

August 23, 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. 379+00 TW234 Ramp C) SCI-823-0.00 Portsmouth Bypass DLZ Job No.: 0121-3070.03 Document #0084

Dear Mr. Weeks:

This letter presents the findings of preliminary evaluations of the proposed culvert and embankment at Station 379+00 (TW 234 Ramp C) 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 379+00 (TW 234 Ramp C) for the above referenced project. The culvert will be a 42-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 in new fill with the flow line as much as eight feet above existing grade. It is therefore anticipated that the culvert will be constructed in accordance with ODOT CMS Item 603.05 Method B. The inlet and outlet of the culvert will be supported by headwalls flush with the face of the pipe at each end. At the time of preparing this letter no further information was available regarding the culvert.

It should be noted that the results of this evaluation are based upon the findings of two borings (C-41 and C-42) located along the proposed alignment of the culvert. The borings were advanced to depths ranging between 15.0 and 21.5 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 ground elevations at the boring locations are reported on the logs.

## **Exploration Findings**

The borings encountered between 3.0 to 13.0 feet of mainly cohesive overburden soil overlying sandstone bedrock. The soils were very stiff to hard in consistency. The bedrock was soft to medium hard, weathered and fractured to varying degrees, but generally improved in quality with depth.



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# **Bearing Capacity Evaluation**

Preliminary plans indicate that the invert elevations at the inlet and outlet of the culvert are 666.7 and 665.0, 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). The headwall footing at the inlet will bear in new embankment fill (ODOT CMS Item 203) and should be designed based on an allowable bearing capacity of 2,500 pounds per square foot (psf). Based on the results of boring C-41, the headwall footing at the culvert outlet will bear on highly weathered/decomposed sandstone. Footings bearing in the weathered/decomposed rock may be designed based on an allowable bearing capacity up to 10 tons per square foot (tsf).

# **Settlement Evaluation**

Soil parameters for use in the settlement calculations were estimated using correlations with moisture content and Atterberg limits. Settlement below the centerline of the embankment was evaluated using the maximum embankment height (approximately 20 feet) as the surcharge load and using the soil profile encountered in boring C-42.

The settlement analysis indicated that the soil below the embankment will yield a total settlement of 6.5 inches. The analysis indicated that 80% of the consolidation settlement (5.2 inches) will occur within approximately forty days after application of the embankment load, while the time required to achieve the total consolidation settlement (2.3 inches) will be approximately six months.

Due to the relatively short consolidation periods, it is not anticipated that procedures to accelerate consolidation will be required. However, recommendations for the use of wick drains have been provided in the Report of Subsurface Investigation for the Shumway Hollow Road Interchange, dated November 29, 2006, presented separately.

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 center of the new embankment fill and the outlet of the culvert is expected to be approximately 6.5 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.

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Wael Alkasawneh, P.E. Geotechnical Engineer

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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.

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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.

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

4.

9.

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

### Granular Soils - Compactness

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

#### Cohesive Soils - Consistency

<u>Term</u>	Unconfined Compression tons/sq.ft.	Blows/Foot Standard Penetration	Hand Manipulation
Very Soft less th	an 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 so	il descriptions are indicated as a percentage by weight of particle sizes.
		<b></b>	- 0 to 10%
		** = = =	
		····· +	- 10 to 20%
		some	- 20 to 35%
		"and"	- 35 to 50%
	f.	The moisture conter	t 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
			Moisture content above plastic limit, but below liquid limit
		Moist	
		Wet	Moisture content above liquid limit
	g.	Moisture content of	cohesionless soils (sands and gravels) is described as follows:
		Term	Relative Moisture or Appearance
1		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 h	ardness and rock quali	ty description.
	а.	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.
	<sup>-</sup> b.		nation, RQD - This value is expressed in percent and is an indirect measure of rock soundness. It is obtained by ngth of all core pieces which are at least four inches long, and then dividing this sum by the total length of the core
11.	Gradat	ion - when tests are per	formed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).
12.		a test is performed to de t is indicated graphically	etermine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture 7.
13.	The sta	indard penetration (N)	alue in blows per foot is indicated graphically.
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HTDRAUL	IC DES	H	GH DÀTÀ
DRAINAGE	AREA	•	10.04 AC.
0 <sub>115</sub>		•	19.82 CFS
0,00		•	28.89 CFS
HW25		•	668.98
HWIDE		-	669.50
V <sub>ES</sub>		•	II.O FPS
V <sub>ebo</sub>		•	9.8 FPS

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	FranSy F: Bo				1	ocation: Sta	Project: SCI-823-0.00 . 378+99.8, 57.4 ft. LT of TR 234 Ramp C BL Date Drilled: 09	/07/	/06					Job No. 0121-3070.03
		×		Samį No	ole		WATER OBSERVATIONS: Water seepage at: None				ATIC	NC T	-	
Depth (ft)	Elev. (ft) 664.9	Blows per 6"	Recovery (in)	Drive	Press / Core	Hand Penetro- meter (tsf)	Water level at completion: None (prior to coring) 3.0' (includes drilling water) DESCRIPTION	% Aggregale	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - PL L Blows per foot - 10 20 30 40
-		7 9 10	_13	1		4.5+	Topsoil - 4* Hard brown SANDY SILT (A-4a), trace clay, trace gravel, dry to damp.							
-3.0	661.9-	15 44 50/5	8	2			Soft to medium hard brown SILTSTONE; arenacous, highly weathered to decomposed. @ 4.5', encountered possible sandstone cobble.							/
		7 16 20	12	3					-					
	-656.4-		5	4			Severely weathered brown SANDSTONE.							1 1 4 4 5 1 4 1 5 4 4 1 1 1 1 1 1 1 1 1
	654.9- 652.6- 649.9-	Core 60"	Rec 56"	RQD 58%	R-1		Soft to medium hard brown SANDSTONE; fine grained to very fine grained argillaceous, highly weathered to decomposed, broken. Medium hard gray SANDSTONE; very fine to fine grained, moderately weathered, thinly bedded to medium bedded, highly fractured.							1     3     1
-	049.9						<u>@ 12.8', 13.0', 13.4', 13.5', clay seams.</u> Bottom of Boring - 15.0'							1       1
20 —														1     1
25 														1       1
- 30								1						•     1     1     1     1     1     1     1     1       •     1     1     1     1     1     1     1     1     1       •     1     1     1     1     1     1     1     1     1       •     1     1     1     1     1     1     1     1     1

