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August 13, 2007

Michael D. Weeks, P.E., P.S.
TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, OH 43017

Re: **Bearing Capacity and Settlement Evaluation**
(Culvert at STA. 474+10)
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document #0067

Dear Mr. Weeks:

This letter includes the findings of preliminary evaluations of the proposed culvert at Station 474+10 on the above-referenced project. The findings of other culvert and embankment evaluations will be submitted in separate documents.

It is our understanding that a new culvert will be constructed at Station 474+10 for the above referenced project. The culvert will be a 72-inch Type A conduit in accordance with ODOT Item 707.03 (Structural Plate Corrugated Steel Structures). Preliminary plans indicate the flow line of the culvert varies from approximately 0 to 6 feet below existing grade along its alignment. It is therefore anticipated that a portion of the embankment fill will need to be placed prior to excavating for construction of the culvert (ODOT CMS Item 603.05 Method B). The maximum cover over the culvert at this location is approximately 52 feet. The inlet and outlet of the culvert will be supported by headwalls flush with the face of the pipe at both ends. At the time of preparing this letter no further information was available regarding the proposed culvert.

It should be noted that the results of these evaluations are based upon the findings of three borings (C-13 through C-15) located along the proposed alignment of the culvert. The borings were advanced to depths ranging between 12.5 and 28 feet below the ground surface. Logs of the borings, a plan and profile drawing showing the approximate locations of the borings, a legend of the boring log terminology and general information regarding the drilling procedures are attached. The surveyed ground elevations at the boring locations are reported on the logs.

Exploration Findings

The borings generally encountered 7.5 to 21.5 feet of soil overlying sandstone bedrock. In boring C-13, the soil consisted of stiff silt (A-4b) underlain by medium dense sandy silt (A-4a), medium dense silt (A-4b), and loose sandy silt (A-4a), respectively. In boring C-14, the soil consisted of stiff silt (A-4b) underlain by hard sandy silt (A-4a), very stiff silt (A-4b), and loose sandy silt (A-4a), respectively. In boring C-15, the soil consisted of very stiff silt (A-4b) to an approximate depth of 7.5 feet where bedrock was encountered. The sandstone bedrock was generally soft to medium hard and slightly weathered.

Bearing Capacity Evaluation

The preliminary plans indicate that the invert elevations at the inlet and outlet of the proposed culvert are 677.63 and 658.72, respectively. The bottoms of the headwall footings were assumed to be 4 feet below the invert elevations to place them below the frost zone and prevent scour of the headwall (Ohio BDM Section 200). Based on the results of the borings, footings at these elevations will bear in medium dense granular material or very stiff to hard cohesive material. Footings bearing in the medium dense granular soil at the inlet may be designed based on an allowable bearing capacity of 2,500 pounds per square foot (psf) and footings bearing in the very stiff to hard cohesive soil at the outlet based on an allowable bearing capacity of 4,000.

Settlement Evaluation

Soil parameters for use in the settlement calculations were estimated using correlations with SPT N-values, moisture content and Atterberg limits. Settlement below the centerline of the embankment was evaluated using the maximum cover of the embankment (approximately 52 feet) as the surcharge load and using the soil profile encountered in boring C-14.

The settlement analysis indicated that the soil below the embankment will yield a total settlement of 2.9 inches of which approximately 0.5 inch will be immediate in the cohesionless soil layer during the construction of the embankment. The analysis indicated that 80% of the consolidation settlement (1.9 inches) in the cohesive layers will occur within approximately three weeks after the end of the embankment construction while the time required to achieve the total consolidation settlement (2.4 inches) will be approximately 5 months.

Secondary compression of the foundation soils is expected to be negligible. Settlement at the ends of the culvert, due to the embankment loading, is also expected to be insignificant. Based on these analyses, differential settlement between the point of maximum embankment height and the ends of the culvert is expected to be approximately 1.8 inches. The settlement analysis is attached.

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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 preliminary findings.

Respectfully submitted,

DLZ OHIO, INC.

Wael Alkasawneh, P.E.
Geotechnical Engineer

Bryan Wilson, P.E.
Senior Geotechnical Engineer

STATE OF OHIO
BRYAN E. WILSON E-57007
REGISTERED PROFESSIONAL ENGINEER

Encl: As noted.

cc: J. Greg Brown, P.E. (TranSystems Corporation), File

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 soils 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.

