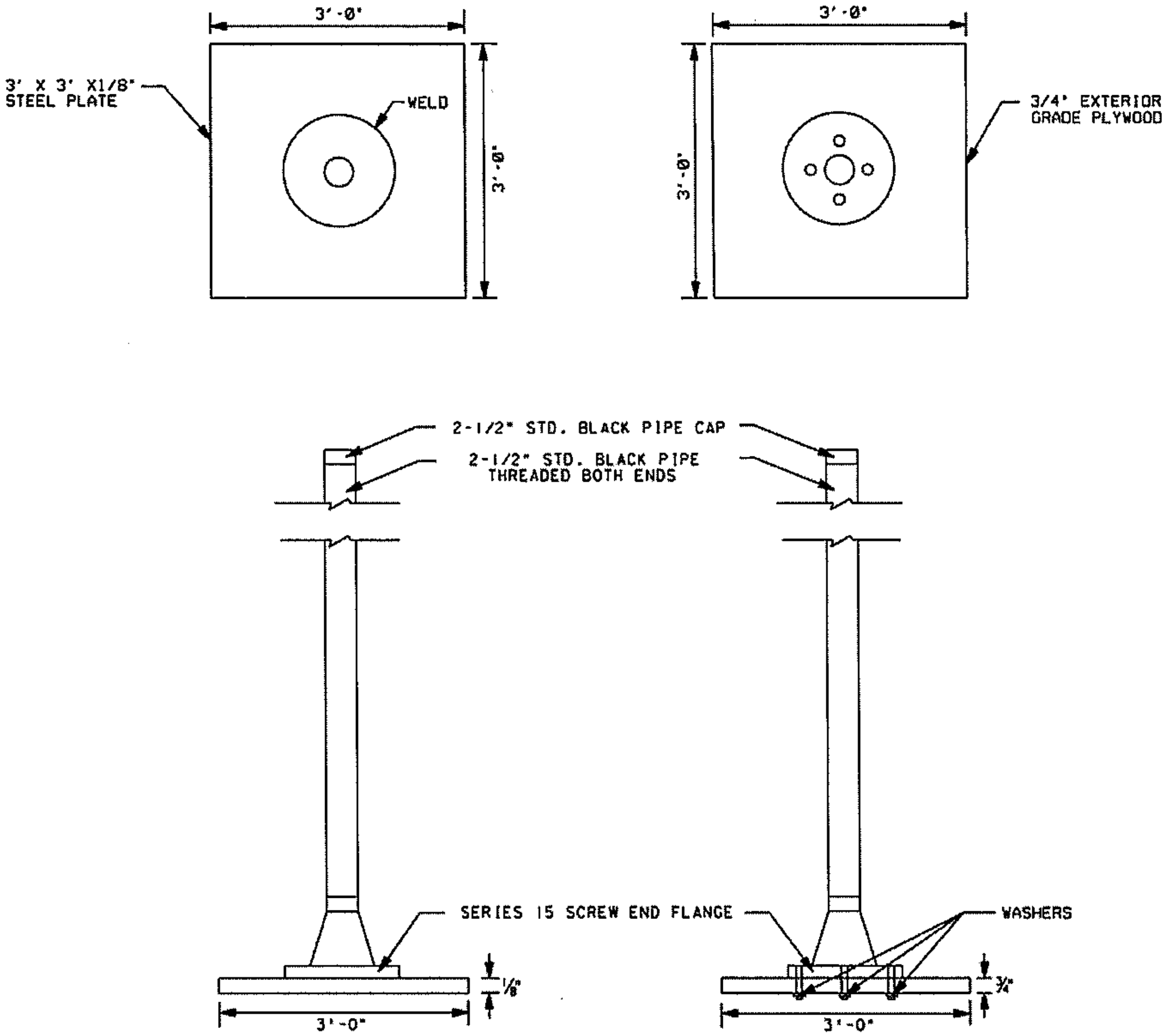
If there are questions regarding our review comments for this project, please contact our office.

TK:JS:JC

District 9 - Tom Barnitz
District 9 - Doug Buskirk
District 9 - Larry Wills
File

SETTLEMENT PLAFORM

NOT TO SCALE



NOTES:

1. SETTLEMENT PLATFORMS SHALL BE PLACED AT THE LOCATION INDICATED IN THE PLANS, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
2. CONTRACTOR HAS OPTION OF USING EITHER STEEL OR PLYWOOD PLATFORM BASE.
3. CONTRACTOR SHALL FURNISH MATERIALS AND LABOR TO EXTEND PIPE UP THROUGH ENTIRE FILL.
4. SETTLEMENT PLATFORMS SHALL BE ANCHORED BY STAKES DRIVEN AT EACH CORNER TO PREVENT OVERTURNING.

DATE: 5-11-1999

APPENDIX II

General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Boring Logs – Six (6) Borings

GENERAL INFORMATION
DRILLING PROCEDURES AND LOGS OF BORINGS

Drilling and sampling were conducted in accordance with procedures generally recognized and accepted as standardized methods of investigation of subsurface conditions concerning geotechnical engineering considerations. Borings were drilled with either a truck-mounted or ATV-mounted drill rig.

Drive split-barrel sampling was performed in 1.5 foot increments at intervals not exceeding 5 feet. In the event the sampler encountered resistance to penetration of 6 inches or less after 50 blows of the drop hammer, the sampling increment was discontinued. Standard penetration data were recorded and one or more representative samples were preserved from each sampling increment.

In borings where rock was cored, NXM or NQ size diamond coring tools were used.

In the laboratory all samples were visually classified by a geotechnical engineer. Moisture contents of representative fine-grained soil samples were determined. A limited number of samples, considered representative of foundation materials present, were selected for performance of grain-size analyses and plasticity characteristics tests. The results of these tests are shown on the boring logs.

The boring logs included in the Appendix have been prepared on the basis of the field record of drilling and sampling, and the results of the laboratory examination and testing of samples. Stratification lines on the boring logs indicating changes in soil stratigraphy represent depths of changes approximated by the driller, by sampling effort and recovery, and by laboratory test results. Actual depths to changes may differ somewhat from the estimated depths, or transitions may occur gradually and not be sharply defined. The boring logs presented in this report therefore contain both factual and interpretative information and are not an exact copy of the field log.

Although it is considered that the borings have disclosed information generally representative of site conditions, it should be expected that between borings conditions may occur which are not precisely represented by any one of the borings. Soil deposition processes and natural geologic forces are such that soil and rock types and conditions may change in short vertical intervals and horizontal distances.

Soil/rock samples will be stored at our laboratory for a period of six months. After this period of time, they will be discarded, unless notified to the contrary by the client.

LEGEND – BORING LOG TERMINOLOGY

Explanation of each column, progressing from left to right

1. Depth (in feet) – refers to distance below the ground surface.

2. Elevation (in feet) – is referenced to mean sea level, unless otherwise noted.

3. Standard Penetration (N) – the number of blows required to drive a 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.

   50/n – indicates number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other than the normal 6-inch increment.

4. The length of the sampler drive is indicated graphically by horizontal lines across the "Standard Penetration" and "Recovery" columns.

5. Sample recovery from each drive is indicated numerically in the column headed "Recovery".

6. The drive sample location is designated by the heavy vertical bar in the "Sample No., Drive" column.

7. The length of hydraulically pressed "Undisturbed" samples is indicated graphically by horizontal lines across the "Press" column.

8. Sample numbers are designated consecutively, increasing in depth.

9. Soil Description

   a. The following terms are used to describe the relative compactness and consistency of soils:

   Granular Soils – Compactness

Term	Blows/Foot Standard Penetration
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	over 50

   Cohesive Soils – Consistency

Term	Unconfined Compression tons/sq.ft.	Blows/Foot Standard Penetration	Hand Manipulation
Very Soft	less than 0.25	below 2	Easily penetrated by fist
Soft	0.25 – 0.50	2 – 4	Easily penetrated by thumb
Medium Stiff	0.50 – 1.0	4 – 8	Penetrated by thumb with moderate pressure
Stiff	1.0 – 2.0	8 – 15	Readily indented by thumb but not penetrated
Very Stiff	2.0 – 4.0	15 – 30	Readily indented by thumb nail
Hard	over 4.0	over 30	Indented with difficulty by thumb nail

   b. Color – If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled".

   c. Texture is based on the Ohio Department of Transportation Classification System. Soil particle size definitions are as follows:

Description		Size	Description		Size
Boulders		Larger than 8"	Sand	– Coarse	2.0 mm to 0.42 mm
Cobbles		8" to 3"		– Fine	0.42 mm to 0.074 mm
Gravel	– Coarse	3" to ¾"	Silt		0.074 mm to 0.005 mm
	– Fine	¾" to 2.0 mm	Clay		smaller than 0.005 mm

d. The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.

e. Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes.

trace	0 to 10%
little	10 to 20%
some	20 to 35%
"and"	35 to 50%

f. Moisture content of **cohesionless soils** (sands and gravels) is described as follows:

Term	Relative Moisture or Appearance
Dry	No moisture present
Damp	Internal moisture, but none to little surface moisture
Moist	Free water on surface
Wet	Voids filled with free water

g. The moisture content of **cohesive soils** (silts and clays) is expressed relative to plastic properties.

Term	Relative Moisture or Appearance
Dry	Powdery
Damp	Moisture content slightly below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content above liquid limit

10. Rock Hardness and Rock Quality Designation

a. The following terms are used to describe the relative hardness of the **bedrock.**

Term	Description
Very Soft	Permits denting by moderate pressure of the fingers. Resembles hard soil but has rock structure. (Crushes under pressure of fingers and/or thumb)
Soft	Resists denting by fingers, but can be abraded and pierced to shallow depth by a pencil point. (Crushes under pressure of pressed hammer)
Medium Hard	Resists pencil point, but can be scratched with a knife blade. (Breaks easily under single hammer blow, but with crumbly edges.)
Hard	Can be deformed or broken by light to moderate hammer blows. (Breaks under one or two strong hammer blow, but with resistant sharp edges.)
Very Hard	Can be broken only by heavy and in some rocks repeated hammer blows.

b. Rock Quality Designation, RQD – This value is expressed in percent and is an indirect measure of rock soundness. It is obtained by summing the total length of all core pieces which are at least four inches long, and then dividing this sum by the total length of the core run.

11. Gradation – when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).

12. When a test is performed to determine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture content is indicated graphically.

13. The standard penetration (N) value in blows per foot is indicated graphically.

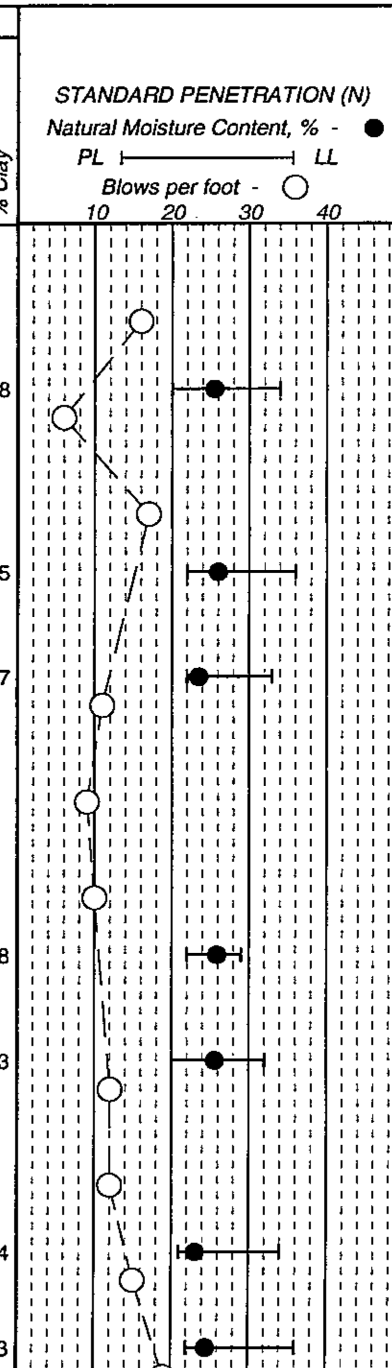
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring B-37 | Location: Sta. 112+40.5, 50.1 ft. LT of SR 823 CL | Date Drilled: 5/7/07 to 5/8/07

WATER OBSERVATIONS: Water seepage at: 17.0', 59.0', 68.5'
Water level at completion: 55.9' (prior to coring)
32.9' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	556.2												
0.3	555.9						Topsoil - 4"						
		5 5 11	13	1			Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.						
3.0	553.2												
		2 3 3	18	2		1.0	Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand; moist.	0	2	--	5	55	38
5													
		5 7 10	8	3		3.5							
							@ 7.5'-9.5', torvane = 0.58-0. 80 tsf.						
					ST-1	3.25		0	1	--	2	32	65
10													
		3 4 7	18	4		1.5		0	0	--	1	52	47
		3 4 5	18	5		2.0							
15							@ 15.5', varved.						
		3 4 6	18	6		1.5							
18.0	538.2												
					ST-2	1.75	Stiff brown SILT (A-4b), "and" clay, trace fine sand; torvane = 0.30-0.40 tsf; moist.	0	0	--	1	61	38
20													
21.5	534.7	3 5 7	18	7		1.75	Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine sand; moist.	0	0	--	1	56	43
		4 5 7	18	8		2.0							
25													
		4 5 10	18	9		2.5		0	0	--	2	44	54
							@ 28.5'-30.0', brownish gray, contains silt and fine sand seams.						
		4 8 11	18	10		3.0		0	0	--	1	36	63
30													



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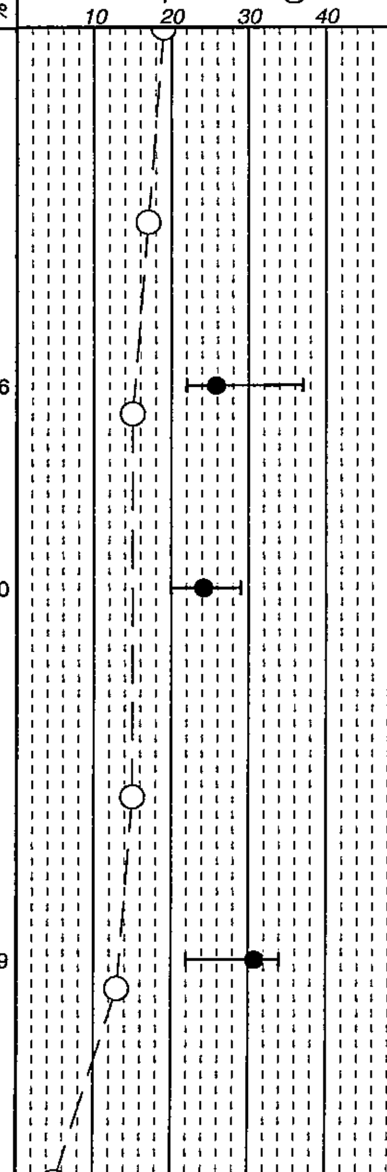
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring B-37 | Location: Sta. 112+40.5, 50.1 ft. LT of SR 823 CL | Date Drilled: 5/7/07 to 5/8/07

WATER OBSERVATIONS: Water seepage at: 17.0', 59.0', 68.5'
Water level at completion: 55.9' (prior to coring)
32.9' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	526.2						Stiff to very stiff brownish gray SILT AND CLAY (A-6a), trace fine sand; contains silt and fine sand seams; moist.						
35		5 7 10	18	11		3.0							
							@ 37.0', gray.						
40		4 6 9	18	12		2.75		0	0	--	1	43	56
43.5	512.7						Stiff to very stiff gray SANDY SILT (A-4a), "and" clay; moist.						
45					ST-3	1.75	@ 43.5'-45.5', torvane = 0.15-0.45 tsf.	0	0	--	3	47	50
							@ 47.0', contains trace organics.						
50		4 6 9	18	13		2.5							
52.0	504.2						Stiff gray SILT AND CLAY (A-6a), trace fine sand; moist.						
55		4 5 8	18	14		1.25		0	0	--	3	58	39
57.0	499.2						Very loose brown FINE SAND (A-3), trace silty clay; moist to wet.						
59.5	496.7	WOR WOH 5	18	15A		-							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

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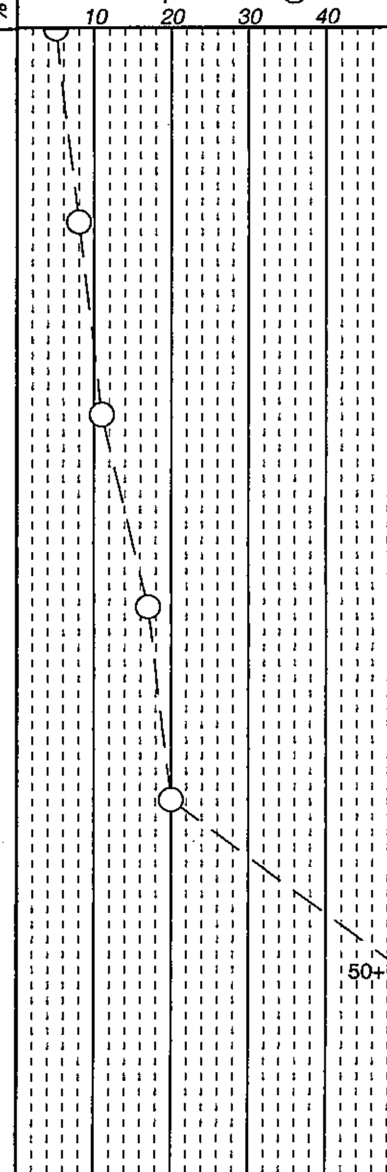
Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	496.2			15B		-	Stiff gray SILT (A-4b), trace to little fine sand, trace clay; moist.						
							@ 62.0', trace to little clay, moist to wet.						
65		WOR 3 5	18	16		1.5							
67.0	489.2						Stiff to very stiff brown SANDY SILT (A-4a), trace to little clay; moist to wet.						
70		1 2 9	18	17		-							
							@ 72.0', little gravel.						
75		3 7 10	18	18		2.0							
							@ 77.0', wet.						
80		4 8 12	18	19		-							
							@ 82.0', little to some fine to coarse sand, little to some gravel, wet.						
84.0	472.2	13 50/5	11	20A 20B			Severely weathered SANDSTONE.						
85.0	471.2	Core 63"	Rec 63"	RQD 52%	R-1		Medium hard gray SANDSTONE; fine grained, moderately to highly weathered, broken. @ 86.6', highly fractured.						
90													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL |——| LL
Blows per foot - ○



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32.9' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ├──┤ LL Blows per foot - ○ 10 20 30 40
90	466.2													
90.3	465.9						Bottom of Boring - 90.3'							
95														
100														
105														
110														
115														
120														

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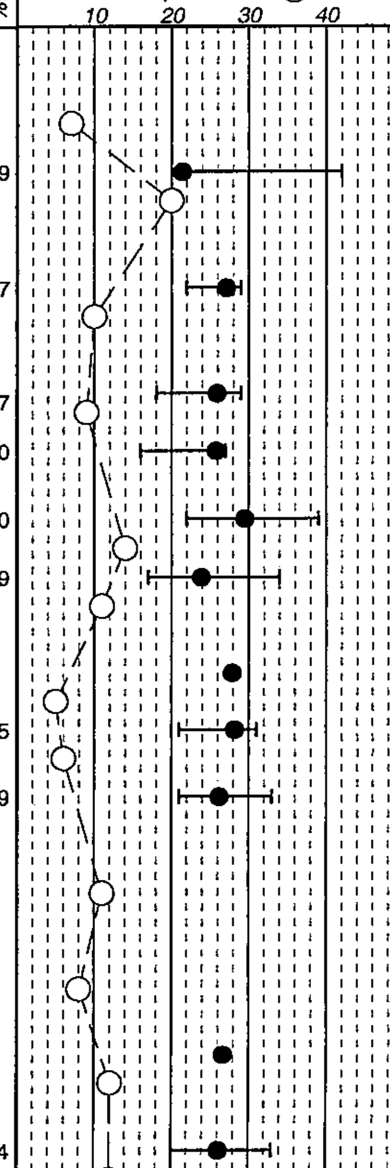
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring B-38 | Location: Sta. 117+97.8, 45.2 ft. RT of SR 823 CL | Date Drilled: 05/03/07 to 05/04/07

WATER OBSERVATIONS: Water seepage at: 18.3', 33.9', 78.5'
Water level at completion: 60.5' (at end of day 5/03/07)
43.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	561.7						Topsoil - 9"						
0.8	560.9	2 3 4	17	1		2.0	Very stiff brown CLAY (A-7-6), trace fine sand; damp to moist.						
		4 9 11	16	2		3.5		0	0	--	1	40	59
5.5	556.2	4 4 6	18	3		1.25	Stiff brown SILT (A-4b), trace fine sand; moist.	0	0	--	1	52	47
8.0	553.7	3 3 6	18	4A 4B		1.0 2.0	Stiff brown SILT AND CLAY (A-6a), trace fine sand; moist.	0	0	--	8	35	57
10					ST-1	1.0-1.5	@ 10.0'-12.0', torvane = 0.5 tsf	0	0	--	9	41	50
12.0	549.7	2 5 9	15	5		0.5	Medium stiff brown SILTY CLAY (A-6b), trace fine sand; contains thin fine sand seams; moist.	0	0	–	2	28	70
		2 4 7	18	6		3.0	@ 13.5'-15.0', very stiff.	0	0	--	2	39	59
15		1 2 3	16	7		1.0							
17.5	544.2	2 3 3	17	8		0.75	Medium stiff brown SILT (A-4b), trace fine sand; contains thin fine sand seams; moist.	0	0	--	1	54	45
19.0	542.7				ST-2	1.0-1.5	Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine sand; contains thin fine sand seams; moist. @ 19.0', torvane = 0.30 tsf @ 21.0', torvane = 0.38 tsf	0	0	--	1	50	49
20		3 4 7	18	9		1.0							
25		3 4 4	18	10		1.0							
		2 5 7	18	11		2.5							
30		3 5 7	18	12		1.75		1	3	--	3	39	54

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



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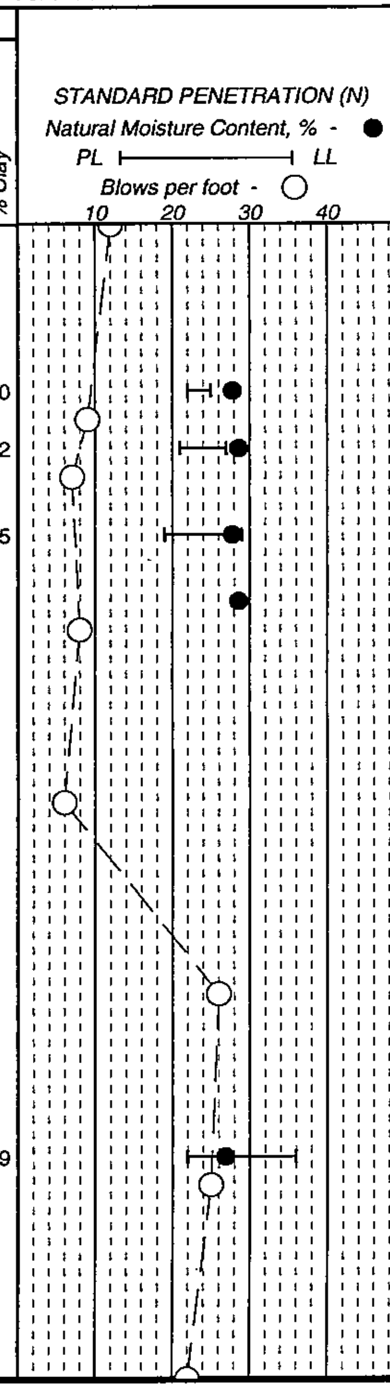
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring B-38 | Location: Sta. 117+97.8, 45.2 ft. RT of SR 823 CL | Date Drilled: 05/03/07 to 05/04/07

WATER OBSERVATIONS: Water seepage at: 18.3', 33.9', 78.5'
Water level at completion: 60.5' (at end of day 5/03/07)
43.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	531.7						Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine sand; moist.						
32.0	529.7						Soft to medium stiff gray SILT (A-4b), little to some clay, trace fine sand; contains thin fine sand seams; moist to wet.						
		2 3 6	18	13		0.5		0	0	--	1	69	30
35		2 2 5	18	14		0.25-0.5		0	0	--	0	78	22
					ST-3	0.5-0.75	@ 37.0'-39.0', torvane = 0.14 tsf.	0	0	--	2	73	25
40		2 4 4	18	15		0.25-0.5							
45		WOH 3 3	14	16		0.25-0.5							
46.5	515.2						Very stiff gray SILT AND CLAY (A-6a), trace fine sand; moist.						
50		5 10 16	18	17		3.0							
							@ 52.0', brownish-gray.						
55		7 11 14	18	18		3.0		0	0	--	1	30	69
60		5 10 12	18	19		2.0							



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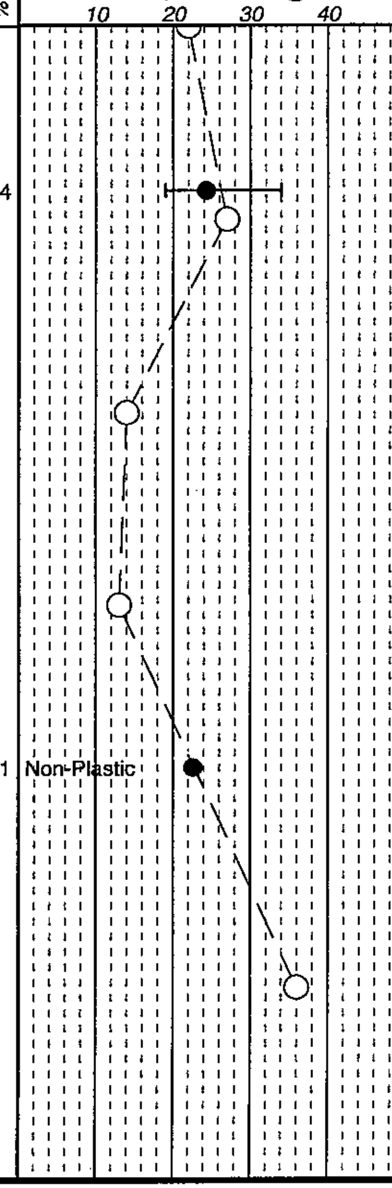
Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	501.7						Stiff to very stiff gray SILT AND CLAY (A-6a), trace fine sand; moist.						
65		6 11 16	18	20		2.0		0	0	--	4	32	64
70		3 5 9	18	21		1.75							
72.0	489.7						Medium dense to dense gray SANDY SILT (A-4a), little clay; moist to wet.						
75		3 5 8	18	22									
80		W O H	18	23			@ 80.0', 10.0' sand heave accumulated overnight; washed out.	0	2	--	42	45	11
85		11 13 23	18	24A 24B									
85.5	476.2	Core 60"	Rec 60"	RQD 85%	R-1		Medium hard gray SANDSTONE; fine to medium grained, slightly to moderately weathered, moderately to highly fractured. @ 85.6'-85.9', iron stained fractures.						
90													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring B-38 | *Location:* Sta. 117+97.8, 45.2 ft. RT of SR 823 CL | *Date Drilled:* 05/03/07 to 05/04/07

WATER OBSERVATIONS: Water seepage at: 18.3', 33.9', 78.5'
Water level at completion: 60.5' (at end of day 5/03/07)
43.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
90	471.7													
90.5	471.2						Bottom of Boring - 90.5'							

Depth scale: 90, 95, 100, 105, 110, 115, 120

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

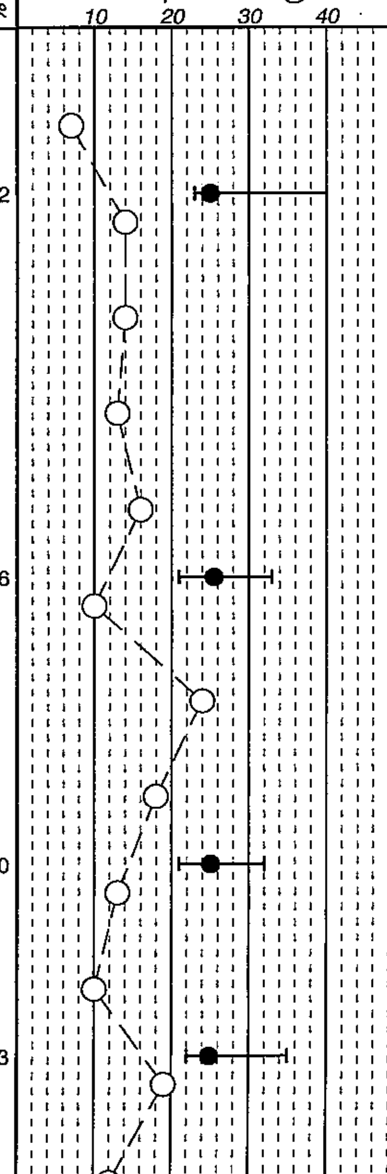
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-39 | Location: Sta. 116+63.5, 22.4 ft. LT of SR 823 CL | Date Drilled: 02/02/05 to 02/03/05

WATER OBSERVATIONS: Water seepage at: 33.5'-50.0', 73.5'-80.0'
Water level at completion: 36.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	566.2												
0.3	565.9						Topsoil - 4"						
		1 3 4	16	1		2.25	Very stiff brown SILTY CLAY (A-6b); damp. @ 0.0'-1.5', contains organics.						
		3 6 8	18	2		3.5		0	0	--	1	47	52
5.5	560.7						Very stiff to hard brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp.						
		3 5 9	18	3		2.25							
		3 5 8	18	4		3.25							
		4 7 9	16	5		2.75							
		3 5 5	18	6		2.75		0	0	--	1	53	46
		5 10 14	16	7		4.0							
		4 8 10	15	8		3.75							
		4 6 7	18	9		3.25		0	0	--	1	59	40
		4 4 6	16	10		3.0							
		6 8 11	18	11		3.0		0	0	--	1	46	53
28.0	538.2						Very stiff brown SILTY CLAY (A-6b), trace fine sand; wet.						
		4 6 6	18	12		3.25							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

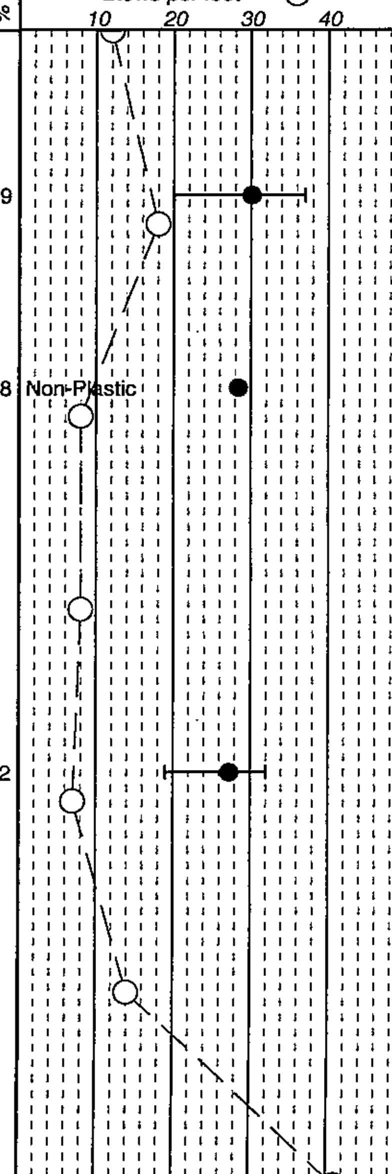
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-39 | Location: Sta. 116+63.5, 22.4 ft. LT of SR 823 CL | Date Drilled: 02/02/05 to 02/03/05

WATER OBSERVATIONS: Water seepage at: 33.5'-50.0', 73.5'-80.0'
Water level at completion: 36.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	536.2						Very stiff brown SILTY CLAY (A-6b), trace fine sand; wet.						
35		6 8 10	18	13		2.25		0	0	--	1	80	19
37.0	529.2						Loose gray SILT (A-4b), trace fine sand; wet.						
40		5 3 5	15	14				0	0	--	1	81	18
45		3 3 5	16	15									
47.0	519.2						Medium stiff to stiff gray SILT AND CLAY (A-6a); damp to wet.						
50		3 3 4	18	16		0.5		0	0	--	1	57	42
55		4 5 9	18	17		1.0							
57.0	509.2						Hard brownish gray CLAY (A-7-6), trace to little fine sand; damp to moist.						
60		9 16 25	18	18		4.5+							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 (9/12/2007 3:14 PM)

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

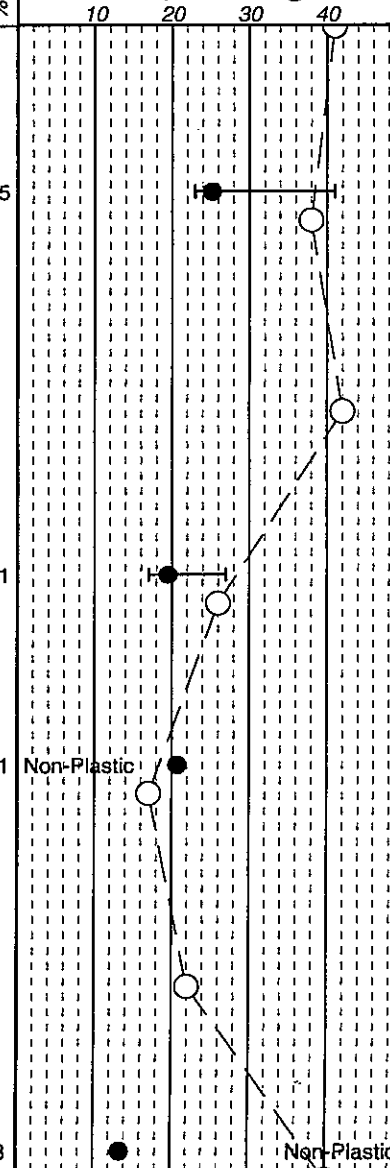
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-39 | *Location:* Sta. 116+63.5, 22.4 ft. LT of SR 823 CL | *Date Drilled:* 02/02/05 to 02/03/05

WATER OBSERVATIONS: Water seepage at: 33.5'-50.0', 73.5'-80.0'
Water level at completion: 36.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	506.2						Hard brownish gray CLAY (A-7-6), trace fine sand; moist.						
65		12 15 23	16	19		4.5+		0	0	--	3	32	65
70		11 18 24	15	20		2.5							
72.0	494.2						Very stiff gray SILT (A-4b), trace fine sand; slightly organic; damp.						
75		5 10 16	16	21		3.5		0	0	--	9	60	31
77.0	489.2						Medium dense brown SANDY SILT (A-4a), trace gravel; slightly organic; wet.						
80		7 8 9	18	22				0	3	--	38	48	11
82.0	484.2						Medium dense gray FINE SAND (A-3), trace gravel, trace silt; moist.						
85		12 10 12	18	23									
87.0	479.2						Severely weathered brown and gray SANDSTONE, argillaceous.						
90		27 23 17	14	24				41	11	--	13	27	8

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-39 | *Location:* Sta. 116+63.5, 22.4 ft. LT of SR 823 CL | *Date Drilled:* 02/02/05 to 02/03/05

WATER OBSERVATIONS: Water seepage at: 33.5'-50.0', 73.5'-80.0'
Water level at completion: 36.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
90	476.2						Severely weathered brown and gray SANDSTONE, argillaceous.							
92.0	474.2						Medium hard to hard gray SANDSTONE; very fine to fine grained, moderately weathered, argillaceous, thinly bedded to massive, slightly fractured, contains few argillaceous laminations. @ 92.0'-92.2', 92.3'-92.5', filled fractures.							
95		Core 60"	Rec 60"	RQD 90%	R-1									
		Core 60"	Rec 56"	RQD 93%	R-2		@ 97.7',97.8', low angle fractures.							
100							@ 100.7'-101.1', highly weathered and broken. @ 101.7'-101.9', decomposed shale layer.							
105		Core 60"	Rec 60"	RQD 100%	R-3									
110		Core 60"	Rec 60"	RQD 100%	R-4		@ 111.0'-111.3', calcareous layer. @ 111.3'-112.0', fine to medium grained clean sandstone.							
112.0	454.2						Bottom of Boring - 112.0'							
115														
120														

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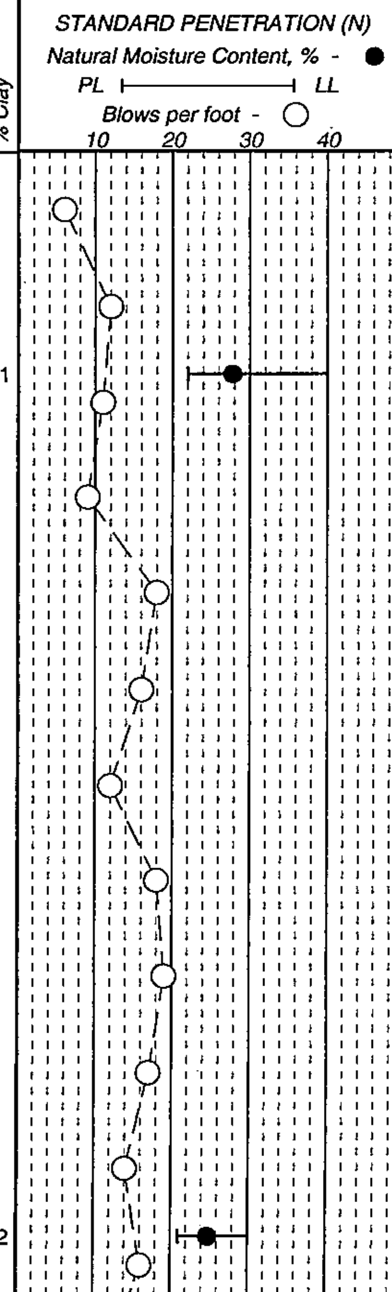
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-40 | Location: Sta. 116+55.2, 36.5 ft. RT of SR 823 CL | Date Drilled: 02/04/05 to 02/09/05

