REVISED
STRUCTURE GEOTECHNICAL REPORT

BRIDGE REPLACEMENT
ILLINOIS ROUTE 1 OVER SUGAR CREEK

F.A.P. 332 (IL Route 1)
Section (21-X-NRH-BY)B-1
Crawford County, Illinois
P-97-028-05
D-97-037-05
Contract No. 74108
PTB 147 Item 27 WO #8
Existing Structure No. 017-0003
Proposed Structure No. 017-0033

Prepared by:

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May 2010

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1.0 PROJECT DESCRIPTION AND PROPOSED STRUCTURE INFORMATION

1.1 Introduction

The geotechnical study summarized in this report was performed for the proposed bridge on Illinois Route 1 over Sugar Creek in Crawford County, Illinois. The purpose of this report is to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project includes replacement of the existing bridge (S.N. 017-0003) located at Illinois Route 1 over Sugar Creek in Crawford County, Illinois. The project is located 2.25 miles north of Illinois Route 33 in Crawford County. The general location of the bridge is shown on a United States Geological Survey (USGS) Topographic Location Map, Exhibit A. The site lies within the limits of the Second Principal Meridian (Sec.19, T7N, R11W) in the Till Plains Section, specifically the Springfield Plain.

1.3 Proposed Bridge Information

The proposed structure (S.N. 017-0033) will consist of a single-span steel I-beam, as shown on the Type, Size and Location (TS&L) Plan as provided by IE Consultants, Inc. (IE), Exhibit B. The structure will be built on a 0 degree skew. The proposed bridge centerline station will be at Station 114+00. The proposed substructure will consist of open integral abutments, with an approximate overall length of 79 feet (ft.) as measured back to back of the abutments. The clear width of the new structure will be 36 ft. Further substructure details will be based on the Structure Geotechnical Report (SGR). H-pile foundations are anticipated to be used for supporting the new bridge. No substantial grading is anticipated. The proposed maximum change in grade is approximately 2 ft. of fill at the approaches according to the undated plan and profile sheets provided by IE for Kaskaskia Engineering Group's (KEG) use. The design high water elevation for the structure is El. 469.2. Staged construction is recommended.

2.0 EXISTING BRIDGE INFORMATION

The original single-span reinforced concrete tee beam structure was constructed in 1935. It consisted of a superstructure 45 ft. in length back to back of abutments and a 23 ft.-2 inch (in.) roadway width. The structure was constructed with 0 degree skew. The superstructure was supported by north and south closed abutments on untreated timber piling. In 1959, the bridge and abutments were widened to a 43 ft.-0 in. roadway.

The Bridge Condition Report (BCR), dated September 10, 2008, recommends a complete structure replacement due to poor condition of the existing tee beams and substructure. The following observations are excerpts from the BCR:

> "The original fascia beams exhibit an extreme amount of map cracking with leaching on the bottom and side of these beams. The bottom of the concrete tee beams are map cracked with leaching at the ends at the abutments due to leaking joints. There is some spalling with exposed reinforcement on the bottom of the concrete tee beams due to extreme map cracking with leaching. There is erosion evident behind the guardrail at all four corners of the structure. The substructure has extensive cracking with leaching evident on the abutments. A vertical leaching crack spans the face of the south abutment. There is also another vertical crack that spans the south abutment face that is not leaching. Riprap is in failure in the front of the southeast and southwest wingwall."

3.0 SITE INVESTIGATION, SUBSURFACE EXPLORATION AND GENERALIZED SUBSURFACE CONDITIONS

The site investigation plan was determined and conducted by the Illinois Department of Transportation (IDOT). A site visit by a representative of KEG to observe all or part of the borings or to make site observations was not included in the scope of services for this project. Therefore, no observations have been made relative to existing conditions of the structure, stream, roadway, or of subsurface sample conditions.

Two standard penetration tests (SPT) borings, designated as Boring No. 1 N Abut and Boring No. 2 S Abut, were drilled near the proposed north and south abutments from August 12-13, 2009. Boring No. 1 N Abut was located near the north abutment at Sta. 113+58, 15 ft. left of the centerline. Boring No. 2 S Abut was located near the south abutment at Sta. 114+42, 12 ft. right of the centerline. Both borings extended to bedrock. Detailed information regarding the nature and thickness of the soils and rock encountered and the results of the field sampling are shown on the IDOT-Provided Boring Logs, Exhibit C. The boring profiles are shown on the Subsurface Data Profile also included in Exhibit C, as provided by IDOT.

The general soil profile in Boring No. 1 N Abut consisted of a ground surface of 8 in. of mixture shoulder aggregate, cinders, and sandy clay. This was followed by a 25 ft. layer of very soft to medium silty, sandy clay and silty, sandy loam from approximate El. 469 to El. 444. This thick, weak layer had an average N-value of 1.4 blows per foot (bpf) and an average unconfined compressive strength of 0.44 tons per square foot (tsf). The subsurface conditions transitioned to sandy clay and sandy clay loam till until approximate El. 434 where clay shale was encountered. The boring terminated in clay shale at El. 433.65 and continued with rock coring. A 10 ft. rock core sample was retrieved from this borehole. The rock core information provided by IDOT indicates recoveries of 83.4 and 98.8 percent for the two, 5 ft. runs. The Rock Quality Designation (RQD) values were 81.8 and 80.2 percent, respectively. The recovered cores were described as silty clay shale. The two reported strength values for the silty clay shale were 4.2 and 21.0 tsf. The IDOT Rock Core Log is also included in Exhibit C.

The profile at Boring No. 2 S Abut showed approximately 12 in. of asphalt and concrete pavement followed by a 14 ft. weak layer very soft to medium silty clay and silty loam from approximate El. 474 to El. 460. This weak layer had an average N-value of 1 bpf with average unconfined compressive strength of 0.42 tsf. The subsurface conditions transitioned to medium to hard sandy clay and sandy clay loam till until approximate El. 436 where a silty clay shale material was encountered. The shale continued until the boring was terminated in rock at El. 430.29. No coring was conducted in this boring.

Table 3.1 shows the estimated top of rock elevations for Borings No. 1 N Abut and No. 2 S Abut.

Table 3.1 – Estimated Bedrock Elevation

Boring	Bedrock Elevation
1 N Abut	434.65
1 S Abut	435.89

Groundwater elevation, encountered during drilling, was at approximate El. 446.7 in Boring No. 1 N Abut, and at Boring No. 2 S Abut groundwater was not encountered. At Boring No. 1 N Abut, groundwater was present at El. 464.5 upon completion and El. 460.8, seven days later. At Boring No. 2 S Abut, groundwater was not present upon completion and El. 461.4, 24 hours later. It should be noted that the groundwater level is subject to seasonal and climatic variations, as well as other factors, and may be present at different depths in the future. In addition, without extended periods of observation, measurement of the true groundwater levels may not be possible.

4.0 GEOTECHNICAL EVALUATIONS

4.1 Settlement

KEG understands that during replacement of the existing structures at this site, the existing concrete abutments in the vicinity of Sugar Creek will be removed and replaced with 2H:1V backslopes covered with riprap. It should be noted that highly compressible layers of silty, sandy loam, and clay were encountered in Boring No.1 at the north abutment from El. 469.65 to El. 444.65. In KEG's opinion, settlements below and within the embankment for the existing loads have occurred long ago, and re-grading these slopes as described above will not induce any additional settlements. In addition, with the approach slabs structurally supported by the integral abutments on one end and supported by the existing embankment subgrades at the other, settlement is not a concern, provided compaction utilizing static or vibratory methods is performed during placement of the porous granular embankment backfill adjacent to the integral abutments. In general, recommended pile units for the new structure should not experience settlements more than 0.4 in.

4.2 Slope Stability

The proposed construction does not result in any significant changes in sideslopes (3:1), backslopes (2:1), or grade changes. Also, the heights of the slopes are less than 15 ft. No issues or concerns regarding the existing slopes are reflected in the documentation, and it has been assumed that the existing slopes are performing adequately. For these reasons, a detailed slope stability analysis was not performed, and slope stability is not considered a concern for this structure.

4.3 Seismic Considerations

The determination of the Seismic Site Class was based on the method described by IDOT AGMU *Memo 09.1 - Seismic Site Class Definition* and the IDOT-provided spreadsheet titled *Seismic Site Class Determination*. Using these resources, the controlling global site class for this project is Site Class C.

Additional seismic parameters were determined for use in design of the structure and evaluation of liquefaction potential. The USGS published information and mapping (http://earthquake.usgs.gov/), including software directly applicable to the AASHTO Guide Specifications for LRFD Seismic Bridge Design, was used to determine the parameters for the project site location. The values, based on a 1000-Year Return Period with a Probability of Exceedance (PE) of 7% in 75 years, and the Site Class previously determined, are summarized below.

Table 4.1 – Summary of Seismic Parameters

Parameter	**Value**
Soil Site Class	C
Peak Ground Acceleration, PGA	0.138g (Site Class B)
Spectral Acceleration Coefficient at Period of 0.2 Sec, Ss	0.285g (Site Class B)
Spectral Acceleration Coefficient at Period of 1.0 Sec, S1	0.083g (Site Class B)
Site Factor, Zero Period, Fpga	1.20 (Site Class C)
Site Factor, Short Period, Fa	1.20 (Site Class C)
Site Factor, Long Period, Fv	1.70 (Site Class C)
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.342g (Site Class C)
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.141g (Site Class C)
Seismic Performance Zone	1

4.4 Scour

The approved Hydraulic Report anticipates a contraction scour of 6 ft. using the 100-year flood design event. Scour countermeasures proposed include protecting the abutment slopes with stone riprap to accommodate the predicted scour. As shown on the Provided Type, Size and Location (TS&L) Plan, Exhibit B, the integral abutments proposed for the bridge are positioned behind a 2:1 (H:V) embankment and lined with Class A5 stone riprap. This is considered an armored embankment and is deemed to be an adequate level of scour protection according to the Bridge Manual.

Table 4.2 shows the Design Scour Elevations. The design scour elevations are located at the base of the pile caps; therefore, no reduction in the scour elevations was applied in the pile design. The near surface soil profile anticipated silty loam material, which would not be considered more scour prone than the default properties assumed in the hydraulic analysis.

Table 4.2 – Design Scour Elevation

Design Scour Elevation (ft)	*N. Abut.*	*S. Abut.*
	467.94	468.40

4.5 Mining Activity

No visual indication of subsurface mining activities was evident at the site. According to the Coal Mines Crawford County, dated August 17, 2009, which was obtained from the Illinois State Geological Survey (ISGS) website, the project site was not undermined. (http://www.isgs.illinois.edu/maps-data-pub/coal-maps.shtml). The nearest abandoned mine is more than seven miles south of the project location.

4.6 Lateral Pile/Pier Response

Generally, the geotechnical engineer provides soil parameters to the structural engineer so that an LPile program, or other approved program, can be used for the lateral or displacement analysis of the foundations. Therefore, in Soil Parameters for Lateral Pile Load Analysis, Exhibit D, KEG has included a copy of the subsurface profile provided by IDOT and has added the assumed soil parameters needed to perform a displacement or lateral pile analysis, if deemed necessary by the structural engineer.

