Structure Geotechnical Report

FAP RTE 327 (US Rt. 50)
Section (51-23B-2)B-1
Lawrence County
Structure (Existing) 051-0015
Structure (Proposed) 051-0066
Contract: 74177
Job Number: P 97-038-06
PTB 147, Item 26 WO #8

Prepared By: Timothy J. Holcomb, P.E.
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HFE File H-09140

Date: December 2, 2010

Prepared For: ESCA Consultants, Inc.
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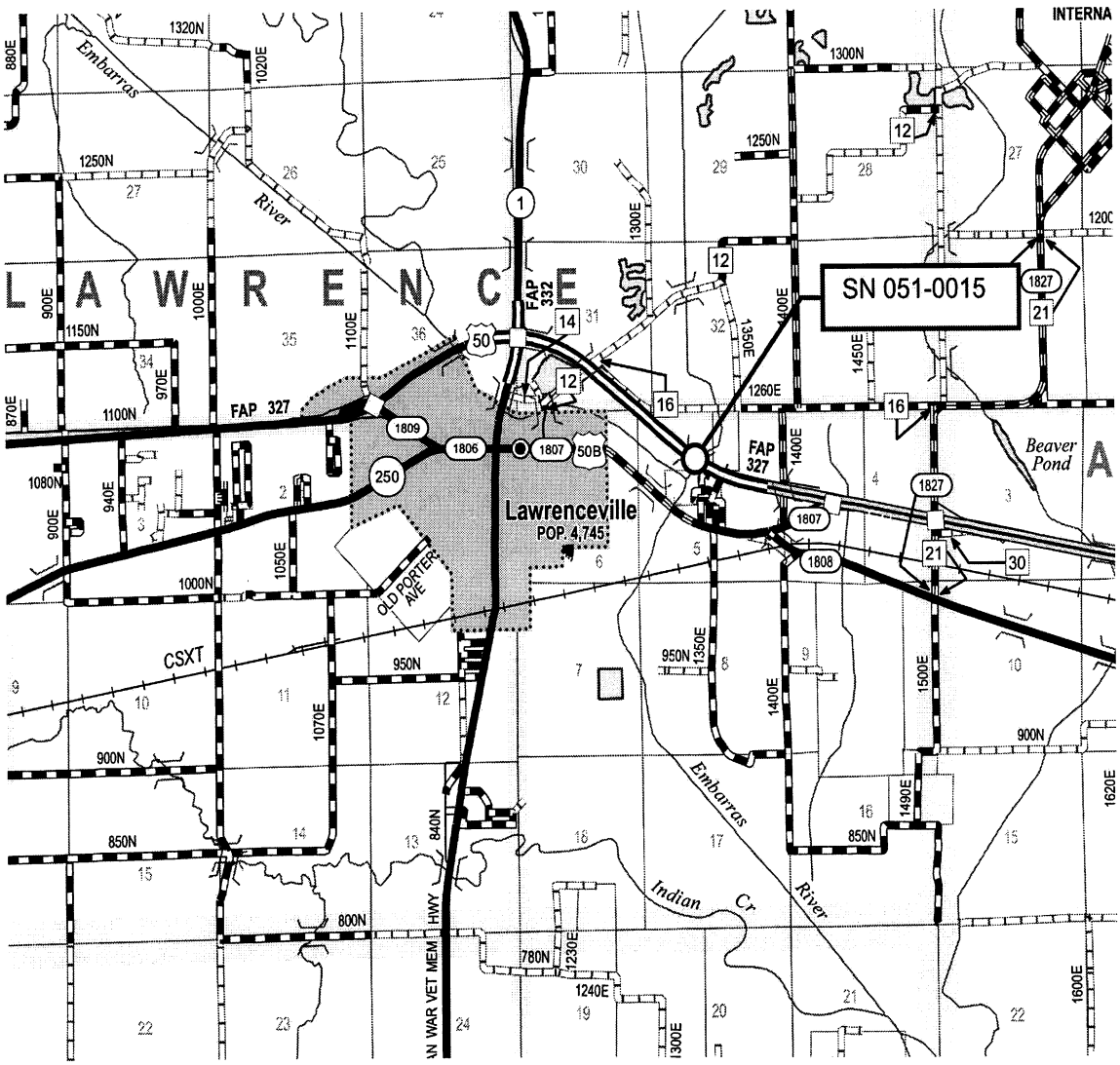
Urbana, Illinois 61803

Attachments: TSL Drawing
Subsurface Profile
Boring Logs
Shelby Tube Test Results
Global Site Classification
Slope Stability Analyses
H Pile Lateral Load Analysis
Liquefaction Analysis Spread Sheets

1.0 Project Description and Proposed Structure Information

This project is to consist of replacement of existing structure 051-0015 carrying US Route #50 over Otter Pond Ditch on the northeast side of Lawrenceville, Illinois in Lawrence County, Illinois. Specifically, the structure is located in the NW 1/4 of Section 5, Township 3 North, Range 11 West of the Third Principal Meridian in Lawrence County, Illinois.

The project includes construction of a seven span structure with a length of 489' 2" back to back of abutments, and a clear width of 40'. The new structure will consist of a concrete deck supported by steel beams resting on intermediate piers and pile supported abutments. The existing and proposed structures are perpendicular to Otter Pond Creek. The new structure will have 2:1 end slopes, an intermediate berm, and a flow line elevation of 400.4. This structure will be constructed using stage construction to maintain one lane of traffic at all times.



2.0 Existing Information

The existing bridge structure was constructed in 1959. It consists of a nine span reinforced concrete slab deck T-beam superstructure. The beams are supported by open abutments on steel piles and solid shaft piers on spread footings founded on rock. The deck width is 35'8" and length is 452'2" back to back of abutments. The existing structure has no skew, and .015ft/ft superelevation. This structure will be completely replaced, and traffic shall be maintained using stage construction.

3.0 Site Investigation, Subsurface Exploration, and Conditions

This structure lies in the Mt. Vernon Hill Country physiographic division of Illinois. Subsoils in this area commonly consist of a thin mantle of loess overlying Illinoisan glacial drift and alluvial soils deposited by the Wabash River. Pennsylvanian deposits of shale, sandstone, coal, and limestone generally lie at shallow depths in this area.

The immediate site subsurface conditions consist of about 3 to 5 inches of asphalt overlying 9 to 13 inches of Portland cement concrete at the existing abutments. Below the concrete lies gray to gray to brown silty clay or clay loam that extends to about 14.5 feet in Boring #1. Below the clay lies variable deposits of gray silty loam, sandy loam, and sand that extend to approximately 22 to 39 feet below the existing bridge deck elevation. A gray sandy clay shale was encountered below the loamy soils that extend down to at least the bottom of the soil borings. Boring #6 encountered black coal at about 36 feet in depth that extends down to at least the bottom of this soil boring.

The upper clay loam soils encountered in Boring #1 are stiff, with unconfined compressive strengths ranging from 1.2 to 6.0 tons per square foot, averaging 2.5 tsf. Standard penetration test values of the loam vary from 7 to 17 blows per foot. Moisture contents vary from 15 to 21 percent, averaging 18 percent. These soils have a moderate to low settlement potential.

The sandy loam encountered in Boring #1 and #6 from about 14.5 to 27 feet, and in Boring #6 from 1 to 17 feet have unconfined compressive strengths ranging from 0.1 to 2.8 tons per square foot, averaging 0.8 tsf. Standard penetration test values range from 3 to 16 blows per foot, averaging 8 bpf. Moisture contents vary from 12 to 36 percent, averaging 19 percent. These soils have a medium to high settlement potential.

The silty loam soils encountered at depths ranging from 17 feet in Boring #6 to 27 feet in Borings #1 and #3 are very soft, with unconfined compressive strengths ranging from 0.1 to 1.0 tons per square foot, averaging 0.3 tsf. Standard penetration test values vary from 0 to 2 blows per foot. The silty loam has a very high settlement potential, and a high potential for liquefaction and scour.

The sand stratum encountered from about 34 to 39 feet in Boring #1 have a standard penetration test value of 1 blow per foot and a moisture content of 25 percent. These soils also have a high settlement and liquefaction potential.

The sandy clay shale is very dense, with standard penetration test values in excess of 100 blows per foot. Moisture contents vary from 4 to 13 percent. Unconfined compressive strengths range from 68 to 206 tons per square foot. The shale bedrock is estimated to be relatively incompressible when subjected to the anticipated structural loadings.

Ground water lies at the following elevations:

Boring No.	Encountered	Upon Completion	After 24+ Hrs.
1	397.7	411.2	428.2
2	400.2	402.2	410.5
3	Dry	Dry	412.1
4	400.4	397.0	411.6
5	398.0	401.5	412.5
6	Dry	407.3	429.3
7	401.7	409.2	406.7

4.0 Geotechnical Evaluation

4.1 Settlement

The proposed structure approach will be constructed increasing the height of the west approach approximately 1.8 feet, and the east approach about 3.0 feet. We do not anticipate settlement concerns with the west approach. Settlement calculations performed assuming 3.0 feet of fill on the east approach indicate approximately 0.4 inch of settlement will occur due to the additional 3.0 feet of fill placed. About ½ of this settlement will probably occur during construction. Therefore, we do not anticipate problems with the settlement of the approach subsoils. No remedial methods are recommended to limit the settlements at this location.

4.2 Slope Stability

Due to the elevation of the existing structure being roughly the same (within a few feet) as the proposed structure, we do not anticipate problems with the new embankment stability. The seismic analysis has been determined using a peak horizontal ground acceleration of 0.087g. Stability analyses have been performed on both end slopes and determined the following factors of safety based upon the unconfined compressive strength tests for the upper soils, and effective strength parameters determined by UU triaxial tests for the marginal soils sampled using Shelby tubes by IDOT. Results of the slope stability analyses performed using the effective strength parameters indicate the proposed end slopes are adequately stable.

Location	Analysis	Factor of Safety
West End Slope	Steady State	2.646
West End Slope	Seismic	2.071
East End Slope	Steady State	2.006
East End Slope	Seismic	1.655

4.3 Seismic Considerations

Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.158
Design Spectral Acceleration at 0.2 sec. (S_{Ds}) = 0.398
Soil Site Class = C

The boring logs and laboratory test data indicates the potential for liquefaction is high in the loamy soils that are very soft at this site. Seismic calculations for piling at this location have been figured assuming liquefaction of this soil stratum. The liquefaction analyses were performed in accordance with the IDOT AGMU 10.1 and spreadsheets to determine liquefiable layers.

4.4 Scour

The estimated design scour is estimated as follows:

Design Scour Elevation (ft.)	W. Abut	Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	Pier 6	E. Abut.
	425.8	391.7	394.0	392.5	394.9	393.6	398.5	427.2

The end slopes and are to be protected with rip-rap, and rip-rap should be used throughout the channel.

4.5 Mining Activity

The mine maps available from the State of Illinois Geological Survey indicate the site has not been undermined. Therefore, subsidence is not a concern at this location.

5.0 Foundation Evaluations and Design Recommendations

5.1 Foundation Recommendations

Steel H piles are feasible foundation types for this structure for both the abutments and intermediate piers. Spread footings or H piles drilled into the bedrock (to achieve fixity) may be feasible for the intermediate piers due to the bedrock located near the bottom of the creek elevation.

Spread Footings

If spread footings are used for support of the intermediate supports, they may be dimensioned using a nominal bearing resistance of up to 20 kips per square foot. The footings should have a minimum width of 24 inches, and be founded at least two feet into dense shale. Based upon the results of the intermediate borings, the spread footings should be founded at an approximate elevation of 392.0, but this will depend on the depth of unweathered shale in this area. Settlements of footings dimensioned using 20 ksf are estimated at less than ¼ inch.

H Piles

If the structure will be supported upon steel H piles, the factored loadings for the abutments and piers have been tabulated using the following assumptions:

Abutments:	950 kips
Intermediate Piers	1780 kips (Piers 1,2,5,6) 2225 kips (Piers 3,4)
Pile Cutoff Elev:	427.0 (West Abutment)
	428.43 (Pier #1)
	409.40 (Piers #2 and #5)
	428.83 (Pier #3)
	429.07 (Pier #4)
	429.46 (Pier #6)
	428.45 (East Abutment)

Due to the size of this structure and the estimated loadings, H-piles appear feasible at this location for support of the axial bridge loadings. The piles should be sized and spaced according to current IDOT LRFD design policy in coordination with the pile tables enclosed. Once the necessary factored resistance available (Rf) is determined from the structural loadings, the nominal required bearing (Rn) and estimated pile lengths can be determined using these tables.

Pile Design Table

West Abutment – Boring No. 1

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 10 x 42	335	184	120	38
HP 12 x 53	416	230	165	38
HP 12 x 63	496	273	243	40
HP 14 x 73	564	318	267	39

East Abutment – Boring No. 6

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 10 x 42	151	83	105	20
	335	184	248	25
HP 12 x 53	184	101	129	20
	418	230	314	25
HP 12 x 63	186	102	130	20
	497	273	392	27
HP 14 x 73	222	122	157	20
	578	318	454	26

The bearing capacity of the piles should be determined for each pile based upon the WADOT pile driving formula with less than 600 kips bearing, and a wave equation for piles in excess of 600 kips.

Due to the shallow depth of bedrock and potential of deep scour down to the top of the shale bedrock, the intermediate piers will require the piles to be installed by setting the piles into 24 inch diameter holes drilled five feet into the bedrock. Upon setting the piles into the holes, they should be driven to their maximum nominal bearing and backfilled with Portland cement concrete. This will result in a minimum five foot deep embedment in the bedrock. Fixity, as well as the maximum nominal and factored resistances of the H piles should be achieved if the piles are installed at this depth into the bedrock. Resistances are estimated as follows for piles set into the bore holes:

Intermediate Pier #1 – Boring #2

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	418	67	259	39.0
HP 12 x 63	497	69	337	40.0
HP 14 x 73	578	95	392	40.0

Intermediate Pier #2 – Boring #2

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	413	67	259	40.0
HP 12 x 63	492	103	337	42.0
HP 14 x 73	574	119	392	42.0

Intermediate Pier #3 – Boring #3

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	408	95	276	22.0
HP 12 x 63	488	137	354	23.0
HP 14 x 73	569	156	413	23.0

Intermediate Pier #4 – Boring #4

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	417	216	392	24.0
HP 12 x 63	496	259	471	25.0
HP 14 x 73	564	294	535	24.0

Intermediate Pier #5 – Boring #5

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	416	136	383	44.0
HP 12 x 63	496	178	462	46.0
HP 14 x 73	564	199	524	45.0

Intermediate Pier #6 – Boring #7

	Rn (kips)	Rf (kips)	Seismic Rf (kips)	Est. Length (ft.)
HP 12 x 53	412	204	341	44.0
HP 12 x 63	492	247	420	45.0
HP 14 x 73	574	288	489	45.0

6.0 Construction Considerations

6.1 Stage Construction

During construction it will be necessary to provide temporary cantilevered sheet piling at the west abutment for stage construction. However, the east abutment will require a temporary soil retention system due to the soft subsoils encountered at this location.

The sheet piles at the west abutment may be designed using the following soil parameters:

Soil Type	Cohesion (ksf)	Phi Angle (deg)	Sat Unit Wt. (PCF)	Moisture (%)
Clay Loam (0-14')	1.2	0	125.0	18
Silty Clay (14-26')	1.0	0	125.0	21

6.2 Existing Foundations

Preliminary drawings indicate the existing abutment piles may interfere with installation of the new H piles. Therefore, some of the abutment piles or may require repositioning during construction to install these to avoid removal of the existing piles. The remaining piles do not appear to conflict with locations of the current piles or spread footings. Therefore, the existing piles and footings may remain in place and should not require removal prior to construction.

6.3 Backfill

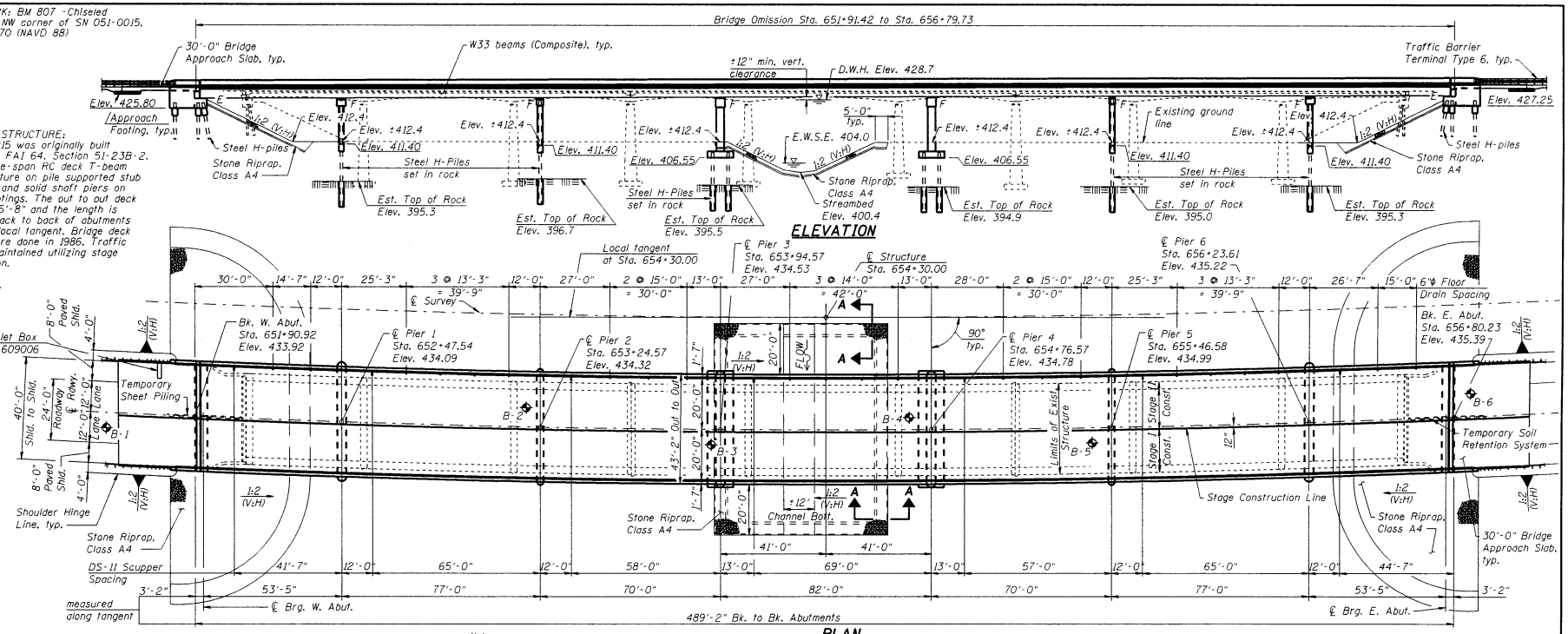
Porous granular embankment (special) will be placed behind both abutments to facilitate drainage. Four inch perforated drains will allow any seepage water to drain out of these abutment backfill areas.

Timothy J. Holcomb, P.E.

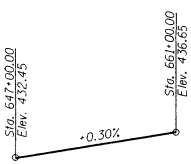
BENCHMARK: BM 807 - Chiseled square on NW corner of SN 051-0015. Elev. 432.70 (NAVD 88)

EXISTING STRUCTURE:
SN 051-0015 was originally built in 1959 as FAI 64, Section 51-23B-2. It is a nine-span RC deck T-beam superstructure on pile supported stub abutments and solid shaft piers on spread footings. The out to out deck width is 35'-8" and the length is 452'-2" back to back of abutments along the local tangent. Bridge deck repairs were done in 1986. Traffic shall be maintained utilizing stage construction.

No salvage.



Note:
All horizontal dimensions measured radially unless noted otherwise.



PROFILE GRADE
(Along ℄ Roadway)

℄ SURVEY CURVE DATA
△ = 27°44'33" (LT)
D = 1°00'01"
R = 5,727.67'
T = 1,414.40'
L = 2,773.32'
E = 172.05'
P.C. Sta. = 647+04.39
P.T. Sta. = 674+77.71
P.I. Sta. = 661+18.79

℄ ROADWAY CURVE DATA
△ = 27°44'33" (LT)
D = 0°59'34"
R = 5,771.67'
T = 1,425.27'
L = 2,794.62'
E = 173.38'
S.E. = 0.034'/'
P.C. Sta. = 647+04.39
P.T. Sta. = 674+99.01
P.I. Sta. = 661+29.66

DESIGN SCOUR ELEVATION TABLE

Design Scour Elevation (Ft.)	W. Abut.	Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	Pier 6	E. Abut.
	425.8	396.2	394.0	392.5	391.9	393.6	395.7	427.2

WATERWAY INFORMATION

Drainage Area = 2350.6 Sq. Mi. Low Grade Elev. 431.60 @ Sta. 640+00

	Freq. Yr.		Q C.F.S.	Opening-Sq. Ft. Exist.	Opening-Sq. Ft. Prop.	Nat. H.W.E.	Head-Ft. Exist.	Head-Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
Design	10	SN 051-0011	20466	5102	5677	425.5	0.7	0.6	426.2	426.1
		Total	40329							
	50	SN 051-0011	31775	6431	7188	428.7	0.9	0.8	429.6	429.5
		SN 051-0015	28091							
		Total	59866							
Overtop.	80	SN 051-0011	38292	6640	7620	429.6	1.9	1.8	431.5	431.4
		SN 051-0015	27270							
		Total	65562							
Base	100	SN 051-0011	39647	6644	7706	430.1	1.8	1.7	431.9	431.8
		SN 051-0015	28481							
		Total	68128							

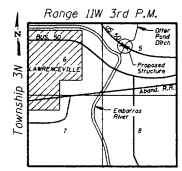
HIGHWAY CLASSIFICATION
FAP Route 327 (US 50)
Functional Class: Other Principal Arterial
ADT: 5155 (2010); 7017 (2032)
DHV: 772 (2032)
ADTT: 21.4%
Design Speed: 70 mph (Future)
Posted Speed: 55 mph
Two Way Traffic
Directional Distribution: 51:49

DESIGN SPECIFICATIONS
2010 AASHTO LRFD
Bridge Design Specifications

LOADING HL-93
Allow 50 psf for future wearing surface.