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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

Terms	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 - 1.00	4 - 8	Penetrated by thumb w/ moderate effort
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 ODOT Classification System. Soil particle size definitions are as follows:

Description	Size	Description	Size
Boulders	Larger than 8"	Sand-Coarse	2.00 mm. to 0.42 mm.
Cobbles	8" to 3"	-Fine	0.42 mm. to 0.074 mm.
Gravel-Coarse	3" to 3/4"	Silt	0.074 mm. to 0.005 mm.
-Fine	3/4" to 2.00" 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. 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

g. 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

10. Rock hardness and rock quality description.

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

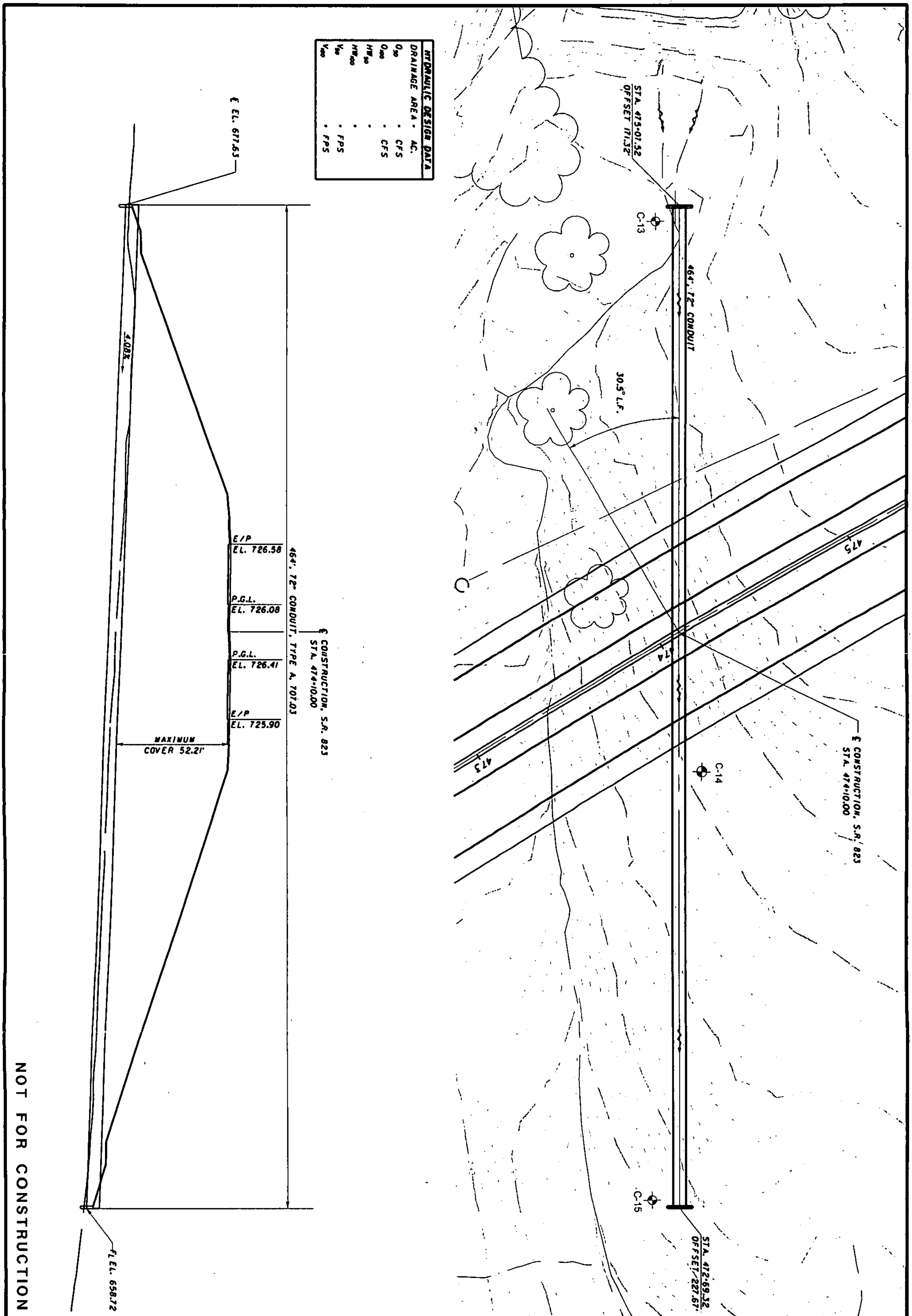
Term	Description
Very Soft	Difficult to indent with thumb nails; resembles hard soil but has rock structure
Soft	Resists indentation with thumb nail but can be abraded and pierced to a shallow depth by a pencil point.
Medium Hard	Resists pencil point, but can be scratched with a knife blade.
Hard	Can be deformed or broken by light to moderate hammer blows.
Very Hard	Can be broken only by heavy blows, and in some rocks, by 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.



