The Indiana Department of Transportation

Office of Geotechnical Engineering
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Driving Indiana's Economic Growth

July 27, 2007

Kim Pryor
32 South Broadway Street
Greenfield, Indiana 46074

Subject: Geotechnical Investigation - Addendum
Des No: 0401228
Project No: DEM – IN55 (001)
I-65/I-70 at Market/Ohio/Washington Street Interchange,
Marion County

Gentlemen:

Attached herewith is the addendum to the Geotechnical Report for the subject project. This addendum provides recommendations for the proposed high mast light towers and the siphon structure for the subject project.

If you have any questions concerning the above matter, please call us.

Very truly yours,

Athar A. Khan, P.E., Manager
Office of Geotechnical Engineering

Youlanda K. Belew
Geotechnical Engineer

AK/YKB
cc: American Structurepoint, Inc. - Attn: Mr. K. Jasinski - Attachments
Indianapolis Dept. of Public Works – Attn: Mr. Bill Chappell - Attachments
Mr. Fike Abbasi - Attachments
Ms. Kimberlee Parker - Attachments
Ms. Susan Languell - Attachments
Mr. David Cohen – Attachments
Mr. Jon Paauwe - Attachments
File

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ATC ASSOCIATES INC.
Engineering Individual Solutions

7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256-3346
317-849-4990
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July 23, 2007

American Structurepoint, Inc.
7260 Shadeland Station
Indianapolis, IN 46256-3957

Attn: Mr. Kevin G. Jasinski, P.E.

Re: Addendum No. 1 to Geotechnical Engineering Investigation
Proposed Washington Street Interchange
Indianapolis, Marion County, Indiana
INDOT Project No. IN 55 (001)
INDOT Des. No. 0401228
ATC Project No. 86.00481.0159

The purpose of this addendum report is to provide recommendations regarding the design of the proposed high mast light tower foundations and the siphon structure for the referenced project. Recommendations for use in design of the high mast light tower foundations and siphon structure are included in the following sections.

High Mast Light Tower Foundations

The project will include the installation of two new high mast lights, one near the crossing of Interstate 65 over Market Street (i.e., south of Market Street and west of Interstate 65) and one near the interchange for Washington Street. The approximate locations of the high mast lights are summarized in the following table:

HIGH MAST LIGHT LOCATIONS

Tower Designation	Station	Line	Offset
T-7	411+45	"I-65"	200 ft Left
T-8	418+47	"I-65"	115 ft Left

It is assumed that the proposed high mast light towers will be supported on drilled shaft foundations. The INDOT Standard High Mast Tower Foundation (INDOT Standard Drawing No. E 807-LTFD-07) consists of a 4.0 ft diameter drilled shaft that is 20 ft long with 20 full length #11 reinforcing steel bars and INDOT Class C concrete. This foundation size, minimum length, reinforcing steel and concrete arrangement were used in our analyses. At the time of this study, the specific information regarding the tower heights and loading conditions had not been determined. For the purpose of this study it

has been assumed that the maximum bending moment, axial force and shear force at the bases of the high mast light towers (i.e., the top of the foundations) will not exceed 500,000 ft-lbs., 8,000 lbs. and 7,000 lbs., respectively, and that the towers can tolerate a maximum pile head deflection of 1 in. If the actual loading conditions on either of the high mast lights exceed these values, the foundations should be analyzed based on the specific loading conditions. Furthermore, if the actual high mast light locations vary from those summarized above, additional analyses, and possibly additional test borings, will be required.

Lateral foundation analyses were performed using the computer program LPILE Plus 5.0 for the high mast light tower locations based on the standard high mast light drilled shaft foundation described above, the assumed cyclic loading conditions (100 cycles) and the test borings that were drilled at or near the proposed foundation locations. The table below lists the soil parameters used in the analyses, which were estimated from the results of the test borings. The results of the lateral foundation analyses are included with this report. The analyses indicate that the proposed high mast lights summarized in the table above can be supported on the INDOT standard foundation (as described above). The analyses indicate that the lateral deflection at the top of the drilled shaft foundations will not exceed about 1 in. under the assumed loading conditions. It should be noted that loading conditions have been assumed and that these analyses do not account for any underground utilities that may be located in the vicinity of the high mast light tower foundations. The recommendations contained herein are based on the assumption that any underground utilities that are located near the tower foundations will provide lateral resistance at least as great as the soil conditions used in the models and that the utilities can withstand the loads imparted by the foundations.

Summary of Parameters for Analysis of Light Tower T-7 Foundation
Boring No. TL-101

Soil Type	Layer Depths, in.	Subgrade Modulus, lbs/cu.in.	Effective Unit Weight, lbs/cu.in.	Cohesion, lbs/sq.in	ε_{50}	Angle of Internal Friction, degrees
Clay	0 – 42	--	0.064	3.5	0.02	0
Sand	42 – 156	90	0.069	0.0	--	32
Sand	156 - 360	125	0.038	0.0	--	34

Summary of Parameters for Analysis of Light Tower T-8 Foundation
Boring No. RB-23

Soil Type	Layer Depths, in.	Subgrade Modulus, lbs/cu.in.	Effective Unit Weight, lbs/cu.in.	Cohesion, lbs/sq.in	ε_{50}	Angle of Internal Friction, degrees
Clay	0 – 60	--	0.064	3.5	0.02	0
Sand	60 – 108	25	0.069	0.0	--	30
Sand	108 – 180	90	0.069	0.0	--	33
Sand	180 - 360	60	0.038	0.0		33

The drilled shafts should be designed and constructed in accordance with INDOT's "Special Provision for Drilled Shaft Foundations", which has been attached. Temporary steel casing will likely be required to prevent caving of the soils into the excavations.

It is recommended that the geotechnical consultant observe the entire drilling operations during the drilled shaft installation process. The inspection of the drilled shaft can be performed without entering the shaft excavations by observing the drilling operations and auger-cuttings throughout the entire length of the shaft excavation. It is important that the shaft excavation and subsurface conditions be monitored until the concrete placement is complete to verify that the otherwise competent soils are not adversely affected by improper construction methods. It is important that the concrete be placed and the casing removed in such a fashion as to prevent "necking" of the drilled shaft and inclusion of soil and water within the shaft. Unless the excavation is entirely dry, the concrete must be placed by tremie or concrete pump in accordance with INDOT's special provisions.

The ground water level in the test borings that were drilled for, or near, the proposed high mast lights was at a depth of about 17 to 18 ft below the existing ground surface. Therefore, the drilled shafts will need to be installed using the "wet method" of construction using a polymer slurry in conjunction with temporary casing to prevent caving of the sides and heaving/deterioration of the materials since the soils below a depth of about 3.5 ft is sand and gravel. The concrete must be placed using a tremie or a pump. Alternatively, it may be possible to depress the ground water level below the drilled shaft bearing elevations in the vicinity of the foundations using deep wells, in which case the "dry method" of construction may be used in conjunction with temporary steel casing to prevent caving of the soils into the foundation excavation. It is recommended that the ground water level be maintained at least 3 ft below the deepest excavation level.

If a shaft excavation is to be entered (which is not recommended), all local, state and federal safety regulations, including those regarding confined space entry, should be followed. No open flame should be permitted on the site near the drilled shaft excavation and no personnel should be allowed to enter the excavation until proper safety precautions for confined space entry have been taken. Such precautions should include proper personal protective equipment and monitoring of the excavations for explosive vapors and oxygen

deficiency. Additional safety measures may be needed depending upon the specific conditions at the foundation locations, the construction procedures employed and the applicable local, state and federal Occupational Health and Safety Administration (OSHA) Regulations.

Market Street Siphon Structure

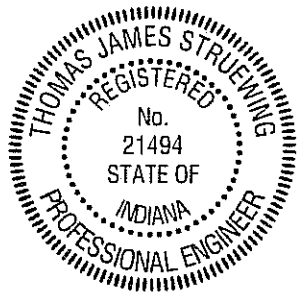
The natural soils encountered at the proposed invert elevation for the proposed siphon (i.e., about El 692) appear suitable for support of the structure. Any very loose sand encountered during excavation should be compacted and any soft cohesive soil should be removed and replaced prior to placing the siphon.

Based upon the ground water data obtained during drilling operations, it appears that dewatering will be required in excavations made during construction. Excavations that will extend below the ground water level will require significant dewatering measures. It will be necessary to install either deep wells or a well point system to adequately depress the ground water level well below the excavation level. It is recommended that the ground water level be maintained at least 3 ft below the base of the deepest excavation. A specialty dewatering contractor should be retained to install and maintain the dewatering system.

We appreciate the opportunity to be of continued service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,

ATC Associates Inc.



Shawn M. Marcum, P.E.
Project Engineer

Thomas J. Struewing, P.E.
Principal Engineer

Copies: (2) American Structurepoint, Inc. Attn: Mr. Kevin G. Jasinski, P.E.
(1) INDOT-Division of Geotechnical Engineering Attn: Mr. Athar A. Khan, P.E.

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
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317-849-4990
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TEST BORING LOG

CLIENT: American Consulting, Inc.
PROJECT NAME: Proposed Washington Street Interchange
PROJECT LOCATION: Marion County, Indiana
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: RB-23
JOB #: 86.00481.0159
STATION: 33+25 "PR-DN"
OFFSET: 30 ft Left

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 712	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.6 ft Concrete (Visual)	711.4	0.6									
Brown and black, moist, medium stiff, loam with cinders and brick fragments (FILL) (Lab No. 1) A-4				1	SS			6-5-3	12.9		Ground surface elevation estimated from plans provided by client
	708.5	3.5									
Brown, moist, medium stiff, silty loam (FILL) (Lab No. 2) A-7-6				2	SS			3-4-3	20.2	1.5	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	706.5	5.5	5								
Brown, moist, very loose, sand and gravel with trace cinders (FILL) (Lab No. 3) A-1-b				3	SS			3-2-2			
	703.5	8.5									
Brown, moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b				4	SS			8-12-14			
			10								Traffic control required
				5	SS		▣	10-12-15			Pavement restoration
			15								
-wet below 18.0 ft							▽				
				6	SS			12-16-18			
			20								
	690.0	22.0									
Gray, moist, very stiff LOAM (Lab No. 1) A-4				7	SS			10-12-12			
	687.0	25.0	25								
Bottom of Test Boring at 25.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
▽ Noted on Drilling Tools 18.0 ft.
▽ At Completion Dry ft.
▽ After -- hours -- ft.
▣ Cave Depth 13.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: American Consulting, Inc.
PROJECT NAME: Proposed Washington Street Interchange
PROJECT LOCATION: Marion County, Indiana
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: TL-101
JOB #: 86.00481.0159
STATION: 411+45 Line "I-65"
OFFSET: 40 ft Left

DRILLING and SAMPLING INFORMATION

Date Started	4/10/07	Hammer Wt.	140 lbs.
Date Completed	4/10/07	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual)		0.2									Boring station and offest estimated from plans provided by client
Brown and dark brown, moist, stiff, loam with trace cinders and brick fragments (FILL) (Lab No. 1) A-4				1	SS			5-5-6			
		3.5									
Brown, moist, medium dense SAND (Lab No. 5) A-2-4			5	2	SS			10-8-9			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				3	SS			9-11-10			
		8.0									
Brown, moist, medium dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b			10	4	SS			4-7-9			
				5	SS			9-9-12			
				6	SS			12-20-22			
			15	7	SS		▼ ▲	11-18-21			
-wet below 17.0 ft				8	SS			7-11-14			
			20								
				9	SS			9-34-26			
			25								
Bottom of Test Boring at 30.0 ft		30.0		10	SS			12-19-22			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
▼ Noted on Drilling Tools 17.0 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
▲ Cave Depth 16.5 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
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TEST BORING LOG

CLIENT: American Consulting, Inc.
PROJECT NAME: Proposed Washington Street Interchange
PROJECT LOCATION: Marion County, Indiana
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: TB-101
JOB #: 86.00481.0159
STATION: 112+90 Line "PR-M"
OFFSET: 5 ft Left

DRILLING and SAMPLING INFORMATION

Date Started	4/2/07	Hammer Wt.	140 lbs.
Date Completed	4/2/07	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

SOIL CLASSIFICATION SURFACE ELEVATION 711	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
1.0 ft Asphalt, 0.6 ft Crushed Limestone (Visual)	709.4	1.6									Boring station, offset and ground surface elevation estimated from plans provided by client
Brown, moist, loose, sand and gravel (POSSIBLE FILL) (Lab No. 3) A-1-b				1	CU						Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	2	CU						
				3	SS			3-3-4			
				4	SS			4-3-4			Borehole hand augered to a depth of 6 ft to verify utility clearance
	700.0	11.0	10								
Brown, moist, loose to medium dense SAND and GRAVEL (Lab No. 3) A-1-b				5	SS			4-3-3			Traffic control required
				6	SS			5-4-4			Pavement restoration
			15	7	SS			5-6-6			
-wet below 18.0 ft				8	SS			7-7-7			
	691.0	20.0	20								
Bottom of Test Boring at 20.0 ft											

TEST DATA

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 18.0 ft.
At Completion Dry ft.
After -- hours -- ft.
Cave Depth 15.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

LPILE Plus for Windows, Version 5.0 (5.0.31)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

This program is licensed to: TL-101

Shawn M. Marcum, P.E.
ATC Associates Inc.

Path to file locations: G:\Documents\ENG\PROJECTS\American Consulting (00481)\0159 (Washington Street Interchange)\Lpile\5.0\
Name of input data file: T-7.lpd
Name of output file: T-7.lpo
Name of plot output file: T-7.lpp
Name of runtime file: T-7.lpr

Time and Date of Analysis

Date: July 12, 2007 Time: 14:47:29

Problem Title

T-7

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 3:
- Computation of Nonlinear Bending Stiffness and Ultimate Bending Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be printed in output file.

Pile Structural Properties and Geometry

Pile Length = 240.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	48.00000000	260574.0000	1810.0000	3200000.
2	240.0000	48.00000000	260574.0000	1810.0000	3200000.

Please note that because this analysis makes computations of ultimate moment capacity and pile response using nonlinear bending stiffness that the above values of moment of inertia and modulus of are not used for any computations other than total stress due to combined axial loading and bending.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 42.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 42.000 in
Distance from top of pile to bottom of layer = 156.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 156.000 in
Distance from top of pile to bottom of layer = 360.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06400
2	42.00	.06400
3	42.00	.06900
4	156.00	.06900
5	156.00	.03800
6	360.00	.03800

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	3.50000	.00	.02000	.0
2	42.000	3.50000	.00	.02000	.0
3	42.000	.00000	32.00	------	------
4	156.000	.00000	32.00	------	------
5	156.000	.00000	34.00	------	------
6	360.000	.00000	34.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Cyclic loading criteria was used for computation of p-y curves

Number of cycles of loading = 100.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 7000.000 lbs
Bending moment at pile head = 6000000.000 in-lbs
Axial load at pile head = 8000.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computations of Ultimate Moment Capacity and Nonlinear Bending Stiffness

---

Number of pile sections = 1

Pile Section No. 1

The sectional shape is a circular drilled shaft (bored pile).

Outside Diameter = 48.0000 In

Material Properties:

Compressive Strength of Concrete = 3.500 Kip/In**2
Yield Stress of Reinforcement = 60. Kip/In**2
Modulus of Elasticity of Reinforcement = 29000. Kip/In**2
Number of Reinforcing Bars = 20
Area of Single Bar = 1.56000 In**2
Number of Rows of Reinforcing Bars = 11
Cover Thickness (edge to bar center) = 4.250 In

Unfactored Axial Squash Load Capacity = 7162.61 Kip

Distribution and Area of Steel Reinforcement

Row Number	Area of Reinforcement In**2	Distance to Centroidal Axis In
1	1.560000	19.7500
2	3.120000	18.7834
3	3.120000	15.9781
4	3.120000	11.6088
5	3.120000	6.1031
6	3.120000	.0000
7	3.120000	-6.1031
8	3.120000	-11.6088
9	3.120000	-15.9781
10	3.120000	-18.7834
11	1.560000	-19.7500

Axial Thrust Force = .00 lbs

Bending Moment in-lbs	Bending Stiffness lb-in2	Bending Curvature rad/in	Maximum Strain in/in	Neutral Axis Position inches	Max. Concrete Stress psi	Max. Steel Stress

