# STRUCTURE GEOTECHNICAL REPORT

## 011-2513

**EX SN 011-7039**

**Culvert carrying IL 16 over a tributary to South Fork Sangamon River**
**FAP 325 (IL 16)**
**Section 8(B-2, B-3)**
**Christian County**

**D-96-522-05**
**Contract 72984**


**Prepared By:** Sadie Jones
IDOT Region 4 District 6
Geotechnical Unit
217-782-6703

**Date:** January 21, 2015

**Checked By:** BK

**Approved By:** Brian Laningham, P.E.
D-6 Geotechnical Engr.
License # 062-053757

**Date:** 1-13-16 (Revised)


**Prepared For:** Mary Coombe
Bloxdorf
Coombe-Bloxdorf,
P.C.
(217)544-8477

**Attachments:** Preliminary TSL
Subsurface Profile
Boring Logs
Special Provisions

This Report has been prepared based on a preliminary general plan sheet received May 2014. Contact the author if there are any questions regarding this Report or if there are modifications to structure location, size, geometry or vertical alignment.

Electronic copies of boring logs are available upon request for inclusion in the plans. Calculations are also available upon request.

This Report has been prepared according to AASHTO Standard Specifications for Highway Bridges 17$^{th}$ Edition 2002 and the 2009 IDOT BBS Bridge Manual.

## Project Description and Proposed Structure Information

This project consists of the removal of the existing single barrel box culvert and its replacement with a double 10ft wide by 4ft high box culvert. The existing box is perpendicular to the roadway, and is to be filled with controlled low strength material. The proposed box culvert will be relocated ± 67ft to the south to better align with the natural stream. Work will be performed under staged construction.

The proposed culvert is 98± ft long and will be constructed on a 45° skew. The maximum fill height over the culvert is ± 2.0 ft. (1.0' HMA + 1.0' Backfill).

## Existing Structure and Site Investigation

The existing structure is a 8 ft wide by 4 ft high concrete box culvert. Existing wingwalls appear integral to the barrel. Archived existing plan information has not been obtained.

The surrounding terrain is level and the land use is primarily agricultural. The existing channel is a drainage tributary. The channel banks have a uniform 2H:1V or steeper vegetated slope with no indications of severe erosion.

New borings were advanced near the center of the proposed culvert. The boring was advanced approximately 10 ft below streambed by the District 6 drill crew according to AASHTO T 206 and the IDOT Geotechnical Manual.

Boring data indicates approximately 13ft of silty clay over 12± ft of clay loam till. The boring data indicates groundwater was encountered at 671.5 ft.

## Geotechnical Evaluation

*Settlement.* The proposed box culvert produces no net increase in loading below the roadway. Outside the roadway calculations indicate settlement of less than one inch is possible. We believe that this amount of settlement is minor and does not require remediation. Settlement problems are not anticipated.

*Slope Stability*. The stability of a 8 ft high 1:1 temporary construction slope has been analyzed. The resulting factor-of-safety is 5.4.

*Seismic Considerations.* Seismic events are not a significant design consideration for culverts.

*Scour.* Scour elevations for cox culverts are not required per All Bridge Design Memo 14.2.

*Mining Activity.* ISGS records indicate no mines in the project area.

**Foundation Evaluation**

*Culvert Barrel.* Because of stage construction and a 45° skew a cast in place culvert must be used. If a roadway closure was considered, then a pre-cast culvert could be utilized. If a pre-cast is utilized then cast in place headwalls should be included. No ground improvement is required.

*Wingwalls*. The proposed wingwall dimensions (14' long) & (5'-9" short) are within the limits allowed for a horizontal cantilever design. Sheet pile and Soldier pile (driven or drilled) walls are another viable option to consider, due to speed and ease of construction. Depending on cost and speed of construction, the designer should utilized the most cost efficient design recommended.