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

Client: ]					_		Project: SCI-823-0.00							Job No. 0121-3070.03
	F: Bo	ring	C-42	Sam		ocation: Sta	a. 378+99.5, 63.7 ft. RT of TR 234 Ramp C BL Date Drilled: 09 WATER	1/08 T			ATI	NC		
Depth (ft)	Elev. (ft) 658.5	Blows per 6"	Recovery (in)	No. Puine		Hand Penetro- meter (tsf)	OBSERVATIONS: Water seepage at: 12.0' - 15.0' Water level at completion: 14.5' (prior to coring) 6.6' (includes drilling water) DESCRIPTION	% Aggregate	% C. Sand	M. Sand	F. Sand		% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ├────── LL Blows per foot - ○ 10 20 30 40
0.9 0.9	657.6-	12 10 8	-18	1		4.5+	Topsoil - 11" Very stiff to hard brown SANDY SILT (A-4a), trace to little clay, contains trace organic material, damp to moist.							Ó
5		4 5 4	16	2		3.5	@ 3.5'-5.0', little to some clay, trace gravel.							¢.
_		4 6 7	10	3		2.0								Å.
_	650.5-	5 6	18	4		3.0	Very stiff brown CLAY (A-7-6), trace to little silt, damp. @ 9.0', light gray.	1						
-	-648.0-	15 36 26		5			Very dense brown COARSE AND FINE SAND (A-3a), little to some silty clay, trace to little gravel, damp to moist.							
13.0 - 15	645.5-	7 11 17	15	6			Soft to medium hard gray SANDSTONE; highly weathered to decomposed.				-			
40 F -		50/3	3	7							ł			
-16.5	<del>-6</del> 42.0-	Core 60"		RQD 86%	R-1		Medium hard gray SANDSTONE; fine grained, slightly weathered, thinly bedded to medium bedded, moderately fractured. @ 19.5', 19.6', 20.3', clay seams.							
21.5	637.0-						Bottom of Boring - 21.5'							
- 25—														

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	CLIENT	TranSystems Inc.	JOB NUMBER	01	21-3070	)-03
	PROJECT	Portsmouth Bypass	SHEET NO.	1	OF	1
	SUBJECT	Culvert at Station 379+00 TW 234 Ramp C	COMP. BY	BEW	DATE	8/15/200
		Bearing Capacity Analysis	CHECKED BY		DATE	
			_			
		· · · · · · · · · · · · · · · · · · ·				
	n of boringo	C 41 and C 42	-			
Base analysis on result	s or bornigs					
		nservatively assume unconfined strength of	1.5 tons per squ	are root.		
q <sub>u</sub> =	= 1.5 tsi					
c =	= 1500 ps	f				
Factor of Safety (FS) =	: 3 (C	DOT BDM 202.2.3.1)				
For cohesive foundation	n soil:					
	1.0011.					
Maximal a Station of						
<u>Meyerhof's Method</u>	n=v*D €	an be neglected since footing depth is les	e than 5 ft			
q <sub>u</sub> =c*N <sub>c</sub> *s <sub>c</sub> +q*N <sub>q</sub>	4-10 0	an be neglected since looting depth is les	s than 5 ft			
			44 and N = 4			
Since footing dimension	is are not ki	hown assume $S_c=1.0$ . For $\phi = 0$ , use $N_c = 5$ .	14 and $N_q = 1$			
$q_a = q_u/FS =$	= 2570 ps	f				
	Use q <sub>a</sub> < 2	2570 psf				

For footings bearing in weathered bedrock, use presumptive allowable bearing of 10 tsf.