psi					
1061033.	1.061033E+12	.00000100	.00002407	24.07339096	79.98588345
574.87834					
5222257.	1.044451E+12	.00000500	.00012036	24.07268143	389.01864
2874.28880					
5222257.	5.802507E+11	.00000900	.00012958	14.39784622	413.12055
7660.91212					
5222257.	4.017121E+11	.00001300	.00018737	14.41311264	587.42660
11060.00651					
5724552.	3.367383E+11	.00001700	.00024563	14.44870377	756.96601
14445.53901					
7052000.	3.358095E+11	.00002100	.00030418	14.48495865	921.10656
17822.41014					
8371672.	3.348669E+11	.00002500	.00036305	14.52187729	1079.77063
21190.38891					
9683385.	3.339098E+11	.00002900	.00042222	14.55948257	1232.87825
24549.22509					
10986930.	3.329373E+11	.00003300	.00048173	14.59777451	1380.34402
27898.67973					
12282153.	3.319501E+11	.00003700	.00054156	14.63684464	1522.08629
31238.41563					
13568788.	3.309461E+11	.00004100	.00060174	14.67664719	1658.00808
34568.21641					
14846663.	3.299259E+11	.00004500	.00066228	14.71727371	1788.02004
37887.70771					
16115541.	3.288886E+11	.00004900	.00072318	14.75874710	1912.02231
41196.57027					
17375145.	3.278329E+11	.00005300	.00078446	14.80106735	2029.90756
44494.50937					
18625245.	3.267587E+11	.00005700	.00084613	14.84430313	2141.56999
47781.11680					
19865578.	3.256652E+11	.00006100	.00090820	14.88850021	2246.89583
51055.99299					
21095835.	3.245513E+11	.00006500	.00097069	14.93368149	2345.76273
54318.76026					
22315736.	3.234165E+11	.00006900	.00103361	14.97991562	2438.04627
57568.93870					
23488948.	3.217664E+11	.00007300	.00109635	15.01850510	2522.76616
60000.00000					
24367176.	3.164568E+11	.00007700	.00115433	14.99124527	2594.44552
60000.00000					
25128521.	3.102287E+11	.00008100	.00121061	14.94574356	2658.06393
60000.00000					
25730637.	3.027134E+11	.00008500	.00126400	14.87057877	2712.96264
60000.00000					
26226135.	2.946757E+11	.00008900	.00131552	14.78113174	2760.93890
60000.00000					
26717043.	2.872800E+11	.00009300	.00136731	14.70221329	2804.28313
60000.00000					
27203287.	2.804463E+11	.00009700	.00141936	14.63261032	2842.92437
60000.00000					
27564314.	2.729140E+11	.00010100	.00146852	14.53982162	2874.81283
60000.00000					
29529491.	2.254160E+11	.00013100	.00182636	13.94170761	2969.59056
60000.00000					
30473339.	1.892754E+11	.00016100	.00216140	13.42482376	2973.55831
60000.00000					
31289787.	1.638209E+11	.00019100	.00249635	13.06991959	2966.56291
60000.00000					
31630699.	1.431253E+11	.00022100	.00281328	12.72975540	2967.97001
60000.00000					

```
   31922593.  1.271816E+11     .00025100     .00311799   12.42225266    2961.14343
60000.00000
   32157157.  1.144383E+11     .00028100     .00343630   12.22882462    2974.73955
60000.00000
   32335076.  1.039713E+11     .00031100     .00377006   12.12239456    2966.43746
60000.00000
   32335076.  9.482427E+10     .00034100     .00412357   12.09259415    2962.88649
60000.00000

Unfactored (Nominal) Moment Capacity at Concrete Strain of 0.003 =   31809.56981
In-Kip
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 7000.000 lbs
Specified moment at pile head = 6000000.000 in-lbs
Specified axial load at pile head = 8000.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment)condition.

Output Verification:

Computed forces and moments are within specified convergence limits.

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 7000.000	M= 6.00E+06	8000.0000	.2765786	6181955.	-51573.6448

Pile-head Deflection vs. Pile Length

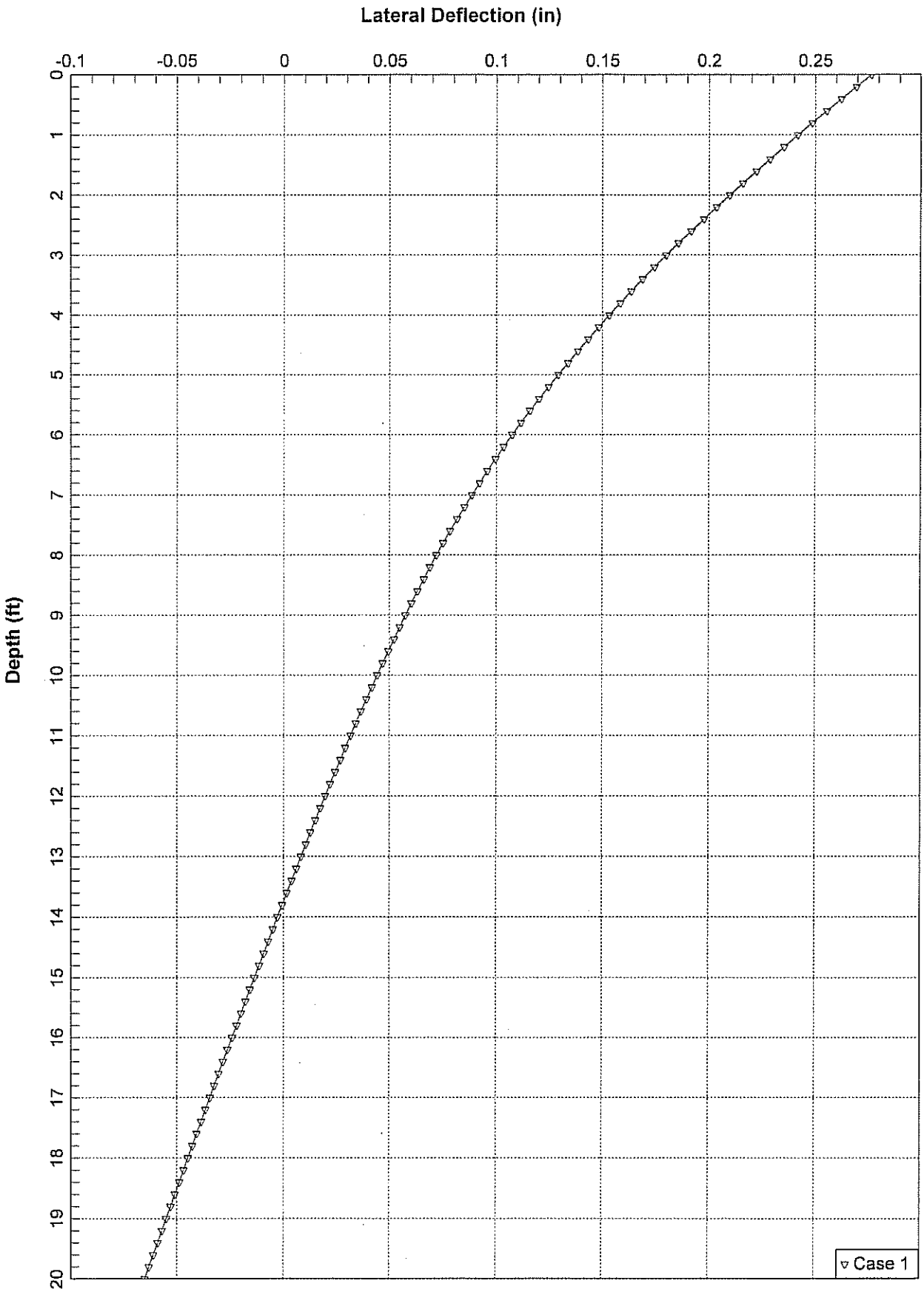
Boundary Condition Type 1, Shear and Moment

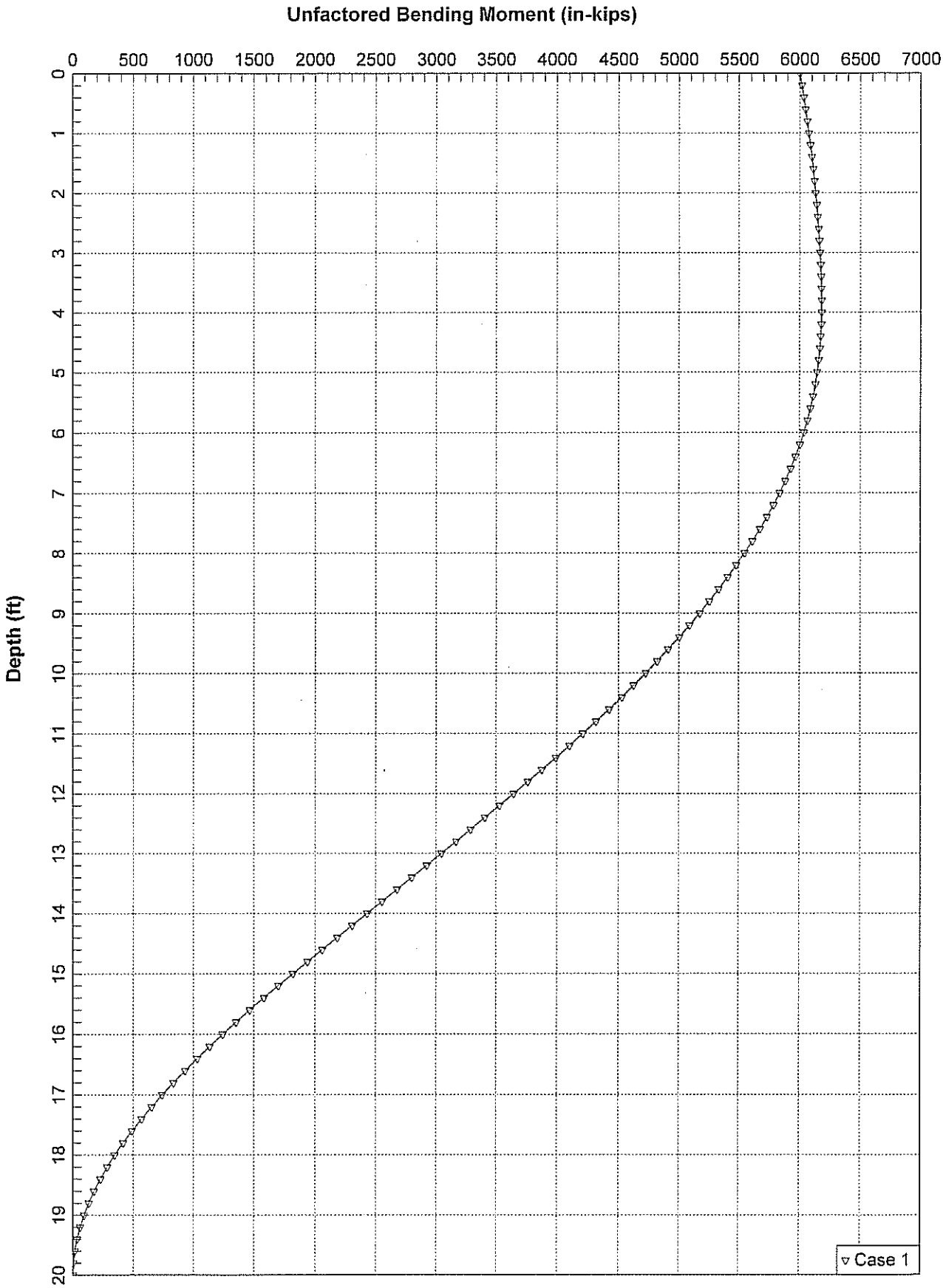
Shear = 7000. lbs
Moment = 6000000. in-lbs

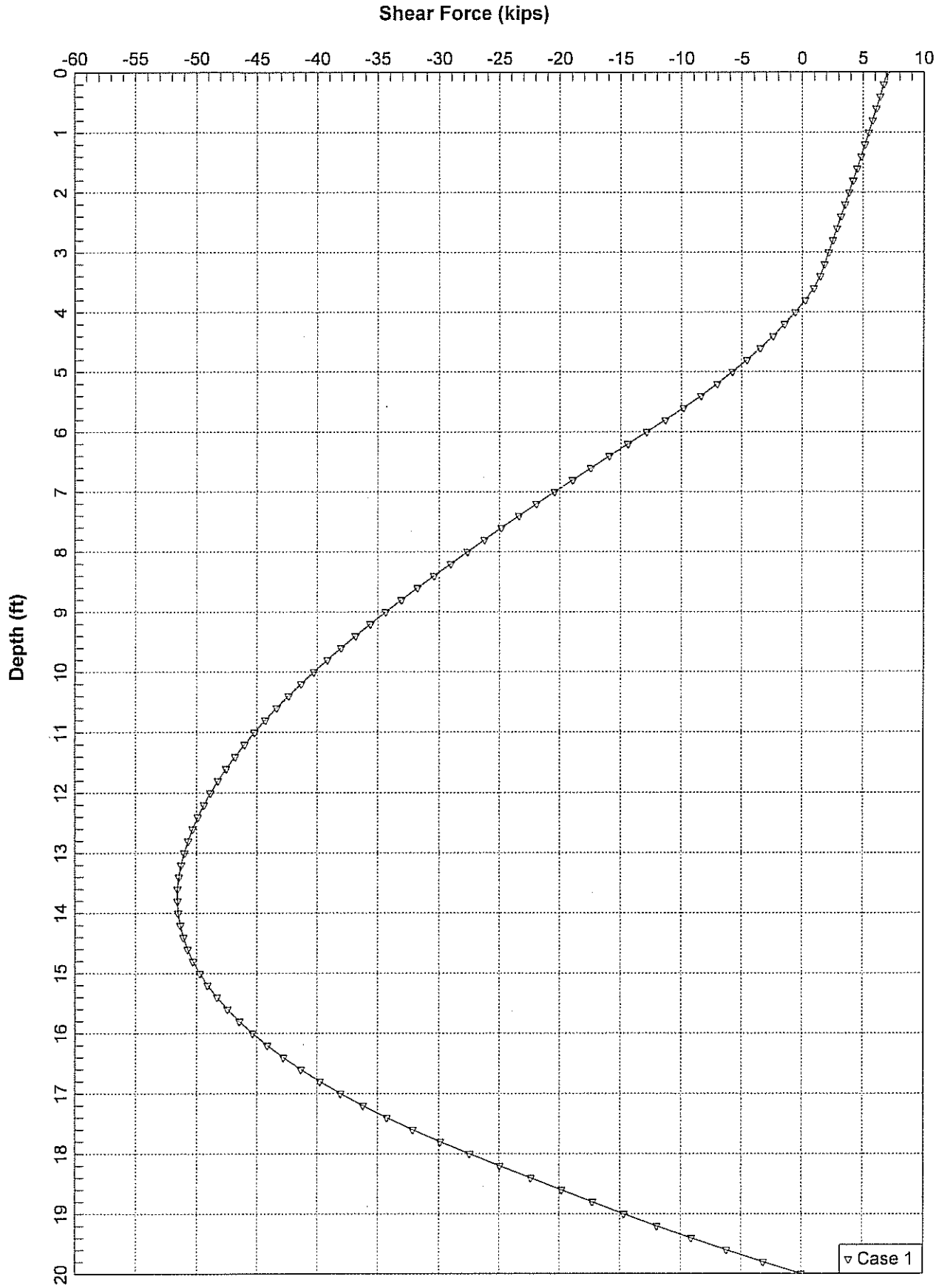
Axial Load = 8000. lbs

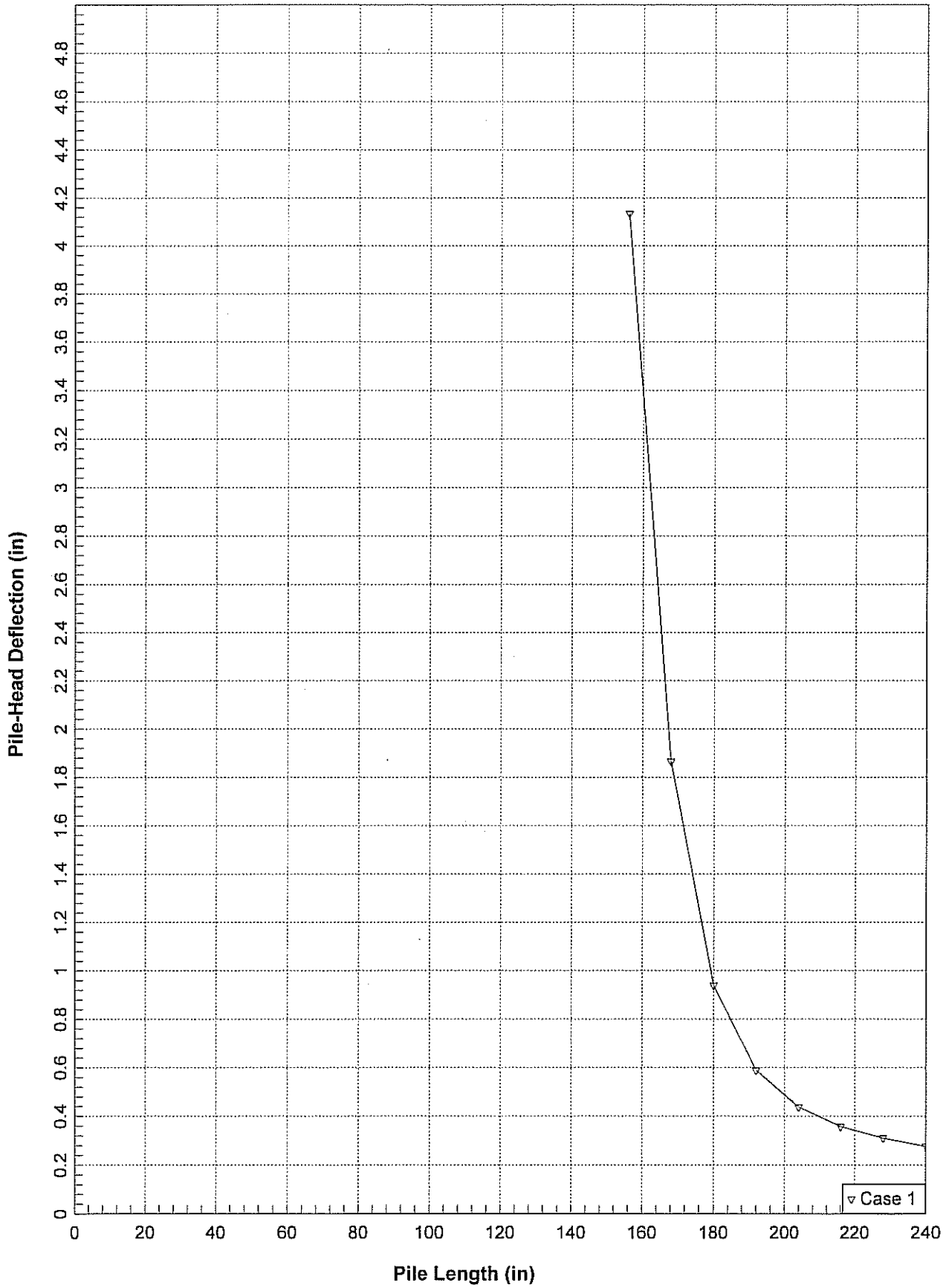
Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
240.000	.27657862	6181955.	-51573.64476
228.000	.31107650	6176289.	-55465.17008
216.000	.35812949	6169233.	-59910.31341
204.000	.43745017	6159578.	-65535.15180
192.000	.58932518	6145578.	-72899.29990
180.000	.93930007	6126353.	-82578.50981
168.000	1.86618296	6103464.	-93737.59672
156.000	4.13580734	6083874.	-102367.24192

The analysis ended normally.


Lateral Deflection (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Unfactored Bending Moment (in-kips)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Shear Force (kips)
-60
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Pile-Head Deflection (in)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
0
20
40
60
80
100
120
140
160
180
200
220
240
Pile Length (in)
Case 1

LPILE Plus for Windows, Version 5.0 (5.0.31)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

This program is licensed to:

RB-23

Shawn M. Marcum, P.E.
ATC Associates Inc.

Path to file locations: G:\Documents\ENG\PROJECTS\American Consulting (00481)\0159 (Washington Street Interchange)\Lpile\5.0\
Name of input data file: T-8.lpd
Name of output file: T-8.lpo
Name of plot output file: T-8.lpp
Name of runtime file: T-8.lpr

Time and Date of Analysis

Date: July 12, 2007 Time: 15: 1:25

Problem Title

T-8

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 3:
- Computation of Nonlinear Bending Stiffness and Ultimate Bending Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-04 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be printed in output file.

Pile Structural Properties and Geometry

Pile Length = 240.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	48.00000000	260574.0000	1810.0000	3200000.
2	240.0000	48.00000000	260574.0000	1810.0000	3200000.

Please note that because this analysis makes computations of ultimate moment capacity and pile response using nonlinear bending stiffness that the above values of moment of inertia and modulus of are not used for any computations other than total stress due to combined axial loading and bending.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 60.000 in

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 60.000 in
Distance from top of pile to bottom of layer = 108.000 in
p-y subgrade modulus k for top of soil layer = 25.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 25.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 108.000 in
Distance from top of pile to bottom of layer = 180.000 in
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

Layer 4 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 360.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06400
2	60.00	.06400
3	60.00	.06900
4	108.00	.06900
5	108.00	.06900
6	180.00	.06900
7	180.00	.03800
8	360.00	.03800

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	3.50000	.00	.02000	.0
2	60.000	3.50000	.00	.02000	.0
3	60.000	.00000	30.00	------	------
4	108.000	.00000	30.00	------	------
5	108.000	.00000	33.00	------	------
6	180.000	.00000	33.00	------	------
7	180.000	.00000	33.00	------	------
8	360.000	.00000	33.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Cyclic loading criteria was used for computation of p-y curves

Number of cycles of loading = 100.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 7000.000 lbs
Bending moment at pile head = 6000000.000 in-lbs
Axial load at pile head = 8000.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computations of Ultimate Moment Capacity and Nonlinear Bending Stiffness

---

Number of pile sections = 1

Pile Section No. 1

The sectional shape is a circular drilled shaft (bored pile).

Outside Diameter = 48.0000 In

Material Properties:

Compressive Strength of Concrete	=	3.500 Kip/In**2
Yield Stress of Reinforcement	=	60. Kip/In**2
Modulus of Elasticity of Reinforcement	=	29000. Kip/In**2
Number of Reinforcing Bars	=	20
Area of Single Bar	=	1.56000 In**2
Number of Rows of Reinforcing Bars	=	11
Cover Thickness (edge to bar center)	=	4.250 In

Unfactored Axial Squash Load Capacity = 7162.61 Kip

Distribution and Area of Steel Reinforcement

Row Number	Area of Reinforcement In**2	Distance to Centroidal Axis In
1	1.560000	19.7500
2	3.120000	18.7834
3	3.120000	15.9781
4	3.120000	11.6088
5	3.120000	6.1031
6	3.120000	.0000
7	3.120000	-6.1031
8	3.120000	-11.6088
9	3.120000	-15.9781
10	3.120000	-18.7834

11 1.560000 -19.7500

Axial Thrust Force = 8000.00 lbs

Bending Moment in-lbs	Bending Stiffness lb-in2	Bending Curvature rad/in	Maximum Strain in/in	Neutral Axis Position inches	Max. Concrete Stress psi	Max. Steel Stress psi
1061027.	1.061027E+12	.00000100	.00002522	25.22189713	83.83864818	608.18502
5222278.	1.044456E+12	.00000500	.00012155	24.31035233	392.78619	2908.75108
5222278.	5.802531E+11	.00000900	.00013275	14.75018692	423.12098	7568.95119
5222278.	4.017137E+11	.00001300	.00019075	14.67296219	597.70993	10962.04323
5801362.	3.412566E+11	.00001700	.00024904	14.64920425	766.96639	14346.69227
7128155.	3.394360E+11	.00002100	.00030762	14.64874649	930.81689	17722.66334
8447153.	3.378861E+11	.00002500	.00036652	14.66073990	1089.18464	21089.71352
9758173.	3.364887E+11	.00002900	.00042573	14.68033218	1241.98937	24447.59057
11061019.	3.351824E+11	.00003300	.00048527	14.70502853	1389.14678	27796.03762
12355489.	3.339321E+11	.00003700	.00054514	14.73343277	1530.56966	31134.77656
13641385.	3.327167E+11	.00004100	.00060535	14.76472092	1666.16838	34463.49674
14918489.	3.315220E+11	.00004500	.00066593	14.79836655	1795.84815	37781.88156
16186549.	3.303377E+11	.00004900	.00072687	14.83400345	1919.50733	41089.63100
17445340.	3.291574E+11	.00005300	.00078819	14.87142563	2037.04372	44386.36870
18694595.	3.279753E+11	.00005700	.00084990	14.91047287	2148.34705	47671.73823
19934024.	3.267873E+11	.00006100	.00091201	14.95103073	2253.30083	50945.37651
21163379.	3.255904E+11	.00006500	.00097455	14.99307632	2351.78811	54206.80099
22382317.	3.243814E+11	.00006900	.00103752	15.03654099	2443.67802	57455.63134
23559692.	3.227355E+11	.00007300	.00110040	15.07394028	2528.11744	60000.00000
24447729.	3.175030E+11	.00007700	.00115861	15.04690933	2599.64239	60000.00000
25208376.	3.112145E+11	.00008100	.00121494	14.99923325	2662.85628	60000.00000
25820561.	3.037713E+11	.00008500	.00126860	14.92468643	2717.58528	60000.00000
26315487.	2.956796E+11	.00008900	.00132016	14.83327103	2765.15227	60000.00000
26805807.	2.882345E+11	.00009300	.00137199	14.75256729	2808.07785	60000.00000
27291401.	2.813546E+11	.00009700	.00142409	14.68131638	2846.28896	60000.00000

27662121.	2.738824E+11	.00010100	.00147355	14.58964920	2877.92983
60000.00000					
29634377.	2.262166E+11	.00013100	.00183256	13.98899460	2969.71191
60000.00000					
30576689.	1.899173E+11	.00016100	.00216864	13.46979904	2974.04958
60000.00000					
31400029.	1.643981E+11	.00019100	.00250475	13.11386490	2968.01496
60000.00000					
31741635.	1.436273E+11	.00022100	.00282317	12.77452469	2969.51092
60000.00000					
32032446.	1.276193E+11	.00025100	.00312821	12.46297073	2959.34143
60000.00000					
32262789.	1.148142E+11	.00028100	.00344757	12.26894760	2972.28634
60000.00000					
32433031.	1.042863E+11	.00031100	.00378348	12.16551590	2968.71002
60000.00000					
32433031.	9.511153E+10	.00034100	.00413778	12.13425064	2959.79569
60000.00000					

Unfactored (Nominal) Moment Capacity at Concrete Strain of 0.003 = 31910.21915
In-Kip

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 7000.000 lbs
Specified moment at pile head = 6000000.000 in-lbs
Specified axial load at pile head = 8000.000 lbs

Non-zero moment for this load case indicates the pile-head may rotate under
the applied pile-head loading, but is not a free-head (zero moment)condition.

Output Verification:

Computed forces and moments are within specified convergence limits.

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 7000.000	M= 6.00E+06	8000.0000	.5211890	6150459.	-57876.8813

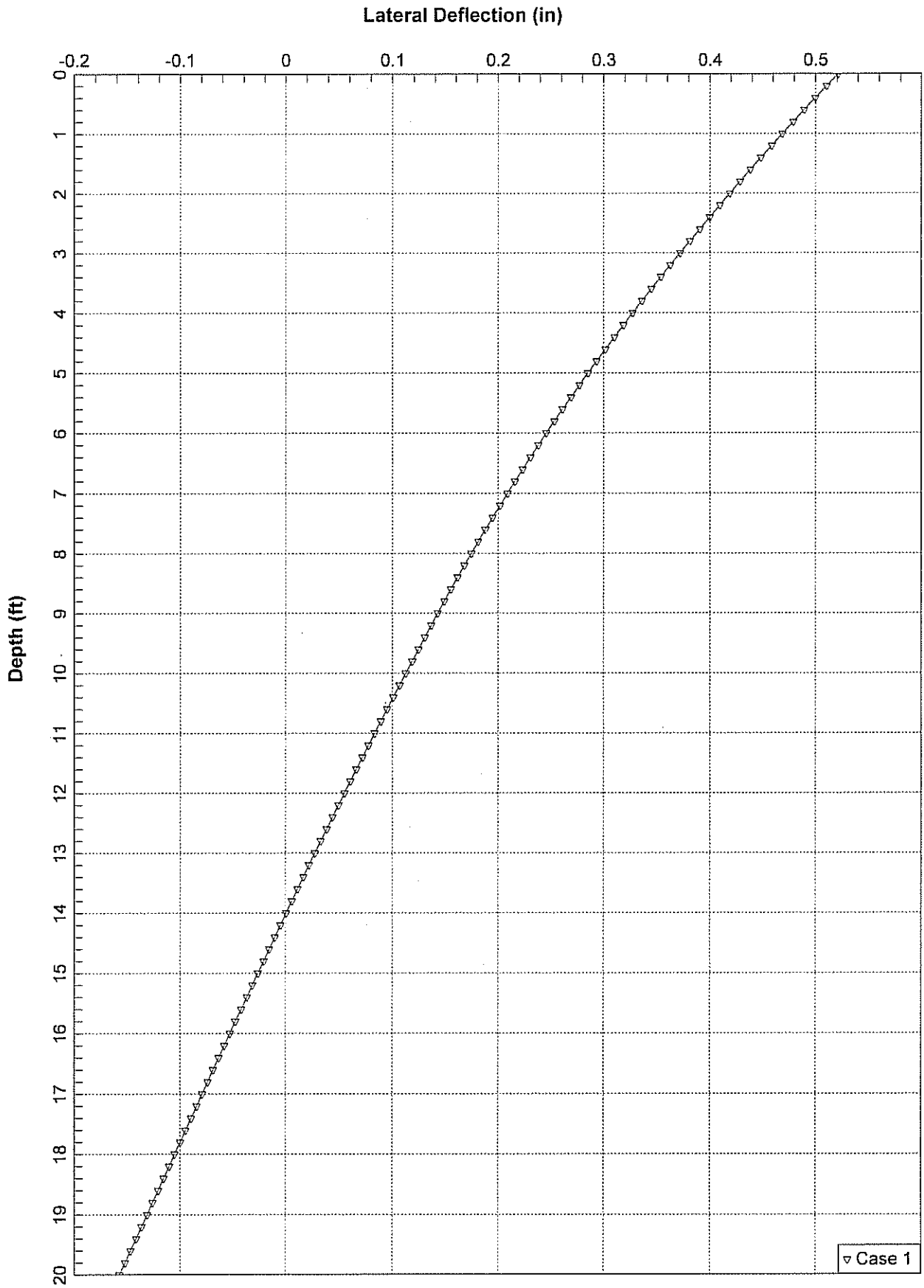
Pile-head Deflection vs. Pile Length

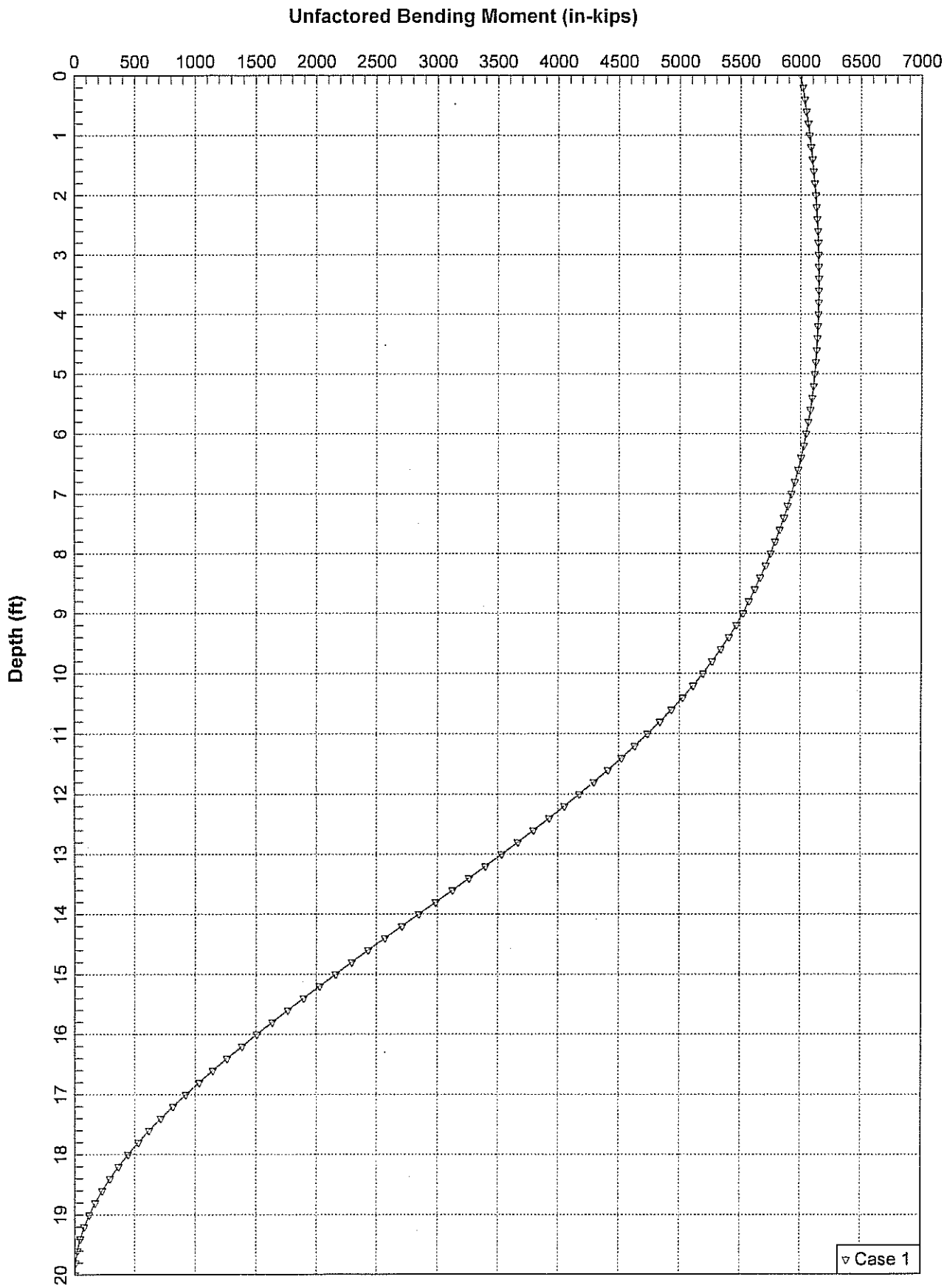
Boundary Condition Type 1, Shear and Moment

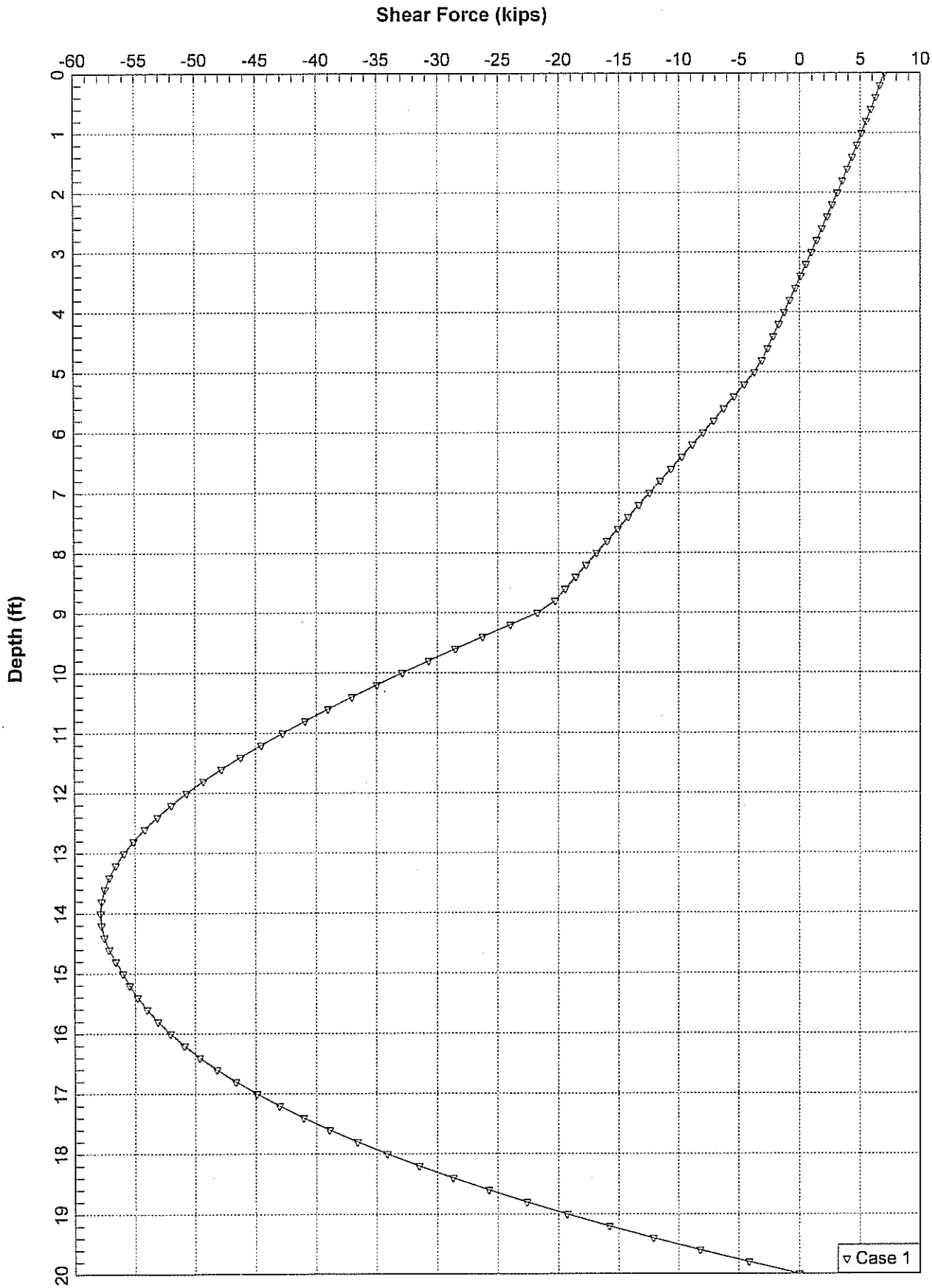
Shear = 7000. lbs
Moment = 6000000. in-lbs
Axial Load = 8000. lbs

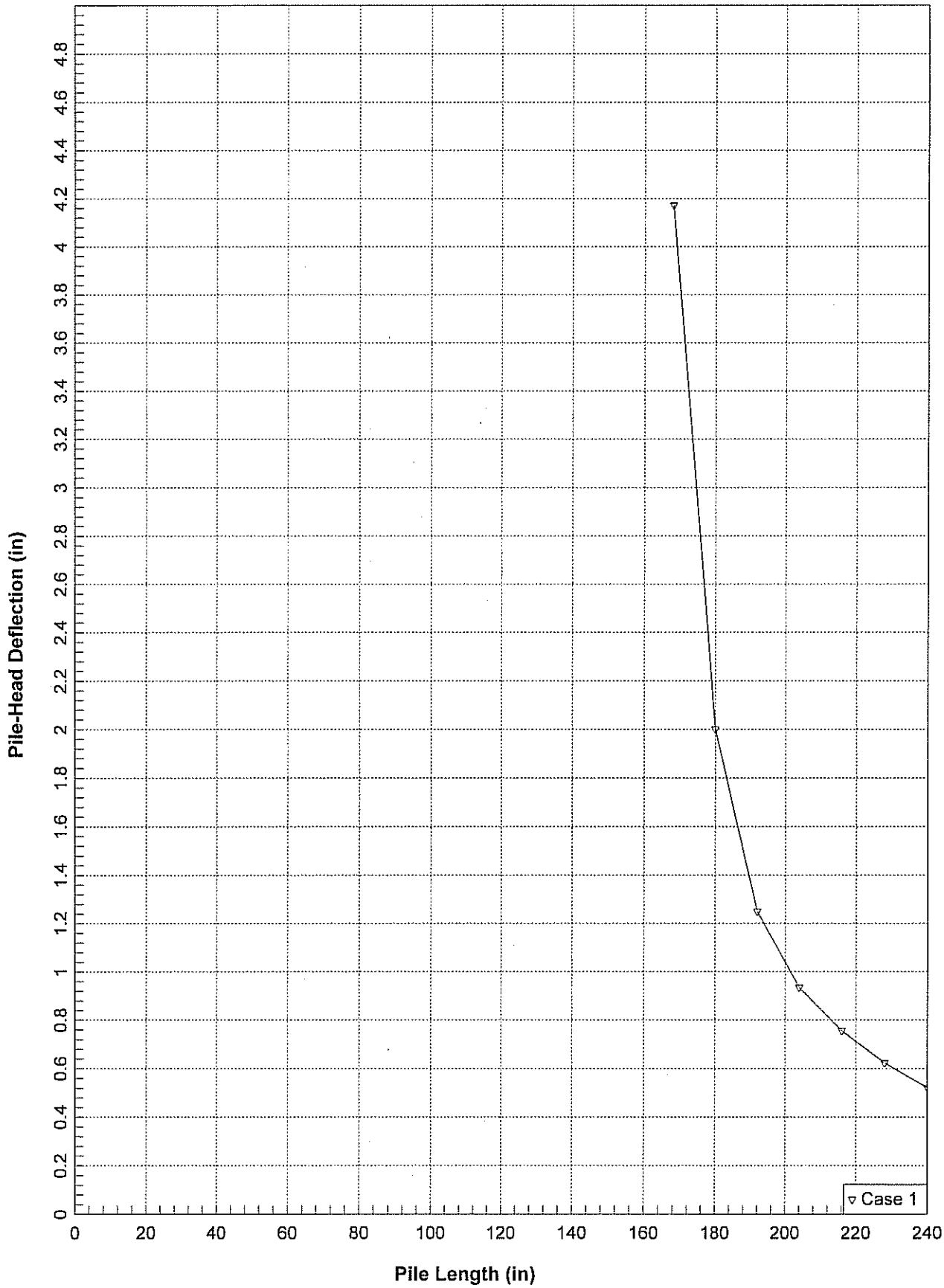
Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
240.000	.52118904	6150459.	-57876.88131
228.000	.62346082	6142331.	-62251.06672
216.000	.75642016	6134167.	-67422.72427
204.000	.93574533	6125834.	-73455.86040
192.000	1.25049992	6115344.	-79932.58159
180.000	2.00097543	6100808.	-87198.74606
168.000	4.17296650	6083065.	-94274.32195

The analysis ended normally.


Lateral Deflection (in)
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Unfactored Bending Moment (in-kips)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Shear Force (kips)
-60
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Pile-Head Deflection (in)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
0
20
40
60
80
100
120
140
160
180
200
220
240
Pile Length (in)
Case 1

INDIANA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
DRILLED SHAFT FOUNDATIONS

734.01 DESCRIPTION

This work consists of furnishing all labor, materials, equipment and services necessary for construction of reinforced concrete drilled straight shafts. Work shall be in strict conformance with the Department's plans, special provisions, Geotechnical Investigation Report, and INDOT Standard Specifications.

734.02 QUALIFICATIONS OF DRILLED SHAFT CONTRACTOR

The contractor performing the work described in this specification shall have installed drilled shafts of both diameter and length similar to those shown on the plans for a minimum of three (3) years prior to the bid date for this project.

734.03 SUBMITTALS

At the time of bid, the contractor shall submit both a list containing at least three (3) projects completed in the last three (3) years on which the contractor has installed drilled shafts of a diameter and length similar to those shown on the plans, and a signed statement that the contractor has inspected both the project site and all the subsurface information including any soil reports/geotechnical reports made available in the contract documents. The list of projects shall contain names and phone numbers of owner's representatives who can verify the contractor's participation on those projects.

No later than one month prior to constructing drilled shafts, the contractor shall submit an installation plan for review by the engineer. This plan will provide information on the following:

(a) Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations for this project.

(b) List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casing, etc.

(c) Details of overall construction operation sequence and the sequence of shaft construction in bents or groups.

(d) Details of shaft excavation methods.

(e) When slurry is required, details of the methods to mix, circulate and desand slurry.

(f) Details of methods to clean the shaft excavation.

(g) Details of reinforcement placement including support and centralization methods.

(h) Details of concrete placement including proposed operational procedures for free fall, tremie or pumping methods.

(i) Details of temporary casing removal including quality control procedure to minimize concrete contamination.

The engineer will evaluate the drilled shaft installation plan for conformance with the plans, specifications and special provisions. Within 14 days after receipt of the plan, the engineer will notify the contractor of any additional information required and/or changes necessary to meet the contract requirements. All procedural approvals given by the engineer shall be subject to trial in the field and shall not relieve the contractor of the responsibility to satisfactorily complete the work as detailed in the plans and specifications.

734.04 MATERIALS

All materials shall meet the requirements of the INDOT-Standard Specification or as otherwise described herein.

(a) CONCRETE: Concrete shall be Class B as per Section 702 of INDOT-Standard Specifications, except that air content requirement are waived.

(b) REINFORCEMENT: Reinforcing steel shall be in accordance with the sizes, dimensions and the details shown on the plans.

734.05 CONSTRUCTION METHODS AND EQUIPMENT

(a) PROTECTION OF EXISTING STRUCTURES: The contractor shall control his operations to prevent damage to existing structures and utilities. Preventive measures shall include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, monitoring and controlling the vibrations from construction activities such as the driving of casing or sheeting, drilling of the shaft, or from blasting, if permitted.

(b) GENERAL: Drilled shafts shall be installed by a contractor or subcontractor who is experienced in this type of work. The drilled shaft contractor shall visit and examine the work site, and all conditions thereon, and take into consideration all such conditions that may affect his work.

The contractor shall perform the excavation required for the straight shafts through whatever materials encountered, to the dimensions and elevations shown on the plans or as otherwise required.

Prior to beginning drilled shaft work, the contractor shall submit to the engineer for approval a detailed sequence of construction of drilled shafts including materials, methods, and equipment to be used such as: mineral slurry, casings, drilling equipment, methods and equipment for cleaning shaft excavations, methods and equipment for casting concrete, removing temporary casings etc. The contractor shall demonstrate the adequacy of his methods and equipment during construction of the first drilled shaft. Failure to demonstrate the adequacy of his methods and equipment is cause for the engineer to require appropriate procedure alterations to eliminate unsatisfactory results prior to continuing drilled shaft construction.

(c) DRY CONSTRUCTION METHOD: The dry construction method shall be used only at sites where the ground water table and soil conditions make it feasible to construct the shaft in a relatively dry excavation.

The dry construction method consists of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation and placing the shaft concrete in a relatively dry excavation.

The dry construction method shall be used only when shaft excavations have 12 inches or less of water that can be removed along with any accumulated seepage water and loose material.

(d) WET CONSTRUCTION METHOD: The wet construction method consists of drilling the shaft excavation below the water table, cleaning the excavation by means of a bailor bucket, air lift pump or other approved devices and placing the shaft concrete which displaces the water or slurry as the shaft excavation is concreted.

Where drilling is through materials having a tendency to cave, the drilling shall be advanced by drilling with a mineral slurry or by any other approved method which will control the size of the excavation.

(e) CASING CONSTRUCTION METHOD: The casing method shall be used when directed or required. In this method, the hole is advanced through caving material by the wet method as described above. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed in the nearly impervious formation. Drilling can proceed as with the dry method to the projected depth.

The placement of the concrete shall proceed as with the dry method except that the casing shall be withdrawn when the concrete is placed. Before the casing is withdrawn the level of the fresh concrete shall be at such a point that the fluid trapped behind casing is

displaced upward. As the casing is withdrawn care shall be exercised to maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

(f) EXCAVATION AND DRILLING EQUIPMENT: The excavation and drilling equipment shall have adequate capacity including power, torque and down thrust to excavate a hole of both the maximum diameter and to a depth of 20 percent beyond the depths shown on the plans.

The excavation and overreaming tools shall be of adequate design, size and strength to perform the work shown in the plans or described herein. When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drill buckets, and/or underreaming tools, the contractor shall provide special drilling equipment including but not limited to: rock core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to construct the shaft excavation to the size and depth required. Approval of the engineer is required before excavation by blasting is permitted.

Sidewall overreaming shall be required when the sidewall of the hole is determined by the engineer to have either softened due to excavation methods, swelled due to delays in concreting, or degraded because of slurry cake buildup. Overreaming may be accomplished with a grooving tool, or overreaming bucket as directed by the engineer. The contractor shall bear all costs associated with both sidewall overreaming and additional shaft concrete placement.

734.06 EXCAVATIONS

Shaft excavations shall be made at the locations, and to the top of shaft elevations, estimated bottom of shaft elevations, shaft geometry, and dimensions as shown in the contract documents. The contractor shall extend drilled shaft tip elevations when the engineer determines that the material encountered during excavation is unsuitable and/or differs from that anticipated in the design of the drilled shaft.

The contractor shall maintain a construction method log during shaft excavation. The log shall contain information such as: the description and approximate top and bottom elevation of each soil or rock material, seepage or groundwater, and remarks.

Excavated materials which are removed from shaft excavations shall be disposed of by the contractor in accordance with the applicable specifications for disposal of excavated materials.

Any drilled shaft concrete over the theoretical amount required to fill any excavations for shafts dimensioned on the plans shall be furnished at the contractor's expense .

The contractor shall not permit workmen to enter the shaft excavation for any reason unless: both a suitable casing has been installed and the water level has been lowered and stabilized below the level to be occupied, and adequate safety equipment and procedures have been provided to workmen entering the excavation.

(a) UNCLASSIFIED EXCAVATION: When drilled shaft excavation is designated as unclassified in the contract documents the contractor shall provide the necessary equipment to remove and dispose of any materials encountered in forming the drilled shaft excavation to the dimensions shown on the plans or as directed by the engineer. No separate payment will be made for either excavation of materials of different densities and character or employment of special tools and procedures necessary to accomplish the excavation in an acceptable fashion. Obstruction removal shall be paid separately.

(b) OBSTRUCTIONS: Surface and subsurface obstructions at drilled shaft locations shall be removed by the contractor. Such obstructions may include man-made materials such as old concrete foundations and natural materials such as boulders. Special procedures and/or tools shall be employed by the contractor after the hole cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets and/or underreaming tools. Such special procedures/tools may include but are not limited to: chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the hole diameter. Blasting shall not be permitted unless specifically approved in writing by the engineer.

(c) LOST TOOLS: Drilling tools which are lost in the excavation shall not be considered obstructions and shall be promptly removed by the contractor without compensation. All costs due to lost tool removal shall be borne by the contractor including but not limited to, costs associated with hole degradation due to removal operations or the time the hole remains open.

734.07 CASINGS

Casings shall be steel, smooth, clean, watertight, and of ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. The outside diameter of casing shall not be less than the specified size of shaft. No extra compensation will be allowed for concrete required to fill an oversized casing or oversized excavation. All casings, except permanent casing, shall be removed from shaft excavations. Any length of permanent casing installed below the shaft cutoff elevation, shall remain in place.

When the shaft extends above ground or through a body of water, the portion exposed above ground or through a body of water may be formed with a removable casing except when the permanent casing is specified. Removable casing shall be stripped from the shaft in a manner that will not damage the concrete. Casings can be removed when the concrete has attained sufficient strength provided: curing of the concrete is continued for the full 72 hours period in accordance with specification; the shaft concrete is not

exposed to salt water or moving water for 7 days; and the concrete reaches a compressive strength of at least 2500 psi as determined from concrete cylinder breaks.

(a) TEMPORARY CASING: All subsurface casing shall be considered temporary unless specifically shown as permanent casing in the contract documents. The contractor shall be required to remove temporary casing before completion of concreting the drilled shaft. Telescoping, predrilling with slurry and/or overreaming to beyond the outside diameter of the casing may be required to install casing.

If the contractor elects to remove a casing and substitute a longer or larger diameter casing through caving soils, the excavation shall be either stabilized with slurry or backfilled before the new casing is installed. Other methods, as approved by the engineer, may be used to control the stability of the excavation and protect the integrity of the foundation soils.

Before the casing is withdrawn, the level of fresh concrete in the casing shall be a minimum of five feet above either the hydrostatic water level or the level of drilling fluid whichever is higher. As the casing is withdrawn, care shall be exercised to maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the shaft concrete.

Temporary casings which become bound or fouled during shaft construction and cannot be practically removed shall constitute a defect in the drilled shaft. The contractor shall be responsible to improve such defective shafts to the satisfaction of the engineer. Such improvement may consist of, but is not limited to removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. All corrective measures including redesign of footings caused by defective shafts shall be done to the satisfaction of the engineer by the contractor without either compensation or an extension of the completion date of the project. In addition, no compensation will be paid for casing remaining in place.

734.08 SLURRY

Only mineral slurries shall be employed when slurry is used in the drilling process unless other drilling fluids are approved by the engineer. The slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry to the hole, the construction of that foundation shall be stopped until either methods to stop slurry loss or an alternate construction procedure has been approved by the engineer.

The mineral slurry shall be premixed thoroughly with clean fresh water and adequate time (as prescribed by the mineral manufacturer) allotted for hydration prior to introduction into the shaft excavation. Slurry tanks of adequate capacity will be required for slurry circulation, storage, and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without the written permission of the engineer. Desanding equipment shall be provided by the contractor as necessary to control slurry sand content to less than 4 percent by volume at any point in the borehole. Desanding will not be required for setting temporary casing, sign post, or lighting mast foundations unless shown in the plans or special provisions. The contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include but are not limited to; agitation, circulation and/or adjusting the properties of the slurry. Disposal of all slurry shall be done offsite in suitable areas by the contract.

At the option of the contractor and with the approval of the engineer, polymer slurry can be used in lieu of mineral slurry.

Control tests using suitable apparatus shall be carried out on the slurry by the contractor to determine density, viscosity and pH. An acceptable range of values for those physical properties is shown in the following table:

MINERAL SLURRY (OR POLYMER SLURRY)
Sodium Bentonite or Attapulgite in Fresh Water

Acceptable Range of Values

Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density (pcf)	64.3 ** - 69.1**(<64)	64.3**-75.0** (< 64)	Density Balance
Viscosity (seconds/quarts)	28 - 45 (40-90)	28 - 45 (40-90)	Marsh Cone
pH	8 - 11 (7-11)	8 - 11 (7-11)	pH paper pH meter

** Increase by 2 pcf in salt water

Notes:

a) *Tests should be performed when the slurry temperature is above 40 degrees Fahrenheit.*

b) *If desanding is required sand content shall not exceed 4 percent (by volume) at any point in the bore hole as determined by the American Petroleum Institute sand content test.*

Tests to determine density, viscosity, and pH value shall be done during the shaft excavation to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first 8 hours of slurry use. When the results show consistent behavior the testing frequency may be decreased to one set every four hours of slurry use.

The contractor shall insure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Prior to placing concrete in any shaft excavation, the contractor shall take slurry samples using a sampling tool. Slurry samples shall be extracted from the base of the shaft and at intervals not exceeding 10 feet up the shaft, until two consecutive samples produce acceptable values for density, viscosity, pH, and sand content.

When any slurry samples are found to be unacceptable, the contractor shall take whatever action is necessary to bring the slurry within specification requirements. Concrete shall not be poured until resampling and testing results produce acceptable values

Reports of all tests required above signed by an authorized representative of the contractor, shall be furnished to the engineer on completion of each drilled shaft.

During construction, the level of mineral slurry in the shaft excavation shall be maintained at a level not less than 4 feet above the highest expected piezometric pressure head along the depth of the shaft. If at any time the slurry construction method fails, in the opinion of the engineer, to produce the desired final results, then the contractor shall both discontinue this method and propose an alternate method for approval of the engineer.

734.09 EXCAVATION INSPECTION

The contractor shall provide equipment for checking the dimensions and alignment of each permanent shaft excavation. The dimensions and alignment shall be determined by the contractor under the direction of the engineer. Final shaft depths shall be measured with a suitable weighted tape or other approved methods after final cleaning. Unless otherwise stated in the specifications, shaft bottoms shall be cleaned mechanically such that a minimum of 50 percent of the base of each shaft will have less than 1/2 inch of sediment at the time of placement of the concrete. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 1/2 inches. Shaft cleanliness will be determined by the engineer, by visual inspection and sounding with the weighted tape for dry shafts or other methods deemed appropriate to the engineer for wet shafts. In addition, for dry excavations, the maximum depth of water shall not exceed 3 inches prior to concrete pour.

734.10 CONSTRUCTION TOLERANCES

The following construction tolerances apply to drilled shafts unless otherwise stated in the contract documents:

(a) The drilled shaft shall be within 3 inches of plan position in the horizontal plane at the plan elevation for the top of the shaft.

(b) The vertical alignment of a vertical shaft excavation shall not vary from the plan alignment by more than 1/4 inch per foot of depth. The alignment of a battered shaft excavation shall not vary by more than 1/2 inch per foot of depth from the prescribed batter.

(c) After all the concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.

(d) All casing diameters shown on the plans refer to O.D. (outside diameter) dimensions. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe. When approved, the contractor may elect to provide a casing larger in diameter than shown in the plans.

(e) The top elevation of the shaft shall have a tolerance of plus 1 inch or minus 3 inches from the plan top of shaft elevation.

(f) Excavation equipment and methods shall be designed so that the completed shaft excavation will have a planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of + 3/8 inch per foot of diameter.

Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. The contractor shall be responsible for correcting all unacceptable shaft excavations and completed shafts to the satisfaction of the engineer. Materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance drilled shaft excavations shall be furnished without either cost to the State or an extension of the completion dates of the project.

734.11 REINFORCING STEEL CAGE CONSTRUCTION AND PLACEMENT

The reinforcing steel cage, consisting of longitudinal bars, ties, cage stiffener bars, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement.

The reinforcing steel in the shaft shall be tied and supported so that the reinforcing steel will remain within allowable tolerances given in INDOT Standard Specifications unless modified by this special provision. Concrete spacers or other approved noncorrosive spacing devices shall be used at sufficient intervals (near the bottom and at intervals not exceeding 10 feet of the shaft) to insure concentric spacing for the entire cage length. Spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the shaft. The spacers shall be of adequate dimension to insure a minimum 3 inch annular space between the outside of the reinforcing cage and the side of

the excavated hole. Approved cylindrical concrete feet (bottom supports) shall be provided to insure that the bottom of the cage is maintained the proper distance above the base.

The elevation of the top of the steel cage shall be checked before and after the concrete is placed. If the rebar cage is not maintained within the specified tolerances, corrections shall be made by the contractor to the satisfaction of the engineer. No additional shafts shall be constructed until the contractor has modified his rebar cage support in a manner satisfactory to the engineer.

734.12 CONCRETE PLACEMENT

Concrete placement shall be performed in accordance with the applicable portions of the INDOT Standard specifications on concrete materials in section 702 except as modified in this special provision and with the requirements herein.

Concrete shall be placed as soon as possible after reinforcing steel placement. Concrete placement shall be continuous from the bottom to the top elevation of the shaft. Concrete placement shall continue after the shaft excavation is full until good quality concrete is evident at the top of shaft. Concrete shall be placed either by free fall or through a tremie or concrete pump. The free fall placement shall only be permitted in dry holes. Concrete placed by free fall shall fall directly to the base without contacting either the rebar cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

The elapsed time from the beginning of concrete placement in the shaft to the completion of the placement shall not exceed 2 hours. Admixtures such as water reducers, plasticizers, and retarders shall not be used in the concrete mix unless permitted in the contract documents. All admixtures, when approved for use, shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the 2 hour placement limit. Prior to concrete placement the contractor shall provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the 2 hour requirement. The Contractor may request a longer placement time provided he supplies a concrete mix that will maintain a slump of 4 inches or greater over the longer placement time as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures appropriate for site conditions.

Minimum concrete slump for placement under slurry by tremie or pump shall be 6 inches. The contractor shall maintain a concrete volume vs. depth chart for all concrete placed under slurry. Minimum depth measurements shall be taken after every truck load of tremie placed concrete and every 2 to 3 feet if pumped.

734.13 TREMIES

Tremies may be used for concrete placement in wet holes. Tremies used to place concrete shall consists of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The tremie shall not contain aluminum parts which will have contact with the concrete. The tremie inside diameter shall be at least 6 times the maximum size of aggregate used in the concrete mix but shall not be less than 10 inches. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends which restrict concrete placement.

The tremie used for concrete placement shall be watertight. Underwater placement shall not begin until the tremie is placed to the shaft base elevation. Valves, bottom plates or plugs may be used only if concrete discharge can begin within one-half tremie diameter of the base. Plugs shall either be removed from the excavation or be of a material, approved by the Engineer, which will not cause a defect in the shaft if not removed. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall be immersed at least 5 feet in concrete at all times after starting the flow of concrete. The flow of the concrete shall be continuous. The concrete in the tremie shall be maintained at a positive pressure differential at all times to prevent water or slurry intrusion into the shaft concrete.

If at any time during the concrete pour, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall removal directed by the Engineer and repour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

734.14 PUMPED CONCRETE

Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. All pump lines shall have a minimum 4 inch diameter and be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation.

For wet excavations, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or be of a material, approved by the Engineer, which will not cause a defect in the shaft if not removed.

The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. When lifting the pump line during concreting, the Contractor may temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation.

If at any time during the concrete pour, the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall removal directed by the Engineer, and repour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

734.15 DROP CHUTES

Drop chutes may be used to direct placement of free fall concrete in excavations where the maximum depth of water does not exceed 3 inches. Free fall is not permitted in wet excavations. Drop chutes shall consist of a smooth tube of one piece construction. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement. The drop chute shall be supported so that the free fall of the concrete measured from the bottom of the chute is less than 60 feet at all times. If concrete placement causes the shaft excavation to cave or slough, or if the concrete strikes the rebar cage or sidewall, the contractor shall reduce the height of free fall and/or reduce the rate of concrete flow into the excavation. If placement cannot be satisfactorily accomplished by free fall in the opinion of the Engineer, the Contractor shall use either tremie or pumping to accomplish the pour.

734.16 DRILLED SHAFT INTEGRITY TESTING

INTEGRITY TESTING: All drilled shafts constructed under slurry shall be tested by the Department, using the crosshole sonic logging and the impulse response test methods on each shaft.

A. CROSSHOLE SONIC LOGGING TEST: All of the drilled shafts drilled under slurry on this project, shall be equipped with access tubes for the crosshole (CSL) sonic logging test. Provision and installation of the tubes shall be the responsibility of the Contractor.

PRINCIPLE: The CSL test provides continuous vertical profiles of the ultrasonic pulse velocity (UPV) of the concrete. The UPV is a function of the density and modulus of the concrete, and can therefore be used to assess the uniformity and homogeneity of the concrete.

Access tubes are attached to the reinforcing cage and installed in the drilled shaft before concrete is placed. Transducer probes, a transmitter and a receiver, are lowered down adjacent pairs of access tubes. An ultrasonic pulse emitted by the transmitter travels through the concrete between the tubes to the receiver. The probes are connected to a control unit that contains a pulse generator/timer/recorder system.

The cables attached to the probes are withdrawn over a measurement wheel that is also connected to the control unit. This system takes a continuous series of

measurements as the probes are raised up the access tubes. The data recorded is the position of the probes for each measurement, the amplitude of the received signal, and the time taken for the ultrasonic pulse to travel from the transmitter to the receiver.

MATERIALS: The contractor shall supply the following materials for the CSL test installation:

(a) Schedule 40 mild steel tubing of 37.5 mm (1.5") internal diameter and threaded sleeve couplers sufficient to install eight full length access tubes in each of the 8 ft (2.44 m) and 10 ft (3.0 m) diameter drilled shafts. In addition, each tube shall have a threaded steel end cap fitted to the bottom.

(b) Clean, potable water sufficient to fill the access tubes completely.

(c) Cement grout sufficient to fill the access tubes on completion of testing.

EQUIPMENT: The contractor shall supply the following equipment and labor for the installation and performance of the CSL test:

(a) Small quantity grout mixing equipment and operator.

(b) Small grout pumping equipment with 25 mm (1.0") tremie pipe capable of reaching the bottom of the access tubes, and operator.

(c) Hosepipe, pump, or other means of placing clean water in the access tubes prior to testing, and for topping up the tubes during testing.

The Department shall provide the testing equipment required for the CSL tests.

The contractor shall supply suitable access to the tops of the shafts and tubes, and a stable work platform for the test operators and equipment close to the head of each shaft. The platform shall, at a minimum, be large enough to accommodate two operators with a standard surveyor's tripod and a small bench or table.

INSTALLATION PROCEDURE: The Contractor shall provide and install the access tubes required for the CSL test according to the following schedule and instructions:

(a) All drilled shafts constructed under slurry shall have CSL access tubes installed in them. Eight (8) tubes shall be placed in each of the 8 ft. (2.44 m) and 10 ft (3.00 m) diameter shafts. The bottom of each tube shall be sealed watertight with a threaded end-cap. Any

coupling of tubing needed to make up the required lengths shall be made using threaded sleeve couplers, sealed watertight.

The tubing shall be round and regular in section, with a clean interior surface, free of defects or obstructions that would prevent the passage of a 30 mm diameter probe through the tube. The exterior surfaces shall be free of any contaminants such as dirt, oil, grease, or heavy rust scale which may inhibit formation of a good mechanical bond with the concrete. The use of used or recycled tubing, or slightly rusted tubing, is acceptable provided that it meets the requirements above.

(b) The tubes shall be installed at approximately equidistant points around the interior of the reinforcing cage, i.e., eight tubes in 8 ft (2.44 m) to 10 ft (3.00 m) diameter shafts shall be spaced approximately 45 degrees apart. Tubes shall be installed parallel to each other and securely attached to the reinforcing cage to prevent excessive movement during reinforcing cage handling and installation, or placement of concrete.

The bottoms of the tubes shall be set 150 mm above the bottom of the reinforcing cage. No tubes are to be placed in contact with the bottom of the drilled shaft. The tops of the tubes shall extend at least 1.0m, and no more than 2.0 m, above the proposed top of the concrete in the shaft. If the top of the concrete will be subsurface or in the river the tubes shall extend at least 1.0m and no more than 2.0 m above grade or water level, or other reasonable access level if coffer dams or casings are used.

(c) The reinforcing cages shall be handled in such a manner as to prevent excessive bending or distortion during lifting or placement. "Excessive" in this instance means bending or distortion that results in kinking or permanent bending of the access tubes, or displacement of the tubes so that they are no longer regularly spaced and parallel to each other. Longitudinal twisting or "spiraling" of the cage that may occur during lifting or placement is not significant, provided that the tubes remain parallel, undamaged, and securely fixed.

(d) When the reinforcing cage and tubes are installed in the shaft, and before concrete is placed, the Contractor shall plumb and record the full depth of the shaft, and the full depth of the interior of at least one of the access tubes, relative to proposed top of concrete, or other site datum. After concrete placement, these figures, together with the elevation of the top of the finished concrete, the concreted length, and the date of concrete placement, shall be tabulated for each shaft and provided to the Department.

(e) Before concrete is placed, the tubes shall be filled completely with clean, potable water, and the tops of the tubes shall be sealed to prevent ingress of concrete or other foreign material. If scheduling conflicts prevent filling of the tubes before concrete placement, the tops shall be temporarily sealed before concrete is placed. The tubes shall then be filled with potable water no later than four hours after placement of concrete. The sealing method may be selected by the Contractor, but shall be such that no significant hammering or horizontal, vertical, or torsional force is required to unseal the tubes.

Excessive force could result in breaking the bond between the concrete and the upper portion of the tube.

(f) Before commencing this work, the Contractor shall submit to the Department his selection of tube type, size, and source, together with his proposed methods of installation, fixing, and sealing. Where the top of concrete will be subsurface, or in the river, the Contractor will also submit his proposed finish level for the tubing, and means of access for the testing team.

(g) CSL tests shall be performed no earlier than five (5) days after placement of the concrete if high early strength concrete is not used. On completion of testing and acceptance of the shafts by the Department, the Contractor shall remove the water from the CSL access tubes, and fill the tubes completely with grout placed by tremie or pumped from the bottom.

B. IMPULSE RESPONSE SPECTRUM (IRS) TEST: Concurrently with the CSL test, the Department shall perform the impulse response test on each of the drilled shafts.

PRINCIPLE: The impulse response test can be used to corroborate shaft integrity, and to evaluate the likely performance of a shaft by comparing the impulse response test data for that shaft with the data from a similar shaft that has been load-tested and also tested by the impulse response method.

The head of the shaft is struck axially with a small sledge hammer that contains a load-cell. The response of the shaft is monitored by a geophone velocity transducer. Both instruments are connected to a data acquisition and processing system, where the raw data are converted into the frequency domain, and velocity is divided by force. The resultant graph of mobility against frequency contains information on:

The dynamic stiffness of the shaft/soil complex
The length of the shaft, or depth of significant anomalies
The regularity of the shaft's cross-section
The average quality of the concrete

MATERIALS: Since impulse response testing will be performed concurrently with the CSL test, no additional materials are required for the performance of this test.

EQUIPMENT: The Contractor shall prepare the heads of the shafts for the impulse response test, and assist in performance of the test by providing the following equipment and labor :

(a) Access to the concrete at the heads of the shafts shall be provided for the Contractor's staff and the Department's testing personnel. This access shall include provision for the

Contractor's and the Department's personnel to enter or be lowered into the inside of the reinforcing steel cage to prepare the concrete surface and perform the test.

(b) Small pneumatic or electric chipping hammer, hand tools, and operators for removing grout, laitence, and contaminated materials from the surface of the concrete, and providing reasonably smooth and level areas of clean, sound concrete.

PROCEDURE: The impulse response test shall be performed no earlier than five days after placement of the concrete in a shaft, unless otherwise determined by the Department.

The Contractor shall prepare each shaft for testing by providing a safe means of personnel access to the concrete surface inside the reinforcing cage, removing any loose debris, and providing on each shaft a minimum of two areas of clean, sound, level concrete, free of laitence, grout, cracking, honeycombing, or contamination.

The surface of the shafts shall be free of standing water, and at least 25 mm (1.0") above any water, slurry, or loose mud around the top of the shaft. The prepared areas shall, at a minimum, be as follows:

(a) In the center of the shaft, with a minimum 75 mm (3.0") diameter, and not more than 25 mm (1.0") above or below the surrounding surface, such that a short handled sledge hammer (2# or 3#) can be used to strike the surface squarely, with the handle parallel to the surface, and without the operators fingers touching the surface.

(b) Near the perimeter of the shaft, within the reinforcing cage, not less than 450 mm (18.0") from the center of the shaft. Minimum 75 mm diameter, and not more than 12.5 mm (0.5") below the surrounding material.

The Department shall make a preliminary interpretation of the test results on site. If anomalous responses are recorded, or the data indicate low modulus or contaminated concrete near the head of the shaft, the Contractor will assist in preparing a new test area near the perimeter of the shaft, at a minimum of 60 degrees from the first test location. The Department will then repeat the test, at the new location.

EVALUATION OF TEST RESULTS: If the tests indicate that there are zones of defective concrete within a shaft, the defects shall be jointly evaluated by the Department and the Contractor. In cases where the nature or extent of a defect remains uncertain, excavation or core-sampling of the defective zone may be required in order to permit visual or laboratory assessment of the material. Such excavation or core-sampling shall be performed by the Contractor under the supervision of the Department. There will be no extra compensation to the contractor for core-sampling or excavation work necessitated by a defect within the concrete.

In the event that a defect is considered deleterious to the performance of the shaft, options for the repair or replacement of the shaft shall be considered. Such repair or replacement shall be completed to the satisfaction of the Department, at no extra cost to the Department.

The decision to accept or reject a drilled shaft shall be made by the Department.

734.17 METHOD OF MEASUREMENT

(a) FURNISHING DRILLED SHAFT DRILLING EQUIPMENT: There will be no measurement of the work performed under this item.

(b) DRILLED SHAFTS: The quantities to be paid for shall be the volume in cubic yards or cubic meters of the completed concrete drilled shaft, of the diameter and containing the reinforcement shown on the plans. The length for the calculation of the quantity, shall be determined as the difference between the plan top of shaft elevation and the final bottom of shaft elevation.

(c) UNCLASSIFIED SHAFT EXCAVATION: The quantities to be paid shall be the volume in cubic yards or cubic meters of completed unclassified shaft excavation of the diameter shown on the plans measured along the centerline of the shaft, including bells. The pay quantity shall be computed as the difference between the plan top of shaft elevation and the plan estimated tip elevation.

(d) EXTRA UNCLASSIFIED SHAFT EXCAVATION: The quantities to be paid shall be the volume in cubic yards or cubic meters of completed unclassified shaft excavation of the diameter shown on the plan measured from the shaft estimated tip elevation shown on the plan to the final authorized and accepted bottom of shaft elevation.

(e) OBSTRUCTIONS: The quantities to be paid shall be the number of hours of work, or fraction thereof per obstruction, after designation as an obstruction by the engineer, required to remove the obstruction and resume excavation.

(f) TRIAL SHAFT:The quantity to be paid shall be the authorized linear feet of trial shaft holes, drilled of the diameter shown on the plans, completed (including backfill when required) and accepted. The linear feet of trial shaft holes shall be determined as the difference between the existing ground surface elevation at the center of the trial shaft hole prior to drilling and the authorized bottom elevation of the hole.

(g) EXPLORATION (SHAFT EXCAVATION): The quantity to be paid shall be the length in linear feet, measured from the bottom of the shaft elevation to the bottom of the exploration hole, for each authorized exploration drilled below the shaft excavation.

(h) INSTRUMENTATION INTEGRITY TESTING AND DATA COLLECTION: The quantity to be paid shall be lump sum for payment of all specified instrumentation,

integrity testing, all cost associated with collection of data, all required analyses and any required reports.

734.18 **BASIS OF PAYMENT**

(a) FURNISHING DRILLED SHAFT DRILLING EQUIPMENT: Payment for this item when made at the contract lump sum amount will be full and complete payment for furnishing and moving the drilling equipment to the project, setting the equipment up at the locations and removing the equipment from the project. Payment of 60 percent of the amount bid for this item will be made when all drilling equipment is on the job, assembled and ready to drill foundation shafts. Payment for the remaining 40 percent of the bid amount will be made when all shafts have been drilled and all shaft concrete has been placed up to the to of the shafts.

(b) DRILLED SHAFTS: Drilled shafts shall be paid for at the contract unit price per cubic yard or cubic meter for drilled shaft of the diameter specified. Such payment shall include the cost of concrete, and reinforcing steel, sonic logging tubes, all labor, materials, equipment, temporary casings, and incidentals necessary to complete the drilled shaft.

(c) UNCLASSIFIED SHAFT EXCAVATION: Unclassified shaft excavation shall be paid for at the contract unit price per cubic yard or cubic meter for drilled shafts of the diameter specified. Such payment shall be full compensation for the shaft excavation including temporary casing, removal from the site and disposal of excavated materials, using slurry as necessary, using drilling equipment, blasting procedures, special tools and drilling equipment to excavate the shaft to the depth indicated on the plans, and furnishing all other labor, materials and equipment necessary to complete the work.

(d) UNCLASSIFIED EXTRA DEPTH EXCAVATION: Unclassified extra depth excavation (UCEDE) shall be paid for at 150 percent of the contract unit price per linear foot for the unclassified Shaft Excavation item of the diameter specified. Such payment shall be full compensation for all costs of excavating below the bottom of shaft elevations shown on the plans, except for the additional costs included under the associated pay items for permanent casing. Work under this item is the same as that described under unclassified shaft excavation together with any additional work as a result of excavating below the plan bottom of shaft elevation. Compensation under this item shall be paid only when the extra depth excavation is authorized by the engineer.