DESIGN STRESSES
FIELD UNITS
f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

SEISMIC DATA
Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.225g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.514g
Soil Site Class = D



LOCATION SKETCH

GENERAL PLAN
US 50 OVER OTTER POND DITCH
FAP ROUTE 327 - SECTION (51-23B-2)B-1
LAWRENCE COUNTY
STATION 654+30.00
STRUCTURE NO. 051-0066

FILE NAME = #FILES#	USER NAME = #USER#	DESIGNED - MTD 08/10	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	SHEET NO. 1 OF 2 SHEETS
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F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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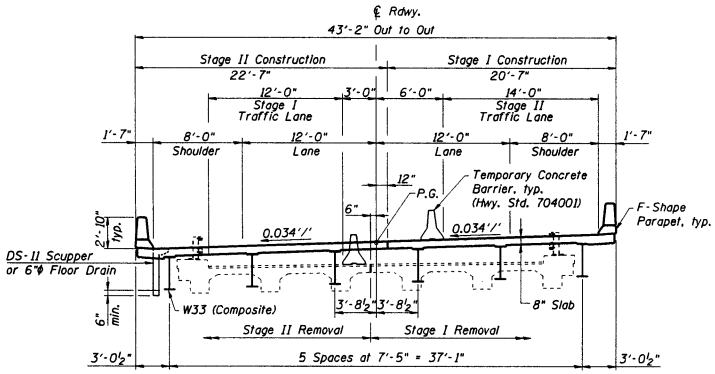
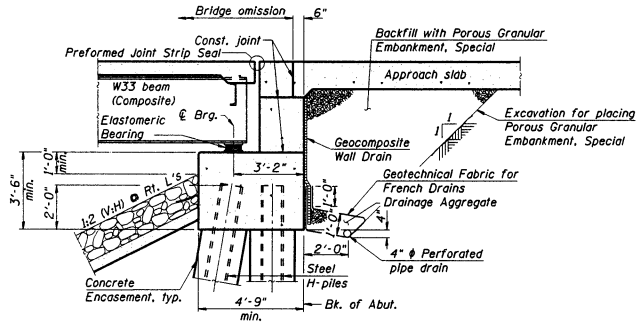
		CONTRACT NO. 74177		
		ILLINOIS FED. AID PROJECT		

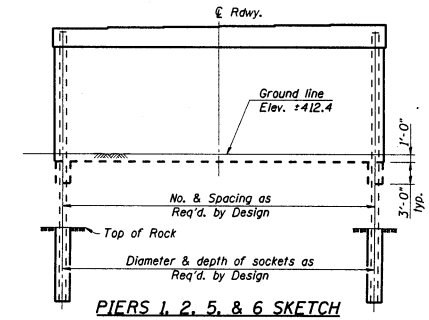


CROSS SECTION
(Looking East)

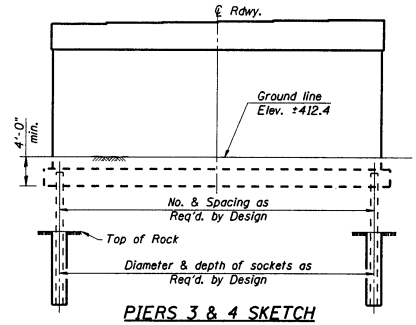
Notes: All horizontal dimensions measured radially unless noted otherwise.
Location of Stage Construction line for substructure units to be determined in final design.



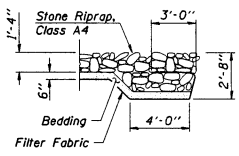
SECTION THRU PILE SUPPORTED
STUB ABUTMENT
(Horiz. dim. ● Rt. L's)



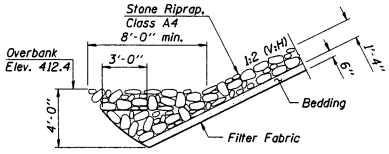
PIERS 1, 2, 5, & 6 SKETCH



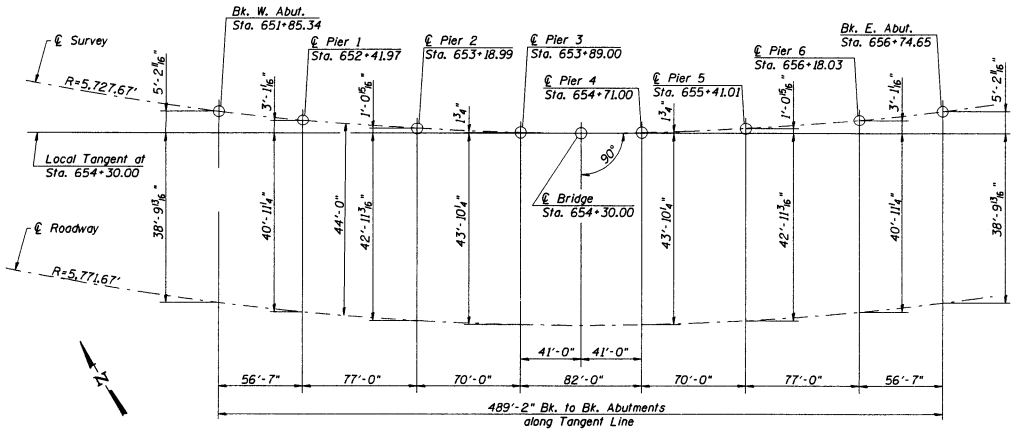
PIERS 3 & 4 SKETCH



SECTION A-A



STONE RIPRAP ANCHOR DETAIL



OFFSET SKETCH

DETAILS
US 50 OVER OTTER POND DITCH
FAP ROUTE 327 - SECTION (51-23B-2)B-1
LAWRENCE COUNTY
STATION 654+30.00
STRUCTURE NO. 051-0066

FILE NAME = 0510066-74177-02-TSL.dgn	USER NAME = DWH	DESIGNED - MTD 08/10	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	SHEET NO. 2 OF 2 SHEETS
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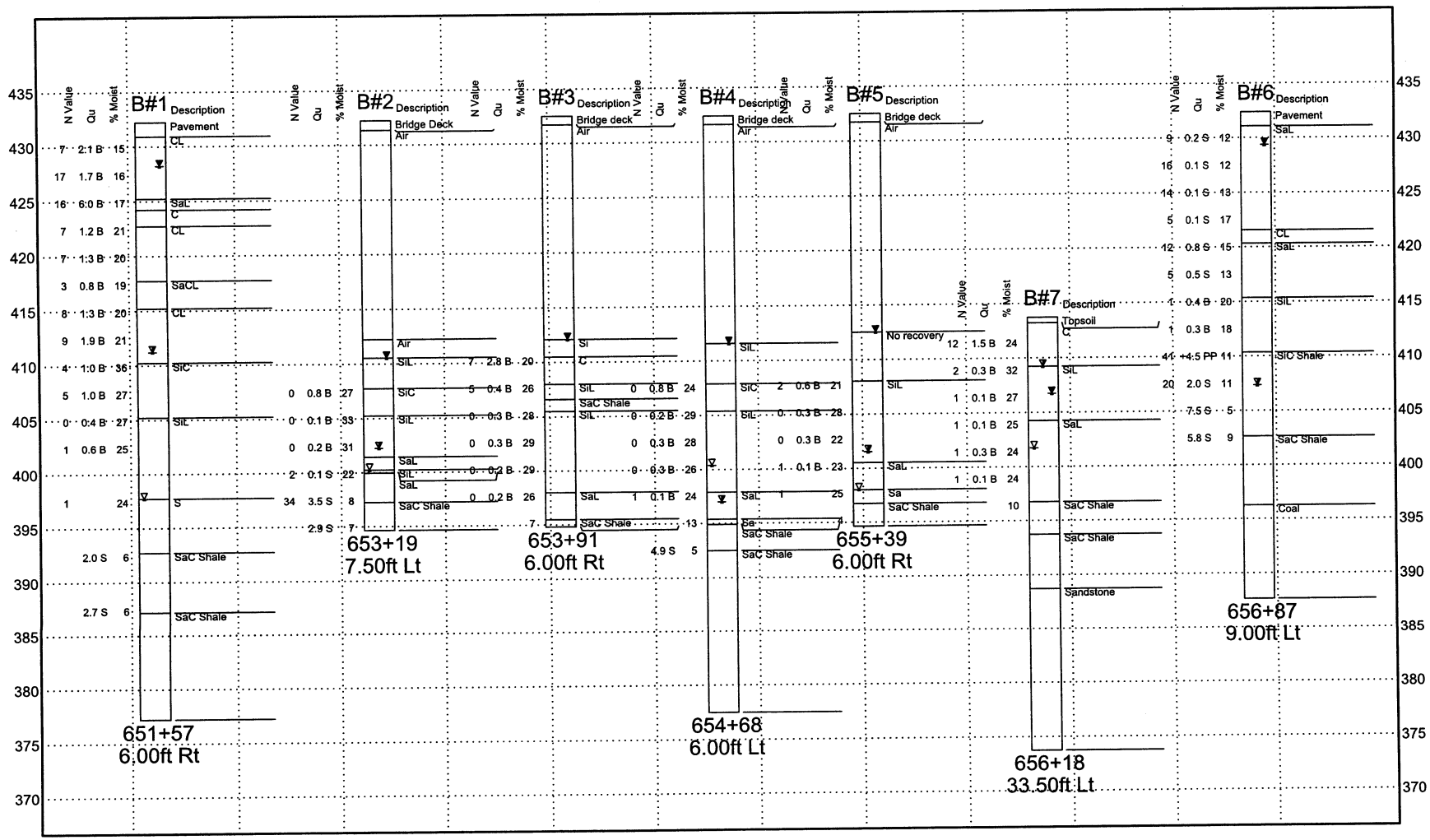
		DATE - 08/10	REVISED -		

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
327	(51-23B-2)B-1	LAWRENCE	-	-
		CONTRACT NO. 74177		
		ILLINOIS FED. AID PROJECT		

Structure Number 051-0015 Otter Pond Ditch
Located in the NW 1/4 of Section 5, Township 3 N, Range 11 W of the 3 P.M.



NOT TO HORIZONTAL SCALE

VARIATIONS IN SUBSURFACE CONDITIONS MAY EXIST BETWEEN BORINGS

Groundwater
- First Encounter
- Completion
- after (refer to log) hours

Abbreviations
WOH - Sampler Advanced by Weight of Hammer, WOP - Weight of Pipe
B.S. - Before Seating

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SUBSURFACE DATA PROFILE

Route: FAP 327 (US 50)

Section: (51-23B-2)B-1

County: Lawrence

SUBSURFACE DATA PROFILE 051-0015.GPJ D6TEMPLT.GDT 10/11/30

SUBSURFACE DATA PROFILE 051-0015.GPJ D6TEMPLT.GDT 10/11/30

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 6/17/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 1 West Abut
Station 651+57
Offset 6.00ft Rt
Ground Surface Elev. 432.22 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 397.7 ft
Upon Completion 411.2 ft
After 1032 **Hrs.** 428.2 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				5 3/4" asphalt on 9 3/4" concrete pavement.
430.92				
				Stiff, damp, gray to brown, CLAY LOAM.
	2			
	3	2.1	15	
	4	B		
-5	2			
	5	1.7	16	
	12	B		
425.22				
	7			Soft, brown, SANDY LOAM.
424.22				
	8	6.0	17	Hard, damp, gray, CLAY.
	8	B		
422.72				
-10	1			Stiff, damp, gray, CLAY LOAM.
	3	1.2	21	
	4	B		
	1			
	3	1.3	20	
	4	B		
417.72				
-15	1			Medium, damp, gray, SANDY CLAY LOAM.
	1	0.8	19	
	2	B		
415.22				
	1			Stiff, damp, gray, CLAY LOAM.
	3	1.3	20	
	5	B		
-20	1			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	4	1.9	21	Stiff, damp, gray, CLAY LOAM. *(continued)*
	5	B		
410.22				
	1			Medium to stiff, damp, gray, SILTY CLAY w/ wood chunks.
	2	1.0	36	
	2	B		
-25	1			
	2	1.0	27	
	3	B		
405.22				
	0			Soft, damp, gray, SILTY LOAM.
	0	0.4	27	
	0	B		
-30	0			
	0	0.6	25	
	1	B		
397.72				
-35	0			Very loose, wet, brown, SAND.
	0		24	
	1			
392.72				
-40	50/3"	2.0	6	

Latitude W 87 deg 39.743 min, Longitude N 38 deg 43.714 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 6/17/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 1 West Abut
Station 651+57
Offset 6.00ft Rt
Ground Surface Elev. 432.22 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 397.7 ft
Upon Completion 411.2 ft
After 1032 **Hrs.** 428.2 ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to very stiff, moist, gray, SANDY CLAY SHALE. *(continued)*		50/2" 50/1"	S	
387.22	-45	50/4" 50/1" 50/1"	2.7 S	6
Borehole continued with rock coring.	-50			
	-55			
	-60			

Latitude W 87 deg 39.743 min, Longitude N 38 deg 43.714 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Date 6/17/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **CORING METHOD** Rotary, surf set diamond bit

STRUCT. NO. 051-0015
Station 654+30

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner

Core Diameter 2.06 in
Top of Rock Elev. 392.72 ft
Begin Core Elev. 387.22 ft

BORING NO. 1 West Abut
Station 651+57
Offset 6.00ft Rt
Ground Surface Elev. 432.22 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Gray, slightly weathered, SANDY CLAY SHALE.	387.22		B1C1	84	71	1.1	
Rock core B1C1 from depth 47.5' to 48.0', Qu = 117 tsf.		-50					
			B1C2	98	73	1	
Rock core B1C2 from depth 52.6' to 53.1', Qu = 148 tsf.							
	377.22	-55					
Extent of exploration.							
Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.		-60					
		-65					

Color pictures of the cores Available on request
Cores will be stored for examination until 08/17/2014
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

657+50
5+91

Field Rock Core Log a.xls

Field Rock Core Log

Date: 6-17-09

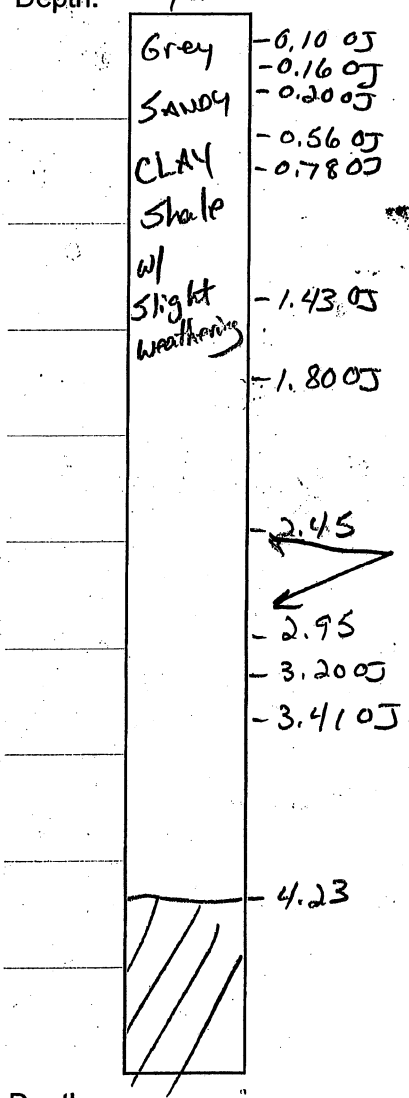
Structure #: 051-0015

Boring #: B1 WAbut

651+57

Rock Core #: B1C1

Depth: 45°



RQD

0.35
0.65
0.36
1.39
0.80
3.55

Depth:

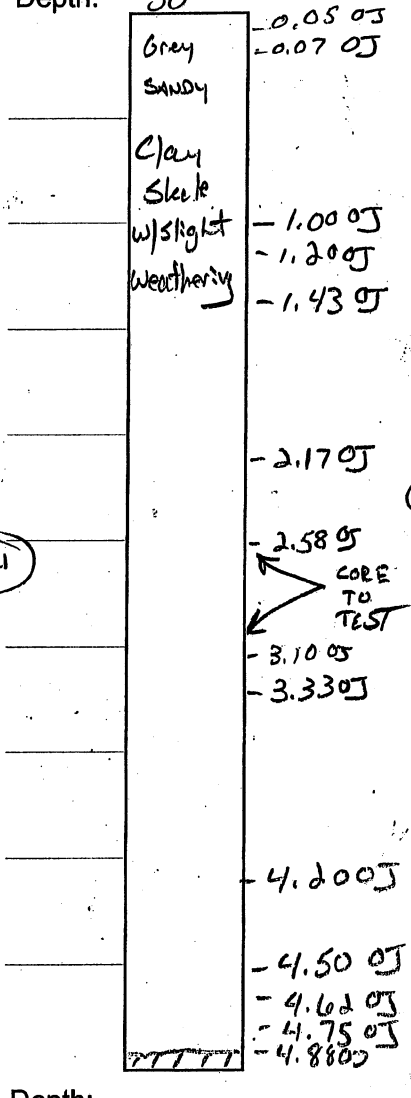
Core Time: 5:40 (1.1 min/ft)

Recovery: 84%

RQD: 71%

Rock Core #: B1C2

Depth: 50°



B1C2

RQD

0.92
0.73
0.41
0.75
0.86
3.67

Depth:

Core Time: 5:10 (1.0 min/ft)

Recovery: 97.6%

RQD: 73.4%

Logged By: Eric Sandschafer

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 6/17/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 2
Station 653+19
Offset 7.50ft Lt
Ground Surface Elev. 432.24 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 400.2 ft
Upon Completion 402.2 ft
After 1032 **Hrs.** 410.5 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
2" asphalt on 8 1/4" bridge deck.			
431.34			
Air.			
-5			
-10			
Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.			
412.24 -20			
Air.			
410.54			
Gray, SILTY LOAM.			
407.74			
-25 Medium, damp, gray, SILTY CLAY.	0 0 0	0.8 B	27
405.24			
Very soft, very damp, gray, SILTY LOAM.	0 0 0	0.1 B	33
-30	0		
401.44	0 0	0.2 B	31
Red, SANDY LOAM.			
400.24			
Gray, SILTY LOAM.	1		
399.94 Very soft, wet, gray, SANDY LOAM.	1 1	0.1 S	22
397.24 -35	8		
Very stiff, moist, gray, SANDY CLAY SHALE.	34 50/5"	3.5 S	8
394.64	50/4"		
Extent of exploration.	50/2" 50/1"	2.9 S	7
-40			

Latitude W 87 deg 39.727 min, Longitude N 38 deg 43.700 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 7/27/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 3
Station 653+91
Offset 6.00ft Rt
Ground Surface Elev. 432.50 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion Dry ft
After 72 **Hrs.** 412.1 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				1 7/8" asphalt on 7 1/8" concrete bridge deck. 431.70
				Air.
-5				
-10				Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.
-15				
-20				
				412.10
				Brown, SILT.
				410.50
	2			Very stiff, damp, brown mottled red, CLAY.
	3 4	2.8	20	B
				408.00
-25	1			Soft, damp, gray, SILTY LOAM.
	2 3	0.4	26	B
				406.60
				Soft, gray, SANDY CLAY SHALE.
				405.50
	0			Soft to very soft, damp, gray, SILTY LOAM.
	0 0	0.3	28	B
-30	0			
	0 0	0.3	29	B
	0			
	0 0	0.2	29	B
				398.00
-35	0			Very soft, damp, gray, SANDY LOAM.
	0 0	0.2	26	B
				395.50
	50			Very dense, moist, gray, SANDY CLAY SHALE. 394.80
	50/2" 50/1"		7	Extent of exploration.
-40				

Latitude W 87 deg 39.706 min, Longitude N 38 deg 43.690 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 7/28/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 4
Station 654+68
Offset 6.00ft Lt
Ground Surface Elev. 432.39 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 400.4 ft
Upon Completion 397.0 ft
After 48 **Hrs.** 411.6 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
				1 3/4" asphalt on 7 7/8" concrete bridge deck. 431.59				
				Air.				
-5								
-10								
-15								
-20								
				Air. *(continued)* 411.59				
				Gray, SILTY LOAM.				
				407.89				
				Medium, damp, gray, SILTY CLAY.	-25	0		
						0	0.8	24
						0	B	
				405.39				
				Very soft, damp, gray, SILTY LOAM.		0		
						0	0.2	29
						0	B	
					-30	0		
						0	0.3	28
						0	B	
						0		
						0	0.3	26
						0	B	
				397.89				
				Very soft, very damp, gray, SANDY LOAM.	-35	0		
						0	0.1	24
						1	B	
				395.39				
				Very dense, wet, gray, fine grained, SAND. *4% passing #200 sieve.* 394.89		8		
						50/4"		13
						50/2"		
				Very dense, moist, gray, SANDY CLAY SHALE.				
				392.49	-40	50/4"	4.9	5

Borehole continued with rock coring.

