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August 1, 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. 22+23 CR 28)
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document #0063

Dear Mr. Weeks:

This letter presents the findings of preliminary evaluations of the proposed culvert at STA 22+23 (CR 28) on the above-referenced project. The findings of other culvert evaluations will be submitted in separate documents.

It is our understanding that a new culvert will be constructed at STA 22+23 (CR 28) for the above referenced project. The culvert will be a 78-inch Type A conduit in accordance with ODOT Item 707.01 (Metallic Coated Corrugated Steel Conduits and Underdrains). Preliminary plans indicate the culvert will be installed beneath CR 28 to carry the flow of a realigned stream. The proposed roadway grade is indicated to be essentially the same as existing. 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 this preliminary evaluation is based upon the findings of two culvert borings (C-60 and C-61) located along the proposed alignment of the culvert. The borings were advanced to depths of 50 and 59 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

Borings C-62 and C-63 were located near the outlet and inlet of the proposed culvert and encountered 29.0 and 43.5 feet, respectively, of stiff to very stiff cohesive soil (A-4a, A-6b, A-7-6). Beneath the cohesive soil, boring C-62 encountered medium dense sand (A-3a) to a depth of 43.5 feet. Beneath the overburden soils, the borings encountered over siltstone and fine-grained

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sandstone bedrock. In boring C-63, the upper 10 feet of rock was deteriorated to the extent that the boring was advanced with augers and the decomposed rock sampled by splitspoon methods.

Bearing Capacity and Settlement Evaluation

The preliminary plans indicate that the invert elevations at the inlet and outlet of the proposed culvert are 708.00 and 707.50, respectively. The bottoms of the headwall footings were assumed to be four 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, the footings will bear in stiff clay (A-7-6). Footings bearing in the stiff clays may be designed based on an allowable bearing capacity of 2,000 pounds per square foot (psf).

Since proposed grade over the culvert will be essentially the same as existing grade, installation of the culvert will likely result in a net decrease in load on the supporting soils. Post construction settlement of the culvert is therefore expected to be negligible.

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

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.

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.