4.7 Liquefaction

As per IDOT AGMU 10.1-Liquefaction Analysis, a site located in Seismic Performance Zone 1 (See Section 4.3 Seismic Considerations) does not require consideration of the geotechnical conditions present and potential for liquefaction. Therefore, a liquefaction analysis was not performed and liquefaction was not considered as a reduction for the pile design capacity or other foundation considerations.

4.8 Approach Slab

In accordance with the ABD memo 08.3, KEG has evaluated the foundation soils at the approach slabs for bearing capacity and excessive settlement. Based on the IDOT Bridge Manual, Section 3.8.10 - Approach Slab Support, the unfactored dead load reaction of the standard approach pavement with parapets is 3.4 kips per ft. of width. Our calculations show that the allowable bearing capacity of the soils under the approach slabs is greater than the actual applied soil pressure under the footing. Therefore, ground modification treatments and/or Special Provisions to satisfy the bearing requirements are not necessary to be included, and excessive settlement for the foundation soils at the approach slabs is not a concern.

5.0 FOUNDATION EVALUATIONS AND DESIGN RECOMMENDATIONS

5.1 General Feasibility

Several foundation types have been considered for use on this structure. In accordance with the Bridge Manual Section 3.8.3 on Open Abutments: Integral, a single row of H-piles or 12 in. and 14 in. metal shell piles are permitted for the foundation of a bridge having this type of abutment with lengths up to 90 ft. The Modified IDOT Static Method of Estimating Pile Length spreadsheet in accordance with AGMU 10.2 – Geotechnical Pile Design was used to calculate the pile lengths. Pile capacities were calculated versus increasing embedment up to the Maximum Nominal Required Bearing ($R_{N\ MAX}$) for a given pile type. The results of this analysis are summarized for each structure location in Table 5.1 and in the Pile Design Tables, Exhibit E.

Based on the subsurface conditions encountered, the depth to bedrock and the results of the pile design analysis, metal shell piles and H-piles are both considered for the support of the proposed structure. The pile design analyses revealed that the metal shell piles would not achieve the capacities required to meet preliminary load demands before reaching the hard till. The likelihood of pile damage occurring in the layer of stiff sandy clay loam till coupled with the risk of pile installation damage and the concern for inadequate penetration to develop lateral fixity, deters recommendation of these pile types. The pile design analyses revealed that the R_{NMAX} for each type of H-pile considered at the north abutment is not achieved before reaching the clay shale material. At the south abutment, the smaller sized H-piles meet their R_{NMAX} in the till before reaching the shale. However, H-piles deriving support primarily from friction, and limited end bearing, have shown unpredictable performance in practice. Therefore, there is potential risk if H-piles are not supported primarily in end bearing, i.e., driven to refusal in the clay shale material.

The structure may benefit from the use of shallow foundations or drilled shafts. These types of foundations are not used with integral abutments, as indicated in the TS&L; however, the structural engineer may consider a semi-integral abutment type which can be used with spread footings and drilled shafts.

The depth to competent bearing material capable of economically supporting the design loads at the north abutment makes the spread footings unfeasible. In accordance with the Geotechnical Manual, the maximum depth at which spread footings are considered economical, as compared to pile foundations, is 10 ft. below the normal depth of a footing.

Based on soil conditions, drilled shafts could be considered as a support system at south abutment. However, the use of drilled shafts is estimated to be cost prohibitive versus driven piles due to the depths required to penetrate the overburden soils and bear in the silty clay shale. In addition, the occurrence of very soft zones below the water table, especially at the north abutment, could present problems requiring casing of the piers. The use of drilled shafts also is accompanied by significantly more complex detailing for seismic considerations. For these reasons, drilled shafts are not deemed as a support foundation alternative for this structure.

5.2 Pile Supported Foundation

The foundations supporting the proposed bridge must provide sufficient support to resist dead and live loads, including seismic loadings. Based on the subsurface conditions encountered, depth to the shale bedrock material, and the design information available to date, H-pile foundations driven to refusal on the shale bedrock are preferred. Table 5.1 LRFD Pile Design shows the practical pile lengths for both Metal Shell Pile and H-pile corresponding to the Maximum Nominal Required Bearing ($R_{N\ MAX}$) values based on the cutoff elevations as provided by IE at the abutment locations. Additional information showing a range of pile capacities and their corresponding pile lengths can be found in Pile Design Tables, Exhibit E.

The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving as well as assist the contractor in selecting a proper hammer size. The Factored Resistance Available (R_F) documents the net long term axial factored pile capacity available at the top of pile to support factored structure loadings. The potential influences of: (a) negative skin friction (down drag) from settlement of compressible layers, (b) loss of support from liquefaction, and (c) loss of support due to material removal (scour) were analyzed. The liquefaction analysis showed no potentially liquefiable layers, and significant additional settlement of the embankment and the foundation units is not anticipated since the subsurface materials mainly consist of cohesive material which are not susceptible to liquefaction and only minor grading is anticipated. Hence, down drag forces should be negligible, and liquefaction values were not applied to the R_F according to the Bridge Manual. Scour elevations were not applied during the pile design analyses to account for scour, since the design scour elevations for both abutments is at the bottom of the abutment caps.

The factored design loads provided by IE are 1236 kips at the abutments. In accordance with the Bridge Manual, when determining the final pile size, normally the lowest weight section necessary, which provides the factored or allowable resistance required, should be selected; however, utilizing the pile sections such as the HP 8x36, HP 10x57, HP 12x74, HP 12x84, HP 14x102, and HP 14x117 that have a limited supply compared to other piling, can cause construction delays and increase the cost of the project. Based on these restrictions and based on the factored design loads provided by IE, the likely pile types to be considered in the pile design analysis were Steel HP 14x73 with an $R_{N\ MAX}$ of 578 kips, Steel HP 12x63 with an $R_{N\ MAX}$ of 497 kips, Steel HP 12x53 with an $R_{N\ MAX}$ of 419 kips, Steel HP 10x42 with an $R_{N\ MAX}$ of 335 kips, and Metal Shell 14 in. with 0.312 in. walls with an $R_{N\ MAX}$ of 516 kips. The LRFD Pile Design Guide Procedure (3.10.1) was used to estimate pile capacity at tip elevations for the pile types and sizes being considered.

At both abutments, the R_{NMAX} for each type of pile considered is achieved prior to reaching the clay shale unit or once driven into the shale material. KEG recommends driving H-piles to the R_{NMAX}. The higher available resistance can allow the number of piles to be reduced, resulting in a net savings despite the increased pile length. The potential for driving damage is minimized with H-pile type foundations, and fewer test piles are necessary when H-pile is driven to the shale. If metal shell piles are to be used, although there is always a risk of damage to metal shell piles during driving, this risk can be minimized by selection of the thicker wall thicknesses. Metal shell would have less inherent risk than friction H-piles; however, it is recognized that IDOT is generally comfortable with H-piles in friction and length estimates based on the current method of analysis. Therefore, the selection of pile types is left to the collective discretion of the designer and the owner.

The minimum pile group shows the minimum number of piles needed at each substructure unit to support the factored design loads after load adjustments described previously. Pile groups were determined by taking the total factored loads for each substructure unit and dividing by the Maximum Factored Resistance Available (R_{FMAX}) for each type of pile considered. The Minimum Pile Groups represent the minimum number of piles needed to support the Strength I loading condition factored structural loads provided by the structural engineer. Larger pile groups may be necessary to meet maximum spacing requirements at each substructure unit. The results are shown in Table 5.1—LRFD Pile Design.

Table 5.1 – LRFD Pile Design

	Pile Designation	$R_{N\ max}$ Max Nominal Required Bearing (kips)	$R_{F\ max}$ Max Factored Resistance Available (kips)	Total Factored Load (kips)	Estimated Pile Length (ft)	Pile Tip Elevation	Min. Pile Group
North Abutment	HP10x42	335	184	1236	39	430.94	7
	HP12x53	418	230	1236	39	430.94	6
	HP12x63	497	273	1236	41	428.94	5
	HP 14x73	578	318	1236	40	429.94	4
	Metal Shell 14”Ø w/.312 walls	134	74	1236	34	435.94	17
South Abutment	HP10x42	332	183	1236	31	439.4	7
	HP12x53	408	225	1236	31	439.4	6
	HP12x63	497	273	1236	36	434.4	5
	HP 14x73	578	318	1236	36	434.4	4
	Metal Shell 14”Ø w/.312 walls	36	20	1236	13	457.4	62

Because of the variations in subsurface conditions, it is recommended that one test pile be driven at each abutment. A test pile is performed prior to production driving so that actual, on-site, field data can be gathered to determine pile driving requirements for the project. This also is the manner in which the contractor's proposed equipment and methodologies identified in their Pile Installation Plan can be assessed. Actual driving equipment and methodologies will affect the estimated pile lengths shown here.

It should be noted that pile driving at the north abutment in the area of the compressible soil should be delayed as long as possible after fill placement to allow for settlement. KEG also recommends driving the production pile for the south abutment prior to the north abutment.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Construction Activities

The construction activities should be performed in accordance with the current IDOT *Standard Specifications for Road and Bridge Construction* and any pertinent *Special Provisions* or policies.

6.2 Temporary Sheeting and Soil Retention

KEG understands that temporary shoring will be required at the abutments during construction. The subsurface conditions below the estimated dredge line indicate weak soils with low unconfined compressive strengths. Therefore, use of the IDOT temporary sheet piling design charts is not feasible at the abutments. The soil retention system should extend from the start of the existing abutments to the end of the proposed abutments and will require more analysis. An Illinois-licensed structural engineer is required to seal the design of the temporary soil retention system.

6.3 Site and Soil Conditions

The soil profile underlying the near surface soils reported in the boring logs, as provided by IDOT, are very soft, saturated soils which are at high risk for deformation under loading. Should any bridge or embankment design considerations assumed by either IDOT or KEG in the analysis stated in this report change, KEG should be contacted to determine if these recommendations still apply.

Soils with high moisture content could complicate construction activities. Soft or disturbed areas should be undercut (typically one to two ft.) and crushed rock, such as CA-6, can be used to provide a working platform.

6.4 Foundation Construction

Conventional pile driving equipment and methodologies should be assumed.

7.0 COMPUTATIONS

Computations and analyses for special circumstances, if any, are included as exhibits. Please refer to each section of the report for reference to the exhibit containing any such calculations or analysis used.

8.0 GEOTECHNICAL DATA

Soil borings can be found in Exhibit C. The Subsurface Profile can also be found in Exhibit C.

9.0 LIMITATIONS

The recommendations provided herein are for the exclusive use of IE and IDOT. They are specific only to the project described and are based on subsurface information obtained at two boring locations within the bridge area, KEG's understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. KEG should be contacted if conditions encountered during construction are not consistent with those described.

