Structure Geotechnical Report

FAS 2869 (IL 37) Over Unnamed Stream
Section 2B-1
Jefferson County
Structure (Existing) 041-0093
Structure (Proposed) 041-2020
Contract: 78210
Job Number: D-99-066-10
PTB 151/51 Work Order #4

Prepared By: Timothy J. Holcomb, P.E.
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HFE File H-11016

Date: September 14, 2011

Prepared For: ESCA Consultants
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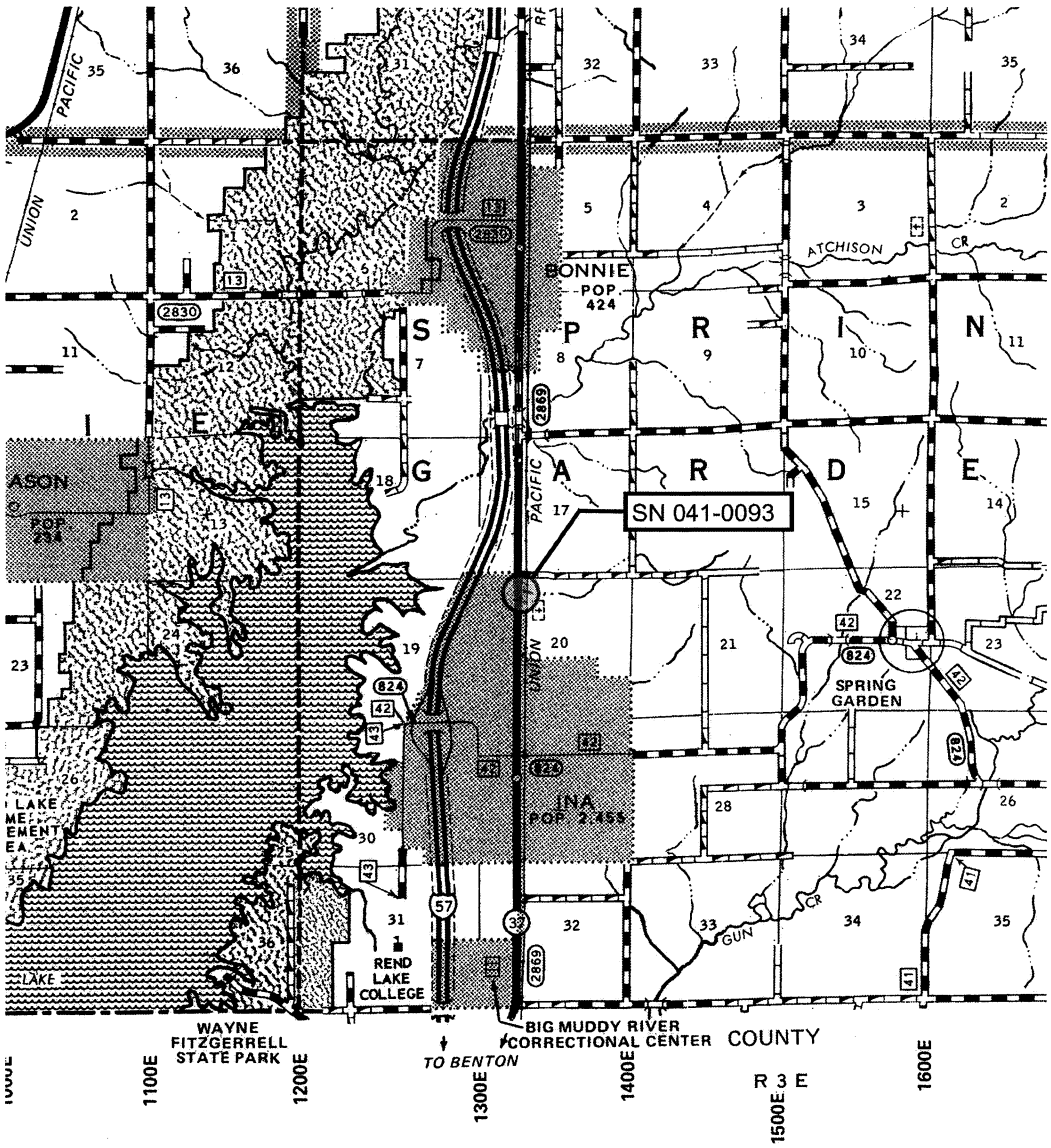
Urbana, Illinois 61803

Attachments: TSL Drawing
Subsurface Profile
Boring Logs

1.0 Project Description and Proposed Structure Information

This structure is to consist of a double box culvert carrying Illinois Route #37 over an unnamed stream north of Ina in Jefferson County, Illinois. The box culvert is located in the NW ¼ of Section 20, Township 4 South, Range 3 East of the Third Principal Meridian in Jefferson County, Illinois.