Latitude W 87 deg 39.691 min, Longitude N 38 deg 43.687 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Date 7/28/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **CORING METHOD** Rotary, surf set diamond bit

STRUCT. NO. 051-0015
Station 654+30

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner

Core Diameter 2.06 in
Top of Rock Elev. 394.89 ft
Begin Core Elev. 392.49 ft

BORING NO. 4
Station 654+68
Offset 6.00ft Lt
Ground Surface Elev. 432.39 ft

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
392.49	B4C1	85	80	1	
Gray, slightly weathered, SANDY CLAY SHALE.					
Rock core B4C1 from 42.9' to 43.4' depth Qu = 72 tsf.					
-45	B4C2	97	96	0.8	
Rock core B4C2 from 49.3' to 49.8' depth Qu = 87.4 tsf.					
-50	B4C3	95	95	0.9	
Rock core B4C3 from 52.9' to 53.5' depth Qu = 104 tsf.					
377.49 -55					
Extent of exploration.					
Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.					

Color pictures of the cores Available on request
Cores will be stored for examination until 07/28/2014
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Field Rock Core Log a.xls

Field Rock Core Log

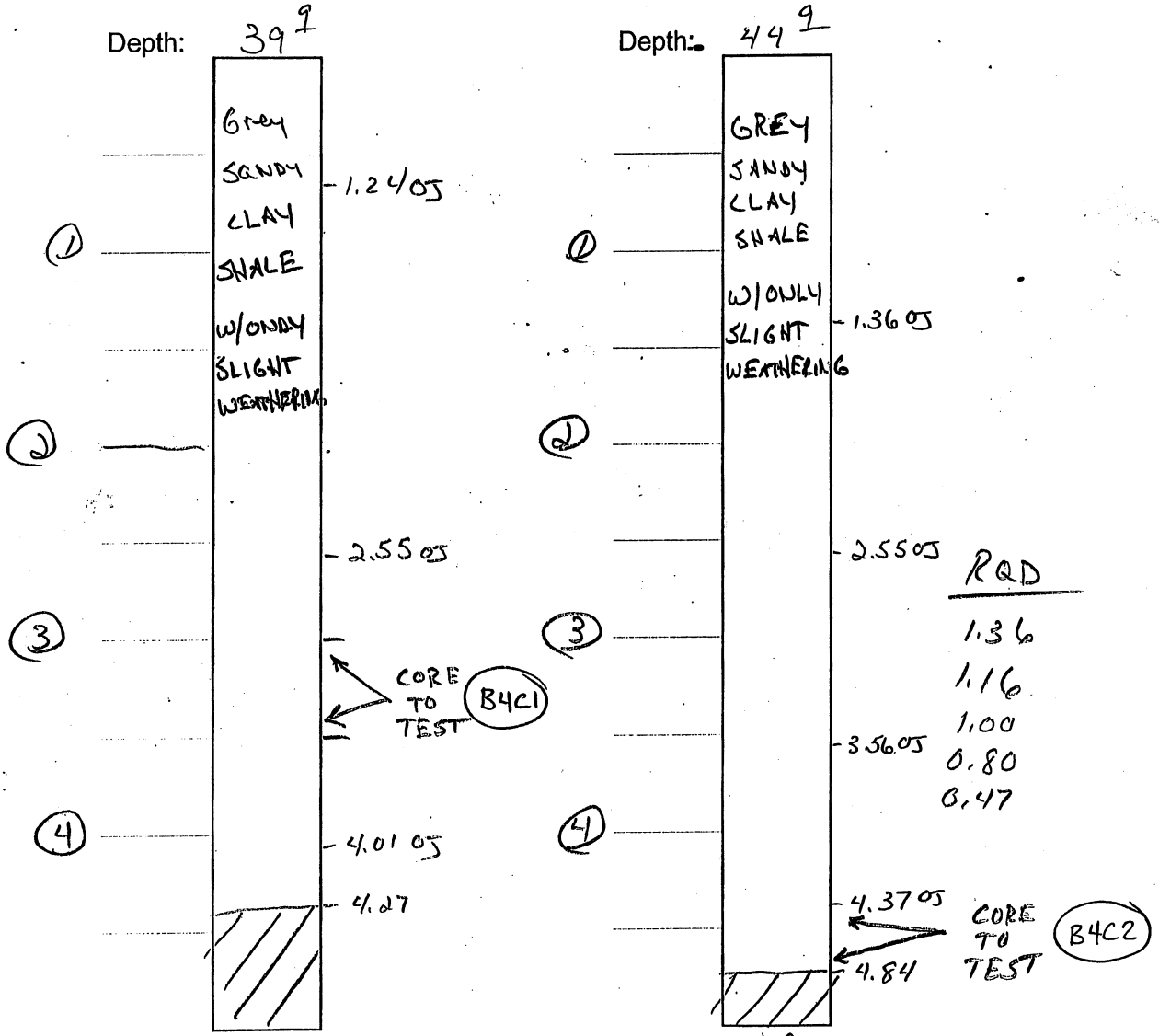
Date: 7-28-09

Structure #: 051-0015

Boring #: B4

Rock Core #: B4 C1

Rock Core #: B4 C2



Depth: 44'

Core Time: 4:45

Recovery: 85.2%

RQD: 80.0%

0.95 ~~1.75~~ MIN/FT

Depth: 49'

Core Time: 4:01

Recovery: 96.8%

RQD: 95.8%

0.8 MIN/FT

Logged By: Eric Sandschafer

Field Rock Core Log a.xls

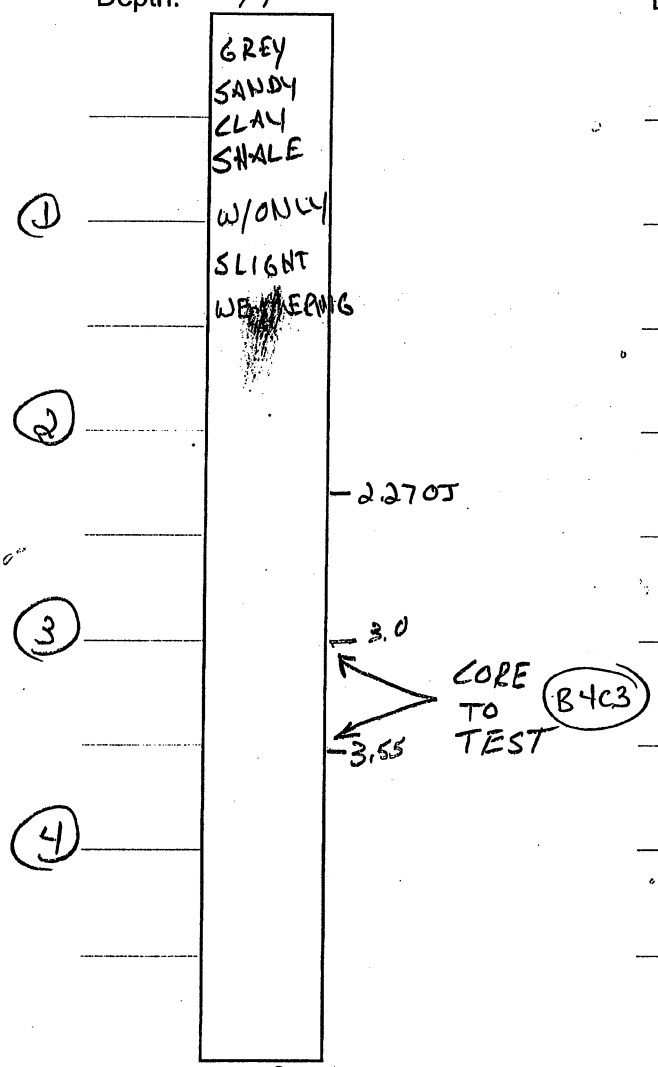
Field Rock Core Log

Date: 7-28-09

Structure # : 051-0015 Boring # : B4

Rock Core # : B4C3 Rock Core # :

Depth: 49' Depth:



RQD
2.27
2.46

Depth: 54' Depth:

Core Time: 4:34 0.9 MIN/FT Core Time:

Recovery: 94.6% Recovery:

RQD: 94.6% RQD:

Logged By: Eric Sandschafer

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 7/29/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 5
Station 655+39
Offset 6.00ft Rt
Ground Surface Elev. 432.53 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 398.0 ft
Upon Completion 401.5 ft
After 24 **Hrs.** 412.5 ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
1 3/4" asphalt on 7 1/2" concrete bridge deck.	431.73				
Air.		-5			
Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.		-10			
		-15			
	412.53	-20			

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
No recovery - rock in sampler shoe.	408.03				
Medium to soft, damp, gray, SILTY LOAM.		-25	0 0 2	0.6 B	21
			0 0 0	0.3 B	28
	400.53	-30	0 0 0	0.3 B	22
Very soft, damp, gray, SANDY LOAM.	398.03		0 0 1	0.1 B	23
Very loose, wet, gray, fine grained, SAND. *10% passing #200 sieve.*	396.73	-35	0 0 1		25
Very dense, moist, gray, SANDY CLAY SHALE.	394.63		38 50/3" 50/2"		4
Extent of exploration.		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Latitude W 87 deg 39.678 min, Longitude N 38 deg 43.676 min, Map Datum WGS 84

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 6/9/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 6 East Abut
Station 656+87
Offset 9.00ft Lt
Ground Surface Elev. 432.34 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion 407.3 ft
After 1224 **Hrs.** 429.3 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				3" asphalt on 13" concrete pavement.
431.04				
				Very soft, damp, gray, SANDY LOAM.
	2			
	3	0.2	12	
	6	S		
-5	4			
	6	0.1	12	
	10	S		
	3			
	6	0.1	13	
	8	S		
-10	2			
	2	0.1	17	
421.54	3	S		
				Gray, CLAY LOAM.
420.34				
	2			Soft to medium, damp, gray, SANDY LOAM.
	4	0.8	15	
	8	S		
-15	2			
	3	0.5	13	
	2	S		
415.34				
	0			Soft, damp, gray, SILTY LOAM w/ some Shale fragments.
	0	0.4	20	
	1	B		
-20	0			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	1	0.3	18	Soft, damp, gray, SILTY LOAM w/ some Shale fragments. *(continued)*
	0	B		
410.34				
	8			Hard, moist, gray, SILTY CLAY SHALE.
	20	+4.5	11	
	21	PP		
-25	9			
	20	2.0	11	
	50/5"	S		
	50/5"			
	50/1"	7.5	5	
	50/1"	S		
402.64				
-30	50/2"	5.8	9	Borehole continued with rock coring.
	50/1"	S		
	50/0"			
-35				
-40				

Latitude W 87 deg 39.653 min, Longitude N 38 deg 43.671 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Date 6/9/09

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **CORING METHOD** Rotary, surf set diamond bit

STRUCT. NO. 051-0015
Station 654+30

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner

Core Diameter 2.06 in
Top of Rock Elev. 410.34 ft
Begin Core Elev. 402.64 ft

BORING NO. 6 East Abut
Station 656+87
Offset 9.00ft Lt
Ground Surface Elev. 432.34 ft

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
402.64 Gray, slight to moderate weathered, SANDY CLAY SHALE.					
-30	B6C1	88	76	1.4	
Rock core B6C1 from 31.6' to 32.1' depth Qu = 104 tsf.					
-35	B6C2	94	71	2.1	
396.24 Black, light weight, very smooth, hard, Estimated COAL.					
Rock core B6C2 from 38.8' to 39.4' depth Qu = 68 tsf.					
-40	B6C3	99	87	1.2	
Rock core B6C3 from 42.0' to 42.5' depth Qu = 206 tsf.					
387.64 Extent of exploration.					
-45					

Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 ove Otter Pond Ditch = 432.70' elevation. Provided by Program Development.

Color pictures of the cores Available on request
Cores will be stored for examination until 06/09/2014
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Field Rock Core Log a.xls

Field Rock Core Log

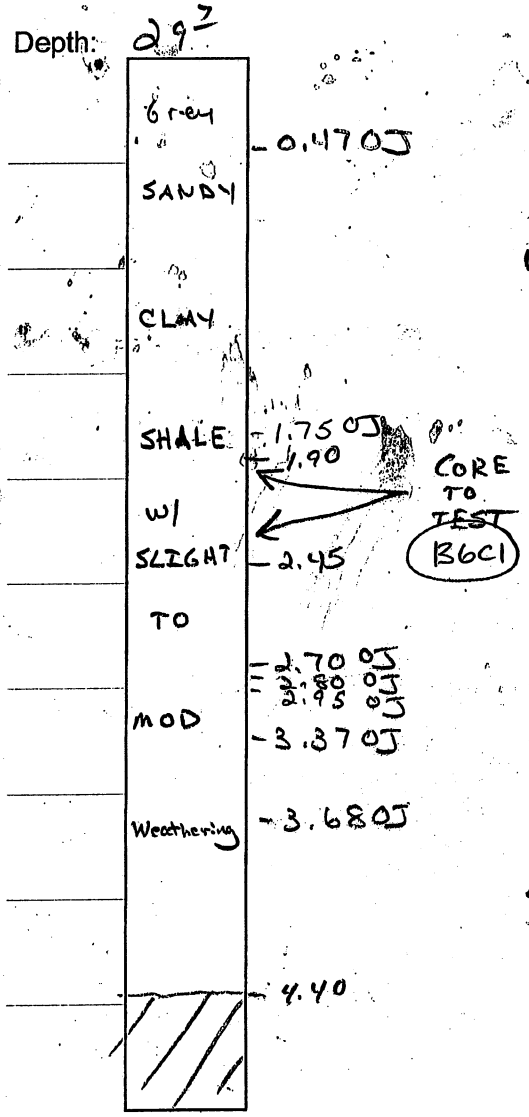
Date: 6-09-09

Structure #: 051-0015

Boring #: BC

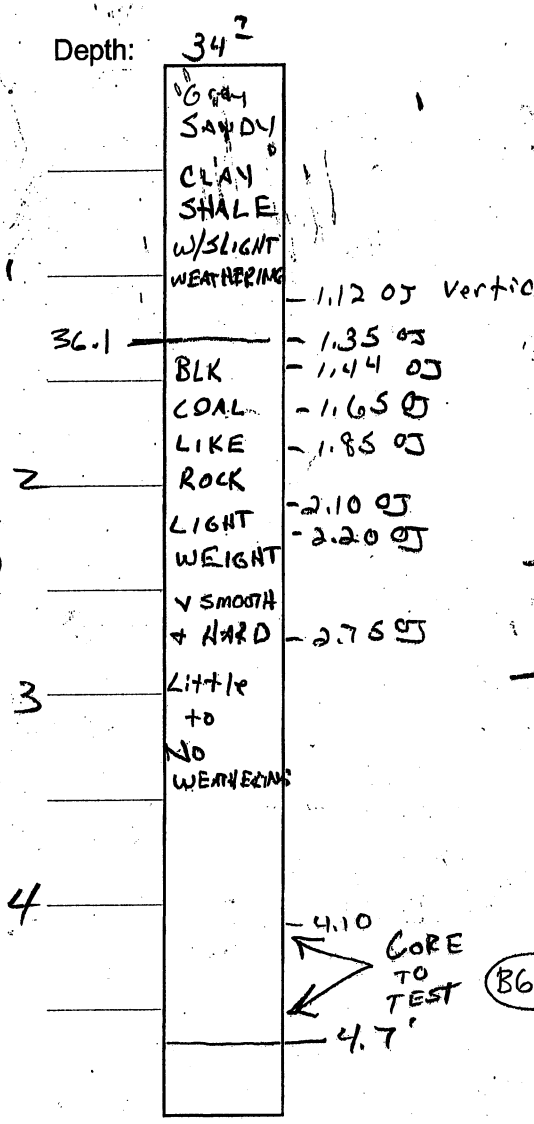
Rock Core #: BC1

Rock Core #: BC2



RQD
0.47
1.27
0.93
0.41
0.70

4.4



RQD
1.12
0.47
1.95
3.54

Depth:

Core Time: 7:01 (1.4 min/ft)

Recovery: 88%

RQD: 75.0%

Depth:

Core Time: 10:30 (2.1 min/ft)

Recovery: 94%

RQD: 70.8%

Logged By: Eric Sandschafer

Field Rock Core Log a.xls

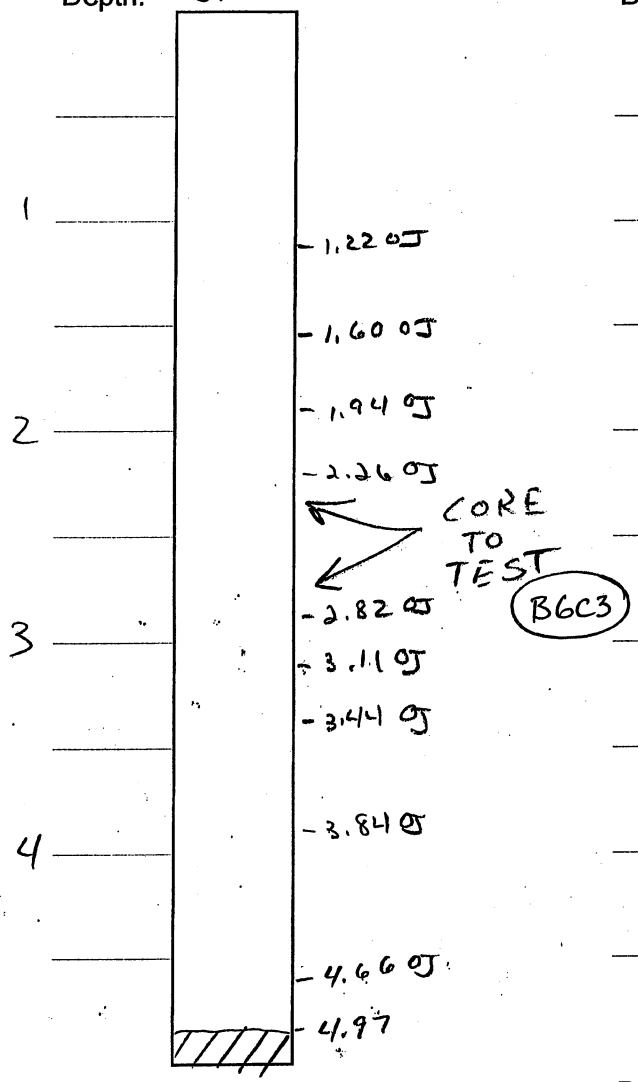
Field Rock Core Log

Date: 6-09-09

Structure # : 051-0015 Boring # : BC

Rock Core # : B6C3 Rock Core # :

Depth: 39Z Depth:



RQD
1.22
0.37
0.34
0.33
0.55
0.33
0.40
0.81
4.35

Depth: Depth:

Core Time: 5:59 (1.2 MIN/FT) Core Time:

Recovery: 99% Recovery:

RQD: 87.0% RQD:

Logged By: Eric Sandschafer

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 11/9/10

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **DRILLING METHOD** Hollow stem auger & split spoon **HAMMER TYPE** Auto 140#

STRUCT. NO. 051-0015
Station 654+30

BORING NO. 7
Station 656+18
Offset 33.50ft Lt
Ground Surface Elev. 413.73 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter 401.7 ft
Upon Completion 409.2 ft
After 72 **Hrs.** 406.7 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
				Topsoil. 413.23
				Stiff, damp, gray, CLAY.
	4			
	5 7	1.5 B	24	
				409.23
-5	0			Soft, damp, gray, SILTY LOAM.
	1 1	0.3 B	32	
	0			
	0 1	0.1 B	27	
				404.23
-10	0			Very soft, wet, gray, SANDY LOAM.
	0 1	0.1 B	25	
	0			
	0 1	0.3 B	24	
-15	1			
	0 1	0.1 B	24	
				396.73
	50/4"		10	Very dense, moist, gray, SANDY CLAY SHALE.
	50/1" 50/1"			
-20	*			* 50/3", 50/2", 50/1", w = 6% 393.72

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
				Borehole continued with rock coring.
-25				
-30				
-35				
-40				

Latitude W 87 deg 39.662 min, Longitude N 38 deg 43.679 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Date 11/9/10

ROUTE FAP 327 (US 50) **DESCRIPTION** Otter Pond Ditch **LOGGED BY** E. Sandschafer

SECTION (51-23B-2)B-1 **LOCATION** NW 1/4, **SEC.** 5, **TWP.** 3 N, **RNG.** 11 W, 3 **PM**

COUNTY Lawrence **CORING METHOD** Rotary, surf set diamond bit

STRUCT. NO. 051-0015
Station 654+30

CORING BARREL TYPE & SIZE NW, conv dbl bbl, split inner

Core Diameter 2.06 in
Top of Rock Elev. 396.73 ft
Begin Core Elev. 393.73 ft

BORING NO. 7
Station 656+18
Offset 33.50ft Lt
Ground Surface Elev. 413.73 ft

DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
393.72					
Gray, slightly weathered, SANDY CLAY SHALE. *Soft, gray, Clay 1" lense.*					
Rock core B7C1 from 22.8' to 23.3' depth Qu = 69.8 tsf.					
388.73 -25					
Gray, slightly weathered, SANDSTONE. *Very thin layers of wood interspersed throughout cores in last three samples. 1" layer of severely weathered Sandstone, in pieces.*	B7C2	95	85	0.9	
Rock core B7C2 from 27.0' to 27.5' depth Qu = 121.6 tsf.					
-30					
	B7C3	94	80	1	
Rock core B7C3 from 34.1' to 34.6' depth Qu = 131.2 tsf.					
-35					
	B7C4	95	88	1.4	
Rock core B7C4 from 36.8' to 37.3' depth Qu = 142.5 tsf.					
Benchmark: BM 807 Chiseled square on NW corner of existing structure 051-0015 over Otter Pond Ditch = 432.70' elevation.					
Extent of exploration. 373.73 -40					