SCI-823-0.00	PHASE I HEADWALL LOCATION SUBMITTAL S.R. 823 STA. 474+10	CALCULATED JCB CHECKED HJS	0 10 20 40 HORIZONTAL SCALE IN FEET

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

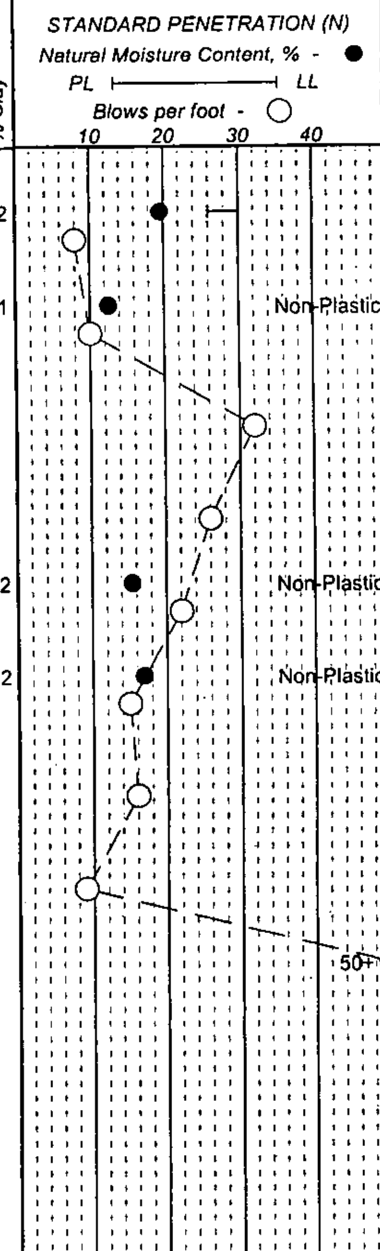
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring C-13

Location: Sta. 475+01.2, 176.4 ft. LT of SR 823 CL | Date Drilled: 06/29/06

WATER OBSERVATIONS: Water seepage at: 19.0' - 20.0'
Water level at completion: 20.0' (prior to coring)
2.0' (includes drilling water, inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	679.4												
0.3	679.1						Topsoil - 4"						
		3 3 5	14	1		1.75	Stiff grayish brown SILT (A-4b), little fine to coarse sand, trace gravel, trace clay; damp.	3	6	--	7	72	12
4.0	675.4	4 5 5	15	2			Medium dense to dense brown SANDY SILT (A-4a), little clay, little gravel; damp.	14	20	--	13	42	11
		6 14 18	18	3									
8.0	671.4	4 13 13	17	4			Medium dense brown and gray SILT (A-4b), trace to some fine to coarse sand, trace gravel, little clay; damp to moist.						
		8 10 12	16	5				2	10	--	15	61	12
		5 7 8	13	6				1	7	--	11	69	12
		4 7 9	16	7									
19.0	660.4	3 5 4	16	8			Loose gray SANDY SILT (A-4a), little to some gravel; damp.						
21.5	657.9	6 50/5	10	9			Severely weathered gray SANDSTONE.						
23.0	656.4	Core 60"	Rec 59"	RQD 80%	R-1		Soft to medium hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, laminated to very thinly bedded, slightly fractured.						
28.0	651.4						Bottom of Boring - 28.0'						



FILE: 0121-3070-03 (4/20/2007 10:14 AM)