The project includes removal of the existing single span bridge and construction of a double box culvert with a width of 39'7 1/4" out to out at headwalls, and length of 39' 0". Each barrel will have interior dimensions of 9 feet high by 10 feet wide. The box culvert will have at 10 degree skew to the existing highway. This structure will be constructed using stage construction.

2.0 Existing Information

The existing bridge was constructed in 1922 and consists of a single span bridge reinforced concrete structure. The bridge is 20' 0" inside face to face of abutments, with an out to out width of 40' 4". The bridge has two 45 degree wingwalls and two 90 degree wingwalls. The existing structure has no skew.

3.0 Site Investigation, Subsurface Exploration, and Conditions

This site lies in the Mt. Vernon Hill Country of the Central Lowland Province Physiographic Division of Illinois. The immediate area has been influenced by loessial deposits overlying stream alluvium and Illinoisan glacial till. Bedrock consists of Pennsylvanian deposits of limestone, shale, sandstone and occasional coal seams.

The borings encountered about 7 to 8 inches of bituminous concrete overlying ten inches of Portland cement concrete. Below the paving materials lies eight feet of brown mottled gray silty clay loam (A-6 classification) that extends down to brown mottled gray silty clay (A-6). Gray to brown weathered shale was encountered in both soil borings at about 19.5 feet in depth. At depths of 24.5 feet in Boring #1, and 22.5 feet in Boring #2 lies a dense gray shale that extends down to at least the bottom of the soil borings.

The upper eight feet of silty clay loam is soft, with unconfined compressive strengths ranging from 0.1 to 0.4 tons per square foot, averaging 0.3 tsf. Moisture contents vary from 25 to 31 percent, averaging 29 percent. These soils have a very high settlement potential.

The silty clay encountered from about 9.5 to 19.5 feet in depth ranges from soft to stiff, with unconfined compressive strengths of ranging from 0.3 to 1.1 tons per square foot, averaging 0.7 tsf. Moisture contents vary from 21 to 28 percent, averaging 24 percent. These soils have a moderate to high settlement potential.

Standard penetration test values of the weathered shale stratum vary from 13 to 73 blows per foot, averaging 40 bpf. Moisture contents vary from 17 to 22 percent, averaging about 20 percent. The weathered shale has a low settlement potential.

The dense unweathered shale has standard penetration test values in excess of 100 blows per foot. RQD tests of the shale cores range from 11 to 67 percent, averaging 44 percent. Unconfined compressive strengths of this shale vary from 90 to 373 psi, averaging 158 psi. The dense shale is estimated to be relatively incompressible when subjected to the anticipated structural loadings.

Ground water was encountered at the following elevations in the soil borings:

	Elevation (MSL)	
Boring No.	First Encountered	Upon Completion
1	405.6	N/M
2	405.7	N/M

* - N/M Not Measured

4.0 Geotechnical Evaluation

4.1 Settlement

The proposed box culvert has an invert elevation ranging from 408.80 to 409.05. The structure has 13 inches of concrete floor slab, and an undetermined undercut of unsuitable soil below the slab and replacement with granular fill, usually about one to two feet thick. This will found the bottom of the crushed stone at about elevation 406. This elevation is about 13.8 feet below the existing ground line. At this depth the silty clay loam has standard penetration test values of 2 to 4 blows per foot, and unconfined strengths of 0.6 to 0.8 tsf. The existing flow line is at approximately elevation 410, which results in four feet of soil excavated to construct the culvert, resulting in an existing unit load of about 250 pounds per cubic foot. With removal of any extremely soft soil and replacement with a well compacted granular fill, as well as the relatively low unit loading of the new culvert, we do not anticipate settlement problems at this site.

4.2 Seismic Considerations

Culverts are considered buried structures, therefore no seismic analysis is necessary.

4.3 Scour

The design scour elevations are as follows:

Design Scour	Upstream	Downstream
Elevation (ft.)	406.05	405.80

Crushed stone at the end of each barrel placed outside of the end of the box culvert should reduce the potential for scour below the culvert. The toe walls at the ends of this culvert should also prevent scour beneath the culvert.