WATER OBSERVATIONS: Water seepage at: 30.0'-46.5', 75.0'-95.0'
Water level at completion: 26.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	567.9												
0.5	567.4	1 2 4	18	1		1.5	Topsoil - 6"						
							Stiff to very stiff brown SILTY CLAY (A-6b), trace fine sand; damp to moist.						
		2 6 6	16	2		3.5							
5		3 5 6	18	3		1.5		0	0	--	1	48	51
		4 4 5	16	4		1.5							
10		6 8 10	18	5		2.5	@ 10.0', very stiff.						
		4 6 10	18	6		2.5							
15		2 5 7	18	7		2.5							
17.0	550.9						Hard brown CLAY (A-7-6), some to "and" silt, trace fine sand; damp to moist.						
		5 8 10	18	8		4.0							
20		3 7 12	16	9		4.5+							
		5 7 10	18	10		4.0							
25		4 6 8	16	11		4.5							
27.5	540.4	5 8 8	18	12		2.25	Stiff to very stiff brown SILT (A-4b), "and" clay, trace fine sand, moist.	0	0	--	2	56	42
30													



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

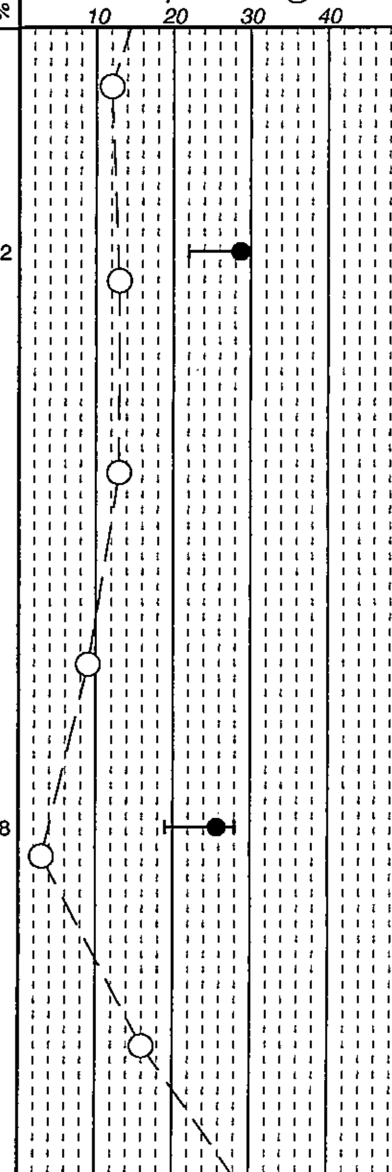
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-40 | Location: Sta. 116+55.2, 36.5 ft. RT of SR 823 CL | Date Drilled: 02/04/05 to 02/09/05

WATER OBSERVATIONS: Water seepage at: 30.0'-46.5', 75.0'-95.0'
Water level at completion: 26.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	537.9	5 5 7	15	13		2.0	Stiff to very stiff brown SILT (A-4b), some to "and" clay, trace fine to coarse sand; moist to wet.						
35		6 7 6	17	14		1.5		0	2	--	2	74	22
40		4 5 8	18	15		2.0							
45		4 4 5	18	16		1.5							
50		WOH WOH 3	18	17		1.5	@ 50.0', trace gravel.	1	1	--	4	56	38
55		4 8 8	18	18		3.5							
60													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



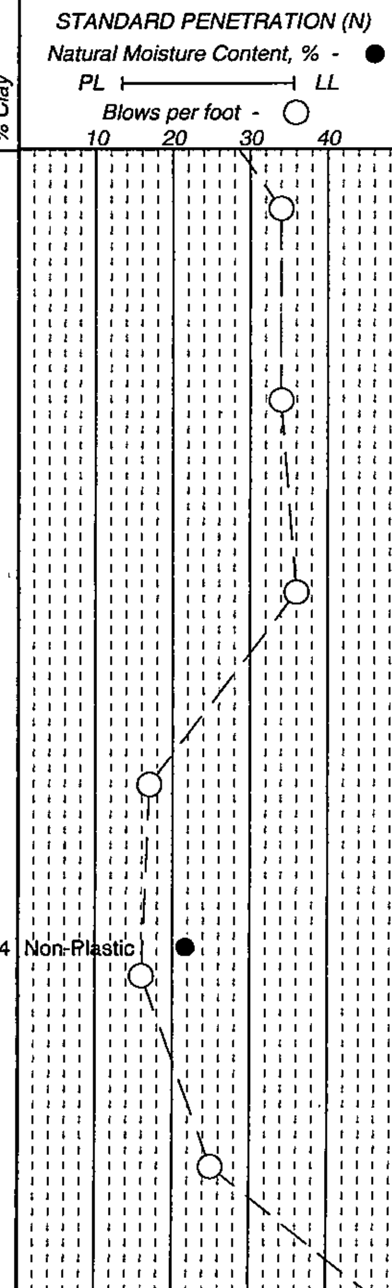
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-40 | Location: Sta. 116+55.2, 36.5 ft. RT of SR 823 CL | Date Drilled: 02/04/05 to 02/09/05

WATER OBSERVATIONS: Water seepage at: 30.0'-46.5', 75.0'-95.0'
Water level at completion: 26.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
60.0	507.9	8 15 19	18	19		3.0	Very stiff to hard gray CLAY (A-7-6), some silt, trace fine sand; damp to moist.							
65		5 15 19	18	20		3.0								
70		11 16 20	16	21		4.5+								
75		4 7 10	18	22		3.5								
78.0	489.9						Medium dense gray and brown SILT (A-4b), some fine to coarse sand, little clay, trace gravel; wet.							
80		WOH WOH 16	15	23				1	2	--	25	58	14	Non-Plastic
85		9 11 14	18	24										
88.0	479.9						Very dense gray COARSE AND FINE SAND (A-3a), little silty clay, trace fine gravel; wet.							
90														



DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. *Project:* SCI-823-0.00 *Job No.* 0121-3070.03

LOG OF: Boring TR-40 *Location:* Sta. 116+55.2, 36.5 ft. RT of SR 823 CL *Date Drilled:* 02/04/05 to 02/09/05

WATER OBSERVATIONS: Water seepage at: 30.0'-46.5', 75.0'-95.0'
Water level at completion: 26.7' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
90	477.9	50/5	5	25			Very dense gray COARSE AND FINE SAND (A-3a), little silty clay, trace fine gravel; wet.							50+
95.0	472.9	Core 60"	Rec 58"	RQD 67%	R-1		Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, argillaceous, arenaceous, thickly bedded to massive, slightly to moderately fractured. @ 95.5',95.8',99.6', low angle clay filled fractures.							
100		Core 60"	Rec 60"	RQD 93%	R-2		@ 100.8',102.7',103.0', low angle clay filled fractures.							
105		Core 60"	Rec 49"	RQD 75%	R-3		@ 106.7',112.5', low angle clay filled fractures.							
110		Core 60"	Rec 60"	RQD 90%	R-4									
115.0	452.9						Bottom of Boring - 115.0'							
120														

STANDARD PENETRATION (N): Natural Moisture Content, % - ●; PL ⊢—⊣ LL; Blows per foot - ○; scale 10, 20, 30, 40

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

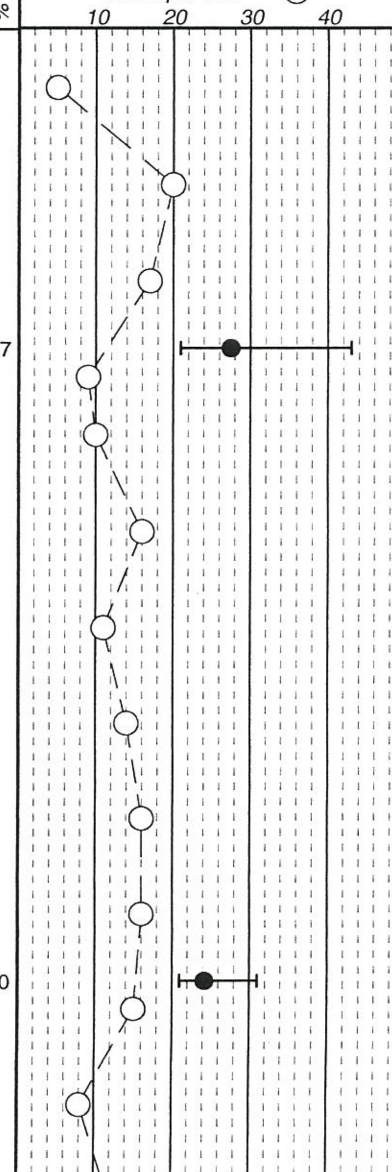
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-41 | Location: Sta. 113+84.4, 12.6 ft. LT of SR 823 CL | Date Drilled: 2/15/05 to 2/16/05

WATER OBSERVATIONS:
Water seepage at: 21.8'-29.5', 69.0'-71.0', 84.0'-93.0'
Water level at completion: 20.2' (Start of Shift 2/16/05 @ 80')
23.5' (prior to coring)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	569.4												
0.8	568.6	2 3 2	15	1		2.0	Topsoil - 9"						
							Very stiff brown CLAY (A-7-6), "and" silt, trace fine sand; moist.						
		4 9 11 (20)	18	2		4.0							
5		4 7 10 (17)	18	3		2.5							
		3 4 5 (9)	18	4		2.25		0	0	--	1	42	57
10		2 4 6 (10)	18	5		2.5							
		4 7 9 (16)	18	6		3.5							
15		3 4 7 (11)	18	7		3.25							
		2 6 8 (14)	18	8		3.5							
20		2 6 10 (16)	18	9		4.0							
21.0	548.4						Very stiff brown SILT (A-4b), "and" clay, trace fine sand; moist.						
		6 7 9 (15)	18	10		3.75							
25		6 7 8 (15)	18	11		2.5		0	1	--	4	55	40
		2 3 5 (8)	18	12		2.5							
30		2 5		13		2.5							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

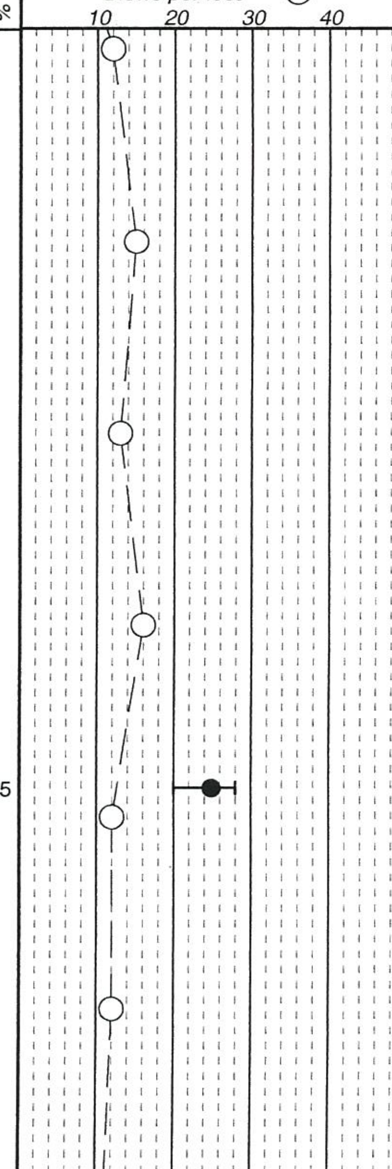
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-41 | Location: Sta. 113+84.4, 12.6 ft. LT of SR 823 CL | Date Drilled: 2/15/05 to 2/16/05

WATER OBSERVATIONS:
Water seepage at: 21.8'-29.5', 69.0'-71.0', 84.0'-93.0'
Water level at completion: 20.2' (Start of Shift 2/16/05 @ 80')
23.5' (prior to coring)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	539.4	7 12	18				Stiff to very stiff gray SILT (A-4b), some to "and" clay, trace fine sand, moist.						
35		3 6 9 15	18	14		2.25							
40		5 6 7 13	18	15		2.5	@ 39.5', becomes gray.						
45		3 7 9 16	18	16		1.5							
50		3 5 7 12	18	17		2.0		0	0	--	2	63	35
55		4 5 7 12	18	18		2.5							
60		2 5		19		1.75							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

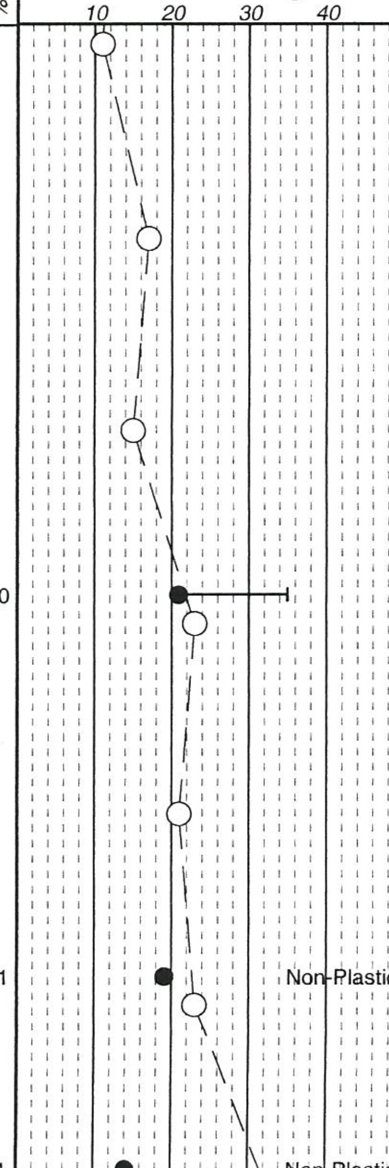
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-41 | Location: Sta. 113+84.4, 12.6 ft. LT of SR 823 CL | Date Drilled: 2/15/05 to 2/16/05

WATER OBSERVATIONS: Water seepage at: 21.8'-29.5', 69.0'-71.0', 84.0'-93.0'
Water level at completion: 20.2' (Start of Shift 2/16/05 @ 80')
23.5' (prior to coring)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	509.4	6 (11)	18				Stiff to very stiff gray SILT (A-4b), some to "and" clay, trace fine sand, moist.						
65		7 7 10 (17)	18	20		2.0	@ 64.0'-65.5', trace organics.						
68.0	501.4						Loose to medium dense brownish gray FINE SAND (A-3), little silty clay; wet.						
70.0	499.4	10 7 8 (18)	18	21			Stiff to very stiff gray SILT AND CLAY (A-6a), trace fine to coarse sand; damp to moist.						
75		5 9 14 (27)	18	22		3.0		0	1	--	4	55	40
80		3 9 12 (21)	18	23		1.5							
83.0	486.4						Loose to medium dense gray SANDY SILT (A-4a), little clay, trace gravel; wet.						
85		10 9 14 (23)	18	24				7	7	--	27	48	11
87.0	482.4						Severely weathered brown SANDSTONE.						
90		10 12		25				36	9	--	35	16	4

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-41 | Location: Sta. 113+84.4, 12.6 ft. LT of SR 823 CL | Date Drilled: 2/15/05 to 2/16/05

WATER OBSERVATIONS: Water seepage at: 21.8'-29.5', 69.0'-71.0', 84.0'-93.0'
Water level at completion: 20.2' (Start of Shift 2/16/05 @ 80')
23.5' (prior to coring)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ (10, 20, 30, 40)
90	479.4	21	17				Severely weathered brown SANDSTONE.							○ (~33)
93.0	476.4						Medium hard to hard brown and gray SANDSTONE; very fine to fine grained, moderately to highly weathered, argillaceous, micaceous, thinly to thickly bedded, highly fractured, with typically low angle rust stained fractures. @ 95.1'-95.5', broken zone. @ 93.0'-93.7', lost recovery.							
95 – 95.6	473.8	Core 60"	Rec 48"	RQD 50%	R-1		Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, argillaceous, micaceous, thinly to thickly bedded, moderately fractured, with typically low angle clay filled fractures.							
100		Core 60"	Rec 60"	RQD 85%	R-2									
105		Core 60"	Rec 54"	RQD 67%	R-3		@ 103.0'-103.5', lost recovery. @ 103.5'-104.0',106.7'- 107.7', broken zones.							
110		Core 60"	Rec 60"	RQD 90%	R-4									
113.0	456.4						Bottom of Boring - 113.0'							
115														
120														

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

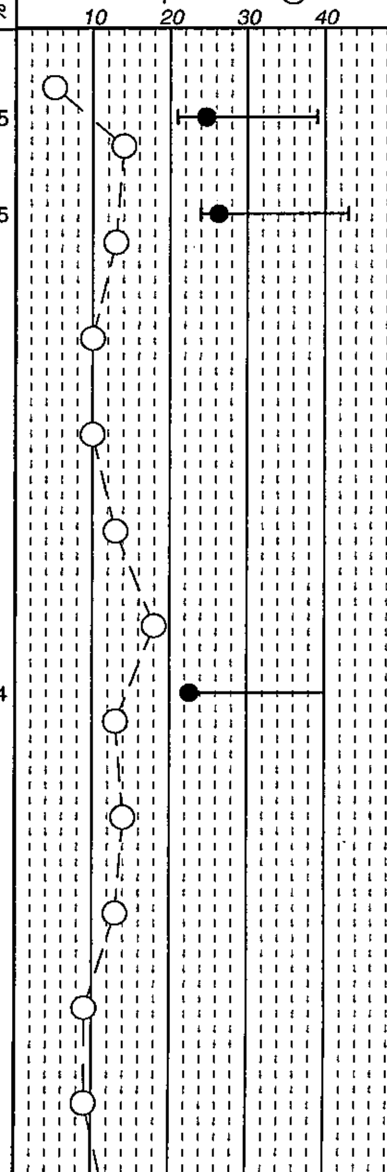
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-42 | Location: Sta. 113+51.7, 30.3 ft. RT of SR 823 CL | Date Drilled: 2/18/05 to 2/22/05

WATER OBSERVATIONS:
Water seepage at: 27.6', 33'-37', 50'-58', 67'-72', 84'-92'
Water level at completion: 25.5' (start of shift 2/22/05)
25.5' (Prior to coring)
25.3' (Includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	568.0												
0.4	567.6	1 3 2	13	1		1.75	Topsoil - 5"						
		4 4 10	18	2		2.0	Stiff dark brown SILT AND CLAY (A-6b), trace fine sand; damp to moist. @ 1.5', brown.	0	1	--	3	51	45
3.5	564.5	4 5 8	18	3		3.5	Very stiff brown CLAY (A-7 6), trace fine to coarse sand; damp to moist.	0	0	--	1	44	55
		2 4 6	18	4		3.5	@ 6.5', varved.						
		2 4 6	18	5		3.75							
		2 6 7	18	6		3.25							
13.5	554.5	4 7 11	18	7		4.0	Very stiff to hard brown SILTY CLAY (A-6b), trace fine sand; damp to moist.						
		4 6 7	18	8		4.5+		0	0	--	1	35	64
		4 5 9	18	9		4.5+							
		3 5 8	18	10		3.5							
		3 4 5	18	11		2.75							
		3 4 5	18	12		3.0	@ 27.6', thin sandy silt seam; wet.						
30		4 5		13		3.0							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

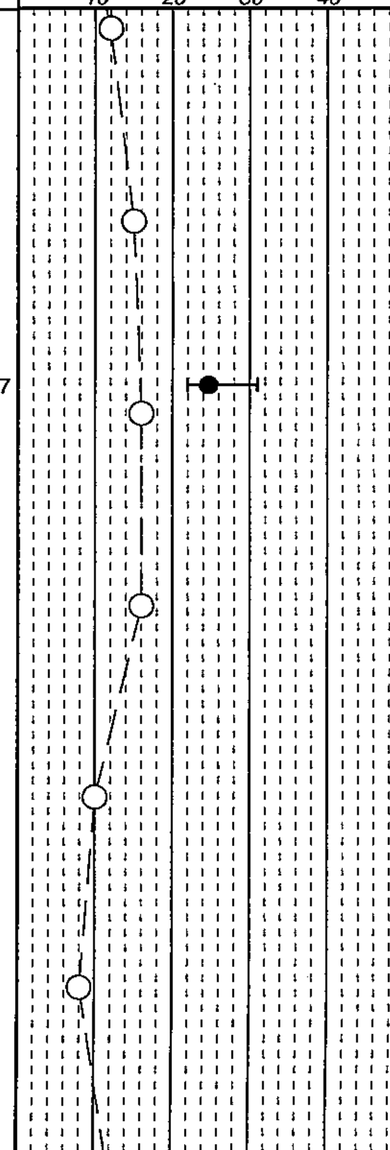
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-42 | Location: Sta. 113+51.7, 30.3 ft. RT of SR 823 CL | Date Drilled: 2/18/05 to 2/22/05

WATER OBSERVATIONS: Water seepage at: 27.6', 33'-37', 50'-58', 67'-72', 84'-92'
Water level at completion: 25.5' (start of shift 2/22/05)
25.5' (Prior to coring)
25.3' (Includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	538.0	7	18				Very stiff to hard brown SILTY CLAY (A-6b), trace fine sand; moist.						
35		4 7 8	18	14		2.0							
37.0	531.0						Very stiff to hard gray SILT (A-4b), "and" clay, trace fine to coarse sand; moist.						
40		6 5 11	18	15		4.5+		0	0	--	0	53	47
45		5 6 10	18	16		3.5							
50		3 4 6	18	17		2.5	@ 49.0', stiff to very stiff; wet.						
55		3 3 5	18	18		1.5							
60		4 5		19		3.25							



DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

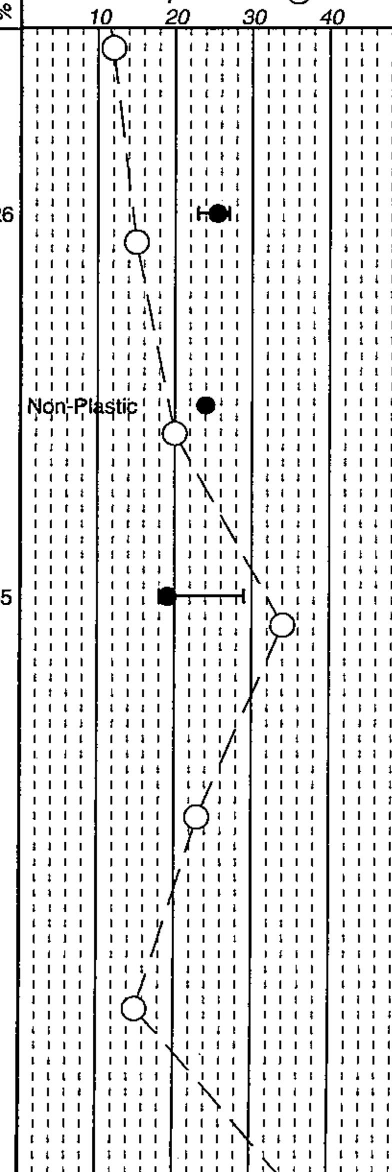
Client: TranSystems, Inc. | *Project:* SCI-823-0.00 | *Job No.* 0121-3070.03

LOG OF: Boring TR-42 | *Location:* Sta. 113+51.7, 30.3 ft. RT of SR 823 CL | *Date Drilled:* 2/18/05 to 2/22/05

WATER OBSERVATIONS:
Water seepage at: 27.6', 33'-37', 50'-58', 67'-72', 84'-92'
Water level at completion: 25.5' (start of shift 2/22/05)
25.5' (Prior to coring)
25.3' (Includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
60	508.0	7	18				Very stiff to hard gray SILT (A-4b), some to "and" clay, trace fine to coarse sand; wet.						
65		4 7 8	18	20		2.0		0	0	--	0	74	26
67.0	501.0						Medium dense brown SANDY SILT (A-4a), trace gravel, trace clay; wet.						
70		4 10 10	18	21				3	11	--	50	36	
72.0	496.0						Very stiff brownish gray SILT AND CLAY (A-6a), trace fine sand; moist to wet.						
75		7 14 20	18	22		2.25		0	0	--	8	57	35
77.0	491.0						Medium dense to dense brownish gray SILT (A-4b), "and" clay, trace gravel; moist to wet.						
80		5 7 16	18	23									
							@ 84.0', wet.						
85		8 6 9	18	24									
88.0	480.0						Dense brown GRAVEL WITH SAND (A-1-b), trace silt; wet.						
90		10 14		25									

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○



FILE: 0121-3070-03 [9/12/2007 3:14 PM]

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-42 | Location: Sta. 113+51.7, 30.3 ft. RT of SR 823 CL | Date Drilled: 2/18/05 to 2/22/05

WATER OBSERVATIONS: Water seepage at: 27.6', 33'-37', 50'-58', 67'-72', 84'-92'
Water level at completion: 25.5' (start of shift 2/22/05)
25.5' (Prior to coring)
25.3' (Includes drilling water)

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○
10 20 30 40

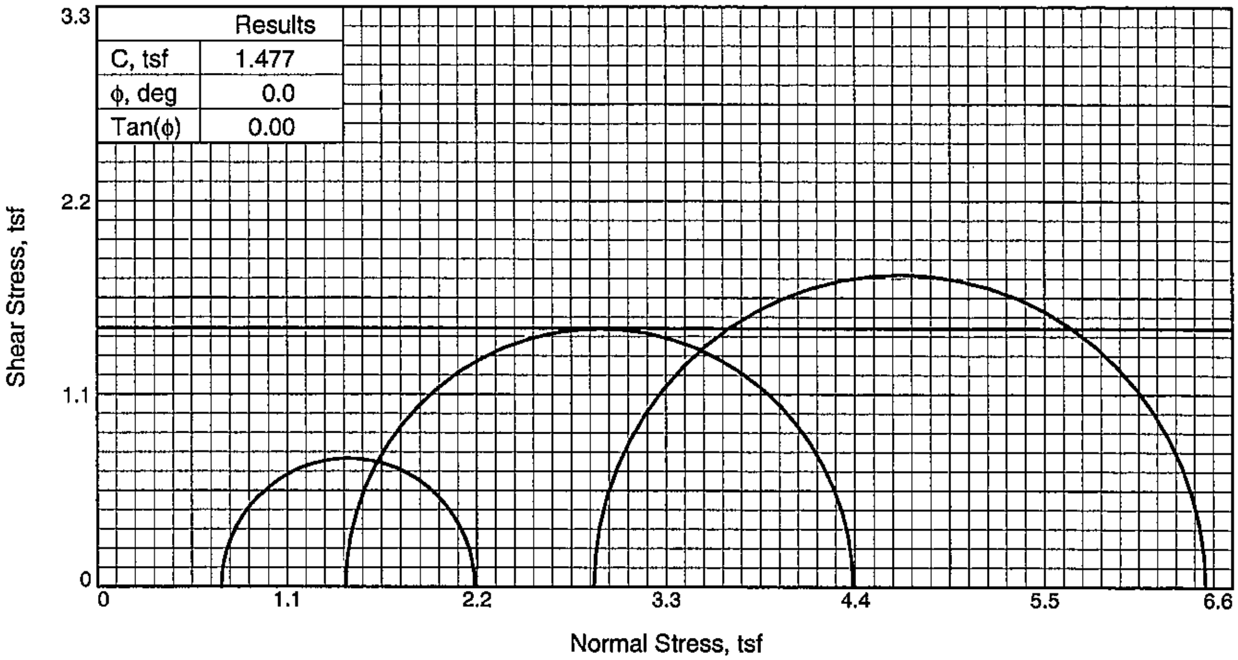
Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
90	478.0	23	18				Dense brown GRAVEL WITH SAND (A-1-b), trace silt; wet.						
92.0	476.0						Medium hard gray SANDSTONE; very fine to fine grained, moderately to highly weathered, argillaceous, micaceous, thickly bedded to massive, highly fractured.						
94.0	474.0	Core 60"	Rec 48"	RQD 75%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, massive, moderately to highly fractured. @ 94.1',94.6',95.1',96.1', 97.4',97.8',100.8',101.4', fractured. @ 104.0', high angle fracture. @ 102.2',105.8',108.9' clay filled fractures.						
100		Core 60"	Rec 58"	RQD 88%	R2								
105		Core 60"	Rec 55"	RQD 60%	R3		@ 104.3'-104.5', high angle fracture. @ 104.5'-105.1', broken.						
110		Core 60"	Rec 59"	RQD 85%	R4								
112.0	456.0						Bottom of Boring - 112.0'						
115													
120													

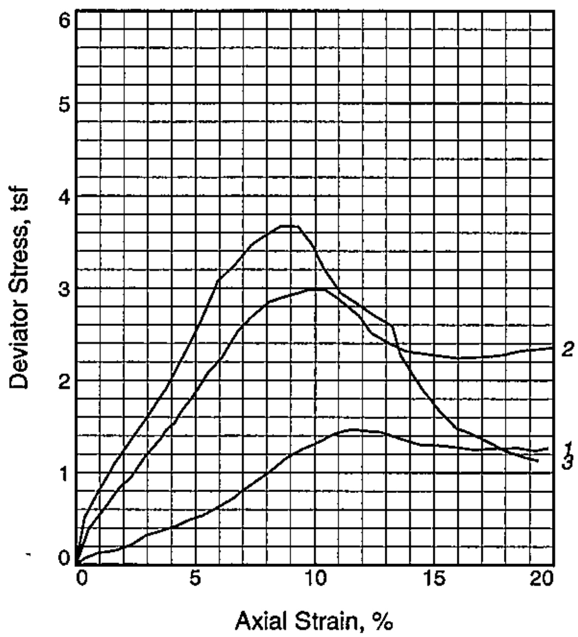
APPENDIX III

Laboratory Test Results

PROJECT SCI-823-0.00
Highland Bend Embankments
SUMMARY OF STRENGTH TESTING

Boring	Sample	Depth (ft.)	Test Performed	Results											
				ODOT Classification	γ_D (pcf)	WC (%)	e_o	Cc	Cr	p_c (tsf)	c (psf)	c' (psf)	φ	φ	qu (tsf)
B-37	ST-1	8.0	UU, CONS	A-6a	97.9	23.8	0.718	0.180	0.070	2.240	2954				
B-37	ST-2	18.0	CIU	A-4b	96.9	25.9					1112	300	17.0	29.5	
B-37	ST-3	43.5	CIU	A-4a	102.6	20.9					1892	1376	13.4	22.7	
B-38	ST-1	10.0	CIU, CONS	A-4a	98.2	26.6	0.748	0.110	0.030	5.726	382	420	18.4	31.1	
B-38	In-Situ	19.0	FVS Test*	A-4b / A-6a							2714*				
B-38	ST-2	19.0	UU , CONS	A-6a	101.3	23.6	0.738	0.340	0.050	6.294	2036				
B-38	ST-2	19.0	CIU	A-6a	98.3	26.8					1304	0	20.9	32.4	
B-38	ST-3	37.0	CIU, CONS	A-4b	96.9	28.6	0.760	0.160	0.030	2.373	0	0	33.1	36.3	





Sample No.		1	2	3
Initial	Water Content,	23.8	22.8	21.1
	Dry Density, pcf	97.9	98.9	103.1
	Saturation,	86.9	85.1	87.5
	Void Ratio	0.7542	0.7365	0.6649
	Diameter, in.	2.79	2.80	2.79
	Height, in.	5.47	5.58	5.59
At Test	Water Content,	23.4	22.1	23.2
	Dry Density, pcf	97.9	98.9	103.1
	Saturation,	85.3	82.5	95.9
	Void Ratio	0.7542	0.7365	0.6649
	Diameter, in.	2.79	2.80	2.79
	Height, in.	5.47	5.58	5.59
Strain rate, in./min.		0.06	0.06	0.06
Back Pressure, tsf		0.00	0.00	0.00
Cell Pressure, tsf		0.72	1.44	2.88
Fail. Stress, tsf		1.47	2.95	3.56
Ult. Stress, tsf		1.45	2.98	3.66
σ_1 Failure, tsf		2.19	4.39	6.44
σ_3 Failure, tsf		0.72	1.44	2.88

Type of Test:
Unconsolidated Undrained

Sample Type: 3" press tube

Description: Lean clay

LL= 36 **PL=** 22 **PI=** 14

Specific Gravity= 2.75

Remarks:

Figure ________

Client: TranSystems, Inc.

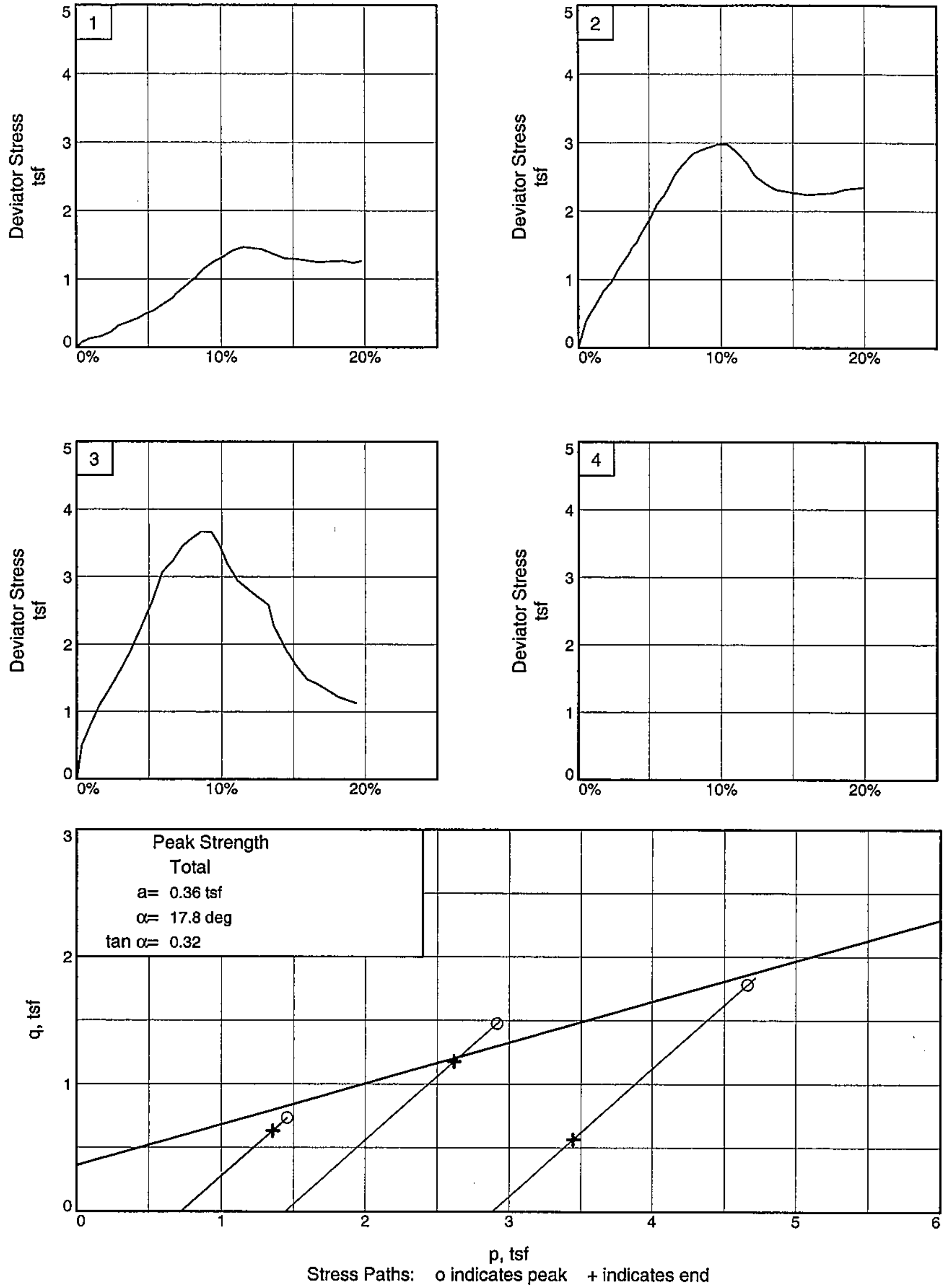
Project: SCI-823-0.00

Source of Sample: B-37 **Depth:** 8.0

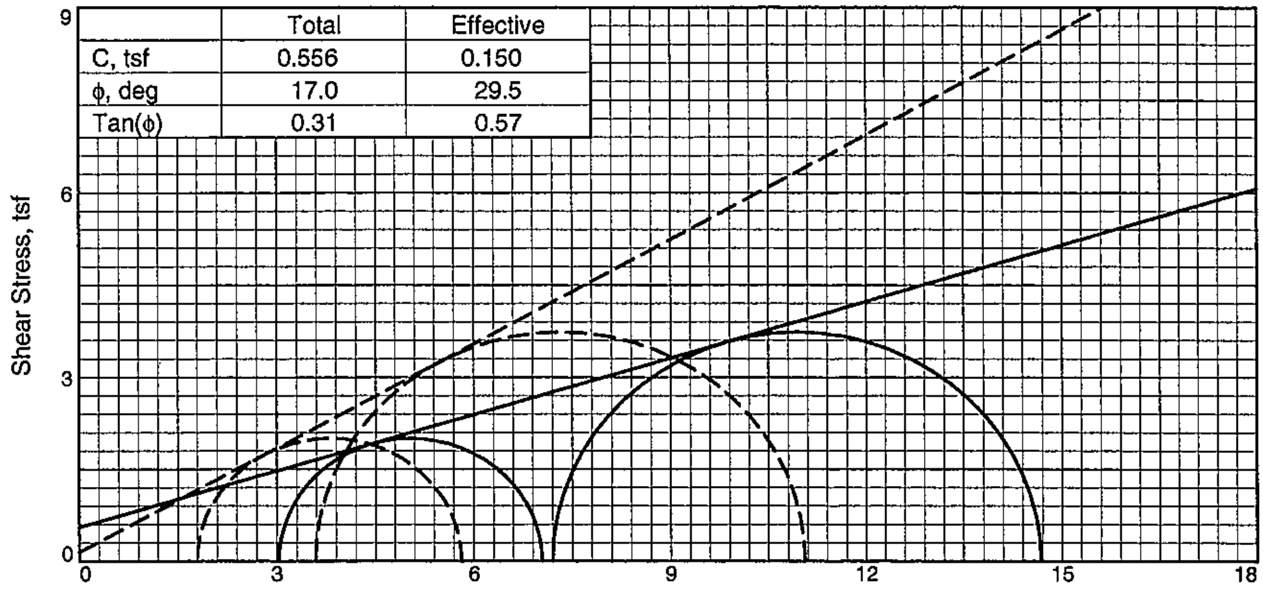
Sample Number: ST-1

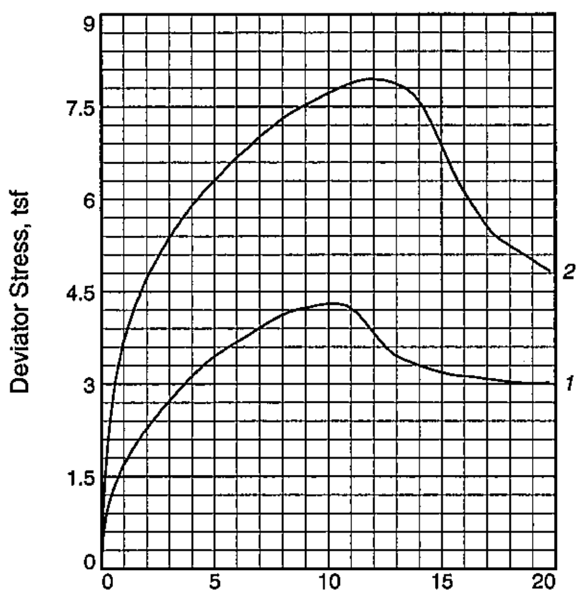
Proj. No.: 0121-3070.03 **Date:** 6/6/07