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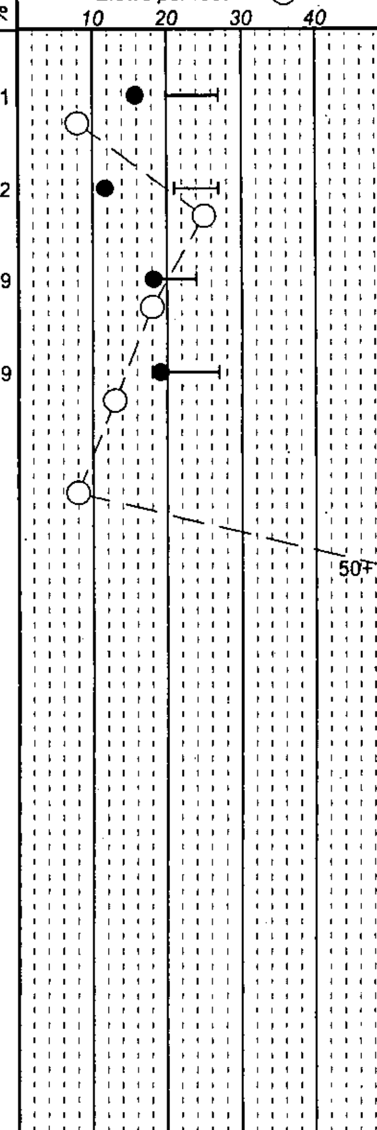
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring C-14 | Location: Sta. 473+69.0, 59.7 ft. RT of SR 823 CL | Date Drilled: 06/29/06

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: None (prior to coring)
14.5' (includes drilling water, inside hollowstem augers)

Depth (ft)	Elev. (ft) 668.8	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	668.6						Topsoil - 2"						
		4 4 4	16	1		--	Stiff brown SILT (A-4b), some clay, trace fine to coarse sand, trace gravel; damp.	3	2	--	5	69	21
4.0	664.8	4 6 19	18	2		4.5+	Hard brown SANDY SILT (A-4a), little clay, some fine to coarse sand, some gravel; damp.	27	21	--	11	29	12
5.5	663.3	5 7 11	17	3		3.5	Very stiff mottled brown and gray SILT (A-4b), little to some clay, trace fine sand; damp to moist.	0	0	--	4	77	19
		4 6 7	18	4		3.25		0	0	--	6	65	29
10.5	658.3	3 4 4	18	5			Loose brown SANDY SILT (A-4a), little clay; moist.						
13.5	655.3	17 50/3	8	6			Severely weathered gray SANDSTONE.						
15.0	653.8	Core 60"	Rec 58"	RQD 48%	R-1		Soft to medium hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, laminated to very thinly bedded, slightly fractured.						
20.0	648.8						Bottom of Boring - 20.0'						

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



FILE: 0121-3070-03 [4/20/2007 10:14 AM]

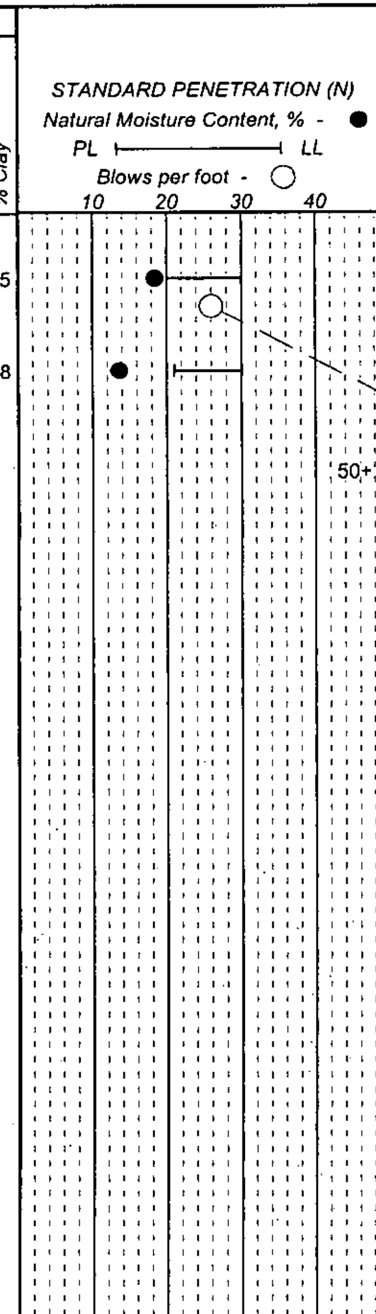
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring C-15 | Location: Sta. 472+64.1, 223.9 ft. RT of SR 823 CL | Date Drilled: 06/29/06