4.4 Mining Activity

The mine maps available from the State of Illinois Geological Survey indicate the site has not been undermined. No coal mining has been performed within at least one mile of this site. Therefore, subsidence is not a concern at this location.

5.0 Foundation Evaluations and Design Recommendations

5.1 Box Culvert and Wingwall Options

Based upon the soil borings, it appears a cast in place culvert is the most feasible structure at this location, due to the marginal soils below the culvert. It is recommended a minimum of twelve to eighteen inches of soil below the proposed box culvert are excavated and replaced prior to construction of the culvert. Due to the soft subsoils encountered in the soil borings near the proposed flow line, it is recommended the undercut be replaced with 8 to 12 inches of three inch minus crushed limestone (CA-2), capped with four to six inches of CA-7 or CA-11 crushed stone. During excavation, a visual observation of the subgrade should be performed to assure most of the soft subsoils at the creek flow line have been removed, and to provide a platform for the culvert slab construction.

Wingwall options include T-type horizontal cantilever wingwalls, or concrete encased sheet piles. It appears the best option is horizontal cantilever wingwalls, which should provide adequate support for the subsoils. Although slightly longer than 14 feet, this type of wingwall will provide the most economical option for this structure. The horizontal pressure on the wingwalls should be calculated in accordance with Figure 3.1.2-1 of the IDOT Culvert Manual.

Backfill of the new structure should consist of a clean free draining material meeting the requirements set forth in the Standard Specifications for Road and Bridge Construction.

6.0 Construction Considerations

6.1 Temporary Sheet Piling

Using the Temporary Sheet Piling Design Chart Tables and Design Guide 3.13.1, it appears sheet piling will not provide adequate lateral support for the on-site subsoils for this structure due to the depth of shale at this site. A temporary soil retention system will be required, and may be designed using the following parameters:

Soil Type	Cohesion (ksf)	Phi Angle (deg)	Sat.Unit Wt. (PCF)
0-9.5'	.25	0	125.0
9.5-20.0'	.70	0	125.0

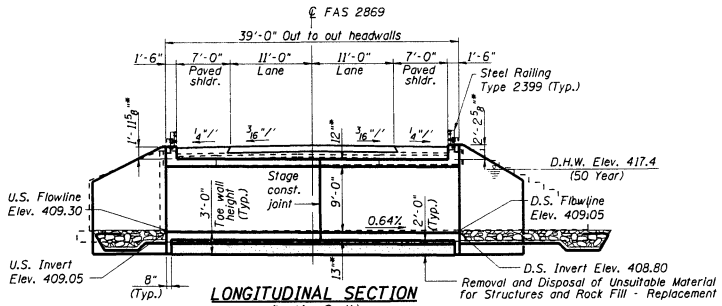
Timothy J. Holcomb, P.E.

BENCHMARK: BM K216 -N.G.S. monument set in top of the SW end of the wingwall at the NW corner of SN 041-0093. Elev. 420.34.

EXISTING STRUCTURE:
SN 041-0093 was originally built in 1922 as Route 37, Section 2-B. It is a single-span reinforced concrete bridge that is 20'-0" inside-face-to-inside face of abutments. Out-to-out width of structure is 40'-4". The structure has two 45 deg. wingwalls and two 90 deg. wingwalls. There is no skew. Traffic shall be maintained utilizing stage construction.

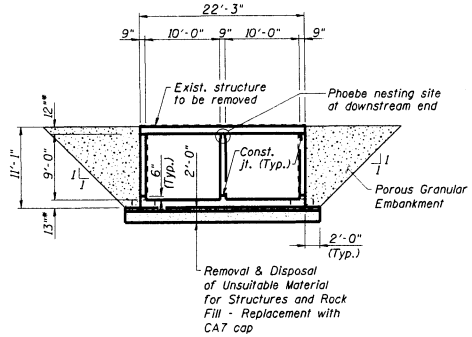
No salvage.

Precast alternate is not allowed.