Exhibit A

USGS Topographic Location Map

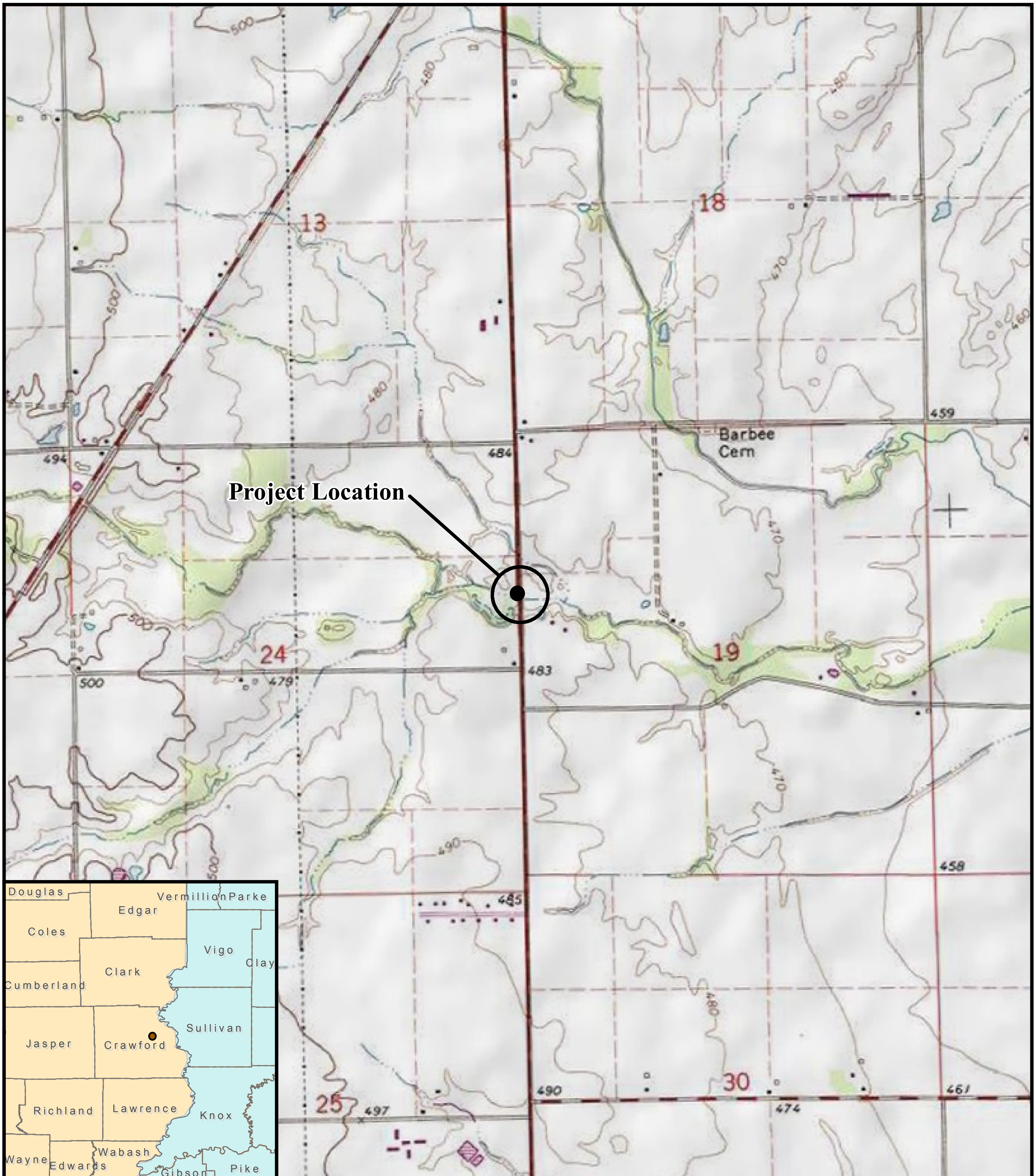

Exhibit A
Location Map
IL 1 over Sugar Creek
Crawford County, Illinois

N

0 500 1,000
Feet

Designed By: IK
Drawn By: TDW
Checked By: MGM
Date: 10/17/09
Project #: 08_0077

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Exhibit B

Provided Type, Size and Location (TS&L) Plan

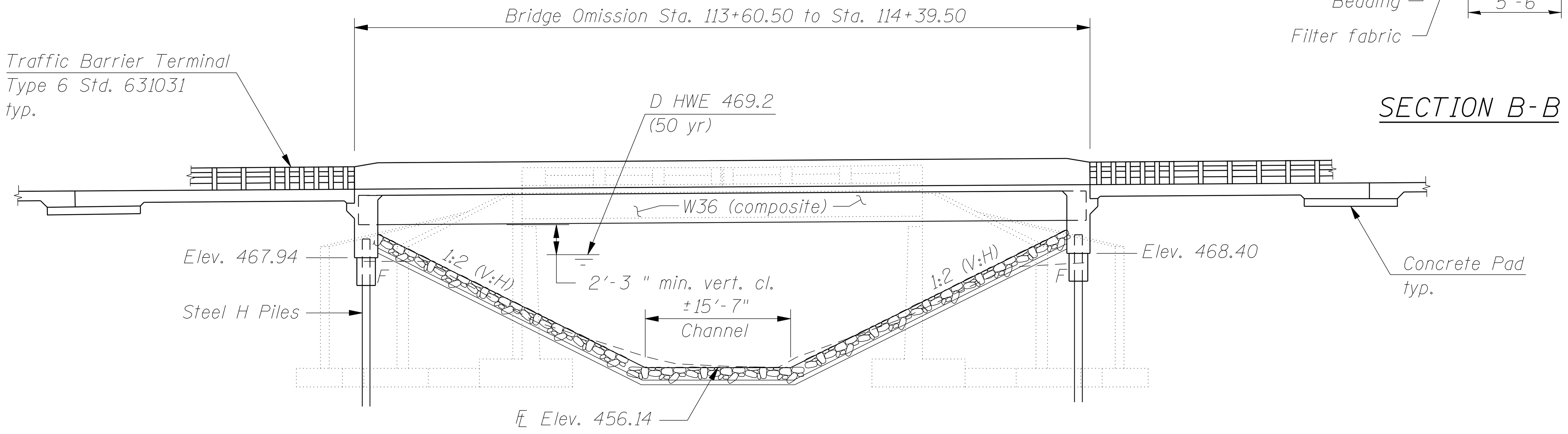
B.M. No. 110 - "□" on the N.W. Wingwall of S.N. 017-0003 24' Rt. of Sta. 113+79.
Elev. 475.355

Ex. Structure No. 017-0003 was built in 1935 as a single span reinforced concrete tee beam structure with a length of 45'-0" bk. to bk. of abut. and a clear width of 23'-2". The closed concrete abutments are supported by untreated timber piling. The structure was widened in 1959 to provide a clear width of 43'-0". There is a concrete bridge rail attached to a concrete deck curb.

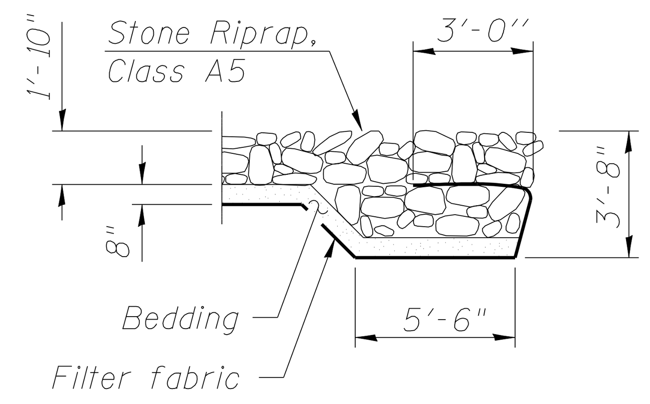
No salvage.

New structure will be constructed using Stage Construction.

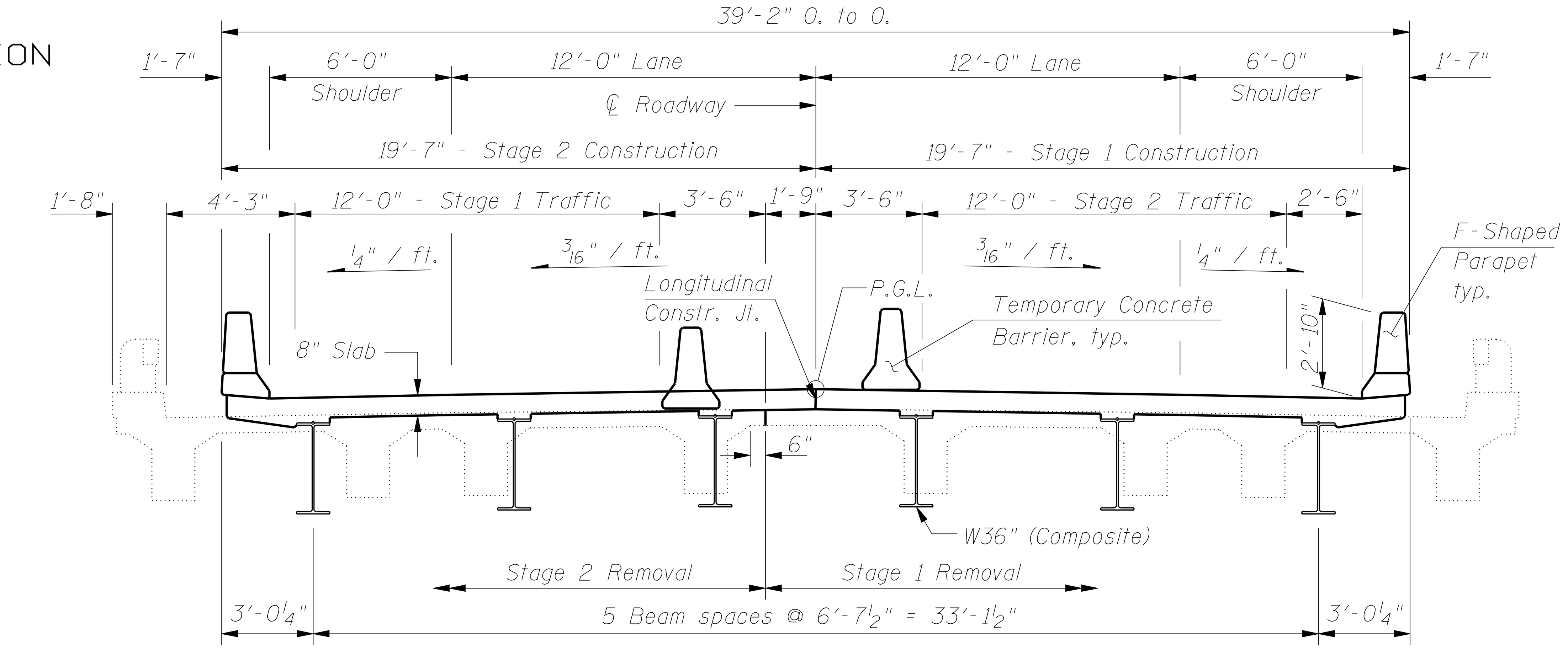
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