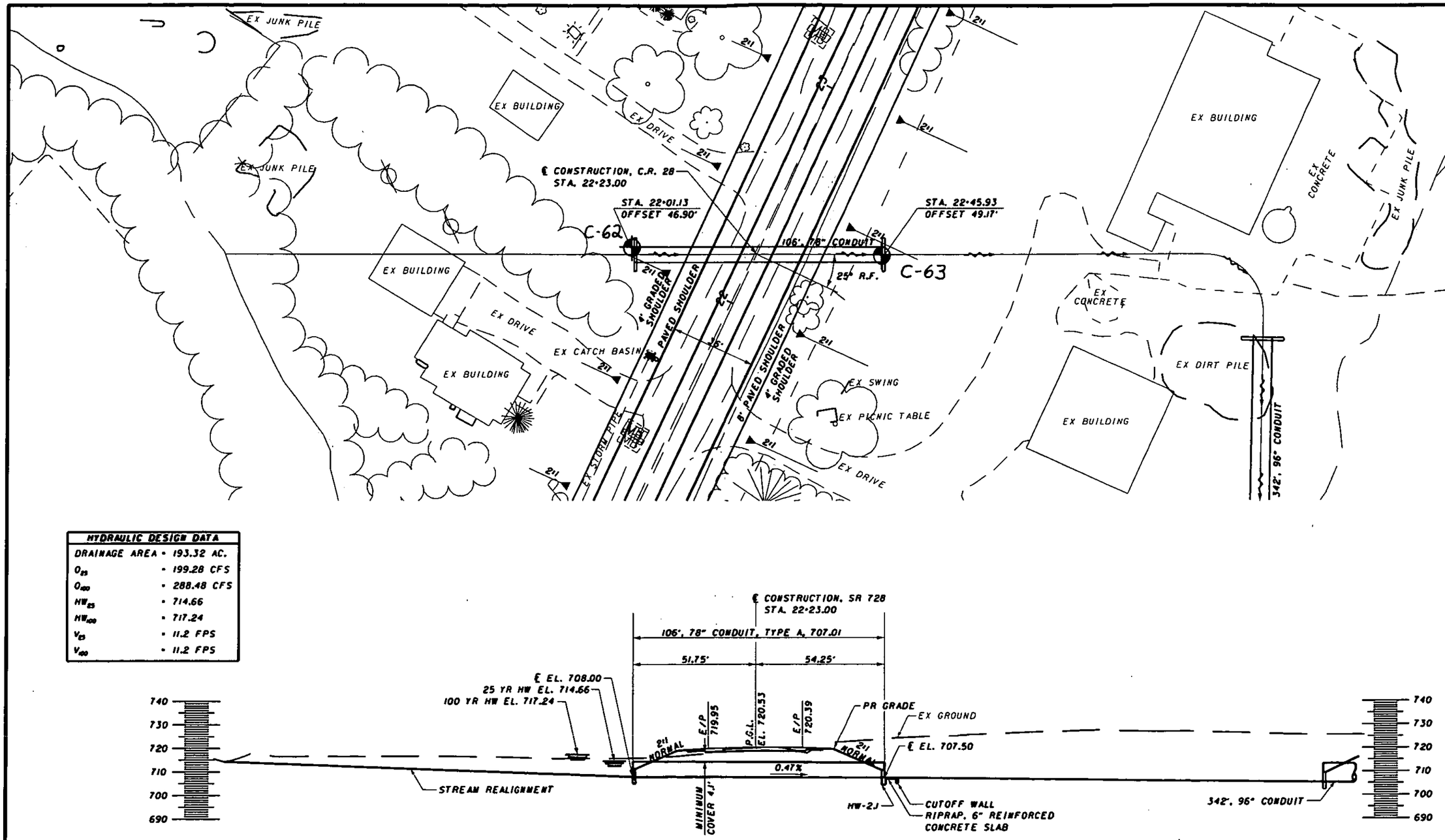
Term	Description
Very Soft	Difficult to indent with thumb nails; resembles hard soil but has rock structure
Soft	Resists indentation with thumb nail but can be abraded and pierced to a shallow depth by a pencil point.
Medium Hard	Resists pencil point, but can be scratched with a knife blade.
Hard	Can 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.



HYDRAULIC DESIGN DATA	
DRAINAGE AREA	= 193.32 AC.
Q_{25}	= 199.28 CFS
Q_{100}	= 288.48 CFS
HW_{25}	= 714.66
HW_{100}	= 717.24
V_{25}	= 11.2 FPS
V_{100}	= 11.2 FPS

HORIZONTAL SCALE IN FEET
0 20 40

CALCULATED MDC
CHECKED HJS

CULVERT DETAIL
C.R 28 STA. 22+23

SCI-823-0.00

1

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-62 | Location: Sta. 22+01.0, 47.7 ft LT of CR 28 CL | Date Drilled: 08/31/06

WATER OBSERVATIONS: Water seepage at: 29.5'-35.0'
Water level at completion: 42.6' (prior to coring)
10.6' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	715.9												
0.6	715.3						Topsoil - 7"						
		2 2 3	16	1			Loose brown SANDY SILT (A-4a), little to some gravel, little clay; damp.	19	12	--	13	40	16
		6 7 9	18	2				28	12	--	13	32	15
5													
6.0	709.9												
		4 4 5	16	3		2.5	Stiff to very stiff brown and gray CLAY (A-7-6); contains organic material; damp.						
		2 3 4	15	4		2.0		0	0	--	1	3	96
10													
		2 4 4	18	5		2.5							
		1 2 2	18	6		1.5							
15													
		1 2 2	18	7		1.5							
		2 3 3	18	8		1.5							
20													
		1 2 3	18	9		1.5							
		WOH 3 4	18	10		1.5							
25													
		WOH 3 3	18	11		--							
29.0	686.9	WOH 6 9	18	12A		1.25	Medium dense gray COARSE AND FINE SAND (A-3a).						
30													

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

66

FILE: Latest Borings [3/1/2007 3:31 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