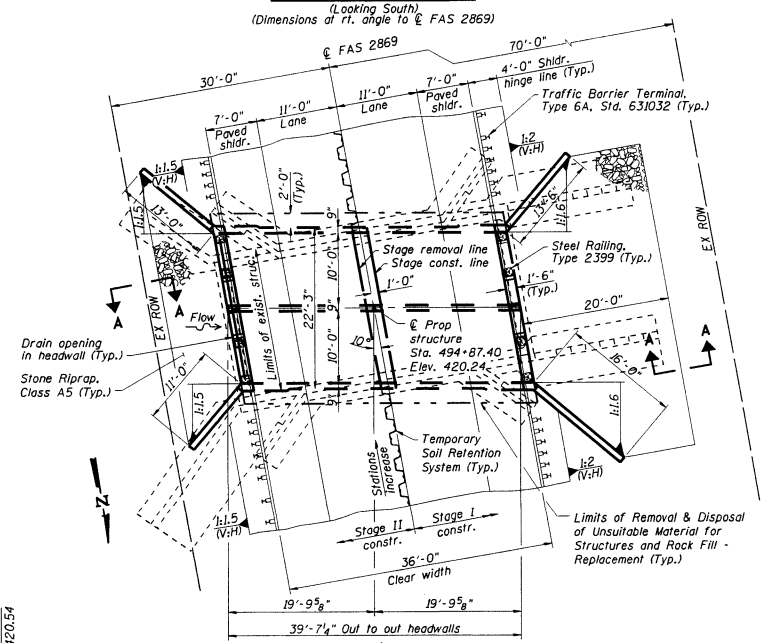


LONGITUDINAL SECTION

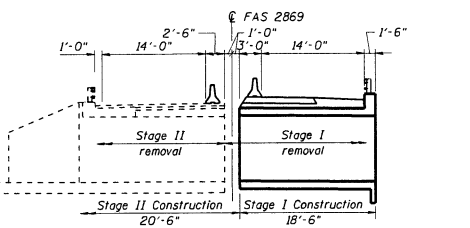
(Looking South)
(Dimensions at rt. angle to ℄ FAS 2869)



SECTION THRU BARREL

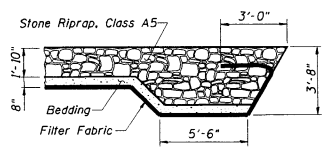


PLAN

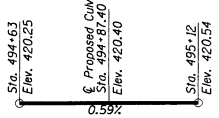


STAGE CONSTRUCTION SKETCH

(Looking South)



SECTION A-A



PROFILE GRADE

(Along ℄ Roadway)

SCOUR INFORMATION

Design Scour Elevation (Ft.)	Downstream	Upstream
	405.80	406.05

WATERWAY INFORMATION

Drainage Area = 1.05 Sq. Mi.
Exist. Low Grade Elev. = 419.94 Ft. @ Sta. 494+00
Prop. Low Grade Elev. = 419.94 Ft. @ Sta. 494+00

Flood	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.
	10	636	118	151	416.6	0.7	0.3	417.3	416.9
Design	50	1060	134	165	417.3	2.0	1.0	419.3	418.3
Base	100	1260	140	171	417.6	2.2	1.3	419.8	418.9
Overtopping (Exist.)	120	1325	142	-	417.7	2.3	-	420.0	-
Overtopping (Prop.)	320	1615	-	180	418.1	-	2.0	-	420.1

10 year velocity through existing bridge = 5.5 ft/s
10 year velocity through proposed culvert = 4.9 ft/s

HIGHWAY CLASSIFICATION

FAS Route 2869 (IL 37)
Functional Class: Other Principal Arterial
ADT: 3810 (2010); 4660 (2030)
DHV: 380 (2010)
ADTT: 5.56%
Design Speed: 55 mph
Posted Speed: 55 mph

DESIGN SPECIFICATIONS

2002 AASHTO

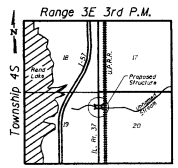
LOADING HS20-44

Allow 50 psf for future wearing surface.

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi
fy = 60,000 psi (Reinf.)



LOCATION SKETCH

PRELIMINARY
AUGUST 5, 2011

GENERAL PLAN
IL 37 OVER UNNAMED STREAM
FAS ROUTE 2869 - SECTION 2B-1
JEFFERSON COUNTY
STATION 494+87.40
STRUCTURE NO. 041-2020