(e) OBSTRUCTIONS: Removal of obstructions shall be paid at the contract unit price per hour for obstructions. The maximum payment per designated obstruction shall not exceed 20 times the unit cost bid for either standard excavation or unclassified excavation, whichever is less. Such payment shall be full compensation for all labor, materials, and equipment necessary to complete the work.

(f) TRIAL SHAFT HOLES: Trial shaft holes of the specified diameter will be paid for at the contractor unit price per linear foot for trial shaft holes. Such payment shall be full compensation for excavating the trial shaft hole through whatever materials are encountered to the bottom of shaft elevation shown on the plans or as authorized by the engineer (using mineral slurry as necessary), providing inspection facilities, backfilling the hole, restoring the site as required and all other expenses to complete the work.

(g) EXPLORATION (SHAFT EXCAVATION): Soil samples and/or rock cores of the diameter and length required and authorized by the engineer will be paid for at the contract unit price per linear foot for either soil sample or rock core. Such payment shall be full compensation for drilling, extracting, packaging and classifying the samples or cores, delivering them to the Department, furnishing concrete to fill the core hole and all other expenses necessary to complete the work.

(h) INSTRUMENTATION INTEGRITY TESTING AND DATA COLLECTION: The lump sum bid price shall include all labor, equipment and material incidental to instrumentation, integrity testing and, when required, data collection and reports.

(i) ITEMS OF PAYMENT:

Payment shall be made under:

1. Furnishing Drilled Shaft Drilling Equipment	Lump Sum
2. Drilled Shaft concrete	cu yd. (m^3).
3. Unclassified Shaft Excavation	cu yd. (m^3).
4. Unclassified Extra Depth Excavation	cu yd. (m^3).
5. Obstructions	Hour
6. Trial Shaft Holes	linear foot (m).
7. Exploration (Shaft Excavation)	linear foot (m).
8. Instrumentation, Integrity Testing and Data Collection	Lump Sum.

GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED WASHINGTON STREET INTERCHANGE
INDIANAPOLIS, MARION COUNTY, INDIANA
INDOT PROJECT NO. IN 55 (001)
INDOT DES. NO. 0401228

ATC PROJECT NO. 86.00481.0159

JUNE 2, 2005

PREPARED FOR:

AMERICAN CONSULTING, INC.
7260 SHADELAND STATION
INDIANAPOLIS, IN 46256-3957

ATTN: MR. KEVIN G. JASINSKI, P.E.

ATC ASSOCIATES INC.
Environmental, Geotechnical and Materials Professionals

7988 Centerpoint Drive, Suite 100
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www.atcassociates.com
317-849-4990
Fax 317-849-4278

June 2, 2006

American Consulting, Inc.
7260 Shadeland Station
Indianapolis, IN 46256-3957

Attn: Mr. Kevin G. Jasinski, P.E.

Re: Geotechnical Engineering Investigation
Proposed Washington Street Interchange
Indianapolis, Marion County, Indiana
INDOT Project No. IN 55 (001)
INDOT Des. No. 0401228
ATC Project No. 86.00481.0159

Gentlemen:

Submitted herewith is the report of our geotechnical engineering investigation for the referenced project. This study was authorized in accordance with our Proposal–Agreement No. PE-05-1676 dated March 9, 2005.

This report contains the results of our field and laboratory testing program in accordance with current INDOT Standards, an engineering interpretation of this data with respect to the available project characteristics and recommendations to aid in the design and construction of the earth-connected phases of this part of the project.

We appreciate the opportunity to be of service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,

ATC Associates Inc.

Shawn M. Marcum, P.E.
Project Engineer

Thomas J. Struewing, P.E.
Principal Engineer

Copies: (8) American Consulting, Inc. Attn: Mr. Kevin G. Jasinski, P.E.
(10) INDOT Attn: Mr. Athar A. Khan, P.E.

SUMMARY OF GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED WASHINGTON STREET INTERCHANGE
INDIANAPOLIS, MARION COUNTY, INDIANA
INDOT PROJECT NO. IN 55 (001)
INDOT DES. NO. 0401228
ATC PROJECT NO. 86.00481.0159

GENERAL INFORMATION

Plans are being developed by American Consulting, Inc. (ACE) for the construction of an interchange at Interstate 65 and Washington Street near downtown Indianapolis in Marion County, Indiana. The project will include the construction of entrance ramps and exit ramps from Interstate 65 to Washington Street and complete reconstruction of the existing pavement. The existing Market Street ramps will be razed and Market Street will be reconstructed from East Street to Cruse Street. The intersection of Southeastern Avenue and Washington Street will be reconstructed with Southeastern Avenue being realigned east of the current intersection. Davidson Street, north of Washington Street, will be reconstructed east of the existing alignment making it necessary to construct retaining walls along the east side of Davidson Street to support the interstate embankments. Davidson Street, south of Washington Street, will be realigned west of the current intersection with Washington Street. Pine Street will be reconstructed from Washington Street to Ohio Street with a new intersection at Market Street. The intersection at Shelby Street and Southeastern Avenue will be reconstructed to accommodate the new alignment of Southeastern Avenue. The existing exit ramp from southbound Interstate 65 at Fletcher Avenue will be widened to two lanes.

Some of the existing highway embankments will be steepened to accommodate the expanded roadway sections. In most cases, the steepened embankment slopes will be made at about 2 (horizontal) to 1 (vertical). Due to right-of-way restrictions and the locations of the proposed roadway sections immediately adjacent to the existing roadway embankments it will be necessary to construct retaining walls along both sides of the Washington Street exit ramp and along the eastern side of Davidson Street north of Washington Street and Market Street.

RETAINING WALLS

Due to right-of-way restrictions and the location of the proposed Washington Street exit ramp (Ramp 5SN) relative to the location of the existing Interstate 65 embankment, it will be necessary to construct retaining walls along both sides of the exit ramp. The retaining wall along the left side of the Washington Street exit ramp will be from about Station 412+50 to 414+06 at approximately 65 ft left and is currently proposed as a sheet-pile retaining wall in order to complete the installation of this wall within a limited timeframe. A soldier pile and lagging retaining wall is currently proposed along the right side of the exit ramp where the wall will be from about Station 409+50 to 413+92 at approximately 21 to 47 ft right.

Due to right-of-way restrictions and the realignment of Davidson Street north of Washington Street and Market Street relative to the location of the existing interstate embankment, it will be necessary to construct retaining walls along the right side of Davidson Street between Stations 30+24 and 34+00 at about 20 ft right and between Stations 34+69 and 38+32 at about 20 ft right. Tied-back soldier pile and lagging retaining walls using two rows and three rows of soil anchors were analyzed.

CUT SLOPES AND GRADING

In most areas of the project, the proposed roadway widening/realignment will be accomplished by cutting the existing earth embankments, with the new embankment slopes at 2 (horizontal) to 1 (vertical) or flatter. Based on analyses of the slopes, it appears that the proposed 2 (horizontal) to 1 (vertical) sideslopes will have satisfactory factors of safety relative to global stability. However, since these slopes are steeper than 3 (horizontal) to 1 (vertical), it will be necessary to take special measures to properly cover these slopes to prevent erosion.

PAVEMENT RECOMMENDATIONS

It is recommended that Type IA Subgrade Treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement subgrade. It is recommended that a CBR value of 4 be used for the design of the pavement.

Report Prepared By:
Shawn M. Marcum, P.E.
Project Engineer

Report Reviewed By:
Thomas J. Struewing, P.E.
Principal Engineer

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GEOTECHNICAL ENGINEERING INVESTIGATION

FIRST SUBMITTAL

PROPOSED WASHINGTON STREET INTERCHANGE
INDIANAPOLIS, MARION COUNTY, INDIANA
INDOT PROJECT NO. IN 55 (001)
INDOT DES. NO. 0401228
ATC Project No. 86.00481.0159

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed construction of an interchange at Interstate 65 and Washington Street in downtown Indianapolis, Indiana. The construction project begins on Washington Street east of College Avenue at Station 209+50 Line "PR-W" and ends at Station 227+00 Line "PR-W" east of Cruse Street. The general location of the project is shown on the Project Location Map and on the Vicinity Map (see Figures 1 and 2 in Appendix A).

This investigation was performed to characterize and evaluate the soils beneath the project site and to develop recommendations for retaining walls, the steepened earth embankments and the pavements. The investigation consisted of an exploratory drilling and sampling program, laboratory testing of soil, engineering analyses and preparation of this report.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either express or implied. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

2.0 PROJECT DESCRIPTION

Plans are being developed by American Consulting, Inc. (ACE) for the construction of an interchange at Interstate 65 and Washington Street near downtown Indianapolis in Marion County, Indiana. The project will include the construction of entrance ramps and exit ramps from Interstate 65 to Washington Street and complete reconstruction of the existing pavement. The existing Market Street ramps will be razed and Market Street will be reconstructed from East Street to Cruse Street. The intersection of Southeastern Avenue and Washington Street will be reconstructed with Southeastern Avenue being realigned east of the current intersection. Davidson Street, north of Washington Street, will be reconstructed east of the existing alignment making it necessary to construct retaining walls along the east side of Davidson Street to support the interstate embankments. Davidson Street, south of Washington Street, will be realigned west of the current intersection with Washington Street. Pine Street will be reconstructed from Washington Street to Ohio Street with a new intersection at Market Street. The intersection at Shelby Street and Southeastern Avenue will be reconstructed to accommodate the new alignment of Southeastern Avenue. The existing exit ramp from southbound Interstate 65 at Fletcher Avenue will be widened to two lanes.

Some of the existing highway embankments will be steepened to accommodate the expanded roadway sections. In most cases, the steepened embankment slopes will be made at about 2 (horizontal) to 1 (vertical). Due to right-of-way restrictions and the locations of the proposed roadway sections immediately adjacent to the existing roadway embankments it will be necessary to construct retaining walls along both sides of the Washington Street exit ramp and along the eastern side of Davidson Street north of Washington Street and Market Street.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of this study was to determine the general subsurface conditions at the project site by drilling test borings and to evaluate these with respect to the earth related aspects of the proposed project. Geologic maps published by the Indiana Geological Survey (e.g., "Geologic Map of the Indianapolis Quadrangle Showing Bedrock and Unconsolidated Deposits", 1979 and the "Surficial Geologic Map of Marion County, Indiana", 1963) were reviewed as part of this study to assess the general soil conditions in the vicinity of the site. In addition, the site has been evaluated with respect to potential construction problems and recommendations are included that address matters of earthwork and quality control during construction.

3.1 Field Investigation

The subsurface conditions for the proposed project were investigated by ATC Associates Inc. (ATC) during the period of February 11, 2006 to March 2, 2006. Drilling was performed with all-terrain-vehicle and truck mounted drilling equipment using hollow-stem augers to advance the boreholes. Where split-spoon samples were taken, they were obtained by using standard penetration test (SPT) procedures (American Association of State Highway and Transportation Officials (AASHTO T 206), generally at 2.5 ft and 5.0 ft intervals, at the locations indicated on the Test Boring Logs.

Subsequent to drilling activities and obtaining 24-hour water level measurements at selected locations, each test borehole was backfilled in accordance with the specifications set forth by the INDOT "Aquifer Protection Guidelines".

The number, locations and depths of the borings were selected by ATC and the soil boring locations were staked in the field by ATC, with approximate boring elevations estimated from roadway plans and cross-sections developed by American Consulting, Inc. The test borings were drilled at the locations noted on the Test Borings Logs in Appendix B.

Logs of all borings, which show visual descriptions of all soil strata encountered using the AASHTO classification system, are included in Appendix B. Sampling information and other pertinent field data and observations are also included on the boring logs. In addition, a sheet defining the terms and symbols used on the logs and explaining the standard penetration test (SPT) procedure is provided immediately preceding the boring logs in Appendix B.

3.2 Laboratory Investigation

The soil samples were visually classified by a geotechnical engineer in accordance with the AASHTO Soil Classification System and the visual classifications were verified or modified based upon the results of laboratory tests. Final boring logs were subsequently prepared and are included in Appendix B. Soil index property tests including natural moisture content (AASHTO T 265), grain size distribution and analyses (AASHTO T 88), Atterberg limits determinations (AASHTO T89 and T90), unconfined compressive strength tests (AASHTO T 208) and soil pH (AASHTO T 200) were performed on representative samples. A California Bearing Ratio (CBR) test (AASHTO T193 – method D) was performed on a representative bag sample. The results of the laboratory tests are included on the boring logs in Appendix B and/or on respective plots or summary sheets in Appendices C and E.

4.0 GENERAL SITE CONDITIONS

4.1 Regional and Site Geology

The project site is located within the New Castle Till Plains and Drainageways, which is part of the Central Till Plain Physiographic Region of the State of Indiana. This area is underlain by limestone and dolomite of Middle Devonian age. The unconsolidated overburden deposits consist mostly of loam till with zones of sand and gravel, silty loam and silty clay loam.

4.2 Subsurface Conditions

The general subsurface conditions at the site were investigated by drilling twenty-three (23) roadway borings and ten (10) retaining wall test borings to depths ranging from 7.5 to 50 ft. The subsurface conditions disclosed by the field investigation are summarized in the following paragraphs. Detailed descriptions of the subsurface conditions encountered in each test boring are presented on the Test Boring Logs in Appendix B. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths and variations in the soil stratigraphy and ground water levels should be expected across this site.

The predominant soil type within the test borings drilled for this project is medium stiff to very stiff natural loam soils and loam embankment fill. Layers of soft to stiff silty loam and silty clay loam were noted near the surface, or immediately below the existing embankment fill, in some test borings. The deeper test borings that were drilled for the retaining structures typically revealed very stiff to hard loam and medium dense to very dense sand and gravel, and sand below the surficial layers of loam fill. Areas of miscellaneous loam and sand and gravel fill (soils containing varying amounts of cinders, brick fragments and other debris) were also encountered in the upper portions in many of the borings.

4.3 Pavement Cores

The existing pavement along Washington Street (Line “PR-W”) was cored at six locations. The following table indicates the locations of the pavement cores and provides a summary of the pavement section encountered:

Location	Station	Pavement Summary
RB-1	212+30, 33 ft Right	1¼ in. Asphalt, 3 in. Brick
C-1	214+50, 8 ft Right	2 ½ in. Asphalt, 2 ½ in. Brick
C-2	217+25, Centerline	2 in. Asphalt, 2 ½ in. Brick
RB-2	219+00, 10 ft Right	2 ¼ in. Asphalt, 3 ½ in. Brick, 2 in. Asphalt, 2 ½ in. Concrete, 9 in. Wood
C-3	222+50, 10 ft Left	3 in. Asphalt, 3 in. Brick
RB-3	225+42, 10 ft Right	2 ¼ in. Asphalt, 3 in. Brick, 6 in. Sand, 12 in. Wood

4.4 Ground Water Conditions

Ground water observations were made during drilling operations (by noting the depth of water on the drilling tools), in the open boreholes following withdrawal of the drilling augers and at 24 hours after the completion of drilling activities in most of the test borings. Free ground water was noted in fifteen of the thirty-three test borings drilled for this project at various depths as noted on the Test Boring Logs in Appendix B.

It must be noted that shallow ground water in central Indiana glacial till deposits is typically contained (or "perched") within discontinuous sand seams or lenses within the clayey glacial till soils. Therefore, the amount of ground water that is encountered in a test boring or excavation is dependent upon the depth, thickness, lateral extent and saturation of any granular zones that are intersected by the test boring or excavation. Thus, ground water may be encountered at varying depths and locations across the site. Fluctuations in the level of the ground water should be expected due to variations in rainfall and other factors not evident at the time of our investigation. Water level readings were made in the drill holes at the times and under the conditions stated on the boring logs in Appendix B.

5.0 DESIGN RECOMMENDATIONS

The following embankment, roadway and retaining wall design recommendations have been developed on the basis of the previously described project characteristics (Section 2.0) and subsurface conditions (Section 4.0). If there is any change in these project criteria, including changes in the roadway alignment, profile grade, cross-sections and typical sections or structure type and location, a review should be made by this office.

5.1 Retaining Walls

5.1.1 Interstate 65 - Washington Street Exit Ramp

Due to right-of-way restrictions and the location of the proposed Washington Street exit ramp (Ramp 5SN) relative to the location of the existing Interstate 65 embankment, it will be necessary to construct retaining walls along both sides of the exit ramp. The retaining wall along the left side of the Washington Street exit ramp will be from about Station 412+50 to 414+06 at approximately 65 ft left and is currently proposed as a sheet-pile retaining wall in order to complete the installation of this wall within a limited timeframe. A soldier pile and lagging retaining wall is currently proposed along the right side of the exit ramp where the wall will be from about Station 409+50 to 413+92 at approximately 21 to 47 ft right.

The highest section of the proposed retaining wall along the left side of the proposed Washington Street ramp, which plans indicate occurs at Station 413+50 Line "PR-5SN" – West Side, was analyzed using the computer program CT-SHORING by Civil Tech Software. Due to a proposed sewer line that will be constructed just east of the proposed retaining wall with an invert elevation at approximately El 711 to 712, an unsupported wall height of 10 ft with a 1 (horizontal) to 1 (vertical) slope at the face of the retaining that extends a distance of 5 ft from the face of the wall was used in the retaining wall analysis. The analysis indicates that a PZ32 sheet-pile section (ASTM A572 Grade 50 steel sheet-pile) with a minimum embedment depth of 27 ft (the embedment depth is measured below the proposed excavation line) should be stable and should have a top deflection of less than 2 in.

This assumes that the existing soil behind the top of the retaining wall is first excavated (i.e., the backslope behind the piling as shown on the cross-section) and an unsupported wall height no greater than 10 ft. If it becomes necessary to have an unsupported height greater than 10 ft, or a 1 to 1 slope can not be maintained at the face of the wall, additional temporary supports (such as tiebacks) will be needed during the construction of the sewer until the sewer is backfilled and the pavement is in-place. The results of the retaining wall analysis (including a sketch indicating the assumed retaining wall geometric conditions) are included in Appendix D.

It is important to note that the embedded portion of the sheet-pile retaining wall will impart additional lateral earth pressures on the proposed sewer line. It is recommended that the proposed sewer line be evaluated to determine the impact of the additional lateral loading and deflection on the structural integrity of this sewer.

The highest section of the proposed retaining wall along the right side of the proposed Washington Street ramp, which plans indicate occurs at Station 412+00 Line "PR-5SN" - East Side, was analyzed using the computer program CT-SHORING. An unsupported wall height of 10 ft with a horizontal ground surface behind the retaining wall and a horizontal ground surface extending from the face of the retaining was used in the analysis. The analysis indicates that a cantilever soldier pile and lagging wall consisting of HP 14x73 piles (Grade 50 steel) with a minimum embedment depth of 24 ft (as measured below the deepest excavation depths), a maximum spacing of 8 ft (center-to-center) and an unsupported wall height no greater than 10 ft should be stable and should have a maximum horizontal deflection at the top of the wall of less than 2 in. If it becomes necessary to have an unsupported height greater than 10 ft or a horizontal ground surface can not be maintained at the face of the wall or behind the wall, additional supports such as tieback anchors or additional wall analyses will be needed. The results of the retaining wall analysis (including a sketch indicating the assumed retaining wall geometric conditions) are included in Appendix D.

5.1.2 Davidson Street Retaining Walls

Due to right-of-way restrictions and the realignment of Davidson Street north of Washington Street and Market Street relative to the location of the existing interstate embankment, it will be necessary to construct retaining walls along the right side of Davidson Street between Stations 30+24 and 34+00 at about 20 ft right and between Stations 34+69 and 38+32 at about 20 ft right. Tied-back soldier pile and lagging retaining walls using soils anchors were analyzed for the highest section north of Washington Street and the highest section north of Market Street.

The highest section of the proposed retaining wall along the right side of the proposed Davidson Street realignment north of Washington Street, which plans indicate occurs at Station 33+40 Line "PR-DN" Right (i.e., top-of-wall at El 739.5 and sewer excavation to El 707), was analyzed using the computer program CT-SHORING. A wall height of 32.5 ft with an installation trench for the sewer lines and a 2 (horizontal) to 1 (vertical) backslope above the top of the wall was used in the analysis. The analysis indicates that a tied-back soldier pile and lagging wall consisting of HP 12x53 piles (Grade 50 steel) with soil anchors and a minimum pile embedment depth of 10 ft (i.e., pile tip at or below El 697), a maximum pile spacing of 8 ft (center-to-center) and three rows of tie-back anchors should be stable and should have a maximum deflection of less than 2 in. The locations of the anchors (as measured from the top of the wall) used in the analyses were 4 ft, 14 ft and 24 ft with corresponding horizontal tie-back capacities of 110 kips, 120 kips and 110 kips. The tie-back anchor capacities will need to be increased according to inclination of the installed soil anchors. The results of the retaining wall analysis (including a sketch indicating the assumed geometric conditions) are included in Appendix D.

It is important to note that the embedded portion of the retaining wall will impart additional lateral earth pressures on the proposed sewer line. It is recommended that the proposed

sewer line be evaluated to determine the impact of the additional lateral loading and deflection on the structural integrity of this sewer.

The highest section of the proposed retaining wall along the right side of the proposed Davidson Street realignment north of Market Street, which plans indicate occurs at Station 35+50 Line "PR-DN" Right (i.e., top-of-wall at El 730 and excavation to El 709), was analyzed using the computer program CT-SHORING. A wall height of 21 ft with a horizontal ground surface extending from the face of the retaining wall and a 2 (horizontal) to 1 (vertical) slope extending back from the top of the wall was used in the analysis. The analysis indicates that a tie-back soldier pile and lagging wall consisting of HP 12x53 piles (Grade 50 steel) with soil anchors and a minimum pile embedment depth of 9 ft (i.e., pile tip at or below El 700), a maximum pile spacing of 8 ft (center-to-center) and two rows of tie-back anchors should be stable and should have a maximum deflection of less than 2 in. The vertical locations of the anchors (as measured from the top of the wall) used in the analysis were 6 ft and 15 ft with corresponding horizontal capacities of 90 kips and 60 kips, respectively. The tie-back anchor loads will need to be increased according to the inclination of the soil anchors. The results of the retaining wall analysis (including a sketch indicating the assumed geometric conditions) are included in Appendix D.

It is recommended that the first two soil anchors should be creep tested and at least five percent of the anchors will be performance tested to 133 percent of the design load. All soil anchors that are not creep or performance tested should be proof tested to 133 percent of the design load.

5.2 Cut Slopes and Grading

In most areas of the project, the proposed roadway widening/realignment will be accomplished by cutting the existing earth embankments, with the new embankment slopes at 2 (horizontal) to 1 (vertical) or flatter. Slope stability analyses were performed for the

cross-sections at Station 413+50 Line "5NS" and Station 394+50 Line "6NS". The results of the slope stability analyses are presented in Appendix E.

The following table summarizes the computed factors of safety as well as the required factors of safety for embankments based on stability analyses using the computer program STABL 6H (see Appendix E for the results of the stability analyses using STABL 6H).

Embankment Location	Embankment Slope / Height Analyzed	Case Analyzed	Calculated Factor of Safety	Required Minimum Factor of Safety
Station 413+50 Line "5NS"	2 (horizontal) to 1 (vertical), 18 ft high	End-of-Construction	2.8	1.2
		Permanent Condition	1.5	1.5
Station 394+50 Line "6NS"	2 (horizontal) to 1 (vertical), 22 ft high	End-of-Construction	4.5	1.2
		Permanent Condition	1.8	1.5

Based on these analyses, it appears that the proposed 2 (horizontal) to 1 (vertical) sideslopes will have satisfactory factors of safety relative to global stability. However, since these slopes are steeper than 3 (horizontal) to 1 (vertical), it will be necessary to take special measures to properly cover these slopes to prevent erosion.

It is important that all earth fill that is placed adjacent to the existing highway embankment be carefully benched into the existing embankment as prescribed in INDOT Standard Specification Section 203.21 in order to preclude a weak zone from forming at the interface between the existing embankment soils and the new fill soils. Such benches should be at least 10 ft wide. The subgrade beneath the new expanded embankment areas should be prepared in accordance with Section 6.2 and the fill placed and compacted in accordance with Section 6.3 of this report. All conventional earth embankment work should be performed in accordance with current INDOT Standard Specifications.

5.3 Pavements

The results of the CBR test conducted for this project, which are included in Appendix F, indicate a CBR value of about 7.7. However, based on our experience with similar soils in this area, it appears that the results of the CBR test are much higher than that which are typically used for the type of soil tested. Therefore, it is our recommendation that a CBR value of 4 be used for the design of the pavement. Recommendations for the removal and replacement of any unsuitable materials that may be encountered during construction are provided in Sections 6.3 and 6.4 of this report.

It is recommended that Type IA Subgrade Treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement subgrade. For this case, it is recommended that a CBR value of 4 be used for the design of the pavement. Adequate drainage should be provided at the site to minimize any increase in moisture content of the subgrade soils.

5.4 Subsurface Drainage

Adequate drainage should be provided at the site with outlets at regular intervals to minimize any increase in moisture content of the subgrade soils. Subsurface drains are recommended and filter fabric should not be needed.

5.5 Sewers

The natural soils encountered at the invert elevations for the proposed sewers are suitable for support of the sewers. Any extremely loose granular soils encountered during excavation should be compacted and any soft cohesive soil or miscellaneous fill should be removed and replaced with compacted engineered fill prior to placing the sewer.

5.6 Corrosion Protection

The soil samples tested for pH (as tabulated below) during the laboratory investigation do not indicate that the soil at the site has a significant potential for causing corrosion. Corrosion protection does not appear to be needed for piles or metallic pipes and drainage structures based on the pH results of the samples tested.

Summary of Soil pH Values

Boring Number	Depth, ft	pH Value
RB-1	3.5 – 5.0	8.1
RB-2	18.5 – 20.0	8.6
RB-15	6.0 – 7.5	7.1
RW-7	8.5 – 10.0	8.3
RW-7	23.5 – 25.0	7.7

6.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

Since this investigation identified actual subsurface conditions only at the test boring locations, it was necessary for our geotechnical engineers to extrapolate these conditions in order to characterize the entire project site. Even under the best of circumstances, the conditions encountered during construction can be expected to vary somewhat from the test boring results and may, in the extreme case, differ to the extent that modifications to the foundation recommendations become necessary. Therefore, we recommend that ATC be retained as geotechnical consultant through the earth-related phases of this project to correlate actual soil conditions with test boring data, identify variations, conduct additional tests that may be needed and recommend solutions to earth-related problems that may develop.

6.1 Site Preparation and Earthwork

All topsoil, wet, soft, loose or otherwise unsuitable surficial bearing soils should be stripped from the project site within the construction limits prior to construction of the roadway. Proofrolling of the natural ground surface should be performed in accordance with the INDOT Standard Specifications Section 203.26 within all areas where new fill will be placed. Care should be exercised during grading operations at the site. Due to the nature of the near-surface soils, the traffic of heavy equipment, including heavy compaction equipment, may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. The grading, therefore, should be done during a dry season, if possible.

Soft, loose or otherwise unsuitable bearing soils encountered during the proofrolling operations should be removed and replaced with structure fill to a depth of at least 2 ft above the ground water level (if free ground water is encountered within an excavation). If removal and replacement is not feasible, aeration and compaction of the soils should be considered or it may be necessary to stabilize the subgrade using other procedures. It is recommended that the proper subgrade treatments be determined at the time of construction, since the actual subgrade condition can best be assessed at that time. The placement of fill should be accomplished in accordance with Section 203.09 of INDOT Standard Specifications. Structure fill material should be as defined in INDOT Standard Specifications, Section 211.02.

6.2 Placement and Compaction of Engineered Fill

Engineered fill should be placed in lift thicknesses not to exceed about 8 in. and compacted to a minimum of 95 percent of the standard Proctor maximum dry density (AASHTO T99) as specified in the current INDOT Standard Specifications. It is possible that some drying of the fill material will be required before being placed in order to meet the INDOT Specification for fill placement. However, adequate moisture conditioning may be difficult during wet seasons. Thus, during such seasons, a granular material may be necessary to satisfy the minimum compaction requirements.

Where the alignment of the roadway crosses existing drainage ditches, the soft sediment in the base of the channels should be removed and replaced with structural fill to a thickness of at least 2.0 ft above the free ground water level. Otherwise, backfilling should be done in accordance with Section 203.09 of the INDOT Standard Specifications.

6.3 Fill Sections

Where fill material is placed on existing slopes, benches should be cut into the existing slopes so as to preclude a shear plane from developing at the interface. Benches having a minimum width of 10 ft should be cut into the natural slopes and existing embankment side slopes that are 4 (horizontal) to 1 (vertical) or steeper before new engineered fill is placed. These benches should be excavated in accordance with Section 203.21 of the INDOT Standard Specifications.

6.4 Erosion Protection

Highly erodible, granular material (such as structure backfill) should not be used in proposed ditches or within 12 in. of the required final grade of side slopes. The material used to encase the embankment should be non-erodible, cohesive material that is free from debris and other deleterious materials and suitable for sustaining vegetation. The final slopes should be seeded or sodded for erosion control. If seeded, the slope should be protected with an erosion control blanket to provide for adequate seed germination and rooting.

All topsoil and any soft sediments should be removed along the entire length of all proposed drainage structures and replaced with engineered fill to an elevation 2 ft above the ground water level or to the invert elevation of the proposed structure, whichever is higher. The outer 10 ft of structural fill under the ends of the structure should be enveloped with a continuous length of permeable non-woven geotextile. This geotextile should extend the entire width of the excavation. All the soils surrounding the drainage structures should be compacted to at least 95 percent of the maximum dry density as determined in accordance with section 203.24 of the INDOT standard specifications. The soil in the bottom of the

excavation, any bedding material, and the structural fill for structural backfill, should be tested to insure compliance with this density criteria. If soft soils are encountered during construction at depths that make removal impractical or if 95 percent of the maximum dry density cannot be obtained at the bottom of the excavation or in other areas, this office should be contacted for additional recommendations.

6.5 Construction Dewatering

Based upon the ground water data obtained during drilling operations, it appears that the ground water level is below the anticipated excavation depths in the areas of proposed sewers. However, depending on the seasonal conditions, some seepage into excavations may be experienced. It is anticipated that any such seepage can probably be handled by conventional dewatering methods such as by pumping from sumps. In cases where a saturated sand layer is encountered in the base of the excavation, it will not be possible to pump water directly from the base of the excavation without causing deterioration of the subgrade soil. In this case, it will be necessary to pump from a sump located adjacent to the excavation or to depress the ground water using wells or well points. If dewatering becomes a significant problem (which is not anticipated), a specialty dewatering contractor should be retained to install and maintain the dewatering system. The best dewatering system for each case must be determined at the time of construction based upon actual field conditions.

APPENDICES

APPENDIX A

PROJECT LOCATION MAP – Figure 1
VICINITY MAP – Figure 2

APPENDIX B

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION
LOGS OF TEST BORINGS – ROADWAY TEST BORINGS (23)
LOGS OF TEST BORINGS – RETAINING WALL TEST BORINGS (10)

APPENDIX C

SUMMARY OF LABORATORY CLASSIFICATION TEST RESULTS
SUMMARY OF SPECIAL LABORATORY TEST RESULTS
GRAIN SIZE DISTRIBUTION CURVES (5)
STANDARD PROCTOR TEST RESULTS (1)
UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS (1)

APPENDIX D

CALCULATIONS FOR RETAINING WALL EXTERNAL STABILITY (4)

APPENDIX E

SLOPE STABILITY CALCULATIONS (2)

APPENDIX F

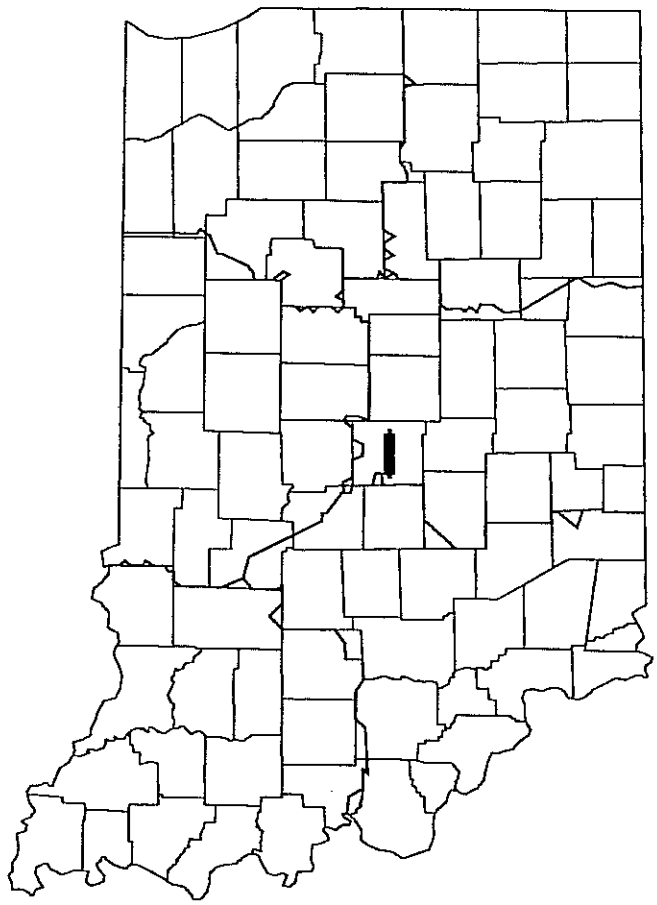
CBR TESTS RESULTS (1)

APPENDIX G

SPECIAL PROVISIONS (TIEBACKS)

APPENDIX A

PROJECT LOCATION MAP – Figure 1
VICINITY MAP – Figure 2



PROJECT LOCATION SHOWN BY
GREENFIELD DISTRICT

N

PROJECT LOCATION MAP

PROPOSED WASHINGTON STREET INTERCHANGE
INDIANAPOLIS, MARION COUNTY, INDIANA
INDOT PROJECT No. IN 55 (001)
INDOT Des. No. 0401228

Project Number: 86.00481.0159		Drn. By: EB
Drawing File: 00481-159A		Ckd. By: SM
Date: 4/06	Scale: NO SCALE	App'd By:
VATC ASSOCIATES INC.		Figure: 1

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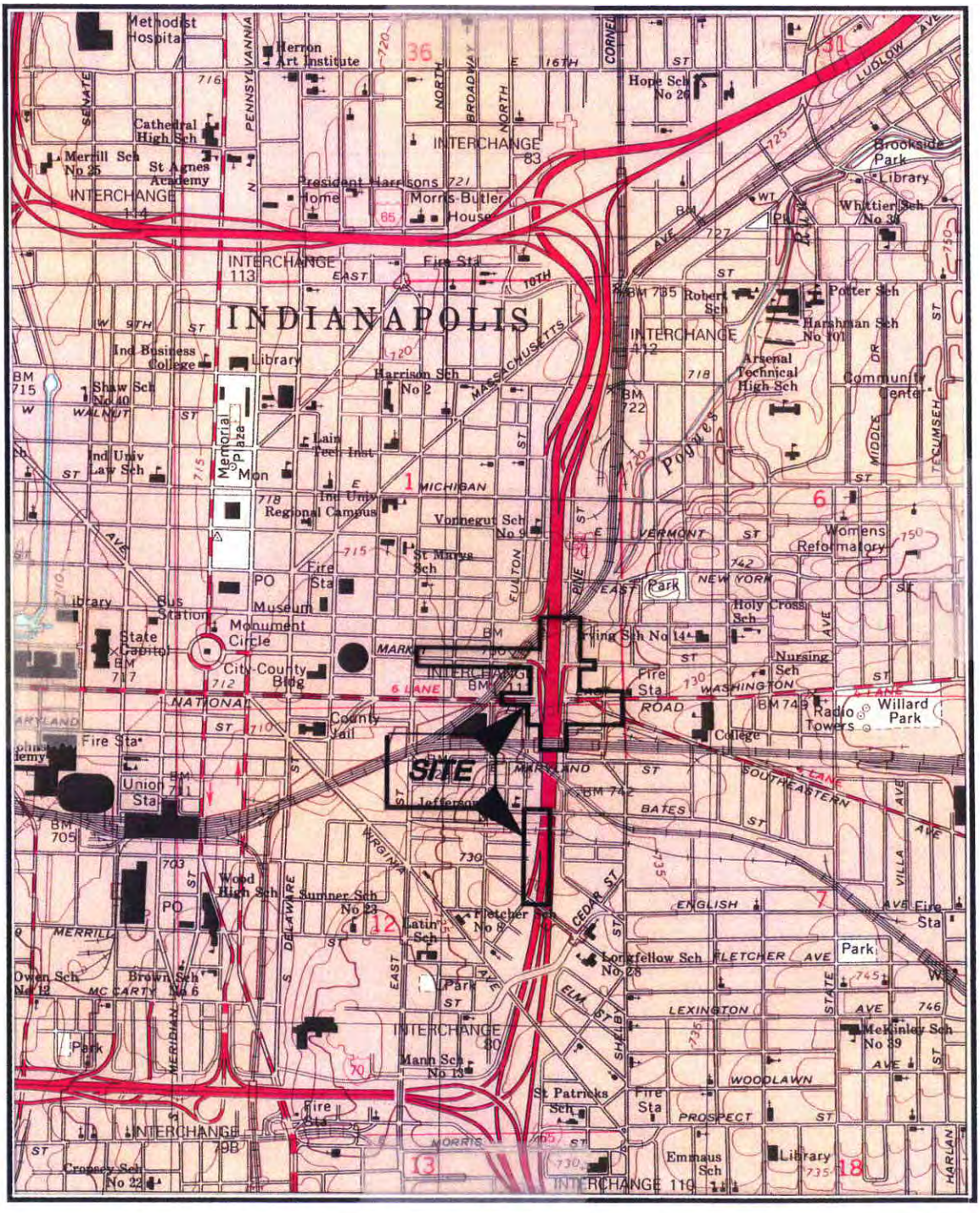

VICINITY MAP

PROPOSED WASHINGTON STREET INTERCHANGE
INDIANAPOLIS, MARION COUNTY, INDIANA
INDOT PROJECT No. IN 55 (001)
INDOT Des. No. 0401228

Project Number: 86.00481.0159		Drn. By: EB
Drawing File: 00481-159A		Ckd. By: SM
Date: 4/06	Scale: 1" = 2000'	App'd By:
VATC ASSOCIATES INC.		Figure: 2

H:\2006\00481\0159

APPENDIX B

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION
LOGS OF TEST BORINGS – ROADWAY TEST BORINGS (23)
LOGS OF TEST BORINGS – RETAINING WALL TEST BORINGS (10)

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

NON-COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	-	5 blows/ft or less
Loose	-	6 to 10 blows/ft
Medium Degree	-	11 to 30 blows/ft
Dense	-	31 to 50 blows/ft
Very Dense	-	51 blows/ft or more

Relative Proportions

Descriptive Term	Percent
Trace	1 – 10
Little	11 – 20
Some	21 – 35
And	36 – 50

Particle Size Identification

Boulders	-	8 inch diameter or more	
Cobbles	-	3 to 8 inch diameter	
Gravel	-	Coarse	- 1 to 3 inch
		Medium	- ½ to 1 inch
		Fine	- ¼ to ½ inch
Sand	-	Coarse	2.00mm to ¼ inch (dia. of pencil lead)
		Medium	0.42 to 2.00mm (dia. of broom straw)
		Fine	0.074 to 0.42mm (dia. of human hair)
Silt			0.074 to 0.002mm (cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency

Very Soft	-	3 blows/ft or less
Soft	-	4 to 5 blows/ft
Medium Stiff	-	6 to 10 blows/ft
Stiff	-	11 to 15 blows/ft
Very Stiff	-	16 to 30 blows/ft
Hard	-	31 blows/ft or more

Plasticity

Degree of Plasticity	Plasticity Index
None to slight	0 – 4
Slight	5 – 7
Medium	8 – 22
High to Very High	over 22

Classification on logs are made by visual inspection of samples.

Standard Penetration Test – Driving a 2.0 in. O.D. 1-3/8 in. I.D. sampler a distance of 1.0 ft into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 in. It is customary for ATC to drive the spoon 6.0 in. to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the test are recorded for each 6.0 in. of penetration on the drill log (example – 6/8/9). The standard penetration test result can be obtained by adding the last two figures (i.e., 8 + 9 = 17 blows/ft). (ASTM D-1586-67).

Strata Changes – In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (——) represents an actually observed change. A dashed line (- - - - -) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
317-849-4990
Fax 317-849-4278

TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-1**
JOB #: **86.00481.0159**
STATION: **212+30 "PR-W"**
OFFSET: **33 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/24/06	Hammer Wt.	140 lbs.
Date Completed	2/25/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 713	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.1 ft Asphalt, 0.3 ft Brick, 0.7 ft Crushed Stone (Visual) Brown, moist, very stiff, loam (FILL) (Lab No. 1) A-4	711.9 710.0	1.1 3.0		1	SS			4-12-5			Ground surface elevation estimated from plans provided by client
Dark brown to black, moist, medium stiff, silty loam (FILL) (Lab No. 2) A-7-6			5	2	SS			3-3-3	39.7	0.25	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				3	SS			3-3-3	36.2	0.25	
Brown, moist, stiff, loam with trace brick fragments (FILL) (Lab No. 1) A-4	705.0	8.0	10	4	SS			8-6-9			Traffic control required
			15	5	SS		▨ 15.0	8-20-25			Pavement restoration
Brown, very moist, medium dense SAND and GRAVEL (Lab No. 3) A-1-b Bottom of Test Boring at 20.0 ft	695.0 693.0	18.0 20.0	20	6	SS			10-13-11			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After 24 hours: Dry ft.
Cave Depth: 15.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-2**
JOB #: **86.00481.0159**
STATION: **219+00 "PR-W"**
OFFSET: **10 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/24/06	Hammer Wt.	140 lbs.
Date Completed	2/25/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 716	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.2 ft Asphalt, 0.3 ft Brick, 0.2 ft Asphalt, 0.2 ft Concrete, 0.8 ft Wood (Visual)	714.3	1.7									Ground surface elevation estimated from plans provided by client
Brown, moist, loose, sand and gravel (FILL) (Lab No. 3) A-1-b	712.5	3.5		1	SS			27-30			
Dark brown to black, moist, medium stiff, silty loam (FILL) (Lab No. 3) A-7-6	710.0	6.0	5	2	SS			3-4-4	27.1		Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Gray, moist, stiff LOAM (Lab No. 1) A-4	706.5	9.5		3	SS			3-5-7	12.1		
Gray, moist, stiff SILTY CLAY LOAM (Lab No. 4) A-6			10	4	SS		▼	12-10-5			Traffic control required
							▩				
			15	5	SS			44-50/0.3'			Pavement restoration
Brown, slightly moist, dense SAND and GRAVEL (Lab No. 3) A-1-b	698.0	18.0		6	SS			9-28-30			
Bottom of Test Boring at 20.0 ft	696.0	20.0	20								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **9.0** ft.
▩ Cave Depth **12.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

GEO-STANDARD-STATE 00481-159.GPJ ATCENVGE.GDT 4/18/07

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
317-849-4990
Fax 317-849-4278

TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-3**
JOB #: **86.00481.0159**
STATION: **225+42 "PR-W"**
OFFSET: **10 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/24/06	Hammer Wt.	140 lbs.
Date Completed	2/25/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 725	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.2 ft Asphalt, 0.3 ft Brick, 0.5 ft Sand, 1.0 ft Wood (Visual)	723.0	2.0									Ground surface elevation estimated from plans provided by client
Brown, moist, stiff LOAM (Lab No. 1) A-4			5	2	SS			4-5-7		3.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	717.5	7.5		3	SS			4-4-4			
Brown, slightly moist, loose to very dense SAND and GRAVEL (Lab No. 3) A-1-b			10	4	SS			6-7-8			Traffic control required
			15	5	SS			50/0.3'			Pavement restoration
	705.0	20.0	20	6	SS			14-18-16			
Bottom of Test Boring at 20.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After 24 hours: Dry ft.
Cave Depth: 13.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-4**
JOB #: **86.00481.0159**
STATION: **5+50 "PR-SE"**
OFFSET: **10 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/27/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 722	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.8 ft Asphalt, 0.3 ft Concrete, 0.3 ft Crushed Stone (Visual)	720.6	1.4									Ground surface elevation estimated from plans provided by client
Brown, moist, medium dense SAND (Lab No. 5) A-2-4				1	SS			10-15-11			
				2	SS			9-8-8			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	716.5	5.5	5								
Brown, moist to slightly moist, medium dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b				3	SS		▨ 6.2	5-9-10			
				4	SS			10-24-24			Traffic control required
			10								
				5	SS			16-40-33			Pavement restoration
			15								
-wet below 19.0 ft				6	SS		● 19.0	18-13-11			
	702.0	20.0	20								
Bottom of Test Boring at 20.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 19.0 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
▨ Cave Depth 6.2 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-5**
JOB #: **86.00481.0159**
STATION: **100+60 "PR-M"**
OFFSET: **5 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 715	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.8 ft Concrete (Visual)	714.2	0.8							
Brown, moist, medium stiff to soft LOAM (Lab No. 1) A-4				1	SS	4-4-5		2.0	Ground surface elevation estimated from plans provided by client
	710.5	4.5		2	SS	5-3-2			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist to slightly moist, medium dense SAND and GRAVEL (Lab No. 3) A-1-b			5	3	SS	4-7-7			
				4	SS	7-7-8			
			10						Traffic control required
				5	SS	9-6-9			Pavement restoration
	700.0	15.0	15						
Bottom of Test Boring at 15.0 ft									

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After -- hours: -- ft.
Cave Depth: 12.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-6**
JOB #: **86.00481.0159**
STATION: **108+00 "PR-M"**
OFFSET: **5 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/11/06	Hammer Wt.	140 lbs.
Date Completed	2/11/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 715	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.2 ft Asphalt, 0.3 ft Crushed Stone (Visual) Dark brown, moist, medium dense to very loose, sand and gravel (FILL) (Lab No. 3) A-1-b	714.5	0.5		1	SS			5-12-9			Ground surface elevation estimated from plans provided by client
				2	SS			3-2-3			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			3-3-5			
	706.5	8.5		4	SS		▨	5-7-10			
Brown, slightly moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b			10								Traffic control required
	700.0	15.0		5	SS			18-20-24			Pavement restoration
			15								
Bottom of Test Boring at 15.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools: None ft.
▽ At Completion: Dry ft.
▼ After -- hours: -- ft.
▨ Cave Depth: 10.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

GEO-STANDARD-STATE 00481-159.GPJ ATCENVGE.GDT 4/18/07

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-7**
JOB #: **86.00481.0159**
STATION: **116+05 "PR-M"**
OFFSET: **3 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 712	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Concrete (Visual)	710.9	1.1									Ground surface elevation estimated from plans provided by client
Brown, moist, medium dense, sand (FILL) (Lab No. 5) A-2-4				1	SS			10-10-10			
	709.0	3.0									
Bottom of Test Boring at 3.0 ft											Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines" Boring encountered concrete sewer at 3 ft and was abandoned Traffic control required

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After -- hours: -- ft.
Cave Depth: -- ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-8**
JOB #: **86.00481.0159**
STATION: **120+50 "PR-M"**
OFFSET: **15 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 711	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Asphalt (Visual)	710.8	0.2									Ground surface elevation estimated from plans provided by client
Brown, moist, hard, loam with crushed stone (FILL) (Lab No. 1) A-4				1	SS			50/0.5'			
				2	SS			4-19-14			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	705.0	6.0	5								
Brown, moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b				3	SS		▨	13-16-13			
				4	SS			10-10-10			
			10								Traffic control required
				5	SS			23-20-13			
	696.0	15.0	15								Pavement restoration
Bottom of Test Boring at 15.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After -- hours -- ft.
▨ Cave Depth **6.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-9**
JOB #: **86.00481.0159**
STATION: **28+50 "PR-DS"**
OFFSET: **2 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/11/06	Hammer Wt.	140 lbs.
Date Completed	2/11/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 716	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Asphalt, 0.7 ft Crushed Stone (Visual)	715.0	1.0									Ground surface elevation estimated from plans provided by client
Brown to gray, moist, medium dense, sand and gravel (FILL) (Lab No. 3) A-1-b				1	SS			8-7-6			
	713.0	3.0									
Brown to dark brown, moist, stiff, loam (FILL) (Lab No. 1) A-4				2	SS			7-7-7			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	710.5	5.5	5								
Brown, slightly moist, dense SAND and GRAVEL (Lab No. 3) A-1-b				3	SS			9-11-19			
	708.5	7.5									
Bottom of Test Boring at 7.5 ft											Pavement restoration

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After -- hours: -- ft.
Cave Depth: 5.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-10**
JOB #: **86.00481.0159**
STATION: **31+30 "PR-DN"**
OFFSET: **28 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (SURFACE ELEVATION 713)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.6 ft Concrete (Visual)	712.4	0.6									Ground surface elevation estimated from plans provided by client
Brown, moist, stiff, loam with trace crushed stone and cinders (FILL) (Lab No. 1) A-4	710.0	3.0		1	SS			4-6-5	43.7		
Dark brown, moist, medium stiff, silty loam (FILL) (Lab No. 2) A-7-6	707.5	5.5	5	2	SS			4-4-4	11.9		Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, medium dense, sand and gravel with trace brick fragments (FILL) (Lab No. 3) A-1-b	704.5	8.5		3	SS			8-12-10			
Brown, moist to slightly moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b			10	4	SS			8-7-6			Traffic control required
				5	SS			12-20-35			Pavement restoration
-wet below 19.0 ft			15	6	SS			14-14-11			
Gray, moist, stiff LOAM (Lab No. 1) A-4	691.0	22.0	20	7	SS			3-6-6			
Bottom of Test Boring at 25.0 ft	688.0	25.0	25								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 19.0 ft.
At Completion Dry ft.
After 24 hours Dry ft.
Cave Depth 13.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-11**
JOB #: **86.00481.0159**
STATION: **36+00 "PR-DN"**
OFFSET: **3 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 726	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Asphalt, 0.5 ft Crushed Stone (Visual)	725.2	0.8									Ground surface elevation estimated from plans provided by client
Black to brown, moist, medium dense, sand and gravel with trace cinders (FILL) (Lab No. 3) A-1-b				1	SS			10-9-7			
	722.5	3.5									Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, stiff to very stiff, loam (FILL) (Lab No. 1) A-4			5	2	SS			5-7-15			
				3	SS			5-6-5	11.1	2.0	
				4	SS			5-7-11			
			10								Traffic control required
	713.0	13.0									
Brown, moist, medium dense sand and gravel (FILL) (Lab No. 3) A-1-b				5	SS			15-16-12			Pavement restoration
			15								
	709.0	17.0									
Brown, moist, stiff SILTY LOAM (Lab No. 2) A-7-6				6	SS			5-5-7	29.7	2.0	
			20				▨				
	702.5	23.5									
Brown, moist, medium dense SAND and GRAVEL (Lab No. 3) A-1-b	701.0	25.0		7	SS			9-12-17			
			25								
Bottom of Test Boring at 25.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After -- hours -- ft.
▨ Cave Depth **21.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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ATC ASSOCIATES INC.
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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RB-12**
JOB # **86.00481.0159**
STATION **42+55 "PR-DN"**
OFFSET **12 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 715	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Asphalt, 0.7 ft Concrete, 0.3 ft Crushed Stone (Visual)	713.7	1.3									
Brown, moist, soft LOAM (Lab No. 1) A-4				1	SS			8-3-2	21.3	1.0	Ground surface elevation estimated from plans provided by client
	711.5	3.5									
Dark brown, moist, medium stiff SILTY LOAM (Lab No. 2) A-7-6				2	SS			2-3-3	38.6	1.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			2-3-4	41.5	1.0	
	705.5	9.5		4	SS		▼	4-2-7			
Gray, moist, medium stiff to very stiff LOAM (Lab No. 1) A-4			10								Traffic control required
				5	SS			3-4-5			Pavement restoration
			15	5A	SS			5-6-9			
				6	SS		▩	4-7-10			
	695.0	20.0	20								
Bottom of Test Boring at 20.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **9.0** ft.
▩ Cave Depth **19.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-13**
JOB #: **86.00481.0159**
STATION: **33+65 "PR-P"**
OFFSET: **25 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 723	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Asphalt (Visual)	722.7	0.3									Ground surface elevation estimated from plans provided by client
Gray to brown, slightly moist, medium dense SAND and GRAVEL with crushed stone (Lab No. 3) A-1-b				1	SS			13-12-13			
	718.5	4.5		2	SS			7-8-11		3.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, very stiff to hard, loam (FILL) (Lab No. 1) A-4			5	3	SS			9-13-14	12.2	2.5	
				4	SS			17-17-13		2.0	
			10								Traffic control required
				5	SS			15-25-12	8.8	3.0	
			15								Pavement restoration
	703.5	19.5		6	SS		▨	14-16-17			
Dark brown, moist, dense to very dense, sand and gravel with trace brick fragments, cinders and crushed stone (FILL) (Lab No. 3) A-1-b			20								
				7	SS			47-50/0.2'			
			25								
Bottom of Test Boring at 30.0 ft	693.0	30.0		8	SS			17-21-24			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After -- hours -- ft.
▨ Cave Depth **20.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RB-14**
JOB # **86.00481.0159**
STATION **37+45 "PR-P"**
OFFSET **3 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/27/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 714	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Brick (Visual) Brown, moist, stiff, loam (FILL) (Lab No. 1) A-4	713.7	0.3		1	SS			3-5-6	14.7		Ground surface elevation estimated from plans provided by client
Brown, moist, loose, sand and gravel (POSSIBLE FILL) (Lab No. 3) A-1-b	710.5	3.5		2	SS			4-4-4			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, soft, loam (POSSIBLE FILL) (Lab No. 1) A-4	708.5	5.5	5	3	SS		▨	3-2-2			
Brown and dark brown, moist, medium stiff SILTY CLAY LOAM (Lab No. 4) A-6	706.0	8.0		4	SS			1-3-4			Traffic control required Pavement restoration
Bottom of Test Boring at 10.0 ft	704.0	10.0	10								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion **Dry** ft.
After -- hours -- ft.
Cave Depth **6.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-15**
JOB #: **86.00481.0159**
STATION: **41+05 "PR-P"**
OFFSET: **5 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/27/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (SURFACE ELEVATION 714)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
1.0 ft Concrete, 0.6 ft Crushed Stone (Visual)	712.4	1.6									Ground surface elevation estimated from plans provided by client
Brown, moist, medium dense, sand and gravel (FILL) (Lab No. 3) A-1-b	712.0	2.0		1	SS			5-5-6			
Brown, moist, stiff to medium stiff, loam with trace brick fragments (FILL) (Lab No. 1) A-4				2	SS			5-5-4	27.0	1.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
	708.5	5.5	5								
Dark brown, moist, medium stiff, silty clay loam (FILL) (Lab No. 4) A-6 (23)				3	SS			3-4-3	30.1	1.5	
	706.0	8.0									
Dark brown, moist, medium stiff, loam with trace brick fragments (FILL) (Lab No. 1) A-4				4	SS		▨	3-4-4			
	703.5	10.5	10								