DLZ



Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-37 **Depth:** 8.0 **Sample Number:** ST-1
Project No.: 0121-3070.03 **Figure** ________ **DLZ, INC.**





Sample No.		1	2
Initial	Water Content,	25.9	25.6
	Dry Density, pcf	96.9	98.0
	Saturation,	94.6	96.0
	Void Ratio	0.7395	0.7196
	Diameter, in.	2.79	2.81
	Height, in.	5.60	5.58
At Test	Water Content,	25.6	24.4
	Dry Density, pcf	96.9	98.0
	Saturation,	93.6	91.5
	Void Ratio	0.7395	0.7196
	Diameter, in.	2.79	2.81
	Height, in.	5.60	5.58
Strain rate, in./min.		0.01	0.01
Back Pressure, tsf		1.2	1.2
Cell Pressure, tsf		4.2	8.4
Fail. Stress, tsf		4.0	7.5
Total Pore Pr., tsf		2.4	4.8
Ult. Stress, tsf		4.0	7.5
Total Pore Pr., tsf		2.4	4.8
$\bar{\sigma}_1$ Failure, tsf		5.8	11.1
$\bar{\sigma}_3$ Failure, tsf		1.8	3.6

Type of Test:
CU with Pore Pressures
Sample Type: Press Tube
Description: Silty clay

LL= 29 **PL=** 22 **PI=** 7
Assumed Specific Gravity= 2.7
Remarks:

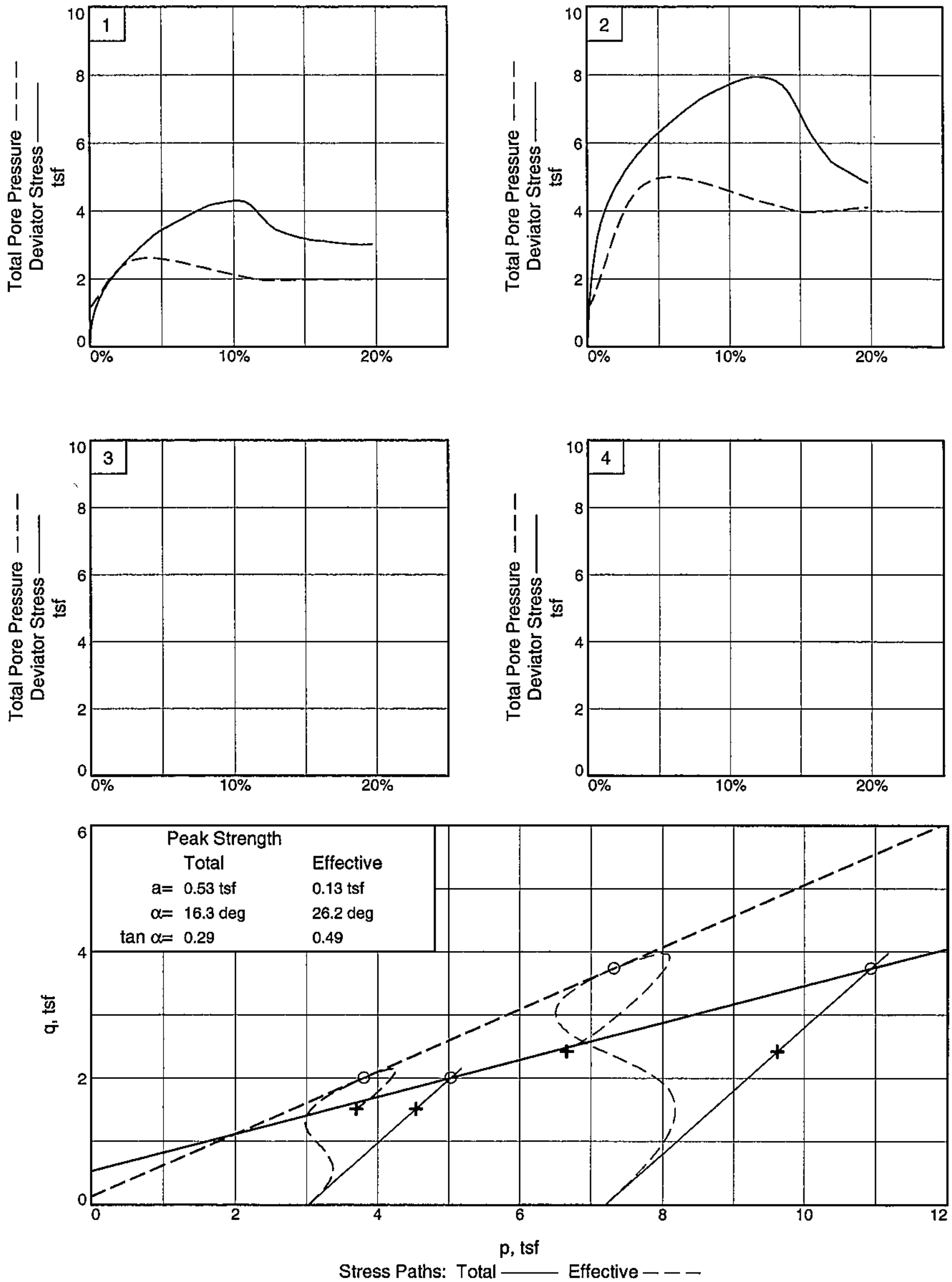
Figure ______

Client: TranSystems, Inc.

Project: SCI-823-0.00

Source of Sample: B-37 **Depth:** 18
Sample Number: ST-2
Proj. No.: 0121-3070.03 **Date:** 6/6/07

DLZ



Client: TranSystems, Inc.

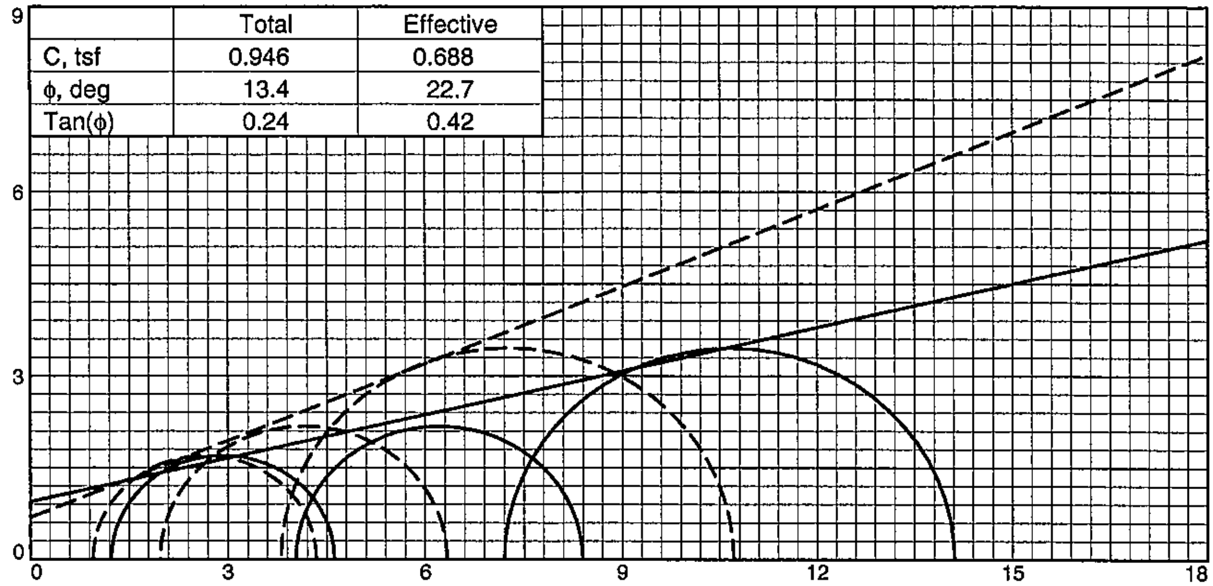
Project: SCI-823-0.00

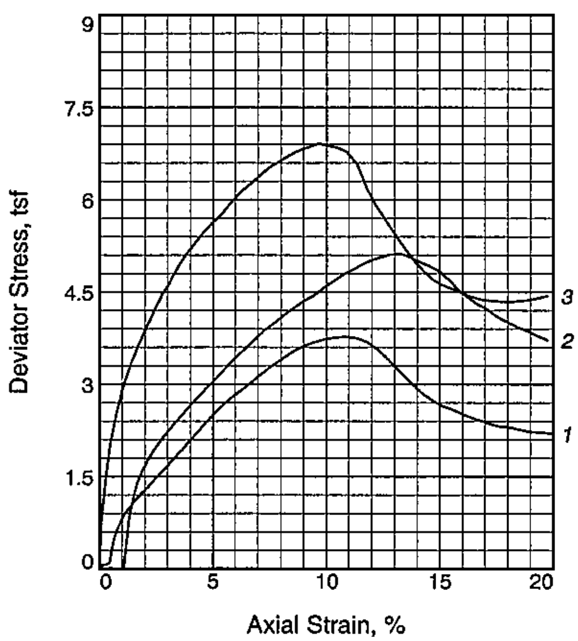
Source of Sample: B-37 **Depth:** 18 **Sample Number:** ST-2

Project No.: 0121-3070.03 **Figure** ______

DLZ, INC.

	Total	Effective
C, tsf	0.946	0.688
ϕ, deg	13.4	22.7
Tan(ϕ)	0.24	0.42





Sample No.		1	2	3
Initial	Water Content,	20.9	22.3	26.0
	Dry Density, pcf	102.6	99.9	98.7
	Saturation,	87.8	87.7	99.1
	Void Ratio	0.6433	0.6866	0.7086
	Diameter, in.	2.80	2.80	2.80
	Height, in.	4.96	5.56	5.60
At Test	Water Content,	27.1	24.5	24.1
	Dry Density, pcf	97.4	101.4	102.2
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.7311	0.6622	0.6494
	Diameter, in.	2.88	2.78	2.76
	Height, in.	4.96	5.56	5.60
Strain rate, in./min.		0.01	0.01	0.01
Back Pressure, tsf		1.2	1.2	1.2
Cell Pressure, tsf		2.4	5.2	8.4
Fail. Stress, tsf		3.4	4.4	6.9
Total Pore Pr., tsf		1.4	3.2	4.6
Ult. Stress, tsf		3.4	4.4	6.9
Total Pore Pr., tsf		1.4	3.2	4.6
$\bar{\sigma}_1$ Failure, tsf		4.3	6.3	10.7
$\bar{\sigma}_3$ Failure, tsf		0.9	2.0	3.8

Type of Test:
CU with Pore Pressures

Sample Type: Press Tube

Description: Lean clay

LL= 29 **PL=** 20 **PI=** 9

Assumed Specific Gravity= 2.7

Remarks:

Figure ________

Client: TranSystems, Inc.

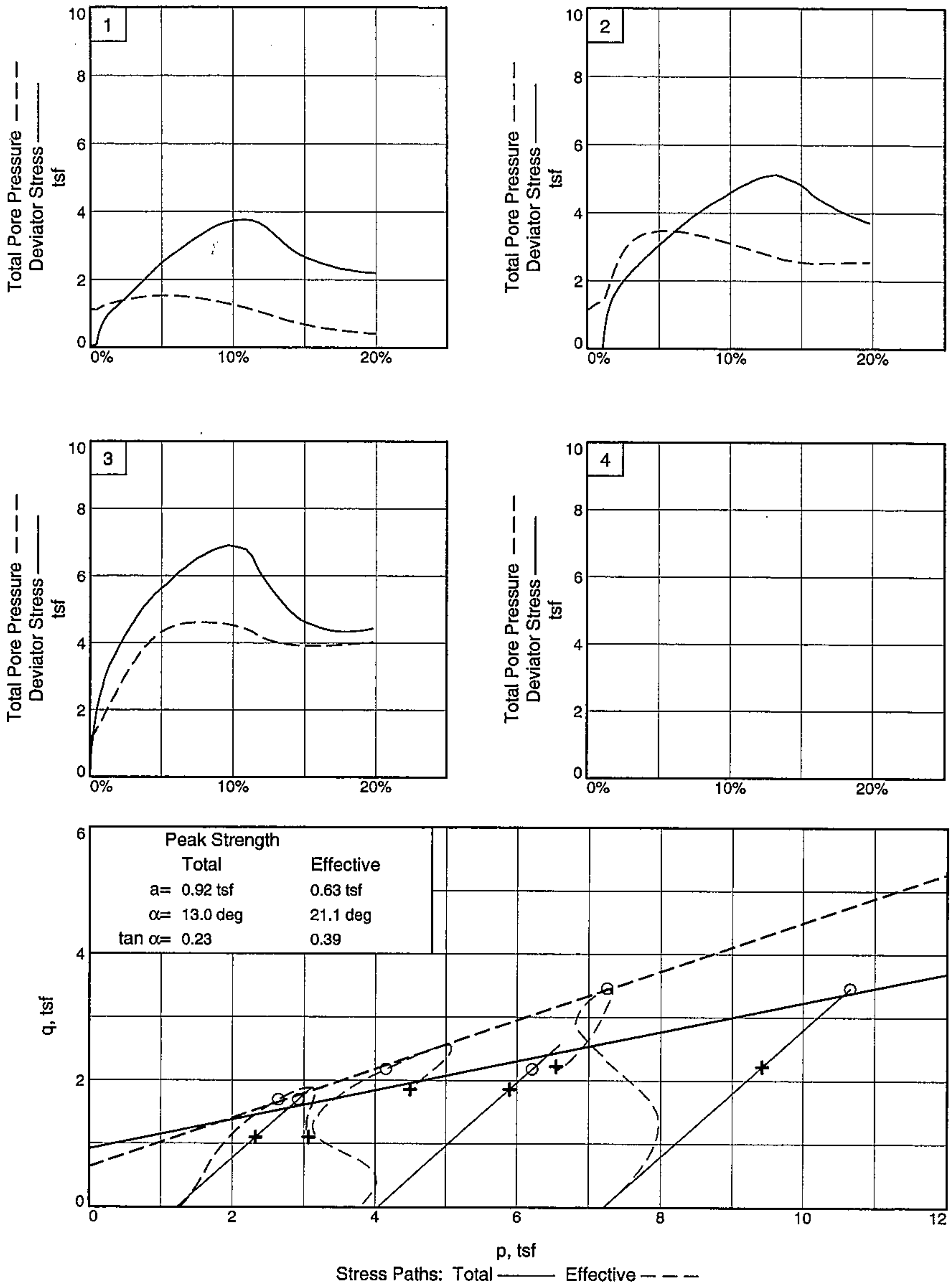
Project: SCI-823-0.00

Source of Sample: B-37 **Depth:** 43.5

Sample Number: ST-3

Proj. No.: 0121-3070.03 **Date:** 6/6/07

DLZ



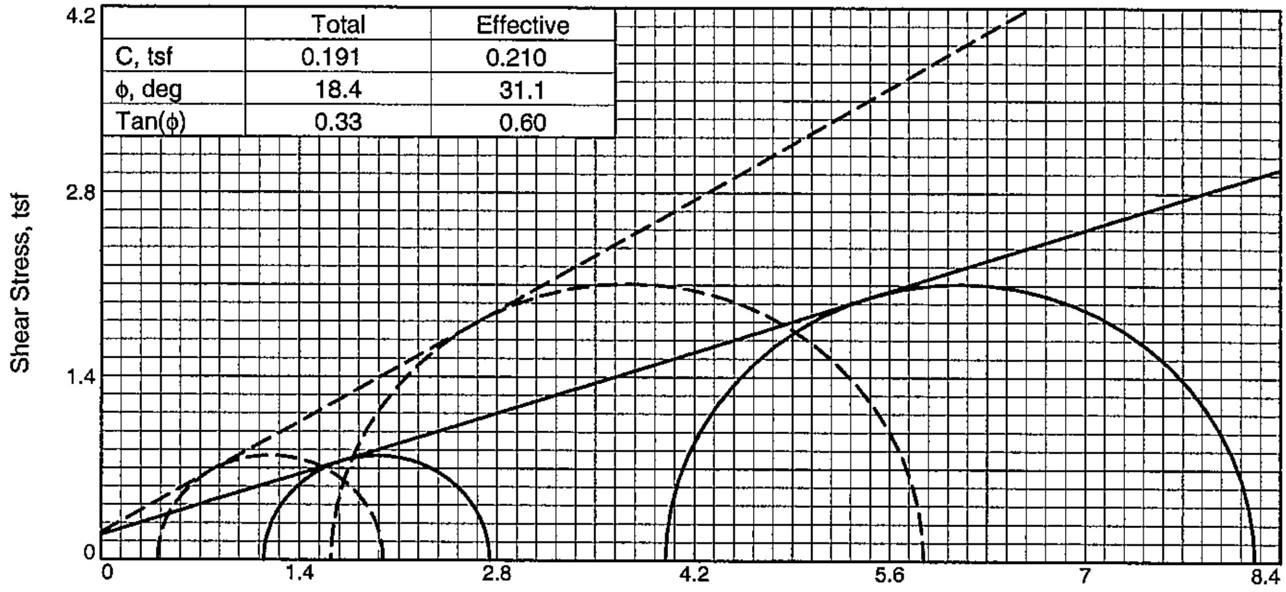
Client: TranSystems, Inc.

Project: SCI-823-0.00

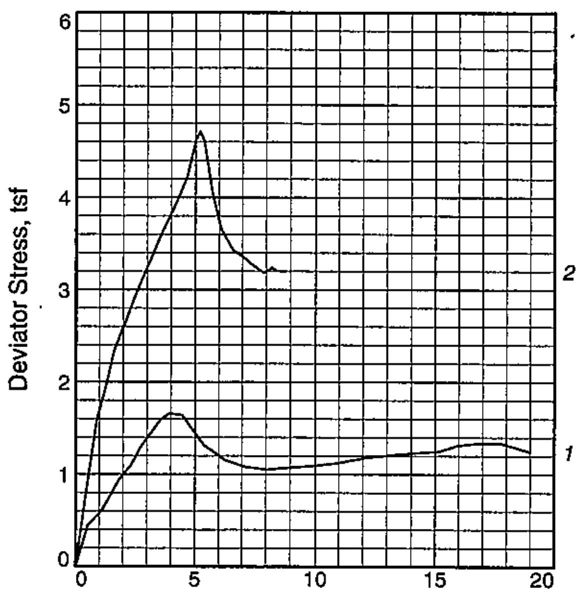
Source of Sample: B-37 **Depth:** 43.5 **Sample Number:** ST-3

Project No.: 0121-3070.03 **Figure** ________

DLZ, INC.



	Total	Effective
C, tsf	0.191	0.210
ϕ, deg	18.4	31.1
Tan(ϕ)	0.33	0.60



	Sample No.	1	2
Initial	Water Content,	26.6	26.0
	Dry Density, pcf	98.2	98.2
	Saturation,	97.8	95.5
	Void Ratio	0.7490	0.7491
	Diameter, in.	2.82	2.82
	Height, in.	5.59	5.58
At Test	Water Content,	27.8	27.0
	Dry Density, pcf	97.3	98.5
	Saturation,	100.0	100.0
	Void Ratio	0.7639	0.7422
	Diameter, in.	2.84	2.82
	Height, in.	5.59	5.58
	Strain rate, in./min.	0.06	0.01
	Back Pressure, tsf	1.00	1.15
	Cell Pressure, tsf	2.15	5.15
	Fail. Stress, tsf	1.59	4.22
	Total Pore Pr., tsf	1.76	3.52
	Ult. Stress, tsf	1.59	4.22
	Total Pore Pr., tsf	1.76	3.52
	$\overline{\sigma}_1$ Failure, tsf	1.99	5.84
	$\overline{\sigma}_3$ Failure, tsf	0.40	1.62

Type of Test:
CU with Pore Pressures

Sample Type: 3" press tube

Description: Lean clay

LL= 27 **PL=** 16 **PI=** 11

Specific Gravity= 2.75

Remarks:

Figure ________

Client: TranSystems, Inc.

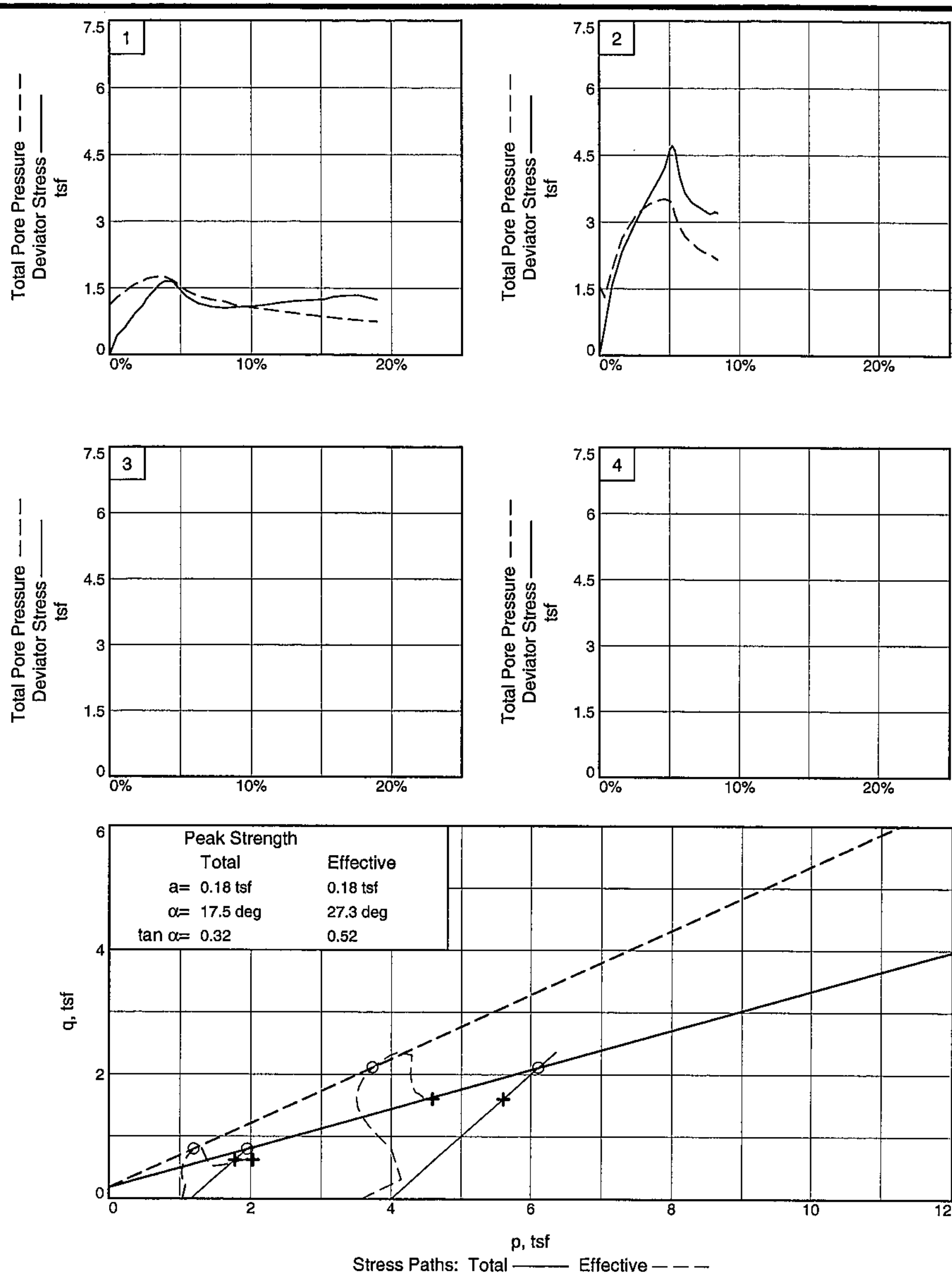
Project: SCI-823-0.00

Source of Sample: B-38 **Depth:** 10.0

Sample Number: ST-1

Proj. No.: 0121-3070.03 **Date:** 5/22/07

DLZ



Client: TranSystems, Inc.

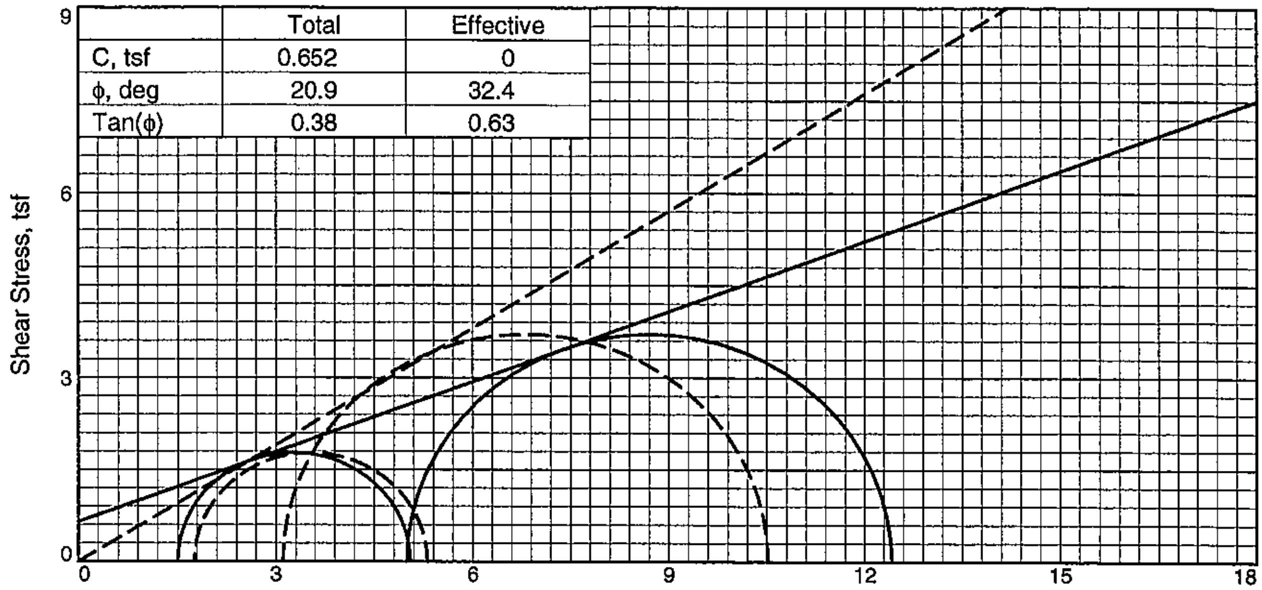
Project: SCI-823-0.00

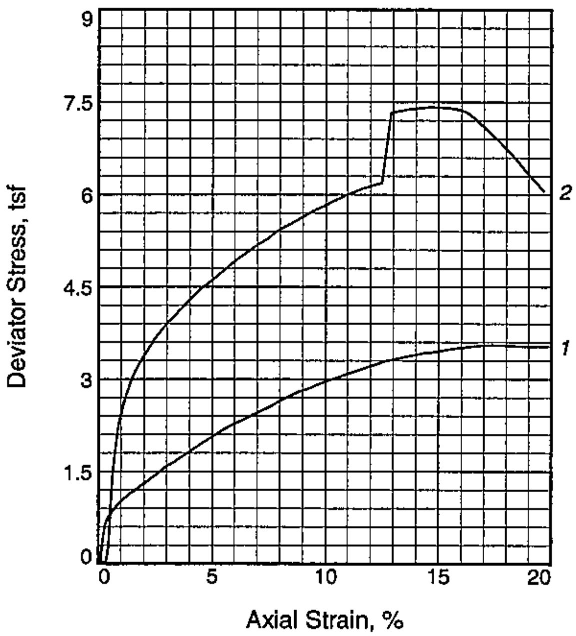
Source of Sample: B-38 **Depth:** 10.0 **Sample Number:** ST-1

Project No.: 0121-3070.03 **Figure** ______

DLZ, INC.

	Total	Effective
C, tsf	0.652	0
ϕ, deg	20.9	32.4
Tan(ϕ)	0.38	0.63





Sample No.		1	2
Initial	Water Content,	26.8	27.4
	Dry Density, pcf	98.3	99.1
	Saturation,	101.3	105.6
	Void Ratio	0.7141	0.7000
	Diameter, in.	2.80	2.81
	Height, in.	5.57	5.57
At Test	Water Content,	0.0	24.9
	Dry Density, pcf	0.0	99.1
	Saturation,	0.0	96.1
	Void Ratio	N/A	0.7000
	Diameter, in.	2.80	2.81
	Height, in.	5.57	5.57
Strain rate, in./min.		0.11	0.01
Back Pressure, tsf		1.2	1.2
Cell Pressure, tsf		2.6	6.1
Fail. Stress, tsf		3.5	7.4
Total Pore Pr., tsf		0.9	3.0
Ult. Stress, tsf			
Total Pore Pr., tsf			
$\bar{\sigma}_1$ Failure, tsf		5.3	10.5
$\bar{\sigma}_3$ Failure, tsf		1.8	3.1

Type of Test:
CU with Pore Pressures
Sample Type:
Description:

Assumed Specific Gravity= 2.7
Remarks:

Figure ________

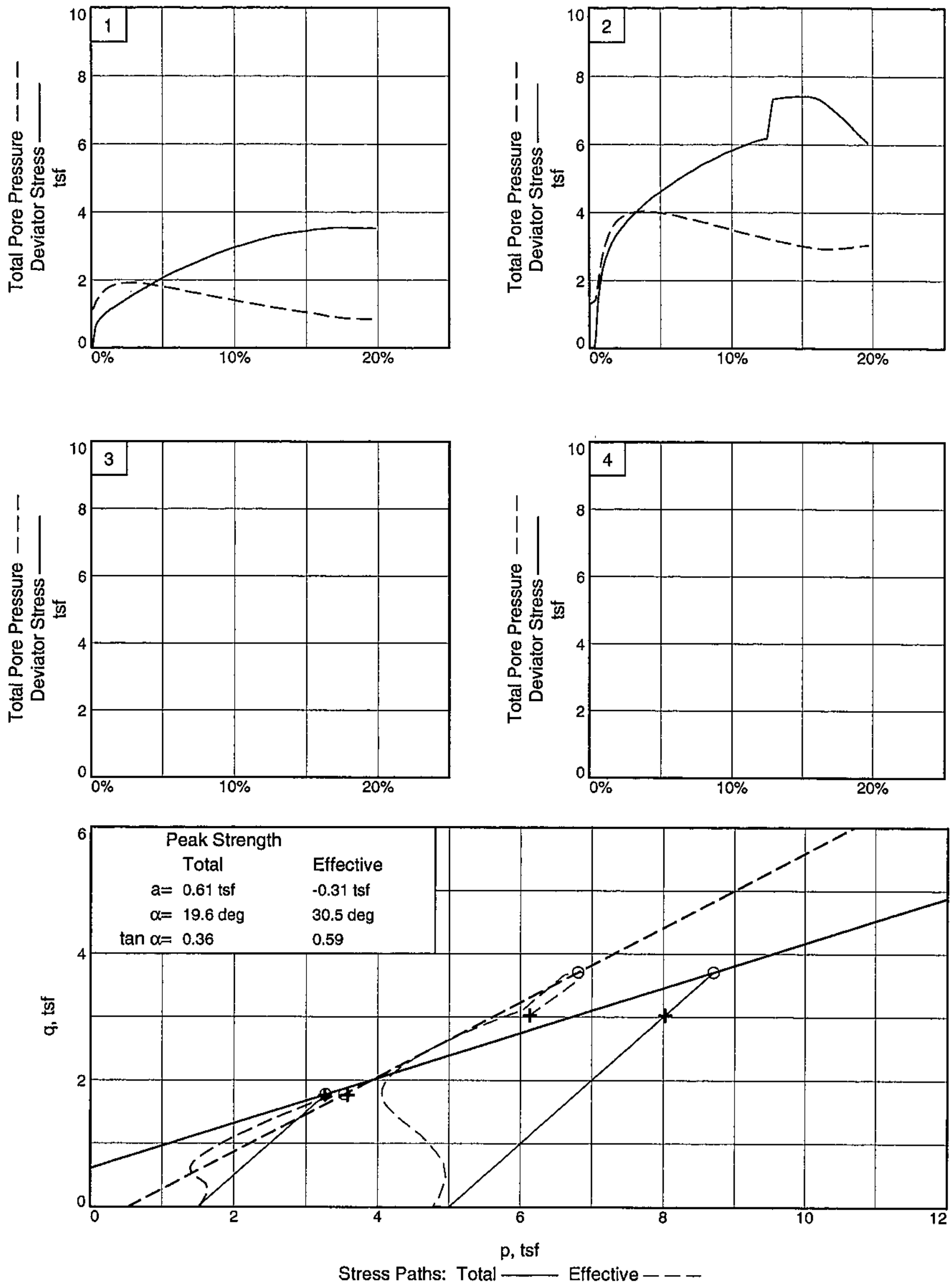
Client: TranSystems, Inc.

Project: SCI-823-0.00

Source of Sample: B-38 **Depth:** 19.0
Sample Number: ST-2

Proj. No.: 0121-3070.03 **Date:**

DLZ



Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-38 **Depth:** 19.0 **Sample Number:** ST-2
Project No.: 0121-3070.03 **Figure** _______

DLZ, INC.