Color pictures of the cores Available on request
Cores will be stored for examination until 11/09/2015
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Field Rock Core Log a.xls

Field Rock Core Log

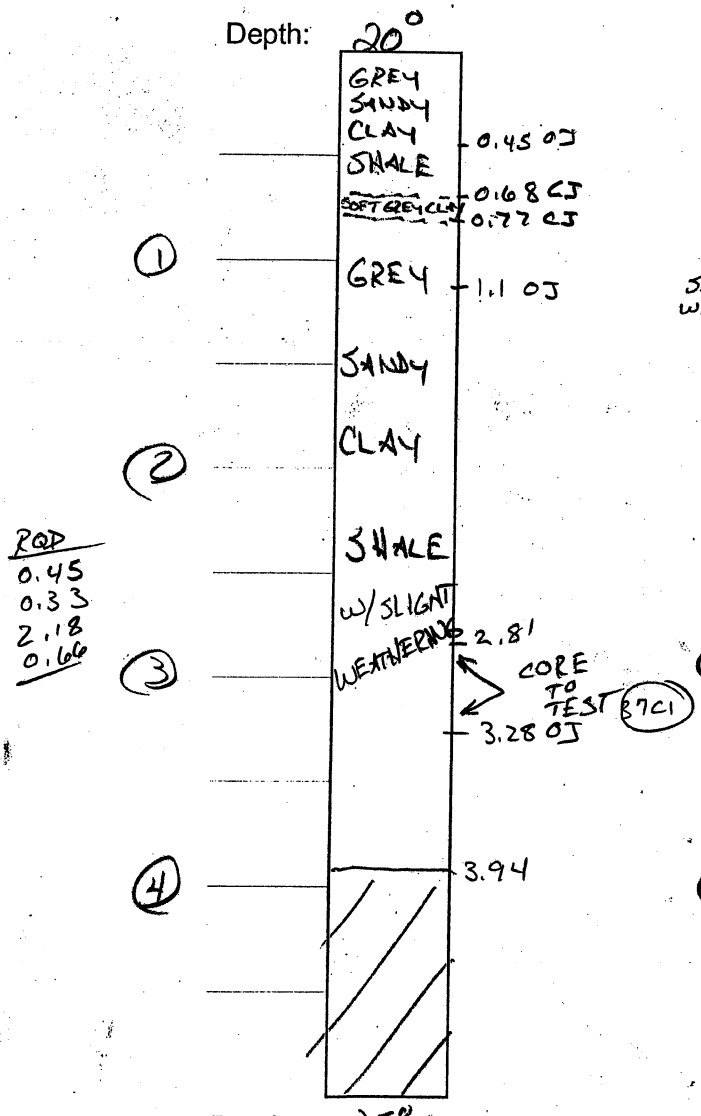
Date: 11-09-10

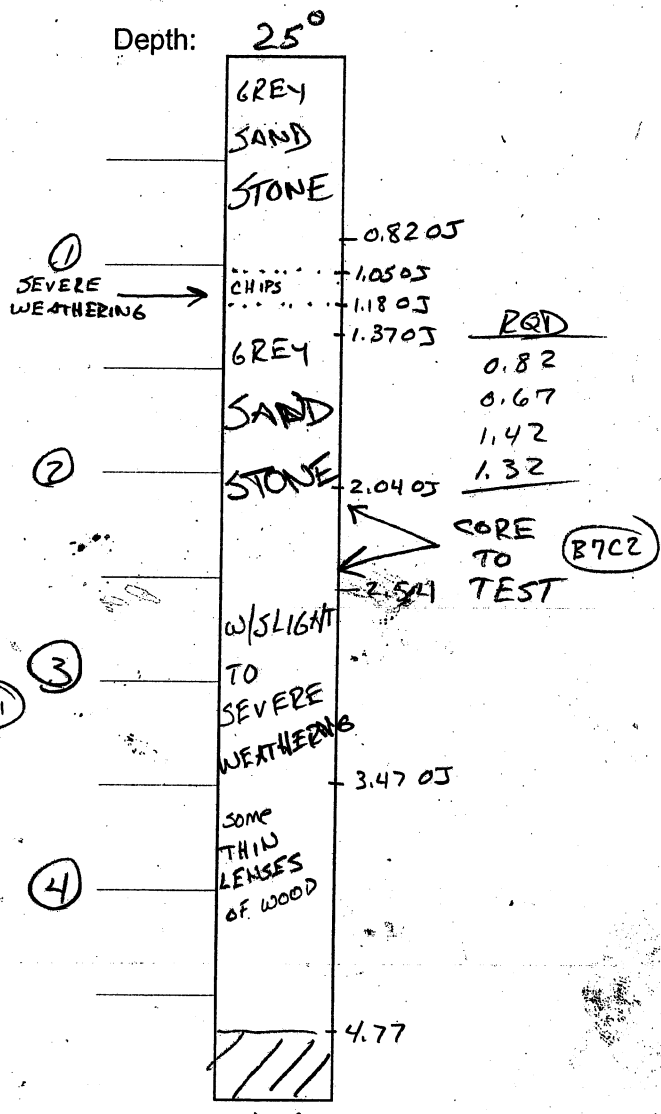
Structure #: 051-0015

Boring #: B7

Rock Core #: B7C1

Rock Core #: B7C2





Depth: 25'

Core Time: 4:14 (0.8 min/ft)

Recovery: 78.6%

RQD: 72.4%

Depth: 30'

Core Time: 4:43 (0.9 min/ft)

Recovery: 95.4%

RQD: 84.6%

Logged By: Eric Sandschafer

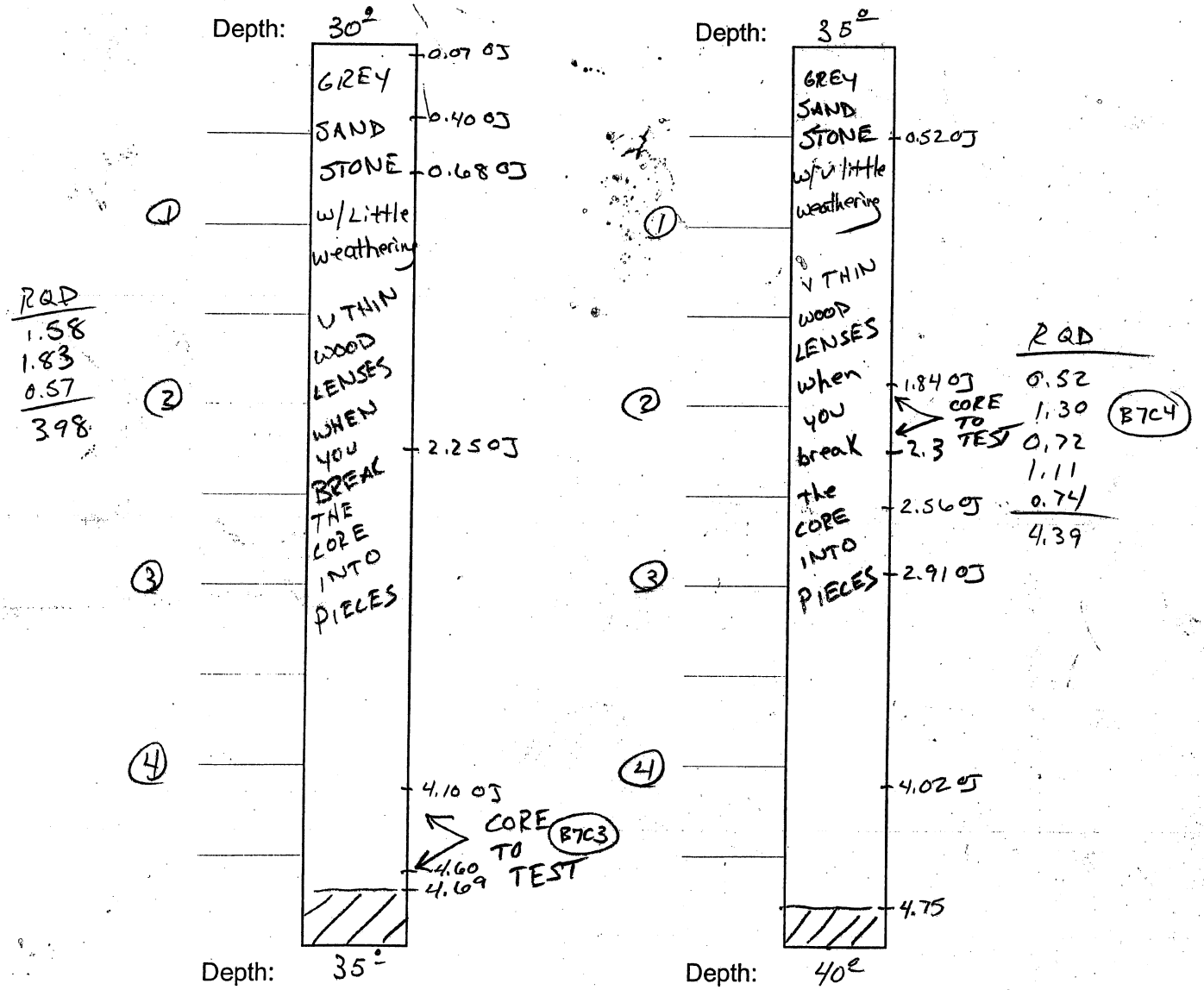
Field Rock Core Log a.xls

Field Rock Core Log

Date: 11-09-10

Structure #: 051-0015 Boring #: B7

Rock Core #: B7C3 Rock Core #: B7C4



Core Time: 4:51 (1.0 min/ft) Core Time: 6:45 (1.4 min/ft)

Recovery: 93.8% Recovery: 95%

RQD: 79.6% RQD: 87.8%

Logged By: Eric Sandschafer

SOILS LAB PROJECT
10004

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 3/23/10

ROUTE FAP 327 (US 50) DESCRIPTION Otter Pond Ditch - Shelby Tubes LOGGED BY E. Sandschafer

SECTION (51-23B-2)B-1 LOCATION NW 1/4, SEC. 5, TWP. 3 N, RNG. 11 W, 3 PM

COUNTY Lawrence DRILLING METHOD Hydraulic Pushed HAMMER TYPE

STRUCT. NO. 051-0015
Station 654+30

BORING NO.6 Shelby Tubes East Abut
Station 656+96
Offset 8.50ft Lt
Ground Surface Elev. 432.34 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After ____ Hrs. N/A ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Augered through.
-5				
422.34 -10			19	Gray, damp, SANDY LOAM. 80% recovery. 23 in TUBE # 1
			18	100% recovery. 30 in TUBE # 2
417.34 -15			18	Gray, damp, SILTY LOAM. 100% recovery. 24 in TUBE # 3
			21	~~100% recovery.~~ 12 in TUBE # 4
412.94 * -20				* Tube refusal, extent of exploration. Gray, SILTY CLAY LOAM SHALE.
-25				
-30				
-35				
-40				

Latitude W 87 deg 39.653 min, Longitude N 38 deg 43.671 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation

Shelby Tube Test Results

Boring No.: B-6 E. Abut. | Ground Surface Elev.: 432.3 | Structure No.: 051-0015 | Route: FAP-327 US-50

Station: 656+96 | Ground Water Elev.: 407.3 | Contract No.: 74177 | Section: (51-23B-2)B-1

Offset: 8.5 ft. Lt. | Begin Sampling Depth: 422.3 | Job No.: D-97-050-06 | County: Lawrence

Drilled by: E. Sandschafer | Tube Length/Diameter: 36 in. / 3 in. | Soils Lab Project No.: 10004 | Location: NW1/4,SEC.5,TWP.3N,RNG11W,3PM

Sample #	Depth (ft)	Elev. (ft)	Qu (tsf)	Moist. (%)	Unit Wt. (pcf)	Triaxial Data				Soil Type, Description and Observations
						c (psf)	Φ (°)	c' (psf)	Φ' (°)	
	0.0	432.3								Not Sampled
	↓	↓								↓
	↓	↓								↓
	↓	↓								↓
	10.0	422.3								↓
1-1	10.6	421.7	048	16.5	126.6					Tan Loam-oxidized w/ isolate Silty Loam pockets
1-2	11.2	421.1	0.61	16.6	132.2					Gray Sandy Loam w/ Loam pockets, top ¾, to blue-gray Clay
1-3	11.9	420.4	UU Tx	17.5	128.5	600	6.7	440	23.1	Blue-gray Clay w/ Silty Loam lenses – shale and sandstones
1-4	12.5	419.8	---	---	---					No Recovery
2-1	13.1	419.2	0.42	15.7	133.4					Tan Sandy Loam w/ Loam pockets – isolated blue-gray Clay pockets
2-2	13.8	418.5	0.24	11.6	123.0					Gray Sandy Loam w/ isolated Silty Loam pockets and wood debris
2-3	14.4	417.9	UU Tx	13.5	121.5	200	33.1	200	35.2	Tan Sandy Loam – fine grained w/ brown Loam pockets
2-4	15.0	417.3	0.69	23.8	122.0					Dark Gray Silty Loam – sandy w/ yellow Sandy Loam pockets
3-1	15.6	416.7	0.40	18.7	123.8					Gray Silty Loam w/ Sandy Loam pockets and isolated sandstones
3-2	16.2	416.1	0.29	18.3	128.8					Gray Loam w/ sandstones and shale pieces
3-3	16.9	415.4	UU Tx	20.0	126.2	660	8.4	360	27.8	Greenish-Gray shaly Clay w/ sandstones
3-4	17.5	414.8	0.30	18.0	125.9					Blue-Gray shaly Clay w/ shale seams
4-1	17.8	414.5	---	17.5	---					Same
4-2	18.4	413.9	---	17.7	---					Weathered Shale w/ shaly Clay layers
4-3	19.0	413.3	---	---	---					No Recovery
4-4	20.0	412.3	---	---	---					No Recovery

Date: 4/19/2010 | Prepared by: Kurt Schmuck | Approved by: | Page 1 of 1

Printed 5/11/2010

BMPR SL24 (Rev 10/26/09)
Formerly BBS 139

SOILS LABORATORY
#10003

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 3/23/10

ROUTE FAP 327 (US 50) DESCRIPTION Otter Pond Ditch - Shelby Tubes LOGGED BY E. Sandschafer

SECTION (51-23B-2)B-1 LOCATION NW 1/4, SEC. 5, TWP. 3 N, RNG. 11 W, 3 PM

COUNTY Lawrence DRILLING METHOD Hydraulic Pushed HAMMER TYPE

STRUCT. NO. 051-0015
Station 654+30

BORING NO. Shelby Tubes West Abut
Station 651+42
Offset 9.00ft Rt
Ground Surface Elev. 432.22 ft

Surface Water Elev. 401.58 ft
Stream Bed Elev. 400.48 ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After ____ Hrs. N/A ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Augered through.
-5				
-10				
-15				
-20				
				Augered through. *(continued)*
407.22 -25				
			25	Gray, damp, SILTY LOAM. *80% recovery.* 24 in TUBE #1
			21	*33% recovery.* 8 in TUBE #2
-30				
			22	*25% recovery.* 6 in TUBE #3
399.72				Brown, wet, SAND. *0% recovery.*
397.22 -35				
				Extent of exploration.
-40				

Latitude W 87 deg 39.743 min, Longitude N 38 deg 43.714 min, Map Datum WGS 84

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation

Shelby Tube Test Results

Boring No.: B-1 W. Abut. | Ground Surface Elev.: 432.2 | Structure No.: 051-0015 | Route: FAP-327 US-50

Station: 651+42 | Ground Water Elev.: 411.2 | Contract No.: 74177 | Section: (51-23B-2)B-1

Offset: 9 ft. Rt. | Begin Sampling Depth: 407.2 | Job No.: D-97-050-06 | County: Lawrence

Drilled by: E. Sandschafer | Tube Length/Diameter: 36 in. / 3 in. | Soils Lab Project No.: 10003 | Location: NW1/4,SEC.5,TWP.3N,RNG11W,3PM

Sample #	Depth (ft)	Elev. (ft)	Qu (tsf)	Moist. (%)	Unit Wt. (pcf)	Triaxial Data				Soil Type, Description and Observations
						c (psf)	Φ (°)	c' (psf)	Φ' (°)	
	0.0	432.2								Not Sampled
	↓	↓								↓
	↓	↓								↓
	↓	↓								↓
	25.0	407.2								↓
1-1	25.6	406.7	1.40	29.2	119.1					Gray Silty Clay w/ isolated Silty Loam pockets
1-2	26.3	405.9	UU Tx	25.5	119.3	1280	4.5	1240	10.6	Gray Silty Clay w/ Silty Loam pockets
1-3	26.9	405.3	0.73	25.4	120.7					Gray Silty Clay-Loam
1-4	27.5	404.7	---	---	---					No Recovery
2-1	27.8	404.4	---	26.1	---					Gray Silty Clay-Loam w/ Silty Loam pockets
2-2	28.4	403.8	UU Tx	24.8	123.9	880	4.0	500	25.3	Gray Silty Clay-Loam w/ Sandy Loam and Silty Loam pockets
2-3	29.0	403.2	---	---	---					No Recovery
2-4	30.0	402.2	---	---	---					No Recovery
3-1	30.2	402.0	---	23.0	---					Gray Silty Clay-Loam w/ Silty Loam pockets
3-2	30.8	401.4	UU Tx	23.7	121.2	400	2.6	240	23.1	Gray Silty Loam w/ Sandy Loam and Silt pockets
3-3	31.4	400.8	---	---	---					No Recovery
3-4	32.5	399.7	---	---	---					No Recovery

Date: 4/19/2010 | Prepared by: Kurt Schmuck | Approved by: _____

Printed 5/10/2010

BMPR SL24 (Rev 10/26/09)
Formerly BBS 139

IDOT Global Site Classification

Structure No. SN 051-0015

Date: 1/26/2010

Boring No.	ds/(di/N)	di	ds/(di/Su)	di	ds/(di/Nch)	di
1	7	100	792	23	45	77
2	67	100	368	4	100	96
3	2	100	200	4.5	100	95.5
4	4	100	135	5.2	100	94.8
5	44	100			44	100
6	15	100	727	17	100	83
Sum:	139	600	2222	53.7	53.7	546.3
Average:	**23**		**627**		**82**	
Site Classification	**D**		**E**		**C**	

XSTABL File: 9140WSS 5-26-10 14:42

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*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*                using the              *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 2005      *
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*                                       *
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```

Problem Description : SN 051-0066 West Abutment SS

SEGMENT BOUNDARY COORDINATES
---

7 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	412.5	100.0	412.5	6
2	100.0	412.5	105.6	415.2	5
3	105.6	415.2	110.6	417.7	4
4	110.6	417.7	120.6	422.7	3
5	120.6	422.7	139.6	432.2	2
6	139.6	432.2	143.6	433.9	1
7	143.6	433.9	200.0	434.0	1

7 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	139.6	432.2	200.0	432.2	2
2	120.6	422.7	200.0	422.7	3
3	110.6	417.7	200.0	417.7	4
4	105.6	415.2	200.0	415.2	5
5	100.4	412.4	200.0	412.4	6
6	.0	405.2	200.0	405.2	7
7	.0	403.0	200.0	403.0	8

ISOTROPIC Soil Parameters
---

8 Soil unit(s) specified

Soil	Unit Weight	Cohesion	Friction	Pore Pressure	Water

Unit No.	Moist (pcf)	Sat. (pcf)	Intercept (psf)	Angle (deg)	Parameter Ru	Constant (psf)	Surface No.
1	125.0	125.0	1000.0	.00	.000	.0	1
2	125.0	125.0	1700.0	.00	.000	.0	1
3	125.0	125.0	1200.0	.00	.000	.0	1
4	125.0	125.0	800.0	.00	.000	.0	1
5	125.0	125.0	1300.0	.00	.000	.0	1
6	119.3	119.3	1240.0	10.60	.000	.0	1
7	123.9	123.9	500.0	25.30	.000	.0	1
8	121.2	121.2	240.0	23.10	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	412.40
2	100.00	412.40
3	129.20	427.00
4	200.00	427.00

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 2 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	397.9	143.6	397.9
2	143.6	397.9	200.0	392.7

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

2000 trial surfaces will be generated and analyzed.