Gray, moist, medium dense, sand and gravel (POSSIBLE FILL) (Lab No. 3) A-1-b				5	SS		●	8-11-12			Traffic control required
	699.5	14.5		6	SS			11-15-18			Pavement restoration
Gray, moist, hard LOAM (Lab No. 1) A-4	699.0	15.0	15								
Bottom of Test Boring at 15.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 13.0 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
▨ Cave Depth 10.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
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Indianapolis, IN 46256
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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-16**
JOB #: **86.00481.0159**
STATION: **391+00 "PR-6NS"**
OFFSET: **12 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 726	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual)	725.7	0.3									Ground surface elevation estimated from plans provided by client
Brown, moist, medium stiff to hard LOAM (Lab No. 1) A-4				1	SS			4-5-6		2.5	
				2	SS		▽	3-3-5	12.7	2.5	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			13-16-17			
Bottom of Test Boring at 7.5 ft	718.5	7.5									Bag sample obtained from 1 to 5 ft

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **Dry** ft.
▨ Cave Depth **3.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-17**
JOB #: **86.00481.0159**
STATION: **393+08 "PR-6NS"**
OFFSET: **65 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 733	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual) Brown, moist, stiff LOAM (Lab No. 1) A-4	732.3	0.7		1	SS			3-7-4		2.0	Ground surface elevation estimated from plans provided by client
				2	SS			3-5-6	18.4	3.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			2-5-7		3.0	
				4	SS			5-1-11	9.6	4.0	
			10				▨				
Brown, slightly moist, hard LOAM (Lab No. 1) A-4	719.5	13.5		5	SS			17-29-34		4.5+	
			15								
				6	SS			19-31-36			
			20								
				7	SS			9-13-21			
			25								
Brown, slightly moist, dense SAND and GRAVEL (Lab No. 3) A-1-b	706.0	27.0									
Bottom of Test Boring at 30.0 ft	703.0	30.0		8	SS			10-15-28			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **Dry** ft.
▨ Cave Depth **10.9** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-18**
JOB #: **86.00481.0159**
STATION: **395+00 "PR-6NS"**
OFFSET: **Centerline**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 712	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual)	711.6	0.4									Ground surface elevation estimated from plans provided by client
Brown, moist, loose SAND and GRAVEL (Lab No. 3) A-1-b				1	SS		▼	5-1-9			
	709.0	3.0									
Gray, moist, very stiff LOAM (Lab No. 1) A-4				2	SS		▼ ▨	7-9-14	8.1	4.5+	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			8-13-17		4.5+	
				4	SS			5-9-13	9.7		
	702.0	10.0	10								
Bottom of Test Boring at 10.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **2.8** ft.
▨ Cave Depth **4.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RB-19**
JOB # **86.00481.0159**
STATION **409+48 "PR-5NS"**
OFFSET **4 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 717	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Asphalt, 0.4 ft Crushed Stone (Visual) Brown, moist, stiff to medium stiff, loam with trace crushed stone and cinders (FILL) (Lab No. 1) A-4	716.3	0.7		1	SS			5-7-7			Ground surface elevation estimated from plans provided by client
				2	SS			4-4-5			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5								
				3	SS			3-4-3			
Bottom of Test Boring at 7.5 ft	709.5	7.5									Traffic control required Pavement restoration

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion **Dry** ft.
After -- hours -- ft.
Cave Depth **5.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-20**
JOB #: **86.00481.0159**
STATION: **411+50 "PR-5NS"**
OFFSET: **30 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 725	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual) Brown to black, moist, medium stiff, loam with trace cinders (FILL) (Lab No. 1) A-4	724.8	0.2		1	SS			3-4-5			Ground surface elevation estimated from plans provided by client Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	2	SS			9-13-12			
Brown, moist, medium dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b	718.0	7.0		3	SS			6-9-14	9.9	3.0	
				4	SS			5-10-10			
			10				▨				
				5	SS			7-13-10			
			15								
				6	SS			24-31-22			
Bottom of Test Boring at 20.0 ft	705.0	20.0	20								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **Dry** ft.
▨ Cave Depth **10.8** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-21**
JOB #: **86.00481.0159**
STATION: **413+45 "PR-5NS"**
OFFSET: **30 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 732	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, moist, stiff to very stiff, loam with trace cinders, brick fragments, wood and crushed stone (FILL) (Lab No. 1) A-4				1	SS			5-10-16			Ground surface elevation estimated from plans provided by client
				2	SS			5-6-7	11.8	3.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			8-14-18			
				4	SS			3-8-9			
			10								
				5	SS			6-7-10	11.1		
			15								
				6	SS			7-8-14			
			20								
	708.5	23.5					▨				
Brown, slightly moist, dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b				7	SS			25-16-20			
			25								
				8	SS			12-32-20			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **Dry** ft.
▨ Cave Depth **22.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-21**
JOB #: **86.00481.0159**
STATION: **413+45 "PR-5NS"**
OFFSET: **30 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, slightly moist, dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b	697.0	35.0	35	9	SS			12-50/0.5'			
Bottom of Test Boring at 35.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After 24 hours: Dry ft.
Cave Depth: 22.5 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-22**
JOB #: **86.00481.0159**
STATION: **412+00 "PR-5SN"**
OFFSET: **32 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 727	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual) Dark brown, moist, very stiff, loam with trace brick fragments (FILL) (Lab No. 1) A-4	726.3	0.7		1	SS			5-9-10			Ground surface elevation estimated from plans provided by client
Brown, moist, very stiff LOAM (Lab No. 1) A-4	723.0	4.0		2	SS			6-10-11		2.0	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b	721.5	5.5	5	3	SS			4-9-14			
				4	SS			4-7-9			
			10				▨ 11.2 ft				
				5	SS			10-15-35			
-wet below 18.5 ft			15				▼ 18.5 ft				
				6	SS			11-9-14			
Bottom of Test Boring at 20.0 ft	707.0	20.0	20								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 18.5 ft.
▽ At Completion Dry ft.
▼ After 24 hours Dry ft.
▨ Cave Depth 11.2 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RB-23**
JOB #: **86.00481.0159**
STATION: **33+25 "PR-DN"**
OFFSET: **30 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 712	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.6 ft Concrete (Visual)	711.4	0.6									Ground surface elevation estimated from plans provided by client
Brown and black, moist, medium stiff, loam with cinders and brick fragments (FILL) (Lab No. 1) A-4				1	SS			6-5-3	12.9		
Brown, moist, medium stiff, silty loam (FILL) (Lab No. 2) A-7-6	708.5	3.5		2	SS			3-4-3	20.2	1.5	Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown, moist, very loose, sand and gravel with trace cinders (FILL) (Lab No. 3) A-1-b	706.5	5.5	5	3	SS			3-2-2			
Brown, moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b	703.5	8.5		4	SS			8-12-14			Traffic control required
-wet below 18.0 ft			10	5	SS			10-12-15			Pavement restoration
Gray, moist, very stiff LOAM (Lab No. 1) A-4	690.0	22.0	15	6	SS			12-16-18			
Bottom of Test Boring at 25.0 ft	687.0	25.0	20	7	SS			10-12-12			
			25								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 18.0 ft.
At Completion Dry ft.
After -- hours -- ft.
Cave Depth 13.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-1**
JOB #: **86.00481.0159**
STATION: **31+55 "PR-DN"**
OFFSET: **55 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 739	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.5 ft Asphalt / Brown, moist, medium dense, sand and gravel (FILL) (Lab No. 3) A-1-b	738.5	0.5		1	SS			6-6-5			Ground surface elevation estimated from plans provided by client
Brown, moist, stiff to hard, loam (FILL) (Lab No. 1) A-4	735.5	3.5		2	SS			7-7-6			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			12-7-7	10.7	2.5	
				4	SS			5-7-8		2.5	
			10								Traffic control required
				5	SS			16-18-50/0.2'	16.9		Pavement restoration
			15								
				6	SS			19-24-19			
			20				▨				
Brown, moist, dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b	715.5	23.5		7	SS			13-21-19			
			25								
	709.0	30.0		8	SS			19-24-27			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 48.0 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
▨ Cave Depth 22.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

GEO-STANDARD-STATE 00481-159.GPJ ATCENVGE.GDT 4/18/07

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-1**
JOB #: **86.00481.0159**
STATION: **31+55 "PR-DN"**
OFFSET: **55 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, moist, very dense to medium dense SAND and GRAVEL (Lab No. 3) A-1-b			35	9	SS			15-50/0.3'			
			40	10	SS			15-20-23			
			45	11	SS			16-28-30			
-wet below 48.0 ft							●				
			50	12	SS			7-12-16			
	689.0	50.0									
Bottom of Test Boring at 50.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 48.0 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
Cave Depth 22.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-2**
JOB #: **86.00481.0159**
STATION: **32+96 "PR-DN"**
OFFSET: **47 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 744	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.4 ft Asphalt (Visual) Brown to black, moist, medium dense, sand and gravel with trace cinders and crushed stone (FILL) (Lab No. 3) A-1-b	743.6	0.4		1	SS			6-7-5			Ground surface elevation estimated from plans provided by client
	739.5	4.5	5	2	SS			6-7-7			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
Brown and dark brown, moist, medium stiff to very stiff, loam with sand and gravel seams (FILL) (Lab No. 1) A-4				3	SS			10-13-15	11.4	3.0	
			10	4	SS			15-13-14			Traffic control required
				5	SS			5-4-4			Pavement restoration
			15								
				6	SS			9-10-14	10.4	3.0	
			20								
	720.5	23.5					▨				
Brown, moist, very stiff to hard LOAM (Lab No. 1) A-4				7	SS			11-11-11			
			25								
	714.0	30.0		8	SS			14-20-10			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After -- hours: -- ft.
Cave Depth: 23.5 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RW-2**
JOB # **86.00481.0159**
STATION **32+96 "PR-DN"**
OFFSET **47 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown to gray, moist, hard LOAM (Lab No. 1) A-4				9	SS			50/0.2'			
			35								
				10	SS			50/0.3'			
			40								
				11	SS			50/0.4'			
			45								
	694.5	49.5		12	SS			26-40-48			
Brown, slightly moist, very dense SAND and GRAVEL (Lab No. 3) A-1-b	694.0	50.0	50								
Bottom of Test Boring at 50.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion **Dry** ft.
After -- hours -- ft.
Cave Depth **23.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-3**
JOB #: **86.00481.0159**
STATION: **35+00 "PR-DN"**
OFFSET: **21 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 730	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual) Brown to dark brown, moist, soft to very stiff, loam with trace cinders, brick fragments and crushed stone (FILL) (Lab No. 1) A-4	729.5	0.5		1	SS			4-4-7			Ground surface elevation estimated from plans provided by client Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				2	SS			5-3-2			
			5	3	SS			3-2-3			
				4	SS			3-4-7	10.4		
			10								
				5	SS			3-5-6			
			15								
				6	SS			11-9-10	17.3		
			20								
Brown, very moist, very loose SAND (Lab No. 5) A-2-4	708.0	22.0		7	SS			2-1-1			
Brown, moist, medium dense SAND and GRAVEL (Lab No. 3) A-1-b	705.0	25.0	25								
	700.0	30.0		8	SS		▨	8-12-14			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 38.0 ft.
▽ At Completion Dry ft.
▼ After 24 hours Dry ft.
▨ Cave Depth 29.3 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-3**
JOB #: **86.00481.0159**
STATION: **35+00 "PR-DN"**
OFFSET: **21 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/28/06	Hammer Wt.	140 lbs.
Date Completed	3/1/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, moist, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b				9	SS	6-12-16			
			35						
-wet below 38.0 ft				10	SS	10-14-32			
			40						
	688.0	42.0							
Gray, moist, hard SILTY CLAY LOAM (Lab No. 4) A-6				11	SS	9-11-23	18.8		
			45						
	683.0	47.0							
Gray, wet, dense SAND and GRAVEL (Lab No. 3) A-1-b				12	SS	1-8-27			
	680.0	50.0	50						
Bottom of Test Boring at 50.0 ft									

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 38.0 ft.
At Completion Dry ft.
After 24 hours Dry ft.
Cave Depth 29.3 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-4**
JOB #: **86.00481.0159**
STATION: **36+00 "PR-DN"**
OFFSET: **70 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/3/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

SOIL CLASSIFICATION SURFACE ELEVATION 750	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Asphalt (Visual)	749.7	0.3									Ground surface elevation estimated from plans provided by client
Brown, moist, stiff to hard, loam (FILL) (Lab No. 1) A-4				1	SS			5-6-9			
				2	SS			6-8-11			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			13-12-12	7.8	4.0	
				4	SS			14-10-15			
			10								Traffic control required
				5	SS		▼	15-18-21		4.5+	Pavement restoration
			15								
				6	SS			11-9-6			
			20								
	726.5	23.5									
Brown, moist, very stiff to hard LOAM (Lab No. 1) A-4				7	SS			8-11-13	13.5	1.5	
			25								
							▨				
	720.0	30.0		8	SS			38-38-22		4.5+	

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **14.0** ft.
▨ Cave Depth **28.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RW-4**
JOB # **86.00481.0159**
STATION **36+00 "PR-DN"**
OFFSET **70 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/3/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, moist, hard LOAM (Lab No. 1) A-4				9	SS			50/0.2'			
			35								
				10	SS			20-32-48			
			40								
				11	SS			50/0.3'			
			45								
	703.0	47.0									
Brown, moist, very dense SAND and GRAVEL (Lab No. 3) A-1-b				12	SS			11-50/0.2'			
	700.0	50.0	50								
Bottom of Test Boring at 50.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools **None** ft.
At Completion **Dry** ft.
After **24** hours **14.0** ft.
Cave Depth **28.5** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-5**
JOB #: **86.00481.0159**
STATION: **37+15 "PR-DN"**
OFFSET: **70 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 750	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Asphalt (Visual)	749.7	0.3									Ground surface elevation estimated from plans provided by client
Brown to dark brown, moist, stiff to very stiff, loam with trace cinders, crushed stone and sand seams (FILL) (Lab No. 1) A-4				1	SS			7-7-8			
				2	SS			8-13-13			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			4-6-8			
				4	SS			5-6-12	14.5		
			10								Traffic control required
				5	SS			9-8-12			Pavement restoration
			15				▨				
				6	SS			9-17-16			
			20								
	728.0	22.0									
Brown, moist, medium dense, sand and gravel (FILL) (Lab No. 3) A-1-b				7	SS			5-9-11			
			25								
	723.0	27.0									
Brown, moist, hard, loam (FILL) (Lab No. 1) A-4				8	SS			15-17-19			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools: None ft.
▽ At Completion: Dry ft.
▼ After -- hours: -- ft.
▨ Cave Depth: 18.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-5**
JOB #: **86.00481.0159**
STATION: **37+15 "PR-DN"**
OFFSET: **70 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	3/2/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown, moist, hard, loam (FILL) (Lab No. 1) A-4	717.0	33.0									
Brown, moist, very dense SAND and GRAVEL (Lab No. 3) A-1-b			35	9	SS			50/0.4'			
			40	10	SS			9-9-13			
	708.0	42.0									
Brown, moist, hard LOAM (Lab No. 1) A-4			45	11	SS			7-15-16		3.0	
				12	SS			8-18-20			
	700.0	50.0	50								
Bottom of Test Boring at 50.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools: None ft.
At Completion: Dry ft.
After -- hours: -- ft.
Cave Depth: 18.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-6**
JOB #: **86.00481.0159**
STATION: **410+00 "PR-5SN"**
OFFSET: **20 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/27/06	Hammer Wt.	140 lbs.
Date Completed	2/28/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION / SURFACE ELEVATION 722	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual)				1	SS			4-3-6			Ground surface elevation estimated from plans provided by client
	719.0	3.0									
Brown, moist, loose to medium dense SAND and GRAVEL (Lab No. 3) A-1-b				2	SS			4-3-5			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			4-4-4			
				4	SS			3-3-4			
-wet below 13.0 ft			10								
				5	SS			6-4-14			
	705.0	17.0	15								
Brown, very moist, stiff LOAM (Lab No. 1) A-4				6	SS			6-7-7	10.6		
			20								
	700.0	22.0									
Gray, moist, very stiff LOAM (Lab No. 1) A-4				7	SS			6-12-16	13.9	3.5	
			25								
Bottom of Test Boring at 30.0 ft	692.0	30.0		8	SS			4-7-12		4.0	

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 13.0 ft.
At Completion Dry ft.
After 24 hours Dry ft.
Cave Depth 10.5 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

GEO-STANDARD-STATE 00481-159.GPJ ATCENVGE.GDT 4/18/07

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-7**
JOB #: **86.00481.0159**
STATION: **411+06 "PR-5SN"**
OFFSET: **13 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/11/06	Hammer Wt.	140 lbs.
Date Completed	2/12/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 726	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil (Visual) Brown, moist, stiff LOAM (Lab No. 1) A-4	725.7	0.3		1	SS			5-6-7	12.5	2.0	Ground surface elevation estimated from plans provided by client
Brown, moist, medium dense SAND (Lab No. 5) A-2-4	723.0	3.0	5	2	SS			6-9-9			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				3	SS			6-10-13			
				4	SS			5-12-14			
Brown to gray, slightly moist, dense SAND and GRAVEL (Lab No. 3) A-1-b	714.0	12.0	10	5	SS			11-14-18			Traffic control required
Gray, moist, hard to very stiff LOAM (Lab No. 1) A-4	708.0	18.0	15	6	SS			40-20-13			
			20	7	SS			11-14-19	8.6	4.5+	
			25								
Bottom of Test Boring at 30.0 ft	696.0	30.0		8	SS			11-12-16			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
Noted on Drilling Tools 22.0 ft.
At Completion Dry ft.
After 24 hours 17.5 ft.
Cave Depth 13.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RW-8**
JOB # **86.00481.0159**
STATION **413+08 "PR-5SN"**
OFFSET **42 ft Right**

DRILLING and SAMPLING INFORMATION

Date Started	2/11/06	Hammer Wt.	140 lbs.
Date Completed	2/11/06	Hammer Drop	30 in.
Drill Foreman	C. Carroll	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Truck	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 720	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.3 ft Asphalt, 0.7 ft Crushed Stone (Visual)	719.0	1.0									Ground surface elevation estimated from plans provided by client
Brown, moist, medium dense to very dense SAND and GRAVEL (Lab No. 3) A-1-b				1	SS			5-7-9			
				2	SS			8-8-7			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
			5	3	SS			9-13-17			
				4	SS			19-40-35			
			10								Traffic control required
				5	SS		▨	9-14-27			Pavement restoration
			15								
				6	SS			9-19-19			
			20								
				7	SS			14-17-22			
			25								
Bottom of Test Boring at 30.0 ft	690.0	30.0		8	SS			15-22-50/0.3'			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **None** ft.
▽ At Completion **Dry** ft.
▼ After -- hours -- ft.
▨ Cave Depth **14.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

ATC ASSOCIATES INC.
7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256
317-849-4990
Fax 317-849-4278

TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-9**
JOB #: **86.00481.0159**
STATION: **412+95 "PR-5SN"**
OFFSET: **52 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 733	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.4 ft Asphalt (Visual)	732.6	0.4									Ground surface elevation estimated from plans provided by client
Black to dark brown, moist, loose, sand and gravel with trace cinders and crushed stone (FILL) (Lab No. 3) A-1-b	730.0	3.0		1	SS			7-5-4			
Dark brown to brown, medium stiff to very stiff, loam with trace cinders, brick fragments, crushed stone and sand seams (FILL) (Lab No. 1) A-4			5	2	SS			6-3-3			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				3	SS			5-8-9			
			10	4	SS			10-10-6	10.5		Traffic control required
			15	5	SS			11-13-10			Pavement restoration
			20	6	SS		▨	3-4-3			
			25	7	SS			8-5-5			
	704.5	28.5					●				
Brown, very moist, hard LOAM (Lab No. 1) A-4	703.0	30.0		8	SS			9-23-14			

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 28.0 ft.
▽ At Completion Dry ft.
▼ After 24 hours 36.0 ft.
▨ Cave Depth 21.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RW-9**
JOB # **86.00481.0159**
STATION **412+95 "PR-5SN"**
OFFSET **52 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
(continued)											
Brown, wet, medium dense to dense SAND and GRAVEL (Lab No. 3) A-1-b											
			35	9	SS		▼	10-12-13			
				10	SS			9-13-28			
	693.0	40.0	40								
Bottom of Test Boring at 40.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **28.0** ft.
▽ At Completion **Dry** ft.
▼ After **24** hours **36.0** ft.
▩ Cave Depth **21.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

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TEST BORING LOG

CLIENT: **American Consulting, Inc.**
PROJECT NAME: **Proposed Washington Street Interchange**
PROJECT LOCATION: **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING #: **RW-10**
JOB #: **86.00481.0159**
STATION: **413+33 "PR-5SN"**
OFFSET: **54 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION 734	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
0.4 ft Asphalt (Visual)	733.6	0.4									Ground surface elevation estimated from plans provided by client
Black, moist, loose, sand and gravel with crushed stone and cinders (FILL) (Lab No. 3) A-1-b	731.0	3.0		1	SS			10-5-4			
Brown to dark brown, moist, stiff to hard, loam with trace crushed stone, cinders and sand seams (FILL) (Lab No. 1) A-4			5	2	SS			5-4-8			Borehole backfilled in accordance with INDOT "Aquifer Protection Guidelines"
				3	SS			9-11-13	9.5	1.5	
			10	4	SS			12-15-19	10.2	2.0	
											Traffic control required
			15	5	SS			11-11-10		1.5	Pavement restoration
	716.5	17.5									
Brown, slightly moist, medium dense to dense, sand and gravel (FILL) (Lab No. 3) A-1-b			20	6	SS			5-15-18			
	711.0	23.0					▨				
Brown, moist, hard to very stiff, loam with trace brick fragments (FILL) (Lab No. 1) A-4			25	7	SS			7-14-18			
	704.0	30.0		8	SS			9-14-9	10.8		

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools 33.5 ft.
▽ At Completion Dry ft.
▼ After -- hours -- ft.
▨ Cave Depth 23.0 ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

GEO-STANDARD-STATE 00481-159.GPJ ATCENVGE.GDT 4/18/07

ATC ASSOCIATES INC.
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TEST BORING LOG

CLIENT **American Consulting, Inc.**
PROJECT NAME **Proposed Washington Street Interchange**
PROJECT LOCATION **Marion County, Indiana**
INDOT Project No. IN 55 (001), INDOT Des. No. 0401228

BORING # **RW-10**
JOB # **86.00481.0159**
STATION **413+33 "PR-5SN"**
OFFSET **54 ft Left**

DRILLING and SAMPLING INFORMATION

Date Started	3/1/06	Hammer Wt.	140 lbs.
Date Completed	3/2/06	Hammer Drop	30 in.
Drill Foreman	W. Bates	Spoon Sampler OD	2.0 in.
Inspector	S. Marcum	Rock Core Dia.	-- in.
Boring Method	HSA-Skid	Shelby Tube OD	-- in.

TEST DATA

SOIL CLASSIFICATION (continued)	Stratum Elevation, ft	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Brown to gray, moist, hard LOAM (Lab No. 1) A-4				9	SS		●	6-14-18			
			35								
	697.0	37.0									
Brown, moist, dense SAND and GRAVEL (Lab No. 3) A-1-b				10	SS			10-17-21			
	694.0	40.0	40								
Bottom of Test Boring at 40.0 ft											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Depth to Groundwater
● Noted on Drilling Tools **33.5** ft.
▽ At Completion **Dry** ft.
▼ After -- hours -- ft.
Cave Depth **23.0** ft.

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
CA - Casing Advancer
MD - Mud Drilling
HA - Hand Auger

APPENDIX C

SUMMARY OF LABORATORY CLASSIFICATION TEST RESULTS
SUMMARY OF SPECIAL LABORATORY TEST RESULTS
GRAIN SIZE DISTRIBUTION CURVES (5)
STANDARD PROCTOR TEST RESULTS (1)
UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS (1)

SUMMARY OF LABORATORY CLASSIFICATION TEST RESULTS

Proposed Washington Street Interchange
Indianapolis, Indiana
INDOT Project No. IN 55 (001)
INDOT Des. No. 0401228
ATC Project No. 86.00481.0159

Laboratory No.	Boring No.	Station, ft	Offset Centerline	Split Spoon Sample No.	Depth, ft	Soil Classification		Particle Size Distribution							Atterberg Limits		
						Textural	AASHTO	Percent passing No. 10 Sieve, %	Percent passing No. 40 Sieve, %	Percent passing No. 200 Sieve, %	Percent Gravel, %	Percent Sand, %	Percent Silt, %	Percent Clay, %	LL	PL	PI
1	RW-7	411+06 "PR-5SN"	13 ft Right	7	23.5 - 25.0	Loam	A-4(0)	88.5	78.0	50.4	11.5	38.1	45.8	4.6	16	12	4
2	RB-1	212+30 "PR-W"	33 ft Right	2	3.5 - 5.0	Silty Loam	A-7-6(17)	97.5	91.8	72.9	2.5	24.6	59.1	13.8	46	21	25
3	RB-2	219+00 "PR-W"	10 ft Right	6	18.5 - 20.0	Sand and Gravel	A-1-b	55.2	31.8	13.5	44.8	41.7	13.5		Non-plastic		
4	RB-15	41+05 "PR-P"	5 ft Left	3	6.0 - 7.5	Silty Clay Loam	A-6(23)	100.0	100.0	98.5	0.0	1.5	69.3	29.2	40	18	22
5	RW-7	411+06 "PR-5SN"	13 ft Right	4	8.5 - 10.0	Sand	A-2-4(0)	86.4	73.4	13.0	13.6	73.4	13.0		Non-plastic		

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Proposed Washington Street Interchange
Indianapolis, Indiana
INDOT Project No. IN 55 (001)
INDOT Des. No. 0401228
ATC Project No.: 86.00481.0159

Boring Number	Laboratory Number	Sample Number	Depth, ft	Blow count, "N"	Natural Moisture Content, %	pH
RB-1	2	2	3.5 - 5.0	6	39.7	8.1
	2	3	6.0 - 7.5	6	36.2	
RB-2	3	2	3.5 - 5.0	8	27.1	
	1	3	6.0 - 7.5	12	12.1	
	3	6	18.5 - 20.0	58		8.6
RB-10	1	1	1.0 - 2.5	11	43.7	
	2	2	3.5 - 5.0	8	11.9	
RB-11	1	3	6.0 - 7.5	11	11.1	
	2	6	18.5 - 20.0	12	29.7	
RB-12	1	1	1.0 - 2.5	5	21.3	
	2	2	3.5 - 5.0	6	38.6	
	2	3	6.0 - 7.5	7	41.5	
RB-13	1	3	6.0 - 7.5	27	12.2	
	1	5	13.5 - 15.0	37	8.8	
RB-14	1	1	1.0 - 2.5	11	14.7	
RB-15	1	2	3.5 - 5.0	9	27.0	
	4	3	6.0 - 7.5	7	30.1	7.1
RB-16	1	2	3.5 - 5.0	8	12.7	
RB-17	1	2	3.5 - 5.0	11	18.4	
	1	4	8.5 - 10.0	12	9.6	
RB-18	1	2	3.5 - 5.0	23	8.1	
	1	4	8.5 - 10.0	22	9.7	
RB-20	1	3	6.0 - 7.5	23	9.9	
RB-21	1	2	3.5 - 5.0	13	11.8	
	1	5	13.5 - 15.0	17	11.1	
RB-23	1	1	1.0 - 2.5	8	12.9	
	2	2	3.5 - 5.0	7	20.2	
RW-1	1	3	6.0 - 7.5	14	10.7	
	1	5	13.5 - 15.0	50+	16.9	
RW-2	1	3	6.0 - 7.5	28	11.4	
	1	6	18.5 - 20.0	24	10.4	

Boring Number	Laboratory Number	Sample Number	Depth, ft	Blow count, "N"	Natural Moisture Content, %	pH
RW-3	1	4	8.5 - 10.0	11	10.4	
	1	6	18.5 - 20.0	19	17.3	
	4	11	43.5 - 45.0	34	18.8	
RW-4	1	3	6.0 - 7.5	24	7.8	
	1	7	23.5 - 25.0	24	13.5	
RW-5	1	4	8.5 - 10.0	18	14.5	
RW-6	1	6	18.5 - 20.0	14	10.6	
	1	7	23.5 - 25.0	28	13.9	
RW-7	1	1	1.0 - 2.5	13	12.5	
	5	4	8.5 - 10.0	26		8.3
	1	7	23.5 - 25.0	32	8.6	7.7
RW-9	1	4	8.5 - 10.0	16	10.5	
RW-10	1	3	6.0 - 7.5	24	9.5	
	1	4	8.5 - 10.0	34	10.2	
	1	8	28.5 - 30.0	23	10.8	

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.5	38.1	45.8	4.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	96.2		
#4	93.7		
#8	89.5		
#10	88.5		
#20	83.7		
#40	78.0		
#60	69.4		
#100	60.1		
#200	50.4		

* (no specification provided)

Soil Description

Loam
Lab No. 1

Atterberg Limits

PL= 12 LL= 16 PI= 4

Coefficients

D_{85}= 1.07 D_{60}= 0.149 D_{50}= 0.0738
D_{30}= 0.0399 D_{15}= 0.0087 D_{10}= 0.0046
C_u= 32.43 C_c= 2.32

Classification

USCS= AASHTO= A-4(0)

Remarks

Sample No.: RW-7 **Source of Sample:** 10262 **Date:**
Location: **Elev./Depth:** 23.5'-25.0'

ATC ASSOCIATES, INC.

Client: ACE
Project: Washington St.
Project No: 86.000481.0159 **Page** 10262

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.5	24.6	59.1	13.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.0		
#4	98.4		
#8	97.7		
#10	97.5		
#20	95.5		
#40	91.8		
#60	85.2		
#100	78.7		
#200	72.9		

* (no specification provided)

Soil Description

Silty Loam
Lab No. 2

Atterberg Limits

PL= 21 LL= 46 PI= 25

Coefficients

D_{85}= 0.247 D_{60}= 0.0494 D_{50}= 0.0362
D_{30}= 0.0095 D_{15}= 0.0026 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO= A-7-6(17)

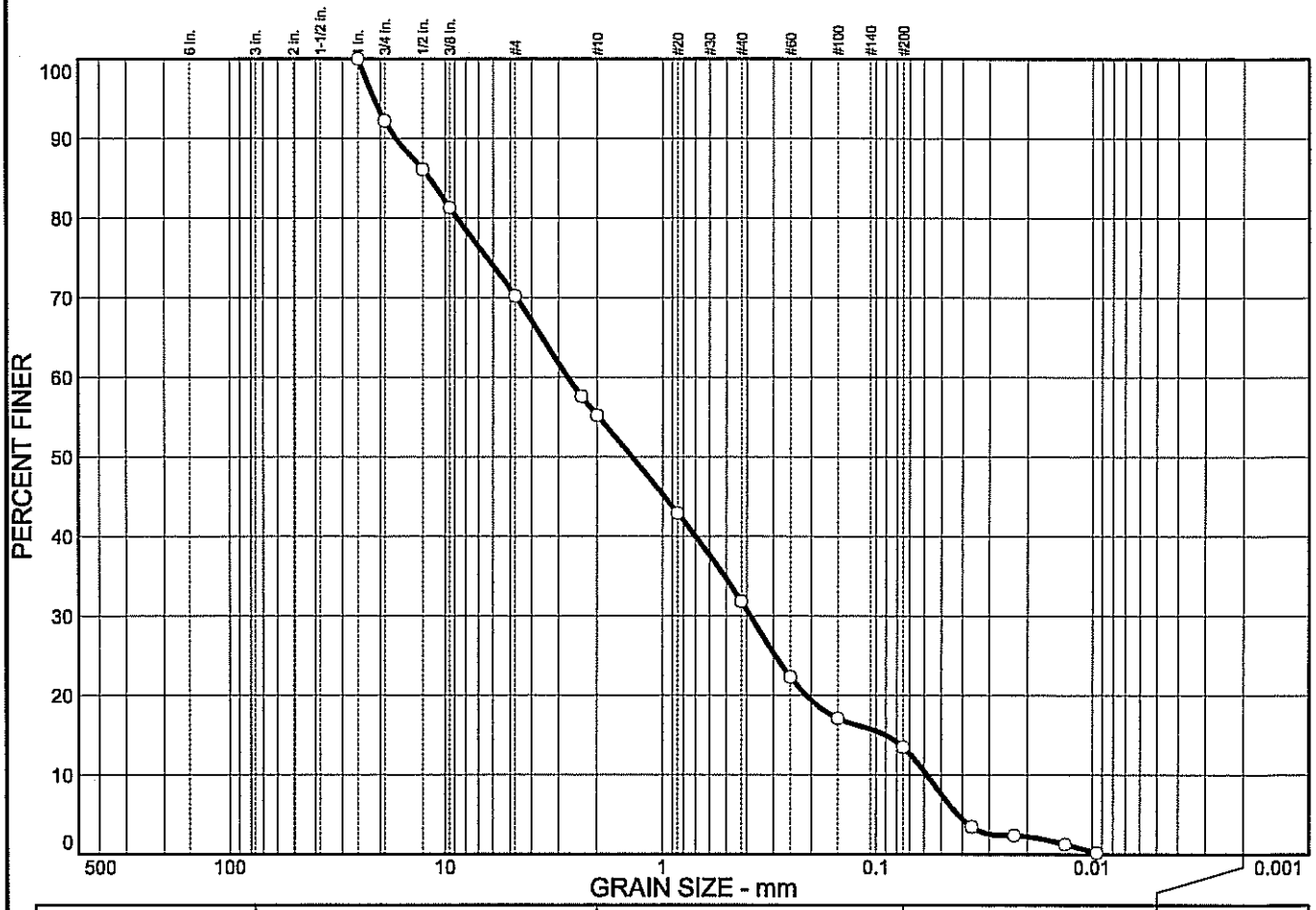
Remarks

Sample No.: RB-1 **Source of Sample:** 10262 **Date:**
Location: **Elev./Depth:** 3.5'-5.0'

ATC ASSOCIATES, INC.

Client: ACE
Project: Washington St.
Project No: 86.000481.0159 **Page** 10262

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	44.8	41.7	13.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	92.2		
.5 in.	86.1		
.375 in.	81.3		
#4	70.2		
#8	57.6		
#10	55.2		
#20	42.9		
#40	31.8		
#60	22.3		
#100	17.1		
#200	13.5		

* (no specification provided)

Soil Description

Sand & Gravel
Lab No. 3

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 11.8 D_{60}= 2.73 D_{50}= 1.39
D_{30}= 0.386 D_{15}= 0.0902 D_{10}= 0.0582
C_u= 46.91 C_c= 0.94

Classification

USCS= AASHTO= A-1-b

Remarks

Sample No.: RB-2 **Source of Sample:** 10262 **Date:**
Location: **Elev./Depth:** 18.5'-20.0'

ATC ASSOCIATES, INC.

Client: ACE
Project: Washington St.
Project No: 86.000481.0159 **Page** 10262

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	1.5	69.3	29.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#60	99.8		
#100	99.5		
#200	98.5		

* (no specification provided)

Soil Description

Silty Clay Loam
Lab No. 4

Atterberg Limits

PL= 18 LL= 40 PI= 22

Coefficients

D_{85}= 0.0534 D_{60}= 0.0177 D_{50}= 0.0111
D_{30}= 0.0023 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO= A-6(23)

Remarks

Sample No.: RB-15 **Source of Sample:** 10347 **Date:**
Location: **Elev./Depth:** 6.0'-7.5'

ATC ASSOCIATES, INC.

Client: ACE
Project: Washington St.
Project No: 86.000481.0159 **Page** 10347

Particle Size Distribution Report

% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	13.6	73.4	13.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	98.9		
#4	94.3		
#8	87.8		
#10	86.4		
#20	80.4		
#40	73.4		
#60	56.5		
#100	28.1		
#200	13.0		

* (no specification provided)

Soil Description

Sand
Lab No. 5

Atterberg Limits

PL= LL= PI= NP

Coefficients

D_{85}= 1.67 D_{60}= 0.269 D_{50}= 0.222
D_{30}= 0.156 D_{15}= 0.0868 D_{10}= 0.0625
C_u= 4.31 C_c= 1.45

Classification

USCS= AASHTO= A-2-4(0)

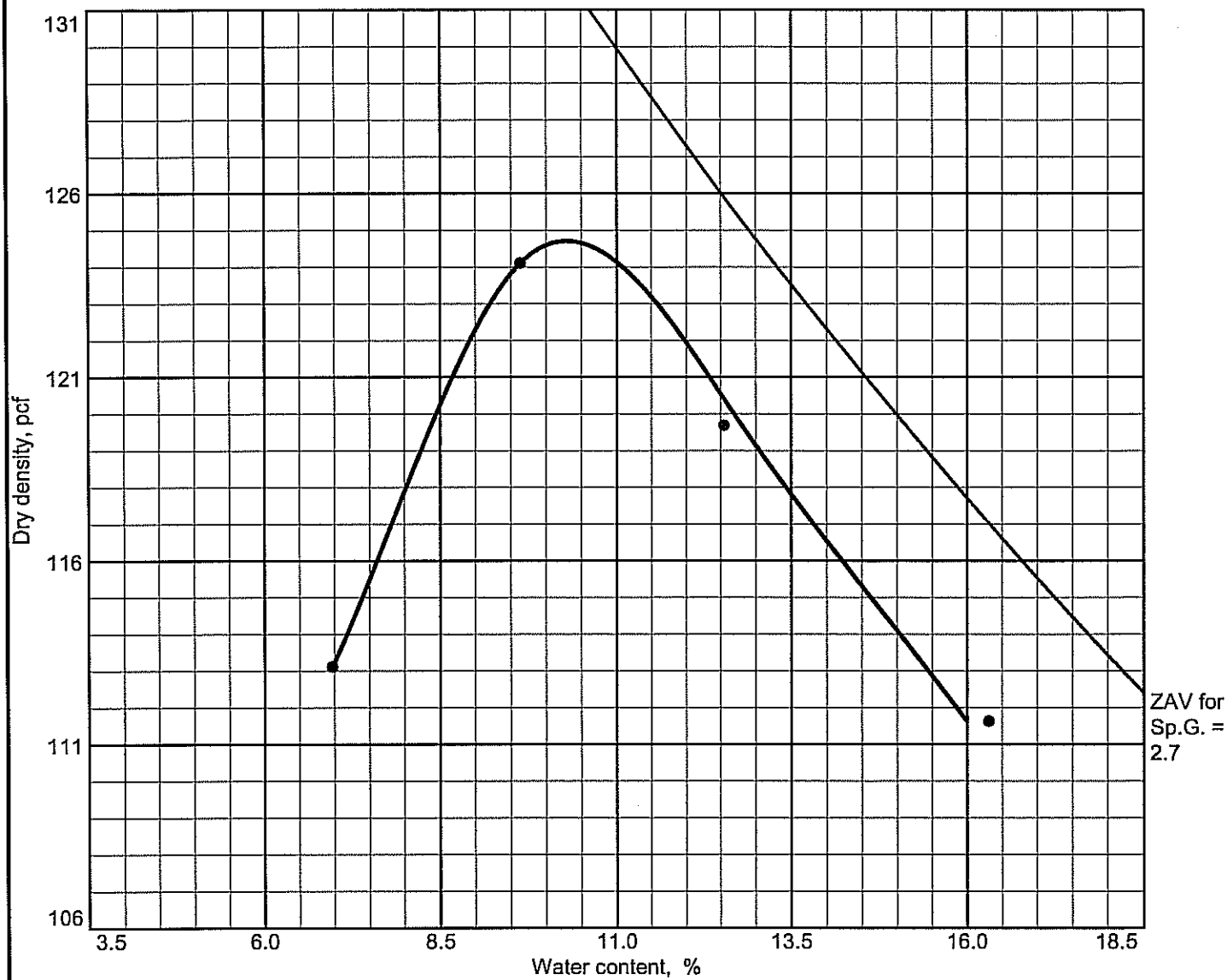
Remarks

Sample No.: RW-7 **Source of Sample:** 10262 **Date:**
Location: **Elev./Depth:** 8.5'-10.0'

ATC ASSOCIATES, INC.

Client: ACE
Project: Washington St.
Project No: 86.000481.0159 **Page** 10262

MOISTURE DENSITY (PROCTOR) RELATIONSHIP TEST



Test specification: AASHTO T 99 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-5.0'								

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 124.7 pcf Optimum moisture = 10.3 %	Loam Lab No. 1

Project No. 86.00481.0159 **Client:** ACE

Project: Washington St.

Date: 03/16/06

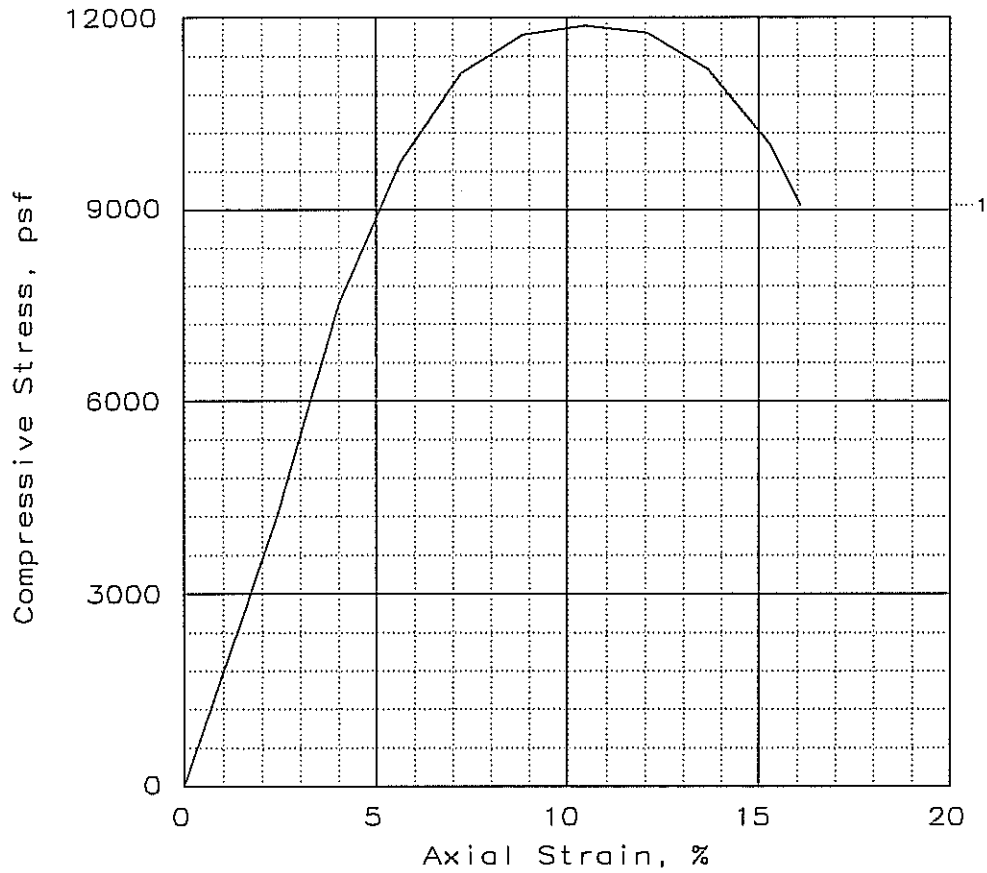
● **Source:** 10403 **Sample No.:** RB-16 **Elev./Depth:** 1.0'-5.0'

Remarks:

MOISTURE DENSITY (PROCTOR) RELATIONSHIP TEST

ATC ASSOCIATES, INC.

UNCONFINED COMPRESSION TEST



SAMPLE NO.:	1			
Unconfined strength, psf	11869			
Undrained shear strength, psf	5935			
Failure strain, %	10.5			
Strain rate, %/min	2.00			
Water content, %	8.6			
Wet density, pcf	150.4			
Dry density, pcf	138.5			
Saturation, %	100.2			
Void ratio	0.2348			
Specimen diameter, in	1.52			
Specimen height, in	3.11			
Height/diameter ratio	2.05			

Description:

			GS= 2.74	Type: Split spoon

Project No.: 86.00481.0159

Date:

Remarks:

Fig. No.: ———

Client: A.C.E.

Project: Washington Street

Location: RW-7, #8B, 28.5-30'

UNCONFINED COMPRESSION TEST

ATC ASSOCIATES INC.

APPENDIX D

CALCULATIONS FOR RETAINING WALL EXTERNAL STABILITY (4)

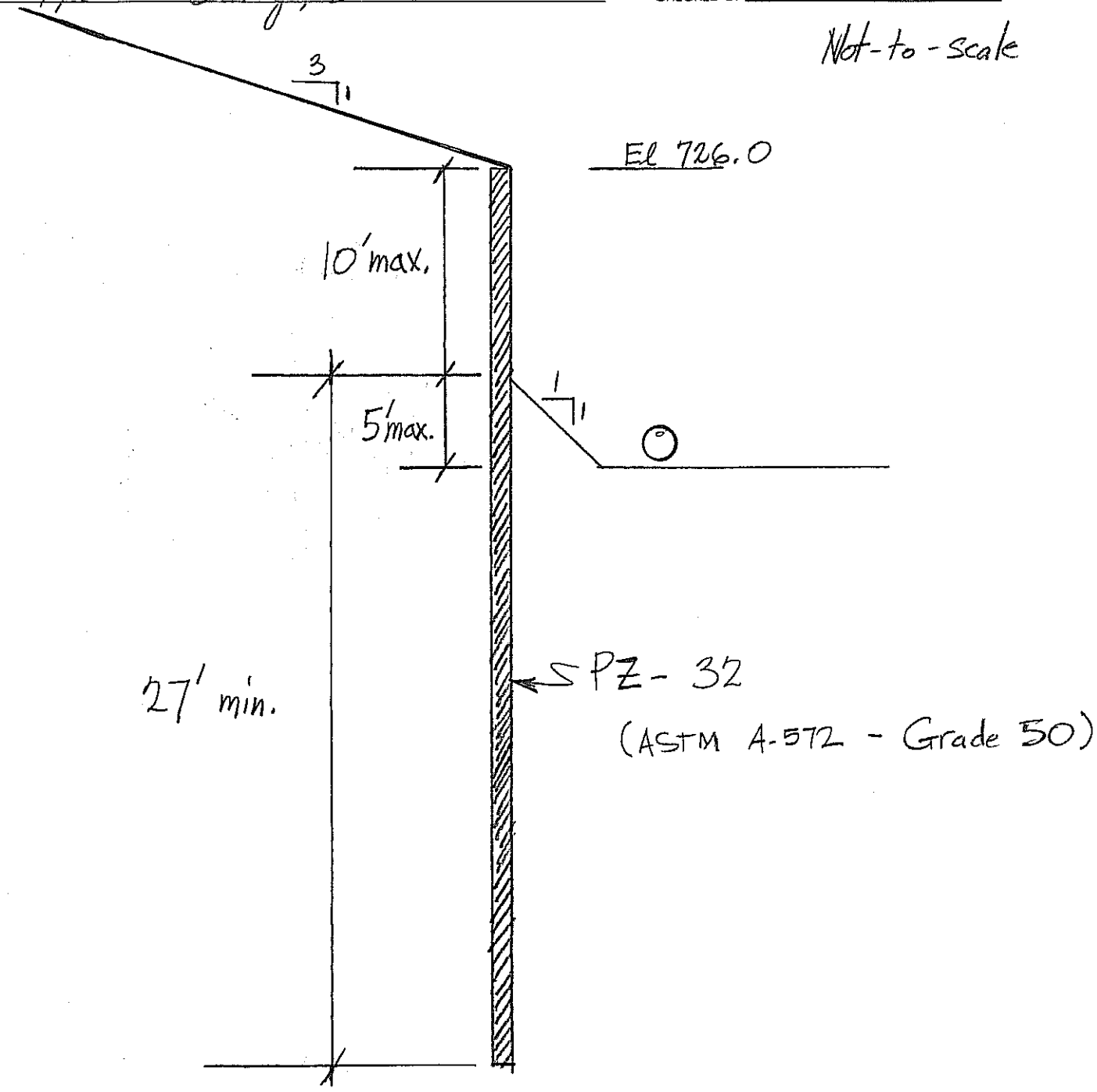
VATC

CLIENT American Consulting

PROJECT Washington Street Interchange
Marion County, Indiana

PROJECT NUMBER 06.00481.0159
SHEET ____ OF ____
DATE 4-3-06
COMPUTED BY T.S.
CHECKED BY ____

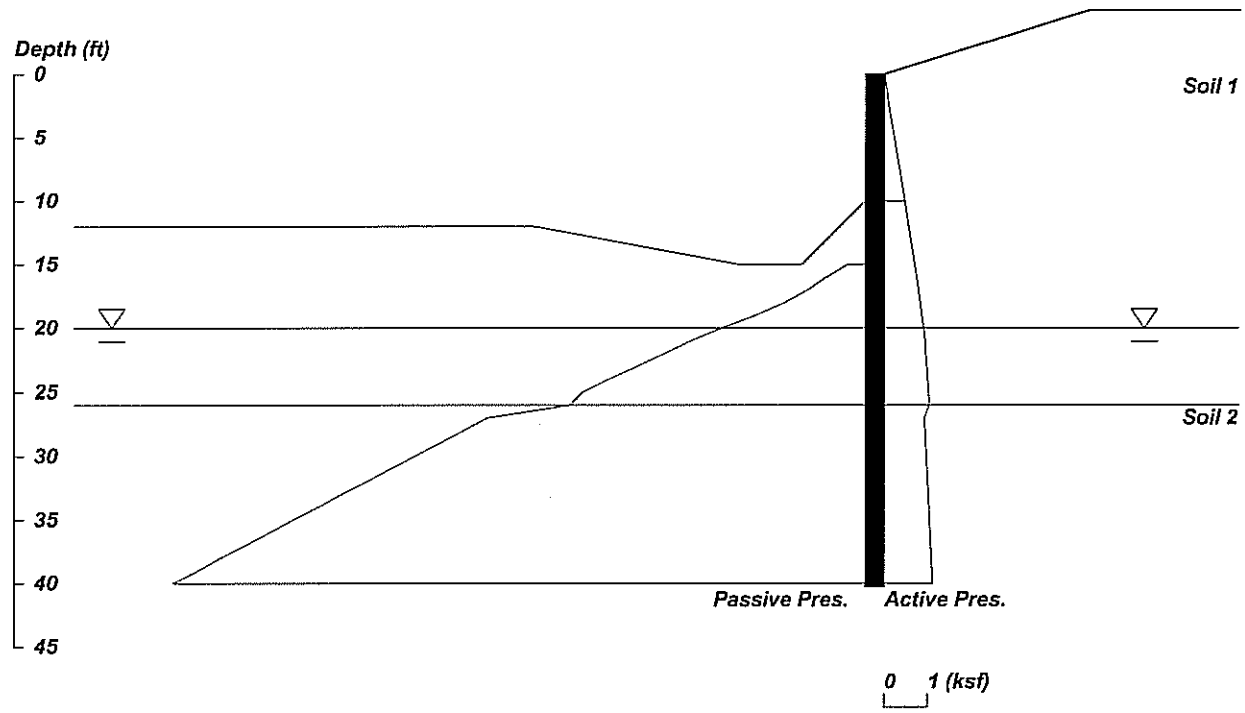
Not-to-scale



Station 413+50 Line "PR-5SN"
65' left

Washington Street Interchange

Station 413+50 Line "PR-5SN" Left



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INPUT DATA

Height of wall= 10.0 Inclination of wall (Active side)= 0

Friction factor betwen wall and soil= 0.5 Inclination of wall (Passive side)= 0

Soil Layer	Depth (Top of Layer)	Density (Total)	Friction (o)
1	0	.125	30
2	26	.130	36

Water table at active side= 20 Water table at passive side= 20

Unit weight of water= 0.062 Water flow (seepage) condition: No seepage

Ground surface:	Passive-X	Passive-Y	Active-X	Active-Y
	5	-5	16	5
	10	-5	100	5
	26	-2		
	100	-2		

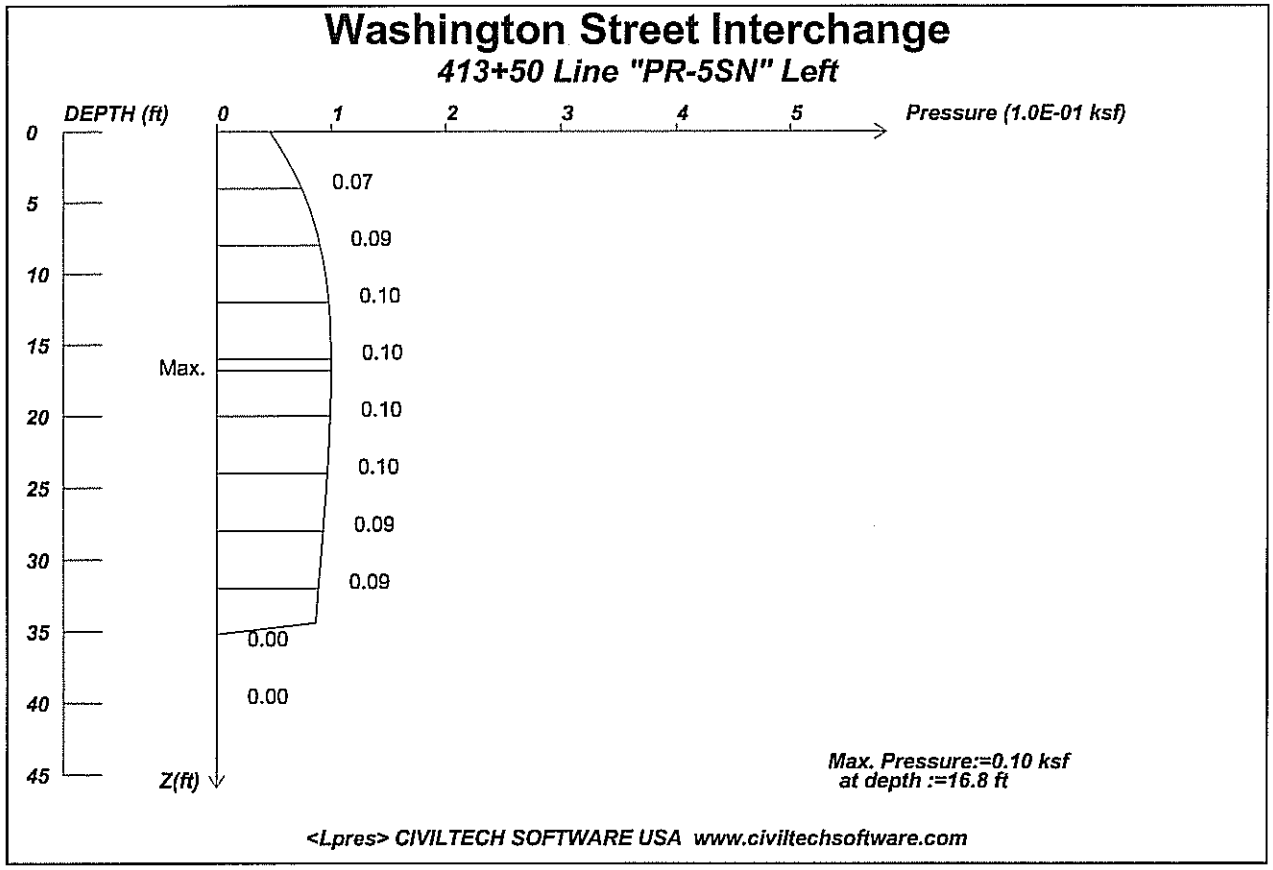
OUTPUT DATA

Calculated Pressure Diagram Total active force above base = 2.44

Wall Top	Depth	Act. Pres.	Depth	Pas. Pres.

	Depth	Act. Pres.	Depth	Pas. Pres.
	0.0	0.000		
	2.0	0.073		
Exc. Base	10.0	0.464		
	10.0	0.464		
	16.0	0.749		
	18.0	0.830	15.0	0.398
	21.0	0.939	16.0	0.909
	22.0	0.960	17.0	1.343
	23.0	0.980	18.0	1.876
	25.0	1.020	19.0	2.570
	26.0	1.039	20.0	3.358
	27.0	0.925	21.0	4.076
	28.0	0.940	22.0	4.684
	32.0	0.999	23.0	5.328
	33.0	1.014	24.0	5.993
	36.0	1.060	25.0	6.602
	37.0	1.074	26.0	6.889
	39.0	1.106	27.0	8.810
	40.0	1.120	28.0	9.372
			30.0	10.503
			31.0	11.074
			32.0	11.634
			33.0	12.212
			34.0	12.764
			35.0	13.332
			36.0	13.884
			37.0	14.439
			38.0	15.024
			39.0	15.549
			40.0	16.138

Units: Length: ft, Force: kip, Pressure: ksf, Density and Pressure Slope: kcf



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Wall Height, H= 10ft Load Depth at Surface, D= -5ft

Wall Type: Semi-Flexible Wall -- The wall is partially flexible. Small movement of the wall is allowed.

Max. Pressure:=0.10ksf at depth :=16.8ft

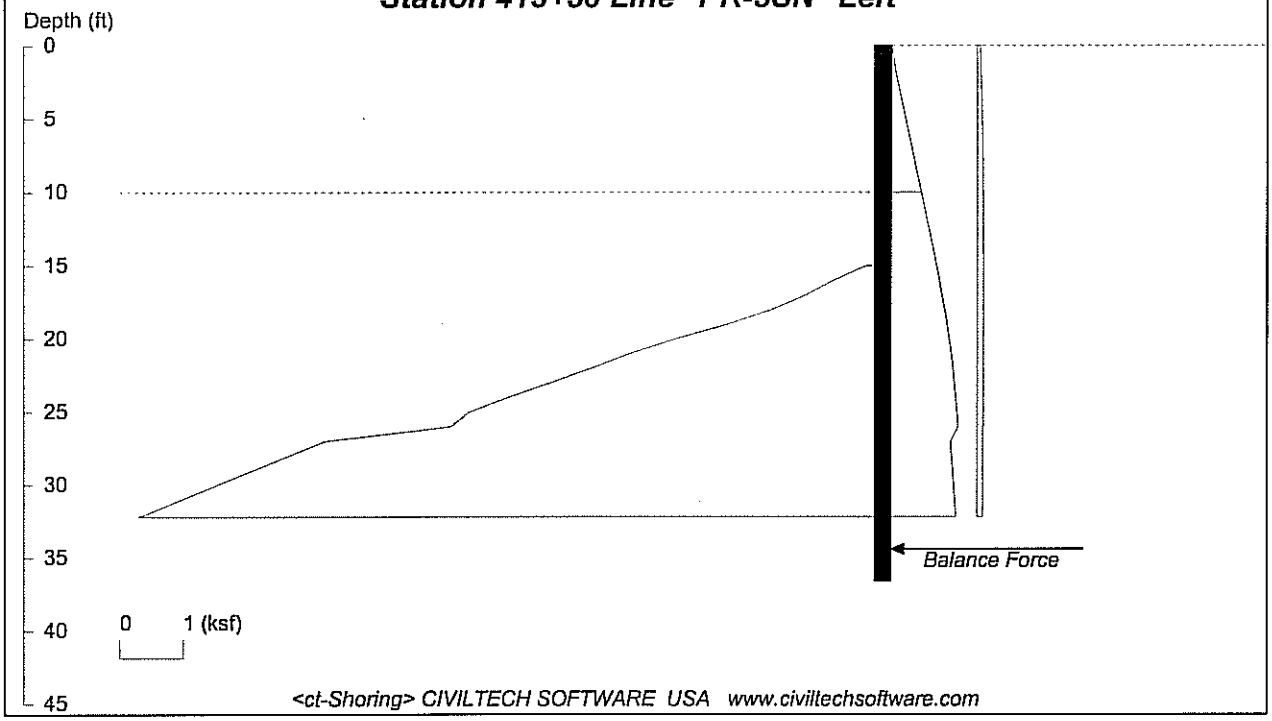
X	Width	Strip Load
16.0	100.0	.20

Depth is measured from top of the wall

Pressure: ksf Length: ft Force: kip

Washington Street Interchange

Station 413+50 Line "PR-5SN" Left



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Date: 5/1/2006 File Name: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washing

WALL HEIGHT: 10.00 MIN. EMBEDMENT: 26.63 MIN. PILE LENGTH: 36.63

MAX. MOMENT: 87.04 AT DEPTH: 24.74

PZ32 has Section Modulus = 38.3 in3/spacing. It is greater than Min. Requirement! Top Deflection = 1.52 in.

Required Min. Section Modulus = 38.0 in3/spacing, Fy=50 ksi=345 MPa, Fb/Fy=0.55

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) X – Depth from wall top

No.	X top	Top Pres.	X bot.	Bot. Pres.	Spacing
1	0.00	0.00	2.00	0.07	1.00
2	2.00	0.07	10.00	0.46	1.00
3	0.00	0.05	0.80	0.05	1.00
4	0.80	0.05	1.60	0.06	1.00
5	1.60	0.06	2.40	0.06	1.00
6	2.40	0.06	3.20	0.07	1.00
7	3.20	0.07	4.00	0.07	1.00
8	4.00	0.07	4.80	0.08	1.00
9	4.80	0.08	5.60	0.08	1.00
10	5.60	0.08	6.40	0.09	1.00
11	6.40	0.09	7.20	0.09	1.00
12	7.20	0.09	8.00	0.09	1.00
13	8.00	0.09	8.80	0.09	1.00
14	8.80	0.09	9.60	0.09	1.00
15	9.60	0.09	10.40	0.09	1.00
16	10.40	0.09	11.20	0.10	1.00
17	11.20	0.10	12.00	0.10	1.00
18	12.00	0.10	12.80	0.10	1.00
19	12.80	0.10	13.60	0.10	1.00
20	13.60	0.10	14.40	0.10	1.00
21	14.40	0.10	15.20	0.10	1.00
22	15.20	0.10	16.00	0.10	1.00
23	16.00	0.10	16.80	0.10	1.00
24	16.80	0.10	17.60	0.10	1.00
25	17.60	0.10	18.40	0.10	1.00
26	18.40	0.10	19.20	0.10	1.00
27	19.20	0.10	20.00	0.10	1.00
28	20.00	0.10	20.80	0.10	1.00
29	20.80	0.10	21.60	0.10	1.00
30	21.60	0.10	22.40	0.10	1.00
31	22.40	0.10	23.20	0.10	1.00
32	23.20	0.10	24.00	0.10	1.00
33	24.00	0.10	24.80	0.10	1.00
34	24.80	0.10	25.60	0.09	1.00
35	25.60	0.09	26.40	0.09	1.00
36	26.40	0.09	27.20	0.09	1.00
37	27.20	0.09	28.00	0.09	1.00
38	28.00	0.09	28.80	0.09	1.00
39	28.80	0.09	29.60	0.09	1.00
40	29.60	0.09	30.40	0.09	1.00
41	30.40	0.09	31.20	0.09	1.00
42	31.20	0.09	32.00	0.09	1.00
43	32.00	0.09	32.80	0.09	1.00
44	32.80	0.09	33.60	0.09	1.00
45	33.60	0.09	34.40	0.09	1.00
46	34.40	0.09	35.20	0.00	1.00
47	35.20	0.00	36.00	0.00	1.00
48	36.00	0.00	36.63	0.00	1.00
49	36.63	0.00	36.63	0.00	1.00
50	36.63	0.00	36.63	0.00	1.00
51	36.63	0.00	36.63	0.00	1.00
52	36.63	0.00	36.63	0.00	1.00

ACTIVE PRESSURE (BELOW DREDGE LINE) Y - Depth from dredge level

No.	Y top	Top Pres.	Pres. Slope	Width
1	0.00	0.46	0.05	1.00
2	6.00	0.75	0.04	1.00
3	8.00	0.83	0.04	1.00
4	11.00	0.94	0.02	1.00
5	12.00	0.96	0.02	1.00
6	13.00	0.98	0.02	1.00
7	15.00	1.02	0.02	1.00
8	16.00	1.04	-0.11	1.00
9	17.00	0.93	0.01	1.00
10	18.00	0.94	0.01	1.00
11	22.00	1.00	0.01	1.00

PASSIVE PRESSURE (BELOW DREDGE LINE) Y – Depth from dredge level

In the calculation, the following passive pressure are divided by a Factor of Safety =2.0

No.	Y top	Top Pres.	Pres. Slope	Width
1	5.00	0.40	0.51	1.00
2	6.00	0.91	0.43	1.00
3	7.00	1.34	0.53	1.00
4	8.00	1.88	0.69	1.00
5	9.00	2.57	0.79	1.00
6	10.00	3.36	0.72	1.00
7	11.00	4.08	0.61	1.00
8	12.00	4.68	0.64	1.00
9	13.00	5.33	0.67	1.00
10	14.00	5.99	0.61	1.00
11	15.00	6.60	0.29	1.00
12	16.00	6.89	1.92	1.00
13	17.00	8.81	0.56	1.00
14	18.00	9.37	0.57	1.00
15	20.00	10.50	0.57	1.00
16	21.00	11.07	0.56	1.00
17	22.00	11.63	0.58	1.00

UNITS: Length/Depth - ft, Force - kip, Moment - kip-ft, Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

SHORING WALL CALCULATION SUMMARY
< ct-SHORING >
The leading shoring design and calculation software
Software Copyright by CivilTech Software
www.civiltechsoftware.com

SHORING SOFTWARE is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
5. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 1992

UNITS:
FORCE-kip, PRESSURE-ksf, MOMENT- kip-ft, LENGTH-ft, DEFLECTION-in.

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Date: 5/1/2006 File: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washington Street Interchange)\shoring\413+50.sho

**********INPUT DATA**********

Title: Washington Street Interchange
Subtitle: Station 413+50 Line "PR-5SN" Left
WALL HEIGHT: 10.0 from top of wall to excavation base
(Excavation base is also defined as dredge level)

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) No.	Xtop	Top Pres.	X-Depth from wall top Xbot.	Bot. Pres.	Spacing
1	0.00	0.00	2.00	0.07	1.00
2	2.00	0.07	10.00	0.46	1.00
3	0.00	0.05	0.80	0.05	1.00
4	0.80	0.05	1.60	0.06	1.00
5	1.60	0.06	2.40	0.06	1.00
6	2.40	0.06	3.20	0.07	1.00
7	3.20	0.07	4.00	0.07	1.00
8	4.00	0.07	4.80	0.08	1.00
9	4.80	0.08	5.60	0.08	1.00
10	5.60	0.08	6.40	0.09	1.00
11	6.40	0.09	7.20	0.09	1.00
12	7.20	0.09	8.00	0.09	1.00
13	8.00	0.09	8.80	0.09	1.00
14	8.80	0.09	9.60	0.09	1.00
15	9.60	0.09	10.40	0.09	1.00
16	10.40	0.09	11.20	0.10	1.00
17	11.20	0.10	12.00	0.10	1.00
18	12.00	0.10	12.80	0.10	1.00
19	12.80	0.10	13.60	0.10	1.00
20	13.60	0.10	14.40	0.10	1.00
21	14.40	0.10	15.20	0.10	1.00
22	15.20	0.10	16.00	0.10	1.00
23	16.00	0.10	16.80	0.10	1.00
24	16.80	0.10	17.60	0.10	1.00
25	17.60	0.10	18.40	0.10	1.00
26	18.40	0.10	19.20	0.10	1.00
27	19.20	0.10	20.00	0.10	1.00
28	20.00	0.10	20.80	0.10	1.00
29	20.80	0.10	21.60	0.10	1.00

30	21.60	0.10	22.40	0.10	1.00
31	22.40	0.10	23.20	0.10	1.00
32	23.20	0.10	24.00	0.10	1.00
33	24.00	0.10	24.80	0.10	1.00
34	24.80	0.10	25.60	0.09	1.00
35	25.60	0.09	26.40	0.09	1.00
36	26.40	0.09	27.20	0.09	1.00
37	27.20	0.09	28.00	0.09	1.00
38	28.00	0.09	28.80	0.09	1.00
39	28.80	0.09	29.60	0.09	1.00
40	29.60	0.09	30.40	0.09	1.00
41	30.40	0.09	31.20	0.09	1.00
42	31.20	0.09	32.00	0.09	1.00
43	32.00	0.09	32.80	0.09	1.00
44	32.80	0.09	33.60	0.09	1.00
45	33.60	0.09	34.40	0.09	1.00
46	34.40	0.09	35.20	0.00	1.00
47	35.20	0.00	36.00	0.00	1.00
48	36.00	0.00	36.80	0.00	1.00
49	36.80	0.00	37.60	0.00	1.00
50	37.60	0.00	38.40	0.00	1.00
51	38.40	0.00	39.20	0.00	1.00
52	39.20	0.00	40.00	0.00	1.00

ACTIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	0.00	0.46	0.05	1.00
2	6.00	0.75	0.04	1.00
3	8.00	0.83	0.04	1.00
4	11.00	0.94	0.02	1.00
5	12.00	0.96	0.02	1.00
6	13.00	0.98	0.02	1.00
7	15.00	1.02	0.02	1.00
8	16.00	1.04	-0.11	1.00
9	17.00	0.93	0.01	1.00
10	18.00	0.94	0.01	1.00
11	22.00	1.00	0.01	1.00
12	23.00	1.01	0.01	1.00
13	26.00	1.06	0.01	1.00
14	27.00	1.07	0.02	1.00
15	29.00	1.11	0.01	1.00
16	30.00	1.12	0.01	1.00

PASSIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	5.00	0.40	0.51	1.00
2	6.00	0.91	0.43	1.00
3	7.00	1.34	0.53	1.00
4	8.00	1.88	0.69	1.00
5	9.00	2.57	0.79	1.00
6	10.00	3.36	0.72	1.00
7	11.00	4.08	0.61	1.00
8	12.00	4.68	0.64	1.00
9	13.00	5.33	0.67	1.00
10	14.00	5.99	0.61	1.00
11	15.00	6.60	0.29	1.00
12	16.00	6.89	1.92	1.00
13	17.00	8.81	0.56	1.00
14	18.00	9.37	0.57	1.00

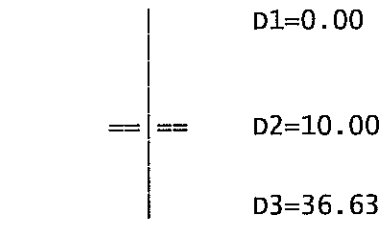
15	20.00	10.50	0.57	1.00
16	21.00	11.07	0.56	1.00
17	22.00	11.63	0.58	1.00
18	23.00	12.21	0.55	1.00
19	24.00	12.76	0.57	1.00
20	25.00	13.33	0.55	1.00
21	26.00	13.88	0.56	1.00
22	27.00	14.43	0.58	1.00
23	28.00	15.02	0.53	1.00
24	29.00	15.54	0.59	1.00
25	30.00	16.13	0.59	1.00

The pressure above will be divided by a Factor of Safety =2.0

**********CALCULATION**********

----------CANTILEVER CASE----------

NUMBER OF BRACE LEVELS= 0



D1 - TOP DEPTH
D2 - EXCAVATION BASE
D3 - PILE TIP

Total Passive Presurre = Total Active Pressure, OK!

PEEK MOMENT= 87.04 AT DEPTH= 24.74

**********RESULTS**********

OVERALL MAXIMUM MOMENT = 87.04 AT DEPTH = 24.74
MINIMUM EMBEDMENT = 26.63
TOTAL MINIMUM PILE LENGTH = 36.63

****

----------SPECIFIED PILE----------

Required Min. Section Modulus = 38.0 in3/feet, Fy=50 ksi=345 MPa, Fb/Fy=0.55
The pile selection is based on the magnitude of the moment only. Axial force is neglected. Ref. Note 3
Sx(in3) and Ix(in4) are per one foot of horizontal width of the pile

PZ32 has been found in Sheet Pile list!
PZ32 Sx= 38.3 Ix= 220.4 Weight= 56

* Note: All the pile dimensions are in English Units per one foot width.

----------SPECIFIED PILE END----------

PZ32 is capble to support the shoring!
Top deflection = 1.52 in.

**********NOTES**********

1. Based on the references, the top brace in a multiple bracing system should be

increased by 15% due to unexpected surcharge load and/or overstress of tieback. During installation of the 2nd brace, the load of the top brace will be increased as excavation needs to go beyond the elevation of the 2nd brace. Users have option to change it in Option Pages.

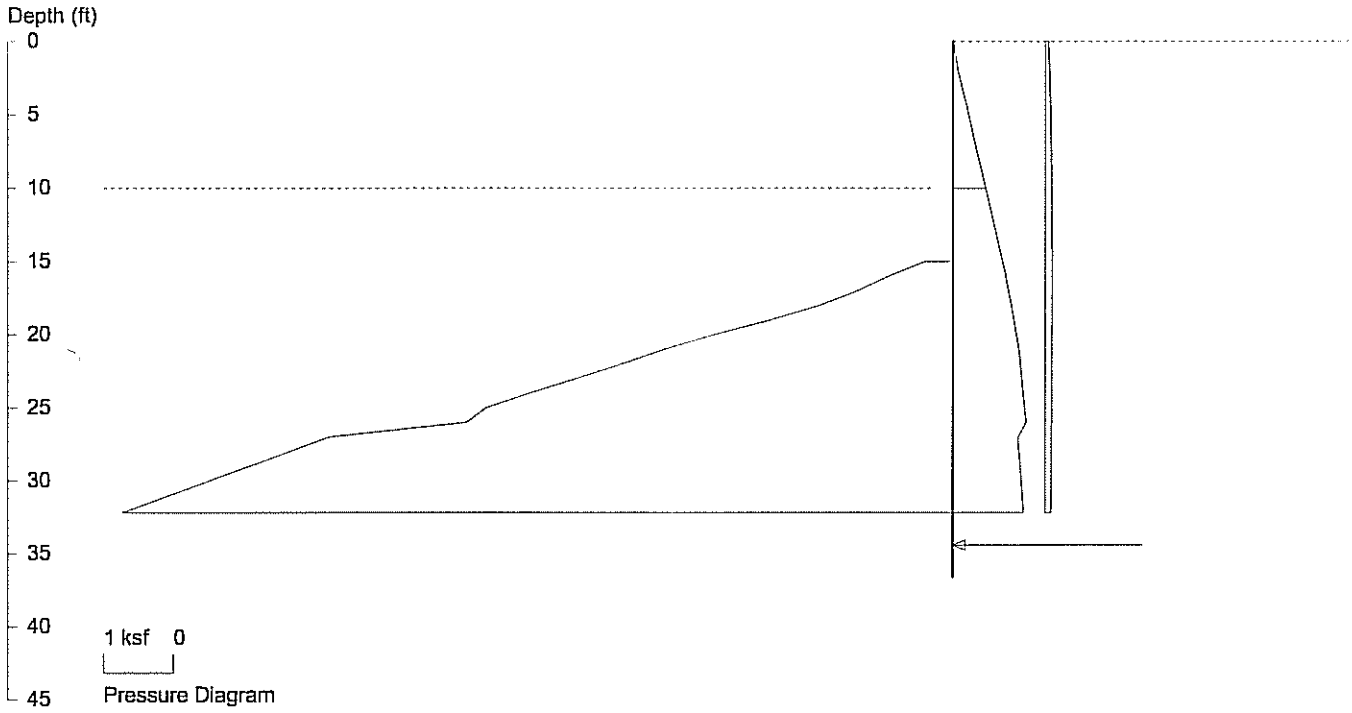
2. The calculated maximum moment is based on a single span. According to the references, the magnitude of moment can be reduced by as much as 80% in a continuous span. The reduction does not apply to cantilever and the next span.

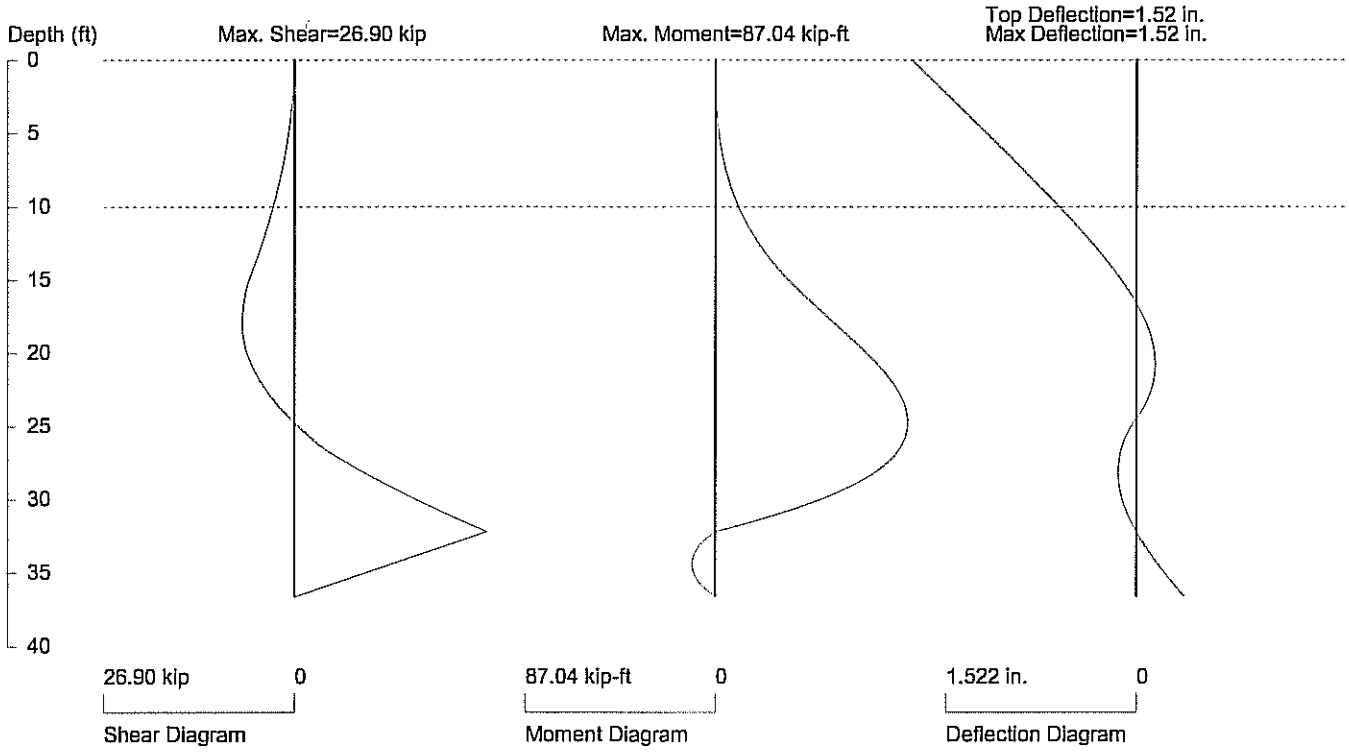
3. The pile selection is based on the moment only. The axial load from the tieback downdrag force is neglected when the downdrag force can be significantly reduced by the friction between the pile, soil, and lagging. However, if the downdrag is very large, it should be considered in your calculation.

**********END**********

Washington Street Interchange

Station 413+50 Line "PR-5SN" Left





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on one soldier pile or one foot spacing of sheet pile

Pile Properties: E (ksi) = 29000, I (in4) = 220.4

File Name: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washington Street Interchange)\shoring

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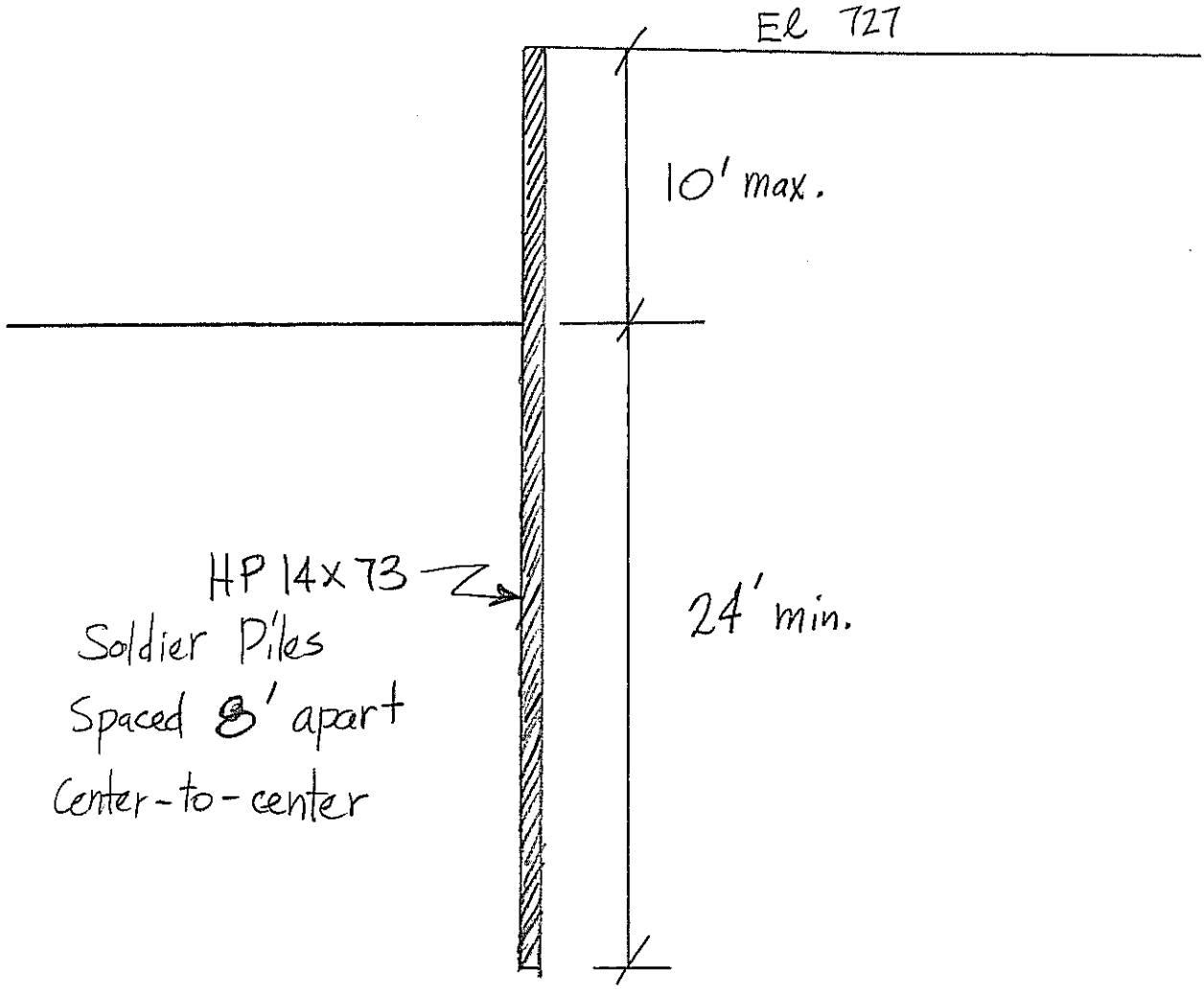
CLIENT American Consulting

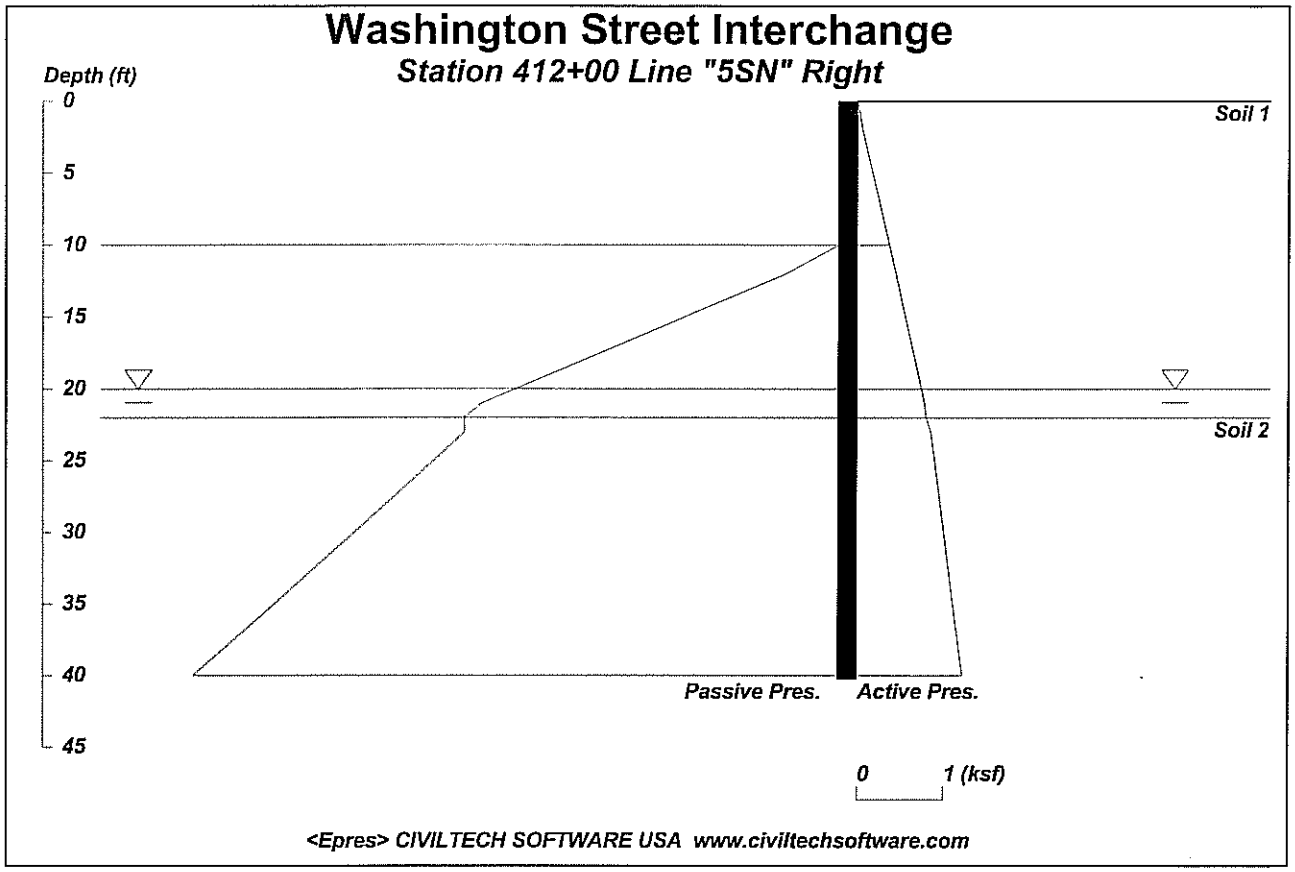
PROJECT Washington Street Interchange
Marion County, Indiana

PROJECT NUMBER 86.00481.0159
SHEET _____ OF _____
DATE 4-3-06
COMPUTED BY T.S.
CHECKED BY _____

Not to scale



Station 412+00 Line "PR-5SN"
39 ft Right



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Date: 4/4/2006 Filename: G:\Documents\ENG\PROJECTS\American Consulting (00481)\0159 (Washington Street Interchange)\s

INPUT DATA

Height of wall= 10.0

Inclination of wall (Active side)= 0

Friction factor betwen wall and soil= 0

Inclination of wall (Passive side)= 0

Soil Layer	Depth (Top of Layer)	Density (Total)	Friction (o)
1	0	.125	32
2	22	.125	30

Water table at active side= 20

Water table at passive side= 20

Unit weight of water= 0.062

Water flow (seepage) condition: No seepage

Ground surface:	Passive-X	Passive-Y	Active-X	Active-Y
	100	0	100	0

OUTPUT DATA

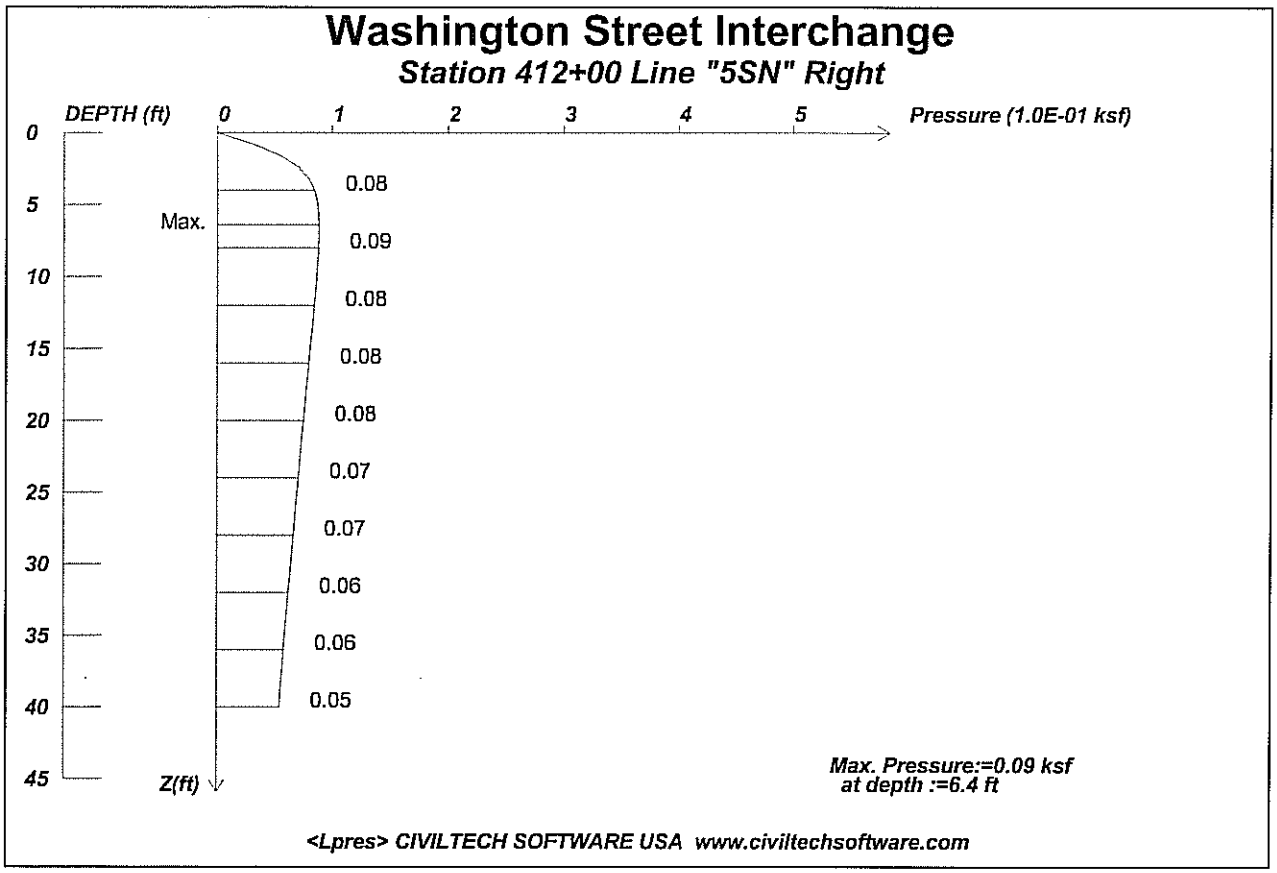
Calculated Pressure Diagram

Total active force above base = 1.92

Wall Top	Depth	Act. Pres.	Depth	Pas. Pres.
	0.0	0.000		
	2.0	0.058		

	Depth	Act. Pres.	Depth	Pas. Pres.
Exc. Base	10.0	0.365		
	10.0	0.365	10.0	0.000
	21.0	0.778	12.0	0.610
	22.0	0.797	21.0	4.171
	23.0	0.853	22.0	4.376
	24.0	0.875	23.0	4.370
	40.0	1.219	24.0	4.551
			26.0	4.918
			29.0	5.472
			37.0	6.972
			40.0	7.537

Units: Length: ft, Force: kip, Pressure: ksf, Density and Pressure Slope: kcf



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Date: 4/4/2006 Filename: G:\Documents\ENG\PROJECTS\American Consulting (00481)\0159 (Washington Street Inte

Wall Height, H= 10ft Load Depth at Surface, D= 0ft

Wall Type: Flexible Wall – The wall is perfectly flexible, or the load is applied before the wall is constructed.

Max. Pressure:=0.09ksf at depth :=6.4ft

X	Width	Strip Load
3.0	100.0	.20

Depth is measured from top of the wall

Pressure: ksf Length: ft Force: kip

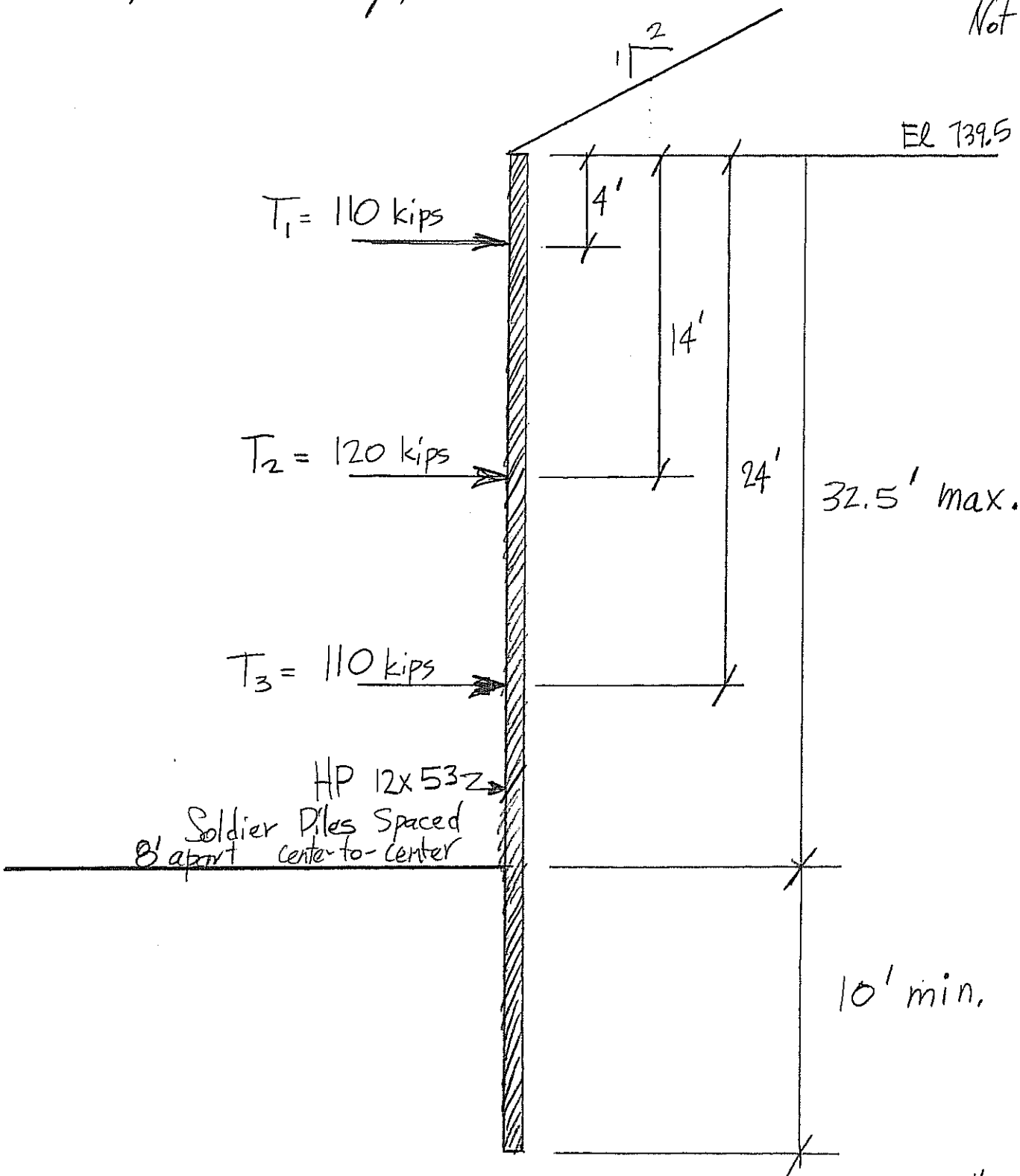
VATC

CLIENT American Consulting

PROJECT Washington Street Interchange
Marion County, Indiana

PROJECT NUMBER 86.00481.0159
SHEET ____ OF ____
DATE 4-3-06
COMPUTED BY T.G.
CHECKED BY ____

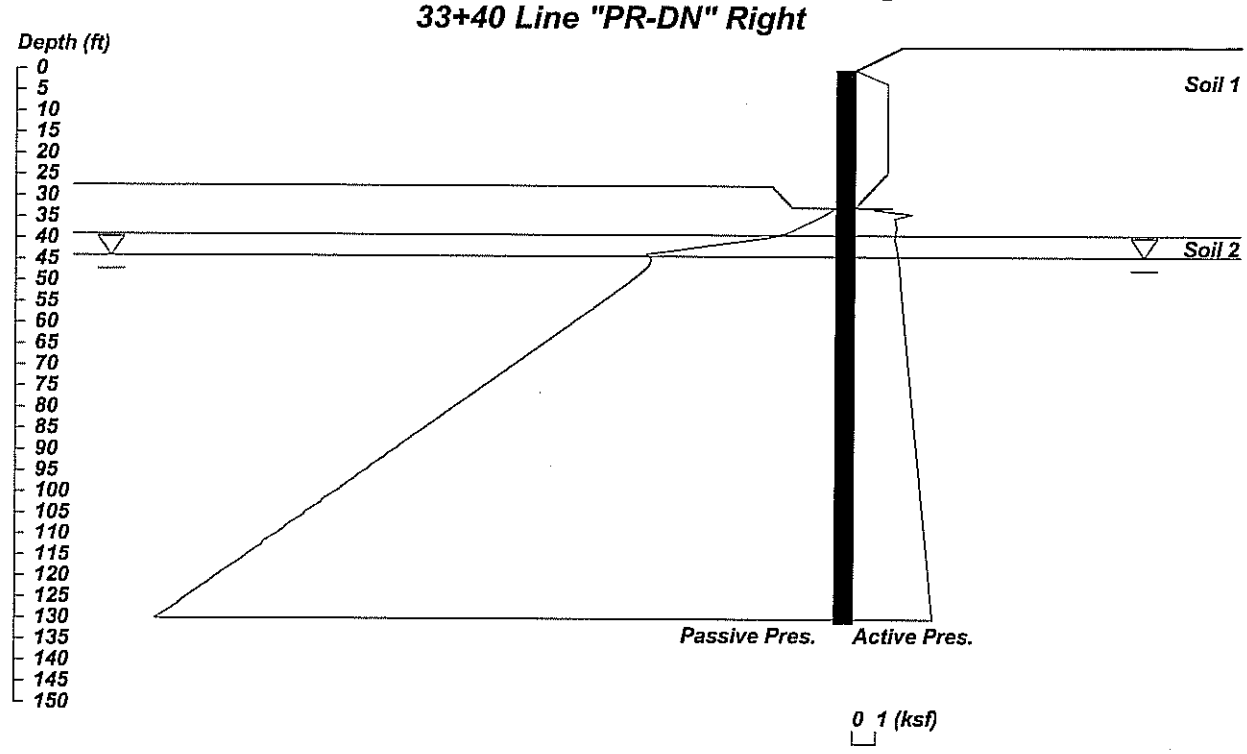
Not to Scale



Station 33+40 Line "PR-DN"
20 ft. Right

Washington Street Interchange

33+40 Line "PR-DN" Right



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INPUT DATA

Height of wall= 32.5

Inclination of wall (Active side)= 0

Friction factor betwen wall and soil= 0

Inclination of wall (Passive side)= 0

Soil Layer	Depth (Top of Layer)	Density (Total)	Friction (o)
1	0	.125	30
2	39	.130	35

Water table at active side= 44

Water table at passive side= 44

Unit weight of water= 0.062

Water flow (seepage) condition: No seepage

Ground surface:	Passive-X	Passive-Y	Active-X	Active-Y
	10	0	11	5.5
	15	5	100	5.5
	100	5		

OUTPUT DATA

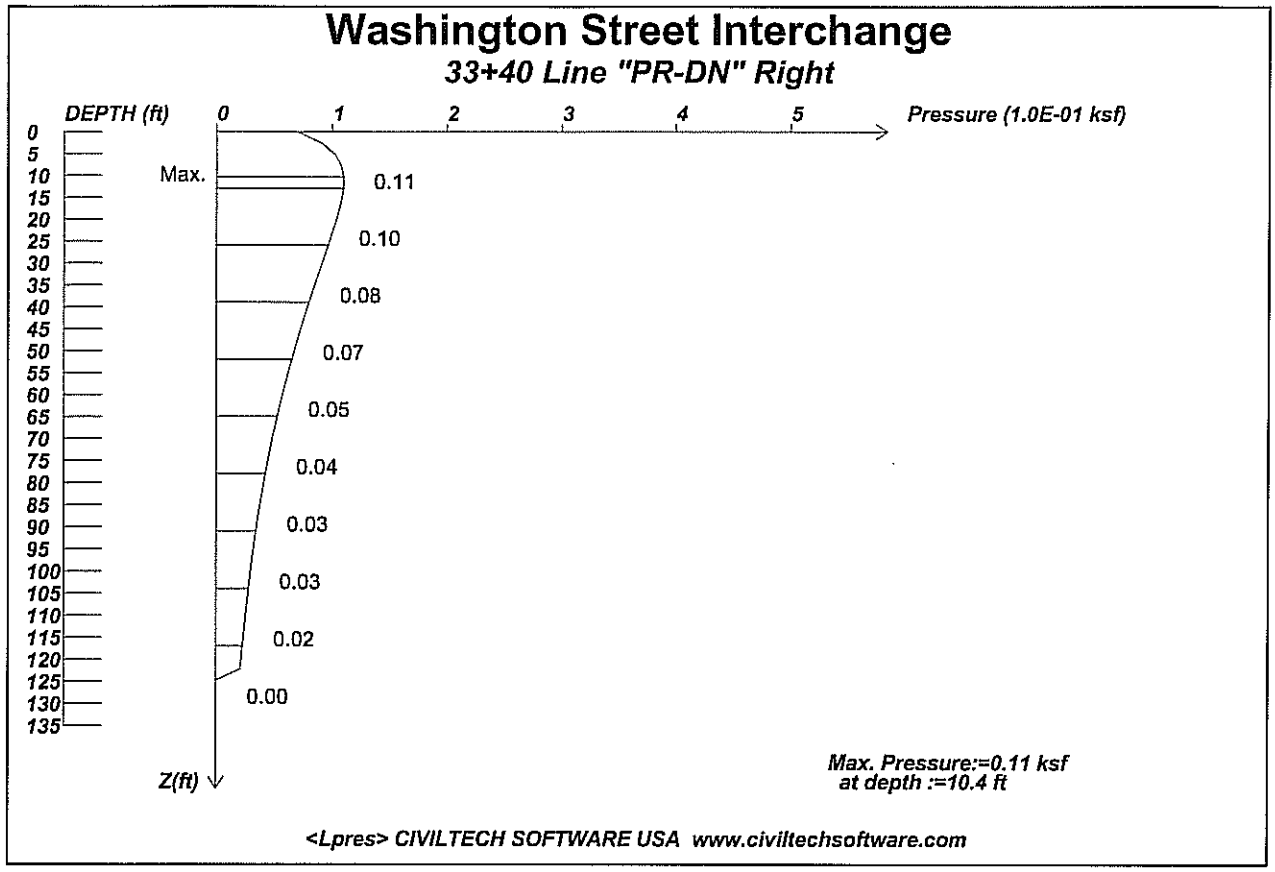
Trapezoid Pressure Diagram

Total active force above base = 36.37

Wall Top	Depth	Act. Pres.	Depth	Pas. Pres.

	Depth	Act. Pres.	Depth	Pas. Pres.
	0.0	0.000		
	3.3	1.356		
	24.4	1.356		
Exc. Base	32.5	0.000		

Depth	Act. Pres.	Depth	Pas. Pres.
32.5	1.558	32.5	0.000
33.0	0.784	34.5	0.563
34.0	2.417	38.5	2.068
35.0	1.663	39.5	2.781
36.0	1.706	40.5	4.008
37.0	1.747	41.5	5.361
40.0	1.688	42.5	6.646
41.0	1.721	43.5	8.037
42.0	1.760	44.5	7.835
43.0	1.794	45.5	7.848
45.0	1.857	46.5	7.978
46.0	1.870	47.5	8.166
48.0	1.902	48.5	8.376
49.0	1.918	49.5	8.609
50.0	1.933	50.5	8.845
52.0	1.968	51.5	9.090
53.0	1.983	52.5	9.340
56.0	2.033	53.5	9.584
57.0	2.050	54.5	9.841
58.0	2.065	55.5	10.085
61.0	2.119	56.5	10.340
62.0	2.135	59.5	11.101
66.0	2.204	60.5	11.346
67.0	2.222	61.5	11.616
68.0	2.239	62.5	11.848
72.0	2.308	63.5	12.117
73.0	2.328	64.5	12.365
74.0	2.345	65.5	12.610
79.0	2.431	66.5	12.868
80.0	2.452	67.5	13.124
81.0	2.469	68.5	13.377
88.0	2.595	74.5	14.896
89.0	2.613	76.5	15.376
90.0	2.631	77.5	15.639
98.0	2.773	78.5	15.910
100.0	2.812	79.5	16.148
111.0	3.010	81.5	16.672
112.0	3.030	82.5	16.890
113.0	3.048	83.5	17.158
127.0	3.301	84.5	17.417
129.0	3.340	85.5	17.647
130.0	3.358	86.5	17.932
		87.5	18.141
		88.5	18.437
		89.5	18.644
		90.5	18.933
		91.5	19.159
		92.5	19.421
		93.5	19.687
		94.5	19.901
		95.5	20.210
		96.5	20.397
		97.5	20.679
		99.5	21.144
		100.5	21.443
		101.5	21.706
		102.5	21.899
		103.5	22.197
		104.5	22.474
		105.5	22.645
		106.5	22.939
		107.5	23.231
		108.5	23.419
		109.5	23.671
		110.5	23.961
		111.5	24.247
		112.5	24.396



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Date: 4/2/2006 Filename: G:\Documents\ENG\PROJECTS\American Consulting (00481)\0159 (Washington Street Int

Wall Height, H= 32.5ft Load Depth at Surface, D= -5.5ft

Wall Type: Semi-Flexible Wall -- The wall is partially flexible. Small movement of the wall is allowed.

Max. Pressure:=0.11ksf at depth :=10.4ft

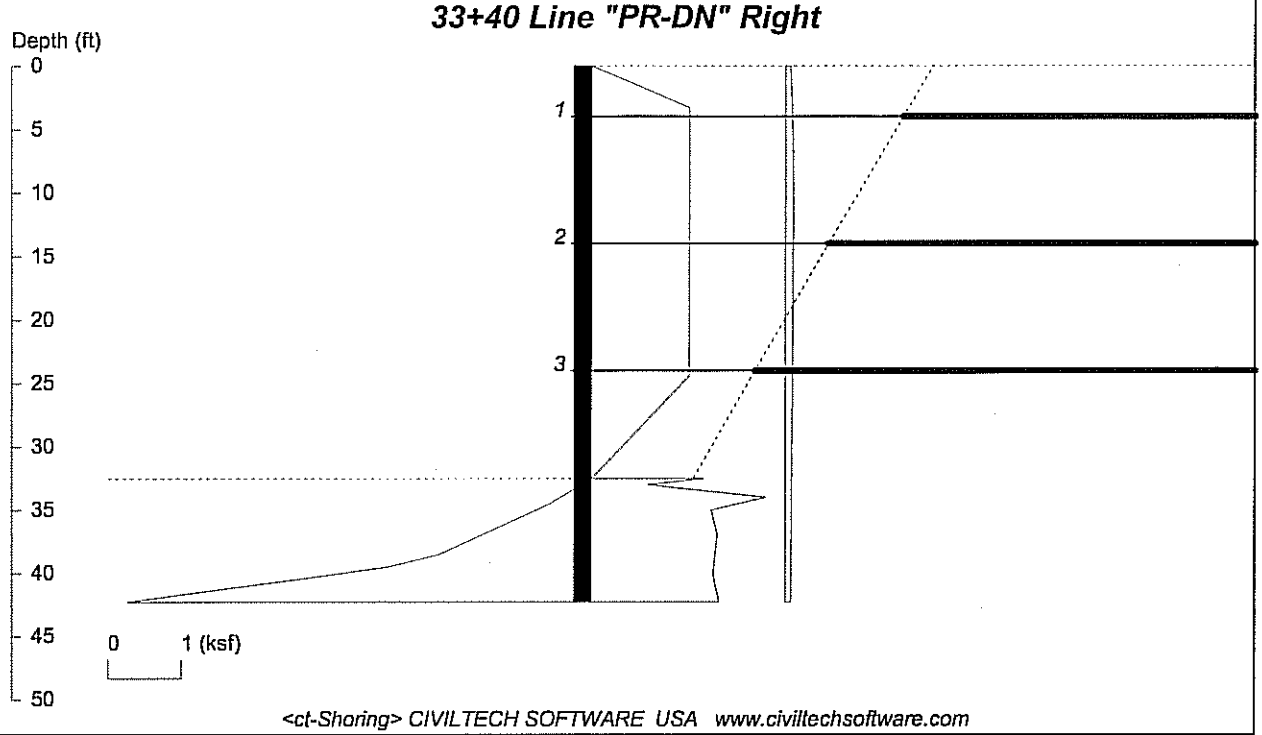
X	Width	Strip Load
11.0	100.0	.20

Depth is measured from top of the wall

Pressure: ksf Length: ft Force: kip

Washington Street Interchange

33+40 Line "PR-DN" Right



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Date: 5/1/2006 File Name: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washing

WALL HEIGHT: 32.50 MIN. EMBEDMENT: 9.77 MIN. PILE LENGTH: 42.27

MAX. MOMENT: 127.09 AT DEPTH: 9.34

HP12X53 has Section Modulus = 66.8 in3/spacing. It is greater than Min. Requirement! Top Deflection = -0.15 in.

Required Min. Section Modulus = 55.5 in3/spacing, Fy=50 ksi=345 MPa, Fb/Fy=0.55

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8):

No.	DEPTH	ANGLE	TOTAL	HORIZ.	VERT.	L_free	L_fixed
1	4.0	0.0	104.3*	104.3	0.0	24.6	66.4
2	14.0	0.0	113.1	113.1	0.0	18.8	72.0
3	24.0	0.0	105.3	105.3	0.0	13.0	67.0

TOTAL VERTICAL FORCE: 0.0 * 1st Brace increased by 15% (DM7.2-103)

NO-LOAD ZONE: V=32.5, H=0.25V, Angle 1=60. TIEBACK: Adhesion=1 ksf Diameter=0.5 ft.

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) X -- Depth from wall top

No.	X top	Top Pres.	X bot.	Bot. Pres.	Spacing
1	0.00	0.00	3.30	1.36	8.00
2	3.30	1.36	24.40	1.36	8.00
3	24.40	1.36	32.50	0.00	8.00
4	0.00	0.07	2.60	0.09	8.00
5	2.60	0.09	5.20	0.10	8.00
6	5.20	0.10	7.80	0.11	8.00
7	7.80	0.11	10.40	0.11	8.00
8	10.40	0.11	13.00	0.11	8.00
9	13.00	0.11	15.60	0.11	8.00
10	15.60	0.11	18.20	0.11	8.00
11	18.20	0.11	20.80	0.10	8.00
12	20.80	0.10	23.40	0.10	8.00
13	23.40	0.10	26.00	0.10	8.00
14	26.00	0.10	28.60	0.09	8.00
15	28.60	0.09	31.20	0.09	8.00
16	31.20	0.09	33.80	0.09	8.00
17	33.80	0.09	36.40	0.08	1.00
18	36.40	0.08	39.00	0.08	1.00
19	39.00	0.08	41.60	0.08	1.00
20	41.60	0.08	42.27	0.08	1.00
21	42.27	0.07	42.27	0.07	1.00
22	42.27	0.07	42.27	0.07	1.00
23	42.27	0.07	42.27	0.07	1.00
24	42.27	0.06	42.27	0.06	1.00
25	42.27	0.06	42.27	0.06	1.00
26	42.27	0.06	42.27	0.06	1.00
27	42.27	0.06	42.27	0.06	1.00
28	42.27	0.05	42.27	0.05	1.00
29	42.27	0.05	42.27	0.05	1.00
30	42.27	0.05	42.27	0.05	1.00
31	42.27	0.05	42.27	0.05	1.00
32	42.27	0.05	42.27	0.05	1.00
33	42.27	0.04	42.27	0.04	1.00
34	42.27	0.04	42.27	0.04	1.00
35	42.27	0.04	42.27	0.04	1.00
36	42.27	0.04	42.27	0.04	1.00
37	42.27	0.04	42.27	0.04	1.00
38	42.27	0.04	42.27	0.04	1.00
39	42.27	0.03	42.27	0.03	1.00
40	42.27	0.03	42.27	0.03	1.00
41	42.27	0.03	42.27	0.03	1.00
42	42.27	0.03	42.27	0.03	1.00
43	42.27	0.03	42.27	0.03	1.00
44	42.27	0.03	42.27	0.03	1.00
45	42.27	0.03	42.27	0.03	1.00
46	42.27	0.03	42.27	0.03	1.00
47	42.27	0.03	42.27	0.03	1.00
48	42.27	0.02	42.27	0.02	1.00
49	42.27	0.02	42.27	0.02	1.00
50	42.27	0.02	42.27	0.02	1.00
51	42.27	0.02	42.27	0.02	1.00
52	42.27	0.00	42.27	0.00	1.00
53	42.27	0.00	42.27	0.00	1.00

ACTIVE PRESSURE (BELOW DREDGE LINE) Y - Depth from dredge level

No.	Y top	Top Pres.	Pres. Slope	Width
1	0.00	1.56	-1.54	1.00
2	0.50	0.78	1.63	1.00
3	1.50	2.42	-0.75	1.00
4	2.50	1.66	0.04	1.00
5	3.50	1.71	0.04	1.00
6	4.50	1.75	-0.02	1.00
7	7.50	1.69	0.03	1.00
8	8.50	1.72	0.04	1.00
9	9.50	1.76	0.03	1.00

PASSIVE PRESSURE (BELOW DREDGE LINE) Y – Depth from dredge level

In the calculation, the following passive pressure are divided by a Factor of Safety =2.0

No.	Y top	Top Pres.	Pres. Slope	Width
1	0.00	0.00	0.28	2.50
2	2.00	0.56	0.38	2.50
3	6.00	2.07	0.71	2.50
4	7.00	2.78	1.23	2.50
5	8.00	4.01	1.35	2.50
6	9.00	5.36	1.29	2.50

UNITS: Length/Depth - ft, Force - kip, Moment - kip-ft, Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

SHORING WALL CALCULATION SUMMARY
< ct-SHORING >
The leading shoring design and calculation software

www.civiltechsoftware.com

SHORING SOFTWARE is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
5. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 1992

UNITS:
FORCE-kip, PRESSURE-ksf, MOMENT- kip-ft, LENGTH-ft, DEFLECTION-in.

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**********INPUT DATA**********

Title: Washington Street Interchange
Subtitle: 33+40 Line "PR-DN" Right
WALL HEIGHT: 32.5 from top of wall to excavation base
(Excavation base is also defined as dredge level)

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) X-Depth from wall top

No.	Xtop	Top Pres.	Xbot.	Bot. Pres.	Spacing
1	0.00	0.00	3.30	1.36	8.00
2	3.30	1.36	24.40	1.36	8.00
3	24.40	1.36	32.50	0.00	8.00
4	0.00	0.07	2.60	0.09	8.00
5	2.60	0.09	5.20	0.10	8.00
6	5.20	0.10	7.80	0.11	8.00
7	7.80	0.11	10.40	0.11	8.00
8	10.40	0.11	13.00	0.11	8.00
9	13.00	0.11	15.60	0.11	8.00
10	15.60	0.11	18.20	0.11	8.00
11	18.20	0.11	20.80	0.10	8.00
12	20.80	0.10	23.40	0.10	8.00
13	23.40	0.10	26.00	0.10	8.00
14	26.00	0.10	28.60	0.09	8.00
15	28.60	0.09	31.20	0.09	8.00
16	31.20	0.09	33.80	0.09	8.00
17	33.80	0.09	36.40	0.08	1.00
18	36.40	0.08	39.00	0.08	1.00
19	39.00	0.08	41.60	0.08	1.00
20	41.60	0.08	44.20	0.07	1.00
21	44.20	0.07	46.80	0.07	1.00
22	46.80	0.07	49.40	0.07	1.00
23	49.40	0.07	52.00	0.06	1.00
24	52.00	0.06	54.60	0.06	1.00
25	54.60	0.06	57.20	0.06	1.00
26	57.20	0.06	59.80	0.06	1.00
27	59.80	0.06	62.40	0.05	1.00
28	62.40	0.05	65.00	0.05	1.00
29	65.00	0.05	67.60	0.05	1.00

30	67.60	0.05	70.20	0.05	1.00
31	70.20	0.05	72.80	0.05	1.00
32	72.80	0.05	75.40	0.04	1.00
33	75.40	0.04	78.00	0.04	1.00
34	78.00	0.04	80.60	0.04	1.00
35	80.60	0.04	83.20	0.04	1.00
36	83.20	0.04	85.80	0.04	1.00
37	85.80	0.04	88.40	0.04	1.00
38	88.40	0.04	91.00	0.03	1.00
39	91.00	0.03	93.60	0.03	1.00
40	93.60	0.03	96.20	0.03	1.00
41	96.20	0.03	98.80	0.03	1.00
42	98.80	0.03	101.40	0.03	1.00
43	101.40	0.03	104.00	0.03	1.00
44	104.00	0.03	106.60	0.03	1.00
45	106.60	0.03	109.20	0.03	1.00
46	109.20	0.03	111.80	0.03	1.00
47	111.80	0.03	114.40	0.02	1.00
48	114.40	0.02	117.00	0.02	1.00
49	117.00	0.02	119.60	0.02	1.00
50	119.60	0.02	122.20	0.02	1.00
51	122.20	0.02	124.80	0.00	1.00
52	124.80	0.00	127.40	0.00	1.00
53	127.40	0.00	130.00	0.00	1.00

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8)

No.	DEPTH	ANGLE
1	4.0	0.0
2	14.0	0.0
3	24.0	0.0

NO-LOAD ZONE: V=32.5, H=0.25V, Angle 1=60.
TIEBACK: Adhesion=1 ksf Diameter=0.5 ft.

ACTIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	0.00	1.56	-1.54	1.00
2	0.50	0.78	1.63	1.00
3	1.50	2.42	-0.75	1.00
4	2.50	1.66	0.04	1.00
5	3.50	1.71	0.04	1.00
6	4.50	1.75	-0.02	1.00
7	7.50	1.69	0.03	1.00
8	8.50	1.72	0.04	1.00
9	9.50	1.76	0.03	1.00
10	10.50	1.79	0.03	1.00
11	12.50	1.86	0.01	1.00
12	13.50	1.87	0.02	1.00
13	15.50	1.90	0.02	1.00
14	16.50	1.92	0.01	1.00
15	17.50	1.93	0.02	1.00
16	19.50	1.97	0.01	1.00
17	20.50	1.98	0.02	1.00
18	23.50	2.03	0.02	1.00
19	24.50	2.05	0.01	1.00
20	25.50	2.07	0.02	1.00
21	28.50	2.12	0.02	1.00
22	29.50	2.13	0.02	1.00
23	33.50	2.20	0.02	1.00

24	34.50	2.22	0.02	1.00
25	35.50	2.24	0.02	1.00
26	39.50	2.31	0.02	1.00
27	40.50	2.33	0.02	1.00
28	41.50	2.35	0.02	1.00
29	46.50	2.43	0.02	1.00
30	47.50	2.45	0.02	1.00
31	48.50	2.47	0.02	1.00
32	55.50	2.60	0.02	1.00
33	56.50	2.61	0.02	1.00
34	57.50	2.63	0.02	1.00
35	65.50	2.77	0.02	1.00
36	67.50	2.81	0.02	1.00
37	78.50	3.01	0.02	1.00
38	79.50	3.03	0.02	1.00
39	80.50	3.05	0.02	1.00
40	94.50	3.30	0.02	1.00

PASSIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	0.00	0.00	0.28	2.50
2	2.00	0.56	0.38	2.50
3	6.00	2.07	0.71	2.50
4	7.00	2.78	1.23	2.50
5	8.00	4.01	1.35	2.50
6	9.00	5.36	1.29	2.50
7	10.00	6.65	1.39	2.50
8	11.00	8.04	-0.20	2.50
9	12.00	7.84	0.01	2.50
10	13.00	7.85	0.13	2.50
11	14.00	7.98	0.19	2.50
12	15.00	8.17	0.21	2.50
13	16.00	8.38	0.23	2.50
14	17.00	8.61	0.24	2.50
15	18.00	8.85	0.25	2.50
16	19.00	9.09	0.25	2.50
17	20.00	9.34	0.24	2.50
18	21.00	9.58	0.26	2.50
19	22.00	9.84	0.24	2.50
20	23.00	10.08	0.25	2.50
21	24.00	10.34	0.25	2.50
22	27.00	11.10	0.25	2.50
23	28.00	11.34	0.27	2.50
24	29.00	11.61	0.23	2.50
25	30.00	11.84	0.27	2.50
26	31.00	12.11	0.25	2.50
27	32.00	12.36	0.25	2.50
28	33.00	12.61	0.26	2.50
29	34.00	12.86	0.25	2.50
30	35.00	13.12	0.25	2.50
31	36.00	13.37	0.25	2.50
32	42.00	14.89	0.24	2.50
33	44.00	15.37	0.26	2.50
34	45.00	15.63	0.27	2.50
35	46.00	15.91	0.24	2.50
36	47.00	16.14	0.26	2.50
37	49.00	16.67	0.22	2.50
38	50.00	16.89	0.27	2.50
39	51.00	17.15	0.26	2.50
40	52.00	17.41	0.23	2.50

The pressure above will be divided by a Factor of Safety =2.0

**********CALCULATION**********

----------MULTIPLE BRACE / TIEBACK CASE----------

NUMBER OF BRACE LEVEL = 3

* CANTILEVER SPAN *

