HIGH-STRAIN DYNAMIC PILE TESTING REPORT
LIVINGSTON COUNTY TEST PILE
EVALUATION OF PILE LOAD TESTS FOR USE
IN MISSOURI LRFD GUILDELINES
LIVINGSTON COUNTY, MISSOURI

Prepared for:

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY
Rolla, Missouri

Prepared by:

GEOTECHNOLOGY, INC.
St. Louis, Missouri

Geotechnology, Inc. Project No. J019907.01

September 27, 2013

September 27, 2013 J019907.01

Dr. Ronaldo Luna, PhD, P.E.
Missouri University of Science and Technology
130 Butler-Carlton Hall
1870 Minor Circle
Rolla, Missouri 65409-0300

Re: High-Strain Dynamic Pile Testing Report
Livingston County Test Pile
Evaluation of Pile Load Tests for use in Missouri LRFD Guidelines
Livingston County, Missouri

Dear Dr. Luna:

Presented in this report are the results of high-strain dynamic testing services performed for the referenced project in accordance with our proposal numbered P019907.01 and dated December 5, 2011. Our services were performed in accordance with ASTM D4945-08 Standard Test Method for High-Strain Dynamic Testing of Deep Foundations.

The test pile program included dynamically monitoring a 14-inch diameter by 3/8-inch and performing a 7-day restrike to estimate the static axial capacity. It is our understanding that a static load test will be performed on the pile. A summary of the test pile is provided in the following table.

TEST PILE SUMMARY						
Test Pile Identifier	**Test Type**	**Pile Type**	**Steel Grade (ksi)**	**End Condition**	**Pile Alignment**	**Test Pile Length (feet)**
Test Pile	End-of-drive and Restrike	PP 14X3/8	45	Closed	Vertical	50

The Federal Highway Administration (FHWA) recommends limiting the tension and compressive stresses during driving to 90 percent of the yield stress ($0.9F_y$), or 40.5 ksi for ASTM A252 Grade 3 steel (i.e. 45 ksi).

Pile Hammer and Driving System

The test pile was driven and restrike test performed using a Delmag D19-42, open-ended diesel hammer. Reportedly, the hammer has a ram weight of 4.0 kips, a maximum rated energy of 43.2 ft-kips, an equivalent rated stroke of 10.8 feet and four fuel settings. The driving system also includes a 2-inch thick aluminum/conbest hammer cushion and a 1.9-kip helmet. The pile driving

equipment and data form for the hammer, which includes the material properties for the cushion materials, is included in Appendix A.

Soil Conditions

Based on the boring logs presented in the project plans and copied in Appendix B, the stratigraphy generally consists of medium to very stiff cohesive soil with varying percentages of sand underlain by medium to very dense sand to the depths explored.

Field Work

The test pile was driven and restrike test performed by APAC-Missouri, Inc. and dynamically monitored by an engineer from Geotechnology. The pile driving blow counts, which are listed on the pile driving record included in Appendix C, were recorded by a representative of the Missouri University of Science and Technology.

During testing, dynamic measurements of strain and acceleration were recorded using a Pile Driving Analyzer (PDA) Model PAX manufactured by Pile Dynamics, Inc. of Cleveland, Ohio. Dynamic monitoring was accomplished using two strain gauges and two accelerometers mounted 28 inches below the pile top. The PDA processed the strain and acceleration records and calculated the transferred energy, compression and tension stress and the mobilized static bearing capacity using the maximum Case Method (RMX) equations.

Data Reduction and Evaluation

An engineer from Geotechnology operated the analyzer and observed the associated testing. The recorded force and velocity curves were viewed real-time to evaluate the pile integrity, data quality and estimated static axial capacity. Data were digitally stored on the PDA for subsequent reprocessing and analysis. The PDA data, which are presented in graphical and tabulated format, are presented as Appendix C. The following information is included in the PDA data summaries.

- BLC – observed blow count
- STK – measured stroke
- EMX – energy transferred to the pile
- ETR – energy transfer ratio, EMX divided by maximum rated energy
- CSX – maximum average axial compressive stress at the sensors
- CSB – maximum computed compressive stress at the tip
- TSX – maximum average tensile stress
- FMX – the maximum compressive force at the sensors
- VMX – the maximum downward velocity at the sensors

- RMX – maximum Case Method capacity using the Case damping constant provided in the summary header

Representative blows from data collected near the end-of-drive (EOD) and near the beginning-of-restrike (BOR) were subsequently analyzed using Case Pile Wave Analysis Program (CAPWAP) signal matching software. The CAPWAP results are presented in Appendix C.

Discussion and Results

Hammer Performance. Presented in the following table are the average and maximum measured stroke, transferred energy and driving efficiency for the test pile.

HAMMER PERFORMANCE SUMMARY									
Test Pile Identifier	**Test Type**	**Stroke STK (feet)**		**Force FMX (kips)**		**Transferred Energy EMX (kip-ft)**		**Driving Efficiency ETR (%)**	
		Avg.	**Max.**	**Avg.**	**Max.**	**Avg.**	**Max.**	**Avg.**	**Max.**
Test Pile	Driving	7.5	8.6	489	541	16.2	19.3	37.4	44.7
	Restrike	8.0	9.2	554	612	18.5	22.1	42.9	51.2

Driving Stresses and Pile Integrity. The maximum compressive and tensile stresses were monitored during testing using the PDA and were maintained within the FHWA recommended limits. Based on our review of the dynamic test data, pile damage was not detected. The maximum pile head compressive stresses averaged over the pile cross section, maximum computed compressive stress at the tip and the maximum average tensile stresses are presented in the following table.

PILE STRESS SUMMARY							
Test Pile Identifier	**Test Type**	**Compressive Stress CSX (ksi)**		**Tip Comp. Stress CSB (ksi)**		**Tensile Stress TSX (ksi)**	
		Avg.	**Max.**	**Avg.**	**Max.**	**Avg.**	**Max.**
Test Pile	Driving	30.4	33.7	21.8	27.4	4.7	10.9
	Restrike	34.5	38.1	28.4	32.3	0.4	0.5

Estimated Static Axial Capacity. A summary of the CAPWAP results is presented in the following table.

CAPWAP RESULTS SUMMARY							
Test Pile Identifier	**Test Type**	**Blow Analyzed**	**Match Quality**	**Ultimate Capacity (kips)**			**JC***
				Total	**Shaft**	**Tip**	
Test Pile	End-of-Drive	1001	1.46	219.6	197.0	22.6	1.0
	Restrike	1	0.86	485.0	436.5	48.5	0.88
		2	1.08	475.2	441.1	34.1	0.83

* Corresponding Case Damping Constant

The CAPWAP results represent an estimate of the ultimate axial capacity at the time of testing. Therefore, CAPWAP results from blows analyzed during driving or at the end-of-drive do not account for capacity changes with time (i.e. setup or relaxation).

Limitations

This report has been prepared on behalf of and for the exclusive use of the client for specific application to the named project as described herein. Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. No other representation, expressed or implied, is included or intended.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the limited testing described herein. The field data collection methods used indicate foundation conditions only at the specific locations where data were obtained, only at the time they were obtained, and only to the depths specified.

The conclusions or recommendations presented in this report should not be used if the nature, design, or location of the facilities is changed or if there is a substantial lapse in time between the submittal of this report and the start of work at the site. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations or use of the testing data.

* * * * *

If we can provide further information or services please contact the undersigned.

Very truly yours,

GEOTECHNOLOGY, INC.

Craig K. Kaibel, P.E.
Senior Project Manager

CKK/JAW:ckk/jsj

Attachments: Appendix A – Pile Driving Equipment Data Form
Appendix B – Copy of Boring Logs (by others)
Appendix C – Pile Driving Record
Appendix D – PDA Summaries
Appendix E – CAPWAP Results

STATE OF MISSOURI
CRAIG K KAIBEL
NUMBER
PE-2008010353
PROFESSIONAL ENGINEER
9/27/2013

APPENDIX A

PILE DRIVING EQUIPMENT DATA FORM

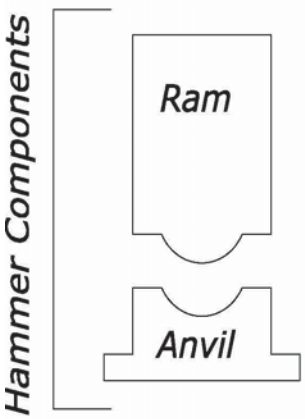
Pile Driving Equipment Data Sheet

Project: Route V Bridge over Canadian Pacific Railroad

Structure Name: Bridge No. A7932

Contract No.: MoDOT Project No. J2S0787

Pile Driving Contractor: APAC-Missouri. Inc.



Hammer

Manufacturer: Delmag

Model: D19-42 Type: Open-ended diesel

Serial No.: Unknown

Rated Energy: 43.24 at 10.81 length of stroke

Modifications: Unknown

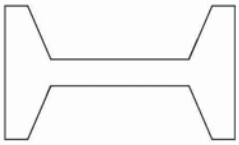
Capblock (Hammer Cushion)

Material: 50% Aluminum and 50% Conbest

Thickness: 2 Area: 227

Modulus of Elasticity (E): 530 kips per square inch

Coefficient of Restitution (e): 0.8



Pile Cap

Helmet
Bonnet
Anvil Block
Drivehead

Weight: 1.899 kips

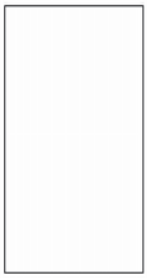
Pile Cushion

Cushion Material: NA

Thickness: NA Area: NA

Modulus of Elasticity (E): NA

Coefficient of Restitution (e): NA



Pile

Pile Type: PP 14 CE Weight/foot: 62.64

Wall Thickness: 3/8-inch Taper: None

Cross Sectional Area: 16.05 square inches

Design Pile Capacity: 220 to 232 kips (Tons)

Length (in leads): Unknown

Description of Splice: No Splice

Tip Treatment Description: Flat Plate

Note: If mandrel is used to drive the pile, attach separate manufacturer's detail sheet(s) including weight and dimensions.

Submitted by: _____ Date: _____

APPENDIX B

COPY OF BORING LOGS (BY OTHERS)

Form T-727-1R3G
Rev. 6-01

MISSOURI DEPARTMENT OF TRANSPORTATION
Construction and Materials

BORING DATA

Sheet 1 of 3

Job No.: J2S0787
County: Livingston **Route:** V
Over: DM&E Railroad
Logged by: E. Thomas
Equipment: Mobile Drill B-31, 3" Augers

Design: A7932
Skew: 12° 3' L.A.
Operator: Abbott
Date of Work: 2-14-15-2011

Bent	Station	Location	Surface Elevation	Log of Material: *	
1	3+14.0 1347228.1E	3.0' RT. 1445015.5N	794.1	0.0-10.0' 10.0-70.0'	Brown, mottled gray, lean clay, moist, stiff. Brown, mottled gray, speckled red, lean clay, scattered sand, moist, very stiff.
4	5+36.0 1347447.1E	17.0' RT. 1445002.6N	787.0	0.0-20.0' 20.0-68.0' 68.0-70.0'	Brown, mottled gray, speckled red lean clay, trace fine sand, moist, very stiff. Brown, mottled gray, scattered sand, moist, stiff to very stiff. Brown sandy clay, wet, medium stiff to very stiff.

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri Central 2402
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet **Coordinate Projection Factor:** 1.0000009

* Persons using this information are cautioned that the materials shown are determined by the equipment used and accuracy of the "log of materials" is limited thereby and by judgment of the operator. THIS INFORMATION IS FOR DESIGN PURPOSES ONLY.

Form T-727-1R3G
Rev. 6-01

MISSOURI DEPARTMENT OF TRANSPORTATION
Construction and Materials

BORING DATA (CORE & SPT)

Sheet 2a of 3

Job No.: J2S0787
County: Livingston **Route:** V
Over: DM&E Railroad
Logged by: E. Thomas
Equipment: CME 850
Hole Stab. by: Hollow Stem Augers
Automatic Hammer Efficiency: 81 %

Design: A7932
Skew: 12° 30' L.A.
Operator: Dunahoe
Drillers Hole No.: V-11-05
Date of Work: 2/16/2011
Drill No.: G-7950

Bent	Station	Location	Surface Elevation, ft.
1	3+14.0 1347225.1E	17.0' RT. 1445001.8N	794.7
Offset to:	7+22.2 1347129.1E	27.3' RT. 1444997.9N	792.5

TEST DATA

Depth, ft.	SPT Blows/6"	N_{60}	P.P., tsf	T_v, tsf	W_n%
6.3	--	--	1.50	0.70	22.9
7.5	2-4-4	11	1.50	--	--
11.3	--	--	4.00	0.90	18.5
12.5	4-7-9	22	4.00	--	15.9
16.3	--	--	4.00	0.90	15.5
17.5	5-8-12	27	4.50	--	--
21.3	--	--	3.50	0.80	17.0
22.5	5-6-10	24	3.75	--	15.5
26.3	--	--	3.00	0.70	15.0
27.5	4-7-9	22	2.75	--	--
30.0	4-6-9	20	2.75	--	17.1
35.0	4-5-9	23	3.00	--	--
40.0	5-8-9	23	2.75	--	22.0
50.6	5-8-6	22	2.75	--	18.0
60.0	5-8-8	22	2.75	--	19.3
70.0	4-8-12	27	3.00	--	17.8
80.0	5-7-11	24	2.50	--	19.6
90.0	6-6-6	16	Sand	--	--
95.0	5-7-10	23	Sand	--	--
100.0	20-28-35	88	Sand	--	--

SOIL CLASSIFICATION TEST DATA

Depth, ft.	LL	PI	ASTM Class.
6.3	50	32	CH
11.3	43	27	CL
16.3	39	24	CL
21.3	39	24	CL
26.3	42	26	CL
40.0	51	30	CH
60.0	26	22	CL
93.0	NA	NP	SP-SM

WATER TABLE OBSERVATIONS

Date	Time Change	Depth Hole Open	Depth To Water
2/7/2011	½ hour	58.0'	31.0'

LOG OF MATERIALS*

Inaccessible due to power line.