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Cr=0.000463xLLxGs         Based on CR below         vcv(ft2/day) = 9343.5*LLY-2.8542)         (Kulhewy and Mayne- 1990)         Soli         Soli       C/C         rganic Sita       0.035-0.06         rganic Sita       0.03-0.06         rganic Sita       0.03-0.06         rganic Clays and Sita       0.03-0.06         rganic Clays and Sita       0.03-0.06         satt       0.03-0.06         satt       0.03-0.06         Satt       0.05-0.07									CHECKED BY		EW	DATE		/23/07	-		
Boring         Sample         W         PL         LL         PI         CC         C/2         a.3           C-42         2         16         15         29         00307         00470				···				Ca	cutations Data								
Octory         Octory         O <tho< th="">         O         <tho< th=""><th></th><th></th><th></th><th></th><th></th><th>•</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>-</th><th></th><th>_</th></tho<></tho<>						•									-		_
C-42         4         22         33         930         0703         07052         07057           C-42         5         11         NP	Boring	Sample	~	PL	LL	РІ	Cc1	Cr <sup>2</sup>	e. <sup>3</sup>		Boring	Sample	<u> </u>	C <sub>v</sub> *(ft <sup>2</sup> /day)	C,*(fi	<sup>2</sup> /sec)	
C-42         4         22         23         33         300         07072         070772					ļ		ļ					<b> </b>					-
C.42       S       11       NP       NP         C.42       S       11       NP	<u>C-42</u>	2										· · · · · · · · · · · · · · · · · · ·					-
Link         D <thd< th=""> <thd< th=""> <thd< th=""> <thd< th=""></thd<></thd<></thd<></thd<>	<u> </u>				t		0(3)	0.067	0.9476					0,85	9.85	E:08)	4
Average       0.00       0.052       0.9483         Maximum       0.41       0.067       0.9510         Cc=PU74       Creation       0.41       0.067       0.9510         Cc=0000483LL/Gs       Creation       0.42       3.96E-05         D/Common CR below       Creation       0.42       3.96E-05         Virtue       Concerning       Concerning       0.032-0.06         Sol       C/Cr       C/Cr       (Kuthewy and Mayne- 1950)         Sol       C/Cr       (Kuthewy and Mayne- 1950)         Tranular Solis       0.042-06       (Kuthewy and Mayne- 1950)         Tranular Solis       0.042-06       (Horder Solis)       0.032-0.06         morphous and Fibrou Petil       0.032-0.06       (Horder Solis)       0.042-06         morphous and Fibrou Petil       0.032-0.06       (Horder Solis)       0.042-06         morphous and Fibrou Petil       0.032-0.06       (Horder Solis)       0.042-06         Maximum       0.032-0.06       (Horder Solis)       0.042-06       (Horder Solis)         C-42       2       16       15       29       (Horder Solis)       0.002-06         C-42       2       16       15       29       (Horder Solis)       0	C-42	5.	11	NP	NP.		<u> </u>	<u> </u>			<u>C-42</u>						4
Average         0.00         0.052         0.9433           Average         0.00         0.052         0.9433           Maximum         0.41         0.067         0.9510           Cc=PU74         Cree 000463XLLxGs         Average         0.14         0.067         0.9510           Cc=000463XLLxGs         Cree 000463XLLxGs         Maximum         3.42         3.96E-05           Cc=000463XLLxGs         Cv(ft2/day) = 9343.5*LL*         Statum         3.42         3.96E-05           ypical Values         Cv(ft2/day) = 9343.5*LL*         Cv(ft2/day) = 9343.5			[									···-	<u> </u>				-
Average       0.30       0.052       0.9433         Maximum       0.41       0.067       0.9510         Cc=PV74       (Creation Cases)       0.41       0.067       0.9510         (Creation Cases)       (Creation Cases)       0.052       0.9433         (Creation Cases)       (Creation Cases)       (Creation Cases)       (Creation Cases)         (Creation Cases)       (Creation Cases)       (Creation C		<u> </u>	┼──┦			-					·			-			-
Average         0.30         0.652         0.9493           Average         0.30         0.652         0.9493           Maximum         0.41         0.667         0.9510           JCc=PV74         Sold         0.057         0.9510           Jpaced nCR below         Minmum         0.41         0.667         0.9510           ypical Values         Curce. Holt and Kovacs (1981)/ Terzaphi, Peck and exerce itamb and Woltman (1969)         Curce. Holt and Kovacs (1981)/ Terzaphi, Peck and exerce itamb and Woltman (1969)           ypical Values         Curce. Holt and Kovacs (1981)/ Terzaphi, Peck and exerce itamb and Woltman (1969)         WM (CRE(C)/1+e.)           ypinic Clays and Silts         0.035.0.065         0.064.0.06         0.01-0.03           Intel and mudstones         0.024.0.04         0.035.0.05         0.036.0.05           intig Clay         0.036.0.05         0.056.0.07         0.036.0.05           Sold         0.023.0.06         Curce italian         0.056.0.07           Boring         Sample         W         PL         LL         PL           C-42         2         16         15         20         Correlation         0.021.0*2           C-42         5         11         PN         Correlation         0.021.0*2	<u> </u>		┝━┈┨		<u>  ·                                    </u>										i		