```
      |      D1=0.00
      |
      |
      |<--   D2=4.00          R2=28.22
```

D1 - TOP DEPTH
D2 - BOTTOM DEPTH R2 - BOTTOM REACTION

TOTAL REACTION: R2 = 28.22
TOTAL PRESSURE ACTING ON WALL = 28.22
Total Reaction = Total Pressure, OK!
CANTILEVER MOMENT = 40.03 AT DEPTH = 4.00

BRACE NO.1 AT DEPTH = 4.00
R2 of Cantilever Span
} Sum of Reaction = Brace Load = 90.68
R1 of Span No.1
Load of Brace 1 increased 15% to 104.28. Ref. Note 1.

---

* MIDDLE SPAN NO.1 *

```
      |<--   D1=4.00          R1=62.46
      |
      |
      |<--   D2=14.00          R2=54.60
```

D1 - TOP DEPTH R1 - TOP REACTION
D2 - BOTTOM DEPTH R2 - BOTTOM REACTION

TOTAL REACTION: R1+R2 = 117.05
TOTAL PRESSURE ACTING ON WALL = 117.05
Total Reaction = Total Pressure, OK!
PEEK MOMENT = 127.09 AT DEPTH = 9.34

BRACE NO.2 AT DEPTH = 14.00
R2 of Span No.1
} Sum of Reaction = Brace Load = 113.09
R1 of Span No.2

---

* MIDDLE SPAN NO.2 *