0.0-10.0' Brown, mottled gray, speckled red, lean to fat clay, moist, stiff.
10.0-40.0' Brown mottled sandy lean clay, with iron nodules, moist, very stiff.
40.0-60.0' Brown mottled sandy lean to fat clay, moist, very stiff.
60.0-88.1' Brown mottled lean clay, with sand.
88.1-101.5' Brown medium grained sand, with silt, moist, medium dense to very dense.

UNCONFINED COMPRESSIVE STRENGTH TEST DATA

Depth, ft.	Qu, ksf	P.P., tsf
16.3	7.3	4.50
21.3	7.9	4.50
26.3	5.3	3.75

SHEAR TEST DATA
DRAINED DIRECT SHEAR TEST

Depth, ft.	Φ'	c', psf
6.3	18.6 (21.8)	367.8 (0)
11.3	29.5 (31.4)	384.0 (0)
21.3	25.6 (32.0)	763.9 (0)

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri Central 2402
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet **Coordinate Projection Factor:** 1.0000009

N_{60} = (Blows/6")(ER/60%)
N_{60} = Blows/6" value for standard 60% SPT efficiency
ER = Measured energy efficiency in percent
Blows = Blows/6" value.

* Persons using this information are cautioned that the materials shown are determined by the equipment used and accuracy of the "log of materials" is limited thereby and by judgment of the operator.
THIS INFORMATION IS FOR DESIGN PURPOSES ONLY

STATE OF MISSOURI
DEAN DAVID FANNIE
NUMBER PE-2002
PROFESSIONAL ENGINEER
THIS SHEET HAS BEEN SIGNED, SEALED AND DATED ELECTRONICALLY.

DATE PREPARED	
6/12/2012	
ROUTE: V	STATE: MO
DISTRICT: BR	SHEET NO.: 35
COUNTY: LIVINGSTON	
JOB NO.: J2S0787	
CONTRACT ID.	
PROJECT NO.	
BRIDGE NO.: A7932	

DATE	DESCRIPTION

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
MoDOT
105 WEST CAPITOL
JEFFERSON CITY, MO 65102
1-888-ASK-MODOT (1-888-275-6636)

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

Detailed Mar. 2012
Checked May 2012

BORING DATA

Note: For locations of borings, see Sheet No. 1.
Note: This drawing is not to scale. Follow dimensions.

Form 17-[illegible]
Rev. [illegible]

MISSOURI DEPARTMENT OF TRANSPORTATION
Construction and Materials

BORING DATA (CORE & SPT)

Sheet 2b of 3

Job No.:	J2S0787			Design:	A7932
County:	Livingston	Route:	V	Skew:	12° 30' L.A.
Over:	DM&E Railroad			Operator:	Donahue
Logged by:	E. Thomas			Drillers Hole No.:	V-11-05
Equipment:	CME 850			Date of Work:	2/16/2011
Hole Stab. by:	Hollow Stem Augers			Drill No.:	G-7950
Automatic Hammer Efficiency:	81 %				

Bent	Station	Location	Surface Elevation, ft.
1	3+14.0 1347225.1E	17.0' RT. 1445001.8N	793.7
Offset to	3+22.7 1347229.1E	27.3' RT. 1445097.9N	792.5

LOG OF MATERIALS*

TEST DATA

Depth, ft.	SPT Blows/6"	N_{60}	P.P., tsf	Tv., tsf	Wn%

UNIT WEIGHTS

Depth, ft.	γsat, pcf	γmoist, pcf	Gsat
6.3		127.6	93.2
11.3		108.8	79.6
12.5	134.1		100
16.3	136.1		100
21.3		112.4	97.9
22.5	136.1		100
26.3	136.8		100
30.0	133.2		100
40.0	129.0		100
50.0	132.8		100
60.0	131.2		100
70.0	133.0		100
80.0	130.8		100
93.0	132.8		100

(A) Assumed
(E) Actual

SOIL CLASSIFICATION TEST DATA

Depth, ft.	LL	PI	ASTM Class.

SIEVE ANALYSIS (Percent Passing)
AASHTO T-88

	Depth, ft. 11.3	21.3	60.0	93.0
1	100.0	100.0	100.0	100.0
3/4	100.0	100.0	100.0	100.0
3/8	100.0	100.0	100.0	100.0
#4	99.1	98.4	98.2	100.0
#10	98.9	97.5	98.3	100.0
#16	97.6	95.9	97.0	99.9
#40	91.8	90.3	91.6	55.7
#50	84.0	85.6	87.7	26.7
#100	70.1	73.6	78.5	11.2
#200	63.1	65.9	72.8	8.2

WATER TABLE OBSERVATIONS

Date	Time Change	Depth Hole Open	Depth To Water

Coordinate System: Modified U.S. State Plane 1983 Coordinate Zone: Missouri Central 2402
Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet Coordinate Projection Factor: 1.0000009

N_{60} = Corrected N value for standard 60% SPT efficiency
$N_{60} = \frac{(Em)(Cn)(N)}{60}$ Em = Measured transfer efficiency in percent.
Cn = Correction factor.
N = Observed N value.
* Parameters and soil classifications are conditional and the materials shown are determined by the equipment used and accuracy of the "feel of materials" method visually and by judgment of the operator.
THIS INFORMATION IS FOR DESIGN PURPOSES ONLY

Form 17-[illegible]
Rev. [illegible]

MISSOURI DEPARTMENT OF TRANSPORTATION
Construction and Materials

BORING DATA (CORE & SPT)

Sheet 3a of 3

Job No.:	J2S0787			Design:	A7932
County:	Livingston	Route:	V	Skew:	12° 30' L.A.
Over:	DM&E Railroad			Operator:	Donahue
Logged by:	E. Thomas			Drillers Hole No.:	V-11-04
Equipment:	CME 850			Date of Work:	2/16/2011
Hole Stab. by:	Hollow Stem Augers			Drill No.:	G-7950
Automatic Hammer Efficiency:	81 %				

Bent	Station	Location	Surface Elevation, ft.
4	5+36.0 1347453.0E	11.0' LT. 1445030.0N	784.9

LOG OF MATERIALS*

0.0-19.2'	Brown mottled lean clay, trace fine sand, moist, very stiff.
19.2-25.0'	Brown silty fine grained sand, moist, dense to very dense.
25.0-74.0'	Brownish-gray lean clay, trace fine sand, moist, very stiff to stiff.
74.0-101.5'	Brown fine to medium grained sand, with silt, moist, medium dense to very dense.

TEST DATA

Depth, ft.	SPT Blows/6"	N_{60}	P.P., tsf	Tv., tsf	Wn%
6.3	--	--	2.00	0.65	18.9
7.5	3-5-7	15	3.25	--	--
11.3	--	--	2.50	0.70	17.7
12.5	3-7-10	23	3.25	--	--
16.3	--	--	3.00	0.80	15.5
17.5	4-7-12	26	3.50	--	15.1
20.5	--	--	Sand	--	17.3
21.0	13-22-33	61	Sand	--	15.3
25.0	3-5-7	16	2.50	--	17.4
30.0	2-3-7	14	1.75	--	--
35.0	5-6-8	19	2.75	--	20.1
40.0	3-4-7	15	1.75	--	--
45.0	5-6-7	18	2.75	--	20.5
50.0	6-9-10	26	2.50	--	19.6
55.0	4-8-11	20	3.00	--	--
60.0	3-4-6	14	1.50	--	21.8
65.0	4-6-7	18	1.75	--	--
70.0	2-4-6	14	1.50	--	--
75.0	21-23-22	61	Sand	--	--
80.0	12-23-30	72	Sand	--	--
85.0	14-18-19	50	Sand	--	--
90.0	17-12-13	34	Sand	--	--
95.0	9-3-6	12	Sand	--	--
100.0	13-22-29	70	Sand	--	--

UNCONFINED COMPRESSIVE STRENGTH TEST DATA

Depth, ft.	Qu, ksf	P.P., tsf
6.3	1.1	1.75
16.3	8.5	3.75

SHEAR TEST DATA
DRAINED DIRECT SHEAR TEST

Depth, ft.	Φ'	c', psf
6.3	24.4 (27.0)	352.2 (0)
11.3	34.2 (35.0)	112.4 (0)

SOIL CLASSIFICATION TEST DATA

Depth, ft.	LL	PI	ASTM Class.
6.3	66	30	CL
11.3	37	22	CL
16.3	39	23	CL
20.5		NP	SM
25.0	36	21	CL
35.0	48	31	CL
75.0		NP	SP-SM
85.0		NP	SM
100.0		NP	SP-SM

WATER TABLE OBSERVATIONS

Date	Time Change	Depth Hole Open	Depth To Water
2/17/2011	1 hour	20.0'	9.0'

Coordinate System: Modified U.S. State Plane 1983 Coordinate Zone: Missouri Central 2402
Coordinate Datum: NAD 83 (CONUS) Coordinate Units: U.S. Survey Feet Coordinate Projection Factor: 1.0000009

N_{60} = Corrected N value for standard 60% SPT efficiency
$N_{60} = \frac{(Em)(Cn)(N)}{60}$ Em = Measured transfer efficiency in percent.
Cn = Correction factor.
N = Observed N value.
* Parameters and soil classifications are conditional and the materials shown are determined by the equipment used and accuracy of the "feel of materials" method visually and by judgment of the operator.
THIS INFORMATION IS FOR DESIGN PURPOSES ONLY

STATE OF MISSOURI
DEAN DAVID FINANE
NUMBER PE-32132
PROFESSIONAL ENGINEER
THIS SHEET HAS BEEN SIGNED, SEALED AND DATED ELECTRONICALLY.

DATE PREPARED: 6/12/2012
ROUTE: V | STATE: MO
DISTRICT: BR | SHEET NO.: 36
COUNTY: LIVINGSTON
JOB NO.: J2S0787
CONTRACT ID.:
PROJECT NO.:
BRIDGE NO.: A7932

DATE	DESCRIPTION

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
MoDOT
105 WEST CAPITOL
JEFFERSON CITY, MO 65102
1-888-ASK-MODOT (1-888-275-6636)

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

BORING DATA

Note: For locations of borings, see Sheet No. 1.

Note: This drawing is not to scale. Follow dimensions.

Sheet No. 36 of 40

Detailed Mar. 2012
Checked May 2012

Form 7-27-1R340
Rev. 6/9/11

MISSOURI DEPARTMENT OF TRANSPORTATION
Construction and Materials

BORING DATA (CORE & SPT)

Sheet 3 of 3

Job No.:	J2S0787		**Design:**	A7932	
County:	Livingston	**Route:** V	**Skew:**	12°30' L.A.	
Over:	DM&E Railroad		**Operator:**	Donahoe	
Logged by:	E. Thomas		**Drillers Hole No.:**	V-11-04	
Equipment:	CME 850		**Date of Work:**	2/14/2011	
Hole Stab. by:	Hollow Stem Augers		**Drill No.:**	G-7930	
Automatic Hammer Efficiency:	81 %				

Bent	Station	Location	Surface Elevation, ft.
4	5+36.0 1347453.0E	11.0' LT. 1445030.0N	764.9

TEST DATA

Depth, ft.	SPT Blows/6"	N_{60}	P.P., tsf	Tv., tsf	Wn%

SOIL CLASSIFICATION TEST DATA

Depth, ft.	LL	PI	AASHTO Class.	ASTM Class.