Vane Shear Test Report

Project	SCI-823	Date	5/3/2007
Project No.	0121-3070.03	Boring Number	B-38 Depth 19'
Client	Transystems		
Drill Rig & Crew	Doug / CME 850		
Tested By	Mott / Riedy		
Weather / Temp.	Rain / 60 degrees		
Soil Type	A-6a		

DRILLING

Hollowstem augers to depth	D_a	17.5
Vane Depth below bottom of augers	D_s	1.5
Augers above ground surface	H_a	2.5
Depth to vane tip	D_t	19

SHEAR VANE

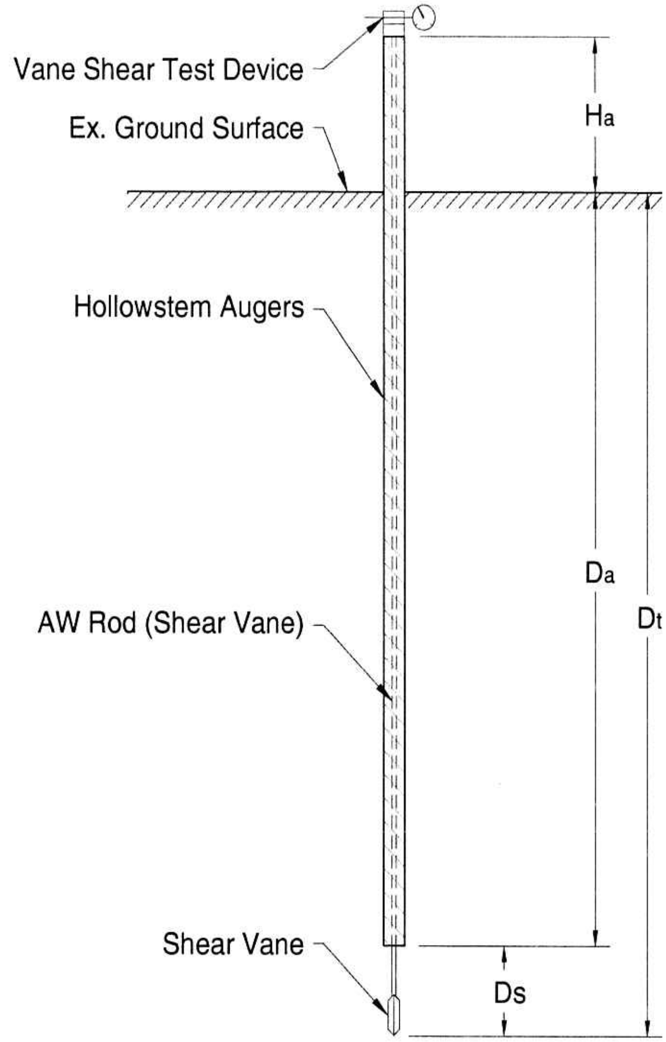
Vane Used	2.0"	2.5"	3.625"
Vane constant, k (lb-in to psf)	5.17	2.59	0.905

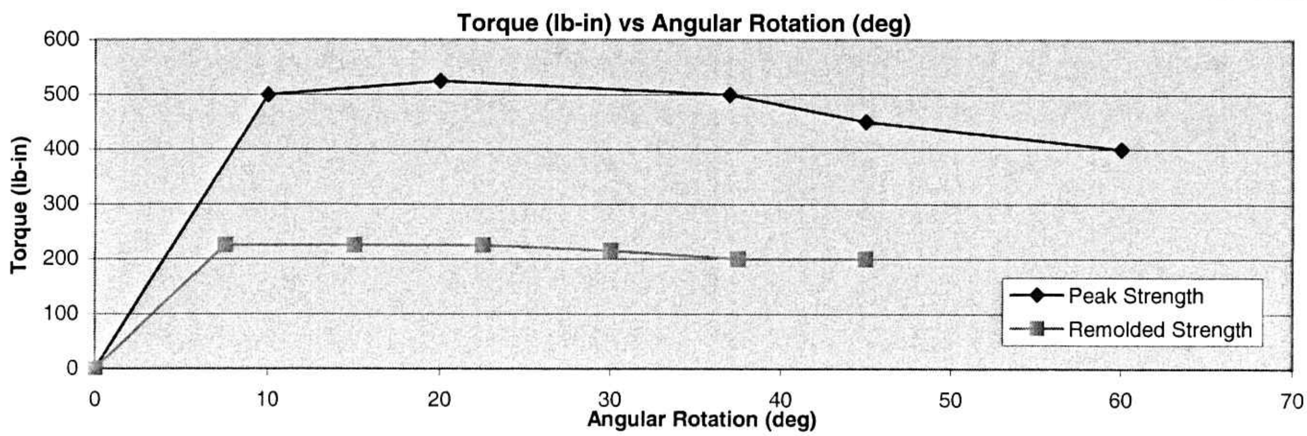
Masurement by: Manual Torqe Reading

Max Torque: 525 lb-in

Max UD Shear Strength 2714 psf

Test Setup





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Vane Shear Test Report

Time *Begin* ________
End ________

Boring Number *B-38* *Depth* 19'

Undisturbed Condition

Time (min)	Tourqe (lb-in)	Angular Rotation (deg)
0.0	0	0
0.5	500	10
1.0	525	20
1.5	500	37
2.0	450	45
2.5	400	60
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
9.5		
10.0		
10.5		
11.0		
11.5		
12.0		
12.5		
13.0		
13.5		
14.0		
14.5		
15.0		
15.5		
16.0		
16.5		
17.0		
17.5		
18.0		

Remolded Condition

Time (min)	Tourqe (lb-in)	Angular Rotation (deg)
0.0	0	0
0.5	225	8
1.0	225	15
1.5	225	23
2.0	215	30
2.5	200	38
3.0	200	45
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
9.5		
10.0		
10.5		
11.0		
11.5		
12.0		
12.5		
13.0		
13.5		
14.0		
14.5		
15.0		
15.5		
16.0		
16.5		
17.0		
17.5		
18.0		

Peak Torque *525* (lb-in) *k=* *5.170* Peak Remolded Torque *225* (lb-in)

Peak Undrained Shear Strength *2714* psf Peak Remolded Shear Strength *1163* psf

Sensitivity *2.3*

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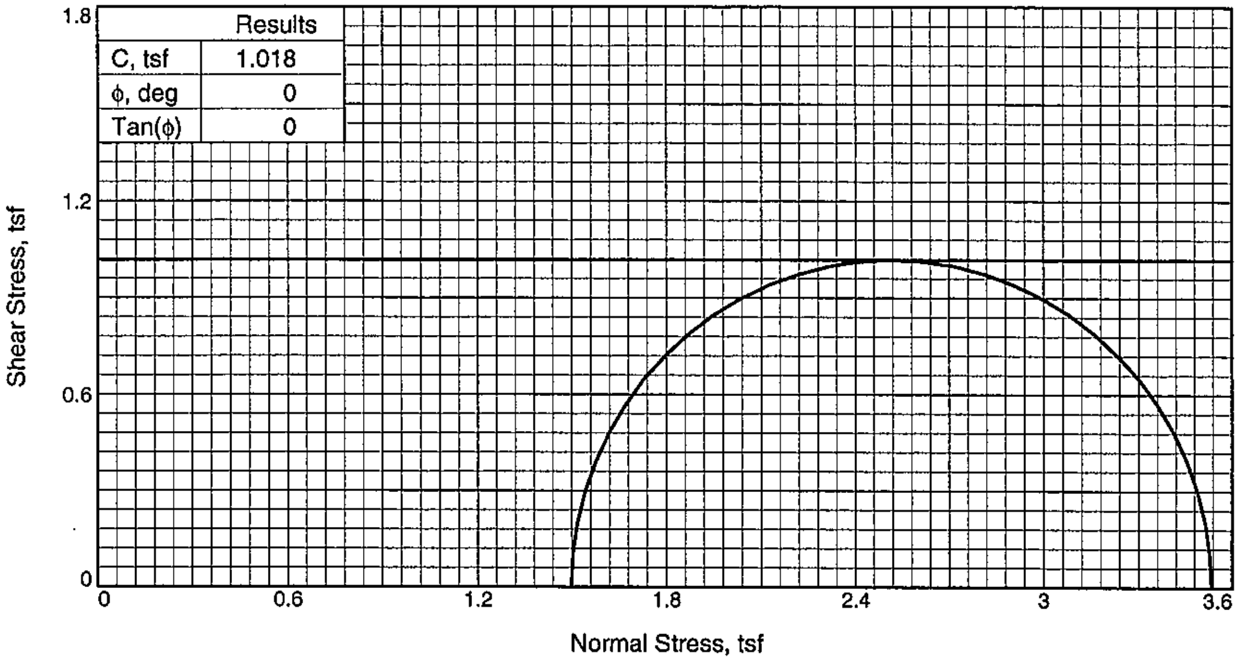
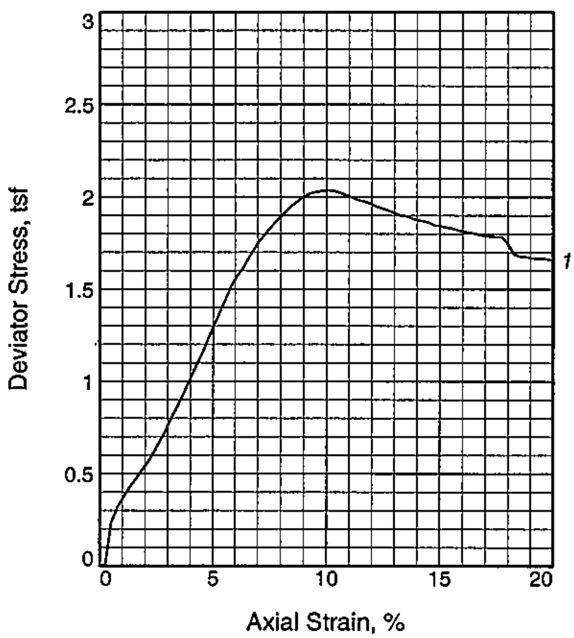




Sample No.		1
Initial	Water Content,	23.6
	Dry Density, pcf	101.3
	Saturation,	93.0
	Void Ratio	0.7004
	Diameter, in.	2.79
	Height, in.	5.09
At Test	Water Content,	26.4
	Dry Density, pcf	101.3
	Saturation,	104.1
	Void Ratio	0.7004
	Diameter, in.	2.79
	Height, in.	5.09
Strain rate, in./min.		0.06
Back Pressure, tsf		0.00
Cell Pressure, tsf		1.50
Fail. Stress, tsf		2.04
Ult. Stress, tsf		
σ_1 Failure, tsf		3.53
σ_3 Failure, tsf		1.50

Type of Test:
Unconsolidated Undrained
Sample Type: 3" press tube
Description:

LL= 33 **PL=** 21 **PI=** 12
Assumed Specific Gravity= 2.76
Remarks: Specific Gravity (Actual)= 2.76

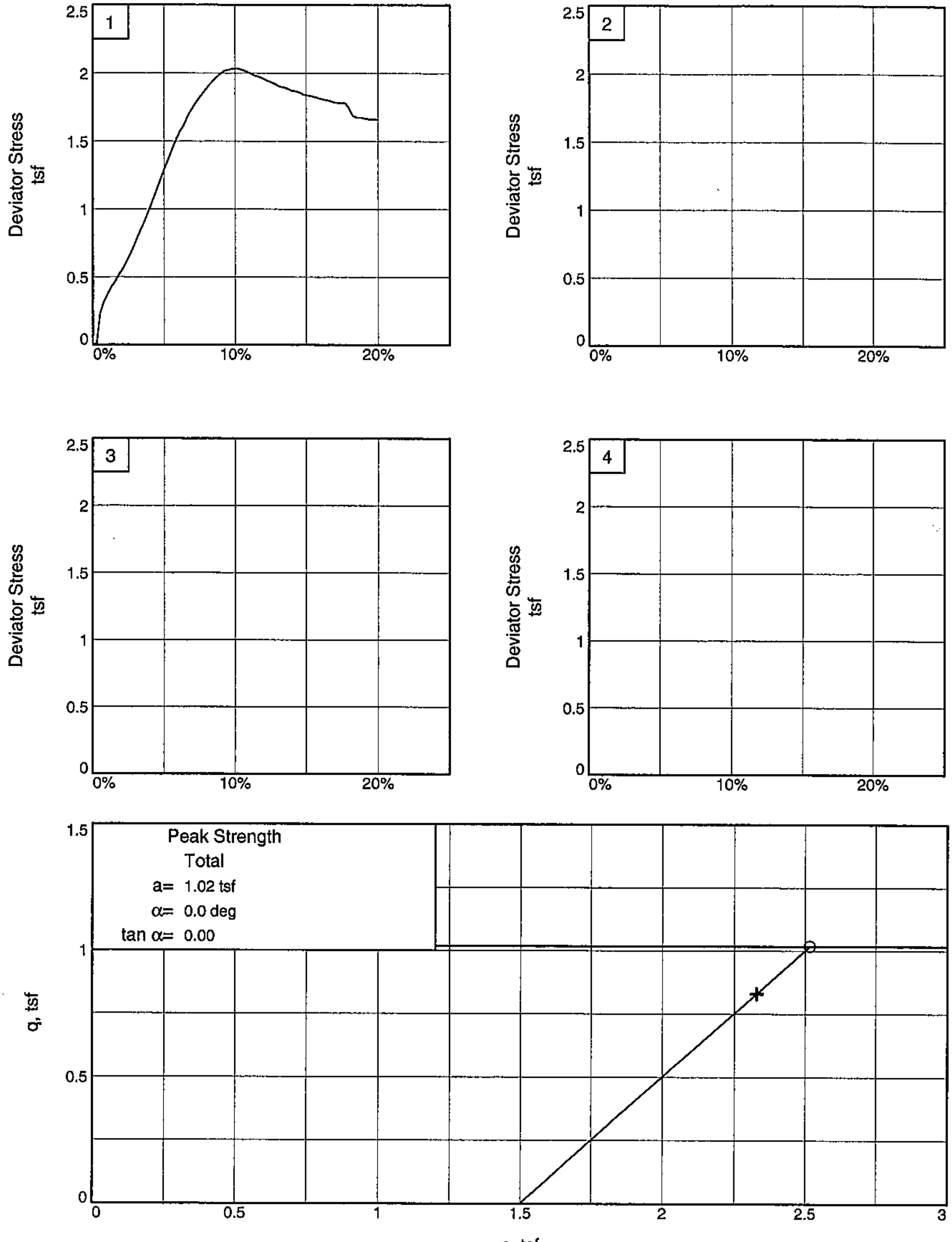
Figure ________

Client: TranSystems, Inc.

Project: SCI-823-0.00

Source of Sample: B-38 **Depth:** 19.0
Sample Number: ST-2
Proj. No.: 0121-3070.03 **Date:** 5/22/07

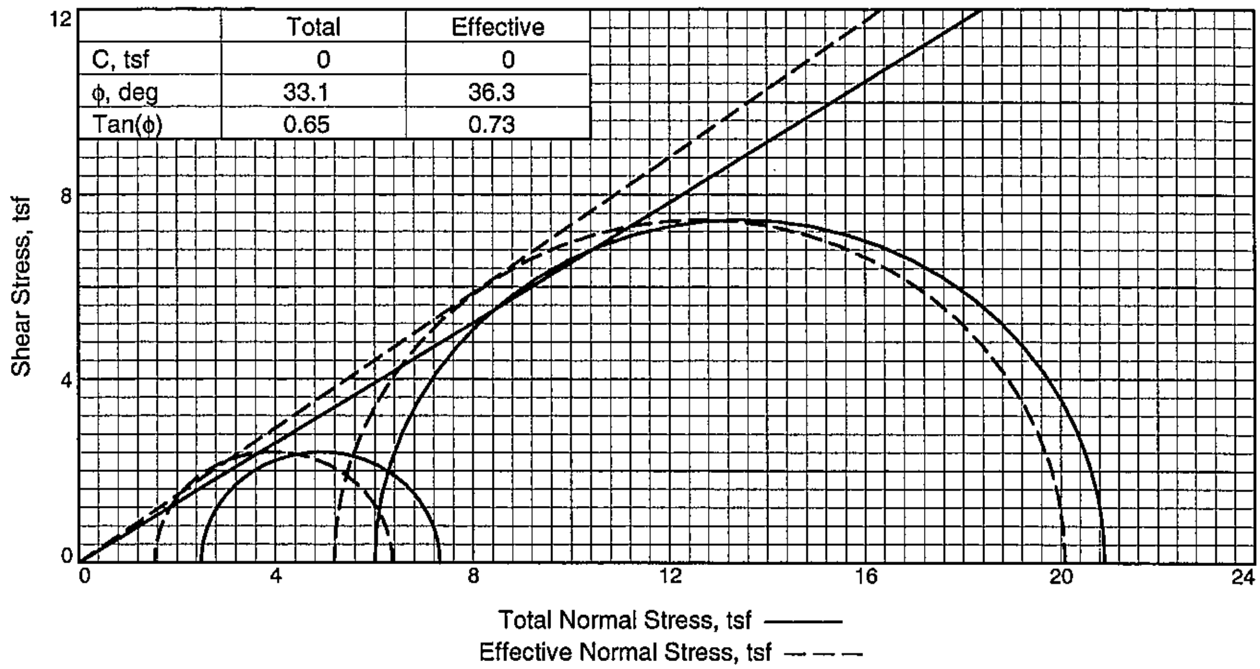
DLZ



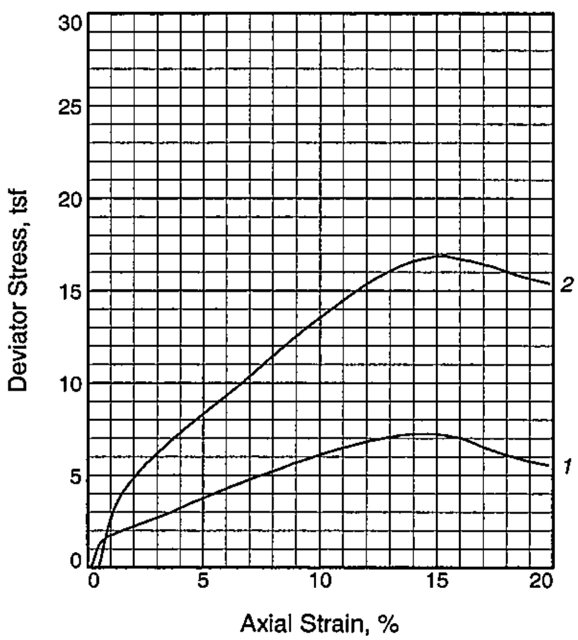
Stress Paths: o indicates peak + indicates end

Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-38 **Depth:** 19.0 **Sample Number:** ST-2
Project No.: 0121-3070.03 **Figure** ________

DLZ, INC.



	Total	Effective
C, tsf	0	0
ϕ, deg	33.1	36.3
Tan(ϕ)	0.65	0.73



	Sample No.	1	2
Initial	Water Content,	28.6	26.9
	Dry Density, pcf	96.9	102.3
	Saturation,	104.5	112.1
	Void Ratio	0.7401	0.6481
	Diameter, in.	2.91	2.99
	Height, in.	5.21	4.77
At Test	Water Content,	24.3	22.5
	Dry Density, pcf	96.9	102.3
	Saturation,	88.6	93.6
	Void Ratio	0.7401	0.6481
	Diameter, in.	2.91	2.99
	Height, in.	5.21	4.77
	Strain rate, in./min.	0.01	0.01
	Back Pressure, tsf	1.2	1.2
	Cell Pressure, tsf	3.7	7.1
	Fail. Stress, tsf	4.8	14.9
	Total Pore Pr., tsf	2.1	2.0
	Ult. Stress, tsf	4.8	14.9
	Total Pore Pr., tsf	2.1	2.0
	$\bar{\sigma}_1$ Failure, tsf	6.4	20.1
	$\bar{\sigma}_3$ Failure, tsf	1.5	5.2

Type of Test:
CU with Pore Pressures

Sample Type: Press Tube

Description:

LL= 29 **PL=** 20 **PI=** 9

Assumed Specific Gravity= 2.7

Remarks:

Client: TranSystems, Inc.

Project: SCI-823-0.00

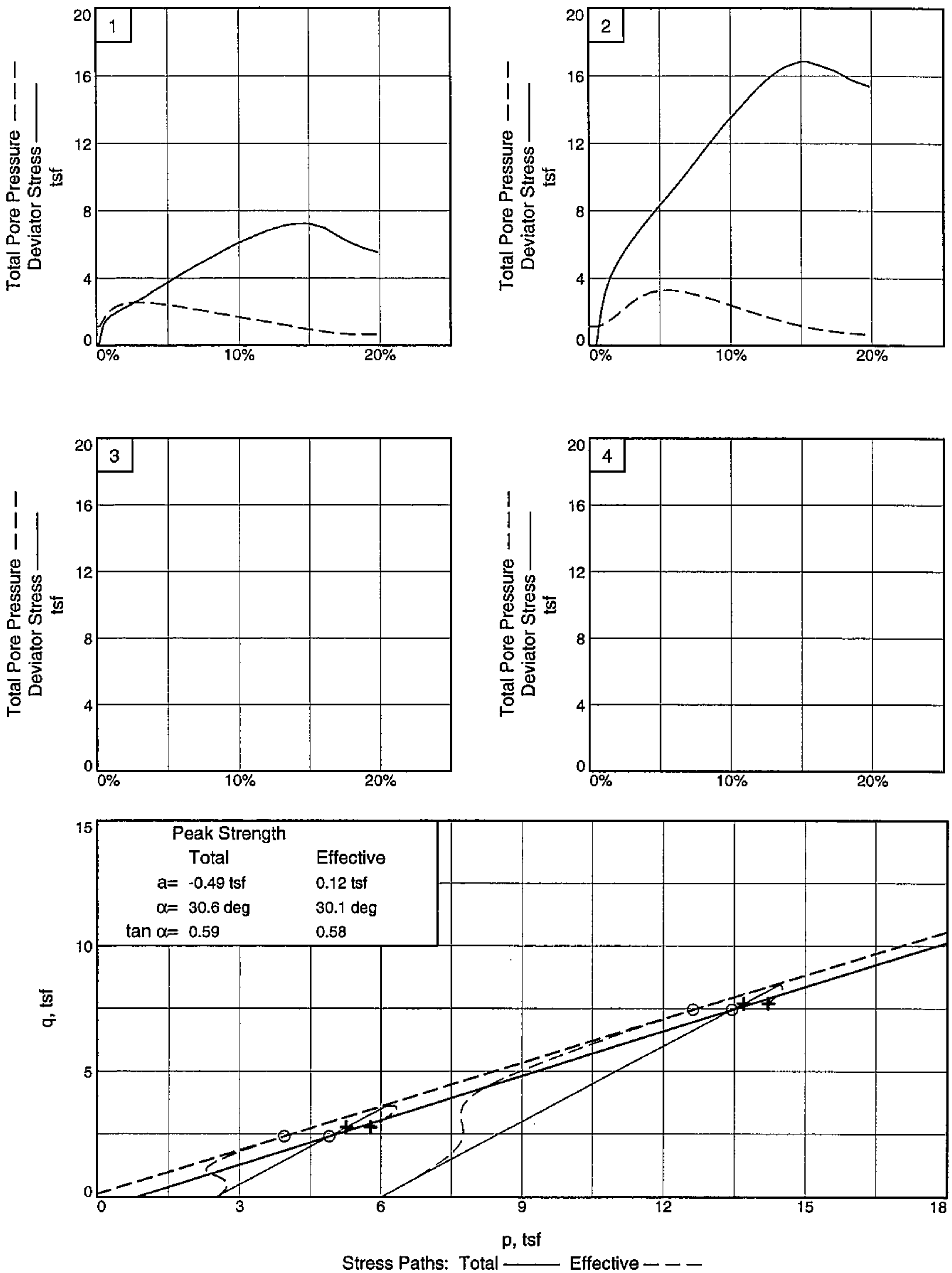
Source of Sample: B-38 **Depth:** 37.0

Sample Number: ST-3

Proj. No.: 0121-3070.03 **Date:** 7/12/07

DLZ

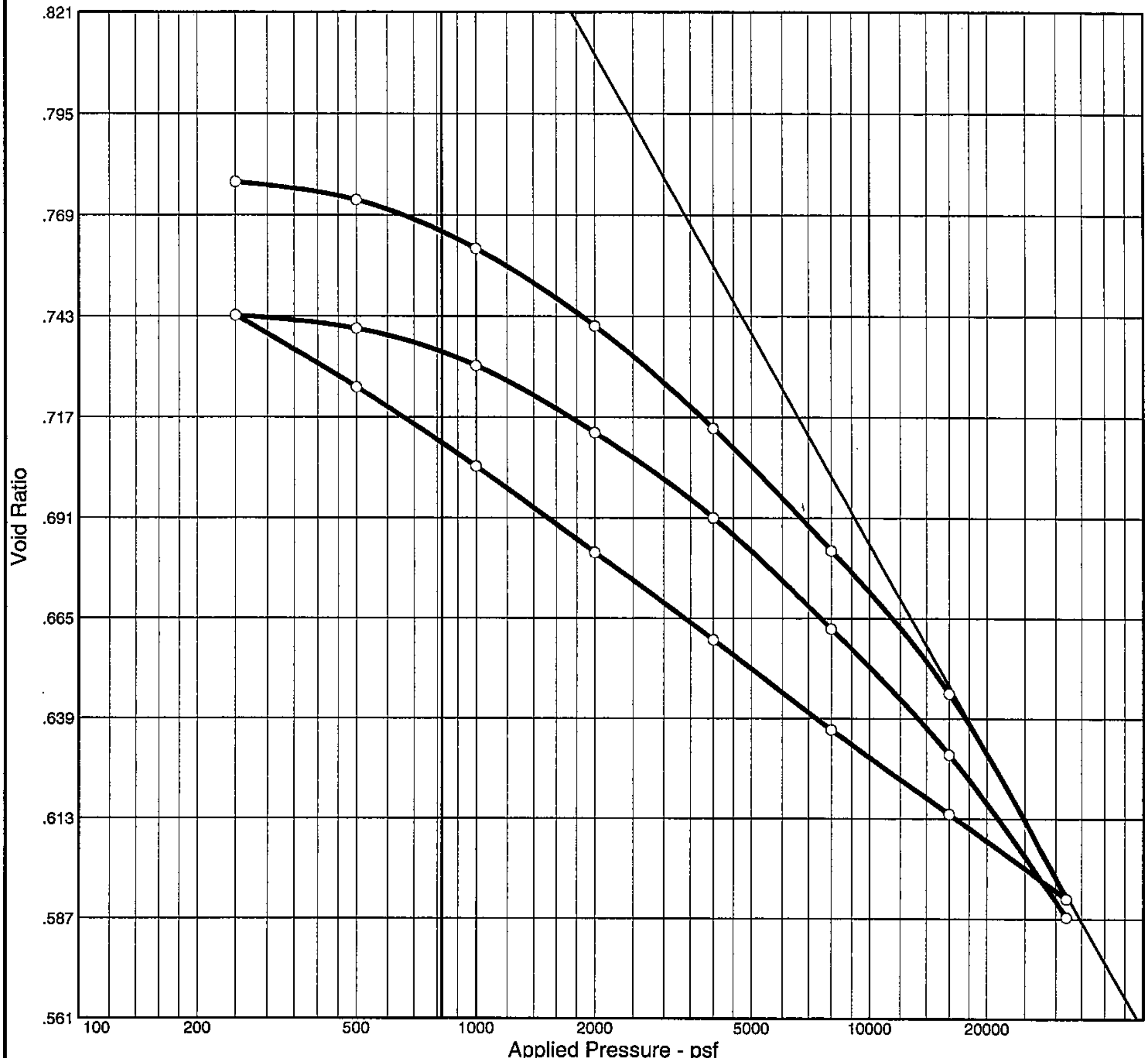
Figure ______



Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-38 **Depth:** 37.0 **Sample Number:** ST-3
Project No.: 0121-3070.03 **Figure** ________

DLZ, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
96.6 %	24.6 %	102.5	36	14	2.82	CL	A-6(14)	0.718

MATERIAL DESCRIPTION

Lean clay

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-37 **Sample No.:** ST-1 **Elev./Depth:** 8.0

DLZ

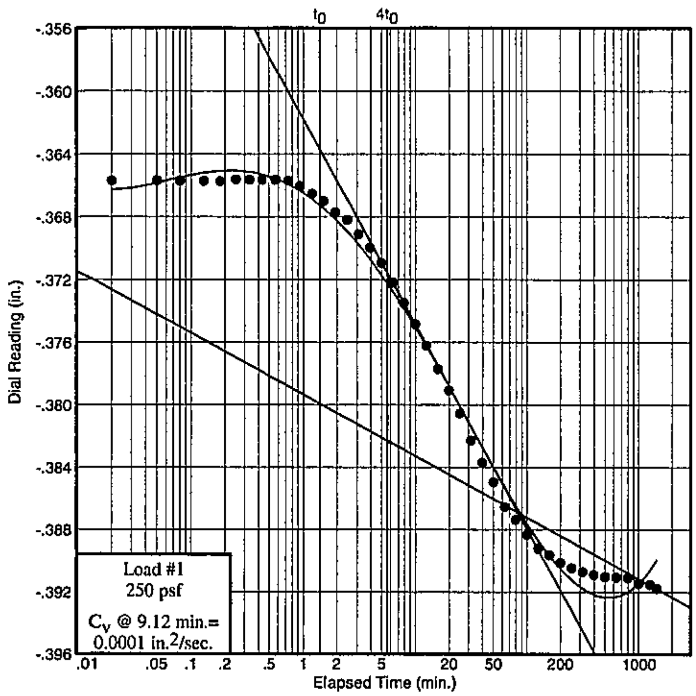
Remarks:

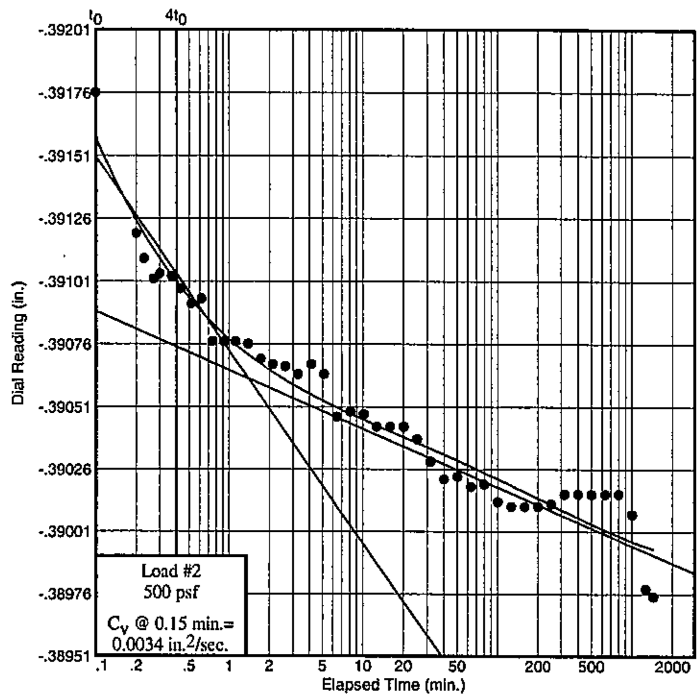
Figure

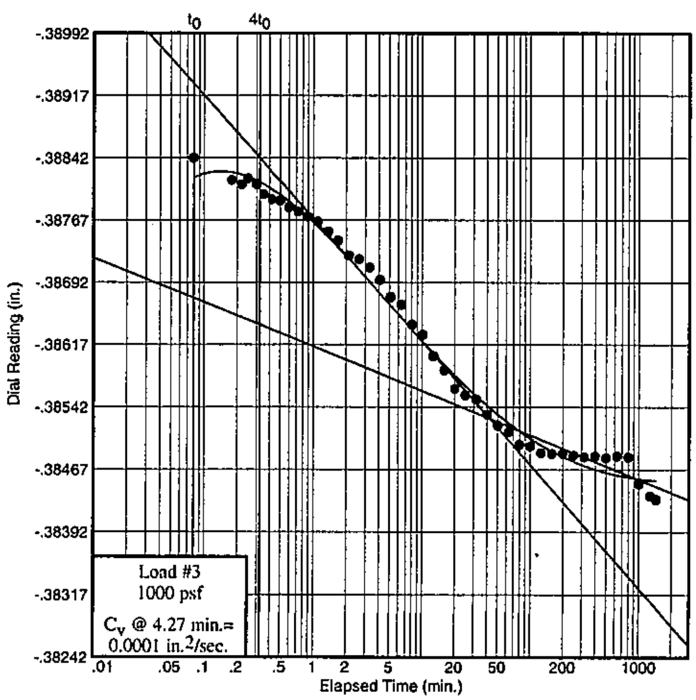
Dial Reading vs. Time

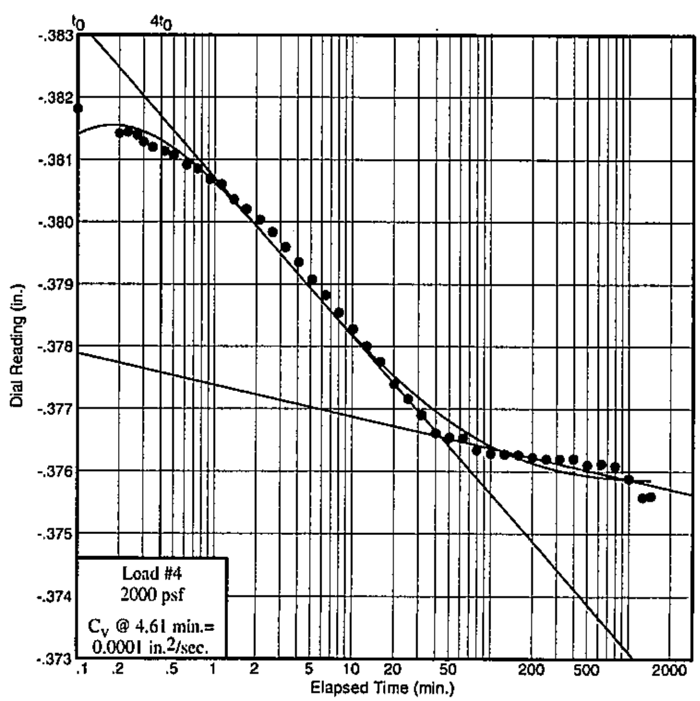
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-37 Sample No.: ST-1 Elev./Depth: 8.0









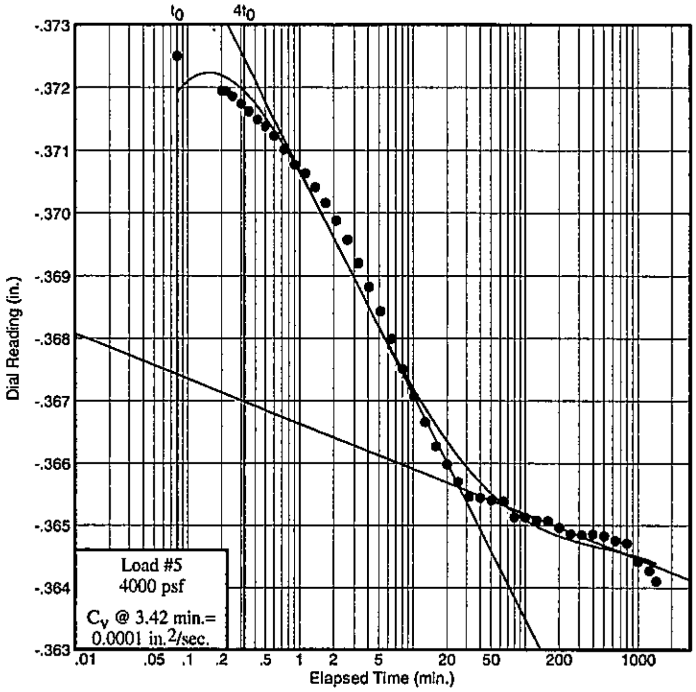
DLZ

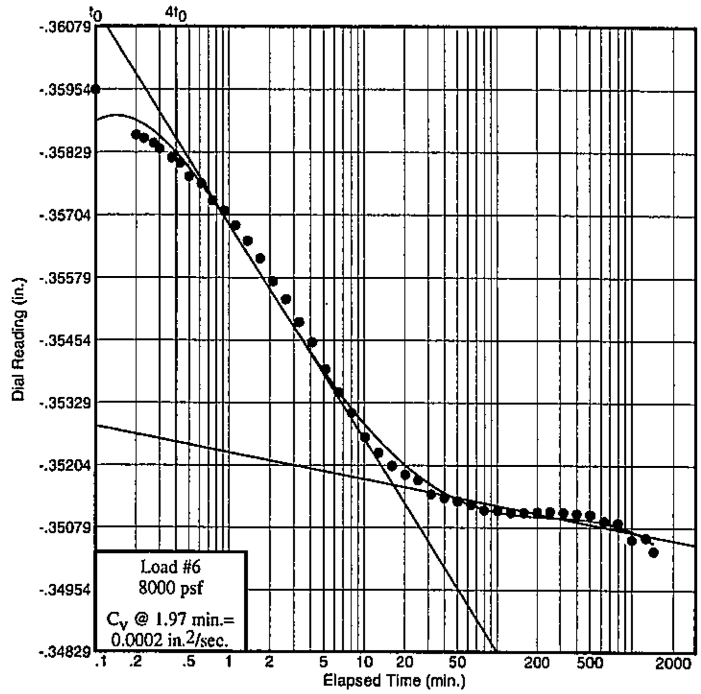
Figure

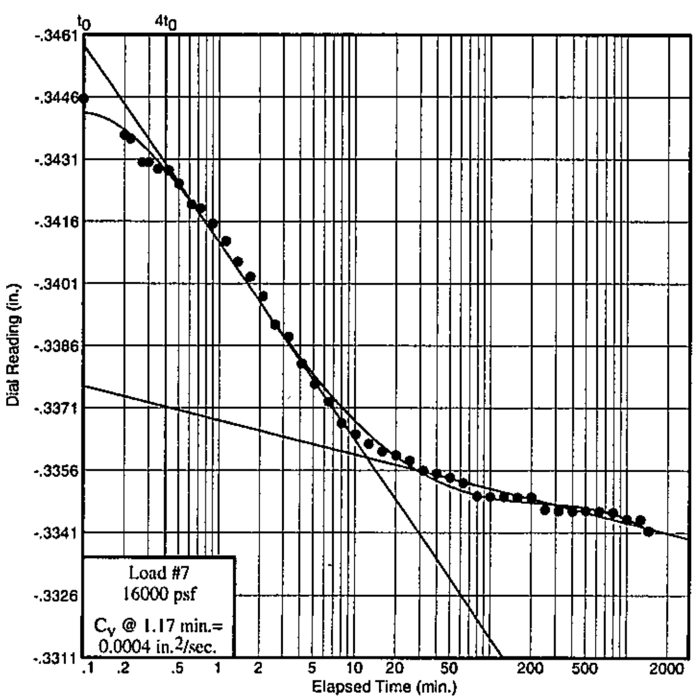
Dial Reading vs. Time

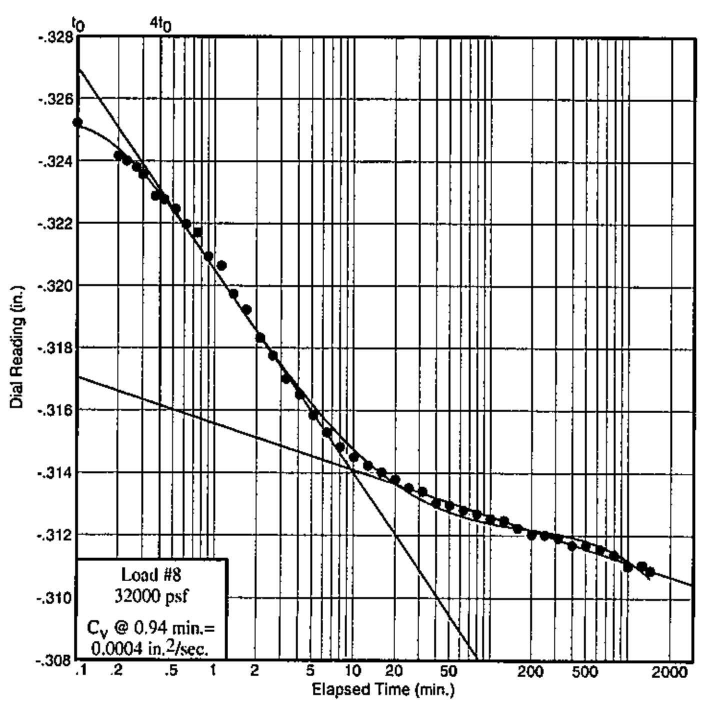
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-37 Sample No.: ST-1 Elev./Depth: 8.0