```
      |<--   D1=14.00          R1=58.50
      |
      |
      |<--   D2=24.00          R2=58.36
```

D1 - TOP DEPTH R1 - TOP REACTION
D2 - BOTTOM DEPTH R2 - BOTTOM REACTION

TOTAL REACTION: R1+R2 = 116.86
TOTAL PRESSURE ACTING ON WALL = 116.86

```
   Total Reaction = Total Pressure,    OK!
PEEK MOMENT = 146.09  AT DEPTH =  19.00
   Using 0.8 Moment = 116.87,  Ref. Note 2
-------------------------------------------------------
BRACE NO.3 AT DEPTH = 24.00
    R2 of Span No.2
                                } Sum of Reaction = Brace Load = 105.25
    R1 of Embedment Span
-------------------------------------------------------

*  EMBEDMENT SPAN  *

      |<--   D1=24.00          R1=46.89
      |
   ==|==    D2=32.50
      |
      |      D3=42.27

      D1 - TOP DEPTH           R1 - TOP REACTION
      D2 - EXCAVATION BASE
      D3 - PILE TIP

TOTAL REACTION: R1 = 46.89
TOTAL PRESSURE ACTING ON WALL = 46.89
   Total Reaction = Total Pressure,    OK!
PEEK MOMENT = 111.71  AT DEPTH=  29.53

**********************************RESULTS*****************************************

OVERALL MAXIMUM MOMENT = 127.09  AT DEPTH = 9.34
MINIMUM EMBEDMENT = 9.77
TOTAL MINIMUM PILE LENGTH = 42.27

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8)
 No.    DEPTH          ANGLE          HORIZONTAL      VERTICAL     TOTAL LOAD
-------------------------------------------------------------------------------
 1      4.0            0.0            104.28          0.00           104.28
 2      14.0           0.0            113.09          0.00           113.09
 3      24.0           0.0            105.25          0.00           105.25
-------------------------------------------------------------------------------
*******************************************************************************


------------------------------SPECIFIED PILE---------------------------
  Required Min. Section Modulus = 55.5 in3/feet, Fy=50 ksi=345 MPa, Fb/Fy=0.55
   The pile selection is based on the magnitude of the moment only. Axial force is
neglected. Ref. Note 3
   Sx(in3) and Ix(in4) are per one foot of horizontal width of the pile

   HP12X53 has been found in Soldier Pile list!
   Area= 15.5   Depth= 11.78   Width= 12.045
   Ix= 393   Sx= 66.8   Iy= 127   Sy= 21.1
   Flange thickness= 0.435   Web thickness= 0.435

   * Note: All the pile dimensions are in English Units.

-------------------------SPECIFIED PILE END---------------------------

   HP12X53 is capble to support the shoring!
   Top deflection = -0.15 in.