WATER TABLE OBSERVATIONS

Date	Time Change	Depth Hole Open	Depth To Water

LOG OF MATERIALS*

UNIT WEIGHTS

Depth, ft.	γsat, pcf	γmoist, pcf	%sat
6.3		100.1	90.9[2]
7.5	128.9		100[1]
11.3		113.5	97.5[2]
16.3	136.1		100[1]
17.5	136.7		100[1]
20.5	133.7		100[1]
21.0	136.4		100[1]
25.0	133.6		100[1]
35.0	130.2		100[1]
45.0	129.7		100[1]
55.0	130.8		100[1]
65.0	128.3		100[1]
75.0	134.7		100[1]
95.0	139.5		100[1]
100.0	131.5		100[1]

[1] Assumed
[2] Actual

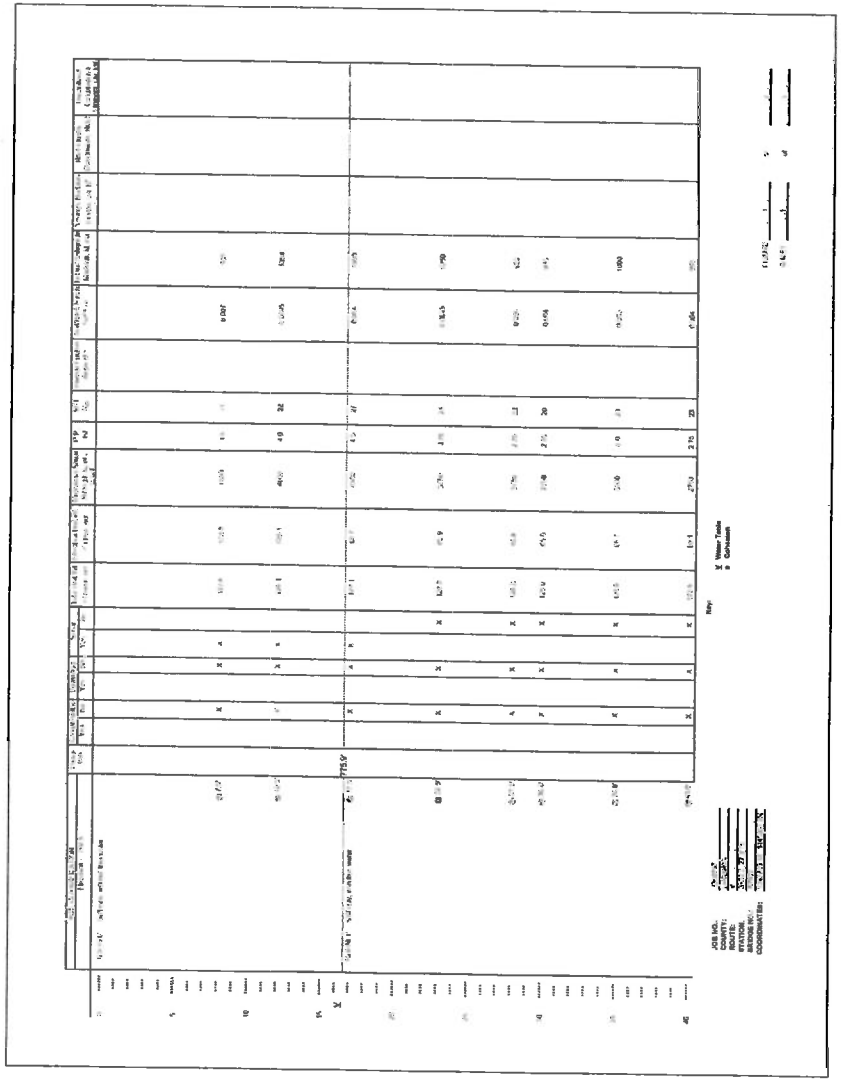
SIEVE ANALYSIS (Percent Passing)
AASHTO T-88

	Depth, ft.					
	11.3	20.5	35.0	75.0	85.0	100.0
1	100.0	100.0	100.0	100.0	100.0	100.0
3/4	100.0	100.0	100.0	100.0	100.0	100.0
3/8	99.8	99.1	100.0	100.0	98.4	95.9
#4	99.3	98.9	99.0	100.0	95.9	95.8
#10	98.7	98.4	97.9	100.0	90.9	92.9
#16	97.2	96.7	96.6	99.7	87.1	91.4
#40	91.4	90.2	91.1	73.3	54.4	61.7
#50	85.5	83.3	86.9	41.2	34.2	42.0
#100	74.2	61.3	77.1	17.5	17.0	17.6
#200	66.3	40.5	71.0	11.8	13.0	8.7

Coordinate System: Modified U.S. State Plane 1983 **Coordinate Zone:** Missouri Central 2402
Coordinate Datum: NAD 83 (CONUS) **Coordinate Units:** U.S. Survey Feet **Coordinate Projection Factor:** 1.0000009

N_{60} = Calculated N value for a standard 60% SPT efficiency.
N_{60} = Measured energy efficiency in percent.
Nm = Observed N-value.

* Persons using this information are cautioned that the materials shown are determined only by the equipment used and accuracy of the local information is limited. Interpretation of the information is the responsibility of the operator.
THIS INFORMATION IS FOR DESIGN PURPOSES ONLY



STATE OF MISSOURI
DEAN DAVID RAWIE
NUMBER PE-28032
PROFESSIONAL ENGINEER
THIS SHEET HAS BEEN SIGNED, SEALED AND DATED ELECTRONICALLY.

DATE PREPARED	6/12/2012
ROUTE	V
STATE	MO
DISTRICT	BR
SHEET NO.	37
COUNTY	LIVINGSTON
JOB NO.	J2S0787
CONTRACT ID.	
PROJECT NO.	
BRIDGE NO.	A7932

DATE	DESCRIPTION

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
MoDOT
105 WEST CAPITOL
JEFFERSON CITY, MO 65101
1-888-ASK-MODOT (1-888-275-6636)

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED.

Detailed Mar. 2012
Checked May 2012

BORING DATA

Note: For locations of borings, see Sheet No. 1.

Note: This drawing is not to scale. Follow dimensions.

APPENDIX C

PILE DRIVING RECORD

GEOTECHNOLOGY INC
FROM THE GROUND UP

PILE DRIVING RECORD

Date:	9/19/2013	Pile Number:	Test Pile
Project Number:	J019907.01	Location:	South of Bent 3
Project Name:	Livingston County Test Pile	Type:	PP 14X3/8
Contractor:	APAC-Missouri, Inc.	Length:	50 feet
Prepared By:	MGS	Vertical/Battered:	Vertical
Surface Elevation:	Not Provided	No. of Segments:	1
Hammer:	Delmag D19-42	Length of Segments:	50 feet

DRIVING RESISTANCE

Feet	Blows	Feet	Blows	Feet	Blows	Feet	Blows	Feet	Blows
1		26	23	51		76		101	
2		27	24	52		77		102	
3		28	26	53		78		103	
4		29	30	54		79		104	
5		30	27	55		80		105	
6	6	31	27	56		81		106	
7	6	32	29	57		82		107	
8	7	33	29	58		83		108	
9	8	34	28	59		84		109	
10	8	35	32	60		85		110	
11	9	36	29	61		86		111	
12	10	37	31	62		87		112	
13	7	38	33	63		88		113	
14	10	39	32	64		89		114	
15	13	40	34	65		90		115	
16	15	41	35	66		91		116	
17	15	42	34	67		92		117	
18	16	43	33	68		93		118	
19	17	44	36	69		94		119	
20	17	45	37	70		95		120	
21	19	46	37	71		96		121	
22	24	47	42	72		97		122	
23	21	48	43	73		98		123	
24	24	49		74		99		124	
25	25	50		75		100		125	

RESTRIKE RESISTANCE

Depth:	48	Depth:	
Inch	Blows	Inch	Blows
1.5"	10	1"	
2"	20	2"	
3"		3"	
4"		4"	
5"		5"	
6"		6"	
7"		7"	
8"		8"	
9"		9"	
10"		10"	
11"		11"	
12"		12"	

TIME

Start Driving:	1:24:42PM	Start Splice:	NA
Finish Driving:	2:04:40PM	Finish Splice:	NA
Driving Time:	39.9 minutes	Splice Time	NA
Interruptions:	See Remarks		

REMARKS

Pile driving and restrike testing performed using highest fuel setting.

Pile driving was halted multiple times to realign the hammer.

Test pile location was predrilled 5 feet (i.e. 43-foot embedment)

APPENDIX D

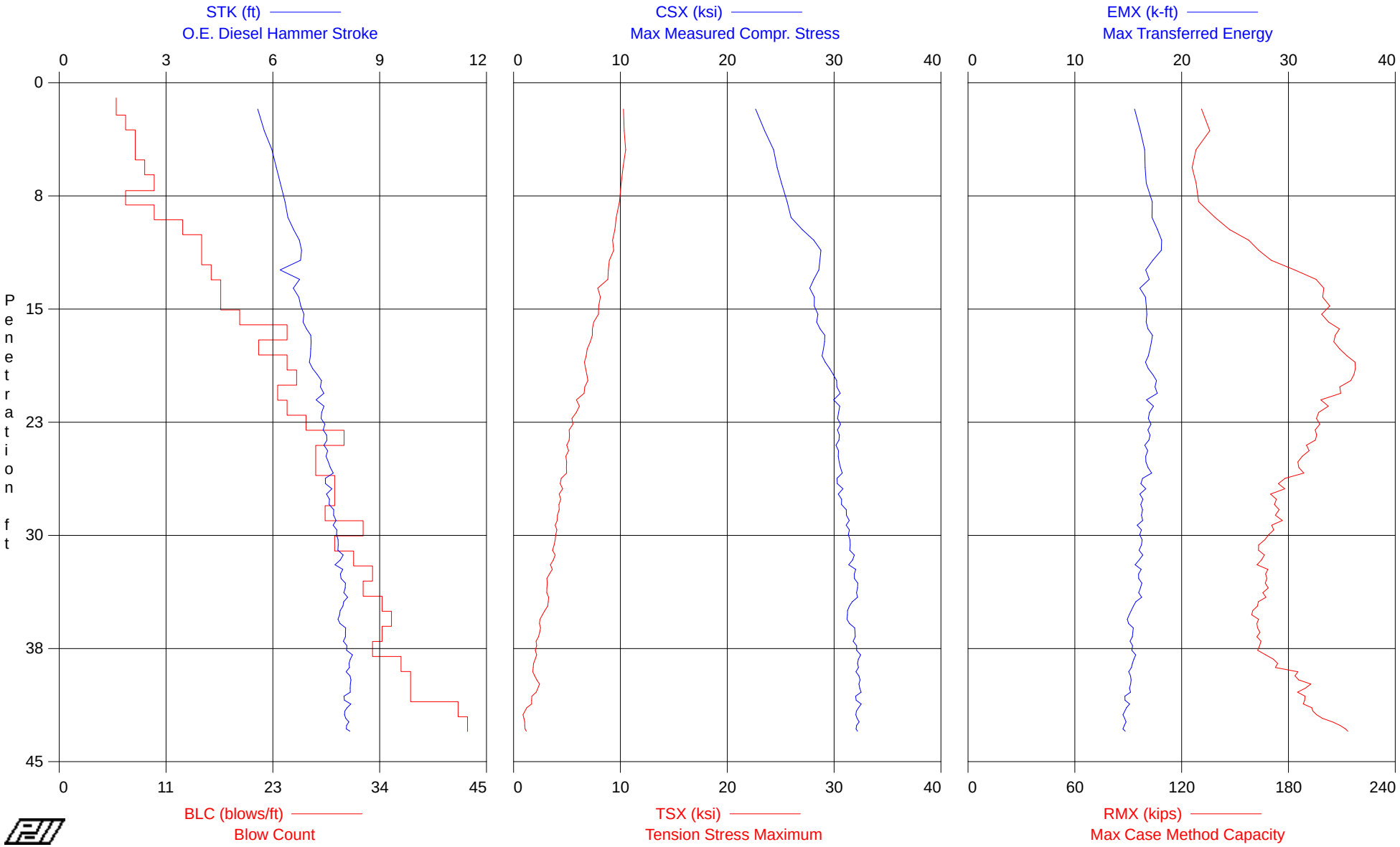
PDA SUMMARIES

Geotechnology, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Sep-2013

Test date: 19-Sep-2013

MS&T Test Pile - Livingston County Test Pile



MS&T Test Pile - Livingston County Test Pile
OP: JRC

PP 14X3/8 CE
Test date: 19-Sep-2013

AR: 16.05 in^2
LE: 47.67 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 1.00

STK: O.E. Diesel Hammer Stroke
EMX: Max Transferred Energy
ETR: Energy Transfer Ratio
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom

TSX: Tension Stress Maximum
FMX: Maximum Force
VMX: Maximum Velocity
RMX: Max Case Method Capacity