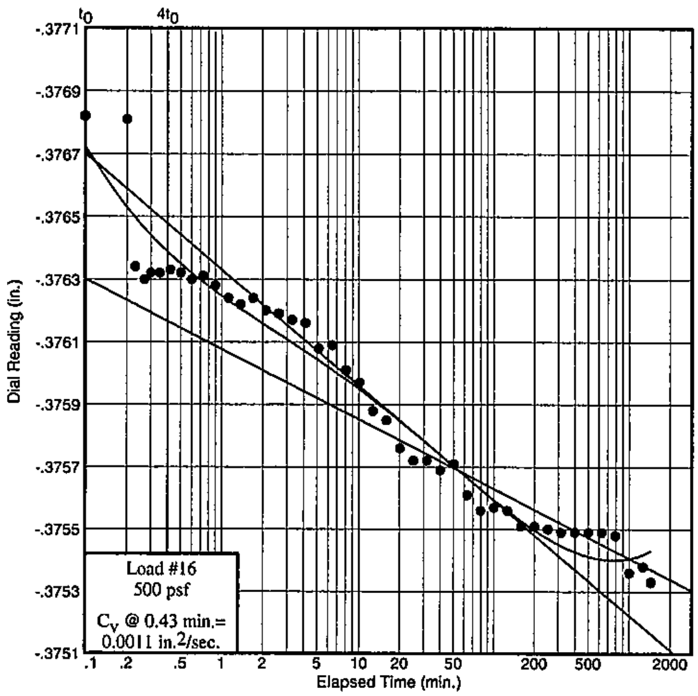
DLZ

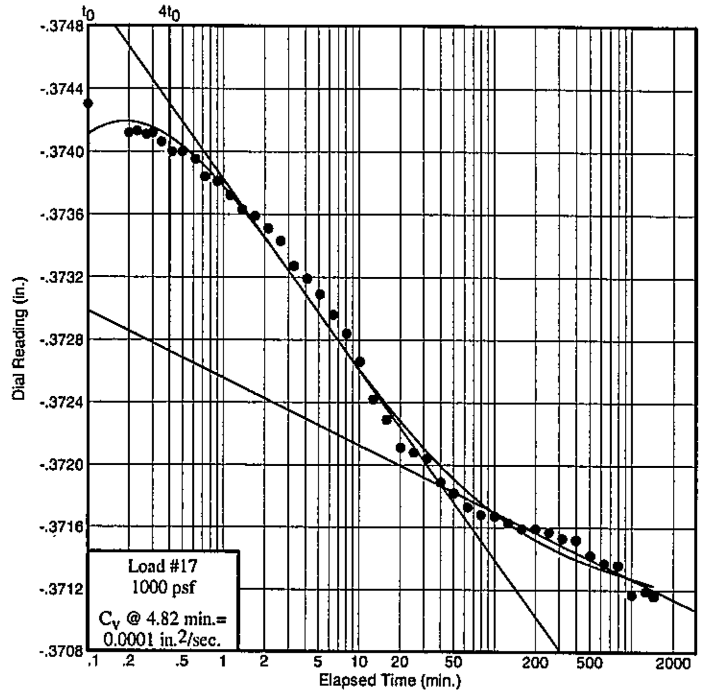
Figure

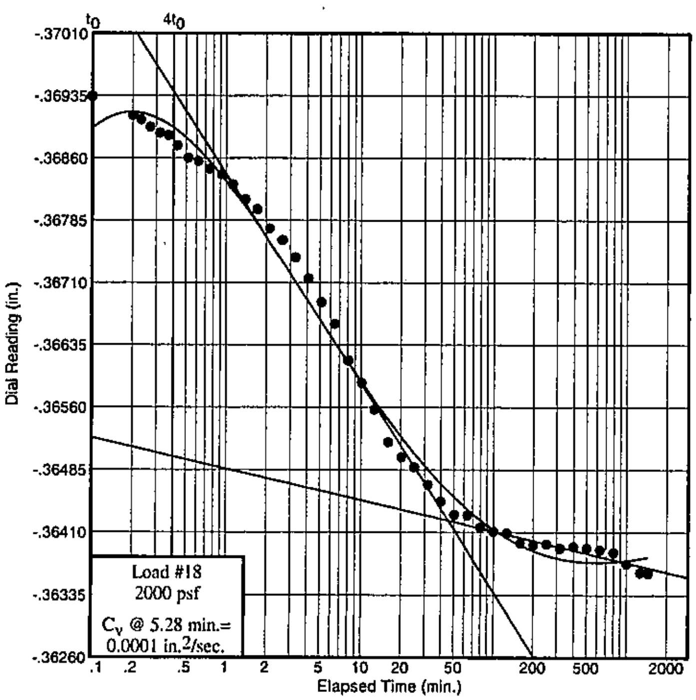
Dial Reading vs. Time

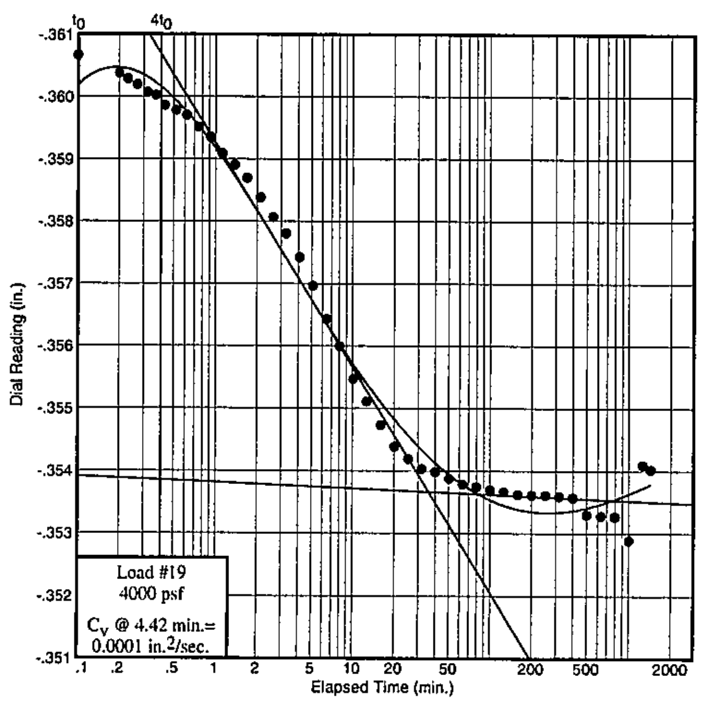
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-37 Sample No.: ST-1 Elev./Depth: 8.0









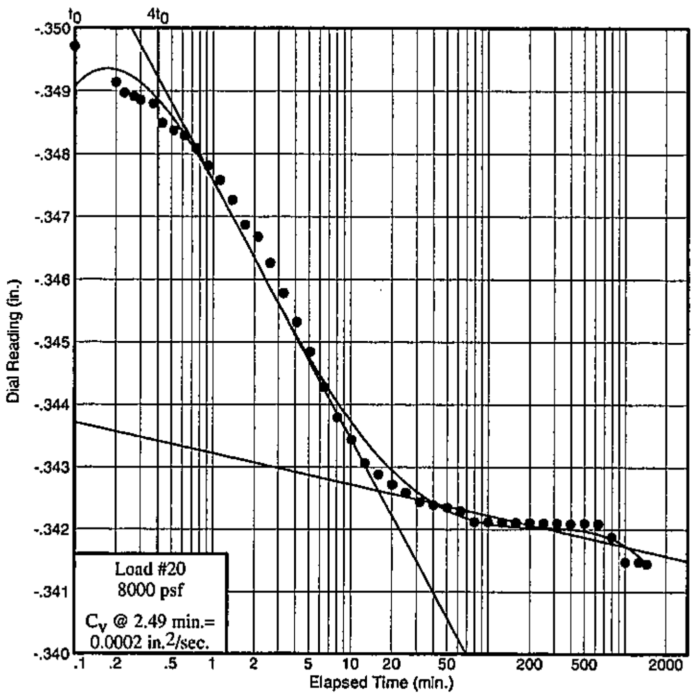
DLZ

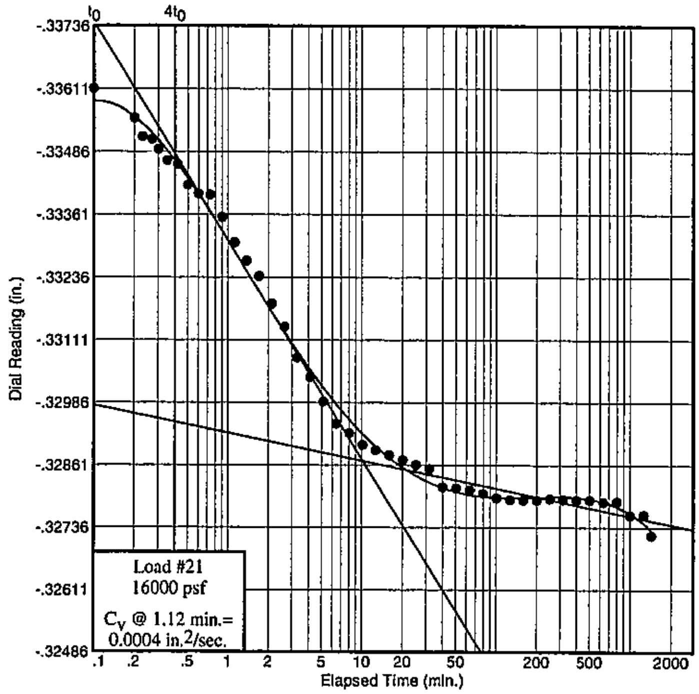
Figure

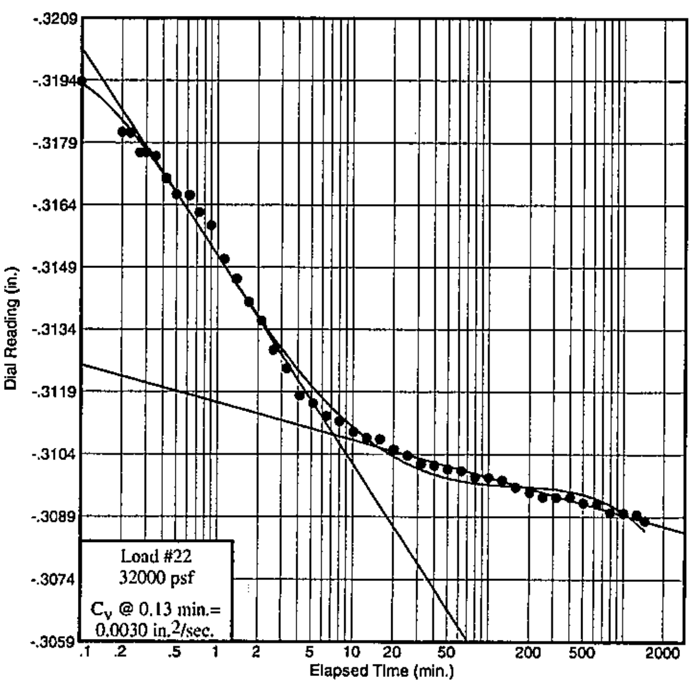
Dial Reading vs. Time

Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-37 | Sample No.: ST-1 | Elev./Depth: 8.0



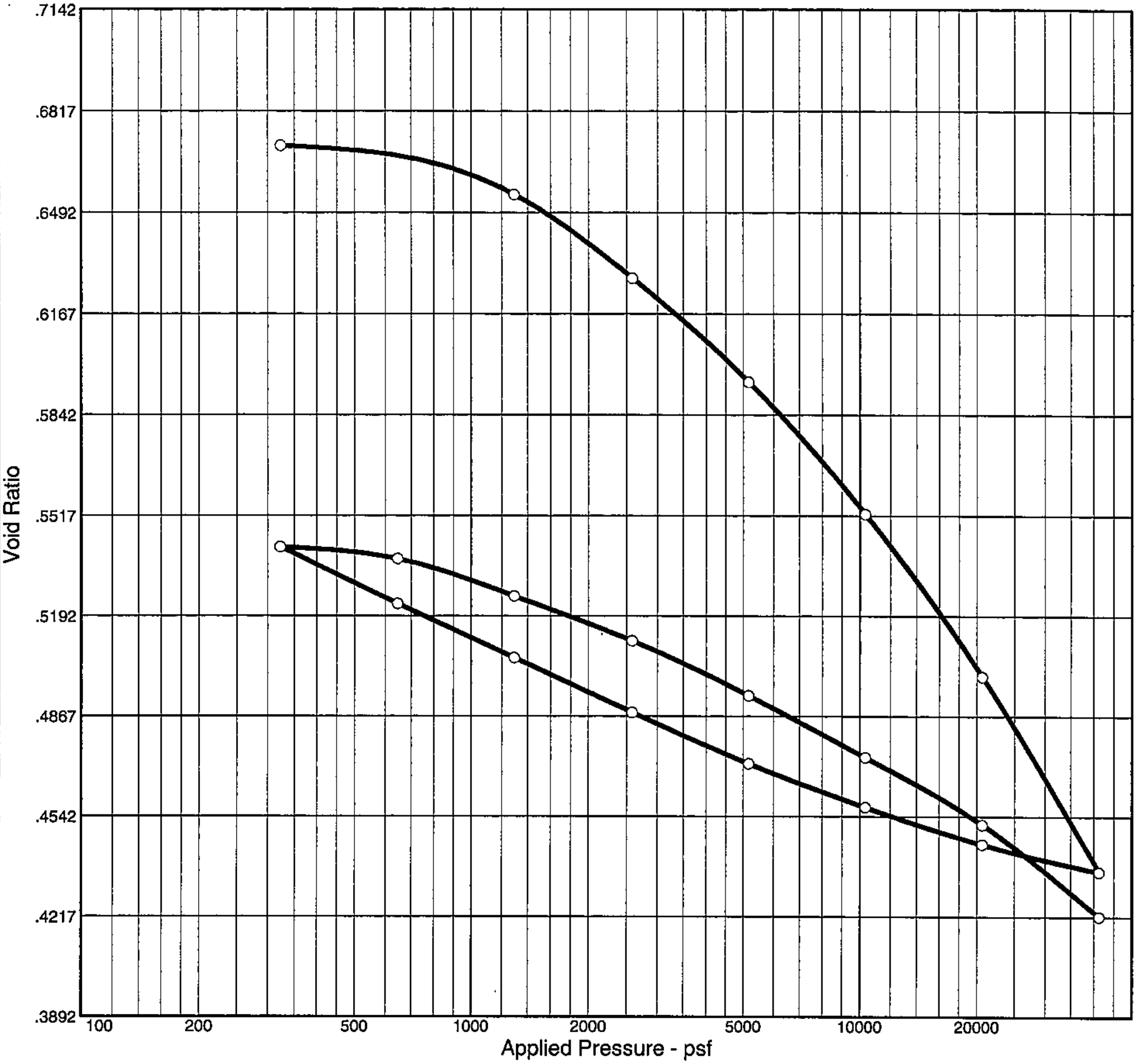




DLZ

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
108.0 %	27.7 %	95.5	29	9	2.75	CL	A-4(8)	0.705

MATERIAL DESCRIPTION

Lean clay

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

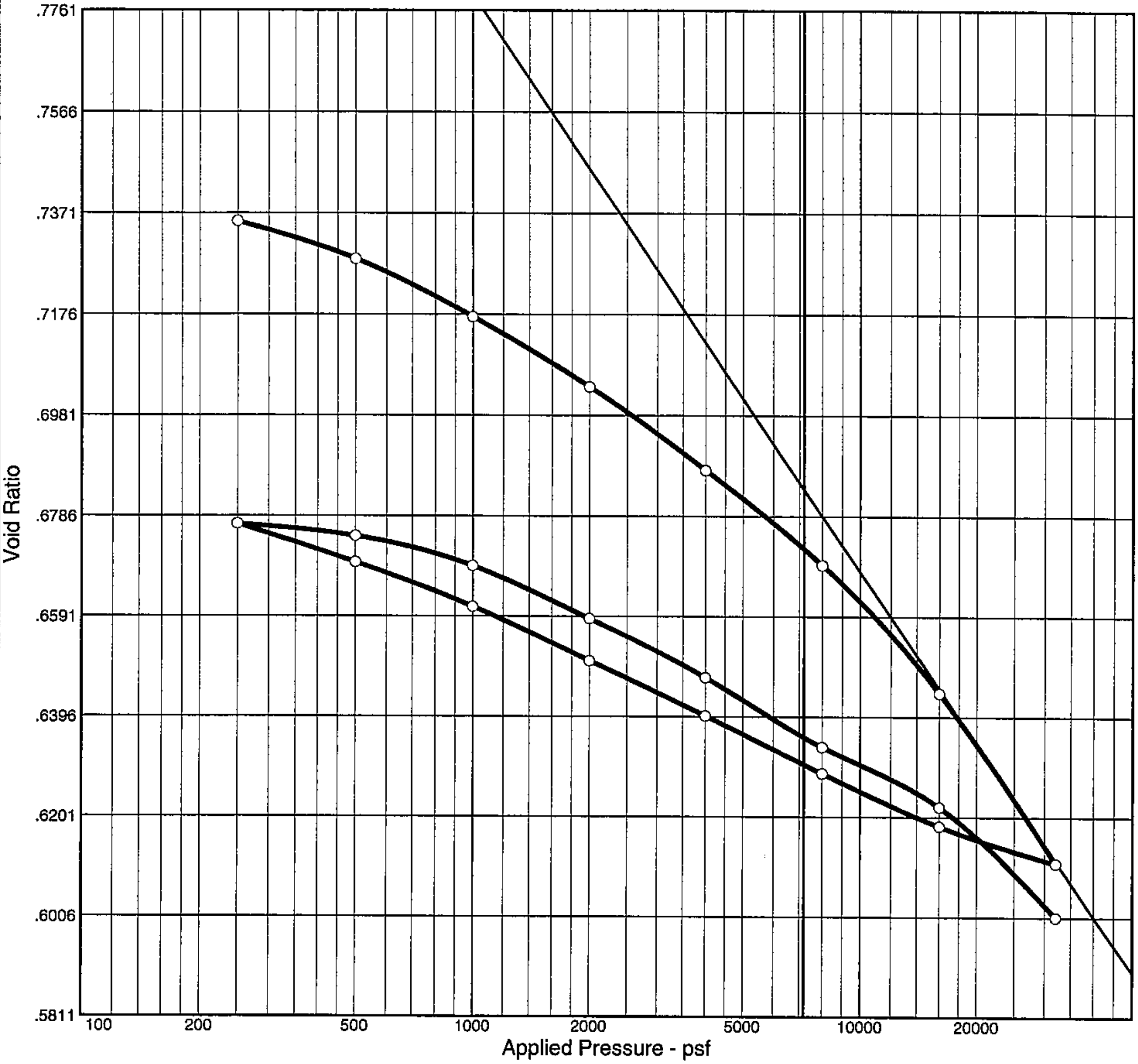
Source: B-37 **Sample No.:** ST-3 **Elev./Depth:** 43.5

DLZ

Remarks:

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
99.9 %	27.7 %	96.4	27	11	2.7	CL	A-6(8)	0.748

MATERIAL DESCRIPTION

Lean clay

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-38 **Sample No.:** ST-1 **Elev./Depth:** 10.0

DLZ

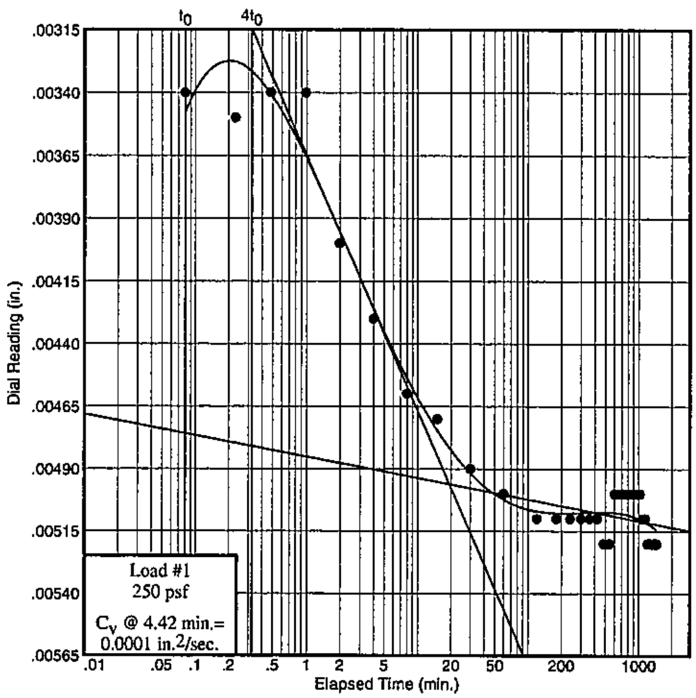
Remarks:

Figure

Dial Reading vs. Time

Project No.: 0121-3070.03
Project: SCI-823-0.00

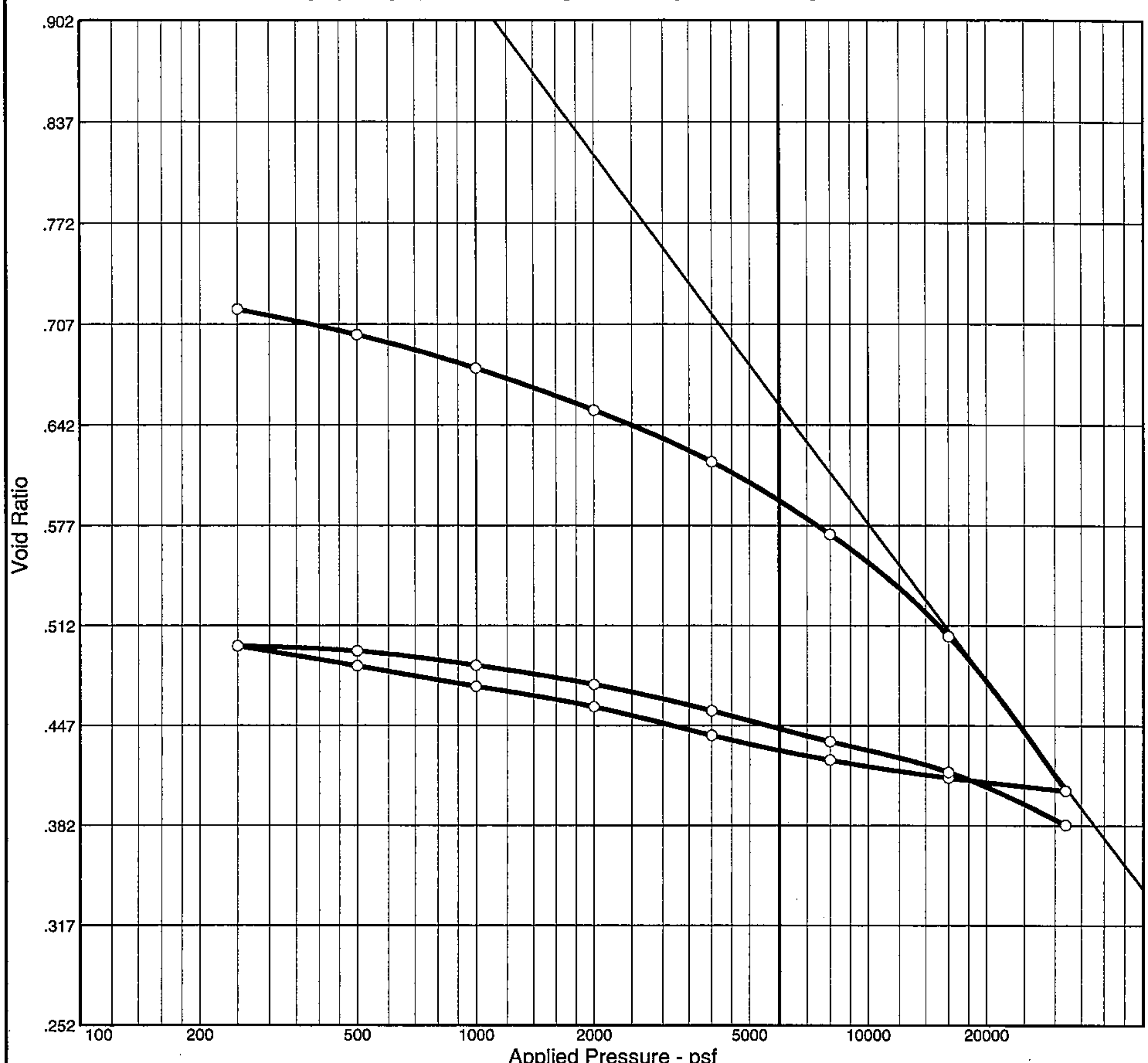
Source: B-38 | Sample No.: ST-1 | Elev./Depth: 10.0



DLZ

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
95.6 %	26.1 %	97.0	33	12	2.7	CL	A-6(12)	0.738

MATERIAL DESCRIPTION

Lean clay

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-38 **Sample No.:** ST-2 **Elev./Depth:** 19.0

DLZ

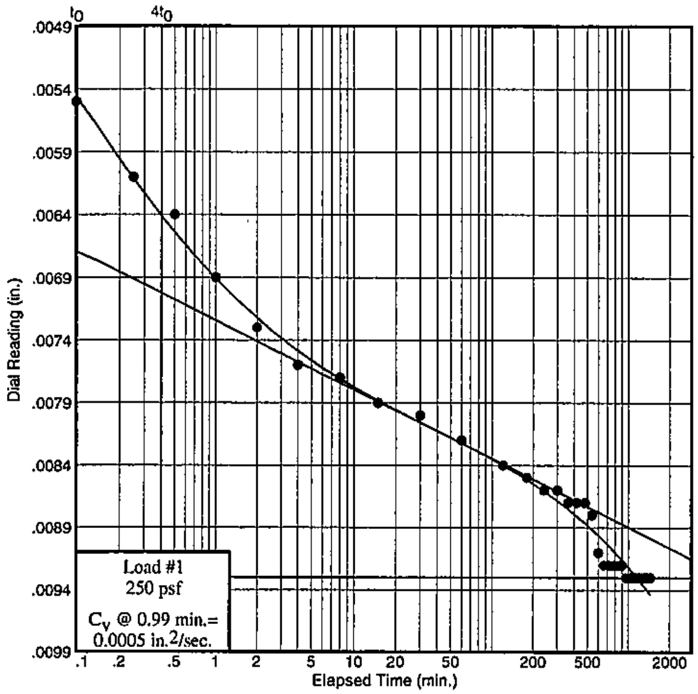
Remarks:

Figure

Dial Reading vs. Time

Project No.: 0121-3070.03
Project: SCI-823-0.00

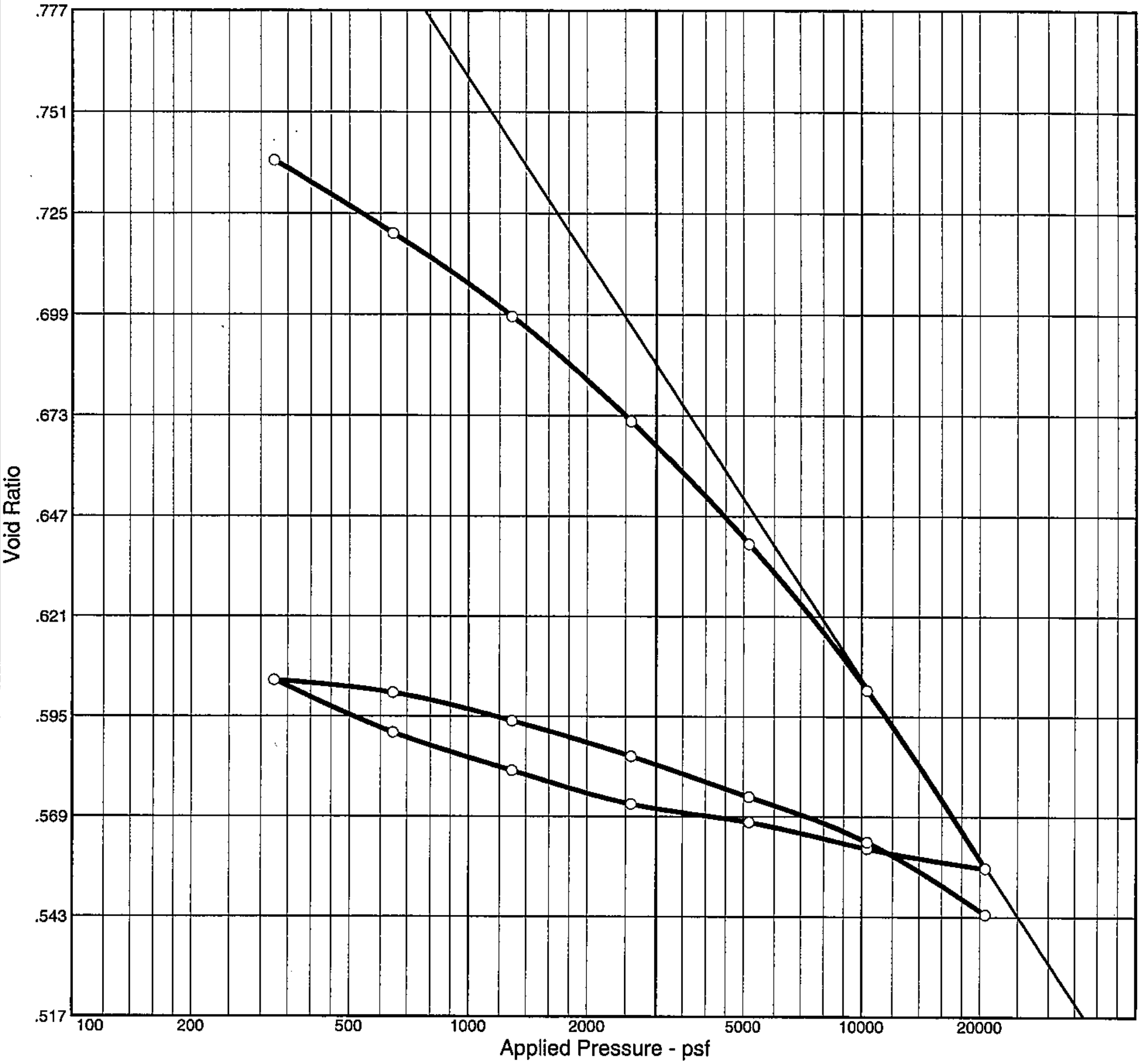
Source: B-38 | Sample No.: ST-2 | Elev./Depth: 19.0



DLZ

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
98.5 %	27.7 %	95.8	29	9	2.7	CL	A-6(10)	0.760

MATERIAL DESCRIPTION

Lean clay

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-38 **Sample No.:** ST-3 **Elev./Depth:** 37.0

DLZ

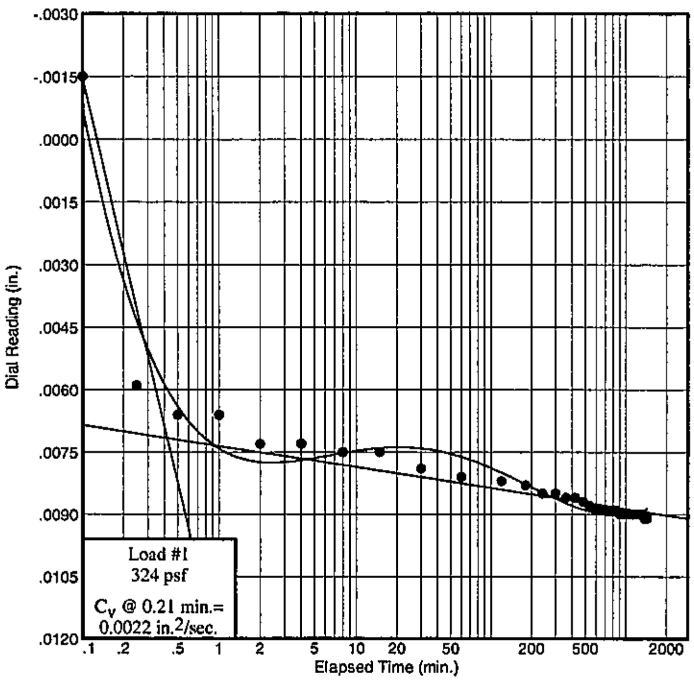
Remarks:

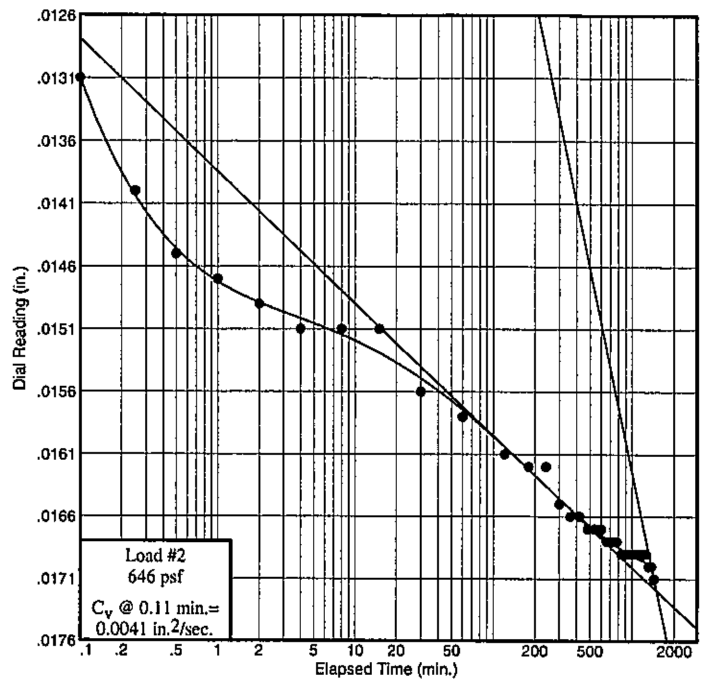
Figure

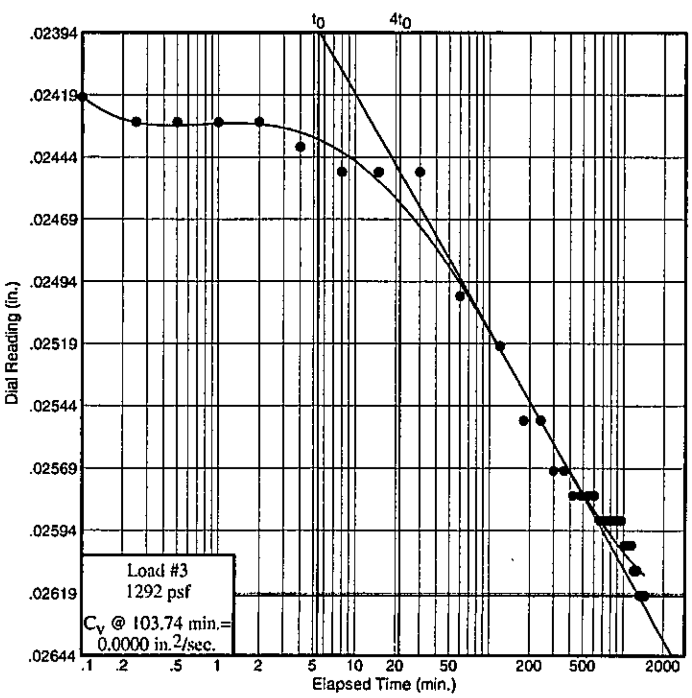
Dial Reading vs. Time

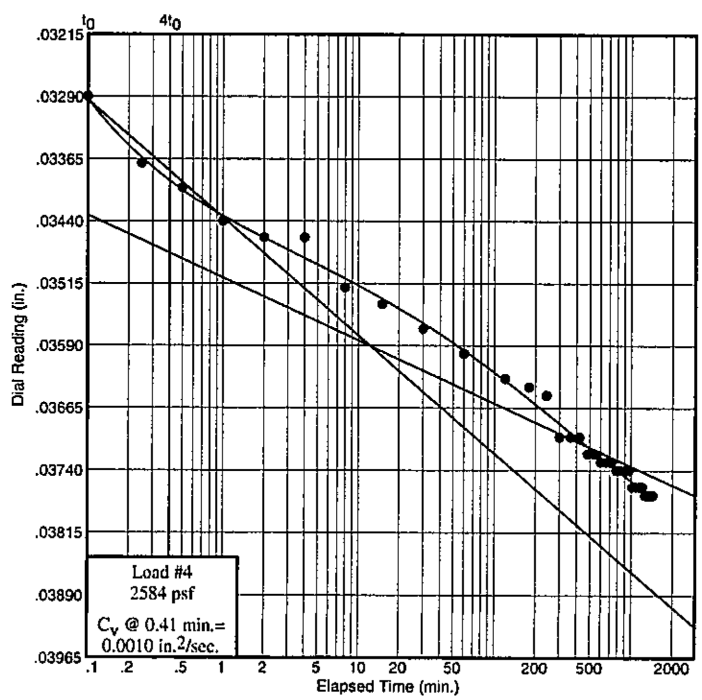
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-38 | Sample No.: ST-3 | Elev./Depth: 37.0









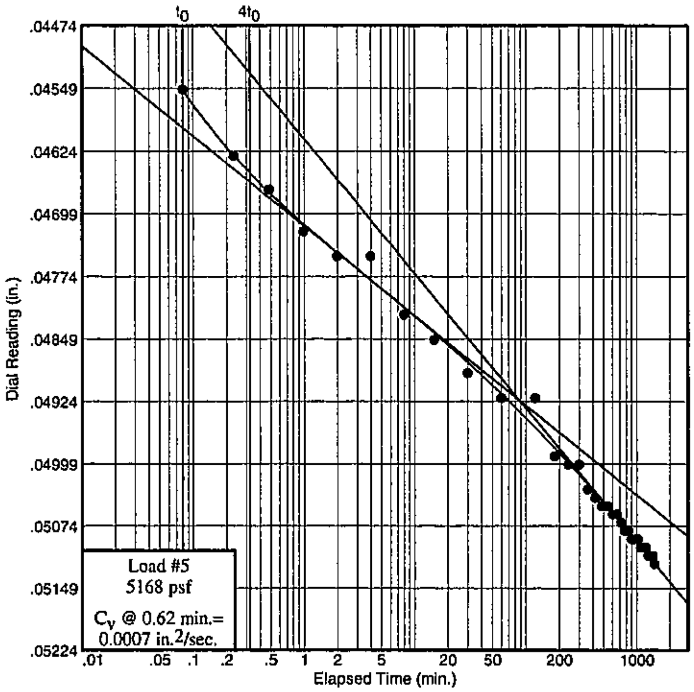
DLZ

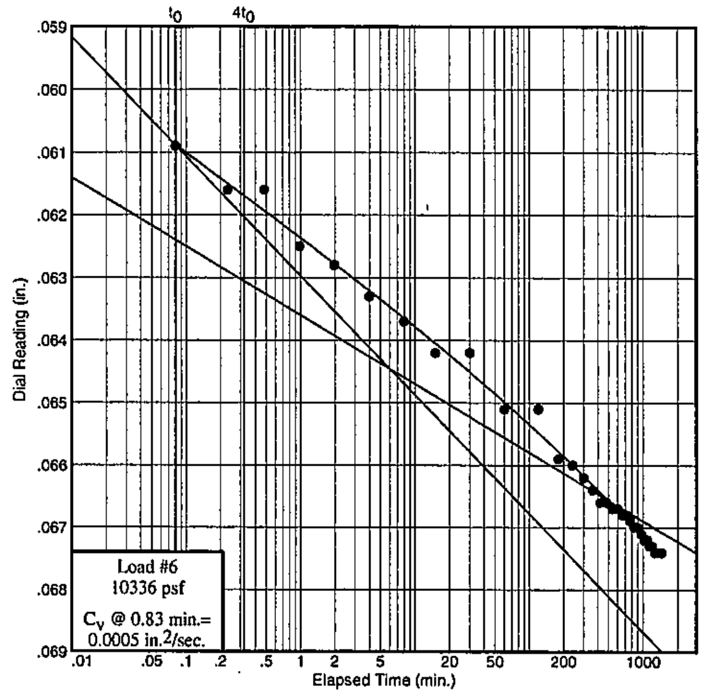
Figure

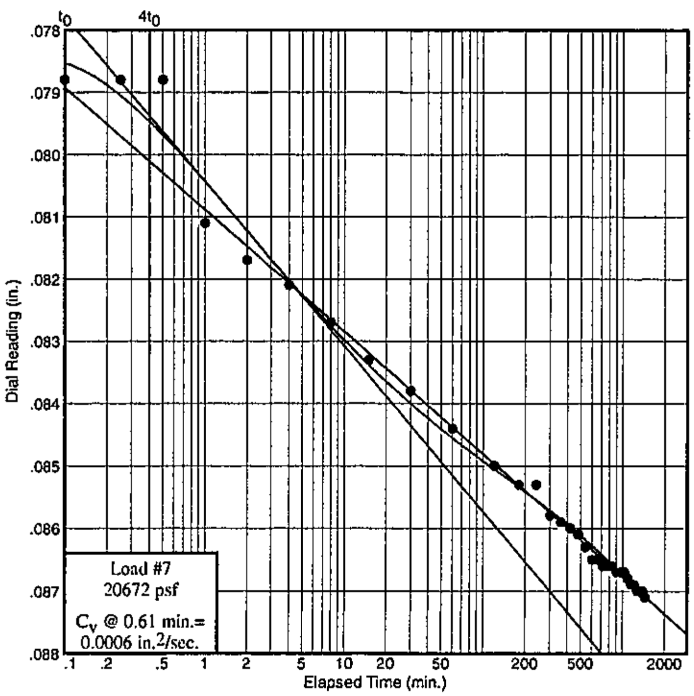
Dial Reading vs. Time

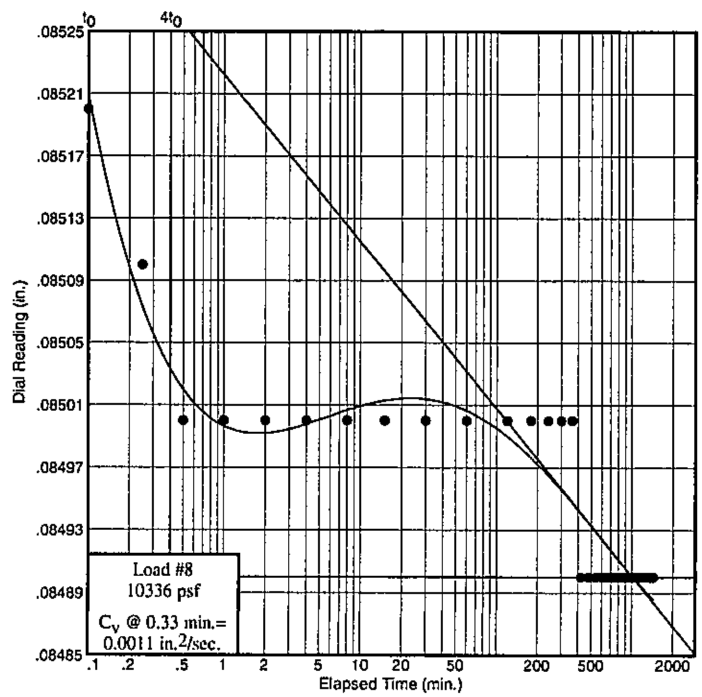
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-38 | Sample No.: ST-3 | Elev./Depth: 37.0