Maximum       0.41       0.987       0.9510         Maximum       0.41       0.987       0.9510         Maximum       0.42       0.987       0.9510         Maximum       0.42       0.987       0.9510         Vipical Values       0.087       0.9510       Maximum       0.42         Source:       Holt and Koves (1981)       Terzephi, Peck and Jase (1985)       C/C       C/C       Correlation Values-Source:       Lamb and Whitmen (1969)         Vipical Values       0.035-0.065       With CR=(C,41+e_0)       9.983       2.339       11.785       2.647         Signark Silts       0.04-0.05       Terruler Solis       0.01-0.03       11.785       2.647       14.447       3.016         Signark Silts       0.03-0.06       0.03-0.06       11.785       2.647       14.447       3.016       17.099       3.825       19.916       4.4892       2.9332       11.785       2.647       14.447       3.016       19.982       23.328       19.916       24.382       10.91       19.982       23.328       11.99       13.139       16.388       16.388       16.388       16.388       16.388       16.328       16.274       33.428       16.114       50.1494       52.174       50.1494<			<b>├──</b> ┨		<u> </u>		1						<u> </u>				7
Maximum       0.41       0.97       0.9510         Maximum       0.41       0.97       0.9510         Cc=PV74		_ <b></b>			1	Auerone	0.30	0.057	0.9493			1	Minmum	0.85	9.85	E-06	7
CC=PV74       Maximum 3.42 3.96E-05         CC=0000463xLLxGs       ) Based on CR below         vpical Values       Correlation Values-Source: Lamb and Whitman (1969)         vvia CR=(CV1+s_0)       943.5 °LL (*2.8542)         (Kuthawy and Mayne - 1990)       Values-Source: Lamb and Whitman (1969)         vvia CR=(CV1+s_0)       943.5 °LL (*2.8542)         via CR=(CV1+s_0)       943.5 °LL (*1.852)         via CR=(CV1+s_0)       943.5 °LL (*1.852)         via CR=(CV1+s_0)       943.5 °L (*1.852)         via CR=(CV1+s_0)       943.2 °L (*1.852)         via CR=						-			· .								1
J. Czer Vr4         J. Based on C.R. bellow         'Cv(ft2/day) = 9343.5*LL*(-2.8542)         (Kulhawy and Mayne-1990)             vpical Values         correct: Holts and Kovacs (1981)/ Terzaphi, Peck and tearl (1995)         'granic Sitis       0.035.0.05         importhous and Fibrous Peat       0.035.0.05         ingranic Sitis       0.040.06         instructure Solits       0.040.06         instructure Solits       0.040.06         instructure Solits       0.030.06         ed       0.030.06         Boring       Sample         W       PI         LL       PI         LL       Consolidation*         132.22       16         15       29         C-42       2         1       NP         C-42       4         2       10         C-42       5         1       NP         1       NP         1       NP         1       NP         1       NP         1       NP         1       Consolidation*         10032       0030         <						Maximum	0.47	0.001	0.5010				-				
Based on CR below       *Cv(rt2/day) = 9343.5*LL*(-2.8542)       (Kulhawy and Mayne-1990)         ypical Values																	
ypical Values         ource: Holtz and Kovacs (1981)/ Terzaphi, Peck and tear (1995)         Soil       C/C; impanic Silts         0.0355.0.06 morphous and Fibrous Peat       0.035.0.06 morphous and Fibrous Peat         ypinic Clays and Silts       0.04-0.06 morphous and Fibrous Peat         incert and mudstores       0.022.0.04 morphous and Fibrous Peat         incert and mudstores       0.022.0.04 morphous and Fibrous Peat         incert and mudstores       0.02-0.06 morphous and Fibrous Peat         eat       0.03-0.06 morphous         eat       0.03-0.06 morphous         Gening       Sample         w       PL         LL       PI         L1       Consolidation*         152.740       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-08w*3 - 0.0021w*2 + 0.4695w - 3.1337         R*e0.9992	/-										*Cv(ft2/day	) = 9343.5*	'LL^(-2.854	2) (Kulhawy	and Mayne	⊢ 1990)	
Course: Holiz and Kovacs (1981)/ Terzaphi, Peck and Isar(1995)       Carcian         Soil       CarC;         Urganic Silts       0.035-0.06         imorphous and Fibrous Peat       0.035-0.06         irganic Silts       0.04-0.05         irganic Silts       0.04-0.05         irganic Silts       0.04-0.06         irganic Silts       0.01-0.03         hale and mudstones       0.02-0.04         ilty Clay       0.03-0.06         isat       0.05-0.07             Boring       Sample         W       PL       LL       PI         Lit       Consolidation**         0.4-2       2       16       15         C-42       5       11       NP       NP         Consolidated when Li<0.7	Basad on on che bolow									•		<u> </u>					
Amorphous and Fibrous Peat       0.035-0.085         Organic Clays and Silts       0.04-0.06         Sinale and mudstones       0.02-0.04         Sinale and mudstones       0.02-0.04         Sinale and mudstones       0.02-0.04         Sinale and mudstones       0.05-0.07         Seat       0.05-0.07 <tr< th=""><th>Aesri (1995)</th><th></th><th></th><th>nd</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>b and Whitma</th><th>n (1969)</th><th></th><th></th></tr<>	Aesri (1995)			nd										b and Whitma	n (1969)		