BL#	depth	BLC	STK	EMX	ETR	CSX	CSB	TSX	FMX	VMX	RMX
	ft	bl/ft	ft	k-ft	(%)	ksi	ksi	ksi	kips	f/s	kips
1	1.00	6	5.4	15.0	34.6	21.9	13.2	10.1	352	15.7	122
6	1.83	6	5.6	15.1	35.0	22.7	13.6	10.2	364	15.7	135
11	2.57	7	5.4	14.4	33.3	22.3	13.4	9.9	358	15.0	129
16	3.25	8	5.5	15.2	35.1	22.6	13.5	9.9	363	14.9	132
21	3.88	8	5.8	16.0	37.0	23.8	13.3	10.2	382	15.4	130
26	4.50	8	6.0	16.2	37.6	24.3	14.2	10.4	391	15.6	127
31	5.11	9	5.9	15.4	35.5	23.9	13.0	10.1	383	14.8	120
36	5.67	9	6.1	16.9	39.0	24.9	14.8	10.3	400	15.5	128
41	6.20	10	6.1	16.3	37.6	24.5	14.5	10.0	393	14.9	126
46	6.70	10	6.3	16.5	38.2	25.3	13.8	10.2	407	15.0	128
51	7.29	7	6.4	18.3	42.3	25.8	14.1	10.1	414	15.2	133
56	8.00	7	6.0	15.5	36.0	24.6	13.5	9.2	395	13.5	137
61	8.50	10	6.4	17.5	40.4	25.8	15.6	9.5	414	14.5	132
66	9.00	10	6.5	17.2	39.8	26.1	15.8	9.9	418	14.6	138
71	9.39	13	6.4	17.2	39.8	26.0	15.6	9.3	417	14.0	140
76	9.77	13	6.5	16.5	38.3	26.7	14.4	9.3	428	13.7	146
81	10.13	15	6.6	17.8	41.2	27.3	15.0	9.0	439	14.1	150
86	10.47	15	6.9	18.0	41.6	28.7	16.6	9.5	460	14.3	156
91	10.80	15	7.0	19.0	44.0	29.6	16.4	10.1	475	14.7	163
96	11.13	15	6.7	17.5	40.5	28.4	15.1	9.1	456	14.2	163
101	11.47	15	6.7	17.2	39.7	28.3	15.0	8.8	454	14.0	169
106	11.80	15	6.9	17.6	40.8	28.9	16.1	9.1	465	14.3	170
111	12.13	16	6.9	17.5	40.5	28.9	16.0	8.9	465	14.2	185
116	12.44	16	6.8	17.5	40.4	29.1	15.9	8.8	467	14.1	186
121	12.75	16	6.9	17.3	40.0	28.2	17.6	9.6	453	15.0	190
126	13.06	17	6.7	16.7	38.6	27.7	16.8	8.7	444	14.5	194
131	13.35	17	6.4	15.5	35.9	27.1	17.6	7.4	435	14.3	207
136	13.65	17	6.9	17.3	40.1	28.7	18.4	8.9	461	15.3	186
141	13.94	17	6.7	16.4	37.9	28.2	18.5	8.2	452	14.9	200
146	14.24	17	6.5	15.8	36.6	27.3	17.7	7.5	439	14.5	204
151	14.53	17	6.7	16.4	37.8	27.9	18.2	7.9	448	14.8	204
156	14.82	17	6.6	16.1	37.2	27.5	17.9	7.5	442	14.6	199
161	15.11	19	7.1	17.5	40.4	29.0	18.6	8.4	465	15.4	202
166	15.37	19	7.1	17.3	40.1	29.0	18.8	8.3	465	15.5	200
171	15.63	19	6.8	16.9	39.1	28.3	17.5	7.4	455	14.9	200
176	15.90	19	6.6	16.1	37.3	27.8	18.0	6.8	446	14.7	208
181	16.13	24	6.7	16.3	37.6	28.0	17.8	6.7	450	14.7	214
186	16.33	24	7.0	17.0	39.4	28.7	18.9	7.4	460	15.2	209
191	16.54	24	7.1	17.5	40.4	29.3	19.3	7.8	470	15.6	205
196	16.75	24	7.1	17.1	39.5	29.0	18.6	7.6	465	15.3	207
201	16.96	24	7.3	17.8	41.2	29.8	19.4	7.8	478	15.7	209
206	17.19	21	7.0	17.1	39.6	29.1	19.0	7.1	467	15.3	205
211	17.43	21	7.1	17.1	39.5	29.3	18.7	7.3	470	15.3	203
216	17.67	21	6.9	16.3	37.7	28.8	18.6	6.9	462	15.1	206
221	17.91	21	7.2	17.6	40.7	29.3	19.4	7.4	470	15.5	209
226	18.13	24	6.9	16.5	38.2	28.7	18.0	6.6	461	15.1	211
231	18.33	24	7.3	17.9	41.4	29.7	19.7	7.2	476	15.7	218
236	18.54	24	7.0	16.8	38.9	29.3	19.2	6.4	470	15.5	221
241	18.75	24	7.1	17.2	39.7	29.7	19.8	6.8	476	15.8	220
246	18.96	24	7.0	16.3	37.7	29.1	19.6	6.3	466	15.4	212
251	19.16	25	7.1	17.0	39.4	29.7	19.9	6.6	477	15.7	219
256	19.36	25	7.3	17.5	40.4	30.2	19.3	7.2	485	16.0	217
261	19.56	25	7.0	16.5	38.2	29.3	19.5	6.3	470	15.5	209
266	19.76	25	7.6	18.4	42.7	30.9	20.3	7.5	496	16.5	221
271	19.96	25	7.4	17.7	40.9	30.5	19.6	7.0	489	16.1	218
276	20.17	23	7.5	18.0	41.7	30.8	20.7	7.1	495	16.5	212
281	20.39	23	7.3	17.3	39.9	30.3	20.1	6.6	487	16.1	204
286	20.61	23	7.6	18.4	42.5	30.8	20.7	6.8	495	16.6	212
291	20.83	23	7.5	17.6	40.6	30.8	19.9	6.6	494	16.3	206
296	21.04	24	7.2	16.6	38.3	29.8	20.2	5.7	479	15.9	198
301	21.25	24	7.3	17.0	39.4	30.2	20.5	5.9	485	16.1	200
306	21.46	24	7.5	17.6	40.8	30.7	20.7	6.3	493	16.5	205
311	21.67	24	7.5	17.3	40.0	30.8	20.9	6.2	494	16.4	199
316	21.88	24	7.4	17.0	39.4	30.5	19.9	6.0	489	16.2	196
321	22.08	26	7.1	16.3	37.7	29.6	20.4	5.2	475	15.8	191

MS&T Test Pile - Livingston County Test Pile
OP: JRC
PP 14X3/8 CE
Test date: 19-Sep-2013

BL#	depth	BLC	STK	EMX	ETR	CSX	CSB	TSX	FMX	VMX	RMX
	ft	bl/ft	ft	k-ft	(%)	ksi	ksi	ksi	kips	f/s	kips
326	22.27	26	7.4	17.0	39.3	30.3	20.9	5.5	487	16.2	195
331	22.46	26	7.5	17.4	40.2	30.8	21.2	5.6	495	16.5	200
336	22.65	26	7.6	17.7	40.9	31.2	20.2	5.9	500	16.6	204
341	22.85	26	7.2	16.2	37.5	29.8	19.6	4.8	478	15.7	188
346	23.03	30	7.6	17.3	40.0	31.0	20.4	5.7	497	16.6	201
351	23.20	30	7.5	16.8	38.9	30.4	21.2	5.2	488	16.4	193
356	23.37	30	7.6	17.5	40.5	30.9	21.3	5.4	495	16.6	201
361	23.53	30	7.5	16.9	39.0	30.2	21.0	5.1	485	16.3	193
366	23.70	30	7.5	17.1	39.5	30.4	20.9	5.1	488	16.3	197
371	23.87	30	7.3	16.2	37.4	29.8	20.8	4.8	479	16.0	187
376	24.04	27	7.3	16.2	37.4	29.9	20.8	4.7	480	16.0	183
381	24.22	27	7.6	16.9	39.2	30.7	21.2	5.3	493	16.4	195
386	24.41	27	7.7	17.2	39.7	30.6	21.0	5.4	491	16.5	196
391	24.59	27	7.8	17.6	40.8	31.2	21.6	5.6	501	16.7	201
396	24.78	27	7.3	15.9	36.7	29.5	20.6	4.4	474	15.9	181
401	24.96	27	7.6	16.7	38.7	30.7	21.1	5.0	493	16.3	188
406	25.15	27	7.5	16.4	37.9	30.1	21.0	4.4	483	16.0	185
411	25.33	27	7.5	16.5	38.1	30.0	20.9	4.7	481	16.2	182
416	25.52	27	7.6	17.1	39.6	31.0	21.6	5.3	497	16.7	187
421	25.70	27	7.4	16.3	37.7	30.0	21.0	4.1	481	16.0	183
426	25.89	27	7.9	17.8	41.1	31.4	21.8	5.4	503	16.8	192
431	26.07	29	7.4	15.7	36.4	29.8	20.9	4.4	478	16.0	173
436	26.24	29	7.3	15.9	36.7	30.1	21.3	4.1	483	16.0	175
441	26.41	29	7.7	17.1	39.5	31.0	21.6	5.2	498	16.7	183
446	26.59	29	7.3	15.6	36.0	29.8	20.8	3.9	479	15.7	175
451	26.76	29	7.6	16.5	38.1	30.6	21.7	4.3	491	16.2	182
456	26.93	29	7.4	16.0	37.1	30.4	21.7	4.2	488	16.1	174
461	27.10	29	7.6	16.8	38.8	30.8	22.0	4.7	494	16.5	175
466	27.28	29	7.3	15.3	35.3	29.9	20.6	3.8	480	15.7	163
471	27.45	29	7.6	16.4	37.9	30.5	21.9	4.5	490	16.3	173
476	27.62	29	7.6	16.6	38.4	31.0	22.4	4.4	498	16.5	174
481	27.79	29	7.7	16.9	39.0	31.1	21.5	4.6	500	16.5	174
486	27.97	29	7.6	16.2	37.6	30.8	22.4	4.1	494	16.3	173
491	28.14	28	7.9	16.9	39.2	31.5	22.3	4.6	505	16.6	181
496	28.32	28	7.6	15.9	36.7	30.9	22.1	4.3	495	16.3	168
501	28.50	28	7.8	16.6	38.5	31.2	22.3	4.2	501	16.5	181
506	28.68	28	7.7	16.4	37.9	31.2	22.8	4.1	501	16.5	172
511	28.86	28	7.8	16.7	38.7	31.7	23.2	4.2	509	16.8	179
516	29.03	32	7.8	16.4	37.9	31.4	21.9	4.1	505	16.5	174
521	29.19	32	7.9	16.6	38.3	31.8	23.2	4.6	511	16.9	175
526	29.34	32	7.7	15.8	36.6	31.2	22.9	3.9	501	16.4	172
531	29.50	32	7.9	16.7	38.5	31.7	23.2	4.4	508	16.8	174
536	29.66	32	7.5	15.1	34.9	30.5	21.7	3.3	490	15.8	165
541	29.81	32	7.9	16.8	38.9	32.0	23.6	4.2	514	16.8	175
546	29.97	32	7.6	15.6	36.0	30.9	22.9	3.6	496	16.2	167
551	30.14	29	7.5	15.6	36.1	30.7	22.9	3.4	493	16.2	166
556	30.31	29	7.9	16.3	37.8	31.3	23.2	3.9	503	16.5	168
561	30.48	29	7.7	16.1	37.2	31.3	22.9	3.7	502	16.4	161
566	30.66	29	7.8	16.3	37.6	31.5	23.4	3.9	506	16.6	159
571	30.83	29	7.9	16.1	37.3	31.6	23.4	3.8	508	16.4	164
576	31.00	29	7.5	15.2	35.0	30.8	22.1	3.0	494	15.9	163
581	31.16	31	8.0	16.3	37.7	31.7	23.6	3.8	510	16.6	169
586	31.32	31	7.9	15.9	36.7	31.5	23.3	3.7	506	16.5	161
591	31.48	31	8.0	16.1	37.3	31.9	22.9	3.6	512	16.4	169
596	31.65	31	8.0	16.5	38.1	32.1	24.1	3.9	515	16.8	168
601	31.81	31	7.7	15.4	35.5	31.2	22.6	3.4	501	16.1	158
606	31.97	31	7.8	15.8	36.5	31.4	23.8	3.2	504	16.2	169
611	32.12	33	7.9	16.1	37.1	32.1	24.2	3.7	516	16.6	167
616	32.27	33	7.8	15.1	35.0	31.4	23.5	2.8	504	15.7	169
621	32.42	33	8.0	16.3	37.7	32.3	24.4	3.7	518	16.8	168
626	32.58	33	8.0	16.2	37.4	32.0	24.0	3.4	514	16.6	171
631	32.73	33	7.9	15.9	36.8	32.0	24.3	3.2	514	16.6	163
636	32.88	33	8.0	16.2	37.5	32.2	24.1	3.4	517	16.7	163
641	33.03	32	8.1	16.5	38.1	32.1	24.3	3.4	516	16.8	165
646	33.19	32	7.8	15.7	36.4	31.5	24.0	2.8	506	16.4	163
651	33.34	32	8.0	16.1	37.2	32.3	24.4	3.1	518	16.6	168
656	33.50	32	7.9	15.6	36.1	31.7	23.2	2.7	508	16.2	166
661	33.66	32	7.9	15.9	36.8	31.8	23.9	3.0	510	16.4	165
666	33.81	32	7.7	15.5	35.8	31.5	23.4	2.8	505	16.3	164
671	33.97	32	7.9	15.7	36.3	31.8	24.4	3.0	511	16.4	163
676	34.12	34	8.1	16.5	38.2	32.4	24.9	3.5	519	16.9	167
681	34.27	34	8.2	16.6	38.3	32.5	25.1	3.6	522	16.9	167
686	34.41	34	8.3	16.7	38.6	32.8	25.3	4.0	526	17.2	160
691	34.56	34	8.2	16.5	38.3	32.5	25.2	3.8	521	17.1	164