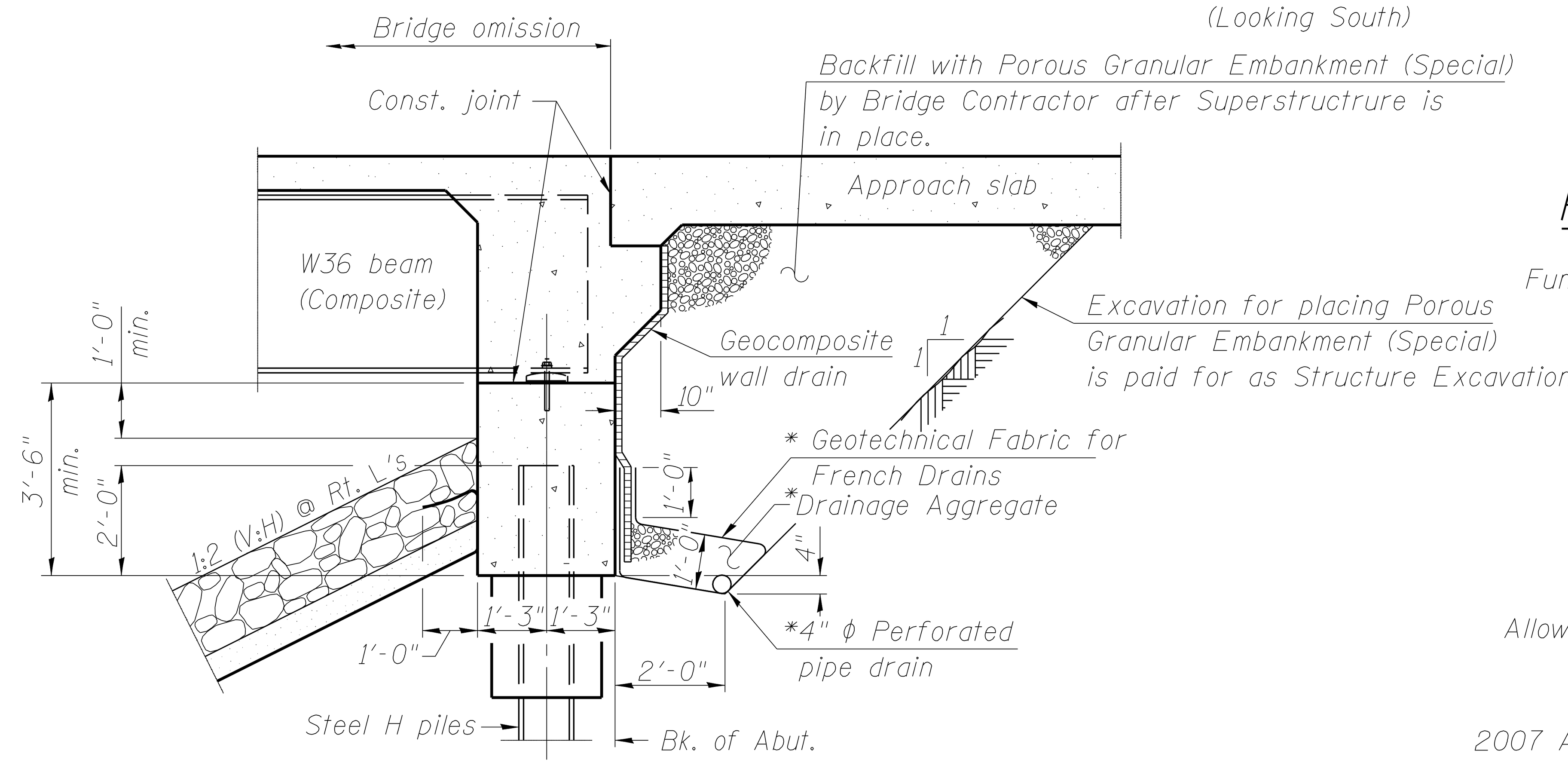
ELEVATION



SECTION B-B



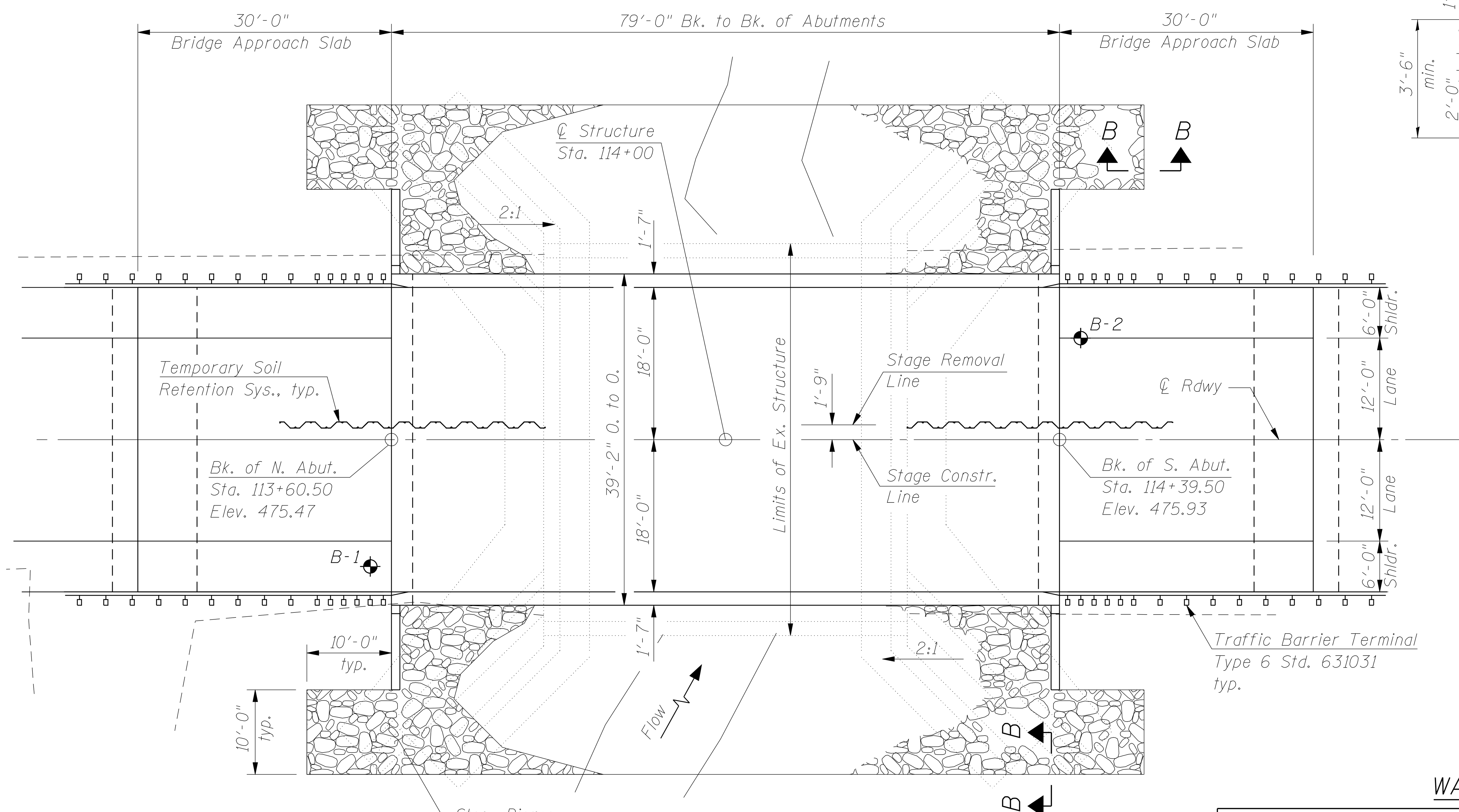
CROSS SECTION
(Looking South)



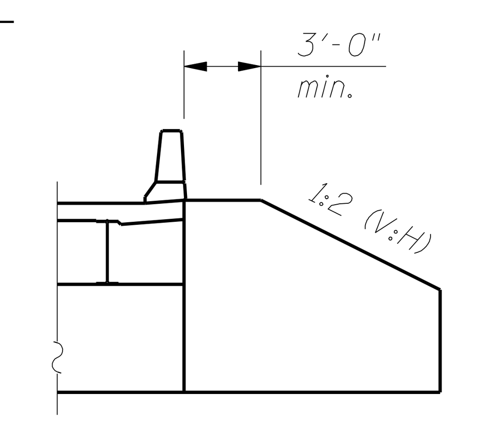
SECTION THRU INTEGRAL ABUTMENT
(Horiz. dim. @ Rt. L's)

*Included in the cost of Pipe Underdrains for Structures.

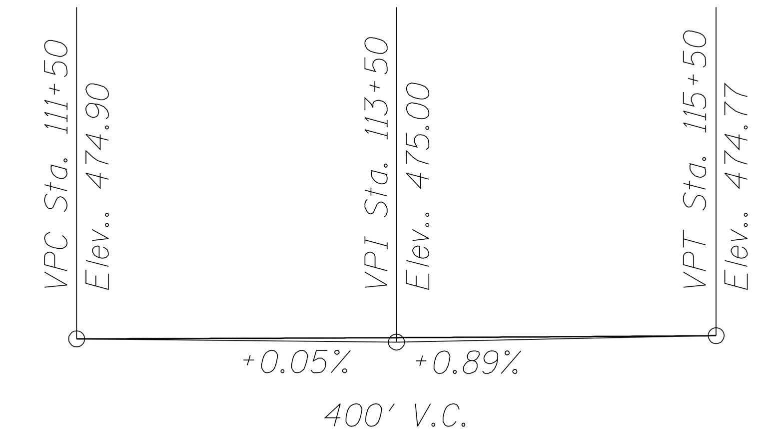
Note:
All drainage system components shall extend to 2'-0" from the end of each wingwall except an outlet pipe shall extend until intersecting with the side slopes. The pipes shall drain into concrete headwalls. (See Article 601.05 of the Standard Specifications and Highway Standard 601101).



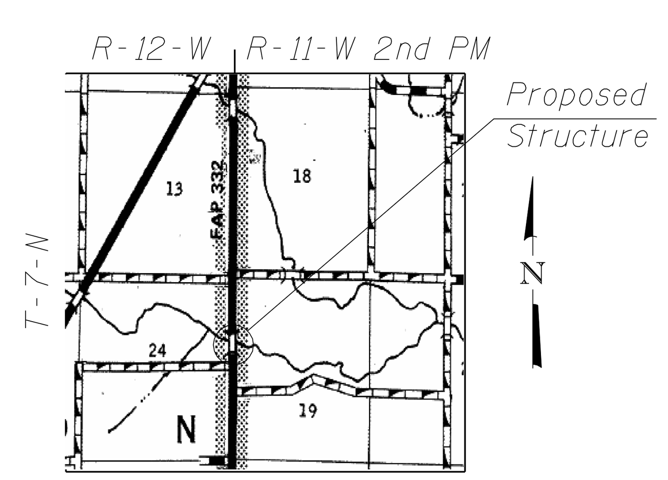
PLAN



WINGWALL DETAIL



PROPOSED PROFILE



LOCATION SKETCH

HIGHWAY CLASSIFICATION
IL Rte. 1 - FAP Rte. 332
Functional Class: Other Principal Arterial
ADT: 2,950 (2007); 3,824 (2032)
ADTT: 575 (2007); 746 (2032)
DHV: 354 (2007); 459 (2032)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
2-Way Traffic
Directional Distribution: 50:50

LOADING HL-93
Allow 50#/sq. ft. for future wearing surface.