40 Surfaces initiate from each of 50 points equally spaced along the ground surface between x = 50.0 ft
and x = 110.0 ft

Each surface terminates between x = 120.0 ft
and x = 200.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

3.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 38 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	73.27	412.50
2	75.55	410.56
3	77.94	408.74
4	80.42	407.05
5	82.98	405.50
6	85.63	404.08
7	88.34	402.80
8	91.12	401.66
9	93.95	400.67
10	96.83	399.83
11	99.75	399.15
12	102.70	398.61
13	105.68	398.24
14	108.67	398.02
15	111.67	397.96
16	114.67	398.05
17	117.66	398.31
18	120.63	398.71
19	123.58	399.28
20	126.49	400.00
21	129.36	400.87
22	132.18	401.89
23	134.94	403.05
24	137.64	404.36
25	140.27	405.81
26	142.82	407.40
27	145.28	409.12
28	147.64	410.96

		9140WSS
29	149.91	412.93
30	152.07	415.01
31	154.12	417.20
32	156.05	419.50
33	157.86	421.89
34	159.53	424.38
35	161.08	426.95
36	162.49	429.60
37	163.76	432.31
38	164.41	433.94

**** Simplified BISHOP FOS = 2.646 ****

****
** **
** Out of the 2000 surfaces generated and analyzed by XSTABL, **
** 30 surfaces were found to have MISLEADING FOS values. **
** **
****

The following is a summary of the TEN most critical surfaces

Problem Description : SN 051-0066 West Abutment SS

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	2.646	111.35	455.10	57.14	73.27	164.41	6.902E+06
2.	2.646	116.66	455.45	56.87	79.39	169.31	7.001E+06
3.	2.649	119.73	454.89	56.86	81.84	172.57	7.206E+06
4.	2.652	112.26	452.36	54.07	75.71	163.08	6.363E+06
5.	2.654	114.43	464.07	65.98	73.27	173.14	8.669E+06
6.	2.655	113.38	449.59	51.15	78.16	162.05	5.892E+06
7.	2.658	117.90	444.20	46.21	84.29	162.93	5.287E+06
8.	2.662	116.39	443.70	45.65	83.06	160.98	5.139E+06
9.	2.662	120.01	446.11	48.17	85.51	166.62	5.698E+06
10.	2.662	117.35	448.75	49.90	83.06	164.98	5.790E+06

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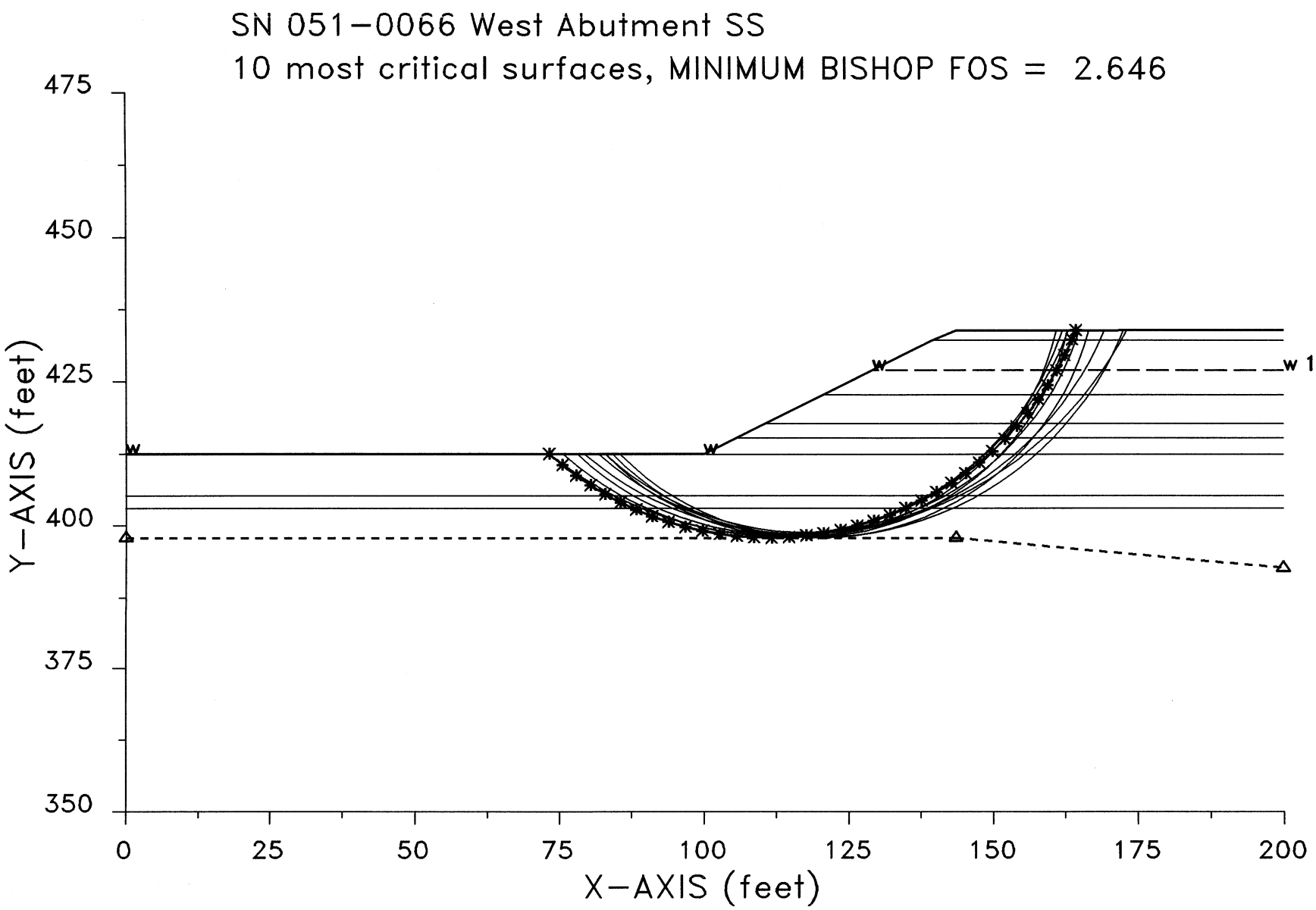
9140WSS 5-26-10 19:54



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*                using the              *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 2005      *
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*        Moscow, ID 83843, U.S.A.       *
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*                                       *
*  Ver. 5.207                 96 - 1992 *
*****************************************
```

Problem Description : SN 051-0066 West Abutment EQ

SEGMENT BOUNDARY COORDINATES

---

7 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	412.5	100.0	412.5	6
2	100.0	412.5	105.6	415.2	5
3	105.6	415.2	110.6	417.7	4
4	110.6	417.7	120.6	422.7	3
5	120.6	422.7	139.6	432.2	2
6	139.6	432.2	143.6	433.9	1
7	143.6	433.9	200.0	434.0	1

7 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	139.6	432.2	200.0	432.2	2
2	120.6	422.7	200.0	422.7	3
3	110.6	417.7	200.0	417.7	4
4	105.6	415.2	200.0	415.2	5
5	100.4	412.4	200.0	412.4	6
6	.0	405.2	200.0	405.2	7
7	.0	403.0	200.0	403.0	8

ISOTROPIC Soil Parameters

---

8 Soil unit(s) specified

Soil	Unit Weight	Cohesion	Friction	Pore Pressure	Water

Unit No.	Moist (pcf)	Sat. (pcf)	Intercept (psf)	Angle (deg)	Parameter Ru	Constant (psf)	Surface No.
1	125.0	125.0	1000.0	.00	.000	.0	1
2	125.0	125.0	1700.0	.00	.000	.0	1
3	125.0	125.0	1200.0	.00	.000	.0	1
4	125.0	125.0	800.0	.00	.000	.0	1
5	125.0	125.0	1300.0	.00	.000	.0	1
6	119.3	119.3	1240.0	10.60	.000	.0	1
7	123.9	123.9	500.0	25.30	.000	.0	1
8	121.2	121.2	240.0	23.10	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	412.40
2	100.00	412.40
3	129.20	427.00
4	200.00	427.00

A horizontal earthquake loading coefficient
of .087 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 2 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	397.9	143.6	397.9
2	143.6	397.9	200.0	392.7

A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.

2000 trial surfaces will be generated and analyzed.

40 Surfaces initiate from each of 50 points equally spaced along the ground surface between x = 50.0 ft and x = 110.0 ft

Each surface terminates between x = 120.0 ft and x = 200.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

3.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 40 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	73.27	412.50
2	75.65	410.68
3	78.12	408.97
4	80.66	407.38
5	83.27	405.90
6	85.95	404.55
7	88.68	403.31
8	91.47	402.21
9	94.31	401.23
10	97.18	400.38
11	100.10	399.66
12	103.04	399.07
13	106.00	398.62
14	108.99	398.31
15	111.98	398.13
16	114.98	398.08
17	117.98	398.18
18	120.97	398.41
19	123.95	398.77

		9140WEQ
20	126.91	399.27
21	129.84	399.91
22	132.74	400.67
23	135.60	401.57
24	138.42	402.60
25	141.19	403.75
26	143.90	405.03
27	146.56	406.43
28	149.14	407.95
29	151.66	409.58
30	154.10	411.33
31	156.45	413.19
32	158.72	415.15
33	160.90	417.22
34	162.98	419.38
35	164.96	421.63
36	166.84	423.97
37	168.61	426.39
38	170.26	428.89
39	171.80	431.47
40	173.14	433.95

**** Simplified BISHOP FOS = 2.071 ****

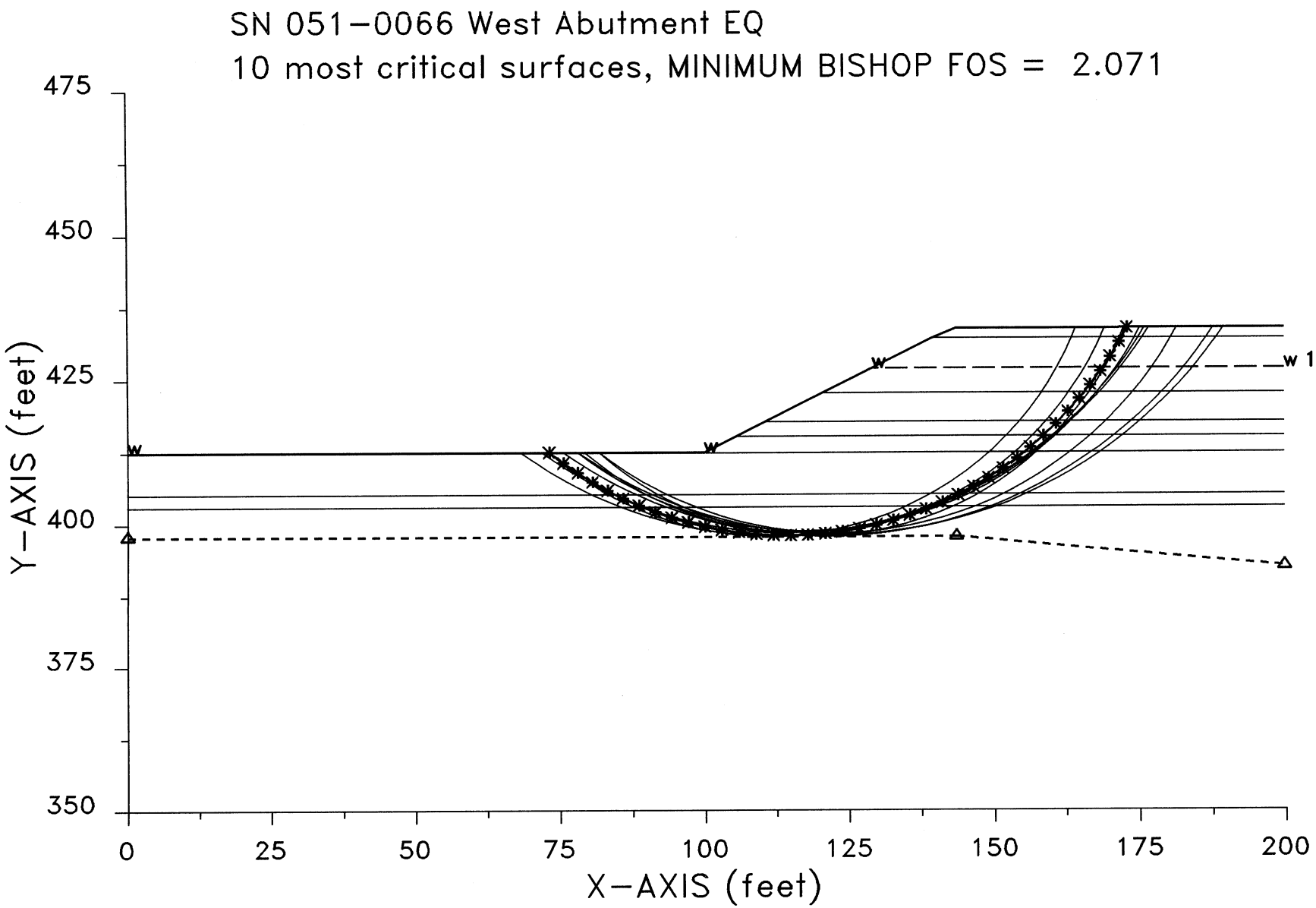
****
**
** Out of the 2000 surfaces generated and analyzed by XSTABL, **
** 12 surfaces were found to have MISLEADING FOS values. **
**
****

The following is a summary of the TEN most critical surfaces

Problem Description : SN 051-0066 West Abutment EQ

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	2.071	114.43	464.07	65.98	73.27	173.14	8.661E+06
2.	2.072	112.73	473.03	75.04	68.37	176.78	1.039E+07
3.	2.087	121.47	477.02	79.10	75.71	187.83	1.177E+07
4.	2.089	114.44	469.93	71.39	72.04	176.11	9.645E+06
5.	2.092	119.73	454.89	56.86	81.84	172.57	7.200E+06
6.	2.102	116.66	455.45	56.87	79.39	169.31	6.996E+06
7.	2.102	117.86	463.56	64.67	78.16	175.36	8.458E+06
8.	2.105	111.35	455.10	57.14	73.27	164.41	6.898E+06
9.	2.111	122.69	465.14	66.63	81.84	181.56	9.137E+06
10.	2.114	123.41	477.37	79.09	78.16	189.53	1.181E+07

* * * END OF FILE * * *


SN 051-0066 West Abutment EQ
10 most critical surfaces, MINIMUM BISHOP FOS = 2.071
475
450
425
400
375
350
Y-AXIS (feet)
0
25
50
75
100
125
150
175
200
X-AXIS (feet)
w
w 1

XSTABL File: 9140ESS 5-26-10 14:58

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*           Method of Slices            *
*                                       *
*        Copyright (C) 1992 - 2005      *
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*        Moscow, ID 83843, U.S.A.       *
*                                       *
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*                                       *
*  Ver. 5.207                96 - 1992  *
*****************************************
```

Problem Description : SN 051-0066 East Abutment SS

SEGMENT BOUNDARY COORDINATES
---

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	412.4	100.0	412.4	4
2	100.0	412.4	105.8	416.0	4
3	105.8	416.0	115.8	420.3	3
4	115.8	420.3	139.8	432.3	2
5	139.8	432.3	143.6	435.4	1
6	143.6	435.4	200.0	435.4	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	139.8	432.3	200.0	432.3	2
2	115.8	420.3	200.0	420.3	3
3	105.8	416.0	200.0	416.0	4

ISOTROPIC Soil Parameters
---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	1000.0	.00	.000	.0	1
2	128.5	128.5	440.0	23.10	.000	.0	1

3	121.5	121.5	200.0	35.20	.000	.0	1
4	126.2	126.2	360.0	27.80	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	412.40
2	100.00	412.40
3	129.20	427.00
4	200.00	427.00

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	396.8	200.0	410.3

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 50 points equally spaced along the ground surface between x = 50.0 ft
and x = 120.0 ft

Each surface terminates between x = 130.0 ft
and x = 200.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

3.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 25 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	95.71	412.40
2	98.51	411.31
3	101.37	410.41
4	104.29	409.71
5	107.25	409.20
6	110.23	408.90
7	113.23	408.79
8	116.23	408.89
9	119.21	409.19
10	122.17	409.69
11	125.09	410.39
12	127.95	411.28
13	130.75	412.36
14	133.47	413.63
15	136.10	415.08
16	138.62	416.70
17	141.03	418.49
18	143.31	420.44
19	145.46	422.53
20	147.46	424.77
21	149.30	427.13
22	150.99	429.62
23	152.50	432.21
24	153.83	434.90
25	154.04	435.40

**** Simplified BISHOP FOS = 2.006 ****

```
**********************************************************************
**                                                                  **
**  Out of the   1000 surfaces generated and analyzed by XSTABL,    **
**        2 surfaces were found to have MISLEADING FOS values.      **
**                                                                  **
**********************************************************************
```

The following is a summary of the TEN most critical surfaces

Problem Description : SN 051-0066 East Abutment SS

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	2.006	113.27	453.35	44.56	95.71	154.04	2.362E+06
2.	2.010	114.74	453.92	45.67	95.71	156.47	2.635E+06
3.	2.011	115.31	454.03	44.87	98.57	156.11	2.431E+06
4.	2.014	114.19	448.80	41.49	94.29	153.45	2.369E+06
5.	2.024	111.28	453.16	44.73	92.86	152.31	2.340E+06
6.	2.025	114.96	446.01	38.73	95.71	152.18	2.153E+06
7.	2.026	111.26	458.78	49.89	92.86	155.32	2.720E+06
8.	2.027	111.22	458.21	48.36	95.71	153.85	2.391E+06
9.	2.031	113.89	459.84	51.89	92.86	159.65	3.261E+06
10.	2.033	115.08	456.81	50.31	91.43	160.59	3.462E+06

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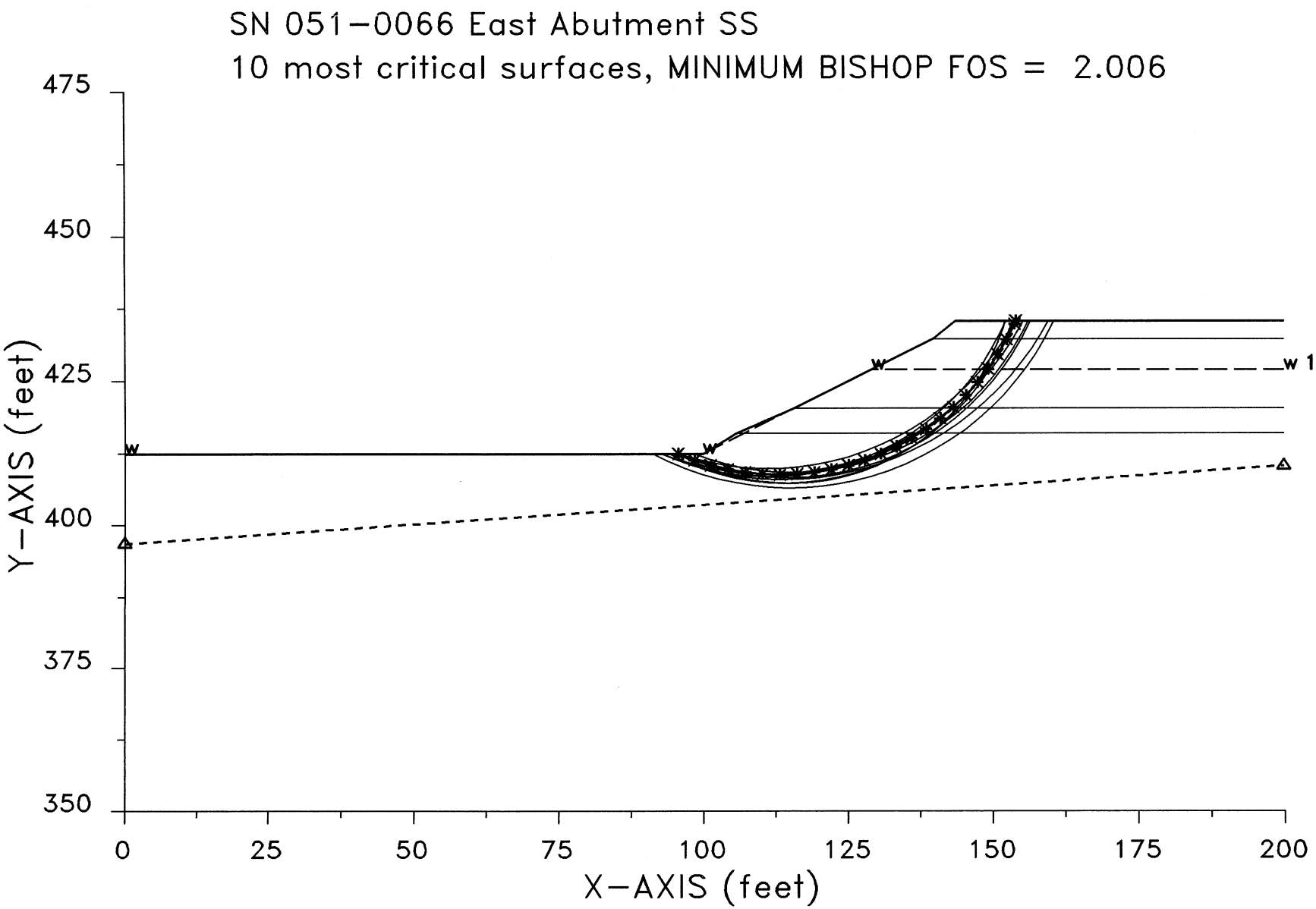
9140ESS 5-26-10 14:58