MS&T Test Pile - Livingston County Test Pile
OP: JRC

PP 14X3/8 CE
Test date: 19-Sep-2013

BL#	depth	BLC	STK	EMX	ETR	CSX	CSB	TSX	FMX	VMX	RMX
	ft	bl/ft	ft	k-ft	(%)	ksi	ksi	ksi	kips	f/s	kips
696	34.71	34	8.1	16.1	37.2	31.9	24.8	3.6	512	16.7	161
701	34.85	34	8.2	16.5	38.0	32.2	25.1	3.7	517	17.1	162
706	35.00	34	7.9	15.2	35.2	31.4	24.3	2.8	504	16.2	158
711	35.14	35	8.0	15.5	35.7	31.5	24.4	3.0	506	16.3	158
716	35.29	35	7.7	14.7	33.9	30.9	24.0	2.4	496	15.9	161
721	35.43	35	7.6	14.2	32.8	30.6	23.7	2.1	490	15.5	168
726	35.57	35	7.9	15.3	35.4	31.8	24.5	2.7	510	16.3	156
731	35.71	35	7.7	14.5	33.6	31.0	24.0	2.3	497	15.8	159
736	35.86	35	7.8	14.7	34.1	31.2	24.3	2.3	501	16.0	162
741	36.00	35	8.0	15.6	36.1	31.9	24.8	2.5	512	16.5	160
746	36.15	34	8.2	15.9	36.8	32.5	25.1	2.9	522	16.7	163
751	36.29	34	7.9	15.2	35.1	31.7	24.6	2.3	508	16.2	160
756	36.44	34	7.9	15.0	34.7	31.4	24.7	2.1	505	16.1	168
761	36.59	34	7.8	14.8	34.2	31.3	24.5	2.1	502	16.0	174
766	36.74	34	8.1	15.4	35.5	32.1	25.0	2.3	516	16.4	163
771	36.88	34	7.8	14.5	33.6	31.2	24.6	1.8	500	15.9	171
776	37.03	33	8.0	15.2	35.2	31.7	24.8	2.1	509	16.2	171
781	37.18	33	8.1	15.4	35.5	31.9	24.9	2.1	511	16.3	170
786	37.33	33	8.1	15.7	36.4	32.3	25.1	2.3	519	16.6	164
791	37.49	33	8.0	15.1	34.9	31.8	24.7	1.8	511	16.1	168
796	37.64	33	8.0	15.2	35.1	32.1	24.9	2.0	515	16.3	157
801	37.79	33	8.3	15.9	36.7	32.4	25.2	2.2	520	16.6	168
806	37.94	33	8.2	15.2	35.2	32.3	25.4	2.0	518	16.1	181
811	38.08	36	8.2	15.8	36.4	32.1	25.3	2.1	516	16.6	175
816	38.22	36	8.4	16.4	37.8	33.2	25.8	2.5	534	16.9	153
821	38.36	36	8.3	15.8	36.6	32.7	25.5	2.1	525	16.5	160
826	38.50	36	7.9	14.7	34.1	31.5	24.9	1.5	506	16.0	169
831	38.64	36	8.0	14.7	34.0	31.9	25.0	1.5	512	15.9	169
836	38.78	36	7.9	14.8	34.3	31.8	25.0	1.6	511	15.9	172
841	38.92	36	8.0	14.9	34.4	32.0	25.2	1.7	513	16.1	180
846	39.05	37	8.0	14.9	34.5	31.8	25.2	1.7	511	16.1	191
851	39.19	37	8.1	15.0	34.6	32.1	25.3	1.8	515	16.1	195
856	39.32	37	8.1	14.9	34.5	32.1	25.1	1.9	516	15.9	175
861	39.46	37	8.3	15.7	36.4	32.8	25.7	2.2	526	16.6	177
866	39.60	37	8.2	15.3	35.3	32.7	25.5	2.2	525	16.3	181
871	39.73	37	8.4	16.0	37.1	33.0	25.8	2.6	530	16.8	193
876	39.87	37	8.1	15.0	34.7	32.2	25.2	2.3	517	16.3	182
881	40.00	37	8.1	15.0	34.7	32.4	25.4	2.4	520	16.3	190
886	40.14	37	7.9	14.4	33.3	31.6	25.1	1.9	507	15.9	196
891	40.27	37	8.3	15.5	35.9	32.8	25.6	2.3	526	16.5	174
896	40.41	37	8.0	15.0	34.6	32.3	25.5	1.9	518	16.2	186
901	40.54	37	8.2	15.2	35.2	32.3	25.5	2.1	519	16.3	199
906	40.68	37	7.9	14.5	33.4	31.7	25.1	1.5	509	15.9	200
911	40.81	37	8.1	15.0	34.6	32.2	25.4	2.0	516	16.2	197
916	40.95	37	8.0	14.9	34.4	32.0	25.5	1.7	513	16.2	192
921	41.07	42	8.0	14.8	34.3	32.2	25.6	1.7	517	16.1	180
926	41.19	42	8.3	15.5	35.9	32.9	26.1	1.8	528	16.3	186
931	41.31	42	8.2	14.9	34.5	32.4	26.0	1.4	520	16.1	194
936	41.43	42	8.2	15.1	34.9	32.6	26.3	1.4	524	16.3	187
941	41.55	42	8.2	15.3	35.5	32.7	26.6	1.4	524	16.6	193
946	41.67	42	8.0	14.6	33.8	31.9	26.1	0.9	512	16.0	201
951	41.79	42	7.9	14.4	33.2	31.9	25.6	0.9	512	15.7	187
956	41.91	42	7.9	14.4	33.3	31.8	26.2	0.8	511	15.9	199
961	42.02	43	8.2	15.1	34.8	32.3	26.7	1.0	518	16.3	205
966	42.14	43	7.8	14.1	32.6	31.7	25.8	0.8	509	15.6	195
971	42.26	43	8.4	15.5	35.8	33.2	27.1	1.4	533	16.5	198
976	42.37	43	8.1	14.7	34.0	32.2	26.8	1.0	517	16.0	212
981	42.49	43	8.1	14.8	34.2	32.1	27.0	1.1	515	16.2	214
986	42.61	43	8.2	15.0	34.7	32.4	27.2	1.2	520	16.2	212
991	42.72	43	8.1	14.6	33.7	32.2	26.6	1.0	517	15.9	204
996	42.84	43	7.9	14.2	32.8	31.8	26.4	0.9	510	15.7	207
1001	42.95	43	8.0	14.2	32.9	31.7	26.5	0.9	509	15.6	225
		Average	7.5	16.2	37.4	30.4	21.8	4.7	489	16.0	180
		Std. Dev.	0.6	1.1	2.4	2.2	3.6	2.7	35	0.7	22
		Maximum	8.6	19.3	44.7	33.7	27.4	10.9	541	17.6	230
		@ Blow#	808	90	90	879	988	14	879	648	252

Total number of blows analyzed: 1003

Time Summary

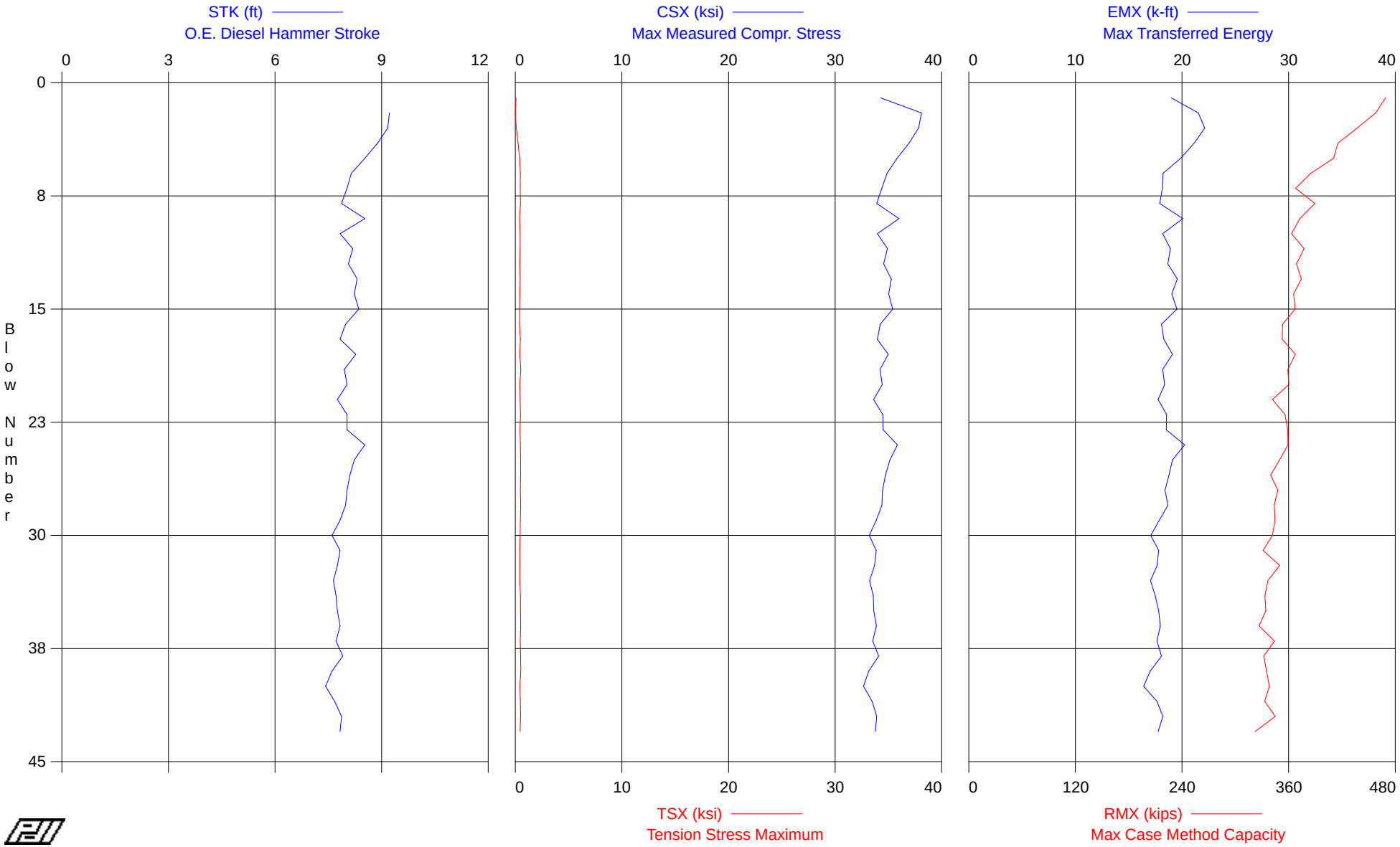
Drive 39 minutes 58 seconds 1:24:42 PM - 2:04:40 PM (9/19/2013) BN 1 - 1003

Geotechnology, Inc. - Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Sep-2013

Test date: 26-Sep-2013

MS&T Test Pile - Livingston County Test Pile BOR



Geotechnology, Inc.
Case Method & iCAP® Results

PDIPLOT Ver. 2012.2 - Printed: 27-Sep-2013

MS&T Test Pile - Livingston County Test Pile BOR
OP: JRC

PP 14X3/8 CE
Test date: 26-Sep-2013

AR: 16.05 in^2
LE: 47.67 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft3
EM: 30,000 ksi
JC: 0.85

STK: O.E. Diesel Hammer Stroke
EMX: Max Transferred Energy
ETR: Energy Transfer Ratio
CSX: Max Measured Compr. Stress
CSB: Compression Stress at Bottom

TSX: Tension Stress Maximum
FMX: Maximum Force
VMX: Maximum Velocity
RMX: Max Case Method Capacity