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None (prior to coring)
5.2' (includes drilling water, inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	657.0						No topsoil						
		4 10 16	18	1		2.5	Very stiff to hard brown SILT (A-4b), trace to some fine to coarse sand, trace gravel, little clay; damp.	1	12	--	13	59	15
		10 20 30	18	2		4.5+		1	1	--	12	68	18
		13 50/3	9	3		4.5+	@ 7.5', auger refusal.						
7.5	649.5	Core 60"	Rec 60"	RQD 97%	R-1		Soft to medium hard gray SANDSTONE; very fine to fine grained, slightly weathered, laminated to very thinly bedded, slightly fractured.						
12.5	644.5						Bottom of Boring - 12.5'						



FILE: 0121-3070-03 [4/20/2007 10:14 AM]

CLIENT	TranSystems Inc.	JOB NUMBER	0121-3070-03		
PROJECT	Portsmouth Bypass	SHEET NO.	1	OF	2
SUBJECT	Culvert at Station 474+10	COMP. BY	BEW	DATE	8/13/2007
	Bearing Capacity Analysis	CHECKED BY		DATE	

Base analysis on results of boring C-15.

From hand penetrometer measurements at and below footing elevation:

qu = 2.5 tsf

c = 2500 psf

Factor of Safety (FS) = 3 (ODOT BDM 202.2.3.1)

For cohesive foundation soil:

Meyerhof's Method

$q_u=S_c*c*N_c+q*N_q$ $q=\gamma*D$ **Can be neglected since footing depth is less than 5 ft**

Since footing Dimensions are not known assume S_c=1.0. For $\phi = 0$, use $N_c = 5.14$ and $N_q = 1$

$q_a=q_u/FS$= 4283.3 psf

Use $q_a <$ 4283 psf

Base analysis on results of boring C-13.

qu =	0	tsf
c =	0	psf
ϕ =	34	degrees
Assume B =	2.5	ft
Assume γ =	120	pcf
Factor of Safety (FS) =	3	(ODOT BDM 202.2.3.1)

For cohesionless foundation soil:

Meyerhof's Method

$q_u = S_c{*}c{*}N_c + q{*}N_q + 0.5\gamma{*}B{*}N_\gamma{*}S_\gamma$ Conservatively use buoyant unit weight in calculation.

$q = \gamma{*}D$

$S_\gamma =$ 1

$N\gamma =$ 31.10 for ϕ equal to 34 degrees

$Nq =$ 30.30 for ϕ equal to 34 degrees

$q_a = q_u/FS =$ 2492

Use $q_a <$ 2500 psf

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Client	TranSystems Inc.	JOB NUMBER	0121-3070.03	
Project	Portsmouth Bypass	SHEET NO.	1	OF 3
Item	Culvert at STA. 474+10	COMP. BY	WMA	DATE 8/7/07
		CHECKED BY	BEW	DATE 8/13/07

Calculations Data

Boring	Sample	w	PL	LL	PI	Cc[1]	Cr[2]	e_o[3]
C-13	1	20	26	30	4	0.05	0.038	0.9901
C-14	1	16	20	27	7	0.09	0.034	0.9755
C-14	2	12	21	27	6	0.08	0.034	0.9633
C-14	3	18	18	24	6	0.08	0.031	0.9826
C-14	4	19	18	27	9	0.12	0.034	0.9760
C-15	1	18	20	30	10	0.14	0.038	0.9710
C-15	2	14	21	30	9	0.12	0.038	0.9600
					Average	**0.10**	**0.035**	**0.9741**
					Maximum	**0.14**	**0.038**	**0.9901**

1)Cc=PI/74
2)Cr=0.000463xLLxGs
3) Based on CR below

Boring	Sample	LL	C_v*(ft²/day)	C_v*(ft²/sec)
C-13	1	30	0.57	6.58E-06
C-14	1	27	0.77	8.88E-06
C-14	2	27	0.77	8.88E-06
C-14	3	24	1.07	1.24E-05
C-14	4	27	0.77	8.88E-06
C-15	1	30	0.57	6.58E-06
C-15	2	30	0.57	6.58E-06
		Minmum	**0.57**	**6.58E-06**
		Average	**0.73**	**8.40E-06**
		Maximum	**1.07**	**1.24E-05**