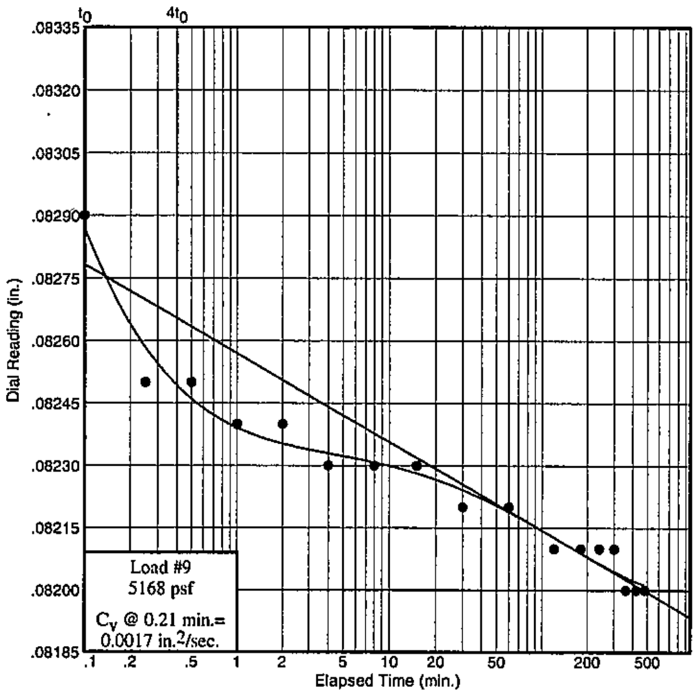
DLZ

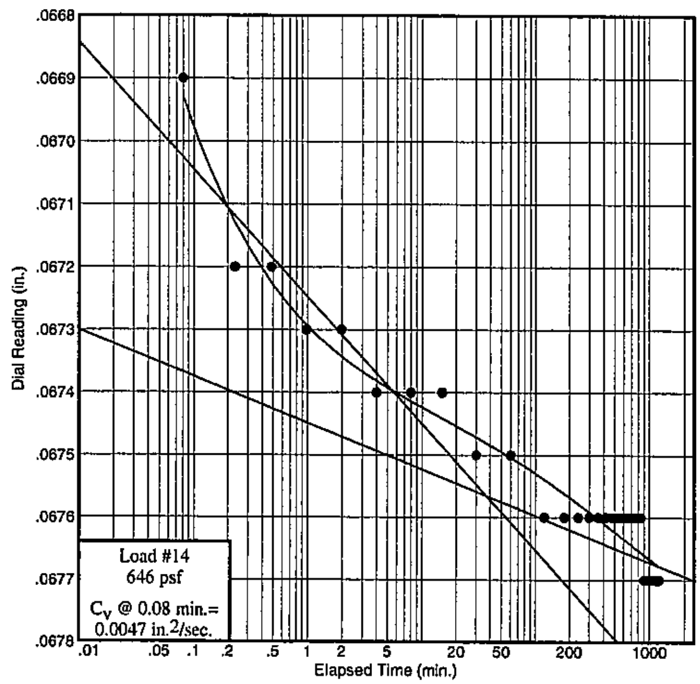
Figure

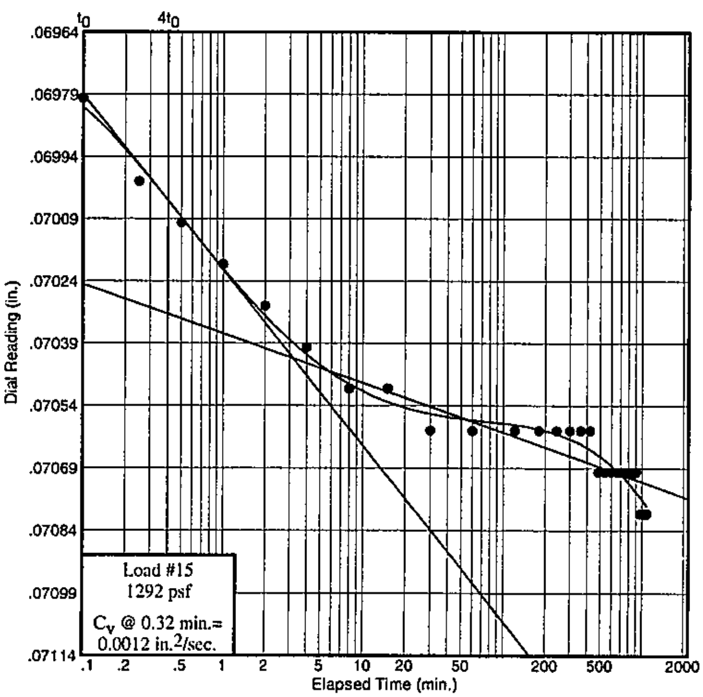
Dial Reading vs. Time

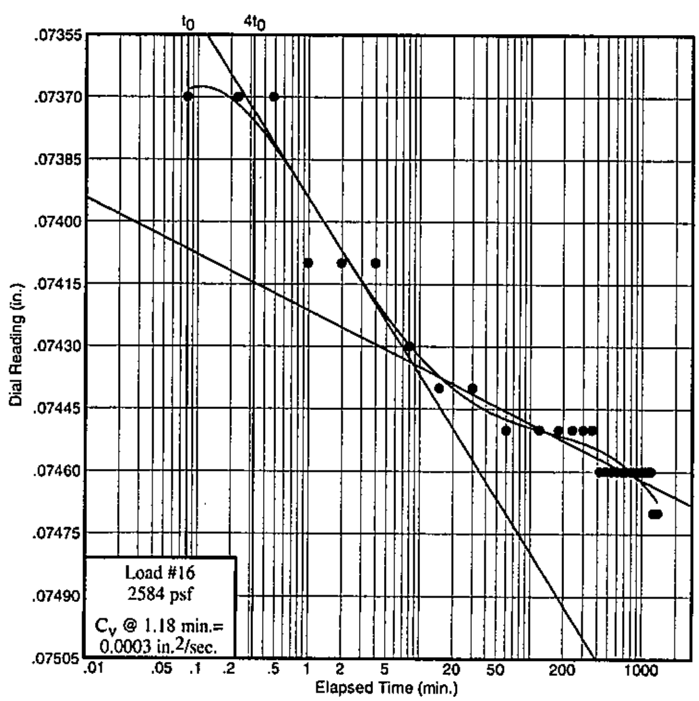
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-38 | Sample No.: ST-3 | Elev./Depth: 37.0









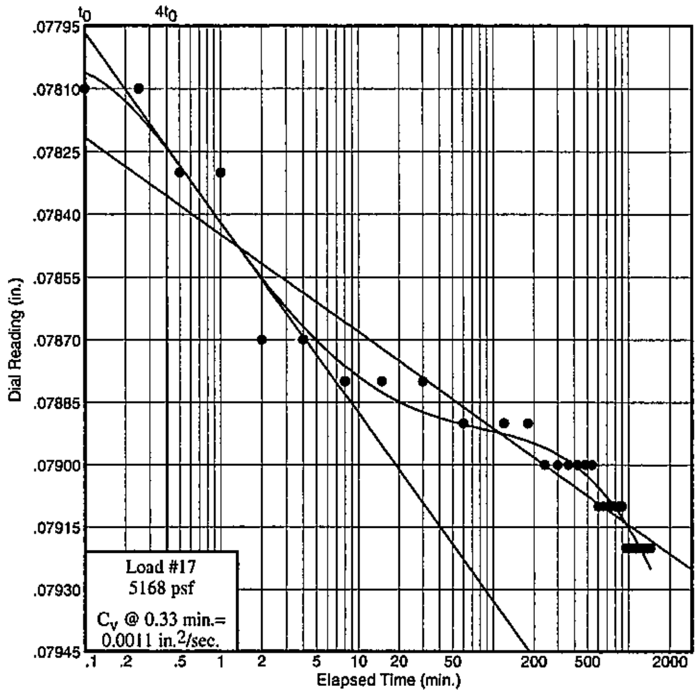
DLZ

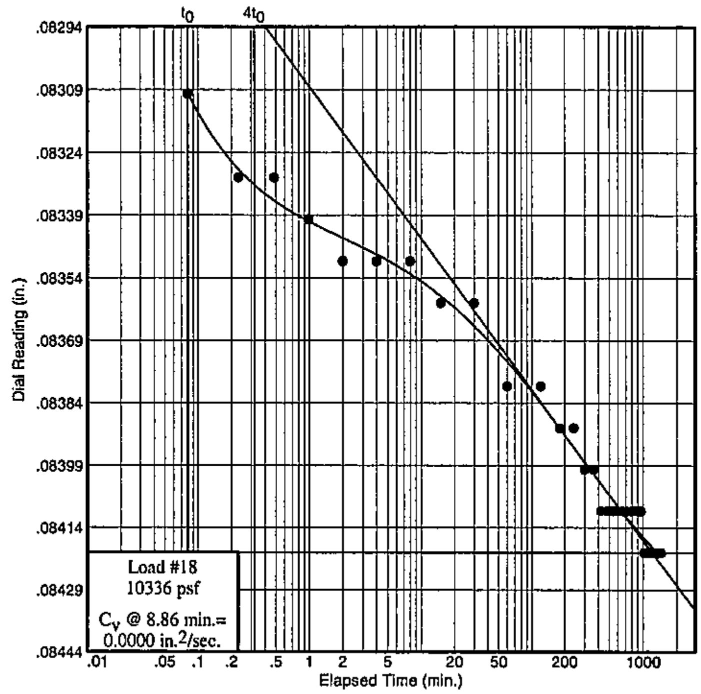
Figure

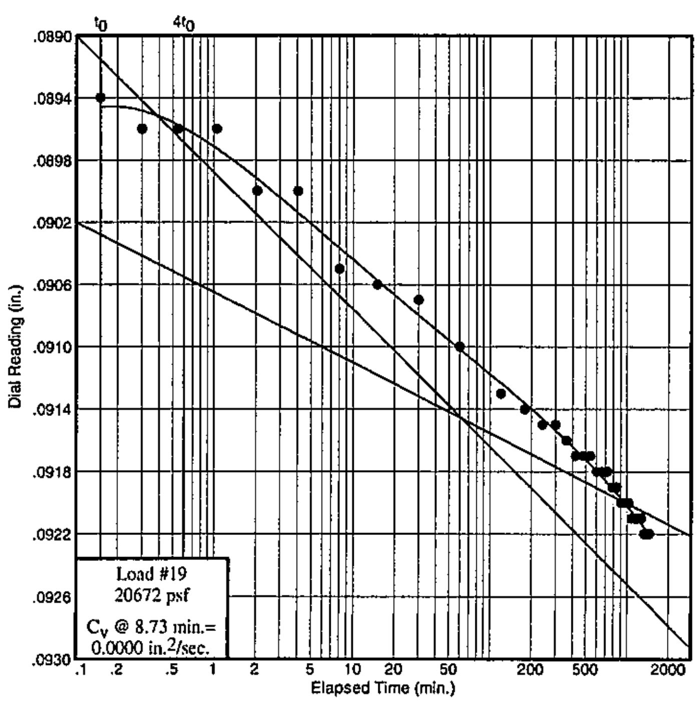
Dial Reading vs. Time

Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-38 | Sample No.: ST-3 | Elev./Depth: 37.0







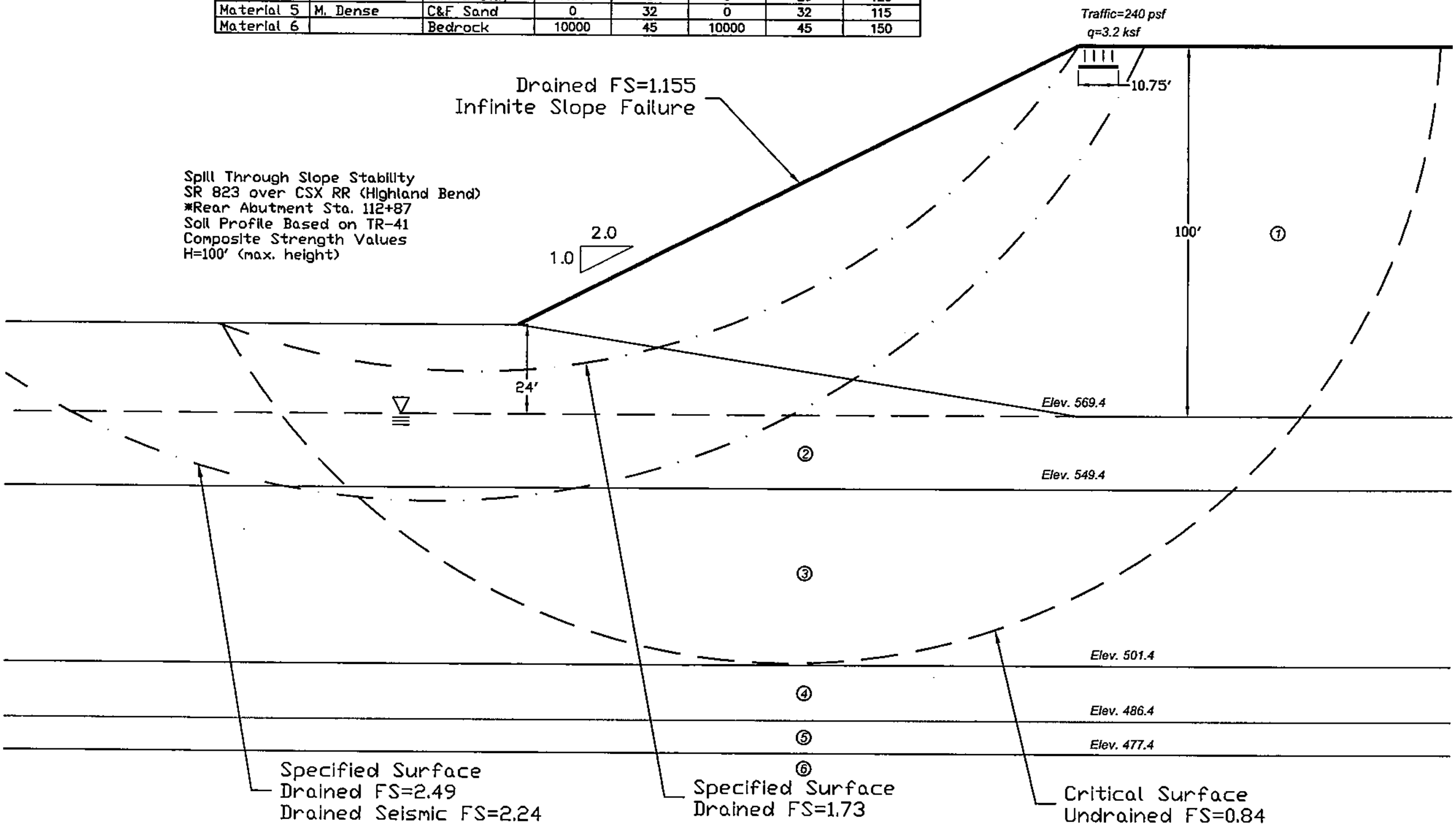
DLZ

Figure

APPENDIX IV

Slope Stability Analyses
Spread Footing Bearing Capacity Calculation
Settlement Calculations
Driven-Pile Analyses

Material	Consistency	Soil Type	Undrained c (psf)	Undrained φ (deg)	Drained c' (psf)	Drained φ' (deg)	γ (pcf)
Material 1	Compacted	Emb. Fill	0	30	0	30	120
Material 2	Stiff	Clay	1700	0	0	30	125
Material 3	Stiff	Silt	1100	0	0	29	120
Material 4	Stiff	Silt & Clay	1500	0	0	29	120
Material 5	M. Dense	C&F Sand	0	32	0	32	115
Material 6		Bedrock	10000	45	10000	45	150



Stability Analyses performed using UTEXAS3 Version 1.201

S/K Sheet 1 of 23

SR 823 OVER CSX RR
REAR ABUTMENT LOCATION
ANALYSES ASSUMING SPREAD FOOTING LOADS

SPILL THROUGH SLOPE STABILITY ANALYSIS

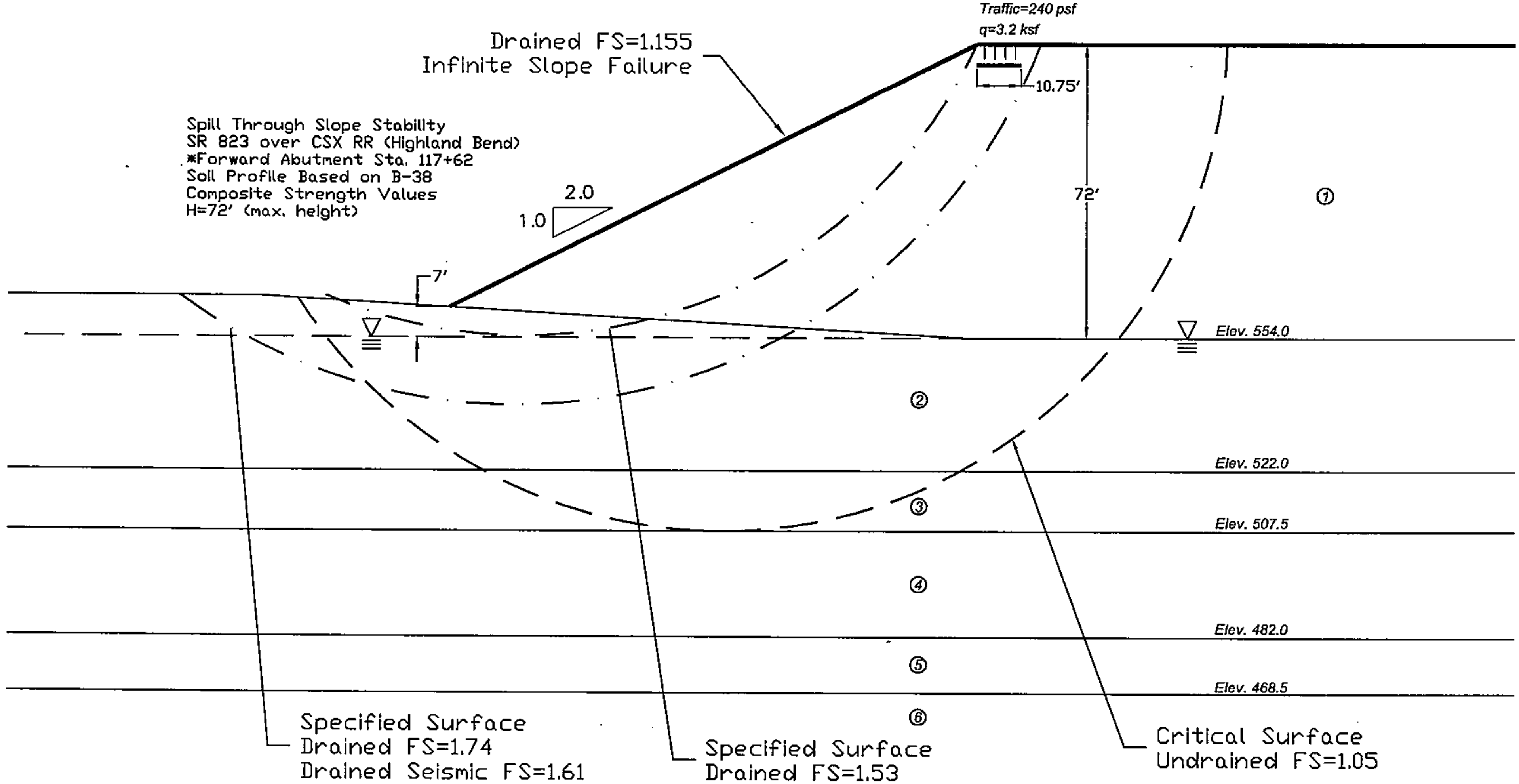
SCI-823-0.00

PROJECT NO. 0121-3070.03	CALC: SJR	DATE 08/28/07

M:\proj\0121\3070.03\Stability Analyses\MSE Wall and Embankment Profiles.dwg, 8/28/2007 3:09:47 PM, \\Dlztree\Q_geotechhplj5100tn

Material	Consistency	Soil Type	Undrained c (psf)	Undrained Φ (deg)	Drained c' (psf)	Drained Φ' (deg)	γ (pcf)
Material 1	Compacted	Emb. Fill	0	30	0	30	120
Material 2	Stiff	Clay/Silt&Clay	1700	0	0	30	125
Material 3	Stiff	Silt	1100	0	0	29	120
Material 4	Stiff	Silt&Clay	2700	0	0	29	120
Material 5	M. Dense	Sandy Silt	0	30	0	30	120
Material 6		Bedrock	10000	45	10000	45	150

Spill Through Slope Stability
SR 823 over CSX RR (Highland Bend)
*Forward Abutment Sta. 117+62
Soil Profile Based on B-38
Composite Strength Values
H=72' (max. height)



Stability Analyses performed using UTEXAS3 Version 1.201

S/R Sheet 2 of 23

SR 823 OVER CSX RR
FORWARD ABUTMENT LOCATION
ANALYSES ASSUMING SPREAD FOOTING LOADS

SPILL THROUGH SLOPE STABILITY ANALYSIS

SCI-823-0.00

PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 08/28/07

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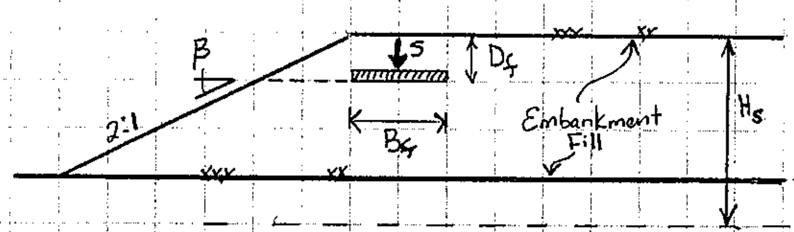
* Spread Footings support abutments

* From Transystems; $B_f = 10.75'$

$DL = 29\ ^{K}/_{ft}$ $LL = 5.5\ ^{K}/_{ft}$

$S = DL + LL = 34.5\ ^{K}/_{ft}$

$\overline{\sigma}_f = S/B_f = \dfrac{34.5\ ^{K}/_{ft}}{10.75\ ft} = 3.2\ ksf$



Assume $D_f = 5.0'$ (Conservative)

Fill Material ; $\phi = \phi' = 30°$

$\beta = \tan^{-1}\left(\frac{1}{2}\right) = 26.6°$

$D_f/B_f = 5.0/10.75 = 0.47$

Assuming Continuous Footings; $L = 114'$ $B = 10.75'$ $L/B = 10.6$

$q_{ult} = \overset{\circ}{\cancel{c}}(N_{cq}) + \frac{1}{2}\gamma(B_f)(N_{\gamma q})$ [FHWA-IF-02-054], Geotechnical Eng. Circular No. 6, Shallow Foundations

$N_{\gamma q}$ taken from graph [FHWA-IF-02-054, Fig. 5-7 (f)], attached

1) Interpolate between $\beta = 0°$ and $\beta = 30°$ for solution for $\beta = 26.6°$
2) Interpolate between $D_f/B_f = 0$ and $D_f/B_f = 1$ for solution to $D_f/B_f = 0.47$

$D_f = 5'$ $b = 0$ $B_f = 10.75'$ $\phi = \phi' = 30°$ $\beta = 26.6°$ $D_f/B_f = 0.47$

For $\beta = 0°$

$D_f/B_f = 0 \longrightarrow {}^{*}N_{\gamma q} = 15$ *Taken from graph

$D_f/B_f = 1 \longrightarrow {}^{*}N_{\gamma q} = 54$

• For $\beta = 0$ & $D_f/B_f = 0.47 \longrightarrow N_{\gamma q} = 33.3$

For $\beta = 30°$

$D_f/B_f = 0 \longrightarrow N_{\gamma q} = 2$

$D_f/B_f = 1 \longrightarrow N_{\gamma q} = 24$

• For $\beta = 30°$ & $D_f/B_f = 0.47 \longrightarrow N_{\gamma q} = 12.3$

cont.

For $\beta = 26.6°$

Interpolate to find solution for $\beta = 26.6°$

$$N_{\gamma q} = 12.3 + \left[\frac{33.3 - 12.3}{30°}\right](30° - 26.6°) = 14.7$$

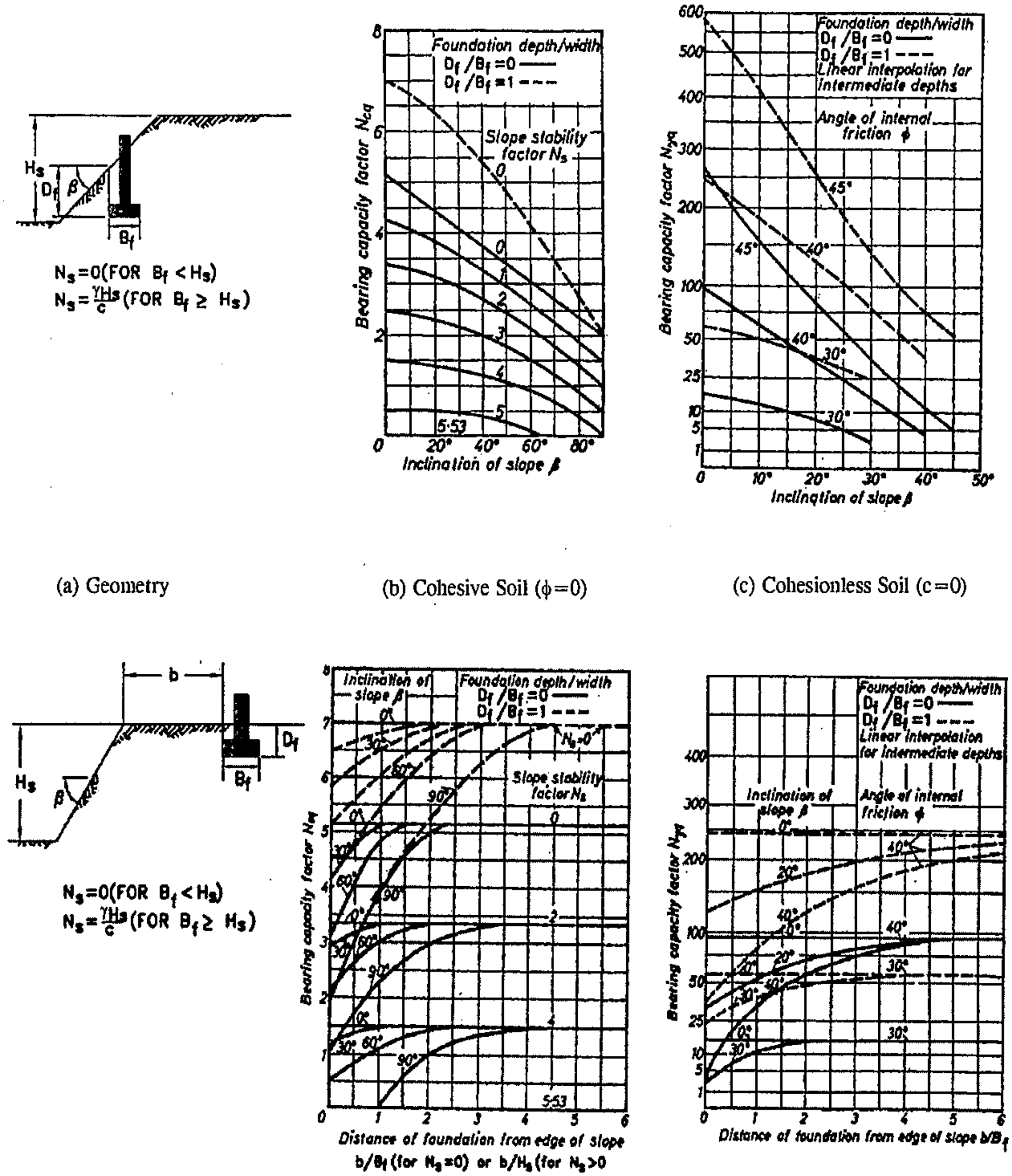
$$\boxed{\text{Use } N_{\gamma q} = 15}$$

$$q_{ult} = \cancel{c \cdot N_{cq}} + \tfrac{1}{2}\gamma \cdot B_f \cdot N_{\gamma q}$$

$$q_{ult} = \tfrac{1}{2}(120\ \text{pcf})(10.75')(15) = 9{,}675\ \text{psf}$$

$$q_{allow} = \frac{q_{ult}}{F.S.} = \frac{9{,}675\ \text{psf}}{2.5} = 3{,}870\ \text{psf}$$

$$\boxed{\text{Use } q_{allow} = 3.5\ \text{ksf}}$$



(a) Geometry (b) Cohesive Soil (φ=0) (c) Cohesionless Soil (c=0)

(d) Geometry (e) Cohesive Soil (φ=0) (f) Cohesionless Soil (c=0)

Figure 5-7: Modified Bearing Capacity Factors for Footing on Sloping Ground, (after Meyerhof, 1957, from AASHTO, 1996)

DLZ ENGINEERS • ARCHITECTS • SCIENTISTS PLANNERS • SURVEYORS

CLIENT: TranSystems Corp
PROJECT: SCI-823
SUBJECT: SR 823 over CSX
Assumed Soil Properties

PROJECT NO. 0121-3070.03
SHEET NO. 6 OF 23
COMP. BY SAK DATE 8-28-07
CHECKED BY DAA DATE 9-11-07

Rear Abutment   H = 100'   Span 1; L = 140'
Allowable DS = 6.72"
Use profile based on TR-41 *Composite Strengths

Depth
0'
Clay   C = 1700 $\phi' = 30°$ $C_c = 0.18$ $C_r = 0.07$ $P_c = 4,480$ psf
$e_0 = 0.718$ $C_v = 0.25$ ft²/day
20'
Silt   C = 1100 $\phi' = 29°$ $C_c = 0.16$ $C_r = 0.03$ $P_c = 4,746$ psf
$e_0 = 0.760$ $C_v = 0.50$ ft²/day
68'
Silt & Clay   C = 1500 $\phi' = 29°$ $C_c = 0.19$ $C_r = 0.07$ $P_c = 4,428$ psf
$e_0 = 0.706$ $C_v = 0.35$ ft²/day
83'
C&F Sand   C = 0 $\phi' = 32°$ $C' = 60$
92'
BEDROCK

* Weighted $C_v = 0.41$ ft²/day
$H_v = 83'/2 = 41.5'$ (Double Drainage)

Forward Abutment   H = 72'   Span 3; L = 140'
Allowable DS = 6.72"
Use profile based on B-38

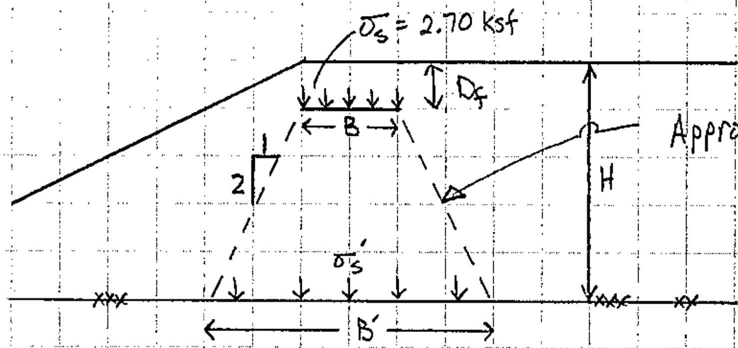
0'
Clay/Silt & Clay
C = 1700 $\phi' = 30°$ $C_c = 0.11$ $C_r = 0.03$ $P_c = 7000$ psf
$e_0 = 0.748$ $C_v \simeq 0.4$ ft²/day
17.5'
$C_c = 0.34$ $C_r = 0.05$ $P_c = 8000$ psf
$e_0 = 0.738$ $C_v \simeq 0.4$ ft²/day
32.0'
Silt   C = 1100 $\phi' = 29°$ $C_c = 0.16$ $C_r = 0.03$ $P_c = 4,746$ psf
$e_0 = 0.760$ $C_v = 0.55$ ft²/day
46.5
Silt and Clay   C = 2700 $\phi' = 29°$ $C_c = 0.19$ $C_r = 0.07$ $P_c = 4,428$ psf
$e_0 = 0.706$ $C_v = 0.27$ ft²/day
72.0'
Sandy Silt   C = 0 $\phi' = 30°$
$\bar{N} = 24.5$ $\bar{\sigma}_0 = 9480$ psf $C' = 40'$
85.5
SANDSTONE

* Weighted $C_v = 0.38$ ft²/day
$H_v = 72'/2 = 36'$ (Double Drainage)

Consolidation of Foundation Soils Due to Footing Loads

* From Dead Load Only ; $DL = 29\ ^k/ft$ $\quad B_f = 10.75'$ $\quad \sigma_s = (29\ ^k/ft)/10.75'$

$\sigma_s = 2.70$ ksf



- $B' = B + 2(H - D_f)(\frac{1}{2})$
- $\sigma_s' = \dfrac{\sigma_s \cdot B}{B'}$

- Rear Abutment : $H = 100'$ $\quad B' = 10.75' + 2(100 - 17.5)(\frac{1}{2}) = 93'$

  $D_f = 17.5'$ (Taken from plans)

$$\sigma_s' = \frac{(2.70\text{ ksf})(10.75')}{93'} = 0.312\text{ Ksf} = 312^{*}\text{ psf}$$

*From DL on existing ground surface.

- Forward Abutment: $H = 72'$ $\quad B' = 10.75' + 2(72 - 17.5)\frac{1}{2} = 65'$

  $D_f = 17.5'$ (Taken from plans)

$$\sigma_s' = \frac{(2.70\text{ ksf})(10.75')}{65'} = 0.447\text{ ksf} = 447^{*}\text{ psf}$$

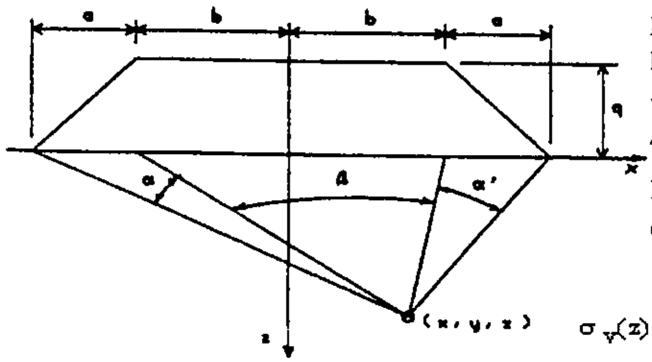
*From DL on existing ground surface.