BL#	STK	EMX	ETR	CSX	CSB	TSX	FMX	VMX	RMX
	ft	k-ft	(%)	ksi	ksi	ksi	kips	f/s	kips
1	0.0	19.0	43.9	34.3	30.6	0.1	550	17.2	469
2	9.2	21.5	49.8	38.1	30.6	0.0	612	18.0	458
3	9.2	22.1	51.2	37.8	32.3	0.1	607	18.7	437
4	8.9	21.1	48.9	36.9	31.3	0.3	593	18.3	416
5	8.5	19.9	46.0	35.8	30.9	0.4	575	17.8	411
6	8.1	18.2	42.1	34.9	29.7	0.5	560	17.1	385
7	8.0	18.2	42.0	34.4	29.0	0.5	552	17.0	368
8	7.9	17.9	41.4	33.9	29.2	0.5	544	16.8	389
9	8.5	20.1	46.4	36.0	30.5	0.4	578	18.0	373
10	7.8	18.2	42.1	34.0	28.2	0.5	545	16.7	363
11	8.2	18.9	43.7	34.9	29.6	0.5	560	17.3	377
12	8.1	18.7	43.2	34.6	29.3	0.4	555	17.1	369
13	8.3	19.6	45.2	35.3	29.8	0.5	566	17.6	374
14	8.2	19.0	44.0	35.0	29.6	0.4	562	17.4	366
15	8.4	19.5	45.1	35.4	29.8	0.4	568	17.6	367
16	8.0	18.1	41.8	34.2	28.8	0.4	550	16.9	353
17	7.8	18.3	42.3	34.0	27.8	0.5	545	16.9	353
18	8.3	19.1	44.2	35.0	29.0	0.4	561	17.3	368
19	7.9	18.2	42.1	34.2	28.5	0.5	549	16.9	359
20	8.0	18.4	42.5	34.4	28.6	0.4	553	17.0	360
21	7.8	17.8	41.1	33.6	27.4	0.4	540	16.7	342
22	8.0	18.6	42.9	34.5	28.6	0.5	553	17.1	356
23	8.0	18.5	42.8	34.5	28.3	0.4	554	17.0	359
24	8.5	20.2	46.8	35.8	29.1	0.5	575	17.8	359
25	8.2	19.1	44.2	35.1	28.6	0.5	564	17.4	350
26	8.1	18.8	43.4	34.7	28.0	0.5	557	17.3	340
27	8.0	18.4	42.6	34.5	27.9	0.5	553	17.0	348
28	8.0	18.7	43.2	34.4	27.7	0.5	552	17.1	344
29	7.8	17.9	41.3	33.9	27.4	0.5	544	16.7	345
30	7.6	17.1	39.5	33.2	26.9	0.5	533	16.3	342
31	7.8	17.8	41.2	33.8	27.5	0.4	543	16.8	331
32	7.8	17.7	40.9	33.7	27.0	0.4	541	16.6	350
33	7.6	17.0	39.4	33.2	26.9	0.4	533	16.4	337
34	7.7	17.5	40.5	33.6	26.8	0.5	539	16.5	333
35	7.8	17.8	41.2	33.6	26.4	0.5	540	16.6	334
36	7.8	18.0	41.5	33.9	26.4	0.5	544	16.7	327
37	7.7	17.7	40.8	33.5	26.9	0.5	538	16.6	344
38	7.9	18.1	41.8	34.1	27.2	0.5	547	16.9	332
39	7.6	17.0	39.4	33.1	26.8	0.5	532	16.4	335
40	7.4	16.4	37.9	32.7	26.2	0.4	524	16.0	338
41	7.7	17.6	40.8	33.5	26.9	0.5	537	16.6	333
42	7.9	18.2	42.1	33.9	27.0	0.5	544	16.8	345
43	7.8	17.8	41.1	33.8	26.5	0.4	542	16.8	322
Average	8.0	18.5	42.9	34.5	28.4	0.4	554	17.1	362
Std. Dev.	0.4	1.2	2.7	1.1	1.5	0.1	18	0.5	33
Maximum	9.2	22.1	51.2	38.1	32.3	0.5	612	18.7	469
@ Blow#	2	3	3	2	3	19	2	3	1

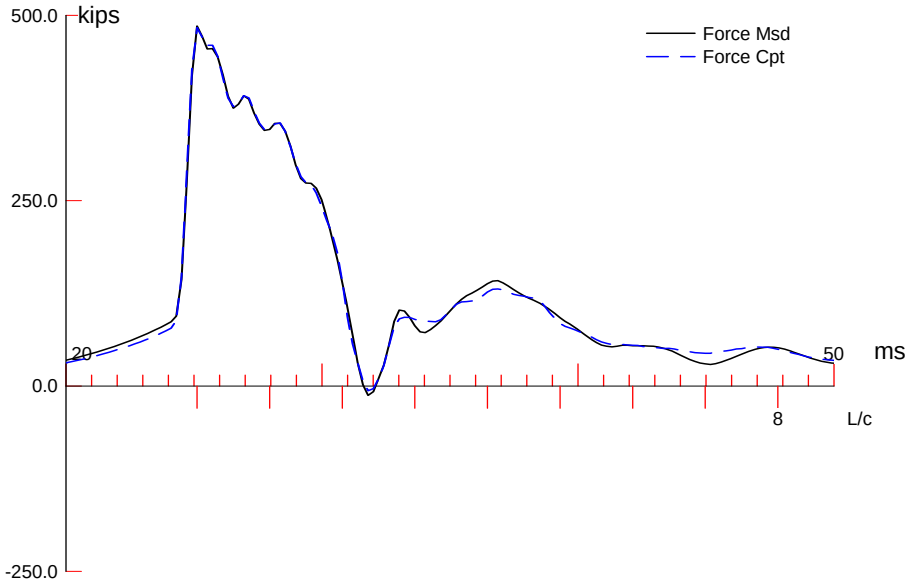
Total number of blows analyzed: 43

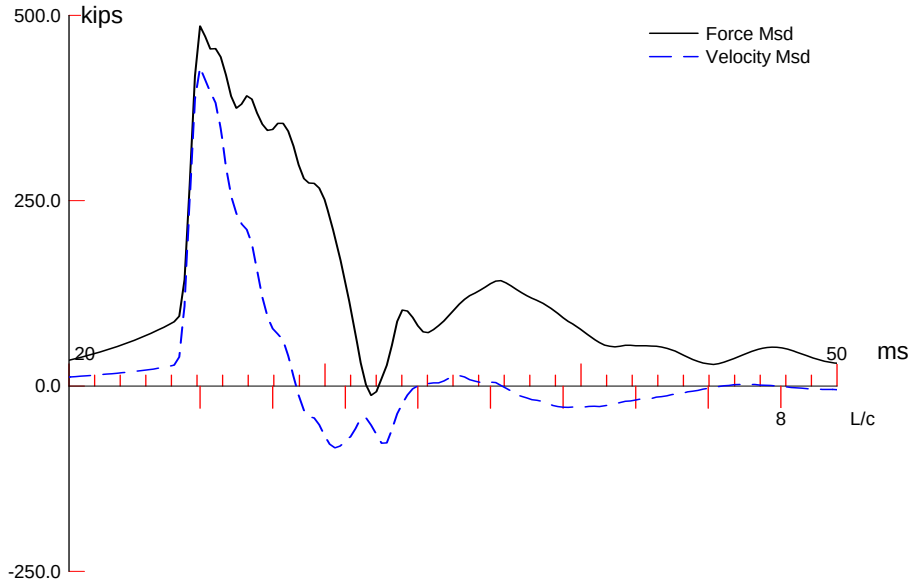
Time Summary

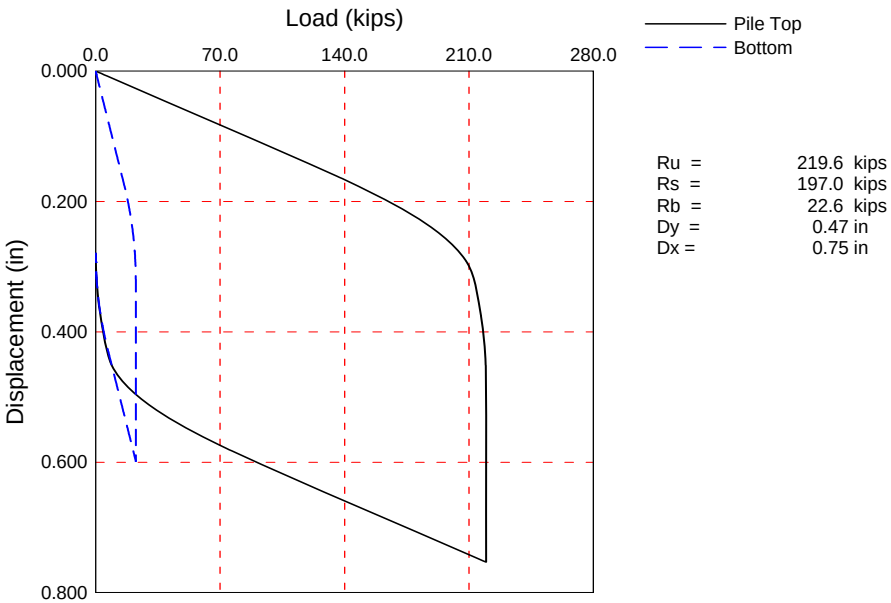
Drive 1 minute 1 second 11:25:23 AM - 11:26:24 AM (9/26/2013) BN 1 - 43

APPENDIX E

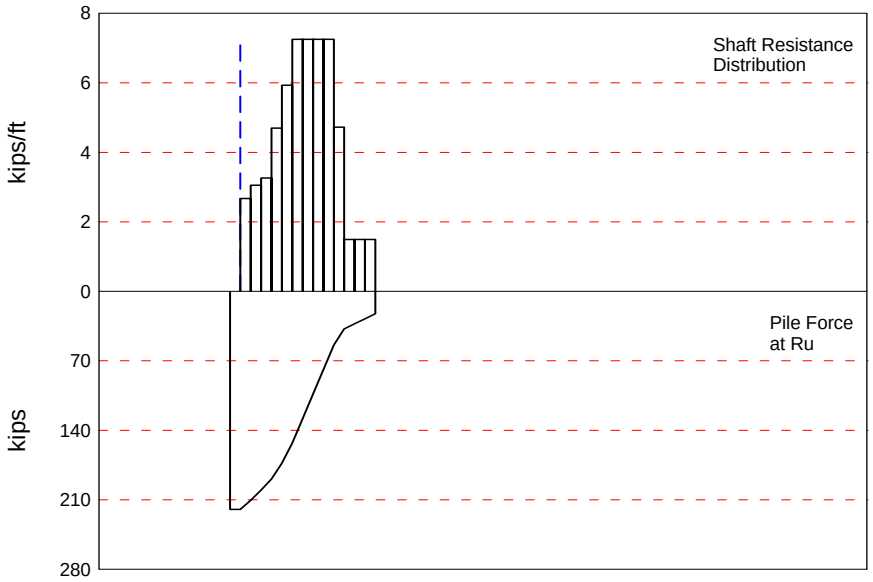
CAPWAP RESULTS







Ru =	219.6	kips
Rs =	197.0	kips
Rb =	22.6	kips
Dy =	0.47	in
Dx =	0.75	in



CAPWAP(R) 2006 Licensed to Geotechnology, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 219.6; along Shaft 197.0; at Toe 22.6 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				219.6				
1	6.8	2.1	9.1	210.5	9.1	4.35	1.19	0.192
2	10.2	5.5	10.4	200.1	19.5	3.05	0.83	0.192
3	13.6	8.9	11.1	189.0	30.6	3.26	0.89	0.192
4	17.0	12.3	16.0	173.0	46.6	4.70	1.28	0.192
5	20.4	15.7	20.2	152.8	66.8	5.93	1.62	0.192
6	23.8	19.1	24.7	128.1	91.5	7.25	1.98	0.192
7	27.2	22.5	24.7	103.4	116.2	7.25	1.98	0.192
8	30.6	25.9	24.7	78.7	140.9	7.25	1.98	0.192
9	34.1	29.3	24.7	54.0	165.6	7.25	1.98	0.192
10	37.5	32.7	16.1	37.9	181.7	4.73	1.29	0.192
11	40.9	36.1	5.1	32.8	186.8	1.50	0.41	0.192
12	44.3	39.5	5.1	27.7	191.9	1.50	0.41	0.192
13	47.7	43.0	5.1	22.6	197.0	1.50	0.41	0.192
Avg. Shaft			15.2			4.59	1.25	0.192
Toe			22.6				21.14	0.400

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.142	0.246
Case Damping Factor		1.321	0.316
Damping Type			Smith
Unloading Quake	(% of loading quake)	77	324
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	65	
Resistance Gap (included in Toe Quake)	(in)		0.172
Soil Plug Weight	(kips)		0.33

CAPWAP match quality = 1.46 (Wave Up Match) ; RSA = 0
Observed: final set = 0.279 in; blow count = 43 b/ft
Computed: final set = 0.264 in; blow count = 45 b/ft

max. Top Comp. Stress = 30.6 ksi (T= 25.5 ms, max= 1.030 x Top)
max. Comp. Stress = 31.5 ksi (Z= 6.8 ft, T= 25.7 ms)
max. Tens. Stress = -1.66 ksi (Z= 37.5 ft, T= 34.2 ms)
max. Energy (EMX) = 13.6 kip-ft; max. Measured Top Displ. (DMX)= 0.46 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	491.4	-4.3	30.6	-0.27	13.56	14.8	0.447
2	6.8	506.2	-4.3	31.5	-0.27	13.20	14.2	0.420
3	10.2	490.3	-0.8	30.5	-0.05	12.20	13.6	0.406
4	13.6	473.9	0.0	29.5	0.00	11.41	13.0	0.401
5	17.0	463.2	0.0	28.9	0.00	10.63	12.2	0.394
6	20.4	441.4	-4.6	27.5	-0.29	9.59	11.3	0.387
7	23.8	409.4	-11.6	25.5	-0.72	8.38	10.4	0.382
8	27.2	368.5	-12.7	23.0	-0.79	6.99	9.6	0.378
9	30.6	331.3	-19.2	20.6	-1.20	5.65	8.9	0.375
10	34.1	293.5	-24.8	18.3	-1.55	4.32	8.3	0.372
11	37.5	250.9	-26.6	15.6	-1.66	2.97	9.1	0.371
12	40.9	222.4	-25.3	13.9	-1.58	2.05	9.6	0.372
13	44.3	225.9	-20.9	14.1	-1.30	1.73	10.9	0.371
14	47.7	168.4	-17.7	10.5	-1.10	0.94	11.8	0.371
Absolute	6.8			31.5			(T =	25.7 ms)
	37.5				-1.66		(T =	34.2 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	582.7	546.7	510.6	474.5	438.5	402.4	366.4	330.3	294.3	258.2
RX	582.7	546.7	510.6	474.5	438.5	402.4	366.4	330.3	294.3	258.2
RU	643.3	613.3	583.3	553.4	523.4	493.4	463.4	433.4	403.4	373.4

RAU = 122.1 (kips); RA2 = 323.1 (kips)

Current CAPWAP Ru = 219.6 (kips);

Case Method matching requires higher damping factor - please check with PDA-W

VMX ft/s	VFN ft/s	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
15.51	0.00	444.2	499.0	508.6	0.458	0.272	0.279	14.0	457.3

Peak Velocity Time = 25.32 ms.