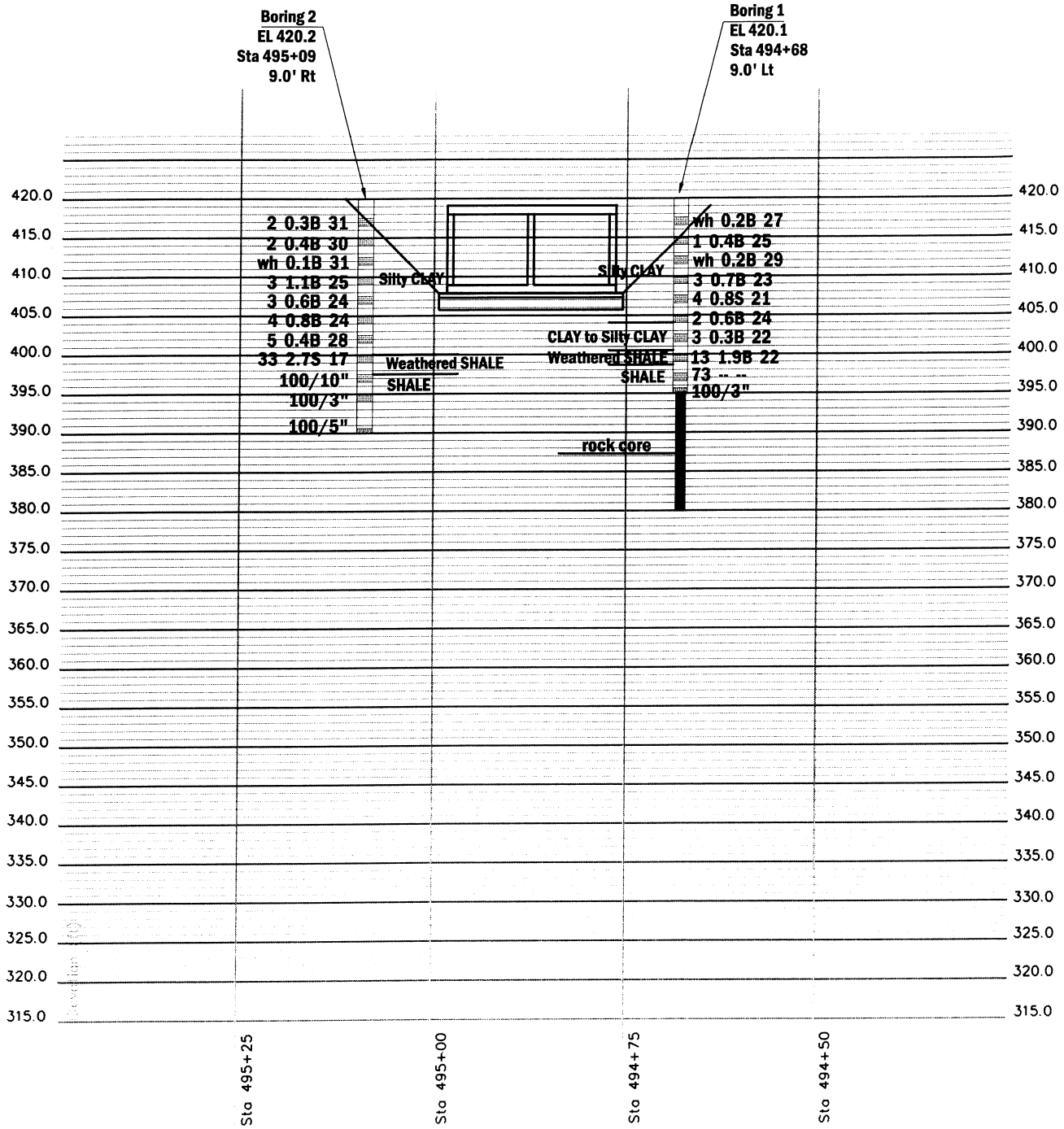
FILE NAME = #FILES#	USER NAME = #USER#	DESIGNED - MJW/RDP	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	
		CHECKED - RDP/JMS	REVISED -		
	PLOT SCALE = #SCALE#	DRAWN - DWH/HAS	REVISED -		
	PLOT DATE = #DATE# #TIME#	CHECKED - 08/11	REVISED -		SHEET NO. 1 OF 1 SHEETS

F.A.S RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2869	2B-1	JEFFERSON	-	-
		CONTRACT NO. 78210		
		ILLINOIS FED. AID PROJECT		

F.A.S. Rt.	Section	County	Structure	Sheet No.
2869	[illegible]	Jefferson	041-0093	1