DLZ SUBJECT

Client TranSystems Corp	JOB NUMBER	0121-3070.03	
Project SCI-823 Portsmouth Bypass	SHEET NO.	8 OF 23	
Item Settlement at abutment location	COMP. BY	SJK	DATE 8-28-07
Rear Abutment, based on TR-41	CHECKED BY	DAA	DATE 9-11-07
Embankment Loading Only			

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft		
Embankment Height:	H =	100	ft		
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	12,000 psf
Width of Slope:	a =	250			
Top half-width of Emb:	b =	45			
Distance from CL:	x =	0			
Output Range:	z =	0	to	92	ft

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \mathrm{atan}\left[\frac{(b-x)}{z}\right] + \mathrm{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \mathrm{atan}\left[\frac{(a+b-x)}{z}\right] - \mathrm{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \mathrm{atan}\left[\frac{(a+b+x)}{z}\right] - \mathrm{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_o
1	10.0	ft	Clay	125	4,480	625	12,000	12,625		0.07	0.18	0.718
2	20.0	ft	Clay	125	4,480	1,875	11,985	13,860		0.07	0.18	0.718
3	30.0	ft	Silt	120	4,746	2,788	11,936	14,724		0.03	0.16	0.760
4	40.0	ft	Silt	120	4,746	3,364	11,845	15,209		0.03	0.16	0.760
5	50.0	ft	Silt	120	4,746	3,940	11,728	15,668		0.03	0.16	0.760
6	60.0	ft	Silt	120	4,746	4,516	11,568	16,084		0.03	0.16	0.760
7	68.0	ft	Silt	120	5,034	5,034	11,401	16,436		0.03	0.16	0.760
8	83.0	ft	Silt and Clay	120	5,697	5,697	11,164	16,860		0.07	0.19	0.706
9	92.0	ft	C&F Sand	115	0	6,366	10,910	17,275	60.0			
10	0.0			0	0							

No.	Settlement:	
1	0.820	ft
2	0.668	ft
3	0.486	ft
4	0.485	ft
5	0.485	ft
6	0.486	ft
7	0.374	ft
8	0.787	ft
9	0.065	ft
10		

Total Settlement

4.656 ft

55.9 in

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \Sigma \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \Sigma\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_0}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \Sigma \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

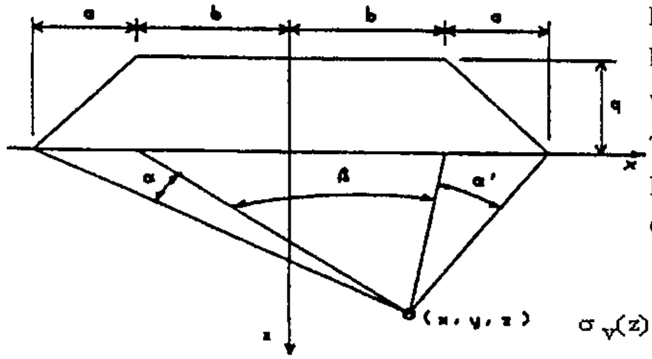
Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \Sigma \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft		
Embankment Height:	H =	100	ft		**(Hγ)+312 psf**
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	12,312 psf
Width of Slope:	a =	250			
Top half-width of Emb:	b =	45			
Distance from CL:	x =	0			
Output Range:	z =	0	to	92	ft

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_o
1	10.0	ft	Clay	125	4,480	625	12,312	12,937		0.07	0.18	0.718
2	20.0	ft	Clay	125	4,480	1,875	12,297	14,172		0.07	0.18	0.718
3	30.0	ft	Silt	120	4,746	2,788	12,247	15,035		0.03	0.16	0.760
4	40.0	ft	Silt	120	4,746	3,364	12,153	15,517		0.03	0.16	0.760
5	50.0	ft	Silt	120	4,746	3,940	12,032	15,972		0.03	0.16	0.760
6	60.0	ft	Silt	120	4,746	4,516	11,869	16,385		0.03	0.16	0.760
7	68.0	ft	Silt	120	5,034	5,034	11,698	16,732		0.03	0.16	0.760
8	83.0	ft	Silt and Clay	120	5,697	5,697	11,454	17,151		0.07	0.19	0.706
9	92.0	ft	C&F Sand	115	0	6,366	11,193	17,559	60.0			
10	0.0			0	0							

No.	Settlement:	
1	0.831	ft
2	0.678	ft
3	0.495	ft
4	0.493	ft
5	0.493	ft
6	0.493	ft
7	0.379	ft
8	0.800	ft
9	0.066	ft
10		

Total Settlement

4.728 ft

56.7 in

With Footing Load

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \sum \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_0}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \sum \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

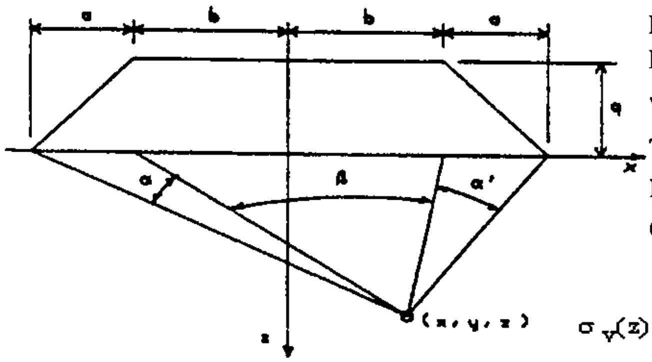
$$(\delta_c)_{ult} = \sum \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

DLZ SUBJECT

Client TranSystems Corp	JOB NUMBER	0121-3070.03	
Project SCI-823 Portsmouth Bypass	SHEET NO.	10	OF 23
Item Settlement at abutment location	COMP. BY	SJR	DATE 8-28-07
Forward Abutment, based on B-38	CHECKED BY	DAA	DATE 9-11-07
Embankment Loading Only			

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft				
Embankment Height:	H =	72	ft				
Fill Unit Weight:	γ_{emb} =	120	pcf		q =	8,640	psf
Width of Slope:	a =	180					
Top half-width of Emb:	b =	45					
Distance from CL:	x =	0					
Output Range:	z =	0	to	86	ft		

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_0 (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_0
1	10.0	ft	Clay/Silt&Clay	125	7,000	625	8,640	9,265		0.03	0.11	0.748
2	17.5	ft	Clay/Silt&Clay	125	7,000	1,719	8,630	10,349		0.03	0.11	0.748
3	32.0	ft	Clay/Silt&Clay	125	8,000	2,797	8,583	11,380		0.05	0.34	0.738
4	46.5	ft	Silt	120	4,746	3,669	8,446	12,114		0.03	0.16	0.760
5	59.0	ft	Silt&Clay	120	4,446	4,446	8,250	12,697		0.07	0.19	0.706
6	72.0	ft	Silt&Clay	120	5,181	5,181	8,027	13,208		0.07	0.19	0.706
7	85.5	ft	Sandy Silt	115	0	5,910	7,781	13,691	40.0			
8	0.0			0	0							
9	0.0			0	0							
0	0.0			0	0							

No.	Settlement:	
1	0.257	ft
2	0.159	ft
3	0.625	ft
4	0.564	ft
5	0.634	ft
6	0.588	ft
7	0.123	ft
9		
0		

Total Settlement

2.950 ft

35.4 in

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) **Eqn:11.24**

$$(\delta_c)_{ult} = \sum \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) **Eqn:11.25**

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_0}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) **Eqn: 11.23**

$$(\delta_c)_{ult} = \sum \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

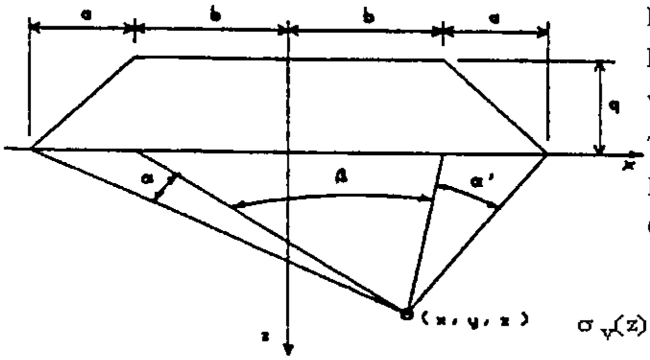
Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \sum \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft		
Embankment Height:	H =	72	ft		(Hγ)+447 psf
Fill Unit Weight:	γ_{emb} =	120	pcf		q = 9,087 psf
Width of Slope:	a =	180			
Top half-width of Emb:	b =	45			
Distance from CL:	x =	0			
Output Range:	z =	0	to	86	ft

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_o
1	10.0	ft	Clay/Silt&Clay	125	7,000	625	9,087	9,712		0.03	0.11	0.748
2	17.5	ft	Clay/Silt&Clay	125	7,000	1,719	9,077	10,795		0.03	0.11	0.748
3	32.0	ft	Clay/Silt&Clay	125	8,000	2,797	9,027	11,824		0.05	0.34	0.738
4	46.5	ft	Silt	120	4,746	3,669	8,883	12,551		0.03	0.16	0.760
5	59.0	ft	Silt&Clay	120	4,446	4,446	8,677	13,123		0.07	0.19	0.706
6	72.0	ft	Silt&Clay	120	5,181	5,181	8,442	13,623		0.07	0.19	0.706
7	85.5	ft	Sandy Silt	115	0	5,910	8,184	14,094	40.0			
8	0.0			0	0							
9	0.0			0	0							
10	0.0			0	0							

No.	Settlement:	
1	0.270	ft
2	0.167	ft
3	0.672	ft
4	0.584	ft
5	0.654	ft
6	0.608	ft
7	0.127	ft
8		
9		
10		

Total Settlement

3.083 ft

37.0 in

With Footing Load

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \sum \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_0}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \sum \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \sum \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

SETTLEMENT ANALYSIS OF SHALLOW FOUNDATIONS
Schmertmann Method

Sheet 12 of 23
SJR 8-28-07
DAA 9-11-07

Date August 29, 2007
Identification SR-823 over CSX RR

Input

Units	E	E or SI
Shape	co	SQ, CI, CO, or RE
B =	10.75	ft
L =	114	ft
D =	17.5	ft
P =	34.5	k/ft
Dw =	100	ft
gamma =	120	lb/ft^3
t =	0.1	yr

Results

q =	5834	lb/ft^2
delta =	2.11	in

Depth to Soil Layer Top (ft)	Bottom (ft)	Es (lb/ft^2)	zf (ft)	I epsilon	strain (%)	delta (in)
0.0	17.5					
17.5	18.5	1000000	0.5	0.383	0.0751	0.0090
18.5	19.5	1000000	1.5	0.749	0.1468	0.0176
19.5	20.5	1000000	2.5	1.115	0.2185	0.0262
20.5	21.5	1000000	3.5	1.481	0.2903	0.0348
21.5	22.5	1000000	4.5	1.848	0.3620	0.0434
22.5	23.5	1000000	5.5	2.214	0.4338	0.0521
23.5	24.5	1000000	6.5	2.580	0.5055	0.0607
24.5	25.5	1000000	7.5	2.946	0.5773	0.0693
25.5	26.5	1000000	8.5	3.312	0.6490	0.0779
26.5	27.5	1000000	9.5	3.678	0.7207	0.0865
27.5	28.5	1000000	10.5	4.044	0.7925	0.0951
28.5	29.5	1000000	11.5	4.036	0.7908	0.0949
29.5	30.5	1000000	12.5	3.907	0.7657	0.0919
30.5	31.5	1000000	13.5	3.779	0.7406	0.0889
31.5	32.5	1000000	14.5	3.651	0.7155	0.0859
32.5	33.5	1000000	15.5	3.523	0.6904	0.0828
33.5	34.5	1000000	16.5	3.395	0.6653	0.0798
34.5	35.5	1000000	17.5	3.267	0.6402	0.0768
35.5	36.5	1000000	18.5	3.139	0.6151	0.0738
36.5	37.5	1000000	19.5	3.011	0.5899	0.0708
37.5	38.5	1000000	20.5	2.883	0.5648	0.0678
38.5	39.5	1000000	21.5	2.754	0.5397	0.0648
39.5	40.5	1000000	22.5	2.626	0.5146	0.0618
40.5	41.5	1000000	23.5	2.498	0.4895	0.0587
41.5	42.5	1000000	24.5	2.370	0.4644	0.0557
42.5	43.5	1000000	25.5	2.242	0.4393	0.0527
43.5	44.5	1000000	26.5	2.114	0.4142	0.0497
44.5	45.5	1000000	27.5	1.986	0.3891	0.0467
45.5	46.5	1000000	28.5	1.858	0.3640	0.0437
46.5	47.5	1000000	29.5	1.730	0.3389	0.0407
47.5	48.5	1000000	30.5	1.601	0.3138	0.0377
48.5	49.5	1000000	31.5	1.473	0.2887	0.0346
49.5	50.5	1000000	32.5	1.345	0.2636	0.0316
50.5	51.5	1000000	33.5	1.217	0.2385	0.0286
51.5	52.5	1000000	34.5	1.089	0.2134	0.0256
52.5	53.5	1000000	35.5	0.961	0.1883	0.0226
53.5	54.5	1000000	36.5	0.833	0.1632	0.0196
54.5	55.5	1000000	37.5	0.705	0.1381	0.0166
55.5	56.5	1000000	38.5	0.577	0.1130	0.0136
56.5	57.5	1000000	39.5	0.448	0.0879	0.0105
57.5	58.5	1000000	40.5	0.320	0.0628	0.0075
58.5	59.5	1000000	41.5	0.192	0.0377	0.0045
59.5	60.5	1000000	42.5	0.064	0.0126	0.0015
60.5	61.5	1000000	43.5	0.000	0.0000	0.0000

DLZ ENGINEERS • ARCHITECTS • SCIENTISTS PLANNERS • SURVEYORS

CLIENT Tran Systems Corp / ODOT D-9 PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass SHEET NO. 13 OF 23
SUBJECT Elastic Settlement AASHTO Method COMP. BY SJK DATE 8-29-07
CHECKED BY DAA DATE 9-11-07

Elastic Settlement of Embankment Fill using AASHTO, Standard Spec for Highway Bridges, 17th Ed.

$$S_e = \frac{\left[q_0 (1-\nu^2) \sqrt{A} \right]}{E_s} \beta_z \quad (4.4.7.2.2\text{-}1)$$

*Assumed Parameters for Compacted Granular Fill

$E_s = 1000$ ksf

$\nu = 0.3$

* Footing Details

$B = 10.75'$ $L \approx 114'$ $A = 1226\ ft^2$ $L/B = 10.6$

For β_z; taken from table 4.4.7.2.2B

$\beta_z = 1.41$

$$q_0 = (DL + LL)/B = \frac{(29\ ^{k/ft} + 5.5\ ^{k/ft})}{10.75'} = 3.2\ ksf$$

$$S_e = \frac{\left[3.2\ ksf\ (1-0.3^2) \sqrt{1226\ ft^2} \right]}{1000\ ksf} (1.41) = 0.10\ ft = 1.2\ in.^*$$

* Do not use: For conservative design, use elastic settlement value from Schmertmann Method, $S_e = 2.1''$

See page 12 of 23

• Rear Abutment Location   Span Length = 140'-0"

Allowable Differential Settlement ; DS = (140')(0.004) = 0.56' = 6.7"

Elastic Settlement of embankment fill = 2.1" (due to footing load)
Consolidation Settlement of foundation soil = 0.8" (due to footing load)
2.9"

Remaining allowable settlement at Rear Abutment = 6.7" - 2.9" = 3.8"
Total Primary Consolidation = 56"
Required U prior to constructing footings: $U_{Req} = [1 - (3.8''/56'')](100) = 93$
* Use $U_{Req} = 95\%$

* Footings may be constructed after at least U=95% or less than 3.8" of primary consolidation is remaining.

• Forward Abutment Location   Span Length = 140'-0"

Allowable Differential Settlement ; DS = (140')(0.004) = 0.56' = 6.7"

Elastic Settlement of embankment fill = 2.1" (due to footing load)
Consolidation Settlement of foundation soil = 1.6" (due to footing load)
3.7"

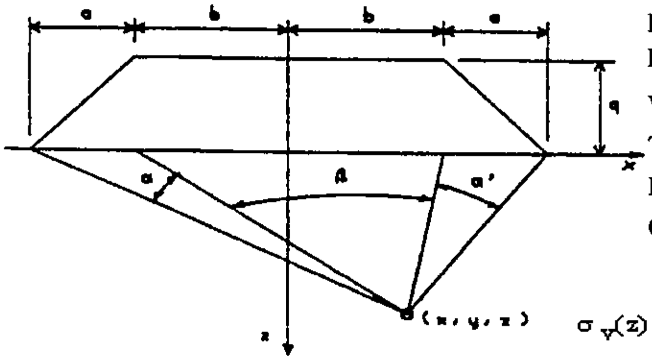
Remaining allowable settlement at Rear Abutment = 6.7" - 3.7" = 3.0"
Total Primary Consolidation = 36"
Required U prior to constructing footings: $U_{Req} = [1 - (3.0''/36'')](100) = 92$
* Use $U_{Req} = 95\%$

* Footings may be constructed after at least U=95% or less than 3.0" of primary consolidation is remaining.

DLZ SUBJECT	Client TranSystems Corp	JOB NUMBER	0121-3070.03
	Project SCI-823 Portsmouth Bypass	SHEET NO.	15 OF 23
	Item Settlement at abutment location	COMP. BY	SJK DATE 8-29-07
	Pier 1, based on TR-41	CHECKED BY	DAA DATE 9-11-07
	Embankment Loading Only at TOE (Pier 1)		

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft		
Embankment Height:	H =	100	ft		
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	12,000 psf
Width of Slope:	a =	200			
Top half-width of Emb:	b =	100			
Distance from CL:	x =	300			
Output Range:	z =	0	to	92	ft

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_o
1	10.0	ft	Clay	125	4,480	625	88	713		0.07	0.18	0.718
2	20.0	ft	Clay	125	4,480	1,875	281	2,156		0.07	0.18	0.718
3	30.0	ft	Silt	120	4,746	2,788	472	3,260		0.03	0.16	0.760
4	40.0	ft	Silt	120	4,746	3,364	660	4,024		0.03	0.16	0.760
5	50.0	ft	Silt	120	4,746	3,940	828	4,768		0.03	0.16	0.760
6	60.0	ft	Silt	120	4,746	4,516	1,009	5,525		0.03	0.16	0.760
7	68.0	ft	Silt	120	5,034	5,034	1,168	6,203		0.03	0.16	0.760
8	83.0	ft	Silt and Clay	120	5,697	5,697	1,369	7,065		0.07	0.19	0.706
9	92.0	ft	C&F Sand	115	0	6,366	1,560	7,925	60.0			
10	0.0			0	0							

No.	Settlement:		Total Settlement
1	0.023	ft	
2	0.025	ft	**0.388 ft**
3	0.012	ft	
4	0.013	ft	
5	0.016	ft	**4.7 in**
6	0.064	ft	
7	0.066	ft	
8	0.156	ft	
9	0.014	ft	
10			

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \sum \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_0}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \sum \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

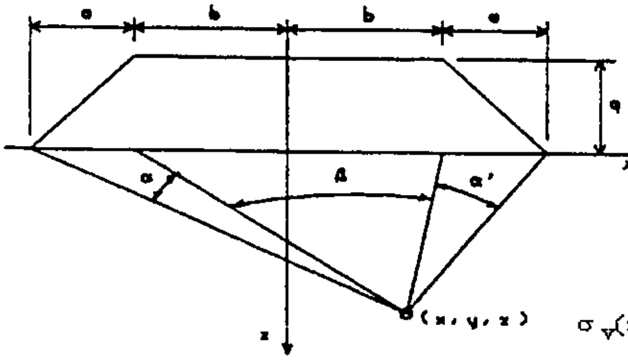
Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \sum \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft			
Embankment Height:	H =	72	ft			
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	8,640	psf
Width of Slope:	a =	144				
Top half-width of Emb:	b =	100				
Distance from CL:	x =	244				
Output Range:	z =	0	to	86	ft	

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)(a\cdot(\alpha(z)+\beta(z)+\alpha'(z))+b\cdot(\alpha(z)+\alpha'(z))+x\cdot(\alpha(z)-\alpha'(z)))$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right]+\operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right]-\operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right]-\operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

Soil Properites: *Settlement is calculated at mid-point of layer*

No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	Cohesionless Soils C'	Cohesive Soils C_r	C_c	e_0
1	10.0	ft	Clay/Silt&Clay	125	7,000	625	82	707		0.03	0.11	0.748
2	17.5	ft	Clay/Silt&Clay	125	7,000	1,719	246	1,964		0.03	0.11	0.748
3	32.0	ft	Clay/Silt&Clay	125	8,000	2,797	455	3,253		0.05	0.34	0.738
4	46.5	ft	Silt	120	4,746	3,669	721	4,389		0.03	0.16	0.760
5	59.0	ft	Silt&Clay	120	4,446	4,446	957	5,403		0.07	0.19	0.706
6	72.0	ft	Silt&Clay	120	5,181	5,181	1,164	6,345		0.07	0.19	0.706
7	85.5	ft	Sandy Silt	115	0	5,910	1,357	7,267	40.0			
8	0.0			0	0							
9	0.0			0	0							
10	0.0			0	0							

No.	Settlement:	
1	0.009	ft
2	0.007	ft
3	0.027	ft
4	0.019	ft
5	0.118	ft
6	0.127	ft
7	0.030	ft
8		
9		
10		

Total Settlement

$\boxed{0.339 \text{ ft}}$

$\boxed{4.1 \text{ in}}$

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \sum\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_c}{\sigma'_0}\right)+\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \sum\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Reference: FHWA NHI-00-045

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \sum\frac{1}{C'}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

SJR 8-29-07
DAA 9-11-07

DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Rear Abutment **Based upon boring TR-41**
Reference: FHWA-RD-86-168 Station 112+87

Wick Drain Spacing **5.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	*Remaining* δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	56.0	5.25	**0.41**	**41.5**	**56**
5	0.0744	0.0012	0.33	0.09	38.3	21.5	34.5				
10	0.1488	0.0024	0.54	0.09	58.3	32.6	23.4				
15	0.2231	0.0036	0.69	0.09	71.9	40.3	15.7	*Assumes double drainage*			
20	0.2975	0.0048	0.79	0.10	81.0	45.3	10.7	*Spacing = 5 ft (triangular)*			
25	0.3719	0.0060	0.85	0.10	86.7	48.6	7.4				
30	0.4463	0.0071	0.89	0.11	90.3	50.6	5.4				
35	0.5206	0.0083	0.92	0.11	92.6	51.9	4.1				
40	0.5950	0.0095	0.94	0.11	94.3	52.8	3.2				
45	0.6694	0.0107	0.95	0.12	95.7	53.6	2.4				
50	0.7438	0.0119	0.97	0.12	97.0	54.3	1.7				
55	0.8181	0.0131	0.98	0.12	98.2	55.0	1.0				
60	0.8925	0.0143	0.99	0.13	99.0	55.5	0.5				
65	0.9669	0.0155	0.99	0.13	99.0	55.5	0.5				

DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Rear Abutment **Based upon boring TR-41**
Reference: FHWA-RD-86-168 Station 112+87

SJR 8-29-07
DAA 9-11-07

Wick Drain Spacing **7.0** feet Use η = 10

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	Remaining δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	56.0	7.35	**0.41**	**41.5**	**56**
5	0.0379	0.0012	0.19	0.09	25.9	14.5	41.5				
10	0.0759	0.0024	0.33	0.09	39.1	21.9	34.1				
15	0.1138	0.0036	0.45	0.09	50.1	28.1	27.9	*Assumes double drainage*			
20	0.1518	0.0048	0.55	0.10	59.3	33.2	22.8	*Spacing = 7 ft (triangular)*			
25	0.1897	0.0060	0.63	0.10	66.8	37.4	18.6				
30	0.2277	0.0071	0.70	0.11	72.9	40.9	15.1				
35	0.2656	0.0083	0.75	0.11	77.9	43.6	12.4				
40	0.3036	0.0095	0.80	0.11	81.9	45.8	10.2				
45	0.3415	0.0107	0.83	0.12	85.0	47.6	8.4				
50	0.3795	0.0119	0.86	0.12	87.5	49.0	7.0				
55	0.4174	0.0131	0.88	0.12	89.4	50.1	5.9				
60	0.4554	0.0143	0.90	0.13	90.9	50.9	5.1				
65	0.4933	0.0155	0.91	0.13	92.1	51.6	4.4				
70	0.5313	0.0167	0.92	0.14	93.1	52.1	3.9				
75	0.5692	0.0179	0.93	0.14	94.0	52.6	3.4				
80	0.6072	0.0190	0.94	0.14	94.7	53.0	3.0				
85	0.6451	0.0202	0.95	0.15	95.4	53.4	2.6				
90	0.6830	0.0214	0.95	0.15	96.1	53.8	2.2				
95	0.7210	0.0226	0.96	0.15	96.7	54.2	1.8				
100	0.7589	0.0238	0.97	0.16	97.4	54.5	1.5				
105	0.7969	0.0250	0.98	0.16	98.0	54.9	1.1				
110	0.8348	0.0262	0.98	0.17	98.5	55.2	0.8				
115	0.8728	0.0274	0.99	0.17	98.9	55.4	0.6				
120	0.9107	0.0286	0.99	0.17	99.2	55.5	0.5				
125	0.9487	0.0298	0.99	0.18	99.2	55.5	0.5				

SJR 8-29-07
DAA 9-11-07

DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Rear Abutment **Based upon boring TR-41**
Reference: FHWA-RD-86-168 Station 112+87

Wick Drain Spacing **9.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	*Remaining* δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	56.0	9.45	**0.41**	**41.5**	**56**
5	0.0230	0.0012	0.13	0.09	20.2	11.3	44.7				
10	0.0459	0.0024	0.22	0.09	29.1	16.3	39.7				
15	0.0689	0.0036	0.31	0.09	37.1	20.8	35.2	*Assumes double drainage*			
20	0.0918	0.0048	0.38	0.10	44.4	24.8	31.2	*Spacing = 9 ft (triangular)*			
25	0.1148	0.0060	0.45	0.10	50.8	28.4	27.6				
30	0.1377	0.0071	0.51	0.11	56.5	31.7	24.3				
35	0.1607	0.0083	0.57	0.11	61.6	34.5	21.5				
40	0.1836	0.0095	0.62	0.11	66.2	37.1	18.9				
45	0.2066	0.0107	0.66	0.12	70.2	39.3	16.7				
50	0.2296	0.0119	0.70	0.12	73.7	41.3	14.7				
55	0.2525	0.0131	0.73	0.12	76.8	43.0	13.0				
60	0.2755	0.0143	0.76	0.13	79.5	44.5	11.5				
65	0.2984	0.0155	0.79	0.13	81.8	45.8	10.2				
70	0.3214	0.0167	0.81	0.14	83.8	46.9	9.1				
75	0.3443	0.0179	0.83	0.14	85.6	47.9	8.1				
80	0.3673	0.0190	0.85	0.14	87.1	48.8	7.2				
85	0.3902	0.0202	0.86	0.15	88.4	49.5	6.5				
90	0.4132	0.0214	0.88	0.15	89.5	50.1	5.9				
95	0.4362	0.0226	0.89	0.15	90.5	50.7	5.3				
100	0.4591	0.0238	0.90	0.16	91.3	51.2	4.8				
105	0.4821	0.0250	0.91	0.16	92.1	51.6	4.4				
110	0.5050	0.0262	0.91	0.17	92.7	51.9	4.1				
115	0.5280	0.0274	0.92	0.17	93.3	52.3	3.7				
120	0.5509	0.0286	0.93	0.17	93.8	52.5	3.5				
125	0.5739	0.0298	0.93	0.18	94.3	52.8	3.2				
130	0.5968	0.0309	0.94	0.18	94.8	53.1	2.9				
135	0.6198	0.0321	0.94	0.18	95.2	53.3	2.7				
140	0.6428	0.0333	0.95	0.19	95.6	53.5	2.5				
145	0.6657	0.0345	0.95	0.19	96.0	53.7	2.3				
150	0.6887	0.0357	0.95	0.19	96.4	54.0	2.0				
155	0.7116	0.0369	0.96	0.20	96.8	54.2	1.8				
160	0.7346	0.0381	0.96	0.20	97.1	54.4	1.6				
165	0.7575	0.0393	0.97	0.20	97.5	54.6	1.4				
170	0.7805	0.0405	0.97	0.21	97.8	54.8	1.2				
175	0.8034	0.0417	0.98	0.21	98.2	55.0	1.0				
180	0.8264	0.0429	0.98	0.21	98.5	55.2	0.8				
185	0.8494	0.0440	0.98	0.22	98.8	55.3	0.7				
190	0.8723	0.0452	0.99	0.22	99.0	55.4	0.6				
195	0.8953	0.0464	0.99	0.22	99.2	55.5	0.5				
200	0.9182	0.0476	0.99	0.23	99.3	55.6	0.4				

DLZ

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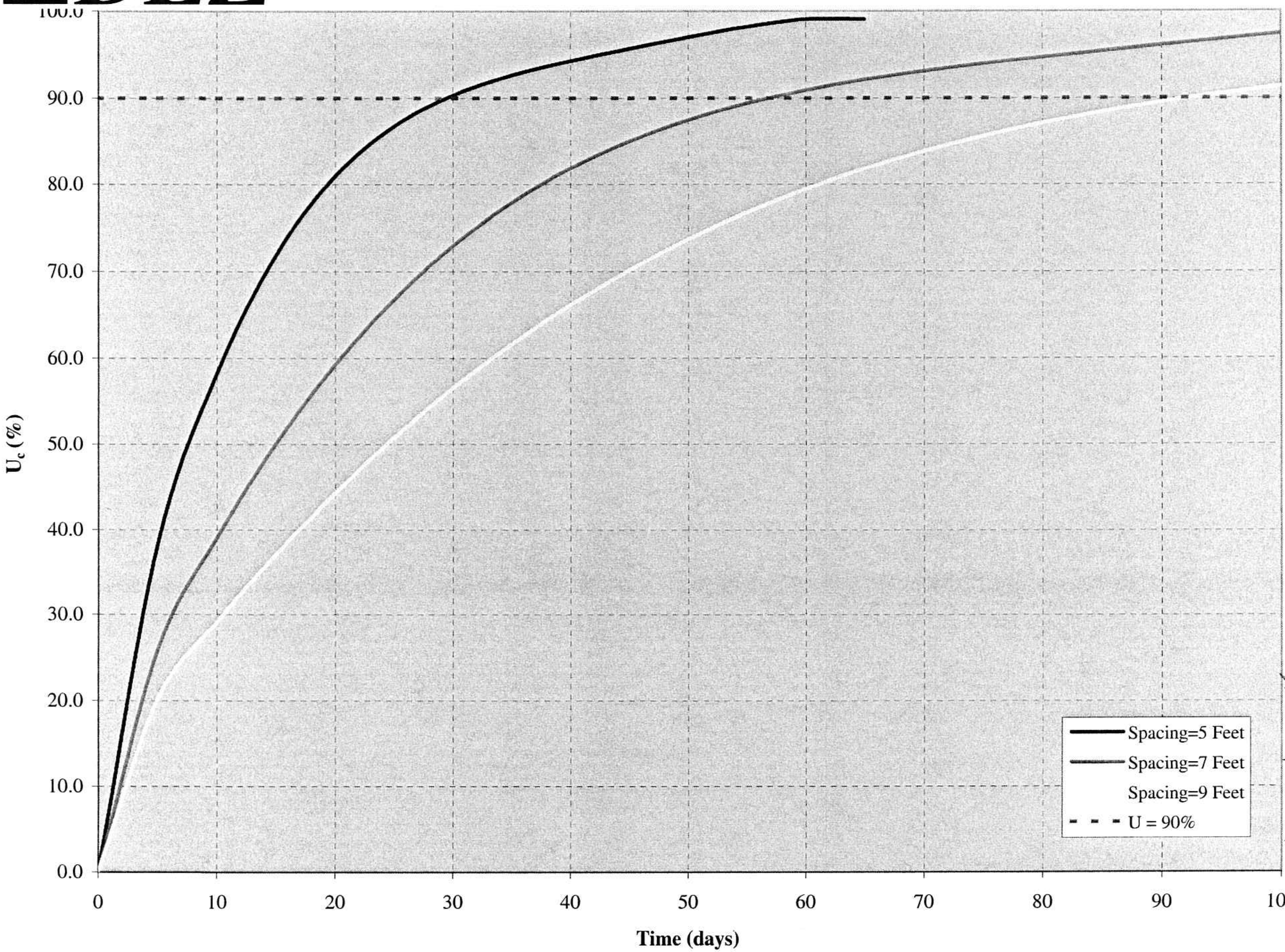
DAA 9-11-07

Estimated Percent Consolidation (combined radial and vertical) vs Time
SR 823 over CSXT Railroad - Rear Abutment (Station 112+87)



DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Forward Abutment **Based upon boring B-38**
Reference: FHWA-RD-86-168 Station 117+62

SJK 8-29-07
DAA 9-11-07

Wick Drain Spacing **5.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	*Remaining* δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	36.0	5.25	**0.38**	**36**	**36**
5	0.0689	0.0015	0.31	0.09	36.7	13.2	22.8				
10	0.1379	0.0029	0.51	0.09	55.9	20.1	15.9				
15	0.2068	0.0044	0.66	0.10	69.5	25.0	11.0				
20	0.2757	0.0059	0.76	0.10	78.8	28.4	7.6				
25	0.3447	0.0073	0.83	0.11	85.0	30.6	5.4				
30	0.4136	0.0088	0.88	0.11	89.1	32.1	3.9				
35	0.4825	0.0103	0.91	0.12	91.7	33.0	3.0				
40	0.5515	0.0117	0.93	0.12	93.4	33.6	2.4				
45	0.6204	0.0132	0.94	0.12	94.8	34.1	1.9				
50	0.6893	0.0147	0.96	0.13	96.1	34.6	1.4				
55	0.7583	0.0161	0.97	0.13	97.3	35.0	1.0				
60	0.8272	0.0176	0.98	0.14	98.4	35.4	0.6				
65	0.8961	0.0191	0.99	0.14	99.1	35.7	0.3				

Assumes double drainage
Spacing = 5 ft (triangular)

DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Forward Abutment **Based upon boring B-38**
Reference: FHWA-RD-86-168 Station 117+62

SJR 8-29-07
DAA 9-11-07

Wick Drain Spacing **7.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	Remaining δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	36.0	7.35	**0.38**	**36**	**36**
5	0.0352	0.0015	0.18	0.09	25.0	9.0	27.0				
10	0.0703	0.0029	0.31	0.09	37.5	13.5	22.5				
15	0.1055	0.0044	0.43	0.10	48.1	17.3	18.7				
20	0.1407	0.0059	0.52	0.10	57.0	20.5	15.5				
25	0.1759	0.0073	0.60	0.11	64.5	23.2	12.8				
30	0.2110	0.0088	0.67	0.11	70.6	25.4	10.6				
35	0.2462	0.0103	0.73	0.12	75.7	27.3	8.7				
40	0.2814	0.0117	0.77	0.12	79.9	28.8	7.2				
45	0.3165	0.0132	0.81	0.12	83.2	30.0	6.0				
50	0.3517	0.0147	0.84	0.13	85.9	30.9	5.1				
55	0.3869	0.0161	0.86	0.13	88.1	31.7	4.3				
60	0.4220	0.0176	0.88	0.14	89.8	32.3	3.7				
65	0.4572	0.0191	0.90	0.14	91.1	32.8	3.2				
70	0.4924	0.0205	0.91	0.15	92.2	33.2	2.8				
75	0.5276	0.0220	0.92	0.15	93.2	33.5	2.5				
80	0.5627	0.0235	0.93	0.16	94.0	33.8	2.2				
85	0.5979	0.0249	0.94	0.16	94.7	34.1	1.9				
90	0.6331	0.0264	0.94	0.17	95.3	34.3	1.7				
95	0.6682	0.0279	0.95	0.17	95.9	34.5	1.5				
100	0.7034	0.0293	0.96	0.18	96.5	34.8	1.2				
105	0.7386	0.0308	0.96	0.18	97.1	35.0	1.0				
110	0.7738	0.0323	0.97	0.18	97.7	35.2	0.8				
115	0.8089	0.0337	0.98	0.19	98.2	35.4	0.6				
120	0.8441	0.0352	0.98	0.19	98.7	35.5	0.5				
125	0.8793	0.0367	0.99	0.20	99.0	35.6	0.4				

Assumes double drainage
Spacing = 7 ft (triangular)

SJR 8-29-07
DAA 9-11-07

DLZ

Time Rate of Consolidation of Foundation Soils with Wick Drians
SR 823 over CSXT Forward Abutment **Based upon boring B-38**
Reference: FHWA-RD-86-168 Station 117+62