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	16.05	29992.2	492.000	3.665

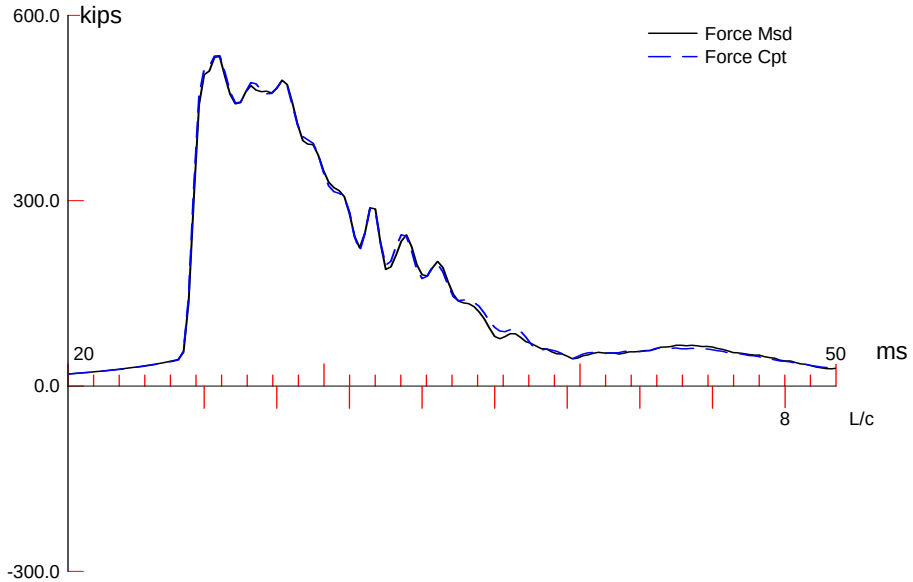
PILE PROFILE AND PILE MODEL

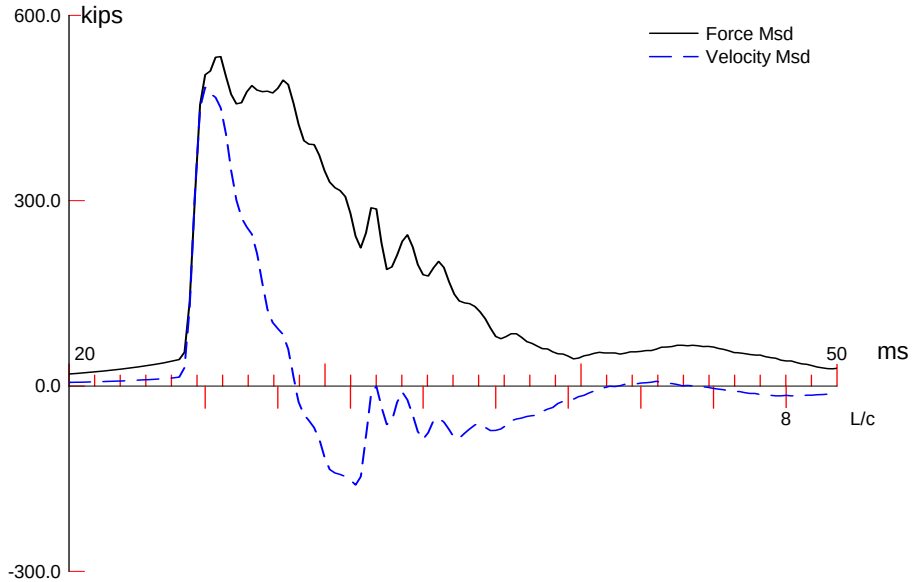
Depth ft	Area in²	E-Modulus ksi	Spec. Weight lb/ft³	Perim. ft
47.67	16.05	29992.2	492.000	3.665

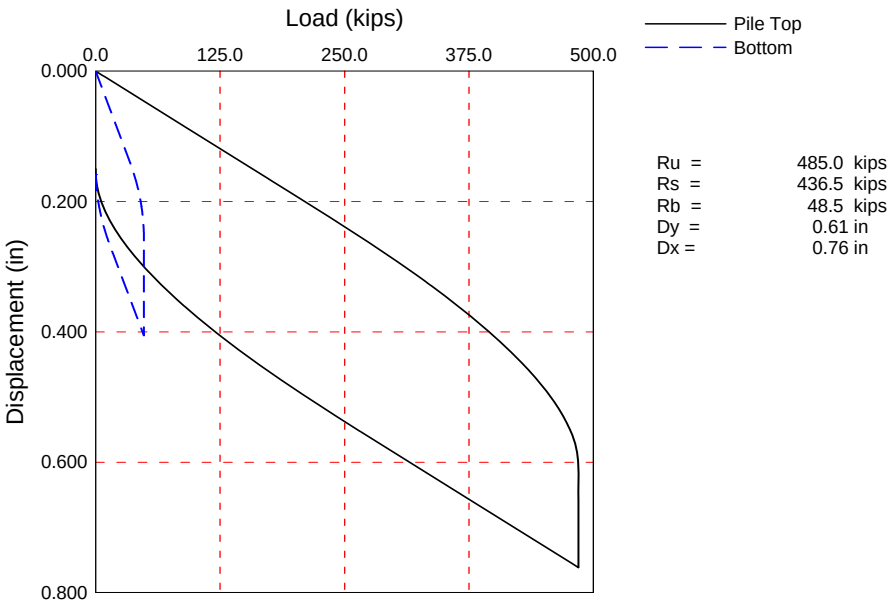
Toe Area 1.069 ft²

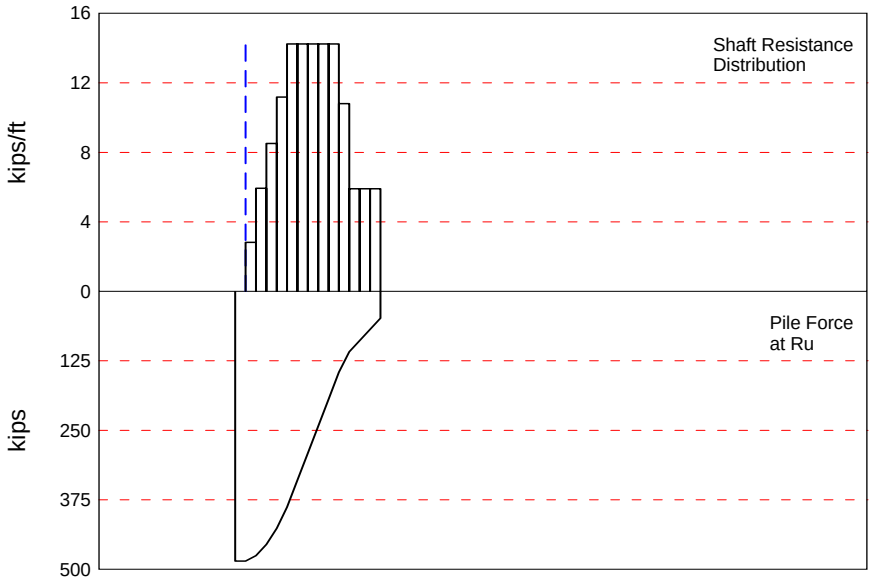
Top Segment Length 3.41 ft, Top Impedance 28.65 kips/ft/s

Pile Damping 1.0 %, Time Incr 0.203 ms, Wave Speed 16807.9 ft/s, 2L/c 5.7 ms









CAPWAP(R) 2006 Licensed to Geotechnology, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 485.0; along Shaft 436.5; at Toe 48.5 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft	Quake in
				485.0					
1	6.8	2.1	9.6	475.4	9.6	4.49	1.22	0.144	0.207
2	10.2	5.5	20.2	455.2	29.8	5.93	1.62	0.144	0.207
3	13.6	9.0	29.0	426.2	58.8	8.52	2.32	0.144	0.207
4	17.0	12.4	38.1	388.1	96.9	11.19	3.05	0.144	0.207
5	20.4	15.8	48.5	339.6	145.4	14.24	3.89	0.144	0.207
6	23.8	19.2	48.5	291.1	193.9	14.24	3.89	0.144	0.207
7	27.2	22.6	48.5	242.6	242.4	14.24	3.89	0.144	0.207
8	30.6	26.0	48.5	194.1	290.9	14.24	3.89	0.144	0.207
9	34.1	29.4	48.5	145.6	339.4	14.24	3.89	0.144	0.207
10	37.5	32.8	36.8	108.8	376.2	10.81	2.95	0.144	0.207
11	40.9	36.2	20.1	88.7	396.3	5.90	1.61	0.144	0.207
12	44.3	39.6	20.1	68.6	416.4	5.90	1.61	0.144	0.199
13	47.7	43.0	20.1	48.5	436.5	5.90	1.61	0.144	0.193
Avg. Shaft			33.6			10.15	2.77	0.144	0.206
Toe			48.5				45.37	0.348	0.197

Soil Model Parameters/Extensions		Shaft	Toe
Case Damping Factor		2.189	0.589
Damping Type			Smith
Unloading Quake	(% of loading quake)	63	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	18	
Resistance Gap (included in Toe Quake) (in)			0.022
Soil Plug Weight	(kips)		0.56

CAPWAP match quality = 0.86 (Wave Up Match) ; RSA = 0
Observed: final set = 0.150 in; blow count = 80 b/ft
Computed: final set = 0.118 in; blow count = 102 b/ft

max. Top Comp. Stress = 34.7 ksi (T= 26.3 ms, max= 1.070 x Top)
max. Comp. Stress = 37.1 ksi (Z= 10.2 ft, T= 26.7 ms)
max. Tens. Stress = -0.73 ksi (Z= 47.7 ft, T= 38.3 ms)
max. Energy (EMX) = 17.6 kip-ft; max. Measured Top Displ. (DMX)= 0.50 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	557.0	0.0	34.7	0.00	17.55	16.0	0.454
2	6.8	586.1	0.0	36.5	0.00	16.79	15.4	0.414
3	10.2	596.2	-0.0	37.1	-0.00	15.33	14.4	0.375
4	13.6	583.9	-0.0	36.4	-0.00	13.42	13.3	0.338
5	17.0	554.0	-0.0	34.5	-0.00	11.32	12.0	0.302
6	20.4	509.0	-0.0	31.7	-0.00	9.41	10.7	0.276
7	23.8	450.4	-0.0	28.1	-0.00	7.69	9.6	0.260
8	27.2	397.9	-0.0	24.8	-0.00	6.25	8.6	0.246
9	30.6	348.0	-0.0	21.7	-0.00	5.01	7.6	0.234
10	34.1	298.1	-0.0	18.6	-0.00	3.92	6.9	0.225
11	37.5	255.9	-0.0	15.9	-0.00	2.93	6.4	0.219
12	40.9	248.2	-0.0	15.5	-0.00	2.21	6.1	0.215
13	44.3	233.6	-3.3	14.6	-0.20	1.81	6.9	0.210
14	47.7	194.1	-11.7	12.1	-0.73	0.93	8.0	0.206
Absolute	10.2			37.1			(T =	26.7 ms)
	47.7				-0.73		(T =	38.3 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	720.1	693.4	666.6	639.9	613.2	586.4	559.7	533.0	506.2	479.5
RX	720.1	693.4	666.6	639.9	613.2	586.4	559.7	533.0	506.2	479.5
RU	840.4	825.7	811.0	796.3	781.6	766.9	752.2	737.5	722.8	708.1

RAU = 199.1 (kips); RA2 = 466.0 (kips)

Current CAPWAP Ru = 485.0 (kips); Corresponding J(RP)= 0.88; J(RX) = 0.88

VMX ft/s	VFN ft/s	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
16.87	0.02	483.4	503.9	533.2	0.498	0.132	0.150	18.3	678.0

Peak Velocity Time = 25.53 ms.