Minor Licolar and Silts       0.04-0.06         Sranular Solts       0.01-0.03         inale and mudstones       0.02-0.04         itty Clay       0.03-0.06         reat       0.05-0.07         Stanular Solts       0.05-0.07         Boring       Sample         W       PL       LL         V       PL       LL         V       V       PL         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V       V         V       V	ource: Holtz and Kovacs (19 Aasri (1995) Soil	C_/C		nd							w%	CR=(C,/1	+0,)	b and Whitma	n (1969)		
Induction       Instantian Solis       0.01-0.03         inate and mudstones       0.02-0.04         itty Clay       0.03-0.06         ieat       0.05-0.07         ieat       0.05-0.07         Boring       Sample         w       PL         LL       PI         Li       Consolidation*         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	ource: Holtz and Kovacs (19) tesri (1995) Soil Drganic Silts	C <sub>a</sub> /C <sub>t</sub>		nd							<b>w%</b> 9.983	CR=(C,/1 2.	+e <sub>s</sub> ) .389	b and Whitma	n (1969)	<u></u>	
Inside and mudstores       0.02-0.04         itty Clay       0.03-0.06         reat       0.05-0.07         reat       0.05-0.07         Boring       Sample         W       PL       LL         L       C-42         2       16       15         C-42       2       16       15         C-42       4       26       23       53         S0       C070       CorrectionsOkdatedI       501.494       52.174         C-42       5       11       NP       NP       CorrectionsOkdatedI         Correlation: CR=-4E-09w^4 + 5E-06w^3 - 0.0021w^4 2 + 0.4695w - 3.1337       R <sup>2</sup> =0.9992         Dyerconsolidated when Li<0.7	ource: Holtz and Kovacs (19) tesri (1995) Soil Organic Silts morphous and Fibrous Peat	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085	Peck ar	nd							<b>w%</b> 9.983 11.785 /	CR=(C,/1 2.	+e <sub>o</sub> )	b and Whitma	n (1969)		-
inty Cuty       0.050007         eat       0.05007         isat       0.05007         Boring       Sample         W       PL       LL         PI       L1       Consolidation*         51.139       16.388         79.829       23.326         152.740       33.469         341.288       46.114         50.422       2         16       15         29       74.30         C-42       4         26       23         53       11         NP       NP         10       10         10       10         10       10         10       10         10       10         11       NP         10       10         11       10         11       10         12       10         13       10         14       10         15       11         15       11         15       10         15       11         15       10         16       10 <td>ource: Holtz and Kovacs (194 tesrl (1995) Soil Irganic Silts Imorphous and Fibrous Peat Irganic Clays and Silts</td> <td>C<sub>a</sub>/C<sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06</td> <td>Peck ar</td> <td>nd</td> <td></td> <td>·</td> <td></td> <td></td> <td></td> <td></td> <td>w% 9.983 11.785 / 14.487</td> <td>CR=(C,/1 2. 3.</td> <td>+6,)</td> <td>b end Whitma</td> <td>n (1969)</td> <td><u></u></td> <td></td>	ource: Holtz and Kovacs (194 tesrl (1995) Soil Irganic Silts Imorphous and Fibrous Peat Irganic Clays and Silts	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06	Peck ar	nd		·					w% 9.983 11.785 / 14.487	CR=(C,/1 2. 3.	+6,)	b end Whitma	n (1969)	<u></u>	
and       0.000000 j         and       0.000000 j         Boring       Sample       w         Boring       Sample       w         C-42       2       16       15       29       c.14000000000000000000000000000000000000	ource: Holtz and Kovacs (19) Assr[ (1995) Soil Organic Silts Imorphous and Fibrous Peat Organic Ctays and Silts Granular Soils	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03	Peck ar	nd					·		<b>w%</b> 9.983 11.785 14.487 17.099 19.816	CR=(C_/1 2 3 3 4	+e <sub>o</sub> ) 389 547 .016 .825 .892	b and Whitma	n (1969)		
Boring         Sample         w         PL         LL         PI         LI         Consolidation*           6         6         6         6         6         6         6         6         79.829         23.326         152.740         33.469         341.288         46.114         501.494         52.174         501.494         52.06w^3 - 0.0021w^2 + 0.4695w - 3.1337         R <sup>2</sup> = 0.9992         50.9992         50.9992         50.9992         50.9992         50.9992         50.9992         50.9992         50.9992	ource: Holtz and Kovacs (19) Aesrl (1995) Soil Drganic Silts unorphous and Fibrous Peat Organic Clays and Silts Granular Soils inste and mudstones	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06	Peck ar	nd							<b>w%</b> 9.983 11.785 14.487 17.099 19.816 25.352	CR=(C_11 2 3 3 4 6	+e <sub>o</sub> )	b and Whitma	n (1969)		
Boring         Sample         w         PL         LL         PI         LI         Consolidation*           6         6         5         29         5         16         15         29         5         16         15         29         5         16         15         29         5         10         0         341.288         46.114         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.06w^3 - 0.0021w^2 + 0.4695w - 3.1337         R <sup>2</sup> =0.9992         29.9992         501.494         52.06w^3 - 0.0021w^2 + 0.4695w - 3.1337         R <sup>2</sup> =0.9992         501.494	Source: Holtz and Kovacs (194 Assr[ (1995) Soil Drganic Silts wromphous and Fibrous Peat Organic Clays and Silts Granular Solts inate and mudstones ithty Clay	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06	Peck ar	nd							<b>w%</b> 9.983 11.785 14.487 17.099 19.816 25.352 28.328	CR=(C <sub>4</sub> /1 2. 3. 3. 4. 6. 8.	+e <sub>0</sub> )	b and Whitma	n (1969)		