**************************************NOTES*************************************
1. Based on the references, the top brace in a multiple bracing system should be
```

increased by 15% due to unexpected surcharge load and/or overstress of tieback. During installation of the 2nd brace, the load of the top brace will be increased as excavation needs to go beyond the elevation of the 2nd brace. Users have option to change it in Option Pages.

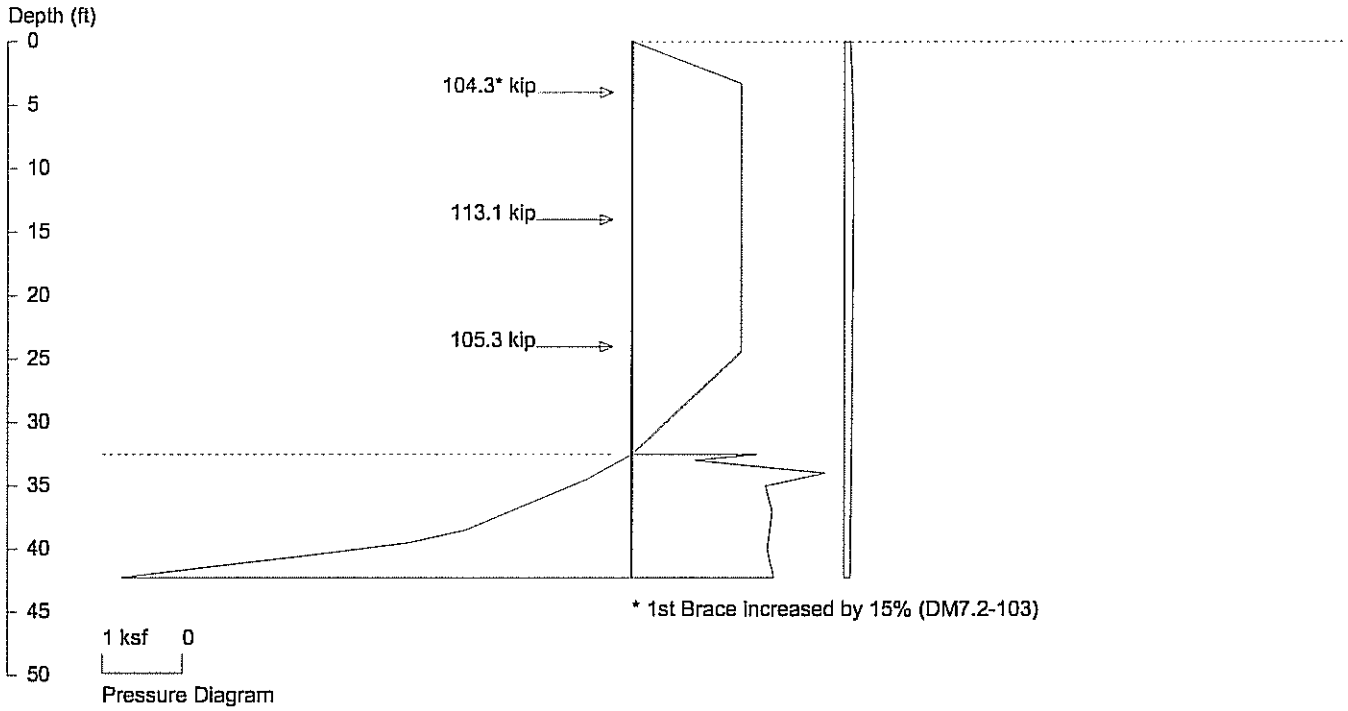
2. The calculated maximum moment is based on a single span. According to the references, the magnitude of moment can be reduced by as much as 80% in a continuous span. The reduction does not apply to cantilever and the next span.

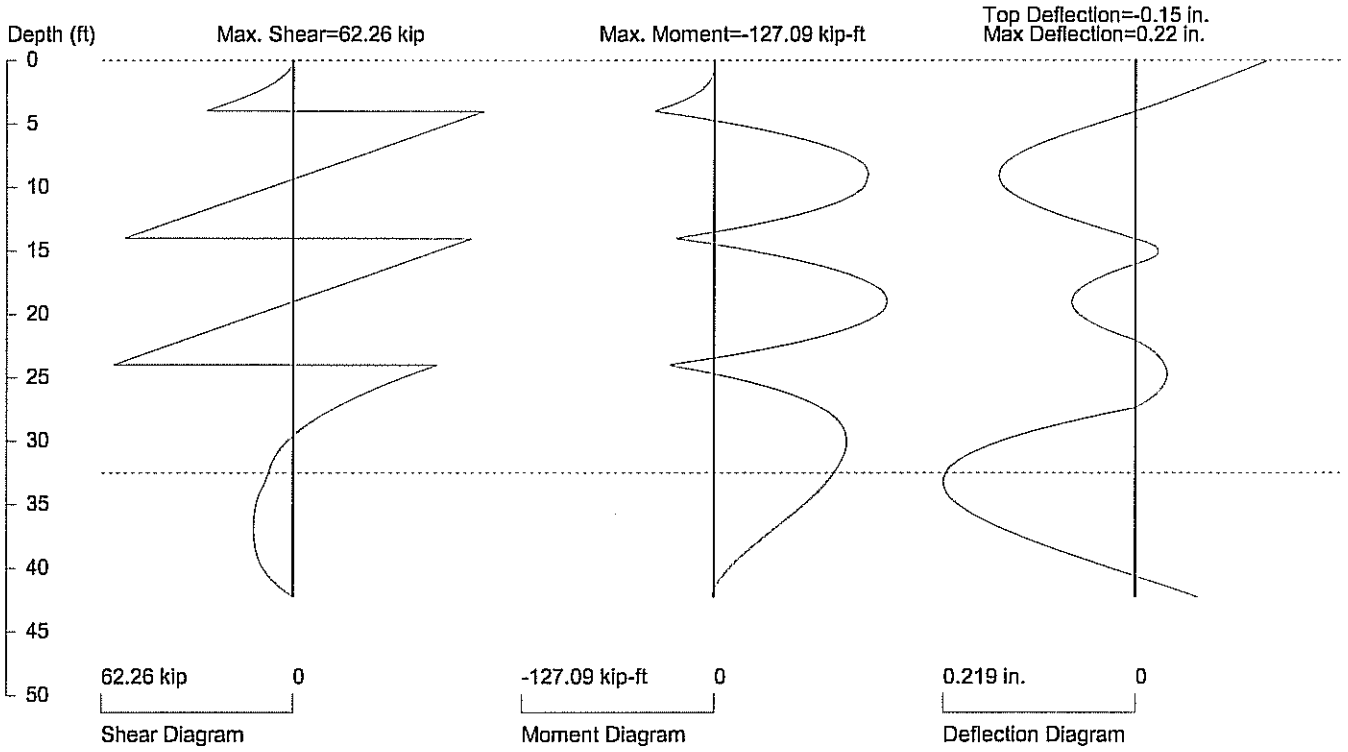
3. The pile selection is based on the moment only. The axial load from the tieback downdrag force is neglected when the downdrag force can be significantly reduced by the friction between the pile, soil, and lagging. However, if the downdrag is very large, it should be considered in your calculation.

**********END**********

Washington Street Interchange

33+40 Line "PR-DN" Right





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on one soldier pile or one foot spacing of sheet pile

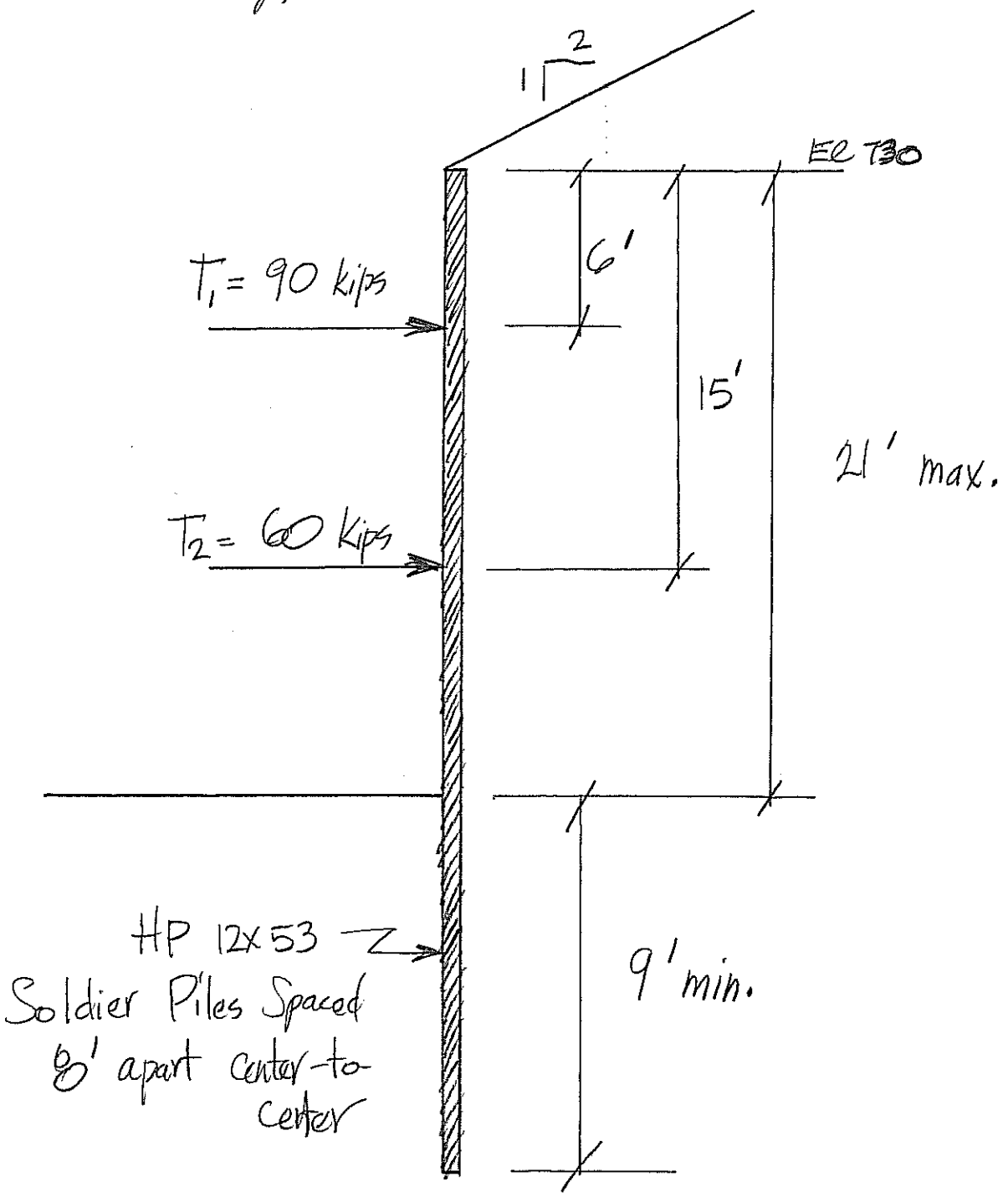
Pile Properties: E (ksi) = 29000, I (in4) = 393

VATC

CLIENT American Consulting

PROJECT Washington Street Interchange
Marion County, Indiana

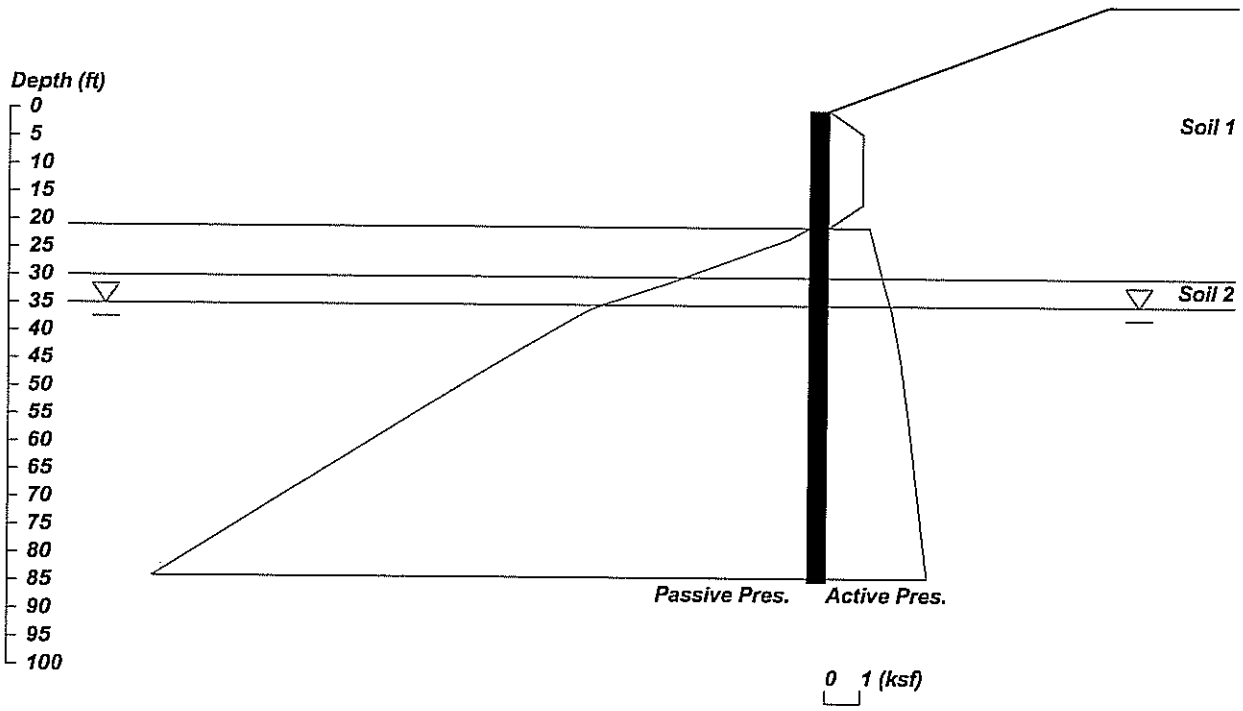
PROJECT NUMBER 86-00481.0159
SHEET ____ OF ____
DATE 4-3-06
COMPUTED BY T.G.
CHECKED BY ____



Station 35+50 "PR- DN"
20' Right

Washington Street Interchange

35+50 Line "PR-DN" Right



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INPUT DATA

Height of wall= 21.0

Inclination of wall (Active side)= 0

Friction factor betwen wall and soil= 0

Inclination of wall (Passive side)= 0

Soil Layer	Depth (Top of Layer)	Density (Total)	Friction (o)
1	0	.125	30
2	30	.130	35

Water table at active side= 35

Water table at passive side= 35

Unit weight of water= 0.062

Water flow (seepage) condition: No seepage

Ground surface:	Passive-X	Passive-Y	Active-X	Active-Y
	100	0	50	19
			150	19

OUTPUT DATA

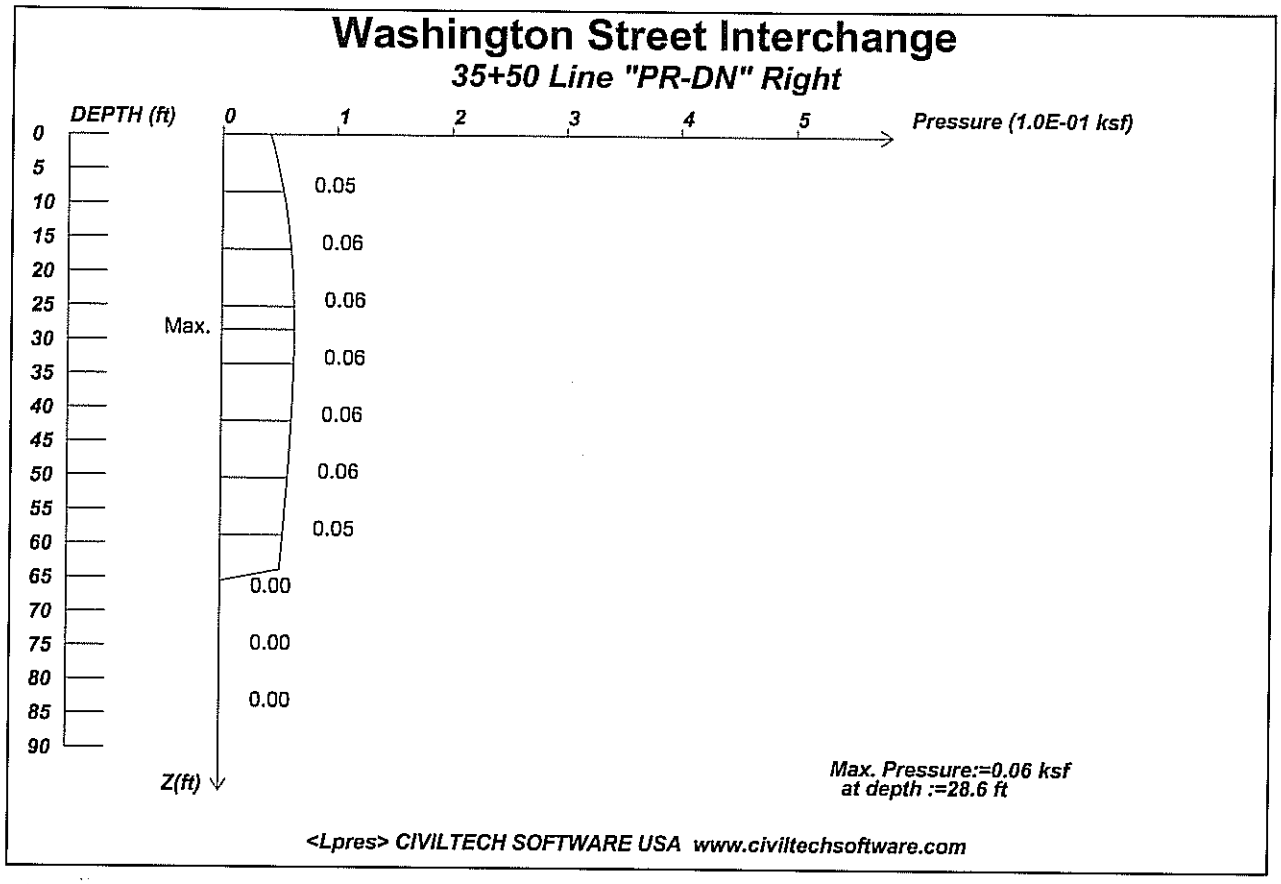
Trapezoid Pressure Diagram

Total active force above base = 16.09

Wall Top	Depth	Act. Pres.	Depth	Pas. Pres.
	0.0	0.000		

	Depth	Act. Pres.	Depth	Pas. Pres.
	4.2	0.958		
	16.8	0.958		
Exc. Base	21.0	0.000		
	21.0	1.151	21.0	0.000
	31.0	1.558	23.0	0.563
	32.0	1.605	31.0	3.954
	36.0	1.789	32.0	4.428
	37.0	1.818	33.0	4.906
	44.0	2.026	35.0	5.860
	45.0	2.051	36.0	6.239
	46.0	2.087	37.0	6.513
	47.0	2.090	38.0	6.784
	48.0	2.122	39.0	7.052
	49.0	2.145	40.0	7.313
	50.0	2.158	41.0	7.576
	51.0	2.180	43.0	8.097
	52.0	2.204	45.0	8.614
	53.0	2.216	49.0	9.640
	54.0	2.247	52.0	10.400
	55.0	2.261	53.0	10.654
	56.0	2.280	69.0	14.696
	57.0	2.306	84.0	18.470
	58.0	2.318		
	59.0	2.344		
	60.0	2.363		
	61.0	2.374		
	62.0	2.408		
	63.0	2.419		
	64.0	2.437		
	65.0	2.464		
	66.0	2.475		
	67.0	2.498		
	69.0	2.531		
	70.0	2.557		
	71.0	2.577		
	72.0	2.588		
	73.0	2.616		
	74.0	2.634		
	75.0	2.645		
	76.0	2.672		
	77.0	2.692		
	78.0	2.703		
	79.0	2.726		
	80.0	2.750		
	81.0	2.761		
	82.0	2.777		
	83.0	2.809		
	84.0	2.820		

Units: Length: ft, Force: kip, Pressure: ksf, Density and Pressure Slope: kcf



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Wall Height, H= 21ft Load Depth at Surface, D= -19ft

Wall Type: Semi-Flexible Wall – The wall is partially flexible. Small movement of the wall is allowed.

Max. Pressure:=0.06ksf at depth :=28.6ft

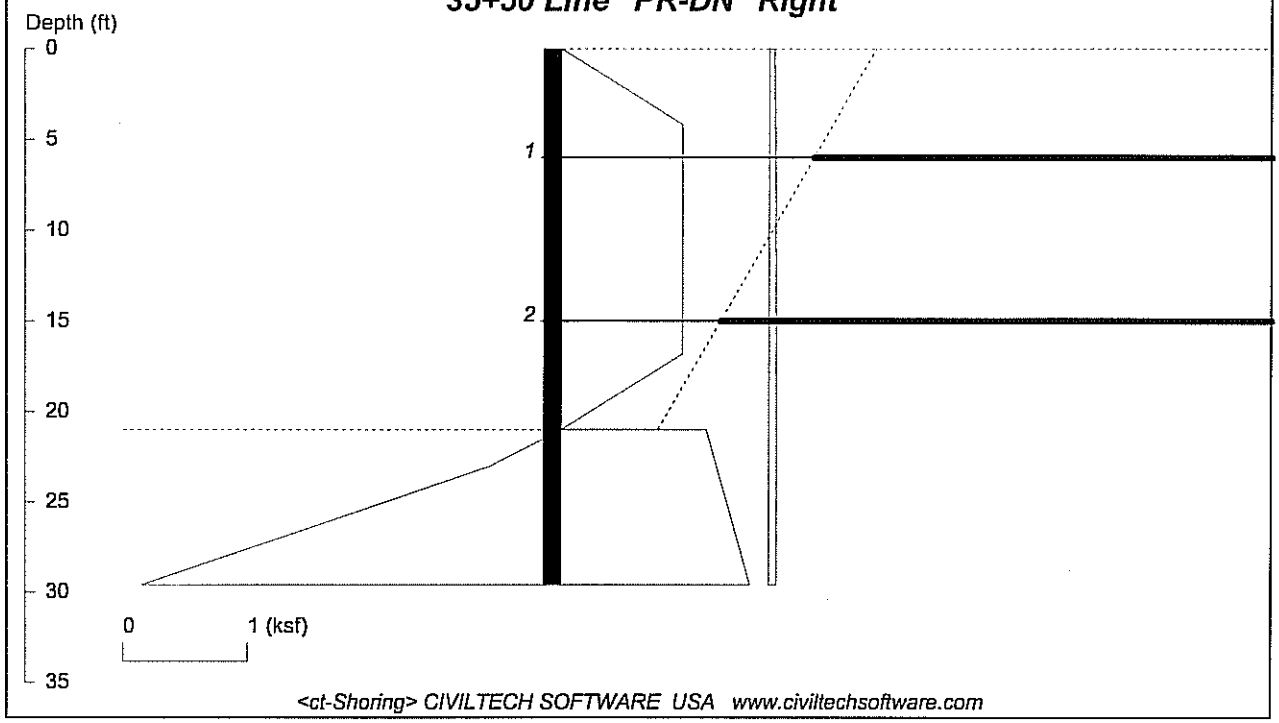
X	Width	Strip Load
50.0	100.0	.20

Depth is measured from top of the wall

Pressure: ksf Length: ft Force: kip

Washington Street Interchange

35+50 Line "PR-DN" Right



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Date: 5/1/2006 File Name: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washing

WALL HEIGHT: 21.00 MIN. EMBEDMENT: 8.59 MIN. PILE LENGTH: 29.59

MAX. MOMENT: 70.35 AT DEPTH: 6.00

HP12X53 has Section Modulus = 66.8 in3/spacing. It is greater than Min. Requirement! Top Deflection = 0.07 in.

Required Min. Section Modulus = 30.7 in3/spacing, Fy=50 ksi=345 MPa, Fb/Fy=0.55

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8):

No.	DEPTH	ANGLE	TOTAL	HORIZ.	VERT.	L_free	L_fixed
1	6.0	0.0	87.8*	87.8	0.0	13.9	55.9
2	15.0	0.0	57.0	57.0	0.0	8.7	36.3

TOTAL VERTICAL FORCE: 0.0 * 1st Brace increased by 15% (DM7.2-103)

NO-LOAD ZONE: V=21.0, H=0.25V, Angle 1=60. TIEBACK: Adhesion=1 ksf Diameter=0.5 ft.

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) X – Depth from wall top

No.	X top	Top Pres.	X bot.	Bot. Pres.	Spacing
1	0.00	0.00	4.20	0.96	6.00
2	4.20	0.96	16.60	0.96	8.00
3	16.60	0.96	21.00	0.00	8.00
4	0.00	0.04	1.70	0.04	8.00
5	1.70	0.04	3.40	0.05	8.00
6	3.40	0.05	5.00	0.05	8.00
7	5.00	0.05	6.70	0.05	8.00
8	6.70	0.05	8.40	0.05	8.00
9	8.40	0.05	10.10	0.05	8.00
10	10.10	0.05	11.80	0.06	8.00
11	11.80	0.06	13.40	0.06	8.00
12	13.40	0.06	15.10	0.06	8.00
13	15.10	0.06	16.60	0.06	8.00
14	16.60	0.06	18.50	0.06	8.00
15	18.50	0.06	20.20	0.06	8.00
16	20.20	0.06	21.80	0.06	8.00
17	21.80	0.06	23.50	0.06	1.00
18	23.50	0.06	25.20	0.06	1.00
19	25.20	0.06	26.90	0.06	1.00
20	26.90	0.06	28.60	0.06	1.00
21	28.60	0.06	29.59	0.06	1.00
22	29.59	0.06	29.59	0.06	1.00
23	29.59	0.06	29.59	0.06	1.00
24	29.59	0.06	29.59	0.06	1.00
25	29.59	0.06	29.59	0.06	1.00
26	29.59	0.06	29.59	0.06	1.00
27	29.59	0.06	29.59	0.06	1.00
28	29.59	0.06	29.59	0.06	1.00
29	29.59	0.06	29.59	0.06	1.00
30	29.59	0.06	29.59	0.06	1.00
31	29.59	0.06	29.59	0.06	1.00
32	29.59	0.06	29.59	0.06	1.00
33	29.59	0.06	29.59	0.06	1.00
34	29.59	0.06	29.59	0.06	1.00
35	29.59	0.06	29.59	0.06	1.00
36	29.59	0.06	29.59	0.06	1.00
37	29.59	0.06	29.59	0.06	1.00
38	29.59	0.05	29.59	0.05	1.00
39	29.59	0.05	29.59	0.05	1.00
40	29.59	0.05	29.59	0.05	1.00
41	29.59	0.05	29.59	0.05	1.00
42	29.59	0.05	29.59	0.05	1.00
43	29.59	0.00	29.59	0.00	1.00
44	29.59	0.00	29.59	0.00	1.00
45	29.59	0.00	29.59	0.00	1.00
46	29.59	0.00	29.59	0.00	1.00
47	29.59	0.00	29.59	0.00	1.00
48	29.59	0.00	29.59	0.00	1.00
49	29.59	0.00	29.59	0.00	1.00
50	29.59	0.00	29.59	0.00	1.00
51	29.59	0.00	29.59	0.00	1.00
52	29.59	0.00	29.59	0.00	1.00
53	29.59	0.00	29.59	0.00	1.00

ACTIVE PRESSURE (BELOW DREDGE LINE) Y - Depth from dredge level

No.	Y top	Top Pres.	Pres. Slope	Width
1	0.00	1.15	0.04	1.00

PASSIVE PRESSURE (BELOW DREDGE LINE) Y – Depth from dredge level

In the calculation, the following passive pressure are divided by a Factor of Safety =2.0

No.	Y top	Top Pres.	Pres. Slope	Width
1	0.00	0.00	0.28	2.50
2	2.00	0.56	0.42	2.50

UNITS: Length/Depth - ft, Force - kip, Moment - kip-ft, Pressure - ksf, Pres. Slope - kip/ft3, Deflection - in

SHORING WALL CALCULATION SUMMARY
< ct-SHORING >
The leading shoring design and calculation software
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SHORING SOFTWARE is developed by CivilTech Software, Bellevue, WA, USA.
The calculation method is based on the following references:

1. FHWA 98-011, FHWA-RD-97-130, FHWA SA 96-069, FHWA-IF-99-015
2. STEEL SHEET PILING DESIGN MANUAL by Pile Buck Inc., 1987
3. DESIGN MANUAL DM-7 (NAVFAC), Department of the Navy, May 1982
4. TRENCHING AND SHORING MANUAL Revision 12, California Department of Transportation, January 2000
5. EARTH SUPPORT SYSTEM & RETAINING STRUCTURES, Pile Buck Inc. 1992

UNITS:
FORCE-kip, PRESSURE-ksf, MOMENT- kip-ft, LENGTH-ft, DEFLECTION-in.

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INPUT DATA

Title: Washington Street Interchange
Subtitle: 35+50 Line "PR-DN" Right
WALL HEIGHT: 21.0 from top of wall to excavation base
(Excavation base is also defined as dredge level)

DRIVING PRESSURE (ACTIVE, WATER, & SURCHARGE) No.	Xtop	Top Pres.	X-Depth from wall top Xbot.	Bot. Pres.	Spacing
1	0.00	0.00	4.20	0.96	8.00
2	4.20	0.96	16.80	0.96	8.00
3	16.80	0.96	21.00	0.00	8.00
4	0.00	0.04	1.70	0.04	8.00
5	1.70	0.04	3.40	0.05	8.00
6	3.40	0.05	5.00	0.05	8.00
7	5.00	0.05	6.70	0.05	8.00
8	6.70	0.05	8.40	0.05	8.00
9	8.40	0.05	10.10	0.05	8.00
10	10.10	0.05	11.80	0.06	8.00
11	11.80	0.06	13.40	0.06	8.00
12	13.40	0.06	15.10	0.06	8.00
13	15.10	0.06	16.80	0.06	8.00
14	16.80	0.06	18.50	0.06	8.00
15	18.50	0.06	20.20	0.06	8.00
16	20.20	0.06	21.80	0.06	8.00
17	21.80	0.06	23.50	0.06	1.00
18	23.50	0.06	25.20	0.06	1.00
19	25.20	0.06	26.90	0.06	1.00
20	26.90	0.06	28.60	0.06	1.00
21	28.60	0.06	30.20	0.06	1.00
22	30.20	0.06	31.90	0.06	1.00
23	31.90	0.06	33.60	0.06	1.00
24	33.60	0.06	35.30	0.06	1.00
25	35.30	0.06	37.00	0.06	1.00
26	37.00	0.06	38.60	0.06	1.00
27	38.60	0.06	40.30	0.06	1.00
28	40.30	0.06	42.00	0.06	1.00
29	42.00	0.06	43.70	0.06	1.00

30	43.70	0.06	45.40	0.06	1.00
31	45.40	0.06	47.00	0.06	1.00
32	47.00	0.06	48.70	0.06	1.00
33	48.70	0.06	50.40	0.06	1.00
34	50.40	0.06	52.10	0.06	1.00
35	52.10	0.06	53.80	0.06	1.00
36	53.80	0.06	55.40	0.06	1.00
37	55.40	0.06	57.10	0.05	1.00
38	57.10	0.05	58.80	0.05	1.00
39	58.80	0.05	60.50	0.05	1.00
40	60.50	0.05	62.20	0.05	1.00
41	62.20	0.05	63.80	0.05	1.00
42	63.80	0.05	65.50	0.00	1.00
43	65.50	0.00	67.20	0.00	1.00
44	67.20	0.00	68.90	0.00	1.00
45	68.90	0.00	70.60	0.00	1.00
46	70.60	0.00	72.20	0.00	1.00
47	72.20	0.00	73.90	0.00	1.00
48	73.90	0.00	75.60	0.00	1.00
49	75.60	0.00	77.30	0.00	1.00
50	77.30	0.00	79.00	0.00	1.00
51	79.00	0.00	80.60	0.00	1.00
52	80.60	0.00	82.30	0.00	1.00
53	82.30	0.00	84.00	0.00	1.00

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8)

No.	DEPTH	ANGLE
1	6.0	0.0
2	15.0	0.0

NO-LOAD ZONE: V=21.0, H=0.25V, Angle 1=60.
TIEBACK: Adhesion=1 ksf Diameter=0.5 ft.

ACTIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	0.00	1.15	0.04	1.00
2	10.00	1.56	0.05	1.00
3	11.00	1.61	0.05	1.00
4	15.00	1.79	0.03	1.00
5	16.00	1.82	0.03	1.00
6	23.00	2.03	0.03	1.00
7	24.00	2.05	0.04	1.00
8	25.00	2.09	0.00	1.00
9	26.00	2.09	0.03	1.00
10	27.00	2.12	0.02	1.00
11	28.00	2.14	0.01	1.00
12	29.00	2.16	0.02	1.00
13	30.00	2.18	0.02	1.00
14	31.00	2.20	0.01	1.00
15	32.00	2.22	0.03	1.00
16	33.00	2.25	0.01	1.00
17	34.00	2.26	0.02	1.00
18	35.00	2.28	0.03	1.00
19	36.00	2.31	0.01	1.00
20	37.00	2.32	0.03	1.00
21	38.00	2.34	0.02	1.00
22	39.00	2.36	0.01	1.00
23	40.00	2.37	0.03	1.00
24	41.00	2.41	0.01	1.00

25	42.00	2.42	0.02	1.00
26	43.00	2.44	0.03	1.00
27	44.00	2.46	0.01	1.00
28	45.00	2.47	0.02	1.00
29	46.00	2.50	0.02	1.00
30	48.00	2.53	0.03	1.00
31	49.00	2.56	0.02	1.00
32	50.00	2.58	0.01	1.00
33	51.00	2.59	0.03	1.00
34	52.00	2.62	0.02	1.00
35	53.00	2.63	0.01	1.00
36	54.00	2.64	0.03	1.00
37	55.00	2.67	0.02	1.00
38	56.00	2.69	0.01	1.00
39	57.00	2.70	0.02	1.00
40	58.00	2.73	0.03	1.00

PASSIVE PRESSURE (BELOW EXCAV. BASE) Y - Depth from excavation base

No.	Y top	Top Pres.	Slope	Width
1	0.00	0.00	0.28	2.50
2	2.00	0.56	0.42	2.50
3	10.00	3.95	0.47	2.50
4	11.00	4.43	0.48	2.50
5	12.00	4.91	0.48	2.50
6	14.00	5.86	0.38	2.50
7	15.00	6.24	0.27	2.50
8	16.00	6.51	0.27	2.50
9	17.00	6.78	0.27	2.50
10	18.00	7.05	0.26	2.50
11	19.00	7.31	0.26	2.50
12	20.00	7.58	0.26	2.50
13	22.00	8.10	0.26	2.50
14	24.00	8.61	0.26	2.50
15	28.00	9.64	0.25	2.50
16	31.00	10.40	0.25	2.50
17	32.00	10.65	0.25	2.50
18	48.00	14.69	0.25	2.50
19	63.00	18.47	0.25	2.50

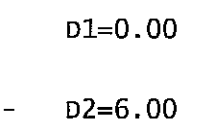
The pressure above will be divided by a Factor of Safety =2.0

**********CALCULATION**********

----------MULTIPLE BRACE / TIEBACK CASE----------

NUMBER OF BRACE LEVEL = 2

* CANTILEVER SPAN *



D1 - TOP DEPTH
D2 - BOTTOM DEPTH R2 - BOTTOM REACTION

TOTAL REACTION: R2 = 32.10
TOTAL PRESSURE ACTING ON WALL = 32.10
Total Reaction = Total Pressure, OK!
CANTILEVER MOMENT = 70.35 AT DEPTH = 6.00

```
BRACE NO.1 AT DEPTH = 6.00
    R2 of Cantilever Span
                              } Sum of Reaction = Brace Load = 76.34
    R1 of Span No.1
   Load of Brace 1 increased 15% to 87.79. Ref. Note 1.
```

* MIDDLE SPAN NO.1 *

```
      |<--   D1=6.00          R1=44.24
      |
      |
      |<--   D2=15.00          R2=28.71

     D1 - TOP DEPTH           R1 - TOP REACTION
     D2 - BOTTOM DEPTH        R2 - BOTTOM REACTION

TOTAL REACTION: R1+R2 = 72.95
TOTAL PRESSURE ACTING ON WALL = 72.95
   Total Reaction = Total Pressure,     OK!
PEEK MOMENT = 50.70  AT DEPTH =  11.47
```

```
BRACE NO.2 AT DEPTH = 15.00
    R2 of Span No.1
                                  } Sum of Reaction = Brace Load = 56.96
    R1 of Embedment Span
```

* EMBEDMENT SPAN *

