



August 14, 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. 543+00 C.R. 28 Ramp D)**  
SCI-823-0.00 Portsmouth Bypass  
DLZ Job No.: 0121-3070.03  
Document #0071

Dear Mr. Weeks:

This letter presents the findings of preliminary evaluation of the proposed culvert at Station 543+00 County Road 28 Ramp D 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 Station 543+00 C.R. Ramp D for the above referenced project. The culvert will be a 63-inch×98-inch (rise×span) Type A elliptical conduit in accordance with ODOT Item 706.04 (Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe). The culvert will be installed using cut and fill construction procedures then an embankment approximately 3.0 feet high will be built over the culvert. 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 two culvert borings (C-58 and C-59) located along the proposed alignment of the culvert. The borings were advanced to depths of 35 and 40 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 28.5 to 33.5 feet of soil overlying sandstone and siltstone bedrock. The overburden materials were variable, consisting of interbedded layers of cohesive (A-6b, A-7-6, A-4b) and granular (A-1-b, A-2-4, A-3a, A-4a) soil. The cohesive materials were generally of medium stiff to very stiff consistency. The granular materials ranged in from loose to very dense but were generally of medium dense compactness. The underlying bedrock

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August 14, 2007  
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consisted of soft to medium hard, interbedded sandstone and siltstone and was generally highly weathered and fractured.

### **Bearing Capacity and Settlement Evaluation**

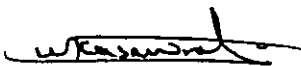
The preliminary plans indicate that the invert elevations at the inlet and outlet of the proposed culvert are 700.30 and 700.00, respectively. The bottoms of the headwall footings were assumed to be 4 feet below the invert elevations to place them below the frost zone and prevent scour of the headwall (Ohio BDM Section 200). Based on the results of the borings, footings at these elevations will bear in stiff to medium stiff cohesive soils. Footings bearing in the native stiff to medium stiff cohesive material at this location may be designed based on an allowable bearing capacity of 1,700 pounds per square foot (psf).

Since the embankment fill over the culvert is only two to three feet thick, post construction settlement of the culvert is expected to be insignificant.


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

<u>Terms</u>	<u>Blows/Foot Standard Penetration</u>
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

### Cohesive Soils - Consistency

<u>Term</u>	<u>Unconfined Compression tons/sq.ft.</u>	<u>Blows/Foot Standard Penetration</u>	<u>Hand Manipulation</u>
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:

<u>Description</u>	<u>Size</u>	<u>Description</u>	<u>Size</u>
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.

<u>Term</u>	<u>Relative Moisture or Appearance</u>
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:

<u>Term</u>	<u>Relative Moisture or Appearance</u>
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.

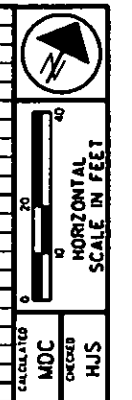
<u>Term</u>	<u>Description</u>
Very Soft	Difficult to indent with thumb nails; resembles hard soil but has rock structure
Soft	Resists indentation with thumb nail but can be abraded and pierced to a shallow depth by a pencil point.
Medium Hard	Resists pencil point, but can be scratched with a knife blade.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