Boring         Sample         w         PL         LL         PI         LI         Consolidation*           6         79.829         23.326         152.740         33.469         341.288         46.114         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.06w^3 - 0.0021w^4 + 0.4695w - 3.1337         R <sup>2</sup> = 0.9992         6000000000000000000000000000000000000	Source: Holtz and Kovacs (194 Assr[ (1995) Soil Drganic Silts wromphous and Fibrous Peat Organic Clays and Silts Granular Solts inate and mudstones ithty Clay	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06	Peck a	nd							<b>w%</b> 9.983 11.785 14.487 17.099 19.816 25.352 28.328 34.174	CR=(C <sub>0</sub> /1 2 3 3 4 6 8 10	+e <sub>6</sub> ) 	b and Whitma	n (1969)		
Boring         Sample         w         PL         LL         PI         LI         Consolidation*           1         1         1         1         1         1         1         1         1         33.469         341.288         46.114         501.494         52.174         501.494         52.174         501.494         52.174         501.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.494         52.174         50.499         52.174	Source: Holtz and Kovacs (194 Assr[ (1995) Soil Drganic Silts wromphous and Fibrous Peat Organic Clays and Silts Granular Solts inate and mudstones ithty Clay	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06	Peck ar	nd			·				<b>w%</b> 9.983 11.765 14.487 17.099 19.816 25.352 28.328 34.174 42.400	CR=(CJ1 2 3 3 4 6 8 8 10 13	+ <b>6</b> ,) 389 547 016 825 931 079 0.369 3.490	b and Whitma	n (1969)		
Builty         Calify         Control         Control <thcontrol< th=""> <thcontrol< th=""> <thcon< td=""><td>Source: Holtz and Kovacs (194 Assr[ (1995) Soil Drganic Silts wromphous and Fibrous Peat Organic Clays and Silts Granular Solts inate and mudstones ithty Clay</td><td>C<sub>a</sub>/C<sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06</td><td>Peck ar</td><td>nd</td><td></td><td></td><td></td><td></td><td></td><td></td><td>w% 9.983 11.785 14.487 17.099 19.816 25.352 28.328 34.174 42.400 51.139</td><td>CR=(CJ1 2 3 3 4 6 6 10 13 16</td><td>+<b>6</b>,) .389 .547 .016 .825 .931 .079 .369 .3490 .3.388</td><td>b and Whitma</td><td>n (1969)</td><td></td><td></td></thcon<></thcontrol<></thcontrol<>	Source: Holtz and Kovacs (194 Assr[ (1995) Soil Drganic Silts wromphous and Fibrous Peat Organic Clays and Silts Granular Solts inate and mudstones ithty Clay	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06	Peck ar	nd							w% 9.983 11.785 14.487 17.099 19.816 25.352 28.328 34.174 42.400 51.139	CR=(CJ1 2 3 3 4 6 6 10 13 16	+ <b>6</b> ,) .389 .547 .016 .825 .931 .079 .369 .3490 .3.388	b and Whitma	n (1969)		
C-42       2       16       15       29       114       [0:07]       Coverconsolidated]         C-42       4       26       23       53       [0:07]       [0:07]       Coverconsolidated]         C-42       5       11       NP       NP       [0:07]       Coverconsolidated]         C-42       5       11       NP       NP       [0:07]       Coverconsolidated]         C-42       5       11       NP       NP       [0:07]       [0:07]       Coverconsolidated]         C-42       5       11       NP       NP       [0:07]       [0:07]       [0:07]         C-42       5       11       NP       NP       [0:07]       [0:07]       [0:07]       [0:07]         Coverconsolidated when Li<0.7	ource: Holtz and Kovacs (19 Itest (1995) Soil Jorganic Silts Imorphous and Fibrous Peat Jorganic Clays and Silts iranular Soils Insile and mudstones itty Clay teot	C <sub>4</sub> /C <sub>6</sub> 0.035-0.065 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07							solidation*		w% 9.983 11.785 14.487 17.099 19.816 25.352 28.328 34.174 42.400 51.139 79.829	CR=(C,/1 2. 3. 3. 4. 6. 8. 8. 10. 11. 13. 16. 23.	+ <b>e</b> <sub>0</sub> )	b and Whitma	n (1969)		
C-42         4         26         23         53         US01         COvercionsOlidated II           C-42         5         11         NP         NP         CovercionsOlidated II         CovercionsOlidated II           C-42         5         11         NP         NP         CovercionsOlidated II         CovercionsOlidated II           C-42         5         11         NP         NP         CovercionsOlidated II         CovercionsOlidated II           Overconsolidated when L1         0	ource: Holtz and Kovacs (19 Itest (1995) Soil Jorganic Silts Imorphous and Fibrous Peat Jorganic Clays and Silts iranular Soils Insile and mudstones itty Clay teot	C <sub>4</sub> /C <sub>6</sub> 0.035-0.065 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07			LL	PI	LI	Con	solidation*		w% 9.963 11.765 14.487 17.099 19.816 25.352 28.328 34.174 42.400 51.139 79.829 152.740	CR=(CJ1 2. 2. 3. 3. 3. 4. 4. 6. 6. 8. 10. 10. 10. 10. 10. 10. 10. 10. 10. 10	+•••) 389 547 016 825 892 931 079 3.369 3.388 3.326 0.469	b and Whitma	n (1969)		