XSTABL File: 9140EEQ 5-26-10 14:58

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*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*        Copyright (C) 1992 - 2005      *
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*        Moscow, ID 83843, U.S.A.       *
*                                       *
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*                                       *
*  Ver. 5.207                 96 - 1992 *
*****************************************
```

Problem Description : SN 051-0066 East Abutment EQ

SEGMENT BOUNDARY COORDINATES

---

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	412.4	100.0	412.4	4
2	100.0	412.4	105.8	416.0	4
3	105.8	416.0	115.8	420.3	3
4	115.8	420.3	139.8	432.3	2
5	139.8	432.3	143.6	435.4	1
6	143.6	435.4	200.0	435.4	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	139.8	432.3	200.0	432.3	2
2	115.8	420.3	200.0	420.3	3
3	105.8	416.0	200.0	416.0	4

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	125.0	125.0	1000.0	.00	.000	.0	1
2	128.5	128.5	440.0	23.10	.000	.0	1

3	121.5	121.5	200.0	35.20	.000	.0	1
4	126.2	126.2	360.0	27.80	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	412.40
2	100.00	412.40
3	129.20	427.00
4	200.00	427.00

A horizontal earthquake loading coefficient
of .087 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	396.8	200.0	410.3

A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 50 points equally spaced
along the ground surface between x = 50.0 ft
and x = 120.0 ft

Each surface terminates between x = 130.0 ft
and x = 200.0 ft

Unless further limitations were imposed, the minimum elevation

at which a surface extends is y = .0 ft

3.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 26 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	95.71	412.40
2	98.48	411.24
3	101.32	410.27
4	104.21	409.48
5	107.15	408.88
6	110.13	408.48
7	113.12	408.28
8	116.12	408.27
9	119.11	408.46
10	122.09	408.85
11	125.03	409.43
12	127.93	410.20
13	130.77	411.16
14	133.55	412.31
15	136.24	413.63
16	138.84	415.13
17	141.33	416.80
18	143.71	418.62
19	145.97	420.60
20	148.09	422.72
21	150.06	424.98
22	151.89	427.36
23	153.55	429.86
24	155.05	432.46
25	156.37	435.15
26	156.47	435.40

**** Simplified BISHOP FOS = 1.655 ****