Sta 495+25 to 394+50

Federal Road Dist No. | Illinois | Fed. Aid Project



Holcomb Foundation Engineering Company

Scale	Project No.	Date
1" = 20'	H-11018	9/14/2011

Horizontal Scale 1 Inch = 20 feet
Vertical Scale 1 Inch = 20 feet

Jefferson County Bridge SN 041-0093 - SGR

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAS 2869 (IL 37) Over stream

Route: FAS 2869 (IL 37 Structure Number: 041-0093 Date: 5/31/2011

Section 2B, 2BY Bored By: R Moberly

County: Jefferson Location: North Ina Checked By: R Graeff

Boring No 1-S
Station 494+68
Offset 9' Lt CL
Ground Surface 420.1Ft

Surf Wat Elev: 410.3
Ground Water Elevation
when Drilling 405.6
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DESCRIPTION
	Cored			7" Asphalt over 10.5" concrete
418.6				
	Augered			Very soft, very moist, brown mottled grey, Silty Clay Loam A-6
	WH			
	WH	0.2B	27	
	WH			
415.6				
5.0	WH			Soft, very moist, brown mottled grey, Silty Clay Loam A-6
	WH	0.4B	25	
	1			
413.1				
	WH			Very soft, very moist, grey, Silty Clay A-6
	WH	0.2B	29	
	WH			
410.6				
10.0	1			Medium, very moist, grey, Silty Clay A-6
	1	0.7B	23	
	2			
408.1				
	1			Medium, very moist, brown mottled grey, Silty Clay A-6
	2	0.8S	21	
	2			
15.0	1			
	1	0.6B	24	
	1			
403.1				
	1			Soft, very moist, brown mottled grey, Clay to Silty Clay A7-6
	2	0.3B	22	
	1			
400.6				
20.0	2			Stiff, moist, grey mottled brown, Clay A7-6 to Weathered Clay Shale
	5	1.9B	22	
	8			
398.6				
	11			Hard, dry to damp, grey, Weathered Clay Shale
	32			
	41			
395.6				
25.0	100/3"			Hard, dry, grey, Clay Shale 395.1

DEPTH	BLOWS	Qu tsf	W%	DESCRIPTION
				Hard, dry, grey, Clay Shale
				Cored 24.8 to 29.8 feet
				80% Recovery; 11% RQD
				Test - 90 psi
390.1			30.0	
				Hard, dry, grey, Clay Shale
				Cored 29.8 to 34.8 feet
				100% Recovery; 67% RQD
				100% Recovery; 67% RQD
				Test - 97 psi
				Test - 127 psi
385.1			35.0	Test - 373 psi
				Hard, dry, grey, Clay Shale
				Cored 34.8 to 39.8 feet
				57% Recovery; 32% RQD
				Test - 105 psi
380.1			40.0	
				Bottom of hole = 39.8 Feet
				Free water observed at 14.5 Ft
				Elevation referenced to BM at NE corner of structure; Elev= 420.3 ft
				Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)
			45.0	
				To convert "N" values to "N60" multiply by 1.25
			50.0	

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAS 2869 (IL 37) Over stream

Route: FAS 2869 (IL 37 Structure Number: 041-0093 Date: 6/1/2011
Section 2B, 2BY Bored By: R Moberly
County: Jefferson Location: North Ina Checked By: R Graeff

Boring No 2-S
Station 495+09
Offset 9' Rt CL
Ground Surface 420.2 Ft

Surf Wat Elev: 410.3
Ground Water Elevation
when Drilling 405.7
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
8" Asphalt over 10" concrete	Cored			Hard, dry, grey, Clay Shale			
418.7							
Soft, very moist, brown mottled grey, Silty Clay Loam A-6 (9)	Augered						
	WH						
	1	0.3B	31				
	1						
5.0	WH			390.2	30.0	100/5"	
	1	0.4B	30				
	1						
413.2				Bottom of hole = 29.9 Feet			
Very soft, wet, grey, Silty Clay Loam A-6 (9)	WH			Free water observed at 14.5 Ft			
	WH	0.1B	31				
	WH			Elevation referenced to BM at NE corner of structure; Elev.=420.3 ft			
410.7							
10.0 Stiff, moist, grey, Clay to Silty Clay A7-6 (13-14)	1			Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)	35.0		
	1	1.1B	25				
	2			To convert "N" values to "N60" multiply by 1.25			
408.2							
Medium, very moist, brown mottled grey, Silty Clay A-6 (10)	1						
	1	0.6B	24				
	2						
15.0	1				40.0		
	2	0.8B	24				
	2						
403.2							
Soft, very moist, brown mottled grey, Silty Clay Loam A-6 (9) with pea gravel	1						
	2	0.4B	28				
	3						
400.7							
20.0 Very stiff, damp, grey and brown, Clay A7-6 to Weathered Clay Shale	3				45.0		
	13	2.7S	17				
	20						
397.7	11						
Hard, dry, grey, Clay Shale	100/10"						
25.0	100/3"				50.0		

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail, B-Bulge S-Shear E-Estimated P-Penetrometer)