C42         5         11         NP         NP         Constant         Constant <thconstant< th="">         Constant         <t< td=""><td>ource: Holtz and Kovacs (19 Isoil Soil Inganic Silts morphous and Fibrous Peat Organic Clays and Silts inate and mudstones itty Clay reat Boring</td><td>C<sub>4</sub>/C<sub>5</sub> 0.035-0.065 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07</td><td></td><td>PL</td><td></td><td></td><td></td><td></td><td></td><td></td><td>w%           9.963           11.785           14.487           17.099           19.816           25.52           28.328           34.174           42.400           51.139           79.829           152.740           341.288</td><td>CR=(CJ1 2. 2. 3. 3. 3. 4. 6. 8. 10. 10. 10. 10. 10. 10. 10. 10. 10. 10</td><td>+•••) 3389 547 016 825 892 931 0.79 0.369 3.388 3.326 0.469 3.114</td><td>b and Whitma</td><td>n (1969)</td><td></td><td></td></t<></thconstant<>	ource: Holtz and Kovacs (19 Isoil Soil Inganic Silts morphous and Fibrous Peat Organic Clays and Silts inate and mudstones itty Clay reat Boring	C <sub>4</sub> /C <sub>5</sub> 0.035-0.065 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07		PL							w%           9.963           11.785           14.487           17.099           19.816           25.52           28.328           34.174           42.400           51.139           79.829           152.740           341.288	CR=(CJ1 2. 2. 3. 3. 3. 4. 6. 8. 10. 10. 10. 10. 10. 10. 10. 10. 10. 10	+•••) 3389 547 016 825 892 931 0.79 0.369 3.388 3.326 0.469 3.114	b and Whitma	n (1969)		
Image: Participation of the second	ource: Holtz and Kovacs (19 Isoil 1995) Soil Irganic Silts morphous and Fibrous Peat Irganic Clays and Silts inste and mudstones iity Clay eat Boring C-42	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07	w 16	PL 15	29	14	007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.52           28.328           34.174           42.400           51.139           79.829           152.740           341.288	CR=(CJ1 2. 2. 3. 3. 3. 4. 6. 8. 10. 10. 10. 10. 10. 10. 10. 10. 10. 10	+•••) 3389 547 016 825 892 931 0.79 0.369 3.388 3.326 0.469 3.114	b and Whitma	n (1969)		
Dverconsolidated when Li<0.7	ource: Holtz and Kovacs (19 Isoil 1995) Soil Drganic Silts morphous and Fibrous Peat Drganic Clays and Silts stanular Soils hate and mudstones ilty Clay reat Boring C-42 C-42	C <sub>a</sub> /C <sub>c</sub> 0.035-0.065 0.035-0.085 0.04-0.065 0.01-0.03 0.02-0.04 0.03-0.065 0.05-0.07 Sample 2 4	w 16 26	PL 15 23	29 53	14	007	Over	consolidated)		w%           9.983           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494	CR=(CJ1 2. 2. 3. 3. 4. 6 8 8 10 10 10 10 10 10 10 10 10 10 10 10 10	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3	1337
Overconsolidated when LI<0.7 Lef: Soils and Foundations Workshop Reference Manual- NHI-00-045 (p. 6.11)	ource: Holtz and Kovacs (194 tesri (1995) Soil Drganic Silts morphous and Fibrous Peat Drganic Clays and Silts inale and mudstones ilty Clay reat Boring C-42 C-42 C-42	C <sub>a</sub> /C <sub>c</sub> 0.035-0.065 0.035-0.085 0.04-0.065 0.01-0.03 0.02-0.04 0.03-0.065 0.05-0.07 Sample 2 4	w 16 26	PL 15 23	29 53	14	007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337
ter: Soils and Foundations Workshop Reference Manual- NHI-00-045 (p. 6.11)	ource: Holtz and Kovacs (194 tesri (1995) Soil Drganic Silts morphous and Fibrous Peat Drganic Clays and Silts inale and mudstones ilty Clay reat Boring C-42 C-42 C-42	C <sub>a</sub> /C <sub>c</sub> 0.035-0.065 0.035-0.085 0.04-0.065 0.01-0.03 0.02-0.04 0.03-0.065 0.05-0.07 Sample 2 4	w 16 26	PL 15 23	29 53	14	007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337
	Boring C-42 C-42 C-42 C-42	C <sub>a</sub> /C <sub>c</sub> 0.035-0.06 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07 Sample 2 4 5	w 16 26	PL 15 23	29 53	14	007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337
	Source: Holtz and Kovacs (19 Assrl (1995) Soil Drganic Silts morphous and Fibrous Peat Drganic Clays and Silts Sranular Soils Inale and mudstones ility Clay Peot Boring C-42 C-42 C-42 C-42 Overconsolidated when Li<0.	C <sub>4</sub> /C <sub>6</sub> 0.035-0.065 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07 Sample 2 4 5 7	w 16 26 11	PL 15 23 NP	29 53 NP		007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337
	Source: Holtz and Kovacs (19 Assrl (1995) Soil Drganic Silts morphous and Fibrous Peat Drganic Clays and Silts Sranular Soils Inale and mudstones ility Clay Peot Boring C-42 C-42 C-42 C-42 Overconsolidated when Li<0.	C <sub>a</sub> /C <sub>c</sub> 0.035-0.065 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07 Sample 2 4 5 7	w 16 26 11	PL 15 23 NP	29 53 NP		007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337
	ource: Holtz and Kovacs (19 Isoil Soil Inganic Silts Imorphous and Fibrous Peat Organic Clays and Silts iranular Soils Ingle and mudstones ilty Clay eat Boring C-42 C-42 C-42 C-42 Overconsolidated when Li<0.	C <sub>a</sub> /C <sub>c</sub> 0.035-0.065 0.035-0.085 0.04-0.06 0.01-0.03 0.02-0.04 0.03-0.06 0.05-0.07 Sample 2 4 5 7	w 16 26 11	PL 15 23 NP	29 53 NP		007	Over	consolidated)		w%           9.963           11.785           14.487           17.099           19.816           25.352           28.328           34.174           42.400           51.139           79.829           152.740           341.288           501.494           Correlation	CR=(CJ1 2. 2. 3. 3. 4. 6. 8. 8. 10. 13. 14. 6. 23. 33. 4. 4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.	+•••) 3889 547 016 825 892 931 0.79 3.388 3.326 3.326 3.326 3.314 2.174			4695w - 3.	1337