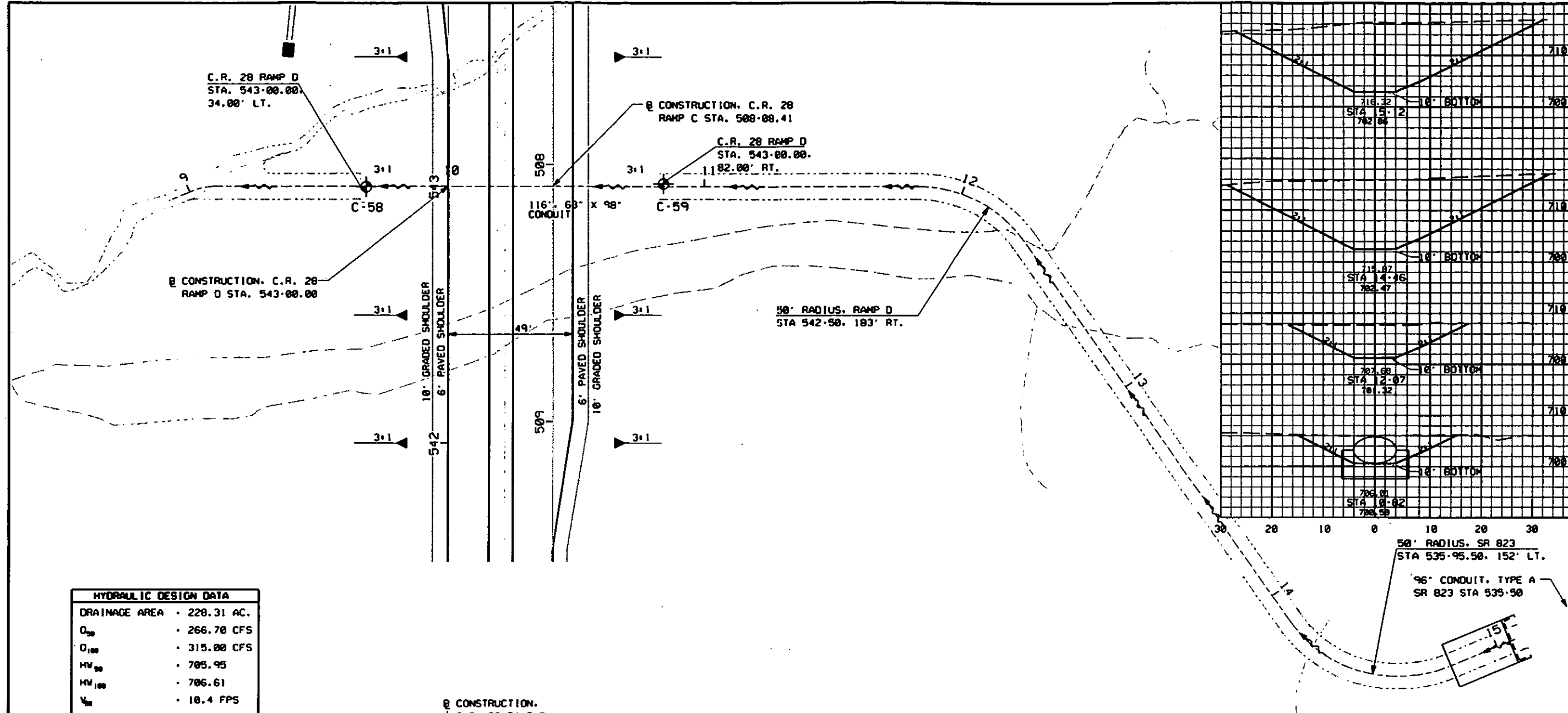
11. Gradation - when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).

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.