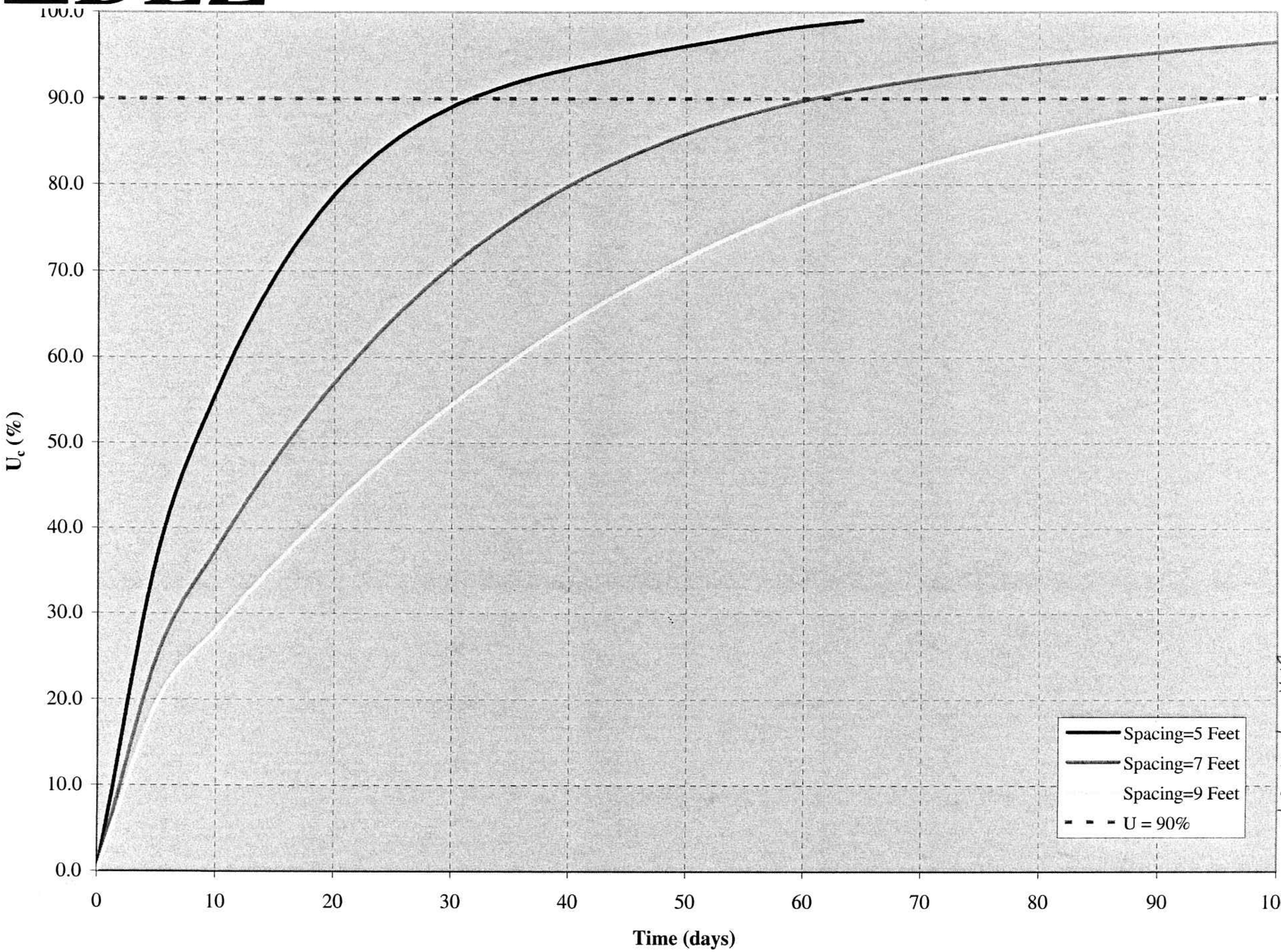
Wick Drain Spacing **9.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	Remaining δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	36.0	9.45	**0.38**	**36**	**36**
5	0.0213	0.0015	0.12	0.09	19.6	7.1	28.9				
10	0.0426	0.0029	0.21	0.09	28.1	10.1	25.9				
15	0.0638	0.0044	0.29	0.10	35.7	12.9	23.1				
20	0.0851	0.0059	0.36	0.10	42.6	15.3	20.7				
25	0.1064	0.0073	0.43	0.11	48.9	17.6	18.4				
30	0.1277	0.0088	0.49	0.11	54.5	19.6	16.4				
35	0.1489	0.0103	0.54	0.12	59.5	21.4	14.6				
40	0.1702	0.0117	0.59	0.12	64.0	23.0	13.0				
45	0.1915	0.0132	0.63	0.12	68.0	24.5	11.5				
50	0.2128	0.0147	0.67	0.13	71.5	25.8	10.2				
55	0.2340	0.0161	0.71	0.13	74.7	26.9	9.1				
60	0.2553	0.0176	0.74	0.14	77.5	27.9	8.1				
65	0.2766	0.0191	0.77	0.14	79.9	28.8	7.2				
70	0.2979	0.0205	0.79	0.15	82.1	29.5	6.5				
75	0.3191	0.0220	0.81	0.15	84.0	30.2	5.8				
80	0.3404	0.0235	0.83	0.16	85.6	30.8	5.2				
85	0.3617	0.0249	0.85	0.16	87.0	31.3	4.7				
90	0.3830	0.0264	0.86	0.17	88.3	31.8	4.2				
95	0.4042	0.0279	0.87	0.17	89.4	32.2	3.8				
100	0.4255	0.0293	0.88	0.18	90.3	32.5	3.5				
105	0.4468	0.0308	0.89	0.18	91.2	32.8	3.2				
110	0.4681	0.0323	0.90	0.18	91.9	33.1	2.9				
115	0.4893	0.0337	0.91	0.19	92.5	33.3	2.7				
120	0.5106	0.0352	0.91	0.19	93.1	33.5	2.5				
125	0.5319	0.0367	0.92	0.20	93.6	33.7	2.3				
130	0.5532	0.0381	0.93	0.20	94.1	33.9	2.1				
135	0.5745	0.0396	0.93	0.21	94.5	34.0	2.0				
140	0.5957	0.0410	0.94	0.21	94.9	34.2	1.8				
145	0.6170	0.0425	0.94	0.21	95.3	34.3	1.7				
150	0.6383	0.0440	0.94	0.22	95.7	34.4	1.6				
155	0.6596	0.0454	0.95	0.22	96.0	34.6	1.4				
160	0.6808	0.0469	0.95	0.23	96.4	34.7	1.3				
165	0.7021	0.0484	0.96	0.23	96.7	34.8	1.2				
170	0.7234	0.0498	0.96	0.23	97.1	34.9	1.1				
175	0.7447	0.0513	0.97	0.24	97.4	35.1	0.9				
180	0.7659	0.0528	0.97	0.24	97.7	35.2	0.8				
185	0.7872	0.0542	0.97	0.25	98.0	35.3	0.7				
190	0.8085	0.0557	0.98	0.25	98.3	35.4	0.6				
195	0.8298	0.0572	0.98	0.25	98.6	35.5	0.5				
200	0.8510	0.0586	0.98	0.26	98.8	35.6	0.4				

Assumes double drainage
Spacing = 9 ft (triangular)

DLZ

Estimated Percent Consolidation (combined radial and vertical) vs Time
SR 823 over CSXT Railroad - Forward Abutment (Station 117+62)



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DRIVEN 1.0

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\CSXRA.DVN
Project Name: SCI-823 Portsmouth Bypass
Project Date: 08/29/2007
Project Client: TranSystems Corp
Computed By: SJR
Project Manager: Nix

PILE INFORMATION

Pier 1

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	5.00 ft	0.00%	120.00 pcf	30.0/30.0	Nordlund
2	Cohesive	23.50 ft	0.00%	120.00 pcf	1700.00 psf	T-79 Steel
3	Cohesive	48.00 ft	0.00%	120.00 pcf	1100.00 psf	T-79 Steel
4	Cohesive	15.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund

1) Assume bottom of pile cap at elevation 577.90 (Top of Soil Profile)
2) Neglect first 5' of pile resistance.
3) Soil profile based upon boring TR-41

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1124.82 psf	42.45 Kips
23.01 ft	Cohesive	N/A	N/A	1188.95 psf	89.69 Kips
28.49 ft	Cohesive	N/A	N/A	1227.99 psf	120.83 Kips
28.51 ft	Cohesive	N/A	N/A	915.36 psf	120.92 Kips
37.51 ft	Cohesive	N/A	N/A	952.94 psf	156.85 Kips
46.51 ft	Cohesive	N/A	N/A	990.51 psf	195.61 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	236.17 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	274.59 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	313.01 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	325.73 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	325.82 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	374.64 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	407.08 Kips
91.51 ft	Cohesionless	6518.69 psf	23.44	N/A	407.27 Kips
100.51 ft	Cohesionless	6777.89 psf	23.44	N/A	537.68 Kips
101.49 ft	Cohesionless	6806.11 psf	23.44	N/A	552.49 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	14.58 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	46.08 Kips	46.08 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	46.08 Kips	46.08 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	46.08 Kips	46.08 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	14.58 Kips	14.58 Kips
5.01 ft	0.05 Kips	21.36 Kips	21.41 Kips
14.01 ft	42.45 Kips	21.36 Kips	63.81 Kips
23.01 ft	89.69 Kips	21.36 Kips	111.06 Kips
28.49 ft	120.83 Kips	21.36 Kips	142.19 Kips
28.51 ft	120.92 Kips	13.82 Kips	134.75 Kips
37.51 ft	156.85 Kips	13.82 Kips	170.67 Kips
46.51 ft	195.61 Kips	13.82 Kips	209.43 Kips
55.51 ft	236.17 Kips	13.82 Kips	250.00 Kips
64.51 ft	274.59 Kips	13.82 Kips	288.41 Kips
73.51 ft	313.01 Kips	13.82 Kips	326.83 Kips
76.49 ft	325.73 Kips	13.82 Kips	339.55 Kips
76.51 ft	325.82 Kips	18.85 Kips	344.67 Kips
85.51 ft	374.64 Kips	18.85 Kips	393.49 Kips
91.49 ft	407.08 Kips	18.85 Kips	425.93 Kips
91.51 ft	407.27 Kips	46.08 Kips	453.35 Kips
100.51 ft	537.68 Kips	46.08 Kips	583.76 Kips
101.49 ft	552.49 Kips	46.08 Kips	598.56 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1124.82 psf	42.45 Kips
23.01 ft	Cohesive	N/A	N/A	1188.95 psf	89.69 Kips
28.49 ft	Cohesive	N/A	N/A	1227.99 psf	120.83 Kips
28.51 ft	Cohesive	N/A	N/A	915.36 psf	120.92 Kips
37.51 ft	Cohesive	N/A	N/A	952.94 psf	156.85 Kips
46.51 ft	Cohesive	N/A	N/A	990.51 psf	195.61 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	236.17 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	274.59 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	313.01 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	325.73 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	325.82 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	374.64 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	407.08 Kips
91.51 ft	Cohesionless	6518.69 psf	23.44	N/A	407.27 Kips
100.51 ft	Cohesionless	6777.89 psf	23.44	N/A	537.68 Kips
101.49 ft	Cohesionless	6806.11 psf	23.44	N/A	552.49 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	14.58 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	46.08 Kips	46.08 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	46.08 Kips	46.08 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	46.08 Kips	46.08 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	14.58 Kips	14.58 Kips
5.01 ft	0.05 Kips	21.36 Kips	21.41 Kips
14.01 ft	42.45 Kips	21.36 Kips	63.81 Kips
23.01 ft	89.69 Kips	21.36 Kips	111.06 Kips
28.49 ft	120.83 Kips	21.36 Kips	142.19 Kips
28.51 ft	120.92 Kips	13.82 Kips	134.75 Kips
37.51 ft	156.85 Kips	13.82 Kips	170.67 Kips
46.51 ft	195.61 Kips	13.82 Kips	209.43 Kips
55.51 ft	236.17 Kips	13.82 Kips	250.00 Kips
64.51 ft	274.59 Kips	13.82 Kips	288.41 Kips
73.51 ft	313.01 Kips	13.82 Kips	326.83 Kips
76.49 ft	325.73 Kips	13.82 Kips	339.55 Kips
76.51 ft	325.82 Kips	18.85 Kips	344.67 Kips
85.51 ft	374.64 Kips	18.85 Kips	393.49 Kips
91.49 ft	407.08 Kips	18.85 Kips	425.93 Kips
91.51 ft	407.27 Kips	46.08 Kips	453.35 Kips
100.51 ft	537.68 Kips	46.08 Kips	583.76 Kips
101.49 ft	552.49 Kips	46.08 Kips	598.56 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1124.82 psf	42.45 Kips
23.01 ft	Cohesive	N/A	N/A	1188.95 psf	89.69 Kips
28.49 ft	Cohesive	N/A	N/A	1227.99 psf	120.83 Kips
28.51 ft	Cohesive	N/A	N/A	915.36 psf	120.92 Kips
37.51 ft	Cohesive	N/A	N/A	952.94 psf	156.85 Kips
46.51 ft	Cohesive	N/A	N/A	990.51 psf	195.61 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	236.17 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	274.59 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	313.01 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	325.73 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	325.82 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	374.64 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	407.08 Kips
91.51 ft	Cohesionless	6518.69 psf	23.44	N/A	407.27 Kips
100.51 ft	Cohesionless	6777.89 psf	23.44	N/A	537.68 Kips
101.49 ft	Cohesionless	6806.11 psf	23.44	N/A	552.49 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	18.60 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	14.58 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	18.85 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	46.08 Kips	46.08 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	46.08 Kips	46.08 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	46.08 Kips	46.08 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	14.58 Kips	14.58 Kips
5.01 ft	0.05 Kips	21.36 Kips	21.41 Kips
14.01 ft	42.45 Kips	21.36 Kips	63.81 Kips
23.01 ft	89.69 Kips	21.36 Kips	111.06 Kips
28.49 ft	120.83 Kips	21.36 Kips	142.19 Kips
28.51 ft	120.92 Kips	13.82 Kips	134.75 Kips
37.51 ft	156.85 Kips	13.82 Kips	170.67 Kips
46.51 ft	195.61 Kips	13.82 Kips	209.43 Kips
55.51 ft	236.17 Kips	13.82 Kips	250.00 Kips
64.51 ft	274.59 Kips	13.82 Kips	288.41 Kips
73.51 ft	313.01 Kips	13.82 Kips	326.83 Kips
76.49 ft	325.73 Kips	13.82 Kips	339.55 Kips
76.51 ft	325.82 Kips	18.85 Kips	344.67 Kips
85.51 ft	374.64 Kips	18.85 Kips	393.49 Kips
91.49 ft	407.08 Kips	18.85 Kips	425.93 Kips
91.51 ft	407.27 Kips	46.08 Kips	453.35 Kips
100.51 ft	537.68 Kips	46.08 Kips	583.76 Kips
101.49 ft	552.49 Kips	46.08 Kips	598.56 Kips

16" Dia. CIP Piles

$q_{all} = 90$ ton FS = 2.0

$q_{ult} = 180 \text{ ton} = 360\text{k}$

$$\Delta_q = \frac{393.5\text{k} - 344.7\text{k}}{85.5' - 76.5} = 5.42 \text{ k/ft.}$$

$$\Delta_D = \frac{393.5\text{k} - 360\text{k}}{5.42 \text{ k/f}} = 6.2'$$

$D = 85.5' - 6.2' = 79.3'$ Say D = 80', el. 497.9'

$$\text{Allowable uplift} = \frac{360^k - 18.9^k}{3.0} = 114^k$$

DRIVEN 1.0

SJR 8-29-07
DAA 9-11-07

GENERAL PROJECT INFORMATION

Filename: C:\DRIVEN\CSXRA.DVN
Project Name: SCI-823 Portsmouth Bypass
Project Date: 08/29/2007
Project Client: TranSystems Corp
Computed By: SJR
Project Manager: Nix

PILE INFORMATION

Pier 1

Pile Type: H Pile - HP14X73
Top of Pile: 5.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	20.00 ft
	- Driving/Restrike	20.00 ft
	- Ultimate:	20.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	5.00 ft	0.00%	120.00 pcf	30.0/30.0	Nordlund
2	Cohesive	23.50 ft	0.00%	120.00 pcf	1700.00 psf	T-79 Steel
3	Cohesive	48.00 ft	0.00%	120.00 pcf	1100.00 psf	T-79 Steel
4	Cohesive	15.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund

1) Assume bottom of pile cap at el. 577.90
2) Neglect first 5' of pile resistance
3) Soil profile based upon boring TR-41

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1134.51 psf	48.03 Kips
23.01 ft	Cohesive	N/A	N/A	1204.85 psf	101.97 Kips
28.49 ft	Cohesive	N/A	N/A	1247.68 psf	137.72 Kips
28.51 ft	Cohesive	N/A	N/A	926.91 psf	137.83 Kips
37.51 ft	Cohesive	N/A	N/A	968.13 psf	178.78 Kips
46.51 ft	Cohesive	N/A	N/A	1009.35 psf	223.21 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	267.13 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	310.22 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	353.32 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	367.59 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	367.70 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	422.47 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	458.86 Kips
91.51 ft	Cohesionless	6518.69 psf	25.15	N/A	459.04 Kips
100.51 ft	Cohesionless	6777.89 psf	25.15	N/A	575.92 Kips
101.49 ft	Cohesionless	6806.11 psf	25.15	N/A	589.18 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	1.55 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	4.90 Kips	4.90 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	4.90 Kips	4.90 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	4.90 Kips	4.90 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	1.55 Kips	1.55 Kips
5.01 ft	0.05 Kips	2.27 Kips	2.33 Kips
14.01 ft	48.03 Kips	2.27 Kips	50.31 Kips
23.01 ft	101.97 Kips	2.27 Kips	104.24 Kips
28.49 ft	137.72 Kips	2.27 Kips	140.00 Kips
28.51 ft	137.83 Kips	1.47 Kips	139.31 Kips
37.51 ft	178.78 Kips	1.47 Kips	180.25 Kips
46.51 ft	223.21 Kips	1.47 Kips	224.69 Kips
55.51 ft	267.13 Kips	1.47 Kips	268.60 Kips
64.51 ft	310.22 Kips	1.47 Kips	311.69 Kips
73.51 ft	353.32 Kips	1.47 Kips	354.79 Kips
76.49 ft	367.59 Kips	1.47 Kips	369.06 Kips
76.51 ft	367.70 Kips	2.01 Kips	369.70 Kips
85.51 ft	422.47 Kips	2.01 Kips	424.47 Kips
91.49 ft	458.86 Kips	2.01 Kips	460.86 Kips
91.51 ft	459.04 Kips	4.90 Kips	463.95 Kips
100.51 ft	575.92 Kips	4.90 Kips	580.82 Kips
101.49 ft	589.18 Kips	4.90 Kips	594.09 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1134.51 psf	48.03 Kips
23.01 ft	Cohesive	N/A	N/A	1204.85 psf	101.97 Kips
28.49 ft	Cohesive	N/A	N/A	1247.68 psf	137.72 Kips
28.51 ft	Cohesive	N/A	N/A	926.91 psf	137.83 Kips
37.51 ft	Cohesive	N/A	N/A	968.13 psf	178.78 Kips
46.51 ft	Cohesive	N/A	N/A	1009.35 psf	223.21 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	267.13 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	310.22 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	353.32 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	367.59 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	367.70 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	422.47 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	458.86 Kips
91.51 ft	Cohesionless	6518.69 psf	25.15	N/A	459.04 Kips
100.51 ft	Cohesionless	6777.89 psf	25.15	N/A	575.92 Kips
101.49 ft	Cohesionless	6806.11 psf	25.15	N/A	589.18 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	1.55 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	4.90 Kips	4.90 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	4.90 Kips	4.90 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	4.90 Kips	4.90 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	1.55 Kips	1.55 Kips
5.01 ft	0.05 Kips	2.27 Kips	2.33 Kips
14.01 ft	48.03 Kips	2.27 Kips	50.31 Kips
23.01 ft	101.97 Kips	2.27 Kips	104.24 Kips
28.49 ft	137.72 Kips	2.27 Kips	140.00 Kips
28.51 ft	137.83 Kips	1.47 Kips	139.31 Kips
37.51 ft	178.78 Kips	1.47 Kips	180.25 Kips
46.51 ft	223.21 Kips	1.47 Kips	224.69 Kips
55.51 ft	267.13 Kips	1.47 Kips	268.60 Kips
64.51 ft	310.22 Kips	1.47 Kips	311.69 Kips
73.51 ft	353.32 Kips	1.47 Kips	354.79 Kips
76.49 ft	367.59 Kips	1.47 Kips	369.06 Kips
76.51 ft	367.70 Kips	2.01 Kips	369.70 Kips
85.51 ft	422.47 Kips	2.01 Kips	424.47 Kips
91.49 ft	458.86 Kips	2.01 Kips	460.86 Kips
91.51 ft	459.04 Kips	4.90 Kips	463.95 Kips
100.51 ft	575.92 Kips	4.90 Kips	580.82 Kips
101.49 ft	589.18 Kips	4.90 Kips	594.09 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.01 ft	Cohesive	N/A	N/A	1120.00 psf	0.05 Kips
14.01 ft	Cohesive	N/A	N/A	1134.51 psf	48.03 Kips
23.01 ft	Cohesive	N/A	N/A	1204.85 psf	101.97 Kips
28.49 ft	Cohesive	N/A	N/A	1247.68 psf	137.72 Kips
28.51 ft	Cohesive	N/A	N/A	926.91 psf	137.83 Kips
37.51 ft	Cohesive	N/A	N/A	968.13 psf	178.78 Kips
46.51 ft	Cohesive	N/A	N/A	1009.35 psf	223.21 Kips
55.51 ft	Cohesive	N/A	N/A	1019.00 psf	267.13 Kips
64.51 ft	Cohesive	N/A	N/A	1019.00 psf	310.22 Kips
73.51 ft	Cohesive	N/A	N/A	1019.00 psf	353.32 Kips
76.49 ft	Cohesive	N/A	N/A	1019.00 psf	367.59 Kips
76.51 ft	Cohesive	N/A	N/A	1295.00 psf	367.70 Kips
85.51 ft	Cohesive	N/A	N/A	1295.00 psf	422.47 Kips
91.49 ft	Cohesive	N/A	N/A	1295.00 psf	458.86 Kips
91.51 ft	Cohesionless	6518.69 psf	25.15	N/A	459.04 Kips
100.51 ft	Cohesionless	6777.89 psf	25.15	N/A	575.92 Kips
101.49 ft	Cohesionless	6806.11 psf	25.15	N/A	589.18 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	30.00	1.98 Kips	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	1.55 Kips
5.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
14.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
64.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
73.51 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.49 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
76.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
85.51 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.49 ft	Cohesive	N/A	N/A	N/A	2.01 Kips
91.51 ft	Cohesionless	6518.98 psf	40.40	4.90 Kips	4.90 Kips
100.51 ft	Cohesionless	7037.38 psf	40.40	4.90 Kips	4.90 Kips
101.49 ft	Cohesionless	7093.82 psf	40.40	4.90 Kips	4.90 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	1.55 Kips	1.55 Kips
5.01 ft	0.05 Kips	2.27 Kips	2.33 Kips
14.01 ft	48.03 Kips	2.27 Kips	50.31 Kips
23.01 ft	101.97 Kips	2.27 Kips	104.24 Kips
28.49 ft	137.72 Kips	2.27 Kips	140.00 Kips
28.51 ft	137.83 Kips	1.47 Kips	139.31 Kips
37.51 ft	178.78 Kips	1.47 Kips	180.25 Kips
46.51 ft	223.21 Kips	1.47 Kips	224.69 Kips
55.51 ft	267.13 Kips	1.47 Kips	268.60 Kips
64.51 ft	310.22 Kips	1.47 Kips	311.69 Kips
73.51 ft	353.32 Kips	1.47 Kips	354.79 Kips
76.49 ft	367.59 Kips	1.47 Kips	369.06 Kips
76.51 ft	367.70 Kips	2.01 Kips	369.70 Kips
85.51 ft	422.47 Kips	2.01 Kips	424.47 Kips
91.49 ft	458.86 Kips	2.01 Kips	460.86 Kips
91.51 ft	459.04 Kips	4.90 Kips	463.95 Kips
100.51 ft	575.92 Kips	4.90 Kips	580.82 Kips
101.49 ft	589.18 Kips	4.90 Kips	594.09 Kips

HP 14x73

$q_{all} = 95$ ton F.S. = 2.0

$q_{ult} = 190$ ton $= 380$ K

$$\Delta q = \frac{424.5^k - 369.7^k}{85.5' - 76.5'} = 6.09 \text{ k/ft}$$

$$\Delta_D = \frac{424.5^k - 380^k}{6.09 \text{ k/ft}} = 7.3 \text{ ft.}$$

$D = 85.5' - 7.3' = 78.2'$ Say $D = 79'$, el. 498.9

$$\text{Allowable uplift} = \frac{380^k - 2.0^k}{3.0} = 126^k$$

DRIVEN 1.0

GENERAL PROJECT INFORMATION

SJR 8-29-07
DAA 9-11-07

Filename: C:\DRIVEN\CSXFA.DVN
Project Name: SCI-823 Portsmouth Bypass — Project Date: 08/29/2007
Project Client: TranSystems Corp
Computed By: SJR
Project Manager: Nix

PILE INFORMATION

Pier 2

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	23.30 ft	0.00%	120.00 pcf	1700.00 psf	T-79 Steel
2	Cohesive	32.50 ft	0.00%	120.00 pcf	1100.00 psf	T-79 Steel
3	Cohesive	18.00 ft	0.00%	120.00 pcf	2700.00 psf	T-79 Steel
4	Cohesionless	17.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund

1) Assume bottom of pile cap at el. 563.8' (Top of Soil profile)
2) Neglect first 5' of pile resistance.
3) Soil profile based upon boring TR-40.

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	18.81 Kips
18.01 ft	Cohesive	N/A	N/A	1120.00 psf	61.04 Kips
23.29 ft	Cohesive	N/A	N/A	1155.32 psf	88.51 Kips
23.31 ft	Cohesive	N/A	N/A	893.65 psf	88.60 Kips
32.31 ft	Cohesive	N/A	N/A	931.23 psf	123.71 Kips
41.31 ft	Cohesive	N/A	N/A	968.80 psf	161.65 Kips
50.31 ft	Cohesive	N/A	N/A	1006.38 psf	202.43 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	227.25 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	227.35 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	282.39 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	337.31 Kips
73.81 ft	Cohesionless	6123.14 psf	21.97	N/A	337.47 Kips
82.81 ft	Cohesionless	6359.84 psf	21.97	N/A	433.77 Kips
90.79 ft	Cohesionless	6569.72 psf	21.97	N/A	525.16 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	18.60 Kips	18.60 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	18.60 Kips	18.60 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	18.60 Kips	18.60 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	21.36 Kips	21.36 Kips
9.01 ft	18.81 Kips	21.36 Kips	40.18 Kips
18.01 ft	61.04 Kips	21.36 Kips	82.40 Kips
23.29 ft	88.51 Kips	21.36 Kips	109.87 Kips
23.31 ft	88.60 Kips	13.82 Kips	102.43 Kips
32.31 ft	123.71 Kips	13.82 Kips	137.53 Kips
41.31 ft	161.65 Kips	13.82 Kips	175.48 Kips
50.31 ft	202.43 Kips	13.82 Kips	216.25 Kips
55.79 ft	227.25 Kips	13.82 Kips	241.07 Kips
55.81 ft	227.35 Kips	33.93 Kips	261.28 Kips
64.81 ft	282.39 Kips	33.93 Kips	316.32 Kips
73.79 ft	337.31 Kips	33.93 Kips	371.24 Kips
73.81 ft	337.47 Kips	18.60 Kips	356.07 Kips
82.81 ft	433.77 Kips	18.60 Kips	452.37 Kips
90.79 ft	525.16 Kips	18.60 Kips	543.76 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	18.81 Kips
18.01 ft	Cohesive	N/A	N/A	1120.00 psf	61.04 Kips
23.29 ft	Cohesive	N/A	N/A	1155.32 psf	88.51 Kips
23.31 ft	Cohesive	N/A	N/A	893.65 psf	88.60 Kips
32.31 ft	Cohesive	N/A	N/A	931.23 psf	123.71 Kips
41.31 ft	Cohesive	N/A	N/A	968.80 psf	161.65 Kips
50.31 ft	Cohesive	N/A	N/A	1006.38 psf	202.43 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	227.25 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	227.35 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	282.39 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	337.31 Kips
73.81 ft	Cohesionless	6123.14 psf	21.97	N/A	337.47 Kips
82.81 ft	Cohesionless	6359.84 psf	21.97	N/A	433.77 Kips
90.79 ft	Cohesionless	6569.72 psf	21.97	N/A	525.16 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	18.60 Kips	18.60 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	18.60 Kips	18.60 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	18.60 Kips	18.60 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	21.36 Kips	21.36 Kips
9.01 ft	18.81 Kips	21.36 Kips	40.18 Kips
18.01 ft	61.04 Kips	21.36 Kips	82.40 Kips
23.29 ft	88.51 Kips	21.36 Kips	109.87 Kips
23.31 ft	88.60 Kips	13.82 Kips	102.43 Kips
32.31 ft	123.71 Kips	13.82 Kips	137.53 Kips
41.31 ft	161.65 Kips	13.82 Kips	175.48 Kips
50.31 ft	202.43 Kips	13.82 Kips	216.25 Kips
55.79 ft	227.25 Kips	13.82 Kips	241.07 Kips
55.81 ft	227.35 Kips	33.93 Kips	261.28 Kips
64.81 ft	282.39 Kips	33.93 Kips	316.32 Kips
73.79 ft	337.31 Kips	33.93 Kips	371.24 Kips
73.81 ft	337.47 Kips	18.60 Kips	356.07 Kips
82.81 ft	433.77 Kips	18.60 Kips	452.37 Kips
90.79 ft	525.16 Kips	18.60 Kips	543.76 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	18.81 Kips
18.01 ft	Cohesive	N/A	N/A	1120.00 psf	61.04 Kips
23.29 ft	Cohesive	N/A	N/A	1155.32 psf	88.51 Kips
23.31 ft	Cohesive	N/A	N/A	893.65 psf	88.60 Kips
32.31 ft	Cohesive	N/A	N/A	931.23 psf	123.71 Kips
41.31 ft	Cohesive	N/A	N/A	968.80 psf	161.65 Kips
50.31 ft	Cohesive	N/A	N/A	1006.38 psf	202.43 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	227.25 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	227.35 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	282.39 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	337.31 Kips
73.81 ft	Cohesionless	6123.14 psf	21.97	N/A	337.47 Kips
82.81 ft	Cohesionless	6359.84 psf	21.97	N/A	433.77 Kips
90.79 ft	Cohesionless	6569.72 psf	21.97	N/A	525.16 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	21.36 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	13.82 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	18.60 Kips	18.60 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	18.60 Kips	18.60 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	18.60 Kips	18.60 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	21.36 Kips	21.36 Kips
9.01 ft	18.81 Kips	21.36 Kips	40.18 Kips
18.01 ft	61.04 Kips	21.36 Kips	82.40 Kips
23.29 ft	88.51 Kips	21.36 Kips	109.87 Kips
23.31 ft	88.60 Kips	13.82 Kips	102.43 Kips
32.31 ft	123.71 Kips	13.82 Kips	137.53 Kips
41.31 ft	161.65 Kips	13.82 Kips	175.48 Kips
50.31 ft	202.43 Kips	13.82 Kips	216.25 Kips
55.79 ft	227.25 Kips	13.82 Kips	241.07 Kips
55.81 ft	227.35 Kips	33.93 Kips	261.28 Kips
64.81 ft	282.39 Kips	33.93 Kips	316.32 Kips
73.79 ft	337.31 Kips	33.93 Kips	371.24 Kips
73.81 ft	337.47 Kips	18.60 Kips	356.07 Kips
82.81 ft	433.77 Kips	18.60 Kips	452.37 Kips
90.79 ft	525.16 Kips	18.60 Kips	543.76 Kips

16" dia. CIP Piles

$q_{all} = 90$ ton $\quad FS = 2.0$

$q_{ULT} = 180 \text{ ton} = 360^{k}$

$$\Delta q = \frac{371.2^{k} - 316.3^{k}}{73.8' - 64.8'} = 6.1 \ {}^{k}/\text{ft.}$$

$$\Delta_D = \frac{371.2^{k} - 360^{k}}{6.1^{k/ft}} = 1.8 \text{ ft.}$$

$$D = 73.8' - 1.8' = 72' \quad \text{el. } 491.8'$$

$$\text{Allowable uplift} = \frac{360^{k} - 34.0^{k}}{3.0} = 109^{k}$$

DRIVEN 1.0

GENERAL PROJECT INFORMATION

SJR 8-29-07
DAA 9-11-07

Filename: C:\DRIVEN\CSXFA.DVN
Project Name: SCI-823 Portsmouth Bypass — Project Date: 08/29/2007
Project Client: TranSystems Corp
Computed By: SJR
Project Manager: Nix

PILE INFORMATION

Pier 2

Pile Type: H Pile - HP14X73
Top of Pile: 5.00 ft
Perimeter Analysis: Box
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	23.30 ft	0.00%	120.00 pcf	1700.00 psf	T-79 Steel
2	Cohesive	32.50 ft	0.00%	120.00 pcf	1100.00 psf	T-79 Steel
3	Cohesive	18.00 ft	0.00%	120.00 pcf	2700.00 psf	T-79 Steel
4	Cohesionless	17.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund

1) Assume bottom of pile cap at el. 563.8' (Top of soil Profile)
2.) Neglect first 5' of pile resistance.
3.) Soil profile based upon boring TR-40

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	21.10 Kips
18.01 ft	Cohesive	N/A	N/A	1126.69 psf	68.88 Kips
23.29 ft	Cohesive	N/A	N/A	1167.96 psf	100.38 Kips
23.31 ft	Cohesive	N/A	N/A	903.09 psf	100.49 Kips
32.31 ft	Cohesive	N/A	N/A	944.31 psf	140.43 Kips
41.31 ft	Cohesive	N/A	N/A	985.54 psf	183.85 Kips
50.31 ft	Cohesive	N/A	N/A	1019.00 psf	229.78 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	256.02 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	256.14 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	317.89 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	379.50 Kips
73.81 ft	Cohesionless	6123.14 psf	23.58	N/A	379.66 Kips
82.81 ft	Cohesionless	6359.84 psf	23.58	N/A	470.02 Kips
90.79 ft	Cohesionless	6569.72 psf	23.58	N/A	555.77 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	1.98 Kips	1.98 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	1.98 Kips	1.98 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	1.98 Kips	1.98 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	2.27 Kips	2.27 Kips
9.01 ft	21.10 Kips	2.27 Kips	23.38 Kips
18.01 ft	68.88 Kips	2.27 Kips	71.16 Kips
23.29 ft	100.38 Kips	2.27 Kips	102.66 Kips
23.31 ft	100.49 Kips	1.47 Kips	101.96 Kips
32.31 ft	140.43 Kips	1.47 Kips	141.90 Kips
41.31 ft	183.85 Kips	1.47 Kips	185.32 Kips
50.31 ft	229.78 Kips	1.47 Kips	231.25 Kips
55.79 ft	256.02 Kips	1.47 Kips	257.49 Kips
55.81 ft	256.14 Kips	3.61 Kips	259.75 Kips
64.81 ft	317.89 Kips	3.61 Kips	321.50 Kips
73.79 ft	379.50 Kips	3.61 Kips	383.11 Kips
73.81 ft	379.66 Kips	1.98 Kips	381.64 Kips
82.81 ft	470.02 Kips	1.98 Kips	472.00 Kips
90.79 ft	555.77 Kips	1.98 Kips	557.75 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	21.10 Kips
18.01 ft	Cohesive	N/A	N/A	1126.69 psf	68.88 Kips
23.29 ft	Cohesive	N/A	N/A	1167.96 psf	100.38 Kips
23.31 ft	Cohesive	N/A	N/A	903.09 psf	100.49 Kips
32.31 ft	Cohesive	N/A	N/A	944.31 psf	140.43 Kips
41.31 ft	Cohesive	N/A	N/A	985.54 psf	183.85 Kips
50.31 ft	Cohesive	N/A	N/A	1019.00 psf	229.78 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	256.02 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	256.14 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	317.89 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	379.50 Kips
73.81 ft	Cohesionless	6123.14 psf	23.58	N/A	379.66 Kips
82.81 ft	Cohesionless	6359.84 psf	23.58	N/A	470.02 Kips
90.79 ft	Cohesionless	6569.72 psf	23.58	N/A	555.77 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	1.98 Kips	1.98 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	1.98 Kips	1.98 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	1.98 Kips	1.98 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	2.27 Kips	2.27 Kips
9.01 ft	21.10 Kips	2.27 Kips	23.38 Kips
18.01 ft	68.88 Kips	2.27 Kips	71.16 Kips
23.29 ft	100.38 Kips	2.27 Kips	102.66 Kips
23.31 ft	100.49 Kips	1.47 Kips	101.96 Kips
32.31 ft	140.43 Kips	1.47 Kips	141.90 Kips
41.31 ft	183.85 Kips	1.47 Kips	185.32 Kips
50.31 ft	229.78 Kips	1.47 Kips	231.25 Kips
55.79 ft	256.02 Kips	1.47 Kips	257.49 Kips
55.81 ft	256.14 Kips	3.61 Kips	259.75 Kips
64.81 ft	317.89 Kips	3.61 Kips	321.50 Kips
73.79 ft	379.50 Kips	3.61 Kips	383.11 Kips
73.81 ft	379.66 Kips	1.98 Kips	381.64 Kips
82.81 ft	470.02 Kips	1.98 Kips	472.00 Kips
90.79 ft	555.77 Kips	1.98 Kips	557.75 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	1120.00 psf	0.00 Kips
9.01 ft	Cohesive	N/A	N/A	1120.00 psf	21.10 Kips
18.01 ft	Cohesive	N/A	N/A	1126.69 psf	68.88 Kips
23.29 ft	Cohesive	N/A	N/A	1167.96 psf	100.38 Kips
23.31 ft	Cohesive	N/A	N/A	903.09 psf	100.49 Kips
32.31 ft	Cohesive	N/A	N/A	944.31 psf	140.43 Kips
41.31 ft	Cohesive	N/A	N/A	985.54 psf	183.85 Kips
50.31 ft	Cohesive	N/A	N/A	1019.00 psf	229.78 Kips
55.79 ft	Cohesive	N/A	N/A	1019.00 psf	256.02 Kips
55.81 ft	Cohesive	N/A	N/A	1460.00 psf	256.14 Kips
64.81 ft	Cohesive	N/A	N/A	1460.00 psf	317.89 Kips
73.79 ft	Cohesive	N/A	N/A	1460.00 psf	379.50 Kips
73.81 ft	Cohesionless	6123.14 psf	23.58	N/A	379.66 Kips
82.81 ft	Cohesionless	6359.84 psf	23.58	N/A	470.02 Kips
90.79 ft	Cohesionless	6569.72 psf	23.58	N/A	555.77 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
4.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
5.00 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.29 ft	Cohesive	N/A	N/A	N/A	2.27 Kips
23.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
32.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
41.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
50.31 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.79 ft	Cohesive	N/A	N/A	N/A	1.47 Kips
55.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
64.81 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.79 ft	Cohesive	N/A	N/A	N/A	3.61 Kips
73.81 ft	Cohesionless	6123.41 psf	30.00	1.98 Kips	1.98 Kips
82.81 ft	Cohesionless	6596.81 psf	30.00	1.98 Kips	1.98 Kips
90.79 ft	Cohesionless	7016.55 psf	30.00	1.98 Kips	1.98 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	2.27 Kips	2.27 Kips
9.01 ft	21.10 Kips	2.27 Kips	23.38 Kips
18.01 ft	68.88 Kips	2.27 Kips	71.16 Kips
23.29 ft	100.38 Kips	2.27 Kips	102.66 Kips
23.31 ft	100.49 Kips	1.47 Kips	101.96 Kips
32.31 ft	140.43 Kips	1.47 Kips	141.90 Kips
41.31 ft	183.85 Kips	1.47 Kips	185.32 Kips
50.31 ft	229.78 Kips	1.47 Kips	231.25 Kips
55.79 ft	256.02 Kips	1.47 Kips	257.49 Kips
55.81 ft	256.14 Kips	3.61 Kips	259.75 Kips
64.81 ft	317.89 Kips	3.61 Kips	321.50 Kips
73.79 ft	379.50 Kips	3.61 Kips	383.11 Kips
73.81 ft	379.66 Kips	1.98 Kips	381.64 Kips
82.81 ft	470.02 Kips	1.98 Kips	472.00 Kips
90.79 ft	555.77 Kips	1.98 Kips	557.75 Kips

HP 14x73

$q_{all} = 95$ ton FS = 2.0

$q_{ULT} = 190$ ton $= 380^{k}$

$$\Delta q = \frac{383.1^{k} - 321.5^{k}}{73.8' - 64.8'} = 6.8\ ^{k}/ft.$$

Use D = 74' , el. 489.8'

$$\text{Allowable uplift} = \frac{380^{k} - 3.6^{k}}{3.0} = 125^{k}$$