DESIGN SPECIFICATIONS
2007 AASHTO LRFD Bridge Design Specifications
with 2008 Interims

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) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.141g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.342g
Soil Site Class = C

WATERWAY INFORMATION

Drainage Area = 7.5 Sq. Mi. Ex. Low Grade Elev. - 474.82 @ Sta. - 110+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	1,870	364	445	467.5	0.0	0.0	467.5	467.5
Design	50	3,090	431	559	469.2	0.7	0.6	469.9	469.8
Base	100	3,640	443	581	469.5	0.9	0.7	470.4	470.2
Overtopping									
Max. Calc.	500	5,030	474	640	470.3	1.7	1.3	472.0	471.6

DESIGN SCOUR ELEVATION TABLE

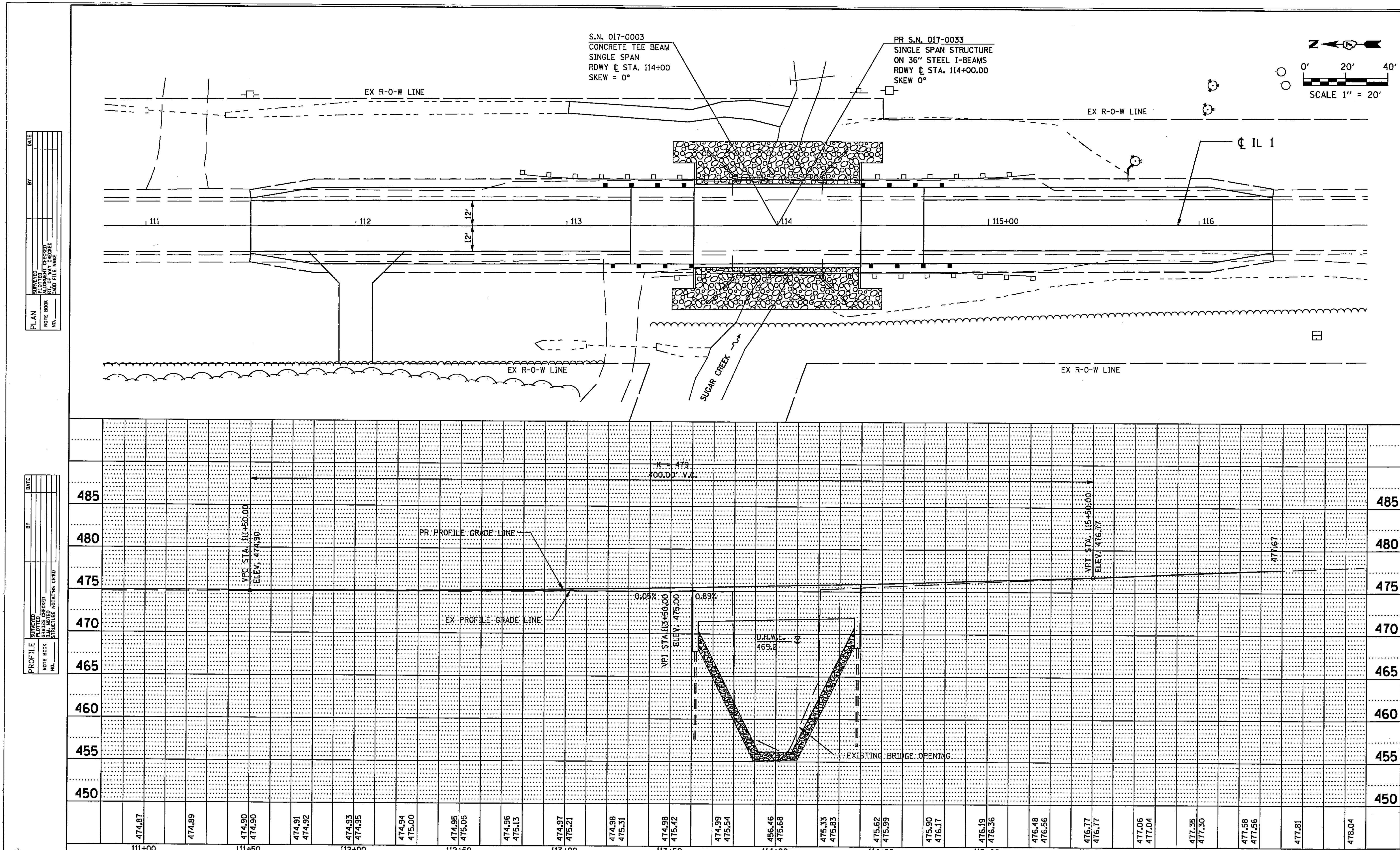
Design Scour	N. Abut.	S. Abut.
Elevation (ft.)	463.94	464.40

DESIGNED	SCD
CHECKED	DRB
DRAWN	THW
CHECKED	SCD

ie consultants
IE CONSULTANTS, INC
6420 SOUTH SIXTH STREET
SPRINGFIELD, ILLINOIS 62712
TEL. (217) 529-8027
FAX (217) 529-4543
WWW.IE-CONSULTANTS.COM

GENERAL PLAN
IL RTE 1 OVER SUGAR CREEK
F.A.P. ROUTE 332
SECTION (21-X-NRH-BY)B-1
CRAWFORD COUNTY
STA. 114+00
S.N 017-0033

SHEET NO.	F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
OF SHEETS	332	(21-X-NHR-BY) B-1	CRAWFORD		
			CONTRACT NO. 74108		
	FED. ROAD DIST. NO. _	ILLINOIS	FED. AID PROJECT		



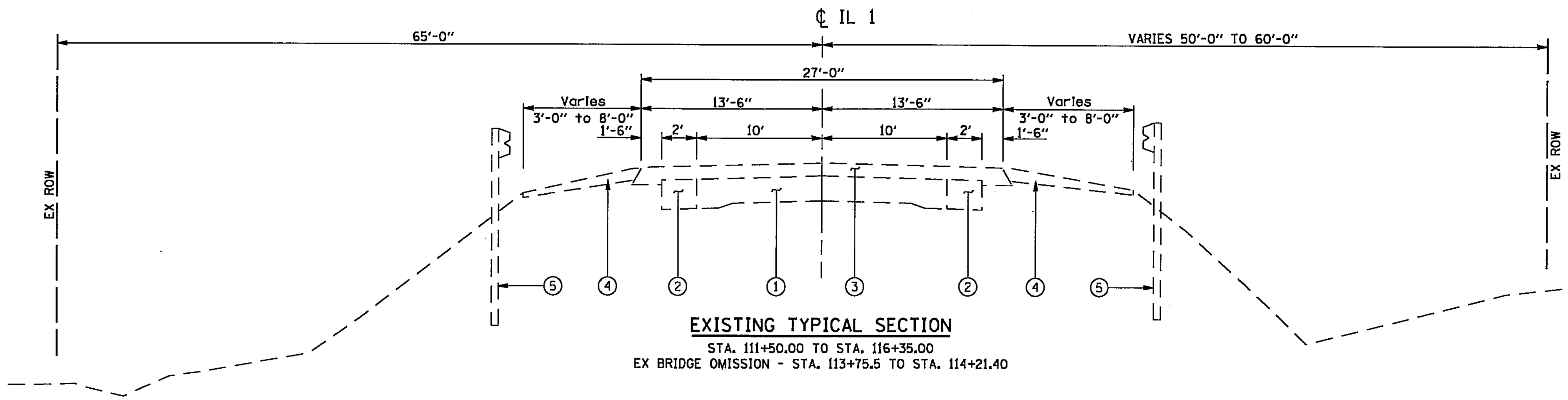
FILE NAME = *FILE*	USER NAME = *USER*	DESIGNED -	REVISED -
		DRAWN -	REVISED -
	PLOT SCALE = *SCALE*	CHECKED -	REVISED -
	PLOT DATE = *DATE*	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

PLAN & PROFILE

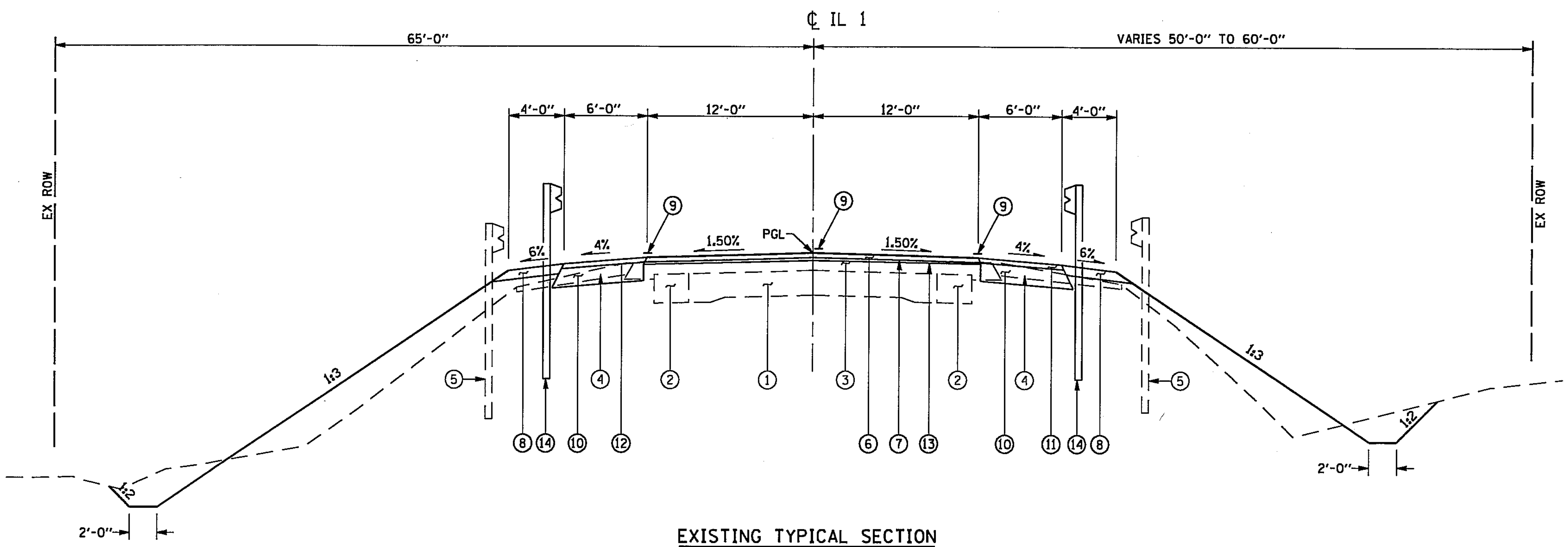
SCALE: | SHEET NO. OF SHEETS | STA. TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(21-NRH-BY) B-1	CRAWFORD		
		CONTRACT NO. 74108		
		ILLINOIS FED. AID PROJECT		