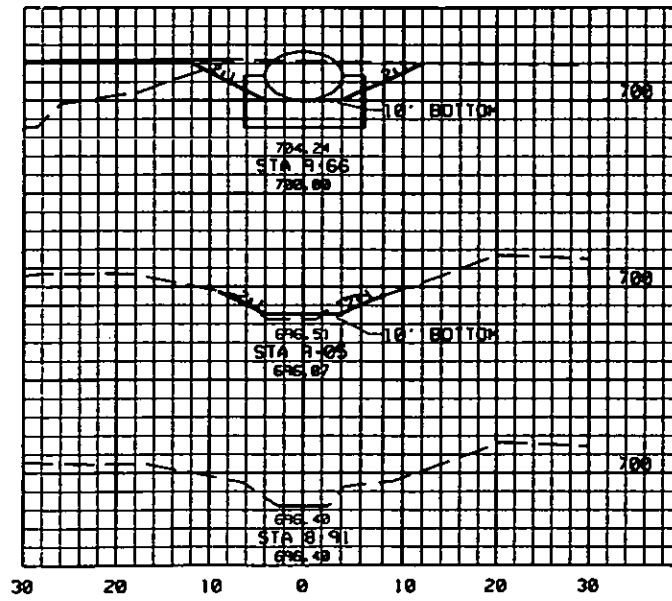
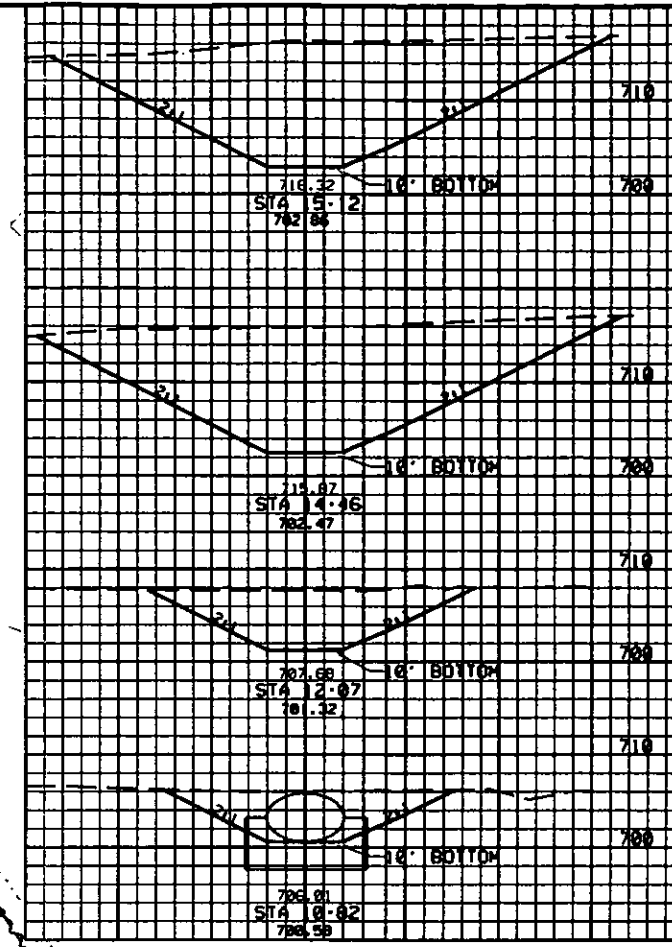
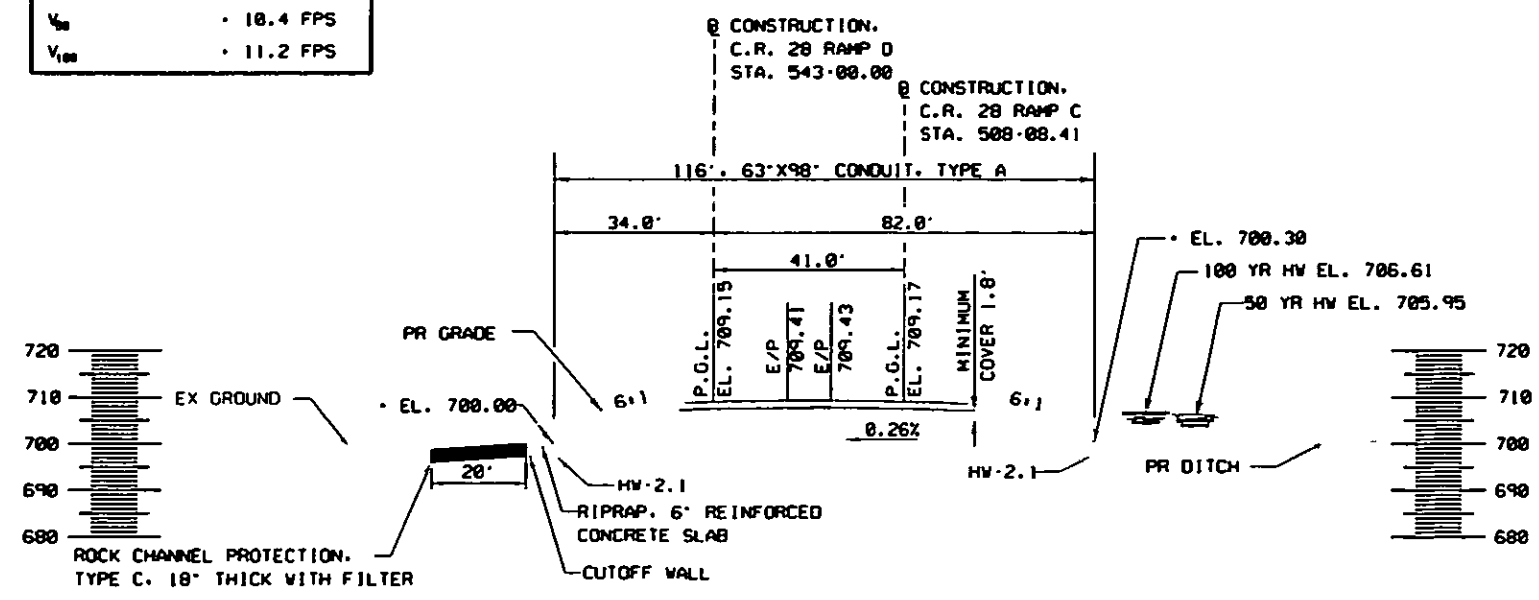
13. The standard penetration (N) value in blows per foot is indicated graphically.