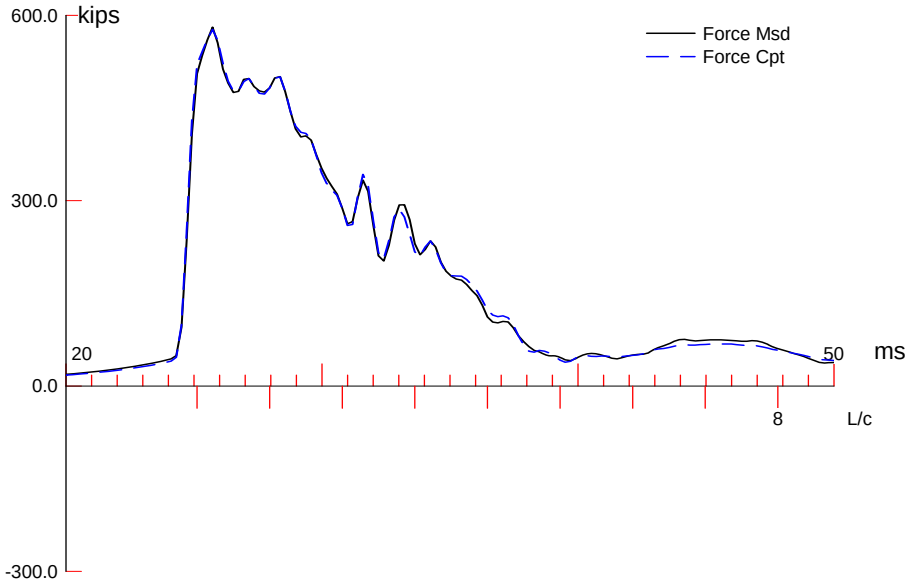
PILE PROFILE AND PILE MODEL

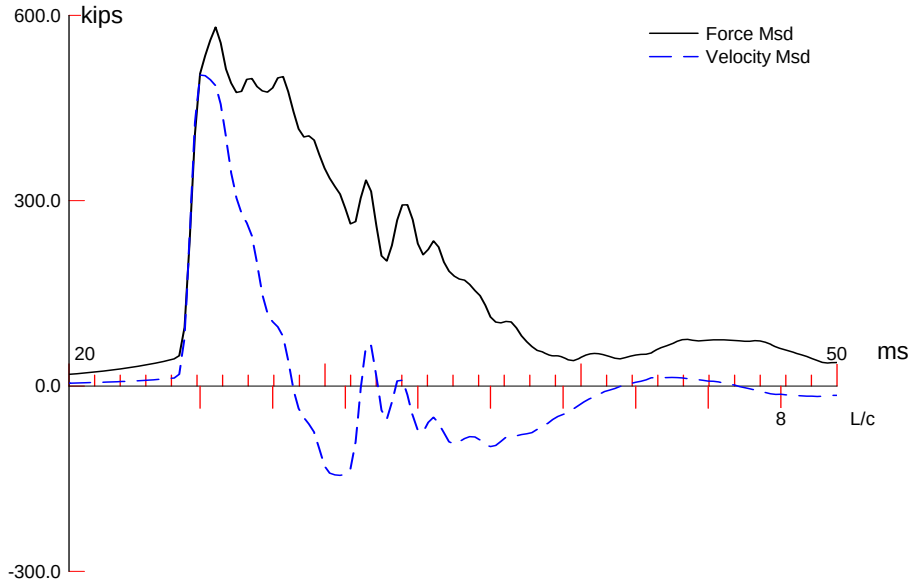
Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	16.05	29992.2	492.000	3.665
47.67	16.05	29992.2	492.000	3.665

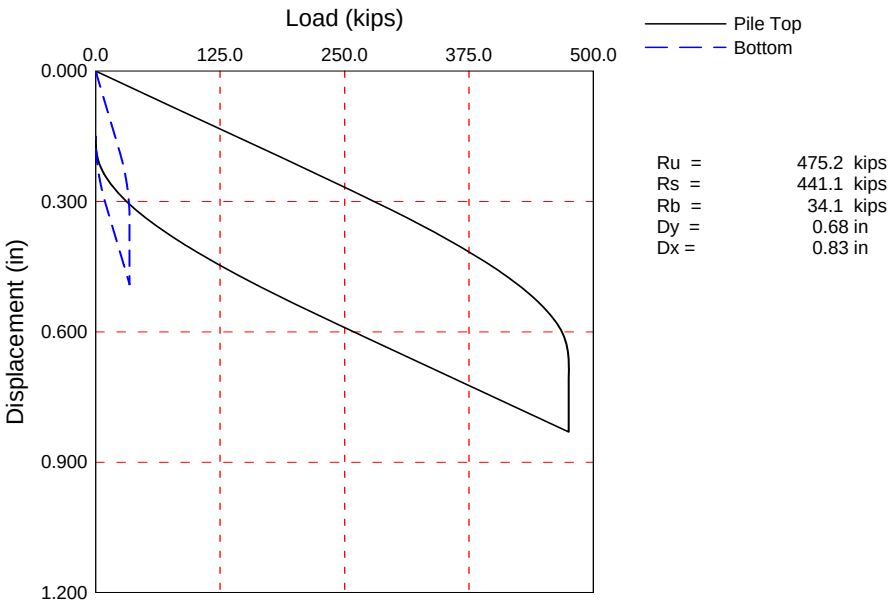
Toe Area 1.069 ft^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Soil Plug kips
1	3.41	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.00
2	6.81	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.01
14	47.67	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.01

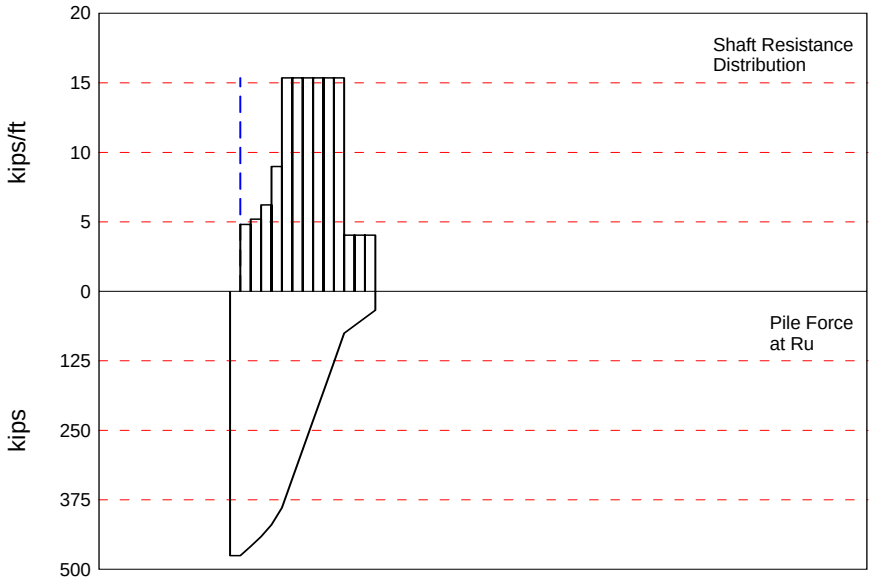
Pile Damping 1.0 %, Time Incr 0.203 ms, Wave Speed 16807.9 ft/s, 2L/c 5.7 ms







Ru =	475.2	kips
Rs =	441.1	kips
Rb =	34.1	kips
Dy =	0.68	in
Dx =	0.83	in



CAPWAP(R) 2006 Licensed to Geotechnology, Inc.

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 475.2; along Shaft 441.1; at Toe 34.1 kips

Soil Sgmnt No.	Dist. Below Gages ft	Depth Below Grade ft	Ru kips	Force in Pile kips	Sum of Ru kips	Unit Resist. (Depth) kips/ft	Unit Resist. (Area) ksf	Smith Damping Factor s/ft
				475.2				
1	6.8	2.1	16.4	458.8	16.4	7.66	2.09	0.137
2	10.2	5.5	17.7	441.1	34.1	5.20	1.42	0.137
3	13.6	9.0	21.2	419.9	55.3	6.23	1.70	0.137
4	17.0	12.4	30.6	389.3	85.9	8.99	2.45	0.137
5	20.4	15.8	52.3	337.0	138.2	15.36	4.19	0.137
6	23.8	19.2	52.3	284.7	190.5	15.36	4.19	0.137
7	27.2	22.6	52.3	232.4	242.8	15.36	4.19	0.137
8	30.6	26.0	52.3	180.1	295.1	15.36	4.19	0.137
9	34.1	29.4	52.3	127.8	347.4	15.36	4.19	0.137
10	37.5	32.8	52.3	75.5	399.7	15.36	4.19	0.137
11	40.9	36.2	13.8	61.7	413.5	4.05	1.11	0.137
12	44.3	39.6	13.8	47.9	427.3	4.05	1.11	0.137
13	47.7	43.0	13.8	34.1	441.1	4.05	1.11	0.137
Avg. Shaft			33.9			10.26	2.80	0.137
Toe			34.1				31.90	0.249

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(in)	0.256	0.262
Case Damping Factor		2.109	0.296
Damping Type			Smith
Unloading Quake	(% of loading quake)	47	104
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	14	
Resistance Gap (included in Toe Quake)	(in)		0.011
Soil Plug Weight	(kips)		0.34

CAPWAP match quality = 1.08 (Wave Up Match) ; RSA = 0
Observed: final set = 0.150 in; blow count = 80 b/ft
Computed: final set = 0.165 in; blow count = 73 b/ft

max. Top Comp. Stress = 37.2 ksi (T= 26.1 ms, max= 1.039 x Top)
max. Comp. Stress = 38.7 ksi (Z= 6.8 ft, T= 26.3 ms)
max. Tens. Stress = -0.16 ksi (Z= 47.7 ft, T= 35.5 ms)
max. Energy (EMX) = 19.6 kip-ft; max. Measured Top Displ. (DMX)= 0.52 in

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages ft	max. Force kips	min. Force kips	max. Comp. Stress ksi	max. Tens. Stress ksi	max. Trnsfd. Energy kip-ft	max. Veloc. ft/s	max. Displ. in
1	3.4	597.6	0.0	37.2	0.00	19.57	16.6	0.484
2	6.8	621.0	0.0	38.7	0.00	18.77	15.9	0.443
3	10.2	605.4	-0.0	37.7	-0.00	16.72	15.1	0.404
4	13.6	598.9	-0.0	37.3	-0.00	14.84	14.1	0.366
5	17.0	589.7	-0.0	36.7	-0.00	13.06	12.8	0.332
6	20.4	562.2	-0.0	35.0	-0.00	11.52	11.4	0.314
7	23.8	497.8	-0.0	31.0	-0.00	9.46	10.2	0.300
8	27.2	440.1	-0.0	27.4	-0.00	7.70	9.1	0.287
9	30.6	388.3	-0.0	24.2	-0.00	6.16	8.1	0.278
10	34.1	335.3	-0.0	20.9	-0.00	4.76	7.3	0.271
11	37.5	281.1	-0.0	17.5	-0.00	3.43	6.8	0.268
12	40.9	238.2	-0.0	14.8	-0.00	2.11	7.5	0.267
13	44.3	219.3	-0.0	13.7	-0.00	1.74	9.1	0.265
14	47.7	165.8	-2.5	10.3	-0.16	0.83	10.2	0.262
Absolute	6.8			38.7			(T =	26.3 ms)
	47.7				-0.16		(T =	35.5 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	730.5	699.8	669.1	638.5	607.8	577.2	546.5	515.9	485.2	454.6
RX	730.5	699.8	669.1	638.5	607.8	577.2	546.5	515.9	485.2	454.6
RU	856.7	838.6	820.6	802.5	784.5	766.5	748.4	730.4	712.4	694.3

RAU = 251.7 (kips); RA2 = 504.1 (kips)

Current CAPWAP Ru = 475.2 (kips); Corresponding J(RP)= 0.83; J(RX) = 0.83

VMX ft/s	VFN ft/s	VT1*Z kips	FT1 kips	FMX kips	DMX in	DFN in	SET in	EMX kip-ft	QUS kips
17.95	0.00	514.3	522.7	597.8	0.522	0.150	0.150	20.5	733.8

Peak Velocity Time = 25.32 ms.

PILE PROFILE AND PILE MODEL

Depth ft	Area in^2	E-Modulus ksi	Spec. Weight lb/ft^3	Perim. ft
0.00	16.05	29992.2	492.000	3.665
47.67	16.05	29992.2	492.000	3.665

Toe Area 1.069 ft^2

Segmnt Number	Dist. B.G. ft	Impedance kips/ft/s	Imped. Change %	Tension Slack in	Tension Eff.	Compression Slack in	Compression Eff.	Perim. ft	Soil Plug kips
1	3.41	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.00
2	6.81	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.01
14	47.67	28.65	0.00	0.000	0.000	-0.000	0.000	3.665	0.01

Pile Damping 1.0 %, Time Incr 0.203 ms, Wave Speed 16807.9 ft/s, 2L/c 5.7 ms