*Cv(ft2/day) = 9343.5*LL^(-2.8542) (Kulhawy and Mayne- 1990)

Typical Values
Source: Holtz and Kovacs (1981)/ Terzaghi, Peck and Mesri (1995)

Soil	C_α/C_c
Organic Silts	0.035-0.06
Amorphous and Fibrous Peat	0.035-0.085
Organic Clays and Silts	0.04-0.06
Granular Soils	0.01-0.03
Shale and mudstones	0.02-0.04
Silty Clay	0.03-0.06
Peat	0.05-0.07

Correlation Values-Source: Lamb and Whitman (1969)

w%	$CR=(C_c/1+e_o)$
9.983	2.389
11.785	2.547
14.487	3.016
17.099	3.825
19.816	4.892
25.352	6.931
28.328	8.079
34.174	10.369
42.400	13.490
51.139	16.388
79.829	23.326
152.740	33.469
341.288	46.114
501.494	52.174

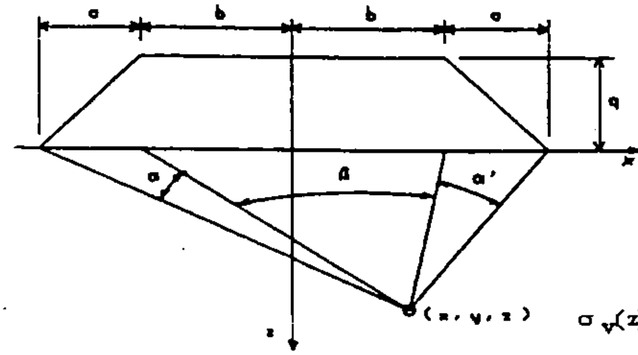
Correlation: CR=-4E-09w^4 + 5E-06w^3 - 0.0021w^2 + 0.4695w - 3.1337
R^2=0.9992

Boring	Sample	w	PL	LL	PI	LI*	Consolidation*
C-13	1	20	26	30	4	-1.5	Overconsolidated
C-14	1	16	20	27	7	-0.571	Overconsolidated
C-14	2	12	21	27	6	-1.5	Overconsolidated
C-14	3	18	18	24	6	0	Overconsolidated
C-14	4	19	18	27	9	0.111	Overconsolidated
C-15	1	18	20	30	10	-0.2	Overconsolidated
C-15	2	14	21	30	9	-0.778	Overconsolidated

* Soils and Foundations Workshop Reference Manual- NHI-00-045 (p. 6.11)

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	20.0	ft		
Embankment Height:	H =	53	ft		
Fill Unit Weight:	γ_{emb} =	120	pcf	q =	6,360 psf
Width of Slope:	a =	167			
Top half-width of Emb:	b =	65			
Distance from CL:	x =	0			
Output Range:	z =	0	to	25	ft

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

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

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*

									Cohesionless Soils	Cohesive Soils		
No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	C'	C_r	C_c	e_o
1	10.5	ft	Cohesive Silt	120	7,448	630	6,360	6,990	0.0	0.04	0.10	0.960
2	13.5	ft	Sandy Silt	110	0	1,425	6,357	7,782	53.0	0.00	0.00	0.000
3	0.0			0	0				0.0	0.00	0.00	0.000
4	0.0			0	0							
5	0.0			0	0							
6	0.0			0	0							
7	0.0			0	0							
8	0.0			0	0							
9	0.0			0	0							
10	0.0			0	0							

No.	Settlement:	
1	0.196	ft
2	0.042	ft
3		
4		
5		
6		
7		
8		
9		
10		

Total Settlement

0.238 ft

2.9 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

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

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

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

SUBJECT			
Client	TranSystems, Inc.	JOB NUMBER	0121-3007.03
Project	SCI-823-0.00	SHEET NO.	3 OF 3
Item	Culvert at STA. 474+10	COMP. BY	WMA DATE 08/07/07
Based on Boring C-14		CHECKED BY	BEW DATE 08/13/07

TIME RATE SETTLEMENT

Coeffecient of consolidation (c_v) = 6.58E-06 ft^2/s

Assumed Life Time = 5 yrs

Drainage Path Condition = 1 (0 for single drainage; 1 for double drainage)

Thickness of Layer = 10.5 ft

Maximum Time Rate Settlement = 2.4 inches

Settlement at (U% =80%) = 1.88 inches 23 days after the end of construction