EXISTING TYPICAL SECTION

STA. 111+50.00 TO STA. 116+35.00
EX BRIDGE OMISSION - STA. 113+75.5 TO STA. 114+21.40



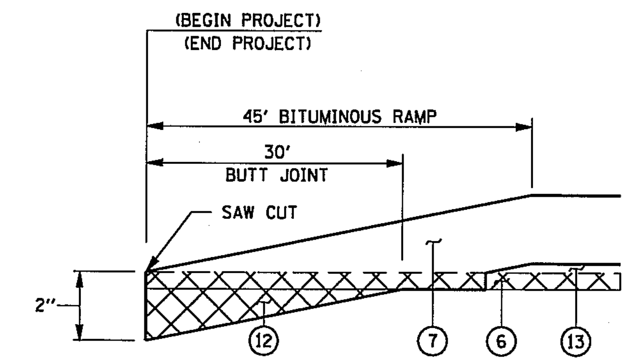
EXISTING TYPICAL SECTION

STA. 111+50.00 TO STA. 116+35.00
EX BRIDGE OMISSION - STA. 113+75.5 TO STA. 114+21.40

LEGEND

1. EX PCC PAVEMENT WITH 18" BRICK SURFACE
2. EX BASE COURSE WIDENING, 9"
3. EX BITUMINOUS RESURFACING
4. EX AGGREGATE SHOULDERS
5. * EX GUARDRAIL
6. HMA SURFACE REMOVAL, VAR. DEPTH
7. HOT-MIX ASPHALT SURFACE COURSE MIX C, N70
8. AGGREGATE SHOULDERS, TYPE B
9. PAINT PAVEMENT MARKING - LINE 4"
10. BASE COURSE WIDENING 8"
11. HOT-MIX ASPHALT SHOULDERS, 2"
12. HOT-MIX ASPHALT SURFACE REMOVAL- BUTT JOINT
13. HMA BINDER COURSE, IL 19.0 N70
14. * GUARDRAIL

* SEE "PLAN SHEETS" FOR GUARDRAIL LOCATIONS.



BUTT - JOINT DETAIL

1. NOTE:

WHERE EXISTING GUARDRAIL IS WITHIN WIDENING LIMITS, CONSTRUCT WIDENING TO EXISTING GUARDRAIL PRIOR TO STAGE 1 AND CONSTRUCT THE REMAINDER IN STAGE 2, OTHERWISE CONSTRUCT ALL WIDENING ON LT IN STAGE 1.

FILE NAME = *FILE*	USER NAME = *USER*	DESIGNED -	REVISED -
		DRAWN -	REVISED -
	PLOT SCALE = *SCALE*	CHECKED -	REVISED -
	PLOT DATE = *DATE*	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

TYPICAL SECTIONS

SCALE: SHEET NO. OF SHEETS STA. TO STA.

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	(21-Y-NHR-BY) B-1	CRAWFORD		
		CONTRACT NO. 74108		
FED. ROAD DIST. NO.	ILLINOIS FED. AID PROJECT			

Exhibit C

IDOT Provided Boring and Rock Core Logs

and Subsurface Profile

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 8/13/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Sugar Creek **LOGGED BY** E. Sandschafer

SECTION (21-X-NRH-BY)B-1 **LOCATION** R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4, **SEC.** , **TWP.** 7N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0003
Station 114+00

BORING NO. 1 N Abut
Station 113+58
Offset 15.00ft Lt
Ground Surface Elev. 474.15 ft

Surface Water Elev. 457.54 ft
Stream Bed Elev. 457.16 ft

Groundwater Elev.:
First Encounter 446.7 ft
Upon Completion 464.5 ft
After 168 **Hrs.** 460.8 ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
8" mixture of aggregate shoulder, cinders and sandy clay.	473.45				
Stiff, damp, red mottled gray, SILTY CLAY.			4 7 6	1.5 B	17
	469.65				
Soft, damp, gray, SILTY LOAM.		-5	1 0 0	0.4 B	22
			0 0 0	0.3 B	21
		-10	0 1 0	0.4 B	25
	462.15				
Very soft, very damp, gray, SANDY LOAM.			0 0 0	0.1 B	25
	458.95	-15	0 0 1	0.6 B	31
Medium, damp, red marbled gray, CLAY.			0 0 0	0.8 B	22
		-20	0		

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium, damp, red marbled gray, CLAY. *(continued)*			1 2	0.8 B	26
			1 1 2	0.8 B	25
	450.85				
Very soft, very damp, gray, SANDY LOAM.		-25	0 0 4	0.1 S	14
			0 2 0	0.1 S	16
	444.65				
Medium, damp, gray, SANDY CLAY.		-30	0 3 4	0.4 B	13
	439.65				
Very stiff, damp, gray, SANDY CLAY LOAM TILL.		-35	12 16 14	3.6 B	9
	434.65	-40	39		

Latitude W 87 deg 41.079 min, Longitude N 39 deg 02.347 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 8/13/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Sugar Creek **LOGGED BY** E. Sandschafer

SECTION (21-X-NRH-BY)B-1 **LOCATION** R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4, **SEC.** , **TWP.** 7N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0003
Station 114+00

BORING NO. 1 N Abut
Station 113+58
Offset 15.00ft Lt
Ground Surface Elev. 474.15 ft

Surface Water Elev. 457.54 ft
Stream Bed Elev. 457.16 ft

Groundwater Elev.:
First Encounter 446.7 ft
Upon Completion 464.5 ft
After 168 **Hrs.** 460.8 ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very dense, moist, gray, CLAY SHALE. *(continued)*	433.65		50/3" 50/2"		8
Borehole continued with rock coring.					
		-45			
		-50			
		-55			
		-60			

Latitude W 87 deg 41.079 min, Longitude N 39 deg 02.347 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 8/13/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Sugar Creek **LOGGED BY** E. Sandschafer

SECTION (21-X-NRH-BY)B-1 **LOCATION** R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4, **SEC.** , **TWP.** 7N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0003
Station 114+00

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

Core Diameter 2.06 **in**
Top of Rock Elev. 434.65 **ft**
Begin Core Elev. 433.65 **ft**

BORING NO. 1 N Abut
Station 113+58
Offset 15.00ft Lt
Ground Surface Elev. 474.15 **ft**

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Gray, slight to moderate weathered, SILTY CLAY SHALE.	433.65		B1C1	83	82	1.2	
Rock core B1C1 from 44.2' to 44.7' depth, Qu = 4.2 tsf.		-45					
			B1C2	99	80	1.1	
Rock core B1C2 from 49.2' to 49.7' depth, Qu = 21 tsf.		-50					
	423.65						
Extent of exploration. Benchmark: BM 110 Cut square on NW wingwall of existing structure, Sta 113+79, 24' Rt = 475.36' elevation. Provided by Program Development.							
		-55					
		-60					

Color pictures of the cores Available on request
Cores will be stored for examination until 08/13/2014
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: 8-13-09

Structure # : 017-0003

Boring # : B1

Rock Core # : B1C1	Rock Core # : B1C2
Depth: 40.5	Depth: 45.5
Grey silty clay shale w/some slight to mod weathering	DK Grey silty clay shale w/ slight to MOD weathering
-0.7 OJ	-0.47 OJ
-1.57 OJ	-3.32 OJ
-1.65 OJ	-3.37 OJ
-2.76 OJ	-3.54 OJ
-3.11 OJ	-3.70
-3.7	Sample to TEST B1C2
Sample to TEST B1C1	-4.24 OJ
-4.17	-4.36 OJ
	-4.60 OJ
	-4.94
RQD: 0.7, 0.88, 1.12, 0.34, 1.05 = 4.09	RQD: 0.47, 2.85, 0.69 = 4.01
Depth:	Depth:
Core Time: 5:15 (1.2 min/ft)	Core Time: 5:15 (1.1 min/ft)
Recovery: 83.4%	Recovery: 98.8%
RQD: 81.8%	RQD: 80.2%

Logged By: Eric Sandschafer

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 8/12/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Sugar Creek **LOGGED BY** E. Sandschafer

SECTION (21-X-NRH-BY)B-1 **LOCATION** R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4, **SEC.** , **TWP.** 7N, **RNG.** , 3 **PM**

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

STRUCT. NO. 017-0003
Station 114+00

BORING NO. 2 S Abut
Station 114+42
Offset 12.00ft Rt
Ground Surface Elev. 475.39 ft

Surface Water Elev. 457.54 ft
Stream Bed Elev. 457.16 ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion Dry ft
After 24 **Hrs.** 461.4 ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
4 1/2" asphalt on 7 1/2" concrete pavement.	474.39				
Soft to medium, damp, gray, SILTY CLAY.			1		
			1	0.4	28
			1	B	
		-5	0		
			1	0.6	16
			1	PP	
			0		
			0	0.6	16
			1	B	
	465.89				
Very soft, damp, gray, SILTY LOAM.		-10	0		
			0	0.2	25
			0	B	
			0		
			1	0.3	22
			0	B	
	460.89				
Medium, damp, brown mottled gray, SANDY CLAY TILL.		-15	6		
			2	0.7	11
			3	B	
			6		
			10	1.0	9
			20	BS	
	455.89				
		-20	24		

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Hard, damp, gray, SANDY CLAY LOAM TILL. *(continued)*			35	4.5	7
			48	BS	
			24		
			50	+4.5	6
			50/5"	PP	
		-25	22		
			30	+4.5	7
			38	PP	
			17		
			29	7.8	7
			36	S	
		-30	16		
			27	6.6	7
			39	S	
		-35	18		
			35	6.7	7
			50	S	
	435.89				
		-40	60		

Latitude W 87 deg 41.080 min, Longitude N 39 deg 02.345 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 8/12/09

ROUTE FAP 332 (IL 1) **DESCRIPTION** Sugar Creek **LOGGED BY** E. Sandschafer

SECTION (21-X-NRH-BY)B-1 **LOCATION** R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4, **SEC.**, **TWP.** 7N, **RNG.**, 3 **PM**

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

STRUCT. NO. 017-0003
Station 114+00

BORING NO. 2 S Abut
Station 114+42
Offset 12.00ft Rt
Ground Surface Elev. 475.39 ft