```
**********************************************************************
**                                                                  **
**  Out of the   1000 surfaces generated and analyzed by XSTABL,   **
**        2 surfaces were found to have MISLEADING FOS values.      **
**                                                                  **
**********************************************************************
```

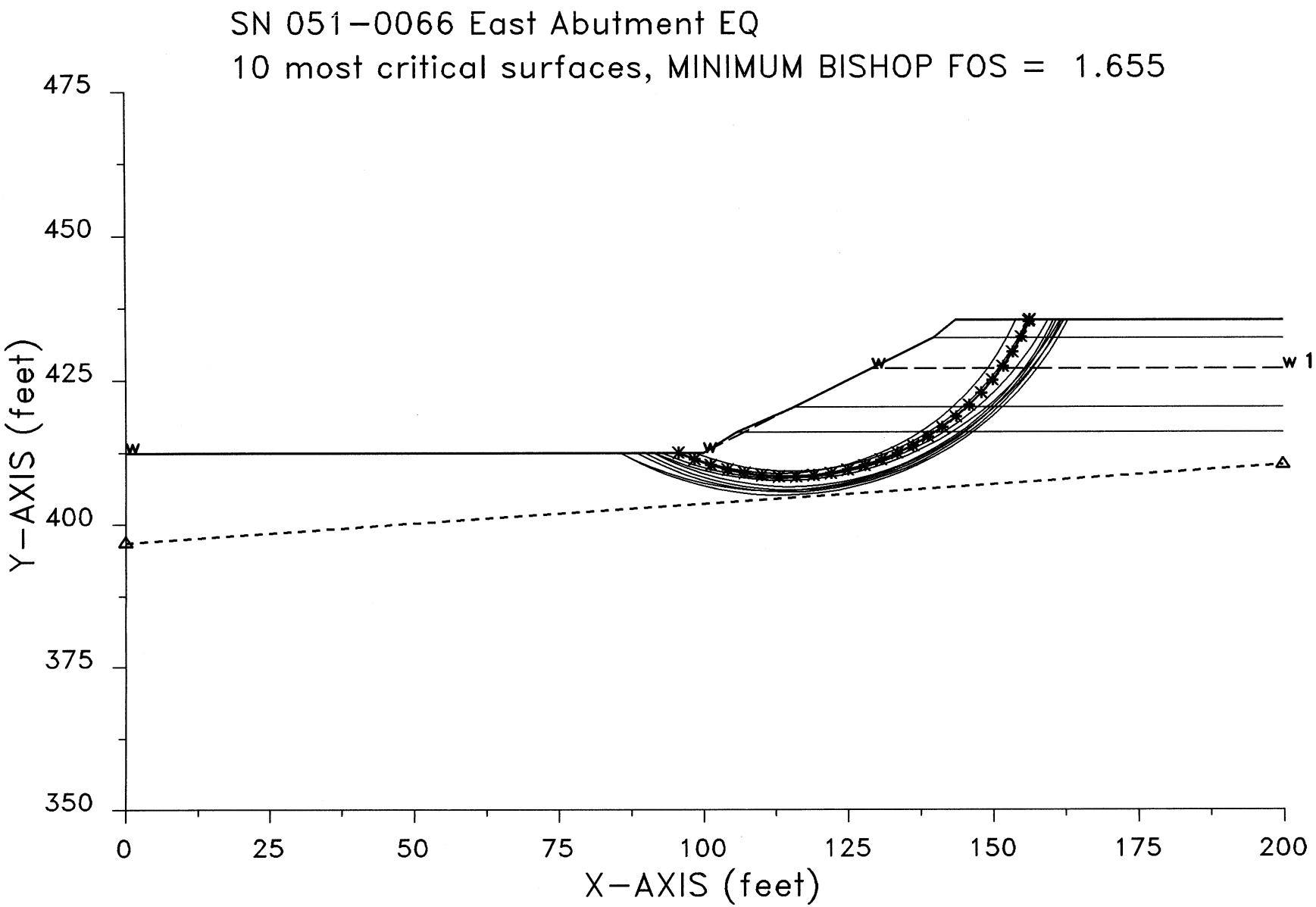
The following is a summary of the TEN most critical surfaces

Problem Description : SN 051-0066 East Abutment EQ

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.655	114.74	453.92	45.67	95.71	156.47	2.589E+06
2.	1.656	115.08	456.81	50.31	91.43	160.59	3.403E+06
3.	1.657	115.31	454.03	44.87	98.57	156.11	2.387E+06
4.	1.658	114.86	456.88	50.95	90.00	161.06	3.580E+06
5.	1.658	113.89	459.84	51.89	92.86	159.65	3.204E+06
6.	1.660	114.51	458.40	52.80	88.57	162.02	3.843E+06
7.	1.661	113.27	453.35	44.56	95.71	154.04	2.321E+06
8.	1.663	113.92	462.63	55.03	91.43	161.75	3.610E+06
9.	1.666	113.44	460.81	55.79	85.71	163.10	4.270E+06
10.	1.667	112.41	462.77	57.01	85.71	162.39	4.175E+06

* * * END OF FILE * * *

9140EEQ 5-26-10 14:58



LPILE Plus for Windows, Version 5.0 (5.0.39)

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

(c) 1985-2007 by Ensoft, Inc.
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This program is licensed to:

Tim Holcomb. P.E.
Holcomb Foundatoin Engineering Co.

Path to file locations: C:\Program Files\Ensoft\
Name of input data file: H09140 5' Socket.lpd
Name of output file: H09140 5' Socket.lpo
Name of plot output file: H09140 5' Socket.lpp
Name of runtime file: H09140 5' Socket.lpr

Time and Date of Analysis

Date: November 4, 2010 Time: 8:15:17

Problem Title

SN 051-0015 Lawrence County L pile Analysis 5' Socket

Program Options

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

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- 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:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 484.40 in

Depth of ground surface below top of pile = 424.80 in

Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 6 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	33.60000000	4937.0000	806.4000	29000000.
2	256.8000	33.60000000	4937.0000	806.4000	29000000.
3	256.8100	11.78000000	394.0000	15.6000	29000000.
4	424.7900	11.78000000	394.0000	15.6000	29000000.
5	424.8000	24.00000000	394.0000	452.4000	29000000.
6	484.8000	24.00000000	394.0000	452.4000	29000000.

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is weak rock, p-y criteria by Reese, 1997
Distance from top of pile to top of layer = 424.800 in
Distance from top of pile to bottom of layer = 484.400 in
Initial modulus of rock at top of layer = 2.0000E+04 lbs/in**2
Initial modulus of rock at bottom of layer = 2.0000E+04 lbs/in**2

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 2 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	424.80	.07523
2	484.40	.07523

Shear Strength of Soils

Shear strength parameters with depth defined using 2 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	424.800	1000.00000	.00	.00050	80.0
2	484.400	1000.00000	.00	.00050	80.0

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

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 9

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 1000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 1500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 4

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 2000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 5

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 2500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 6

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 3000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 7

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 3500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 8

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 4000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

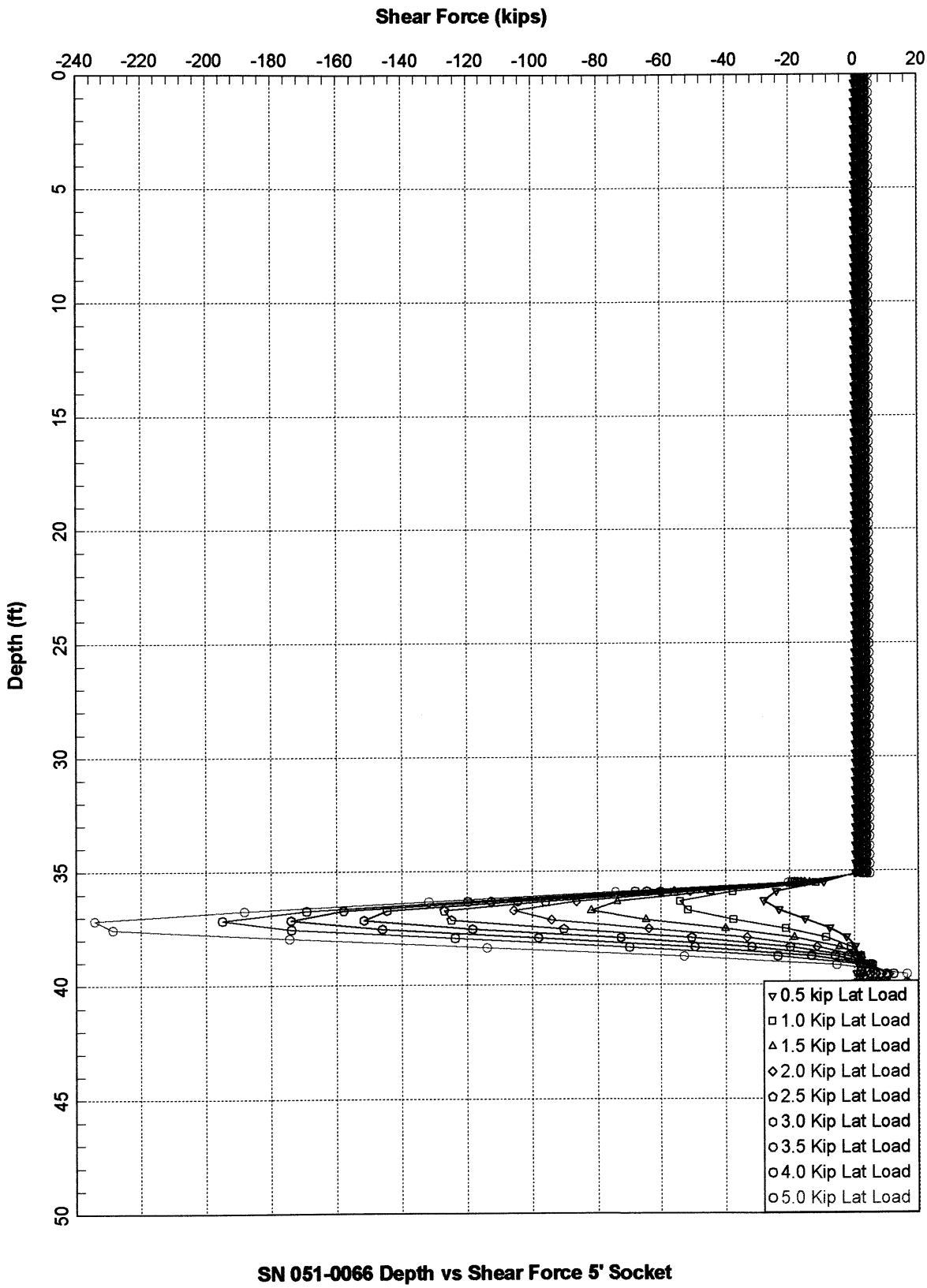
Load Case Number 9

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 5000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 120000.000 lbs

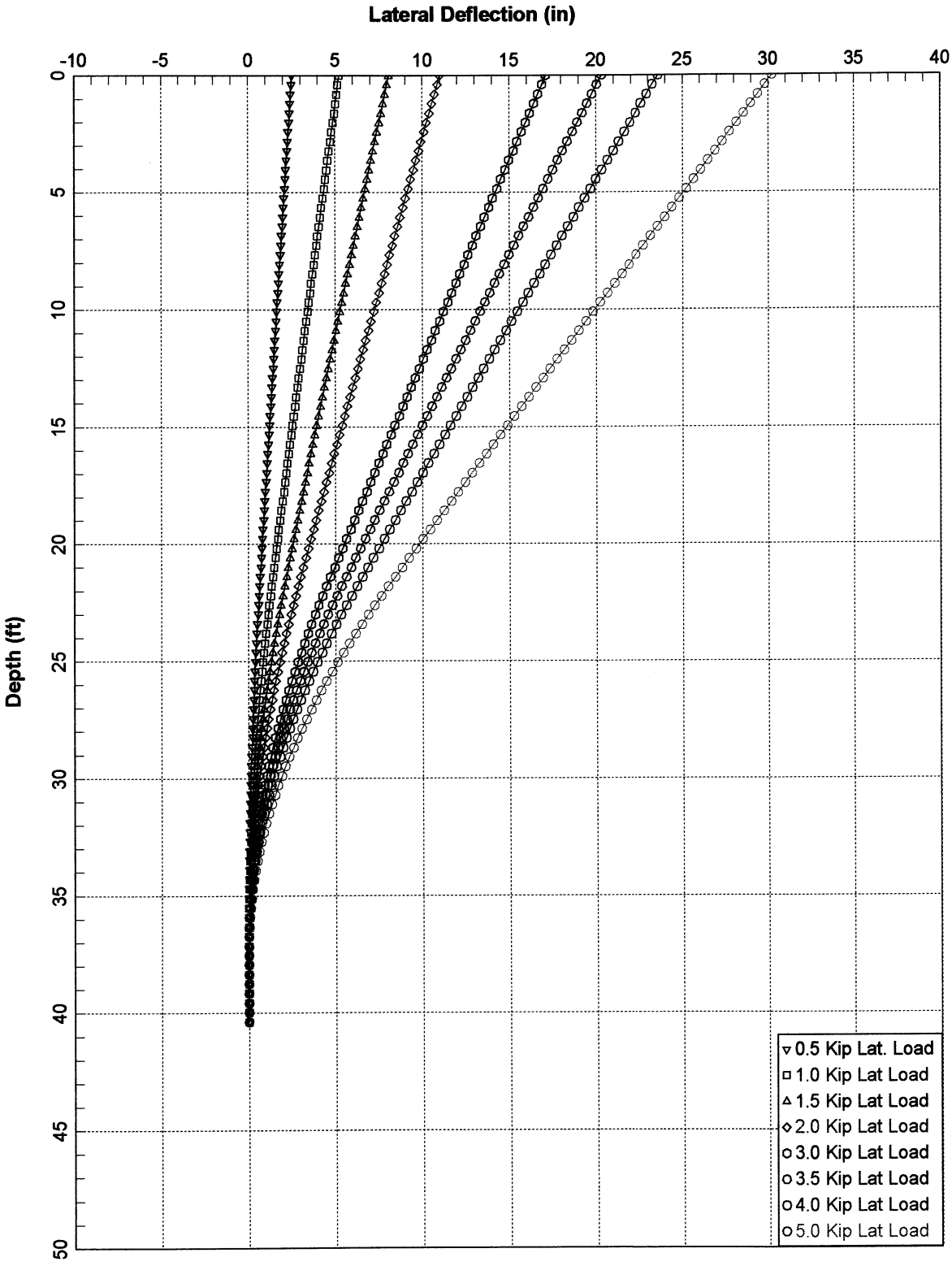
(Zero moment at pile head for this load indicates a free-head condition)

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

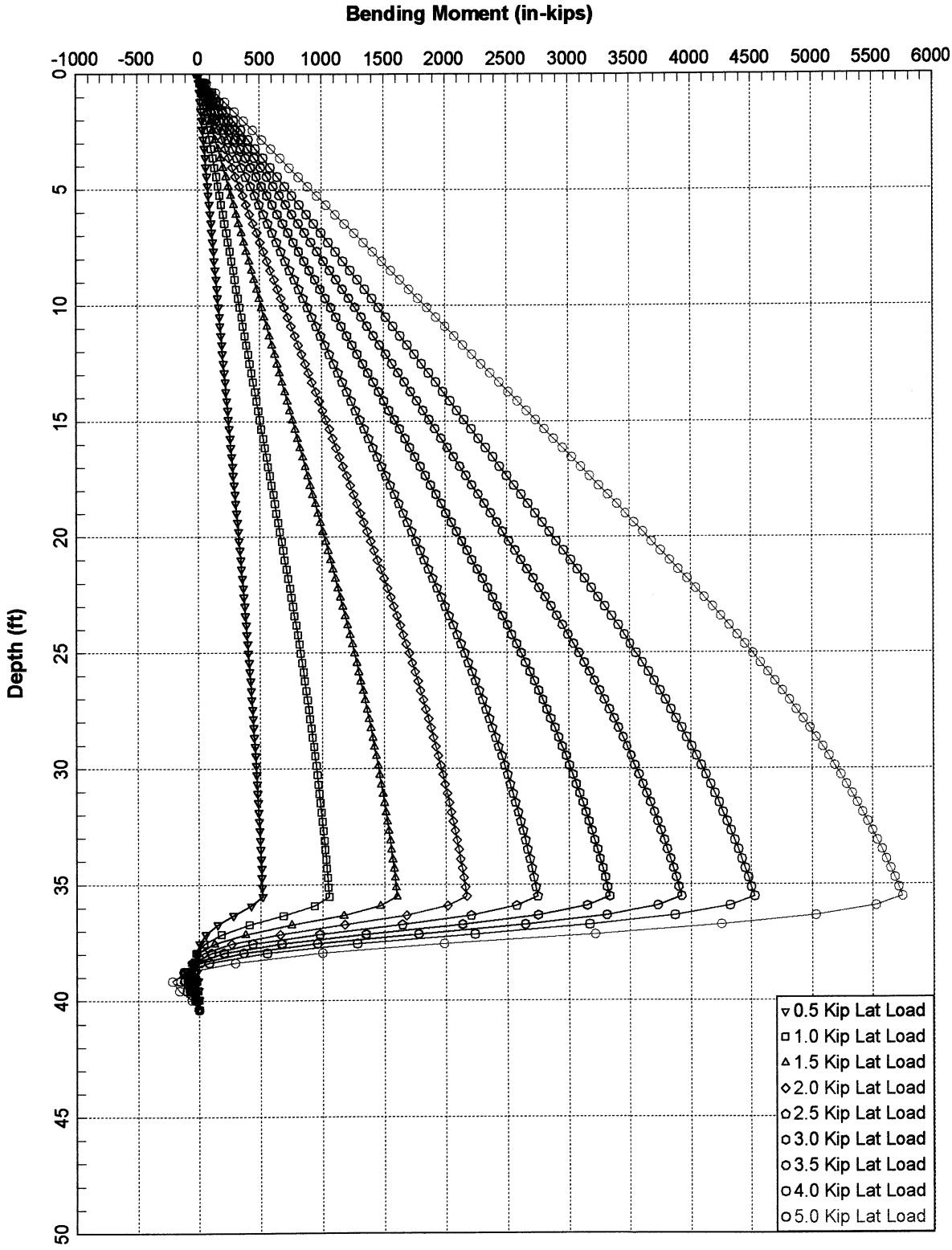
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 500.000 lbs



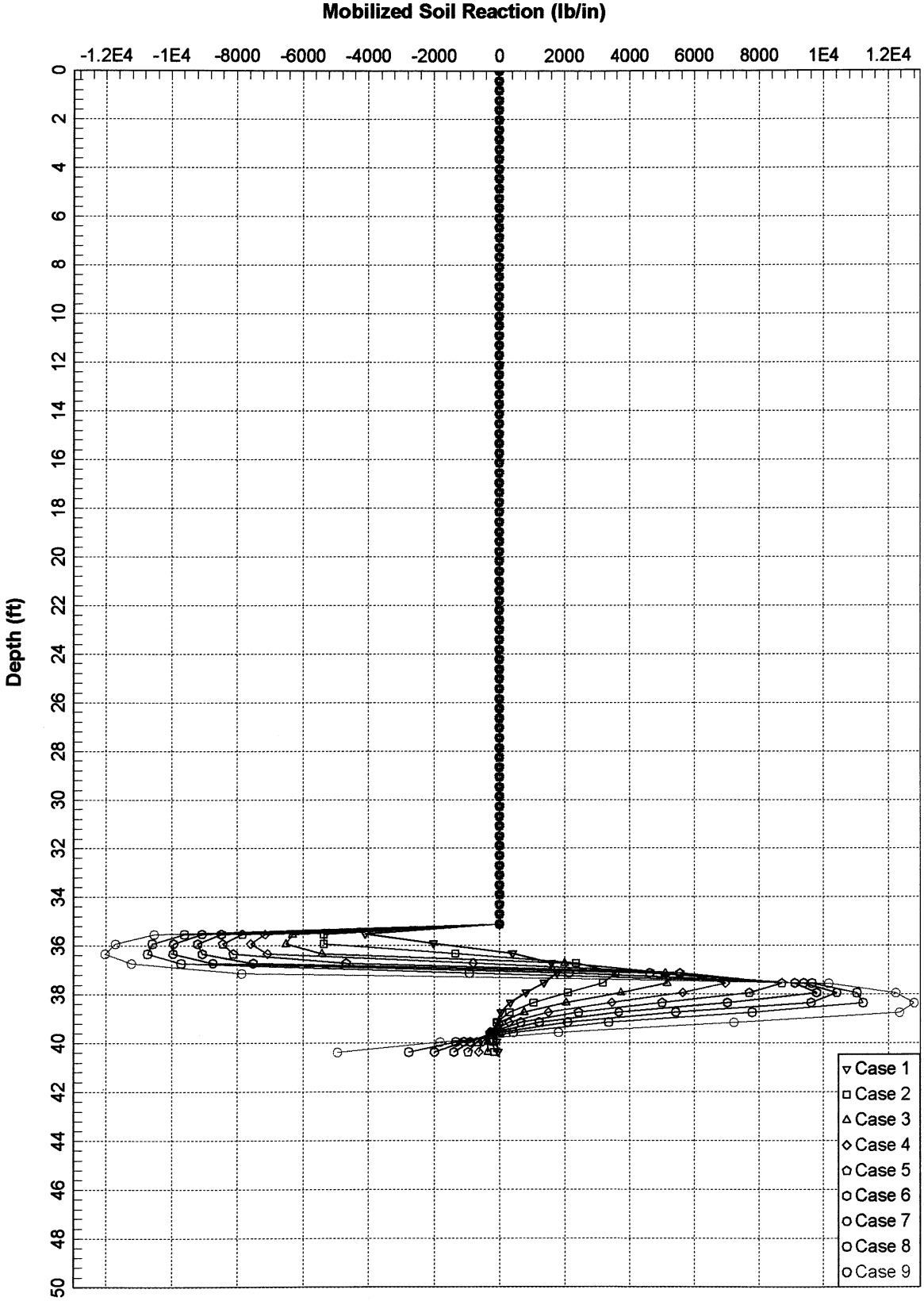
SN 051-0066 Depth vs Shear Force 5' Socket

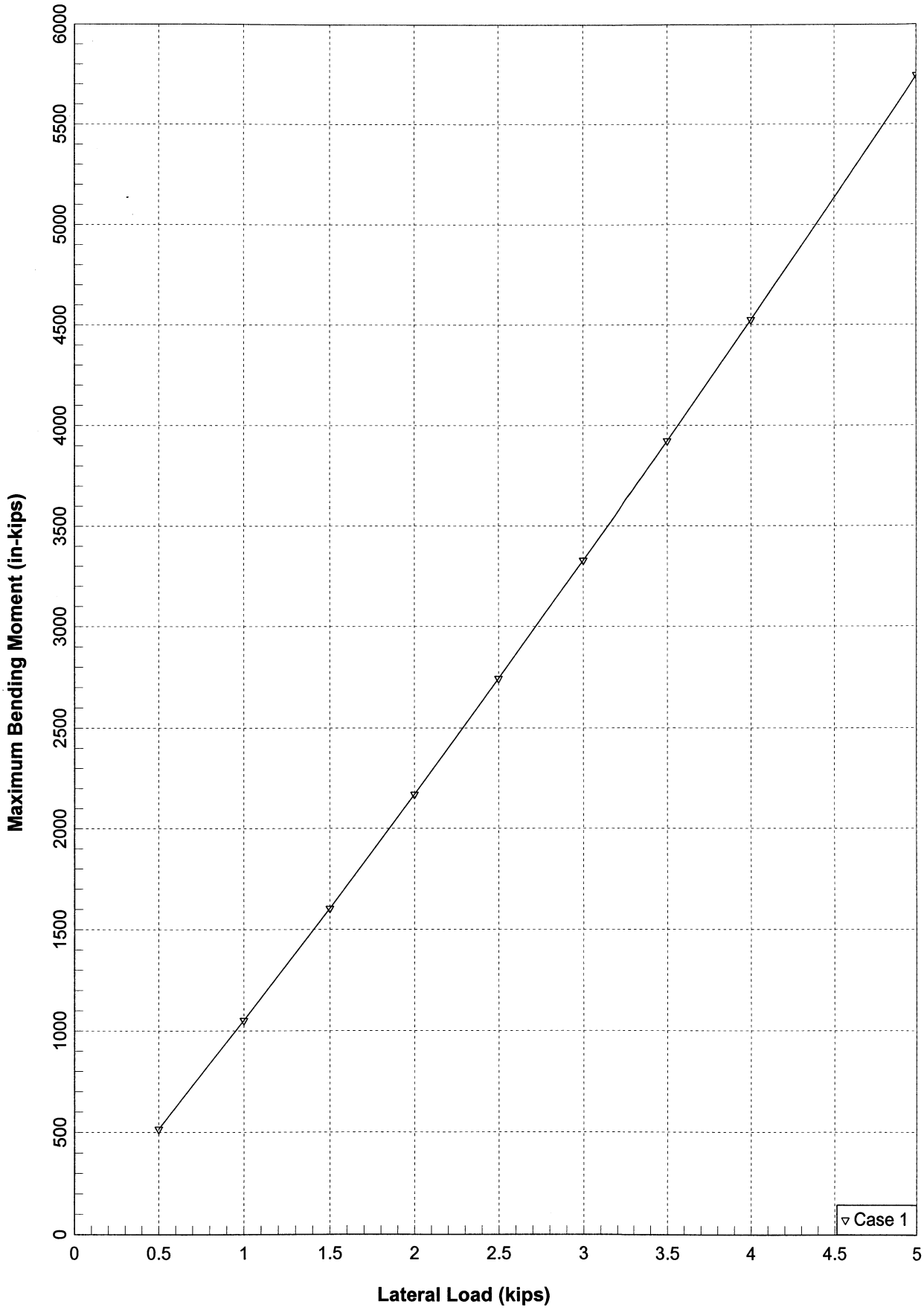


SN 051-0066 Depth vs Lateral Deflection 5' Socket



SN 051-0066 Depth vs. Bending Moment 5' Socket


Mobilized Soil Reaction (lb/in)
-1.2E4
-1E4
-8000
-6000
-4000
-2000
0
2000
4000
6000
8000
1E4
1.2E4
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
Case 1
Case 2
Case 3
Case 4
Case 5
Case 6
Case 7
Case 8
Case 9


Maximum Bending Moment (in-kips)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Lateral Load (kips)
Case 1

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== B-1 West Abut.
ELEVATION OF BORING GROUND SURFACE ========== 432.22 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 4.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 4.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 1.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 303 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.13
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.533

	BORING DATA							CONDITIONS DURING DRILLING						CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
429.72	2.5	7	2.1	100				0.130	0.325	13.300	20.960	0.228	0.130	0.445	0.445	1.500	**0.537**	0.908	**0.155**	N.L. (1)
427.22	5	17	1.7	100				0.065	0.488	34.625	46.549	0.260	0.065	0.608	0.732	1.500	**0.614**	0.839	**0.172**	N.L. (3)
424.72	7.5	16	6	100				0.082	0.693	29.968	40.961	0.155	0.082	0.813	1.093	1.468	**0.357**	0.769	**0.177**	N.L. (3)
422.22	10	7	1.2	100				0.061	0.845	12.084	19.500	0.209	0.061	0.965	1.402	1.257	**0.413**	0.701	**0.174**	2.374 (D)
419.72	12.5	7	1.3	100				0.062	1.000	12.193	19.631	0.211	0.062	1.120	1.713	1.205	**0.399**	0.638	**0.166**	2.404 (D)
417.22	15	3	0.8	100				0.057	1.143	5.217	11.260	0.124	0.057	1.263	2.011	1.132	**0.221**	0.579	**0.157**	1.408 (C)
414.72	17.5	8	1.3	100				0.062	1.298	13.712	21.454	0.234	0.062	1.418	2.322	1.130	**0.416**	0.528	**0.147**	2.830 (D)
412.22	20	9	1.9	100				0.067	1.465	15.125	23.150	0.259	0.067	1.585	2.646	1.096	**0.446**	0.483	**0.137**	3.255 (D)
409.72	22.5	4	1	80				0.059	1.613	6.542	12.850	0.139	0.059	1.733	2.949	1.052	**0.230**	0.445	**0.129**	1.783 (C)
407.22	25	5	1	80				0.059	1.760	7.972	14.566	0.156	0.059	1.880	3.253	1.032	**0.252**	0.413	**0.122**	2.066 (C)
404.72	27.5	1	0.4	20				0.049	1.883	1.561	5.300	0.074	0.049	2.003	3.531	1.012	**0.118**	0.388	**0.117**	1.009 (C)
402.22	30	1	0.6	20				0.053	2.015	1.523	5.259	0.074	0.053	2.135	3.820	0.999	**0.116**	0.367	**0.112**	1.036 (C)
399.72	32.5	1		0				0.043	2.123	1.495	1.495	0.051	0.043	2.243	4.083	0.989	**0.079**	0.350	**0.109**	0.725 (C)
397.22	35	1		0				0.043	2.230	1.466	1.466	0.051	0.043	2.350	4.347	0.980	**0.078**	0.337	**0.106**	0.736 (C)
394.72	37.5	1		0				0.043	2.338	1.438	1.438	0.051	0.043	2.458	4.610	0.971	**0.077**	0.326	**0.104**	0.740 (C)
392.22	40	50	2	100				0.067	2.505	82.429	103.915	0.750	0.067	2.625	4.934	0.918	**1.083**	0.318	**0.102**	N.L. (3)
389.72	42.5	50		100				0.076	2.695	79.669	100.603	0.725	0.076	2.815	5.280	0.893	**1.017**	0.311	**0.100**	N.L. (3)
387.22	45	50		100				0.076	2.885	77.091	97.509	0.702	0.076	3.005	5.626	0.870	**0.959**	0.306	**0.098**	N.L. (3)
384.72	47.5	50		100				0.076	3.075	74.671	94.606	0.679	0.076	3.195	5.972	0.849	**0.906**	0.302	**0.096**	N.L. (3)
382.22	50	50		0				0.076	3.265	72.391	72.391	0.505	0.076	3.385	6.318	0.829	**0.658**	0.299	**0.095**	N.L. (3)
379.72	52.5	50		0				0.076	3.455	70.232	70.232	0.488	0.076	3.575	6.664	0.811	**0.622**	0.297	**0.094**	N.L. (3)
377.22	55	50		0				0.076	3.645	68.181	68.181	0.471	0.076	3.765	7.010	0.795	**0.588**	0.295	**0.094**	N.L. (3)
374.72	57.5	50		0				0.076	3.835	66.226	66.226	0.455	0.076	3.955	7.356	0.779	**0.557**	0.294	**0.093**	N.L. (3)
372.22	60	50		0				0.076	4.025	64.360	64.360	0.439	0.076	4.145	7.702	0.765	**0.527**	0.293	**0.093**	N.L. (3)
369.72	62.5	50		0				0.076	4.215	62.579	62.579	0.424	0.076	4.335	8.048	0.751	**0.500**	0.292	**0.092**	N.L. (3)
367.22	65	50		0				0.076	4.405	60.880	60.880	0.409	0.076	4.525	8.394	0.738	**0.474**	0.288	**0.091**	N.L. (3)
364.72	67.5	50		0				0.076	4.595	59.264	59.264	0.395	0.076	4.715	8.740	0.726	**0.450**	0.284	**0.090**	N.L. (3)
362.22	70	50		0				0.076	4.785	57.731	57.731	0.381	0.076	4.905	9.086	0.715	**0.428**	0.281	**0.089**	N.L. (3)
359.72	72.5	50		0				0.076	4.975	56.282	56.282	0.367	0.076	5.095	9.432	0.704	**0.406**	0.277	**0.088**	N.L. (3)
357.22	75	50		0				0.076	5.165	54.916	54.916	0.354	0.076	5.285	9.778	0.694	**0.386**	0.274	**0.086**	N.L. (3)
354.72	77.5	50		0				0.076	5.355	53.437	53.437	0.340	0.076	5.475	10.124	0.684	**0.365**	0.270	**0.085**	N.L. (3)
352.22	80	50		0				0.076	5.545	51.957	51.957	0.324	0.076	5.665	10.470	0.675	**0.344**	0.267	**0.084**	N.L. (3)
349.72	82.5	50		0				0.076	5.735	50.512	50.512	0.309	0.076	5.855	10.816	0.666	**0.323**	0.263	**0.083**	N.L. (3)

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 & w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== Boring #2
ELEVATION OF BORING GROUND SURFACE ========== 410.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 78 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.1
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.521

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
408	2.5	0.01	0.8	20				0.057	0.143	0.020	3.636	0.062	0.057	0.143	0.299	1.500	**0.147**	0.808	**0.289**	**0.509 (C)**
405.5	5	0.01	0.1	20				0.035	0.230	0.019	3.636	0.062	0.035	0.230	0.542	1.500	**0.147**	0.644	**0.259**	**0.568 (C)**
403	7.5	0.01	0.2	20				0.042	0.335	0.019	3.635	0.062	0.042	0.335	0.803	1.446	**0.142**	0.507	**0.207**	**0.686 (C)**
400.5	10	2	0.1	20				0.035	0.423	3.944	7.872	0.095	0.035	0.423	1.047	1.422	**0.212**	0.394	**0.166**	**1.277 (C)**
398	12.5	50		100				0.076	0.613	115.559	143.671	1.050	0.076	0.613	1.393	1.500	**2.475**	0.302	**0.117**	**N.L. (3)**
395.5	15	50		100				0.076	0.803	113.201	140.841	1.029	0.076	0.803	1.739	1.475	**2.385**	0.228	**0.084**	**N.L. (3)**
393	17.5	50		100				0.076	0.993	110.013	137.016	1.000	0.076	0.993	2.085	1.355	**2.129**	0.169	**0.061**	**N.L. (3)**
390.5	20	50		100				0.076	1.183	106.381	132.657	0.968	0.076	1.183	2.431	1.263	**1.920**	0.123	**0.043**	**N.L. (3)**
388	22.5	50		100				0.076	1.373	102.566	128.080	0.933	0.076	1.373	2.777	1.190	**1.745**	0.087	**0.030**	**N.L. (3)**
385.5	25	50		100				0.076	1.563	98.744	123.493	0.899	0.076	1.563	3.123	1.130	**1.595**	0.058	**0.020**	**N.L. (3)**
383	27.5	50		100				0.076	1.753	95.025	119.030	0.865	0.076	1.753	3.469	1.079	**1.467**	0.036	**0.012**	**N.L. (3)**
380.5	30	50		100				0.076	1.943	91.473	114.768	0.833	0.076	1.943	3.815	1.036	**1.355**	0.018	**0.006**	**N.L. (3)**
378	32.5	50		100				0.076	2.133	88.123	110.747	0.802	0.076	2.133	4.161	0.998	**1.258**	0.005	**0.002**	**N.L. (3)**
375.5	35	50		100				0.076	2.323	84.985	106.982	0.774	0.076	2.323	4.507	0.964	**1.172**	-0.006	**-0.002**	**N.L. (3)**
373	37.5	50		100				0.076	2.513	82.057	103.468	0.747	0.076	2.513	4.853	0.934	**1.097**	-0.014	**-0.005**	**N.L. (3)**
370.5	40	50	2	100				0.067	2.680	79.668	100.601	0.725	0.067	2.680	5.176	0.911	**1.038**	-0.020	**-0.007**	**N.L. (3)**
368	42.5	50	2	100				0.067	2.848	77.416	97.899	0.705	0.067	2.848	5.500	0.889	**0.984**	-0.025	**-0.008**	**N.L. (3)**
365.5	45	50	2	100				0.067	3.015	75.288	95.346	0.685	0.067	3.015	5.823	0.869	**0.935**	-0.029	**-0.009**	**N.L. (3)**
363	47.5	50	2	100				0.067	3.183	73.270	92.924	0.666	0.067	3.183	6.147	0.850	**0.890**	-0.031	**-0.010**	**N.L. (3)**
360.5	50	50		0				0.076	3.373	71.076	71.076	0.495	0.076	3.373	6.493	0.831	**0.646**	-0.034	**-0.011**	**N.L. (3)**
358	52.5	50		0				0.076	3.563	68.996	68.996	0.478	0.076	3.563	6.839	0.813	**0.610**	-0.035	**-0.012**	**N.L. (3)**
355.5	55	50		0				0.076	3.753	67.016	67.016	0.461	0.076	3.753	7.185	0.796	**0.577**	-0.037	**-0.012**	**N.L. (3)**
353	57.5	50		0				0.076	3.943	65.128	65.128	0.445	0.076	3.943	7.531	0.780	**0.546**	-0.038	**-0.012**	**N.L. (3)**
350.5	60	50		0				0.076	4.133	63.324	63.324	0.430	0.076	4.133	7.877	0.766	**0.517**	-0.038	**-0.013**	**N.L. (3)**
348	62.5	50		0				0.076	4.323	61.599	61.599	0.415	0.076	4.323	8.223	0.752	**0.491**	-0.039	**-0.013**	**N.L. (3)**
345.5	65	50		0				0.076	4.513	59.953	59.953	0.401	0.076	4.513	8.569	0.739	**0.465**	-0.041	**-0.013**	**N.L. (3)**
343	67.5	50		0				0.076	4.703	58.385	58.385	0.387	0.076	4.703	8.915	0.727	**0.442**	-0.045	**-0.014**	**N.L. (3)**
340.5	70	50		0				0.076	4.893	56.896	56.896	0.373	0.076	4.893	9.261	0.716	**0.419**	-0.048	**-0.016**	**N.L. (3)**
338	72.5	50		0				0.076	5.083	55.488	55.488	0.360	0.076	5.083	9.607	0.705	**0.398**	-0.052	**-0.017**	**N.L. (3)**
335.5	75	50		0				0.076	5.273	54.092	54.092	0.346	0.076	5.273	9.953	0.695	**0.378**	-0.055	**-0.018**	**N.L. (3)**
333	77.5	50		0				0.076	5.463	52.558	52.558	0.331	0.076	5.463	10.299	0.685	**0.356**	-0.059	**-0.019**	**N.L. (3)**
330.5	80	50		0				0.076	5.653	51.125	51.125	0.315	0.076	5.653	10.645	0.676	**0.335**	-0.062	**-0.020**	**N.L. (3)**
328	82.5	50		0				0.076	5.843	49.725	49.725	0.300	0.076	5.843	10.991	0.667	**0.314**	-0.066	**-0.021**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 & w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== Boring #3
ELEVATION OF BORING GROUND SURFACE ========== 412.10 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 48 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.1
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.521

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
409.6	2.5	0.01	0.01	20				0.016	0.040	0.020	3.636	0.062	0.016	0.040	0.196	1.500	**0.147**	0.762	**0.637**	**0.231 (C)**
407.1	5	7	2.8	10				0.072	0.220	13.859	15.028	0.160	0.072	0.220	0.532	1.500	**0.378**	0.563	**0.232**	**1.629 (D)**
404.6	7.5	5	0.4	10				0.049	0.343	9.386	10.459	0.117	0.049	0.343	0.811	1.500	**0.276**	0.399	**0.161**	**1.714 (D)**
402.1	10	0.01	0.3	10				0.046	0.458	0.019	0.889	0.049	0.046	0.458	1.082	1.359	**0.105**	0.265	**0.107**	**0.981 (C)**
399.6	12.5	0.01	0.3	10				0.046	0.573	0.020	0.890	0.049	0.046	0.573	1.353	1.299	**0.100**	0.158	**0.064**	**1.563 (C)**
397.1	15	0.01	0.2	10				0.042	0.678	0.020	0.890	0.049	0.042	0.678	1.614	1.256	**0.097**	0.073	**0.029**	**3.345 (C)**
394.6	17.5	0.01	0.2	10				0.042	0.783	0.020	0.890	0.049	0.042	0.783	1.875	1.221	**0.094**	0.005	**0.002**	**47.000 (C)**
392.1	20	50		100				0.076	0.973	112.734	140.280	1.025	0.076	0.973	2.221	1.366	**2.199**	-0.048	**-0.019**	**N.L. (3)**
389.6	22.5	50		100				0.076	1.163	108.378	135.053	0.986	0.076	1.163	2.567	1.272	**1.969**	-0.090	**-0.034**	**N.L. (3)**
387.1	25	50		100				0.076	1.353	104.066	129.879	0.947	0.076	1.353	2.913	1.197	**1.781**	-0.122	**-0.045**	**N.L. (3)**
384.6	27.5	50		100				0.076	1.543	99.908	124.889	0.909	0.076	1.543	3.259	1.136	**1.622**	-0.148	**-0.053**	**N.L. (3)**
382.1	30	50		100				0.076	1.733	95.965	120.158	0.873	0.076	1.733	3.605	1.084	**1.488**	-0.167	**-0.059**	**N.L. (3)**
379.6	32.5	50		100				0.076	1.923	92.266	115.719	0.840	0.076	1.923	3.951	1.040	**1.373**	-0.183	**-0.064**	**N.L. (3)**