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WATER OBSERVATIONS: Water seepage at: 29.5'-35.0'
Water level at completion: 42.6' (prior to coring)
10.6' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
30	685.9			12B			Medium dense gray COARSE AND FINE SAND (A-3a); contains organic material; moist to wet.							
35		12 11 7	14	13										
40		5 7 12	18	14										
43.5	672.4	50/5	5	15			Severely weathered gray SANDSTONE.							50+
45.0	670.9						Soft to medium hard gray SILTSTONE interbedded with SANDSTONE; highly weathered to decomposed.							
47.3	668.6	Core 60"	Rec 46"	RQD 58%	R-1		Soft to medium hard gray SILTSTONE; highly weathered to decomposed, argillaceous, thinly bedded, highly fractured. @ 49.8'-49.9', clay seam.							
50.0	665.9						Bottom of Boring - 50.0'							
55														
60														

FILE: Latest Borings [8/1/2007 3:31 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 C-63 | Location: Sta. 22+44.3, 47.7 ft. RT of CR 28 CL | Date Drilled: 08/30/06 to 08/31/06

WATER OBSERVATIONS: Water seepage at: 38.5'-39.0'
Water level at completion: 42.2' (prior to corings)
7.7' (includes drilling water)

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	723.9												
0.8	723.1	6 7 8	11	1		3.5	Topsoil - 10" Medium stiff to very stiff light brown SILTY CLAY (A-6b), trace fine to coarse sand; contains roots; damp.	0	1	--	2	47	50
		5 6 7	9	2		3.5	@ 3.5'-5.0', mottled brown and gray.						
5													
6.0	717.9	4 6 7	13	3		4.0	Stiff to very stiff brown and gray CLAY (A-7-6); moist.	0	0	--	0	9	91
		3 4 6	16	4		2.5							
10		3 5 6	18	5		3.0							
		3 4 5	18	6		2.5	@ 13.5'-20.0', mottled brown and gray.						
15		2 3 4	18	7		2.0							
		2 2 5	18	8		2.5		0	0	--	0	3	97
20		2 3 3	18	9		1.0	@ 21.0'-30.0', gray.						
		2 3 4	18	10		1.5							
25		1 2 3	18	11		1.0							
		WOH WOH 3	18	12		1.0							
30													

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

58

70

FILE: Latest Borings [8/1/2007 3:31 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

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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
30	693.9						Stiff gray CLAY (A-7-6); damp.						
		2 3 3	18	13		1.5							
35													
38.5	685.4	2					Loose gray COARSE AND FINE SAND (A-3a); wet.						
39.5	684.4	4 11	18	14A 14B		2.0	Stiff to very stiff gray CLAY (A-7-6); damp.						
40													
43.5	680.4	3					Dense gray COARSE AND FINE SAND (A-3a); wet.						
44.5	679.4	18 15	18	15A 15B			Dense reddish brown and gray GRAVEL WITH SAND (A-1-b); damp. (Decomposed sandstone)						
45													
		26 32 21	14	16									
50													
54.0	669.9	50/3	3	17			Soft to medium hard gray SANDSTONE; very fine grained, highly weathered to decomposed, thin bedded, broken. @ 54.1'-54.6', decomposed argillaceous zone.						
55													
56.8	667.1	Core 60"	Rec 56"	RQD 83%	R-1		Soft to medium hard gray SILTSTONE; fine grained, highly weathered to decomposed, argillaceous, thinly bedded, highly fractured.						
59.0	664.9						Bottom of Boring - 59.0'						
60													

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40
53 →
50+

FILE: Latest Borings | 8/1/2007 3:31 PM |

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CLIENT	TranSystems Inc.	JOB NUMBER	0121-3070-03		
PROJECT	Portsmouth Bypass	SHEET NO.	1	OF	1
SUBJECT	Culvert at Station 22+23 CR 28	COMP. BY	BEW	DATE	8/1/2007
	Bearing Capacity Analysis	CHECKED BY		DATE	

Base analysis on results of borings C-62 and C-63.

From hand penetrometer measurements at and below footing elevation:

q_u = 1.25 tsf

c = 1250 psf

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

For cohesive foundation soil:

Meyerhof's Method

$q_u = c^* N_c^* s_c^* d_c + q^* N_q$ $q = \gamma^* D$ **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

$q_a = q_u/FS$ = 2141.7 psf

Use $q_a <$ 2142 psf