\* Assume Jc & 1396 pst . Taken from Shumway Hollow Interchange Report, Romp C Analysis

			SUBJE	CT Clier	nt TranSystem	is, Inc.	JOB NUMBER	0121-3070.0	13		
4.2					ect SCI-823-0.0		SHEET NO.		2	OF	3
654				Item	<u></u>	TA.379+00 TW 234 Ramp C	COMP. BY	WN	1A	DATE	08/10/07
					d on Boring C-4		CHECKED BY	BE		DATE	08/23/07
						<u> </u>				-	
-				SETT	LEMENT	ANALYSIS - EMBAN	NKMENT				
	Embank	ment Ir	<u>aformaiton:</u>			Groundwater Table:	D= 12.0	ft	•		
	0		6 <u>16</u> 6	• <u>• •</u>		Embankment Height:	H = 20	ft			
ļ						Fill Unit Weight:	$\gamma_{emb} = 120$	pcf	q = 2,	400 psf	
						Width of Slope:	a = 54				
						Top half-width of Emb	b = 20				
1	$\prec$	5	a	[		Distance from CL:	$\mathbf{x} = 0$	•			
		Ň						to 2	20 ft		
• .			$\searrow$			Output Range:		10 .	20 11		
						*See Data output Atta					
				V(	ı, a <sup>4</sup> (	$z) := \left(\frac{q}{\pi a}\right) (a (\alpha(z) +  $	$\beta(z) + \alpha'(z) + b$	o (α(z) + a	t'(z)) + x	(a(z) -	α'(z)))
		_		· ·	[z.,			[(a+b+	- x1 1	Гrъ	+ x1 1
. (	3(z) := at	an (b -	$\frac{x}{b}$ + atan $\frac{(b+x)}{b+x}$	<u>0</u>   -œ'	(z) := atan (4+	$\left(\frac{b-x}{z}\right) - \operatorname{atan}\left(\frac{(b-x)}{z}\right)$	a(z) <sup>:=</sup> atar		<u></u> a	itan [ <u>&gt;-</u>	<u></u>
		_ z							•	-	
-			Refe	rence: US Army	Corps of Engin	eers EM 1110-1-1904 "Settlen					
						•	C	ohesionless			
1	Soil Pro	perties:	Settlement is c	calculated at mi			_1 ( 0	SoilsC'	<u> </u>	hesive So C <sub>e</sub>	
											eo
	Bot. of L	ayer	Soil Type	$\gamma_{soil}$ (pcf	) σ' <sub>c</sub> (psf)	$\sigma'_{o}$ (psf) $\Delta \sigma z$ (psf)	$\sigma'_{f}$ (psf)			-c	· · · · ·
	Bot. of L 8.0	ayer ft	Soil Type Sandy Silt	$\gamma_{soil}$ (pcf)	) σ' <sub>c</sub> (psf) 1,396	$\frac{\sigma_{o}^{\circ} \text{ (psf)}}{480}  \frac{\Delta \sigma z \text{ (psf)}}{2,399}$	2,879	0.0	0.04	0.19	0.951
No. 1									1		
No. 1 2	8.0 10.5	ft	Sandy Silt	120	1,396	480 2,399	2,879	0.0	0.04	0.19	0.951
No. 1	8.0 10.5 14.0	ft ft	Sandy Silt Clay	120 120	1,396 1.396	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4	8.0 10.5 14.0 0.0	ft ft	Sandy Silt Clay	120 120 0	1,396 1.396 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4 5	8.0 10.5 14.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0	1,396 1.396 0 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4	8.0 10.5 14.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0	1,396 1.396 0 0 0 0 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4 5 6 7	8.0 10.5 14.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4 5 6 7 8	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 1 2 3 4 5 6 7	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385	2,879 3,495	0.0	0.04	0.19 0.41	0.951 0.948
No. 1 2 3 4 5 6 7 8 9	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385           1,244         2,368	2,879 3,495 3,612	0.0 0.0 140.0	0.04 0.07 0.00	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay	120 120 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385	2,879 3,495 3,612	0.0 0.0 140.0	0.04 0.07 0.00	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft	Sandy Silt Clay Sand	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385           1,244         2,368   Reference: Geotechnical Engi Overconsolidated Soils	2,879 3,495 3,612 	0.0 0.0 140.0	0.04 0.07 0.00	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft 	Sandy Silt Clay	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	480 2,399 1,110 2,385 1,244 2,368 Reference: Geolechnical Engi	2,879 3,495 3,612 	0.0 0.0 140.0	0.04 0.07 0.00	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	480         2,399           1,110         2,385           1,244         2,368   Reference: Geotechnical Engi Overconsolidated Soils	$\frac{2,879}{3,495}$ $3,612$ $\frac{3}{3,612}$ $\frac{1}{3,612}$ $\frac{1}{3,612}$ $\frac{1}{3,612}$ $\frac{1}{3,612}$ $\frac{1}{3,612}$	0.0 0.0 140.0	0.04 0.07 0.00	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $1,110$ $2,385$ $1,244$ $2,368$ $Reference: Georechnical Engineration of the second second$	2,879 $3,495$ $3,612$ $a,612$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 Coduto, 1999 1.24 qn:11.25	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $1,110$ $2,385$ $1,244$ $2,368$ $Reference: Georechnical Engineration of the second second$	2,879 $3,495$ $3,612$ $a,612$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 Coduto, 1999 1.24 qn:11.25	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{1,110} = 2,399$ $\frac{1,110}{2,385}$ $\frac{1,244}{2,368}$ $Reference: Geotechnical Engineration of the second s$	2,879 $3,495$ $3,612$ $a,612$ $a,61$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $1,110$ $2,385$ $1,244$ $2,368$ $Reference: Geotechnical Engineration of the second second$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{1}{3,612}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $1,110$ $2,385$ $1,244$ $2,368$ $Reference: Geotechnical Engineration of the second second$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{1}{3,612}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{1,110} = 2,399$ $\frac{1,110}{2,385}$ $\frac{1,244}{2,368}$ $Reference: Geotechnical Engineration of the second s$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{1}{3,612}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 	0.19 0.41 0.00	0.951 0.948
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $\frac{1,110}{2,385}$ $\frac{2,399}{1,110}$ $\frac{2,385}{1,244}$ $\frac{2,368}{2,368}$ $Reference: Geotechnical Engineration of the second s$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{3}{5}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{140.0}{1}$ $\frac{1}{\sigma'} = 0$ $\frac{\sigma'}{\sigma'} = 0$	0.04 0.07 0.00 0.00	0.19 0.41 0.00	0.951 0.948 0.000
No. 1 2 3 4 5 6 7 8 9 10 No. 1	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $\frac{1,110}{2,385}$ $\frac{2,368}{1,244}$ $\frac{2,368}{2,368}$ $Reference: Geotechnical Engineration of the second secon$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{1}{3,612}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{1}{140.0}$ $\frac{1}{1$	0.04 0.07 0.00 0.00	0.19 0.41 0.00	0.951 0.948 0.000
No. 1 2 3 4 5 6 7 8 9 10 No. 1 2 3 4 5 6 7 8 9 10 10 10 10 10 10 10 10 10 10	8.0 10.5 14.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	ft ft ft 	Sandy Silt Clay Sand Total Settlemen 0.545	120 120 0 0 0 0 0 0 0 0 0 0 0 120 0 0 0 0 0 0 0 0 0 0 0 0 0	1,396 1.396 0 0 0 0 0 0 0 0 0 0 0 0 0	$\frac{480}{2,399}$ $\frac{1,110}{2,385}$ $\frac{2,399}{1,110}$ $\frac{2,385}{1,244}$ $\frac{2,368}{2,368}$ $Reference: Geotechnical Engineration of the second s$	$\frac{2,879}{3,495}$ $3,612$ $\frac{3,612}{3,612}$ $\frac{1}{3,612}$	$\frac{0.0}{0.0}$ $140.0$ $\frac{140.0}{1}$ $\frac{1}{\sigma'} = 0$ $\frac{\sigma'}{\sigma'} = 0$	0.04 0.07 0.00 0.00 0.00 0.00 0.00 0.00	0.19 0.41 0.00	0.951 0.948 0.000



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