377.1	35	50		100				0.076	2.113	88.818	111.581	0.809	0.076	2.113	4.297	1.001	**1.273**	-0.194	**-0.067**	**N.L. (3)**
374.6	37.5	50		100				0.076	2.303	85.612	107.735	0.780	0.076	2.303	4.643	0.968	**1.185**	-0.204	**-0.070**	**N.L. (3)**
372.1	40	50	2	100				0.067	2.470	83.004	104.605	0.756	0.067	2.470	4.966	0.941	**1.117**	-0.211	**-0.072**	**N.L. (3)**
369.6	42.5	50	2	100				0.067	2.638	80.553	101.664	0.733	0.067	2.638	5.290	0.916	**1.056**	-0.216	**-0.074**	**N.L. (3)**
367.1	45	50	2	100				0.067	2.805	78.244	98.893	0.712	0.067	2.805	5.613	0.894	**1.001**	-0.220	**-0.075**	**N.L. (3)**
364.6	47.5	50	2	100				0.067	2.973	76.059	96.271	0.692	0.067	2.973	5.937	0.874	**0.950**	-0.224	**-0.076**	**N.L. (3)**
362.1	50	50		0				0.076	3.163	73.691	73.691	0.516	0.076	3.163	6.283	0.852	**0.691**	-0.226	**-0.077**	**N.L. (3)**
359.6	52.5	50		0				0.076	3.353	71.453	71.453	0.498	0.076	3.353	6.629	0.833	**0.651**	-0.228	**-0.077**	**N.L. (3)**
357.1	55	50		0				0.076	3.543	69.329	69.329	0.480	0.076	3.543	6.975	0.814	**0.615**	-0.229	**-0.077**	**N.L. (3)**
354.6	57.5	50		0				0.076	3.733	67.307	67.307	0.464	0.076	3.733	7.321	0.798	**0.581**	-0.231	**-0.077**	**N.L. (3)**
352.1	60	50		0				0.076	3.923	65.380	65.380	0.448	0.076	3.923	7.667	0.782	**0.550**	-0.232	**-0.077**	**N.L. (3)**
349.6	62.5	50		0				0.076	4.113	63.543	63.543	0.432	0.076	4.113	8.013	0.767	**0.521**	-0.232	**-0.077**	**N.L. (3)**
347.1	65	50		0				0.076	4.303	61.792	61.792	0.417	0.076	4.303	8.359	0.753	**0.494**	-0.234	**-0.078**	**N.L. (3)**
344.6	67.5	50		0				0.076	4.493	60.128	60.128	0.402	0.076	4.493	8.705	0.741	**0.468**	-0.238	**-0.079**	**N.L. (3)**
342.1	70	50		0				0.076	4.683	58.550	58.550	0.388	0.076	4.683	9.051	0.728	**0.444**	-0.241	**-0.080**	**N.L. (3)**
339.6	72.5	50		0				0.076	4.873	57.060	57.060	0.374	0.076	4.873	9.397	0.717	**0.422**	-0.245	**-0.081**	**N.L. (3)**
337.1	75	50		0				0.076	5.063	55.656	55.656	0.361	0.076	5.063	9.743	0.706	**0.401**	-0.248	**-0.082**	**N.L. (3)**
334.6	77.5	50		0				0.076	5.253	54.302	54.302	0.348	0.076	5.253	10.089	0.696	**0.381**	-0.252	**-0.083**	**N.L. (3)**
332.1	80	50		0				0.076	5.443	52.775	52.775	0.333	0.076	5.443	10.435	0.686	**0.359**	-0.255	**-0.084**	**N.L. (3)**
329.6	82.5	50		0				0.076	5.633	51.287	51.287	0.317	0.076	5.633	10.781	0.676	**0.337**	-0.259	**-0.085**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 & w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== Boring #4
ELEVATION OF BORING GROUND SURFACE ========== 411.59 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 48 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.1
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.521

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
409.09	2.5	0.01	0.01	20				0.016	0.040	0.020	3.636	0.062	0.016	0.040	0.196	1.500	**0.147**	0.762	**0.636**	**0.231 (C)**
406.59	5	0.01	0.01	10				0.016	0.080	0.020	0.889	0.049	0.016	0.080	0.392	1.500	**0.116**	0.562	**0.470**	**0.247 (C)**
404.09	7.5	0.01	0.2	10				0.042	0.185	0.020	0.890	0.049	0.042	0.185	0.653	1.500	**0.116**	0.397	**0.239**	**0.485 (C)**
401.59	10	0.01	0.3	10				0.046	0.300	0.021	0.890	0.049	0.046	0.300	0.924	1.479	**0.114**	0.264	**0.138**	**0.826 (C)**
399.09	12.5	0.01	0.3	10				0.046	0.415	0.021	0.891	0.049	0.046	0.415	1.195	1.386	**0.107**	0.156	**0.077**	**1.390 (C)**
396.59	15	1	0.1	10				0.035	0.503	2.104	3.019	0.058	0.035	0.503	1.439	1.334	**0.123**	0.070	**0.034**	**3.618 (C)**
394.09	17.5	50		10				0.076	0.693	120.210	123.679	0.900	0.076	0.693	1.785	1.500	**2.121**	0.003	**0.001**	**N.L. (3)**
391.59	20	50		100				0.076	0.883	115.695	143.834	1.051	0.076	0.883	2.131	1.420	**2.346**	-0.051	**-0.021**	**N.L. (3)**
389.09	22.5	50		100				0.076	1.073	111.075	138.290	1.010	0.076	1.073	2.477	1.313	**2.084**	-0.092	**-0.036**	**N.L. (3)**
386.59	25	50		100				0.076	1.263	106.527	132.832	0.969	0.076	1.263	2.823	1.230	**1.873**	-0.125	**-0.048**	**N.L. (3)**
384.09	27.5	50		100				0.076	1.453	102.158	127.589	0.929	0.076	1.453	3.169	1.163	**1.699**	-0.150	**-0.056**	**N.L. (3)**
381.59	30	50		100				0.076	1.643	98.028	122.633	0.892	0.076	1.643	3.515	1.107	**1.553**	-0.170	**-0.062**	**N.L. (3)**
379.09	32.5	50		100				0.076	1.833	94.163	117.996	0.857	0.076	1.833	3.861	1.060	**1.428**	-0.185	**-0.067**	**N.L. (3)**
376.59	35	50		100				0.076	2.023	90.568	113.682	0.825	0.076	2.023	4.207	1.019	**1.320**	-0.197	**-0.070**	**N.L. (3)**
374.09	37.5	50		100				0.076	2.213	87.232	109.679	0.794	0.076	2.213	4.553	0.983	**1.227**	-0.206	**-0.072**	**N.L. (3)**
371.59	40	50	2	100				0.067	2.380	84.521	106.426	0.770	0.067	2.380	4.876	0.955	**1.155**	-0.213	**-0.074**	**N.L. (3)**
369.09	42.5	50	2	100				0.067	2.548	81.977	103.373	0.746	0.067	2.548	5.200	0.929	**1.090**	-0.219	**-0.076**	**N.L. (3)**
366.59	45	50	2	100				0.067	2.715	79.583	100.499	0.724	0.067	2.715	5.523	0.906	**1.031**	-0.223	**-0.077**	**N.L. (3)**
364.09	47.5	50	2	100				0.067	2.883	77.320	97.784	0.704	0.067	2.883	5.847	0.884	**0.978**	-0.226	**-0.078**	**N.L. (3)**
361.59	50	50		0				0.076	3.073	74.872	74.872	0.525	0.076	3.073	6.193	0.862	**0.711**	-0.229	**-0.079**	**N.L. (3)**
359.09	52.5	50		0				0.076	3.263	72.560	72.560	0.507	0.076	3.263	6.539	0.842	**0.670**	-0.231	**-0.079**	**N.L. (3)**
356.59	55	50		0				0.076	3.453	70.369	70.369	0.489	0.076	3.453	6.885	0.823	**0.632**	-0.232	**-0.079**	**N.L. (3)**
354.09	57.5	50		0				0.076	3.643	68.286	68.286	0.472	0.076	3.643	7.231	0.805	**0.597**	-0.233	**-0.079**	**N.L. (3)**
351.59	60	50		0				0.076	3.833	66.303	66.303	0.455	0.076	3.833	7.577	0.789	**0.565**	-0.234	**-0.079**	**N.L. (3)**
349.09	62.5	50		0				0.076	4.023	64.413	64.413	0.439	0.076	4.023	7.923	0.774	**0.534**	-0.235	**-0.079**	**N.L. (3)**
346.59	65	50		0				0.076	4.213	62.615	62.615	0.424	0.076	4.213	8.269	0.760	**0.506**	-0.237	**-0.079**	**N.L. (3)**
344.09	67.5	50		0				0.076	4.403	60.907	60.907	0.409	0.076	4.403	8.615	0.747	**0.480**	-0.241	**-0.080**	**N.L. (3)**
341.59	70	50		0				0.076	4.593	59.288	59.288	0.395	0.076	4.593	8.961	0.734	**0.455**	-0.244	**-0.081**	**N.L. (3)**
339.09	72.5	50		0				0.076	4.783	57.760	57.760	0.381	0.076	4.783	9.307	0.722	**0.432**	-0.248	**-0.082**	**N.L. (3)**
336.59	75	50		0				0.076	4.973	56.323	56.323	0.368	0.076	4.973	9.653	0.711	**0.411**	-0.251	**-0.083**	**N.L. (3)**
334.09	77.5	50		0				0.076	5.163	54.973	54.973	0.355	0.076	5.163	9.999	0.700	**0.390**	-0.255	**-0.084**	**N.L. (3)**
331.59	80	50		0				0.076	5.353	53.514	53.514	0.340	0.076	5.353	10.345	0.690	**0.369**	-0.258	**-0.085**	**N.L. (3)**
329.09	82.5	50		0				0.076	5.543	51.985	51.985	0.325	0.076	5.543	10.691	0.681	**0.347**	-0.262	**-0.086**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 & w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== Boring #5
ELEVATION OF BORING GROUND SURFACE ========== 408.00 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 105 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.1
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.521

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
405.5	2.5	2	0.6	20				0.053	0.133	3.925	7.851	0.095	0.053	0.133	0.289	1.500	**0.223**	0.834	**0.310**	**0.719 (C)**
403	5	0.01	0.3	20				0.046	0.248	0.019	3.635	0.062	0.046	0.248	0.560	1.500	**0.147**	0.690	**0.266**	**0.553 (C)**
400.5	7.5	0.01	0.3	20				0.046	0.363	0.019	3.635	0.062	0.046	0.363	0.831	1.424	**0.140**	0.567	**0.222**	**0.631 (C)**
398	10	1	0.1	20				0.035	0.450	1.954	5.724	0.078	0.035	0.450	1.074	1.374	**0.167**	0.465	**0.189**	**0.884 (C)**
395.5	12.5	1	0.01	20				0.016	0.490	2.035	5.811	0.078	0.016	0.490	1.270	1.351	**0.166**	0.381	**0.168**	**0.988 (C)**
393	15	50		100				0.076	0.680	117.502	146.002	1.068	0.076	0.680	1.616	1.500	**2.516**	0.313	**0.127**	**N.L. (3)**
390.5	17.5	50		100				0.076	0.870	113.961	141.753	1.036	0.076	0.870	1.962	1.428	**2.324**	0.258	**0.099**	**N.L. (3)**
388	20	50		100				0.076	1.060	109.997	136.996	1.000	0.076	1.060	2.308	1.320	**2.074**	0.214	**0.080**	**N.L. (3)**
385.5	22.5	50		100				0.076	1.250	105.878	132.054	0.963	0.076	1.250	2.654	1.235	**1.869**	0.180	**0.065**	**N.L. (3)**
383	25	50		100				0.076	1.440	101.780	127.137	0.926	0.076	1.440	3.000	1.167	**1.699**	0.153	**0.054**	**N.L. (3)**
380.5	27.5	50		100				0.076	1.630	97.813	122.376	0.890	0.076	1.630	3.346	1.111	**1.554**	0.132	**0.046**	**N.L. (3)**
378	30	50		100				0.076	1.820	94.041	117.849	0.856	0.076	1.820	3.692	1.063	**1.430**	0.116	**0.040**	**N.L. (3)**
375.5	32.5	50		100				0.076	2.010	90.493	113.592	0.824	0.076	2.010	4.038	1.022	**1.323**	0.103	**0.035**	**N.L. (3)**
373	35	50		100				0.076	2.200	87.179	109.615	0.794	0.076	2.200	4.384	0.985	**1.229**	0.093	**0.032**	**N.L. (3)**
370.5	37.5	50		100				0.076	2.390	84.094	105.913	0.766	0.076	2.390	4.730	0.953	**1.147**	0.085	**0.029**	**N.L. (3)**
368	40	50	2	100				0.067	2.558	81.581	102.897	0.743	0.067	2.558	5.054	0.928	**1.083**	0.079	**0.027**	**N.L. (3)**
365.5	42.5	50	2	100				0.067	2.725	79.216	100.059	0.721	0.067	2.725	5.377	0.904	**1.025**	0.074	**0.025**	**N.L. (3)**
363	45	50	2	100				0.067	2.893	76.984	97.381	0.701	0.067	2.893	5.701	0.883	**0.972**	0.071	**0.024**	**N.L. (3)**
360.5	47.5	50	2	100				0.067	3.060	74.871	94.846	0.681	0.067	3.060	6.024	0.863	**0.924**	0.068	**0.023**	**N.L. (3)**
358	50	50		0				0.076	3.250	72.578	72.578	0.507	0.076	3.250	6.370	0.843	**0.671**	0.066	**0.022**	**N.L. (3)**
355.5	52.5	50		0				0.076	3.440	70.408	70.408	0.489	0.076	3.440	6.716	0.824	**0.633**	0.064	**0.021**	**N.L. (3)**
353	55	50		0				0.076	3.630	68.346	68.346	0.472	0.076	3.630	7.062	0.806	**0.598**	0.063	**0.021**	**N.L. (3)**
350.5	57.5	50		0				0.076	3.820	66.382	66.382	0.456	0.076	3.820	7.408	0.790	**0.566**	0.062	**0.021**	**N.L. (3)**
348	60	50		0				0.076	4.010	64.507	64.507	0.440	0.076	4.010	7.754	0.775	**0.536**	0.061	**0.020**	**N.L. (3)**
345.5	62.5	50		0				0.076	4.200	62.718	62.718	0.425	0.076	4.200	8.100	0.761	**0.508**	0.061	**0.020**	**N.L. (3)**
343	65	50		0				0.076	4.390	61.012	61.012	0.410	0.076	4.390	8.446	0.747	**0.482**	0.059	**0.019**	**N.L. (3)**
340.5	67.5	50		0				0.076	4.580	59.389	59.389	0.396	0.076	4.580	8.792	0.735	**0.457**	0.055	**0.018**	**N.L. (3)**
338	70	50		0				0.076	4.770	57.849	57.849	0.382	0.076	4.770	9.138	0.723	**0.434**	0.052	**0.017**	**N.L. (3)**
335.5	72.5	50		0				0.076	4.960	56.394	56.394	0.368	0.076	4.960	9.484	0.712	**0.412**	0.048	**0.016**	**N.L. (3)**
333	75	50		0				0.076	5.150	55.023	55.023	0.355	0.076	5.150	9.830	0.701	**0.391**	0.045	**0.015**	**N.L. (3)**
330.5	77.5	50		0				0.076	5.340	53.562	53.562	0.341	0.076	5.340	10.176	0.691	**0.370**	0.041	**0.013**	**N.L. (3)**
328	80	50		0				0.076	5.530	52.075	52.075	0.326	0.076	5.530	10.522	0.681	**0.349**	0.038	**0.012**	**N.L. (3)**
325.5	82.5	50		0				0.076	5.720	50.624	50.624	0.310	0.076	5.720	10.868	0.672	**0.328**	0.034	**0.011**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 & w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 2/24/10

REFERENCE BORING NUMBER ========== B-6 East Abut.
ELEVATION OF BORING GROUND SURFACE ========== 432.34 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 3.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 3.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.262
EARTHQUAKE MOMENT MAGNITUDE ========== 6.1
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 1.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = 1.571

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = 530 FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 6.13
Source-To-Site Distance, R (km) = 13
Ground Motion Prediction Equations = CEUS
PGA = 0.533

	BORING DATA							CONDITIONS DURING DRILLING						CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
429.84	2.5	9	0.2	100				0.104	0.260	18.061	26.673	0.330	0.042	0.225	0.256	1.500	**0.777**	0.983	**0.191**	**4.068 (D)**
427.34	5	16	0.1	100				0.035	0.348	34.072	45.886	0.251	0.035	0.313	0.500	1.500	**0.592**	0.967	**0.264**	**N.L. (3)**
424.84	7.5	14	0.1	100				0.035	0.435	28.225	38.870	0.078	0.035	0.400	0.743	1.500	**0.183**	0.948	**0.300**	**N.L. (3)**
422.34	10	5	0.1	100				0.035	0.523	9.539	16.447	0.175	0.035	0.488	0.987	1.491	**0.410**	0.925	**0.319**	**1.285 (D)**
419.84	12.5	12	0.8	30				0.057	0.665	24.645	33.154	1.423	0.057	0.630	1.285	1.500	**3.355**	0.898	**0.313**	**10.719 (D)**
417.34	15	5	0.5	30				0.051	0.793	9.607	15.796	0.168	0.051	0.758	1.569	1.317	**0.348**	0.868	**0.307**	**1.134 (D)**
414.84	17.5	1	0.4	80				0.049	0.915	1.903	7.284	0.090	0.049	0.880	1.847	1.208	**0.171**	0.835	**0.299**	**0.572 (C)**
412.34	20	1	0.3	80				0.046	1.030	1.877	7.253	0.090	0.046	0.995	2.118	1.176	**0.166**	0.798	**0.290**	**0.572 (C)**
409.84	22.5	41		100				0.074	1.215	87.628	110.154	0.798	0.074	1.180	2.459	1.264	**1.585**	0.760	**0.270**	**N.L. (3)**
407.34	25	50		100				0.076	1.405	102.683	128.219	0.934	0.076	1.370	2.805	1.191	**1.748**	0.722	**0.252**	**N.L. (3)**
404.84	27.5	50		100				0.076	1.595	98.641	123.369	0.898	0.076	1.560	3.151	1.131	**1.595**	0.685	**0.236**	**N.L. (3)**
402.34	30	50		100				0.076	1.785	94.801	118.761	0.863	0.076	1.750	3.497	1.080	**1.464**	0.649	**0.221**	**N.L. (3)**
399.84	32.5	50		100				0.076	1.975	91.194	114.433	0.830	0.076	1.940	3.843	1.036	**1.352**	0.617	**0.209**	**N.L. (3)**
397.34	35	50		100				0.076	2.165	87.827	110.393	0.800	0.076	2.130	4.189	0.998	**1.254**	0.588	**0.197**	**N.L. (3)**
394.84	37.5	50		100				0.076	2.355	84.695	106.634	0.771	0.076	2.320	4.535	0.965	**1.169**	0.563	**0.188**	**N.L. (3)**
392.34	40	50		100				0.076	2.545	81.781	103.137	0.745	0.076	2.510	4.881	0.935	**1.094**	0.542	**0.180**	**N.L. (3)**
389.84	42.5	50		100				0.076	2.735	79.066	99.879	0.720	0.076	2.700	5.227	0.908	**1.027**	0.524	**0.173**	**N.L. (3)**
387.34	45	50		100				0.076	2.925	76.527	96.832	0.696	0.076	2.890	5.573	0.883	**0.967**	0.510	**0.168**	**N.L. (3)**
384.84	47.5	50		100				0.076	3.115	74.144	93.972	0.674	0.076	3.080	5.919	0.861	**0.913**	0.498	**0.163**	**N.L. (3)**
382.34	50	50		0				0.076	3.305	71.896	71.896	0.501	0.076	3.270	6.265	0.841	**0.662**	0.489	**0.160**	**N.L. (3)**
379.84	52.5	50		0				0.076	3.495	69.767	69.767	0.484	0.076	3.460	6.611	0.822	**0.625**	0.481	**0.157**	**N.L. (3)**
377.34	55	50		0				0.076	3.685	67.743	67.743	0.467	0.076	3.650	6.957	0.805	**0.591**	0.475	**0.154**	**N.L. (3)**
374.84	57.5	50		0				0.076	3.875	65.813	65.813	0.451	0.076	3.840	7.303	0.789	**0.559**	0.470	**0.153**	**N.L. (3)**
372.34	60	50		0				0.076	4.065	63.970	63.970	0.436	0.076	4.030	7.649	0.773	**0.529**	0.467	**0.151**	**N.L. (3)**
369.84	62.5	50		0				0.076	4.255	62.211	62.211	0.420	0.076	4.220	7.995	0.759	**0.502**	0.464	**0.150**	**N.L. (3)**
367.34	65	50		0				0.076	4.445	60.532	60.532	0.406	0.076	4.410	8.341	0.746	**0.476**	0.453	**0.146**	**N.L. (3)**
364.84	67.5	50		0				0.076	4.635	58.934	58.934	0.392	0.076	4.600	8.687	0.734	**0.451**	0.449	**0.145**	**N.L. (3)**
362.34	70	50		0				0.076	4.825	57.418	57.418	0.378	0.076	4.790	9.033	0.722	**0.428**	0.446	**0.143**	**N.L. (3)**
359.84	72.5	50		0				0.076	5.015	55.984	55.984	0.364	0.076	4.980	9.379	0.711	**0.407**	0.442	**0.142**	**N.L. (3)**
357.34	75	50		0				0.076	5.205	54.633	54.633	0.351	0.076	5.170	9.725	0.700	**0.387**	0.439	**0.141**	**N.L. (3)**
354.84	77.5	50		0				0.076	5.395	53.106	53.106	0.336	0.076	5.360	10.071	0.690	**0.365**	0.435	**0.139**	**N.L. (3)**
352.34	80	50		0				0.076	5.585	51.644	51.644	0.321	0.076	5.550	10.417	0.680	**0.343**	0.432	**0.138**	**N.L. (3)**
349.84	82.5	50		0				0.076	5.775	50.216	50.216	0.305	0.076	5.740	10.763	0.671	**0.322**	0.428	**0.137**	**N.L. (3)**

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