Surface Water Elev. 457.54 ft
Stream Bed Elev. 457.16 ft

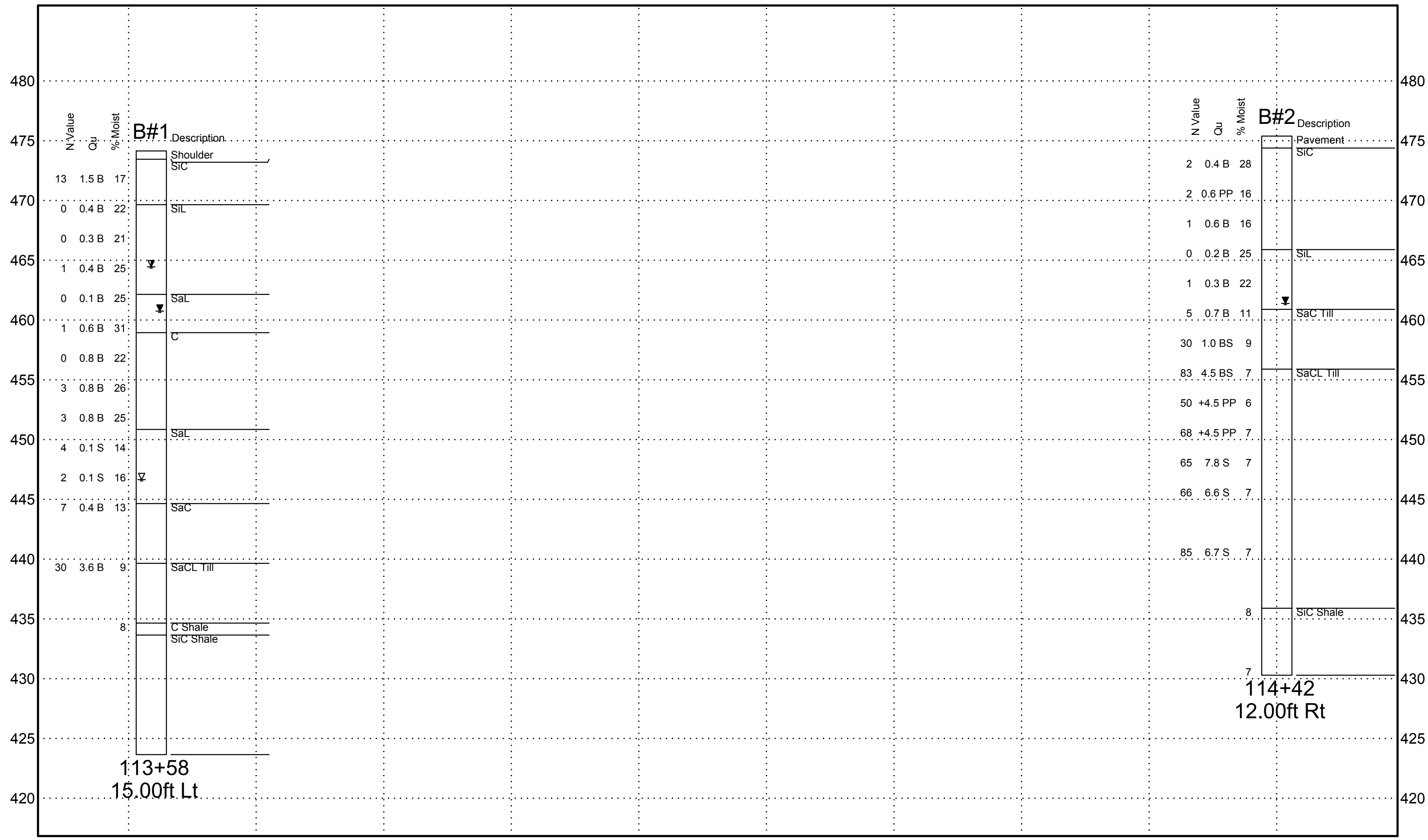
Groundwater Elev.:
First Encounter Dry ft
Upon Completion Dry ft
After 24 **Hrs.** 461.4 ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very dense, moist, gray, SILTY CLAY SHALE. *(continued)*		50/4"		8
		50/2"		
430.29	-45	50/4"		
Extent of exploration.		50/2"		7
		50/1"		
Benchmark: BM 110 Cut square on NW wingwall of existing structure, Sta 113+79, 24' Rt = 475.36' elevation. Provided by Program Development.				
	-50			
	-55			
	-60			

Latitude W 87 deg 41.080 min, Longitude N 39 deg 02.345 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)

Structure Number 017-0003 Sugar Creek
Located in the R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4 of Section , Township 7N, Range of the 3 P.M.



NOT TO HORIZONTAL SCALE

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

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

SUBSURFACE DATA PROFILE

Route: FAP 332 (IL 1)

Section: (21-X-NRH-BY)B-1

County: Crawford

SUBSURFACE DATA PROFILE 017-0003.GPJ D6TEMPLT.GDT 09/09/01

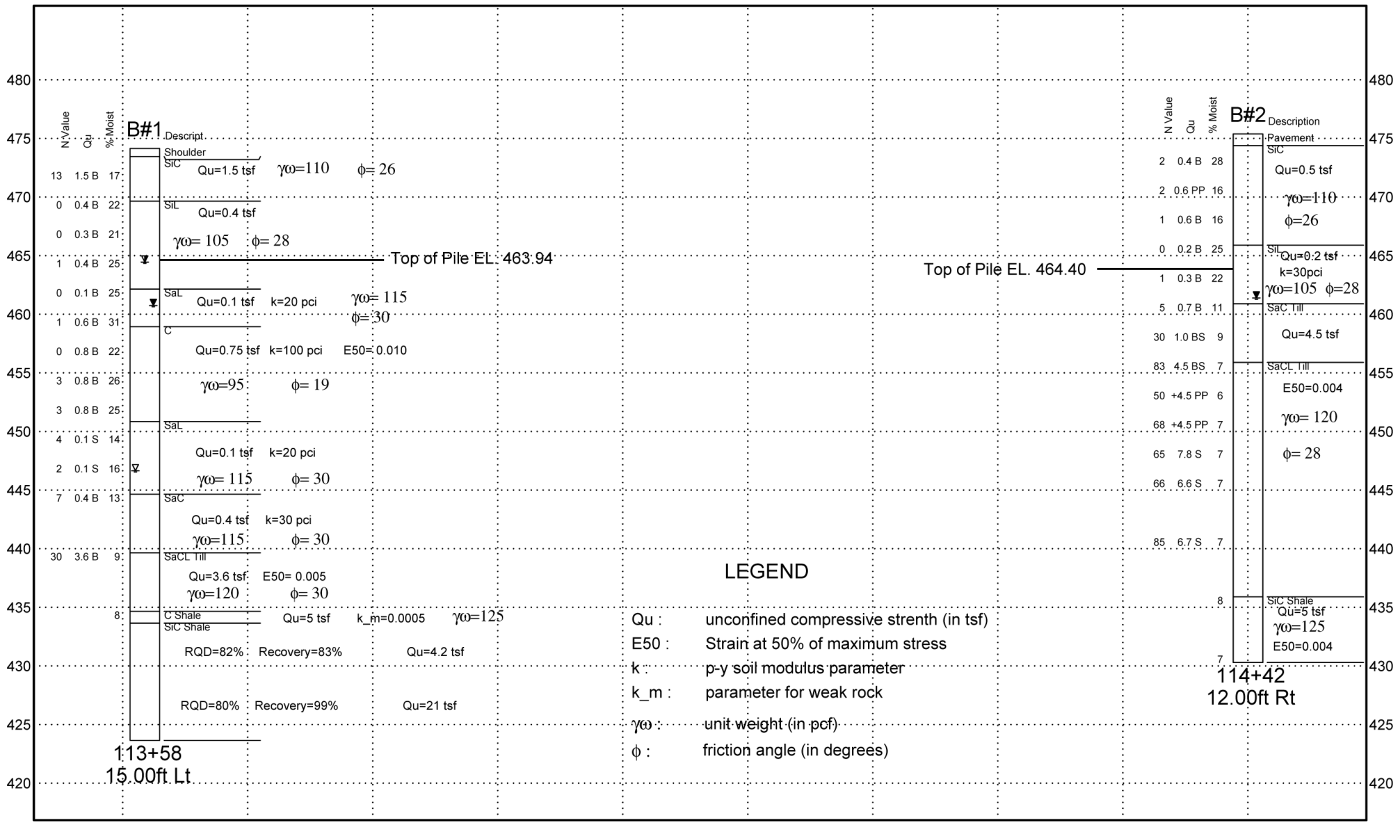
SUBSURFACE DATA PROFILE 017-0003.GPJ D6TEMPLT.GDT 09/09/01

Exhibit D

Soil Parameters

for Lateral Pile Load Analysis

Structure Number 017-0003 Sugar Creek
Located in the R12W, Sec 24, NE 1/4; R11E, Sec 19, NW 1/4 of Section , Township 7N, Range of the 3 P.M.



NOT TO HORIZONTAL SCALE

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

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

LATERAL PILE SOIL PARAMETERS

Route: FAP 332 (IL 1)
Section: (21-X-NRH-BY)B-1
County: Crawford

SUBSURFACE DATA PROFILE 017-0003.GPJ D6TEMPLT.GDT 09/09/01

SUBSURFACE DATA PROFILE 017-0003.GPJ D6TEMPLT.GDT 09/09/01

Exhibit E

Pile Design Tables

M O D I F I E D I D O T S T A T I C M E T H O D O F E S T I M A T I N G P I L E L E N G T H

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 5/3/2010

SUBSTRUCTURE================================ North abut.
REFERENCE BORING =========================== 1
GROUND SURFACE ELEV. AT BORING ============= 474.15 FT.
PILE CUTOFF ELEV. ============================ 469.94 FT.
GROUND SURFACE ELEV. AGAINST PILE DURING DRIV 464.94 FT.
GROUND WATER ELEVATION===================== 460.80 FT.
HAMMER EFFICIENCY=========================== 73 %
LRFD or ASD or SEISMIC ========================= LRFD

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	**335** KIPS	**184** KIPS	**42** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1236 KIPS
TOTAL WIDTH OF SUBSTRUCTURE ================ 39.20 FT.
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE == 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 252.24 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 94.59 KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter============ 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area====== 0.680 SQFT. Unplugged Pile End Bearing Area==== 0.086 SQFT.

GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) = None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 467.94 FT.
TOP ELEV. OF LIQUEF. (so layers above apply DD) ===== 0.00 FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
462.65	2.29	0.30			3.7		6.2	5.4		***5.7***	6	0	0	3	7
460.15	2.50	0.40			5.2	2.5	***9.6***	7.7	0.3	13.2	10	0	0	5	10
457.65	2.50	0.10			1.4	0.6	***14.1***	2.0	0.1	15.6	14	0	0	8	12
455.15	2.50	0.60			7.6	3.8	***23.0***	11.2	0.5	27.0	23	0	0	13	15
452.65	2.50	0.80			9.8	5.1	***32.7***	14.4	0.6	41.4	33	0	0	18	17
450.15	2.50	0.80			9.8	5.1	***42.5***	14.4	0.6	55.7	43	0	0	23	20
447.65	2.50	0.80			9.8	5.1	***47.8***	14.4	0.6	69.5	48	0	0	26	22
445.15	2.50	0.10			1.4	0.6	***49.2***	2.0	0.1	71.6	49	0	0	27	25
442.65	2.50	0.10			1.4	0.6	***52.5***	2.0	0.1	73.8	52	0	0	29	27
440.15	2.50	0.40			5.2	2.5	***57.7***	7.7	0.3	81.6	58	0	0	32	30
437.65	2.50	0.40			5.2	2.5	***83.4***	7.7	0.3	91.9	83	0	0	46	32
435.15	2.50	3.60	30		28.9	22.9	***112.3***	42.6	2.9	134.4	112	0	0	62	35
434.15	1.00	3.60	30		11.6	22.9	***123.8***	17.0	2.9	151.5	124	0	0	68	36
433.15	1.00	3.60	30		11.6	22.9	***135.4***	17.0	2.9	168.5	135	0	0	74	37
432.15	1.00	3.60	30		11.6	22.9	257.8	17.0	2.9	***199.6***	200	0	0	110	38
431.15	1.00		100	Hard Till	15.6	133.7	224.6	23.0	16.9	***216.4***	216	0	0	119	39
430.15	1.00			Shale	41.2	84.9	***265.8***	60.6	10.7	277.0	266	0	0	146	39.8
429.15	1.00			Shale	41.2	84.9	***307.0***	60.6	10.7	337.7	307	0	0	169	40.8
428.15	1.00			Shale	41.2	84.9	***348.2***	60.6	10.7	398.3	~~348~~	~~*0*~~	~~*0*~~	~~*191*~~	~~*41.8*~~
427.15	1.00			Shale	41.2	84.9	***389.3***	60.6	10.7	458.9	~~389~~	~~*0*~~	~~*0*~~	~~*214*~~	~~*42.8*~~
426.15	1.00			Shale	41.2	84.9	***430.5***	60.6	10.7	519.6	~~431~~	~~*0*~~	~~*0*~~	~~*237*~~	~~*43.8*~~
425.15	1.00			Shale		84.9			10.7						

Pile Design Table for North abut. utilizing Boring #1

Pile Type	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	110	61	37
Metal Shell 12"Φ w/.25" walls			
	110	61	37
Metal Shell 14"Φ w/.25" walls			
	134	74	37
Metal Shell 14"Φ w/.312" walls			
	134	74	37
Steel HP 8 X 36			
	272	149	42
Steel HP 10 X 42			
	135	74	37
	200	110	38
	216	119	39
	335	184	42

Pile Type	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	139	76	37
	207	114	38
	221	122	39
	454	250	45
Steel HP 12 X 53			
	168	93	37
	239	132	38
	259	142	39
	418	230	42
Steel HP 12 X 63			
	170	94	37
	246	135	38
	265	146	39
	497	273	44
Steel HP 12 X 74			
	158	87	36
	173	95	37
	252	139	38
	269	148	39
	589	324	45
Steel HP 12 X 84			
	161	88	36
	175	96	37
	257	141	38
	273	150	39
	664*	365	45

Pile Type	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	133	73	32
	174	96	35
	190	105	36
	207	114	37
	291	160	38
	314	173	39
	578	318	43
Steel HP 14 X 89			
	134	74	32
	176	97	35
	193	106	36
	209	115	37
	300	165	38
	320	176	39
	705*	388	45
Steel HP 14 X 102			
	136	75	32
	178	98	35
	195	107	36
	212	117	37
	306	168	38
	325	179	39
	810*	445	45
Steel HP 14 X 117			
	138	76	32
	181	99	35
	198	109	36
	215	118	37
	314	173	38
	331	182	39
	929*	511	45
Precast 14"x 14"			
	170	94	37
Timber Pile			
	93	51	37

* In lieu of the hammer selection criteria and use of the FHWA Modified Gates formula specified in Section 512 of the Standard Specifications, the Contractor shall conduct a wave equation analysis to establish the driving criteria at all pile foundations which specify a nominal required bearing above 600 kips. The analysis and calculations shall be submitted to the Engineer for approval.

MODIFIED IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified 5/3/2010

SUBSTRUCTURE============================== South abut.
REFERENCE BORING ========================== 2
GROUND SURFACE ELEV. AT BORING ============= 475.39 FT.
PILE CUTOFF ELEV. ========================== 470.40 FT.
GROUND SURFACE ELEV. AGAINST PILE DURING DRIV 465.40 FT.
GROUND WATER ELEVATION===================== 461.40 FT.
HAMMER EFFICIENCY========================== 73 %
LRFD or ASD or SEISMIC ====================== LRFD

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	**332** KIPS	**183** KIPS	**35** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========= 1236 KIPS
TOTAL WIDTH OF SUBSTRUCTURE =============== 39.20 FT.
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE == 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 252.24 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 94.59 KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter============ 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area====== 0.680 SQFT. Unplugged Pile End Bearing Area==== 0.086 SQFT.

GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) = None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 468.40 FT.
TOP ELEV. OF LIQUEF. (so layers above apply DD) ===== 0.00 FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
463.90	1.50	0.60			4.6		***5.8***	6.7		6.9	6	0	0	3	7
461.40	2.50	0.20			2.7	1.3	***9.2***	4.0	0.2	10.9	9	0	0	5	9
458.90	2.50	0.30			4.0	1.9	***15.7***	5.9	0.2	17.2	16	0	0	9	12
456.40	2.50	0.70			8.7	4.5	***26.3***	12.8	0.6	30.2	26	0	0	14	14
455.90	0.50	1.00			2.3	6.4	***28.7***	3.5	0.8	33.7	29	0	0	16	15
455.40	0.50	1.00			2.3	6.4	***31.0***	3.5	0.8	37.1	31	0	0	17	15
454.90	0.50	1.00			2.3	6.4	***33.4***	3.5	0.8	40.6	33	0	0	18	16
454.40	0.50	1.00			2.3	6.4	***35.7***	3.5	0.8	44.0	36	0	0	20	16
453.90	0.50	1.00			2.3	6.4	160.4	3.5	0.8	***63.0***	63	0	0	35	17
453.40	0.50		83	Hard Till	7.3	128.6	166.3	10.7	16.3	***73.5***	74	0	0	40	17
452.90	0.50		83	Hard Till	7.1	127.4	172.2	10.5	16.1	***83.8***	84	0	0	46	18
452.40	0.50		83	Hard Till	7.0	126.1	179.2	10.3	16.0	***94.1***	94	0	0	52	18
451.90	0.50		83	Hard Till	7.0	126.1	184.9	10.3	16.0	***104.3***	104	0	0	57	19
451.40	0.50		83	Hard Till	6.9	124.8	212.1	10.1	15.8	***116.9***	117	0	0	64	19
448.90	2.50		100	Hard Till	45.8	145.2	209.5	67.4	18.4	***178.2***	178	0	0	98	22
446.40	2.50		68	Hard Till	21.4	96.8	223.3	31.5	12.2	***208.8***	209	0	0	115	24
443.90	2.50		65	Hard Till	18.5	89.2	241.8	27.2	11.3	***235.9***	236	0	0	130	27
441.40	2.50		66	Hard Till	18.5	89.2	***257.7***	27.2	11.3	262.8	258	0	0	142	29
438.90	2.50		66	Hard Till	17.5	86.6	296.9	25.8	11.0	***291.4***	291	0	0	160	32
436.40	2.50		85	Hard Till	26.3	108.3	***323.1***	38.7	13.7	330.0	323	0	0	178	34
435.40	1.00		85	Hard Till	10.5	108.3	***332.3***	15.5	13.7	345.3	332	0	0	183	35
434.40	1.00		85	Hard Till	10.3	107.0	***341.3***	15.1	13.5	360.3	~~341~~	~~0~~	~~0~~	~~188~~	~~36~~
433.40	1.00		85	Hard Till	10.1	105.7	***369.2***	14.8	13.4	377.3	~~369~~	~~0~~	~~0~~	~~203~~	~~37~~
432.40	1.00		100	Hard Till	13.5	123.5	***344.0***	19.8	15.6	392.3	~~344~~	~~0~~	~~0~~	~~189~~	~~38~~
431.40	1.00			Shale	41.2	84.9	***385.2***	60.6	10.7	452.9	~~385~~	~~0~~	~~0~~	~~212~~	~~39~~
430.40	1.00			Shale	41.2	84.9	***426.4***	60.6	10.7	513.5	~~426~~	~~0~~	~~0~~	~~235~~	~~40~~
429.40	1.00			Shale	41.2	84.9	***467.6***	60.6	10.7	574.2	~~468~~	~~0~~	~~0~~	~~257~~	~~41~~
428.40	1.00			Shale	41.2	84.9	***508.8***	60.6	10.7	634.8	~~509~~	~~0~~	~~0~~	~~280~~	~~42~~
427.40	1.00			Shale		84.9			10.7						

Pile Design Table for South abut. utilizing Boring #2

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	29	16	16
Metal Shell 12"Φ w/.25" walls			
	29	16	16
Metal Shell 14"Φ w/.25" walls			
	36	20	16
Metal Shell 14"Φ w/.312" walls			
	36	20	16
Steel HP 8 X 36			
	168	92	24
	184	101	27
	197	109	29
	226	124	32
	248	136	34
	255	140	35
	263	145	36
	268	148	38
	286	157	39
Steel HP 10 X 42			
	117	64	19
	178	98	22
	209	115	24
	236	130	27
	258	142	29
	291	160	32
	323	178	34
	332	183	35

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	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	124	68	19
	183	101	22
	214	118	24
	241	133	27
	265	145	29
	298	164	32
	332	182	34
	341	188	35
	350	193	36
	353	194	38
	454	250	41
Steel HP 12 X 53			
	141	77	19
	213	117	22
	250	137	24
	282	155	27
	314	173	29
	349	192	32
	395	217	34
	413	227	35
Steel HP 12 X 63			
	147	81	19
	219	121	22
	256	141	24
	289	159	27
	321	177	29
	357	196	32
	403	222	34
	422	232	35
	439	241	38
	497	273	40
Steel HP 12 X 74			
	152	84	19
	223	123	22
	260	143	24
	293	161	27
	326	179	29
	362	199	32
	409	225	34
	427	235	35
	445	245	36
	446	245	38
	589	324	41
Steel HP 12 X 84			
	157	86	19
	227	125	22
	264	145	24
	297	163	27
	330	181	29
	367	202	32
	414	228	34
	433	238	35
	451	248	36
	453	249	38
	664*	365	43

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	154	85	19
	173	95	19
	259	143	22
	303	167	24
	342	188	27
	380	209	29
	422	232	32
	478	263	34
	500	275	35
	521	287	36
	541	298	38
	578	318	39
Steel HP 14 X 89			
	161	89	19
	181	100	19
	266	146	22
	310	170	24
	349	192	27
	388	213	29
	431	237	32
	487	268	34
	509	280	35
	530	292	36
	549	302	38
	705*	388	41
Steel HP 14 X 102			
	167	92	19
	188	103	19
	271	149	22
	314	173	24
	354	195	27
	392	216	29
	437	240	32
	493	271	34
	515	283	35
	536	295	36
	557	306	38
	810*	445	43
Steel HP 14 X 117			
	159	87	18
	173	95	19
	195	107	19
	277	152	22
	321	176	24
	360	198	27
	399	220	29
	445	245	32
	501	276	34
	524	288	35
	545	300	36
	564	310	38
	929*	511	43
Precast 14"x 14"			
	45	25	16
Timber Pile			
	151	83	17