CALCULATED  
MDC  
CHECKED  
HJS



HYDRAULIC DESIGN DATA	
DRAINAGE AREA	• 228.31 AC.
$Q_{50}$	• 266.70 CFS
$Q_{100}$	• 315.00 CFS
$HV_{50}$	• 705.95
$HV_{100}$	• 706.61
$V_{50}$	• 10.4 FPS
$V_{100}$	• 11.2 FPS



CULVERT DETAIL  
C.R. 28 RAMP D STA. 543+00

SCI-823-6.81







Client: TranSystems, Inc.

Project: SCI-823-0.00

Job No. 0121-3070.03

LOG OF: Boring C-59

Location: Sta. 508+07.4, 43.3 ft. LT of SR 728 Ramp C BL

Date Drilled: 08/28/06

to 08/29/06

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	WATER OBSERVATIONS: Water seepage at: None Water level at completion: 7.0' (includes drilling water)	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ 10 20 30 40				
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay					
0	705.7																	
0.8	704.9	6					Topsoil - 10"											
		4	18	1			Loose to medium dense light brown SILT (A-4b), little clay, little fine to coarse sand, trace gravel; damp to moist.											
		7	14	2				8	4	-	10	63	15					
5		9	14															
6.0	699.7	3	12	3			Medium dense mottled brown and red SANDY SILT (A-4a), trace gravel; damp.											
		9	12															
8.5	697.2	6	12	4		2.0	Medium stiff to stiff brown and gray CLAY (A-7-6), trace fine sand; moist.											
		11	12															
10		2	18	5		1.0												
		3	18															
		4	18															
15		WOH	18	6		0.75		0	0	-	1	27	72					52
		WOH	18															
		WOH	18	7		1.0												
		WOH	18															
		WOH	18	8		1.0												
		WOH	18															
20		1	18	9		1.0												
		2	18															
		2	18															
23.5	682.2	8	18	10			Medium dense gray GRAVEL WITH SAND AND SILT (A-2-4); damp.											
		8	18															
25		11	18															
26.0	679.7	6	18	11			Loose gray SANDY SILT (A-4a); damp.											
		4	18															
		5	18															
28.5	677.2	24	16	12			Very dense brown and gray GRAVEL WITH SAND (A-1-b), trace silty clay; damp.											
		30	16															
30		45	16															

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

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

LOG OF: Boring C-59 Location: Sta. 508+07.4, 43.3 ft. LT of SR 728 Ramp C BL Date Drilled: 08/28/06 to 08/29/06

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetro-meter (tsf)	WATER OBSERVATIONS: Water seepage at: None Water level at completion: 7.0' (includes drilling water)	GRADATION						STANDARD PENETRATION (N)						
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	Natural Moisture Content, % - ●		Blows per foot - ○				
DESCRIPTION													PL	LL	10	20	30	40		
30	675.7						Very dense brown and gray GRAVEL WITH SAND (A-1-b), trace silty clay; damp.													75
33.5	672.2	50/3	3		13		Soft gray SANDSTONE; decomposed, thinly bedded.													50+
35.0	670.7			Core 60"	Rec 48"	RQD 80% R-1	Soft to medium hard gray SILTSTONE interbedded with SANDSTONE; highly weathered, argillaceous, thinly bedded, highly fractured. @ 30.0'-35.0', 36.4'-36.9', lost recovery.													
40.0	665.7						Bottom of Boring - 40.0'													
45																				
50																				
55																				
60																				

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



CLIENT TranSystems Inc.  
PROJECT Portsmouth Bypass  
SUBJECT Culvert at Station 543+00 CR 28 Ramp D  
Bearing Capacity Analysis

JOB NUMBER 0121-3070-03  
SHEET NO. 1 OF 1  
COMP. BY BEW DATE 8/14/2007  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

Base analysis on results of borings C-58 and C-59.

From hand penetrometer measurements at and below footing elevation:

$$q_u = 1 \text{ tsf}$$

$$c = 1000 \text{ psf}$$

$$\text{Factor of Safety (FS)} = 3 \quad (\text{ODOT BDM 202.2.3.1})$$

For cohesive foundation soil:

**Meyerhof's Method**

$$q_u = c * N_c * s_c * d_c + q * N_q \quad q = \gamma * D \quad \text{Can be neglected since footing depth is less than 5 ft}$$

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

$$q_a = q_u / \text{FS} = 1713.3 \text{ psf}$$

Use  $q_a < 1713 \text{ psf}$