```
      |<--   D1=15.00          R1=28.25
      |
   ==|==    D2=21.00
      |
      |      D3=29.59

     D1 - TOP DEPTH           R1 - TOP REACTION
     D2 - EXCAVATION BASE
     D3 - PILE TIP

TOTAL REACTION: R1 = 28.25
TOTAL PRESSURE ACTING ON WALL = 28.25
   Total Reaction = Total Pressure,     OK!
PEEK MOMENT = 51.09  AT DEPTH=  18.99
```

**********RESULTS**********

OVERALL MAXIMUM MOMENT = 70.35 AT DEPTH = 6.00
MINIMUM EMBEDMENT = 8.59
TOTAL MINIMUM PILE LENGTH = 29.59

BRACE, TIEBACK, OR DEADMEN ANCHOR (Spacing = 8)

No.	DEPTH	ANGLE	HORIZONTAL	VERTICAL	TOTAL LOAD
1	6.0	0.0	87.79	0.00	87.79
2	15.0	0.0	56.96	0.00	56.96

****

----------SPECIFIED PILE----------
Required Min. Section Modulus = 30.7 in3/feet, Fy=50 ksi=345 MPa, Fb/Fy=0.55

The pile selection is based on the magnitude of the moment only. Axial force is neglected. Ref. Note 3
Sx(in3) and Ix(in4) are per one foot of horizontal width of the pile

HP12X53 has been found in Soldier Pile list!
Area= 15.5 Depth= 11.78 Width= 12.045
Ix= 393 Sx= 66.8 Iy= 127 Sy= 21.1
Flange thickness= 0.435 Web thickness= 0.435

* Note: All the pile dimensions are in English Units.

----------SPECIFIED PILE END----------

HP12X53 is capble to support the shoring!
Top deflection = 0.07 in.

**********NOTES**********

1. Based on the references, the top brace in a multiple bracing system should be increased by 15% due to unexpected surcharge load and/or overstress of tieback. During installation of the 2nd brace, the load of the top brace will be increased as excavation needs to go beyond the elevation of the 2nd brace. Users have option to change it in Option Pages.

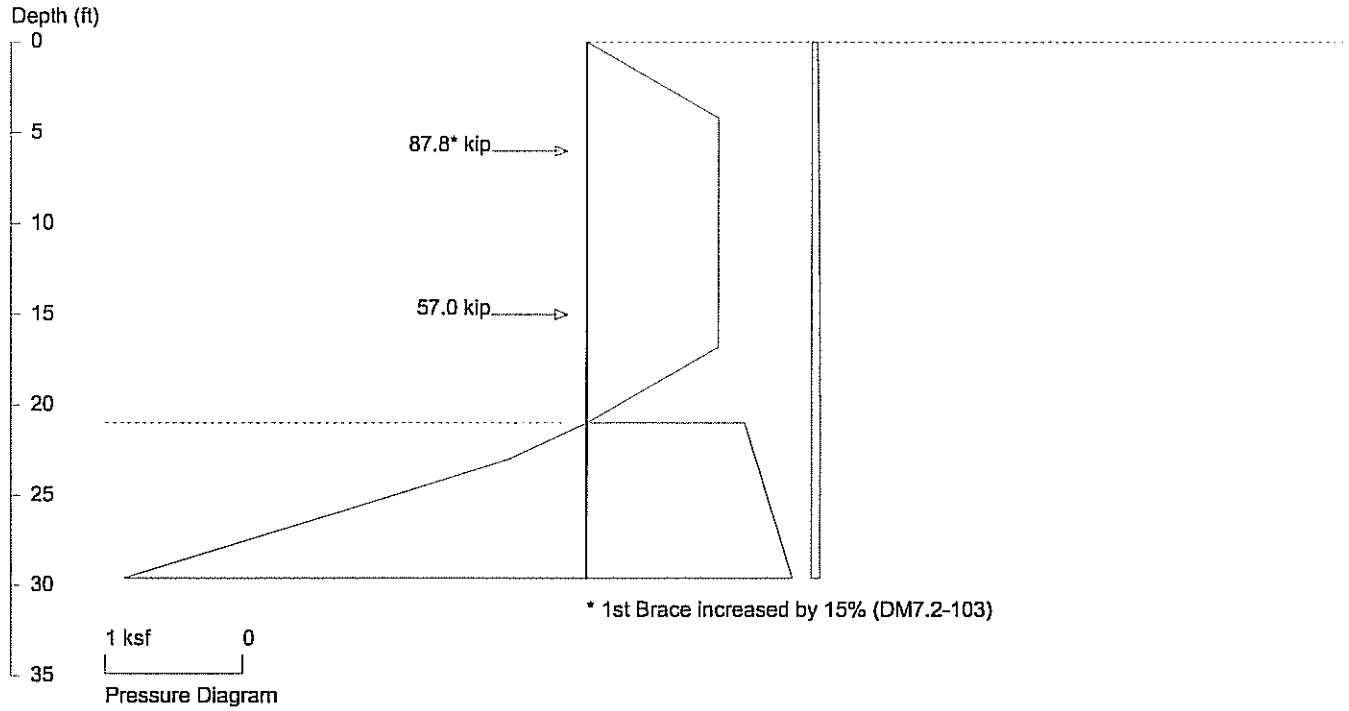
2. The calculated maximum moment is based on a single span. According to the references, the magnitude of moment can be reduced by as much as 80% in a continuous span. The reduction does not apply to cantilever and the next span.

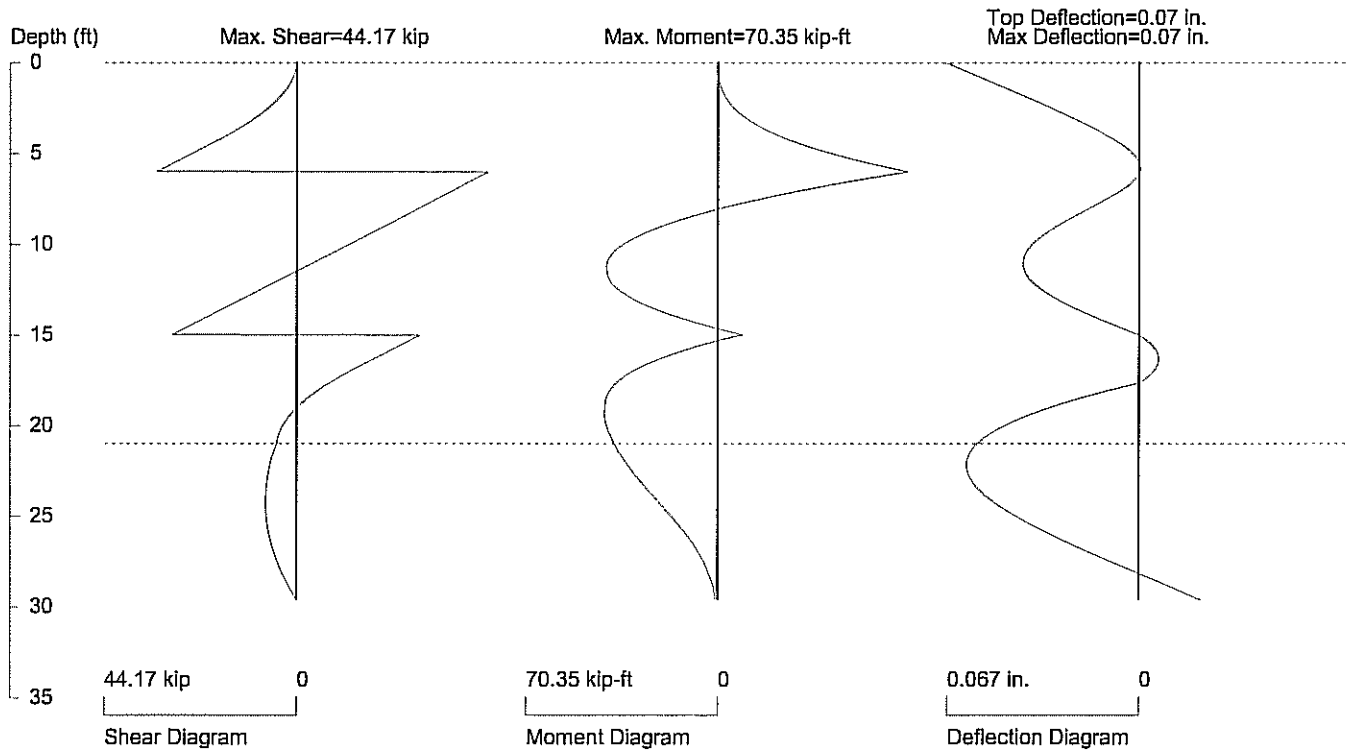
3. The pile selection is based on the moment only. The axial load from the tieback downdrag force is neglected when the downdrag force can be significantly reduced by the friction between the pile, soil, and lagging. However, if the downdrag is very large, it should be considered in your calculation.

**********END**********

Washington Street Interchange

35+50 Line "PR-DN" Right





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on one soldier pile or one foot spacing of sheet pile

Pile Properties: E (ksi) = 29000, I (in4) = 393

 File Name: G:\Documents\ENG\PROJECTS\American Consulting (00481)\00481.0159 (Washington Street Interchange)\shoring

APPENDIX E

SLOPE STABILITY CALCULATIONS (2)

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	03-29-06
Time of Run:	8:37am
Run By:	Shawn Marcum
Input Data Filename:	C:WASH1
Output Filename:	C:WASH1.OUT
Plotted Output Filename:	C:WASH1.PLT

PROBLEM DESCRIPTION Washington Street Interchange
Station 413+50 Line "5NS"
End of Construction (Undrained Conditions)

BOUNDARY COORDINATES

4 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.00	52.00	33.00	1
2	52.00	33.00	60.00	35.00	1
3	60.00	35.00	90.00	51.00	1
4	90.00	51.00	150.00	51.00	1
5	.00	28.00	150.00	28.00	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	1000.0	.0	.00	.0	0
2	130.0	130.0	.0	36.0	.00	.0	0

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	91.00	149.00	200.0	.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 20.00 ft.
and X = 55.00 ft.

Each Surface Terminates Between X = 90.00 ft.
and X = 120.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.00	33.75

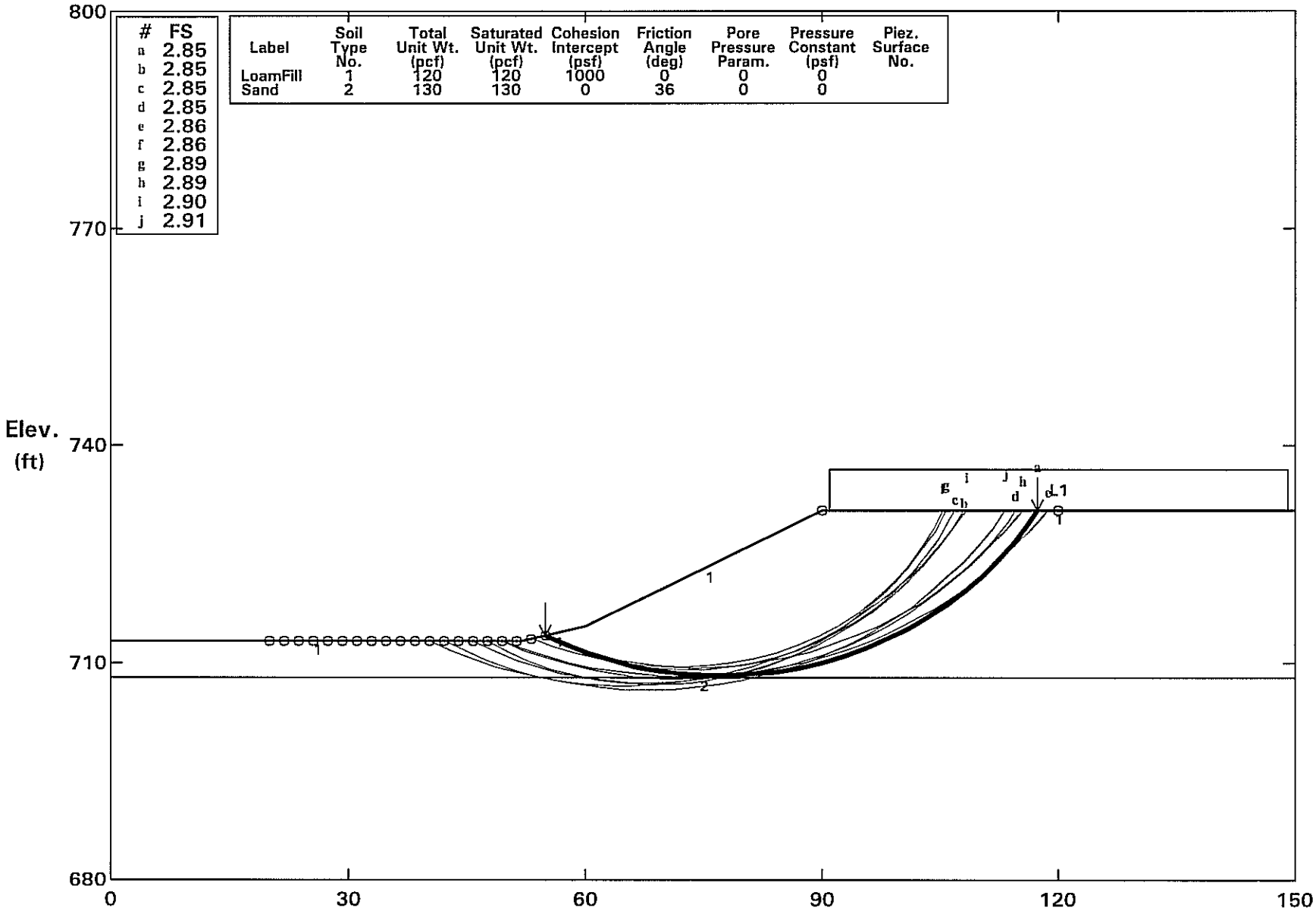
2	57.69	32.43
3	60.47	31.28
4	63.31	30.32
5	66.20	29.53
6	69.14	28.93
7	72.11	28.52
8	75.10	28.30
9	78.10	28.27
10	81.10	28.43
11	84.08	28.78
12	87.03	29.32
13	89.94	30.04
14	92.80	30.95
15	95.60	32.04
16	98.32	33.31
17	100.95	34.74
18	103.49	36.34
19	105.92	38.10
20	108.23	40.01
21	110.42	42.06
22	112.48	44.25
23	114.39	46.56
24	116.14	48.99
25	117.41	51.00

Circle Center At X = 77.1 ; Y = 75.4 and Radius, 47.2

*** 2.846 ***

Washington Street Interchange Station 413+50 Line "5NS"

Ten Most Critical. C:WASH1.PLT By: Shawn Marcum 03-29-06 8:37am



STABL6H FSmin = 2.85 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	03-28-06
Time of Run:	4:08pm
Run By:	Shawn Marcum
Input Data Filename:	C:WASH2
Output Filename:	C:WASH2.OUT
Plotted Output Filename:	C:WASH2.PLT

PROBLEM DESCRIPTION Washington Street Interchange
Station 413+50 Line "5NS"
Long Term (Drained Conditions)

BOUNDARY COORDINATES

4 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.00	52.00	33.00	1
2	52.00	33.00	60.00	35.00	1
3	60.00	35.00	90.00	51.00	1
4	90.00	51.00	150.00	51.00	1
5	.00	28.00	150.00	28.00	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	75.0	28.0	.00	.0	0
2	130.0	130.0	.0	36.0	.00	.0	0

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	91.00	149.00	200.0	.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 35.00 ft.
and X = 75.00 ft.

Each Surface Terminates Between X = 90.00 ft.
and X = 120.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 16 Coordinate Points

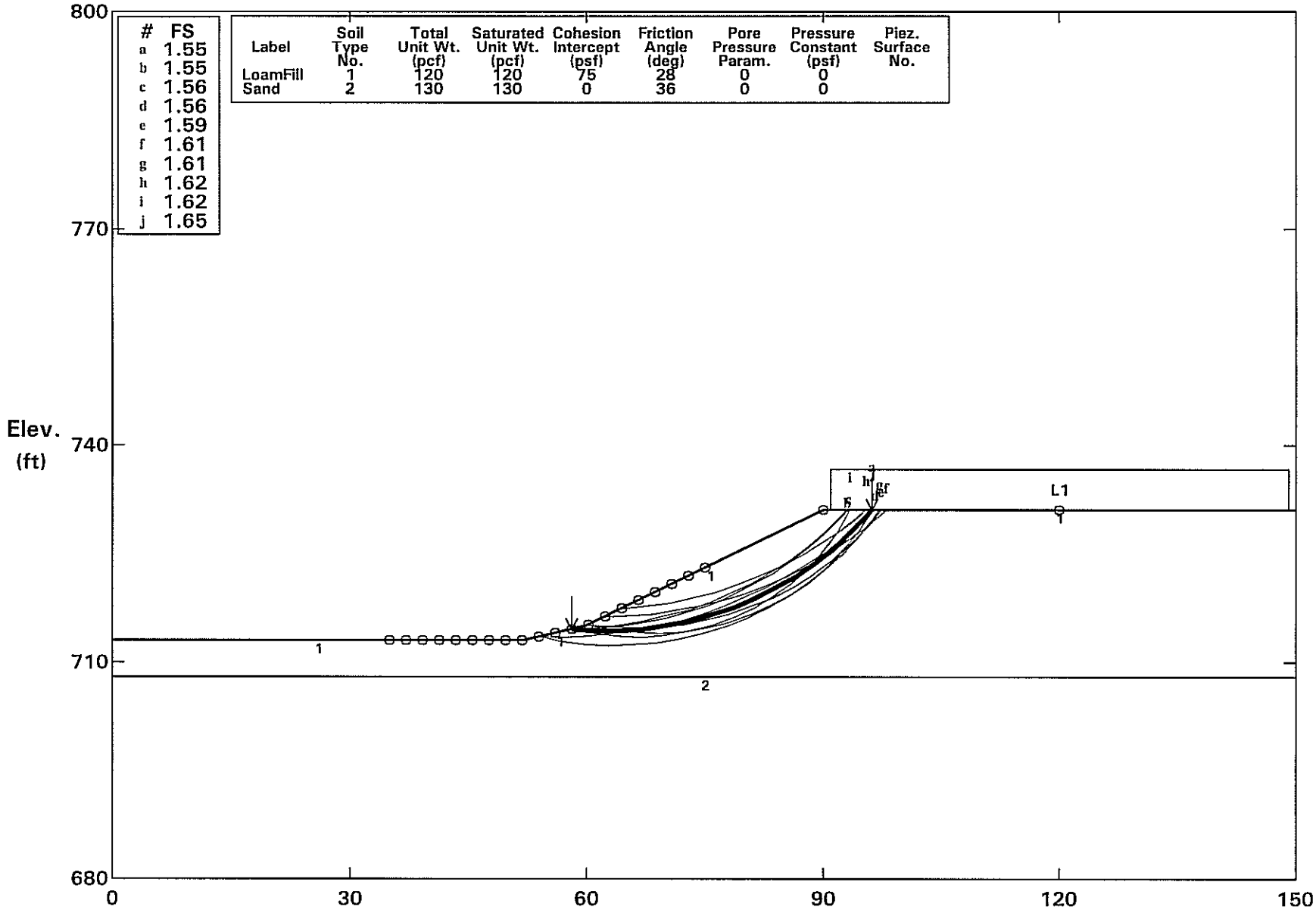
Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.16	34.54
2	61.15	34.34
3	64.15	34.35
4	67.14	34.57
5	70.11	35.00
6	73.04	35.64
7	75.92	36.49
8	78.73	37.55
9	81.46	38.79
10	84.09	40.23
11	86.61	41.85
12	89.02	43.65
13	91.29	45.61
14	93.41	47.73
15	95.38	49.99
16	96.14	51.00

Circle Center At X = 62.5 ; Y = 76.6 and Radius, 42.3

*** 1.551 ***

Washington Street Interchange Station 413+50 Line "5NS"

Ten Most Critical. C:WASH2.PLT By: Shawn Marcum 03-28-06 4:08pm



STABL6H FSmin = 1.55 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	03-28-06
Time of Run:	10:01am
Run By:	Shawn Marcum
Input Data Filename:	C:WASH3
Output Filename:	C:WASH3.OUT
Plotted Output Filename:	C:WASH3.PLT

PROBLEM DESCRIPTION Washington Street Interchange
Station 394+50 Line "6NS"
End of Construction (Undrained Conditions)

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	27.00	23.00	27.00	1
2	23.00	27.00	35.00	31.00	1
3	35.00	31.00	90.00	31.00	1
4	90.00	31.00	115.00	43.00	1
5	115.00	43.00	145.00	53.00	1
6	.00	22.00	23.00	22.00	2
7	23.00	22.00	35.00	26.00	2
8	35.00	26.00	90.00	26.00	2
9	90.00	26.00	115.00	33.00	2
10	115.00	33.00	145.00	40.00	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	120.0	120.0	1000.0	.0	.00	.0	0
2	125.0	125.0	2500.0	.0	.00	.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 40.00 ft.
and X = 95.00 ft.

Each Surface Terminates Between X = 114.00 ft.
and X = 144.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 22 Coordinate Points

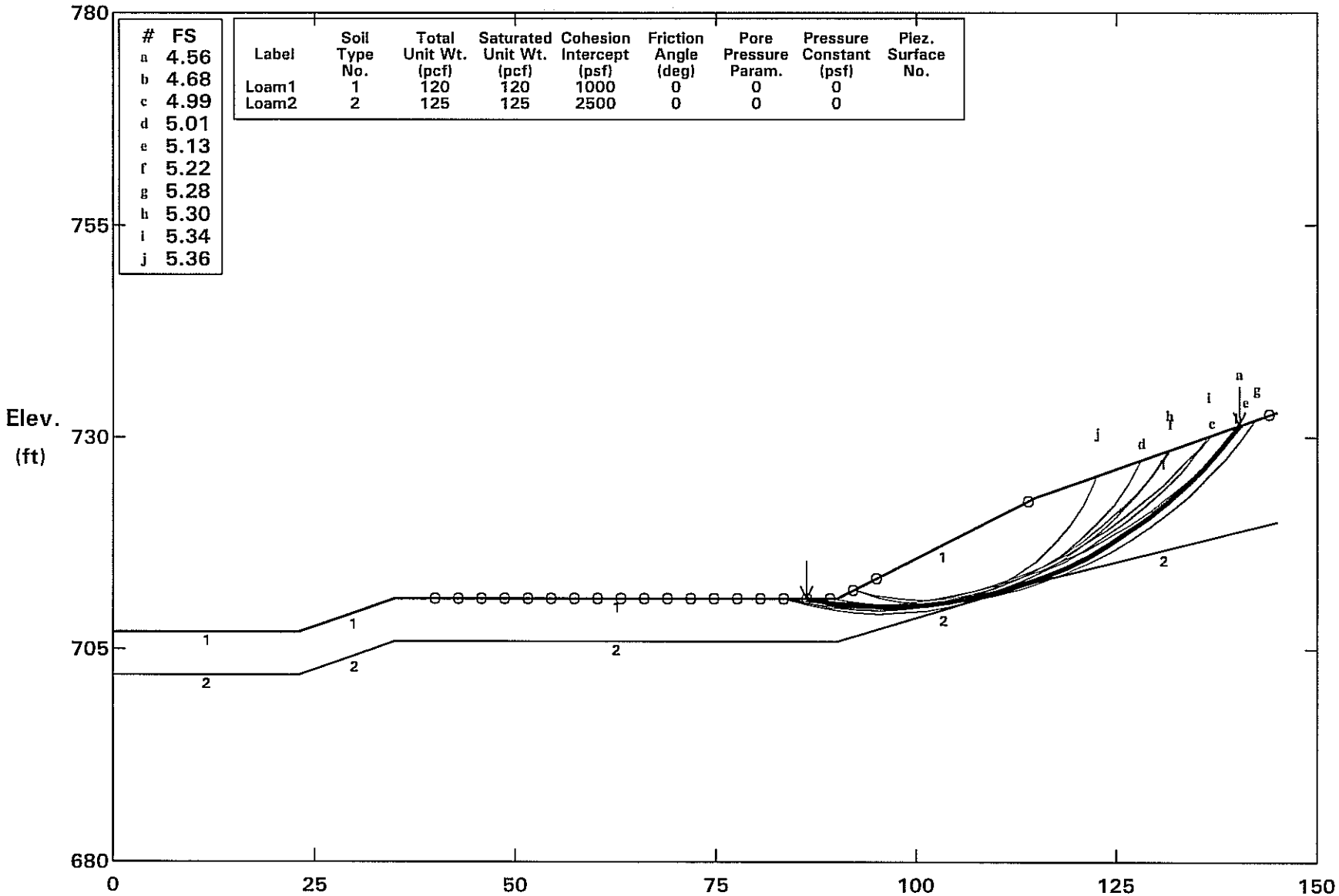
Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.32	31.00
2	89.28	30.54
3	92.26	30.23
4	95.26	30.09
5	98.26	30.11
6	101.26	30.29
7	104.24	30.63
8	107.19	31.13
9	110.12	31.78
10	113.01	32.60
11	115.85	33.56
12	118.63	34.68
13	121.35	35.95
14	124.00	37.36
15	126.57	38.91
16	129.05	40.60
17	131.44	42.42
18	133.72	44.36
19	135.90	46.42
20	137.96	48.60
21	139.91	50.88
22	140.34	51.45

Circle Center At X = 96.4 ; Y = 85.9 and Radius, 55.8

*** 4.556 ***

Washington Street Interchange Station 394+50 Line "6NS"

Ten Most Critical. C:WASH3.PLT By: Shawn Marcum 03-28-06 10:01am



STABL6H FSmin = 4.56 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	03-28-06
Time of Run:	4:11pm
Run By:	Shawn Marcum
Input Data Filename:	C:WASH4
Output Filename:	C:WASH4.OUT
Plotted Output Filename:	C:WASH4.PLT

PROBLEM DESCRIPTION Washington Street Interchange
Station 394+50 Line "6NS"
Long Term (Drained Conditions)

BOUNDARY COORDINATES

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	27.00	23.00	27.00	1
2	23.00	27.00	35.00	31.00	1
3	35.00	31.00	90.00	31.00	1
4	90.00	31.00	115.00	43.00	1
5	115.00	43.00	145.00	53.00	1
6	.00	22.00	23.00	22.00	2
7	23.00	22.00	35.00	26.00	2
8	35.00	26.00	90.00	26.00	2
9	90.00	26.00	115.00	33.00	2
10	115.00	33.00	145.00	40.00	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.

1	120.0	120.0	75.0	28.0	.00	.0	0
2	125.0	125.0	100.0	28.0	.00	.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 40.00 ft.
and X = 95.00 ft.

Each Surface Terminates Between X = 114.00 ft.
and X = 144.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 22 Coordinate Points

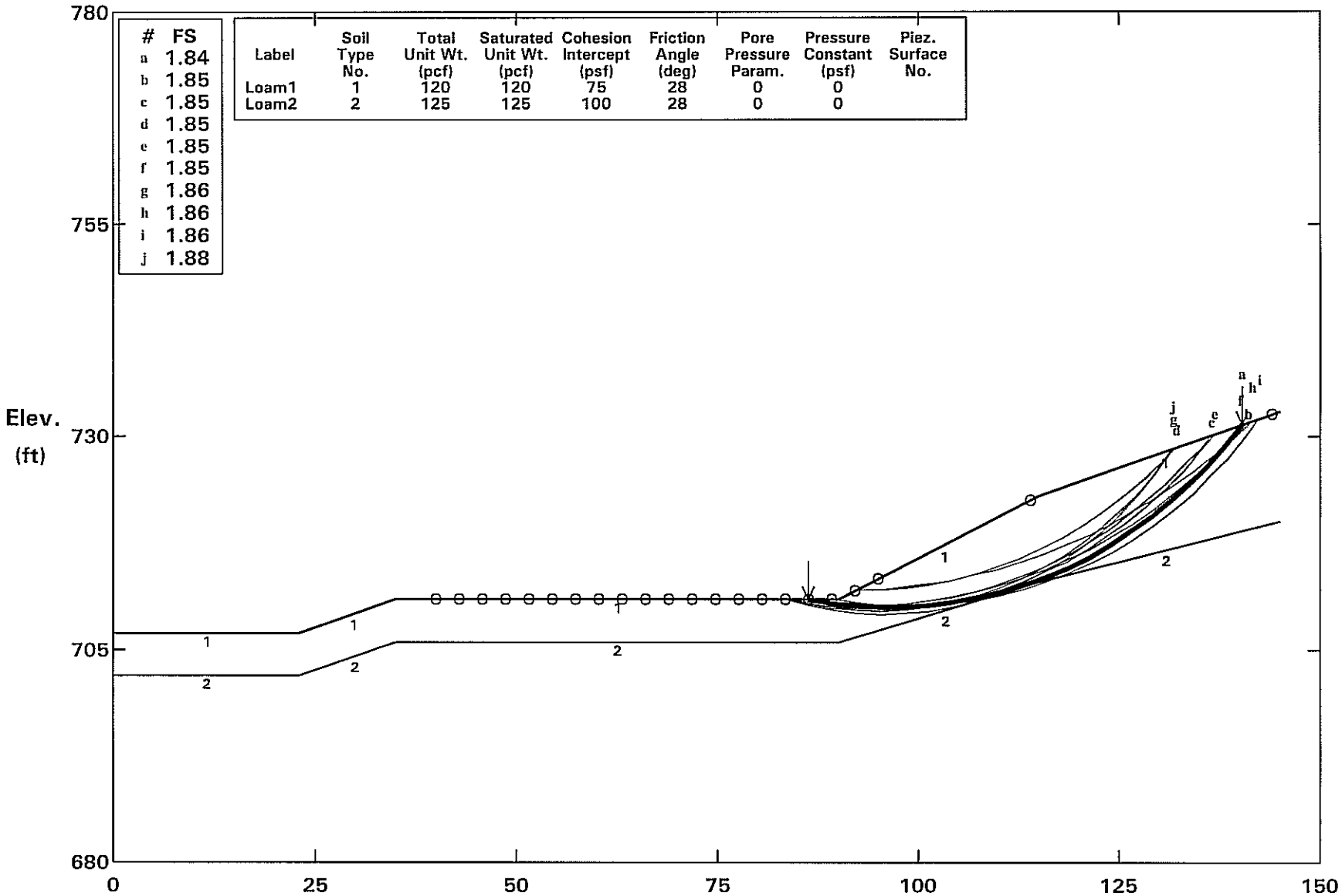
Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.32	31.00
2	89.28	30.54
3	92.26	30.23
4	95.26	30.09
5	98.26	30.11
6	101.26	30.29
7	104.24	30.63
8	107.19	31.13
9	110.12	31.78
10	113.01	32.60
11	115.85	33.56
12	118.63	34.68
13	121.35	35.95
14	124.00	37.36
15	126.57	38.91
16	129.05	40.60
17	131.44	42.42
18	133.72	44.36
19	135.90	46.42
20	137.96	48.60
21	139.91	50.88
22	140.34	51.45

Circle Center At X = 96.4 ; Y = 85.9 and Radius, 55.8

*** 1.838 ***

Washington Street Interchange Station 394+50 Line "6NS"

Ten Most Critical. C:WASH4.PLT By: Shawn Marcum 03-28-06 4:11pm



STABL6H FSmin = 1.84 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

APPENDIX F

CBR TESTS RESULTS (1)

CBR TEST RESULTS

(AASHTO T-193)

INDIANA DEPARTMENT OF TRANSPORTATION

Proposed Washington Street Interchange
Indianapolis, Indiana
INDOT Project No. IN 55 (001)
Des. Nos. 0401228
ATC Project No. 86.00481.0159

Boring Number RB-16

Station ..... 391+00 "PR-6NS"

Sample Depth ..... 1.0 - 5.0 ft

Sample Description ..... Loam, A-4

Maximum Dry Density ..... 124.7 lbs/ft^3

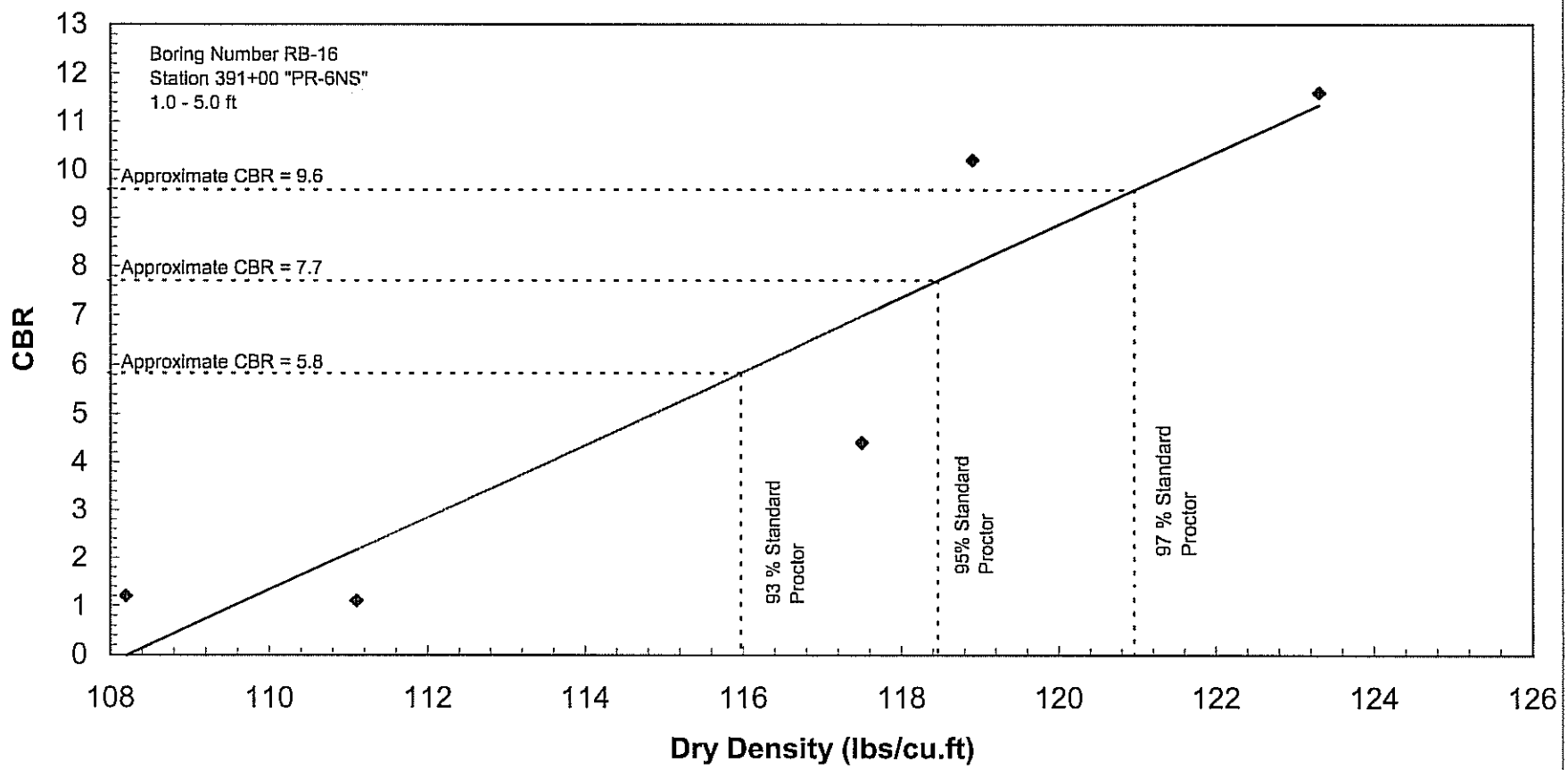
Optimum Moisture Content ..... 10 %

Surcharge Weight for Soaking ..... 0.11 kN (25 lbs)

Specimen	As Molded Water Content, %	Water Content After Soaking, %	Initial Dry Density, lbs/ft^3	Percent Maximum Dry Density	Swell, %	CBR, % at 0.1 inch Penetration	CBR, % at 0.2 inch Penetration
1	10.0	17.1	108.2	86.8	0.39	1.2	1.1
2	10.9	16.6	111.1	89.1	0.28	1.1	1.3
3	10.5	12.5	117.5	94.2	0.13	4.4	3.9
4	10.1	13.6	118.9	95.3	0.13	10.2	7.9
5	10.1	11.8	123.2	98.8	0.04	16.5	16.5
6	9.9	11.6	123.3	98.8	0.00	11.6	10.8

California Bearing Ratio Test Results

Proposed Washington Street Interchange
Indianapolis, Indiana
INDOT Project No. IN 55 (001)
Des. Nos. 0401228
ATC Project No. 86.00481.0159



APPENDIX G

SPECIAL PROVISIONS (TIEBACKS)

TIEBACK CONTRACTOR QUALIFICATIONS

Prior to the commencement of tieback work, the Contractor shall submit to the project engineer a report which identifies the Contractor's personnel who will be performing and supervising the tieback work. The report shall include the names of an engineer-in-charge, on-site supervisors, and drill operators. The report shall also contain a list of employers' names and telephone numbers, location and dates of previous permanent tieback projects, and the extent of work performed. This information must be verifiable. Tieback work shall be defined as all activities related to the tiebacks, including furnishing, fabricating, drilling, installing, and testing the tiebacks.

ENGINEER-IN-CHARGE. The engineer-in-charge shall be a registered professional engineer and shall be responsible for overseeing the tieback work and verifying the results of the tieback testing. The engineer-in-charge shall have three (3) years of construction experience in the installation of permanent tieback and shall have overseen the successful installation of 100 permanent tiebacks. The work experience time period is computed by the addition of all documented durations of tieback work time on construction projects.

ON-SITE SUPERVISORS. An on-site supervisor shall be present at the job site at all times during the performance of tieback work. The on-site supervisor shall have one (1) year of construction experience in the installation of permanent tiebacks and shall have supervised the successful installation of 100 permanent tiebacks. The work experience time period is computed by the addition of all documented durations of tieback work time on construction projects.

DRILL OPERATORS. Drill operators shall have successfully installed a minimum of 50 permanent tiebacks and have 2 years experience with permanent tieback installation.

The project engineer will approve or reject the Contractor's personnel with thirty (30) calendar days following the submission of the report of names and verifiable resume information. Tieback work shall not commence until a written letter of approval has been provided by the project engineer. In the event the Contractor elects to substitute personnel, verifiable resume information shall be submitted to the project engineer prior to that individual's performance of tieback work. The project engineer will approve or reject the Contractor's proposed substitute within fifteen (15) calendar days.

In addition to the above, the project engineer may take any action afforded to him pursuant to INDOT Specifications in order to be assured that all personnel have the sufficient and requisite skill and experience to perform properly the work assigned to them.

TIEBACKS

DESCRIPTION. This work shall consist of furnishing and installing permanent tiebacks constructed in accordance with these provisions and in reasonably close conformity with the lines, grades, design requirements, details and dimensions shown on the plans or otherwise directed. The tieback work to be performed shall comply with the latest edition of "Recommendations for Prestressed Rock and Soil Anchors" Published by the Post Tensioning Institute located at 301 W. Osborn, Suite 3500, Phoenix, Arizona, 85013 (Telephone 601-265-9158) and FHWA-DP-68-IR, "Permanent Ground Anchors" (latest edition) except as modified herein. Reference shall also be made to "Tiebacks" FHWA/Rd-82/047, Federal Highway Administration, Washington, D.C., July 1982.

DEFINITIONS. The definitions of the various components and procedures of the tieback system are provided below.

a) **Tieback.** A structural system which uses an anchor in the ground to secure a tendon which applies a force to a structure. The tieback is composed of a tendon (bar or strand), grout, sheathing, corrosion inhibitor coating, anchor head, bearing plate, trumpet, spacers, and centralizers.

b) **Anchor.** The portion of the tieback system that transmits the tensile force in the prestressing steel to the ground. The anchor generally consists of two components: 1) The tendon and 2) the anchor grout.

c) **Tendon.** The prestressing steel (bar or strand) and anchorage and also the sheathing and coating when required.

d) **Anchorage.** The anchor head and bearing plate which transfer the tension force in the tendon to the structure.

e) **Sheathing.** Enclosure around the unbonded length of the prestressing steel to prevent the prestressing steel from bonding to the surrounding grout and to provide corrosion protection.

f) **Coating.** Material used to protect against corrosion and/or lubricate the prestressing steel in the unbonded length.

g) **Anchor Grout.** (Primary Grout). Material that is injected into the anchor hole to cover the anchor length of the tendon and provide the medium for transmitting the tendon tensile force to the ground within the bond length.

h) **Secondary Grout.** Material that is injected into the anchor hole to cover the stressing length of the tendon to provide corrosion protection.

i) **Anchor Length.** (Tendon Bond Length). The length of the tieback system where the tensile force in the tendon is transferred to the ground.

j) **Unbonded Length.** The length of the tieback system which is free to elongate and is located between the anchor head and tendon bond length.

k) **Jacking Length.** The length of the prestressing steel which is located on the jacking side of the final anchorage position and tensioned during the stressing of the tendon.

l) **Unbonded Testing Length (Stressing Length).** The sum of the unbonded length and the jacking length which is equal to the length of the tendon that is free to elongate elastically during stressing.

m) **Design Load.** Anticipated final maximum effective load in the anchor after allowance for time dependent losses or gains. Design loads are shown in the tieback table in the plans.

n) **Proof Load.** Temporary prestressing load in an anchor at a force level greater than its design load for testing purposes.

o) **Transfer (Lock-Off) Load.** Prestressing force in an anchor after proof loading immediately after the force has been transferred from the jack to the stressing anchorage.

p) **Alignment Load.** The nominal load maintained on an anchor during testing to assure that the testing equipment remains in proper position.

q) **Proof Test.** An anchor load test that requires the application of defined incremental loads to the anchor tendon. The movement of the tendon is recorded at each load increment.

r) **Performance Test.** This load test requires the application of defined incremental loading and unloading of the anchor tendon. The movement of the tendon is recorded at each loading and unloading increment. The maximum load applied during this test is maintained constant for a defined time period while movements are recorded.

s) **Creep Test.** The loading and unloading increments for this test are the same as used for a performance test. The movement of the tendon is recorded at each loading and unloading increment and the movement of the tendon is also recorded for a defined extended time period while maintaining certain load increments.

t) **Creep Movement.** The time dependent movements of the tieback at a constant load.

u) **Creep Curve.** A semilogarithmic plot of creep movement versus times with the units of time plotted on the logarithmic axis.

v) **Creep Rate.** The slope of the creep curve per log cycle of time.

w) **Minimum guaranteed ultimate strength (GUTS).** The minimum guaranteed breaking load of the tendon as defined in the pertinent ASTM Specification for tendon material.

x) **Initial Lift-Off Reading.** A check made to determine that the actual transfer load is within 5% of the desired transfer load. This check is made immediately after transferring the load to the stressing anchorage.

MATERIALS. The materials shall be in accordance with the requirements shown below. The Contractor shall make arrangements to provide for the complete tieback system, cement grout, and all other incidentals necessary to complete the work.

a) **Bar Type Tendon.** Steel bars shall conform to the requirements of ASTM A722 "Uncoated High Strength Bars for Prestressed Concrete".

b) **Strand Type Tendon.** The strand shall conform to the requirements of ASTM A416 "Uncoated Seven Wire Stress-Relieved Steel Strand for Prestressed Concrete" or to Compact Strand requirements as per ASTM 779 "Uncoated Seven Wire Compacted Stress-Relieved Steel Strand for Prestressed Concrete".

c) **Sheathing.** The sheath (bond breaker) shall be either a Polyvinylchloride (PVC), Polyethylene, or polypropylene pipe or tube. The sheath may surround the individual prestressing steel elements or the entire prestressing steel. The material shall be capable of withstanding damage during shipping, handling and installation. The sheath shall have a minimum wall thickness of 0.04 inches (1mm). The material is subject to the approval of the Engineer. PVC pipe or tube shall conform to the requirements of ASTM D3915. Polypropylene pipe or tube shall be designation Type II 26500D and conform to the requirements of ASTM D-2146. Polyethylene pipe or tube shall be high density polyethylene cell classification334413 and conform to the requirements of ASTM D-3350.

d) **Corrosion Inhibitor Coating.** The coating shall consist of a grease film compound to provide both corrosion inhibiting properties and lubricating properties. Corrosion inhibitor coating requirements shall be as follows:

- Drop Point; 300 Degrees Fahrenheit Minimum in conformity with ASTM D-566 or ASTM D-2265.
- Flash Point; 300 Degrees Fahrenheit Minimum in conformity with ASTM D-92.
- Water Content; 0.1% Maximum in conformity with ASTM D-95.
- Oil Separation; 0.5% by weight maximum at 160 degrees Fahrenheit in conformity with FTMS 791B, Method 321.2.
- Corrosion Test; 5% Salt Fog at 100 degrees Fahrenheit. 5 mils (Q panel Type S).

Normal Conditions: Rust Grade 7 or better after 720 hours.
Aggressive Conditions: Rust Grade 7 or better after 1000 hours.
Corrosion test to be performed in accordance with ASTM B-117 and ASTM D-610.

- Soak Test; 5% Salt Fog at 100 degrees Fahrenheit. 5 mils (Q panel Type S). Immerse panels in 50% salt solution and expose to 5% salt fog. No emulsification after 720 hours in conformity with ASTM B-117 Modified. Water Soluble.
  Ions: Chlorides – 10 ppm Max. by ASTM D-512
  Nitrates – 10 ppm Max. by ASTM D-992
  Sulfides – 10 ppm Max. by APHA 427D (15th Edition)

- Sheathing Hardness and Volume Change; 10% maximum for volume, 15% maximum for hardness after 40 days at 150 degrees Fahrenheit in conformity with ASTM D4289. Sheathing tensile strength change 30% maximum after 40 days at 150 degrees Fahrenheit in conformity with ASTM D-638.

e) **Bearing Plate.** The bearing plate shall be in accordance with 711.

f) **Anchor Head.** The anchor head shall be in accordance with 711.

g) **Centralizers.** Centralizers shall be fabricated from a plastic material which is nondetrimental to the prestressing steel.

h) **Grout.** Cement anchor grout (primary grout) shall consist of a pumpable mixture. The cement shall be a Type I, Type II, or Type III conforming to ASTM C150. The grout shall conform to the applicable requirements of 702. Grout additives may be used provided the Contractor submits information concerning the grout additive and obtains approval from the Engineer. Chemical additives that are non-detrimental to the prestressing steel which can control bleed, and/or retard set may be used in the anchor grout.

i) **Trumpet.** The trumpet shall be made of steel or plastic.

j) **Spacers.** Spacers shall be fabricated from a plastic material which is nondetrimental to the prestressing steel.

GENERAL CONSTRUCTION REQUIREMENTS. The Contractor shall be responsible for determining the anchor bond length and anchor diameter necessary to develop adequate load capacity to satisfy anchor testing acceptance criteria for the design load shown in the plans. The anchor bond lengths, anchor diameter, and other related tieback items are the calculated dimensions and recommended details from the preliminary design. The details and dimension relating to the tieback system shown on the plans are for information only. The Contractor shall use his expertise to determine tendon type, drilling method, grouting pressures, multiple grouting techniques, bonded lengths variations such as undereaming or belling anchor diameters, etc. The Contractor

shall provide a tieback system as per the limitations and requirements defined in this provision and as shown on the plans.

Tieback anchors shall not extend beyond the project right-of-way or perpetual easement provided for this purpose.

The Contractor has the option of providing two closely spaced tiebacks with approximately one-half the full design load of single tieback. The anchor zones shall be more than 5 ft. (1.5 m) apart. For design purposes, the grout/rock bond stress may be assumed to be 25 psi.

The Contractor shall determine the anchor length necessary to satisfy anchor testing acceptance criteria except that the minimum anchor length shall be 24.8 feet (7.57 m). Where the anchors penetrate the bedrock, the distance between them shall not be less than 5 ft (1.5 m).

The tiebacks shall be installed at the angle shown on the plans. Tiebacks which are installed at an angle which varies from the plan value may require adjustments to the design load value such that the required horizontal force component is acceptable.

Couplers shall not be used unless permission has been granted by the Engineer. The ultimate capacity of the couplers shall not be less than the GUTS of the tendon.

The physical dimensions of the anchorage components shall be suitable for transferring the tension force in the tendon to the proposed caisson. The ultimate capacity of the anchorage shall not be less than 95 percent of the GUTS of the tendon.

A trumpet shall be used to make the transition from the bearing plate to the protection over the unbonded length. A tight fitting seal shall be provided at the end of the trumpet. The trumpet shall be completely filled with anticorrosion grease or grout.

TENDON CONSTRUCTION REQUIREMENTS. The Contractor shall furnish and install a tendon size which when tensioned to the tieback design load, the loading does not tension the tendon beyond 60 percent of the GUTS of the tendon and the tendon when tensioned to the maximum test load (1.33 times the tieback design load), the loading does not tension the tendon beyond 80 percent of the GUTS.

Tendons shall be shop fabricated. The bond length shall be clean. The unbonded length of the tendon shall have the grease and sheath installed at the shop. The grease (corrosion inhibitor) shall fill all space between strand wires or bar and the sheathing. Tendons shall be stored and handled in such a manner as to avoid damage or corrosion. Prestressing steel shall be protected from dirt, rust, or deleterious substances. (A light coating of rust on the steel will not affect the function of the tendon.) Corrosion or pitting is cause for tendon rejection. If the Engineer is uncertain about the extend of the corrosion, the steel shall be tested, at the Contractor's expense, to determine if the tendon still meets the appropriate ASTM Specification.

GROUT CONSTRUCTION REQUIREMENTS. The Contractor shall furnish and install the grout in accordance with the following requirements unless otherwise directed.

Anchor grout placement by tremie method or pressure grouting are acceptable methods of grout placement.

The grouting equipment shall be sized to enable the tieback to be grouted in one continuous operation. Neat cement grouts should be screened to remove lumps. The maximum size of the screen openings shall be 0.250 inches (6 mm). Mixing and storage times should not cause excessive temperature buildup in the grout. The mixer should be capable of continuously agitating the grout even if grout admixtures are used.

The anchor grout shall be injected at the lowest point of the tieback. The grout may be placed using grout tubes, casing or drill roads. The grout can be placed before or after insertion of the tendon. The quantity of the grout shall be recorded. The grout takes shall be controlled to prevent excessive ground heave.

The tieback shall remain undisturbed for a minimum of three days or until the grout has cured to a cube strength of 3,500 psi.

The Contractor shall provide the Engineer with his proposed grout mix design and shall include documentation by appropriate standard test results which indicate that the proposed mix will develop a 7-day compressive strength which is greater than 3,500 psi (AASHTO T 106). Grout water/cement ratio shall be between 0.35 and 0.45.

Generally, strength testing of the grout will not be required during construction of the tieback because proof-testing of the tieback will verify the performance of the grout at part of the overall tieback system. The engineer may request that the Contractor perform a standard compression strength test(s) on grout samples obtained from the initial installation of the tiebacks. Compression strength tests will be required if additional admixtures are used or irregularities occur in grout consistency and/or tieback testing results. (AASHTO T 106).

TIEBACK INSTALLATION CONSTRUCTION REQUIREMENTS. The Contractor shall install the tiebacks in accordance with the following requirements unless otherwise directed.

Auger drilling, rotary drilling or percussion-driven casing may be used to install tieback systems. Installation of tiebacks may require drilling through new concrete, old concrete, earth, and shale. In the bonded anchor zone rotary percussion drills shall be used. No water shall be used in drilling the anchor bond length hole. Drill and clean with air only. The specialty contractor shall determine the appropriate installation methods. The centerline of the hole for the tendon shall be located within three inches of the plan location.

Installation of tiebacks shall be in accordance with the overall project sequence of construction.

Centralizers shall position the tendon in the drill hole such that a minimum of 0.5 inch (12 mm) of grout cover is provided for the full length of the tendon. The spacing of the centralizers shall not exceed 10 feet (3.0 m). Spacers shall be used to separate elements of multi-element tendons. A combination centralizer-spacer can be used.

REPORT OF TIEBACK INSTALLATION. The Contractor shall submit a Final Report of Tieback Installation to the Engineer. The Contractor shall furnish to the Engineer three copies of a bound and typed Final Report containing the following information:

1. A tabulation of data from all tieback testing.
2. Type of instrumentation used for conducting testing.
3. Testing procedures.
4. Plates of all graphical test date.
5. Contractor's general opinion of plans and specifications.
6. Construction procedures.
7. Grouting records.
8. Construction difficulties and/or special techniques.

METHOD OF MEASUREMENT. Tiebacks will be measured by the number of acceptable tiebacks per design load, installed complete in place.

BASIS OF PAYMENT. The accepted quantities of "Tiebacks" will be paid for at the contract unit price per each complete in place. Payment shall include all labor, equipment, tendon, grout, corrosion protection, anchorage, trumpet, centralizers, spacers, final pocket grout, and final report of tieback installation and other miscellaneous items necessary to complete the work.

TIEBACK SYSTEM TESTING

DESCRIPTION. The Contractor shall load test each tieback as described in the provision unless otherwise directed. The Contractor is responsible for all testing and preparation of a final report as outlined herein.

CONSTRUCTION REQUIREMENTS. A calibrated hydraulic jack and pump shall be used to load the tendon. The jack and pump shall be calibrated as a unit. The Contractor shall submit the calibration curve to the Engineer for approval prior to performing any tests. Each load increment shall be totally applied in less than 60 seconds after the jack pump is started. All observation time periods begin when the jack pump is started. The total and creep movements of the anchor shall be measured to the nearest 0.001 inch (.025 mm) with a dial indicator. The dial indicator shall be supported on a reference independent of the anchor structure.

All jacks, pumps, load cells, dial gauges and other instruments used to measure load and deflection of the tieback system shall be accompanied by documented verification of the calibration of the gauges and devices. The calibration shall have been obtained within the past year and shall have been verified by reliable testing agency equipped to do the required calibrating. The Engineer shall be furnished with all appropriate documentation. A calibrated mastergage shall be kept on the site to at least once a day check the test gauge.

Before tieback testing operations may begin on a tieback, lagging panel installation and backfill placement and compaction shall be completed to a level no less than 5 ft. (1.5 m) above the level of the adjacent tieback. This criteria does not apply within areas of the project in which the lagging panel installation does not extend to a depth within 5 ft. (1.5 m) of the tieback location.

Testing shall not be performed until after the anchor grout has cured for 3 days or until the grout has cured to a curb strength of 3500 psi.

Each tieback system shall be load tested in accordance with the following:

1) **Creep Test** – Creep tests shall be conducted on the first two tiebacks installed or as directed. Creep tests shall be conducted by incrementally loading, holding the load, measuring movement and unloading the tieback and recording the movements as per the following loading sequence:

   P = Tieback design load for production anchor
   AL = Alignment load which is normally between 2 and 10 percent of the design load.

1.	AL	11.	0.25P	21.	0.25P
2.	0.25P	12.	0.50P	22.	0.50P
3.	AL	13.	0.75P	23.	1.00P
4.	0.25P	14.	1.00P	24.	1.20P
5.	0.50P	15.	AL	25	1.33P
6.	AL	16.	0.25P	26.	1.20P
7.	0.25P	17.	0.50P	27.	1.00P
8.	0.50P	18.	1.00P	28.	LOCK-OFF
9.	0.75P	19.	1.20P		
10.	AL	20.	AL		

Loading 2, 5, 9, 14, 19, and 25 shall be maintained constant for the following holding periods respectively: 10, 30, 30, 45, 60, and 300 minutes. All other loads shall be held until movement stabilizes (approximately one minute). During the holding periods the movements shall be recorded at each of the following elapsed times: 0, 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes.

Care must be taken to assure that the applied loads are maintained constant during the holding periods. A load cell shall be used to monitor the applied loads during the holding periods. The total movement and residual anchor movement shall be plotted as a function of load. A creep curve showing the creep movement for each load increment shall be plotted as a function of the logarithm of time.

The creep – tested tieback is acceptable if the measured elastic movements exceed 0.80 of the theoretical elongation of the unbonded length plus the jacking length at the maximum test load; and the creep curve plotted from the movement data indicates a creep rate of less than 0.08 inches per log cycle of time during the final log cycle.

2) **Performance Test** – Performance tests shall be performed on the third and fourth tieback installed or as directed. In addition, performance tests shall be performed on 7 percent of the remaining tiebacks or as directed. Performance tests shall be conducted by incrementally loading and unloading the tieback and recording the movements as per the following loading sequence:

1.	AL	11.	0.25P	21.	0.25P
2.	0.25P	12.	0.50P	22.	0.50P
3.	AL	13.	0.75P	23.	1.00P
4.	0.25P	14.	1.00P	24.	1.20P
5.	0.50P	15.	AL	25	1.33P
6.	AL	16.	0.25P	26.	1.20P
7.	0.25P	17.	0.50P	27.	1.00P
8.	0.50P	18.	1.00P	28.	LOCK-OFF
9.	0.75P	19.	1.20P		
10.	AL	20.	AL		

The anchor tendon may be completely unloaded prior to lock-off, if circumstances warrant. Final stressing then does not require further movement readings.

The test load number 25 shall be held for 10 minutes. Total movements with respect to a fixed reference point shall be recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the total movement between 1 minute and 10 minutes exceeds 0.04 in. (1mm), the test load shall be held for an additional 50 minutes. Total movements shall be recorded at 15 minutes, 20, 25, 30, 45, and 60 minutes.

All other loads shall be held until movement has stabilized (approximately one minute). Care must be taken to assure that the applied load is maintained constant during the holding period. A load cell shall be used to monitor the applied load during the holding period. A creep curve showing the creep movement between 1 minute and 10 minutes (between 6 and 60 minutes if the loading is held for 60 minutes) shall be plotted as a function of the logarithm of time.

A performance-tested tieback is acceptable if:

1. The total elastic movement obtained from the performance test exceeds 80% of the theoretical elongation of the stressing length; and be less than the theoretical elongation of the stressing length plus 50% of the bond length, and

2. The creep rate does not exceed 0.080 inches per logarithmic cycle of time during the final log cycle of the performance test, regardless of the tendon length and load.

3) **Proof Test.** All tiebacks which are not subject to creep tests or performance tests shall be proof tested. Proof tests shall be conducted by incrementally loading and recording the movements as per the following sequence:

1. AL
2. 0.25P
3. 0.50P
4. 0.75P
5. 1.00P
6. 1.20P
7. 1.40P
8. 1.00P
9. LOCK-OFF

Loading number 7 shall be maintained constant for a 10-minute holding period. All other loads shall be held until movement has stabilized, but not more than one minute. During the holding period, the movement shall be recorded at each of the following elapsed times: 0, 1, 2, 3, 4, 5, 6, and 10 minutes. If the movement between 1 and 10 minutes exceeds 0.04 inches, the test load shall be held for an additional 50 minutes. Total movements shall be recorded at 15, 20, 25, 30, 45, and 60 minutes. The total movement shall be plotted as a function of load for each proof-tested tieback. A proof-tested anchor is acceptable if:

1. The total movement obtained from the proof test measured between 50% of the design load and test load exceeds 80% of the theoretical elastic elongation of the free stressing length for this load increment; and

2. The creep rate does not exceed 0.080 inches per logarithmic cycle of time during the final log cycle of the proof test, regardless of tendon length or load.

Proof-tested anchors which fail to meet the above acceptance criteria will be acceptable if the load is maintained until a creep rate is determined and the creep rate is less than 0.08 inches per log cycle of time.

4) **Lift-Off Test** – Performance of initial lift-off readings are required on each tieback. This test involves reconnecting the jack and gradually applying the load until the tendon begins to elongate. The jack extension should be immediately terminated after deflection begins and the load required for the lift-off recorded. The lift-off load should be approximately equal to the design load plus an allowance for long term losses. If the lift-off varies more than 5% from the design load plus losses, the transfer load should be adjusted and the lift-off test repeated.

In addition, at approximately 5% of the anchor locations (specific tiebacks to be determined by the Engineer), lift-off tests shall be performed at 3 to 7 days post-lock-off.

Should the Contractor request permission to use a tieback that has failed to satisfy testing acceptance criteria, he must retest the anchor to determine the

actual tieback capacity which will satisfy the testing acceptance criteria. The retesting can only be done 1) if approved by the Engineer and 2) provided that the total movement measured at the anchor head was greater than 0.8 of the theoretical elastic elongation of the stressing length. An additional tieback shall then be installed at a location specified by the Engineer, and in accordance with this provision. This additional tieback shall be tested to determine if the total capacity of the two tiebacks exceeds the 1.33P load. Changes or modifications of the method of installation or tieback type shall require additional testing as determined by the Engineer.

METHOD OF MEASUREMENT. Creep test, failure tests, performance tests, and proof tests will be measured by the number of tests authorized and accepted. Additional tests described in this section, lift-off testing, and all replacement and/or additional tiebacks which are necessary as a result of the Contractor's procedures shall not be measured for payment.

BASIS OF PAYMENT. The accepted quantities of creep tests, failure tests, performance tests, and proof tests will be paid for at the contract unit price per each. Payment shall include all labor, equipment, load cells, materials, and other miscellaneous items necessary to complete the work.