Sheet Pile and Soldier Wall. Because the existing soil conditions are a clay material, earth pressures are time dependent in nature. Permanent sheet and soldier pile structures in clay should be evaluated for immediate (after construction) and for long term conditions. Due to creep affects the long term value of c (cohesion) approaches zero and $\phi$ ranges from 20 to 30 degrees in clay material. The long term case approaches piling in granular soils.

In the immediate condition $\phi = 0$, the coefficient of Active $K_a$ and Passive $K_p$ earth pressures are equal to 1.0. In the long term condition c = 0, the coefficient of Active $K_a$ and Passive $K_p$ earth will need to be calculated. These coefficients are based on the: angle of backfill slope $\beta$, angle of internal friction $\phi$, and angle of wall friction $\delta$.

For the drained condition, the sheet pile wall would be backfilled with a clean granular material which would effectively eliminate the water table. The active loads (above the dredge line) are based on angle of backfill slope $\beta$ in degrees, angle of internal friction ranging from $\phi = 30–35$ degrees, and angle of wall friction ranging from $\delta = 12–17$ degrees. The active & passive loads (below the dredge line) are based on angle of backfill slope $\beta$ in degrees, angle of internal friction ranging from $\phi = 20–30$ degrees, and angle of wall friction $\delta = 0$ degrees.

In the analysis, the designer may assume drainage will provided through weep holes approximately 1.0 ft, above the finish grade line of the stream bed. The designer may assume that water behind the wall will be no higher than the weep holes. Weep holes for soldier pile wings can be used in tandem with geocomposite wall drain.

The structural designer may choose to utilize a Wall Anchorage System to reduce the length and section modulus of sheet pile. The designer should contact the District 6 Geotechnical Engineer for assistance if needed

## Construction Considerations

*Stage Construction*. Currently, this project is proposed to be built under stage construction, however, if a roadway closure is utilized, considerable savings could be seen.

*Temporary Soil Retention.* Temporary retention will be required to facilitate stage construction. The estimated maximum retained height is 8 ft. A preliminary analysis indicates a cantilevered sheet pile wall is feasible. In lieu of the "Temp. Soil Retention System" pay item, the pay item for "Temp. Sheet Piling" may be used.

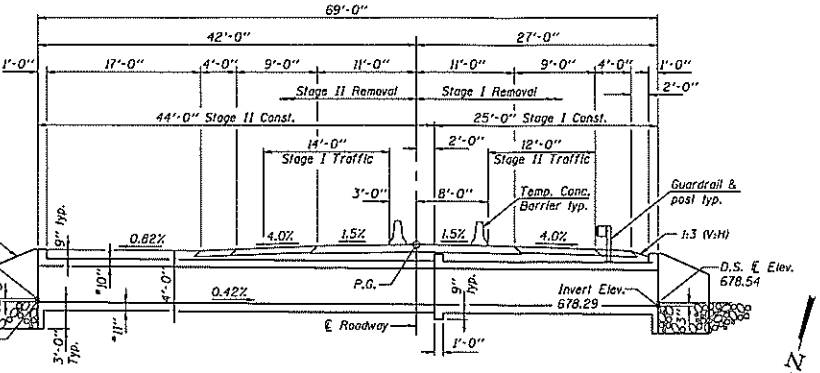
*Backfill.* Backfill should consist of granular culvert backfill. The special provision is attached. A detail showing pay limits should be included. Pay limits include the temporary excavation limits in a section along the roadway and from edge of shoulder to edge of shoulder in a section along the culvert.

*Ground Improvement*. No ground improvement appears necessary

Bench Mark: BM#49 - Chiseled "O" on West end of South headwall.
Station 363+44.20, 21.6' Lt., Elev. 683.826

Existing Structure: Structure No. 011-7039 is an 8' x 4' R.C. Box Culvert 41.5' in length. It was constructed in 1923 as SBI Rte. 16, Section 16 O Sta. 363+41 and was extended in 1956 as Section (15,16X,16)1. Traffic during construction to be maintained utilizing stage construction.

No salvage



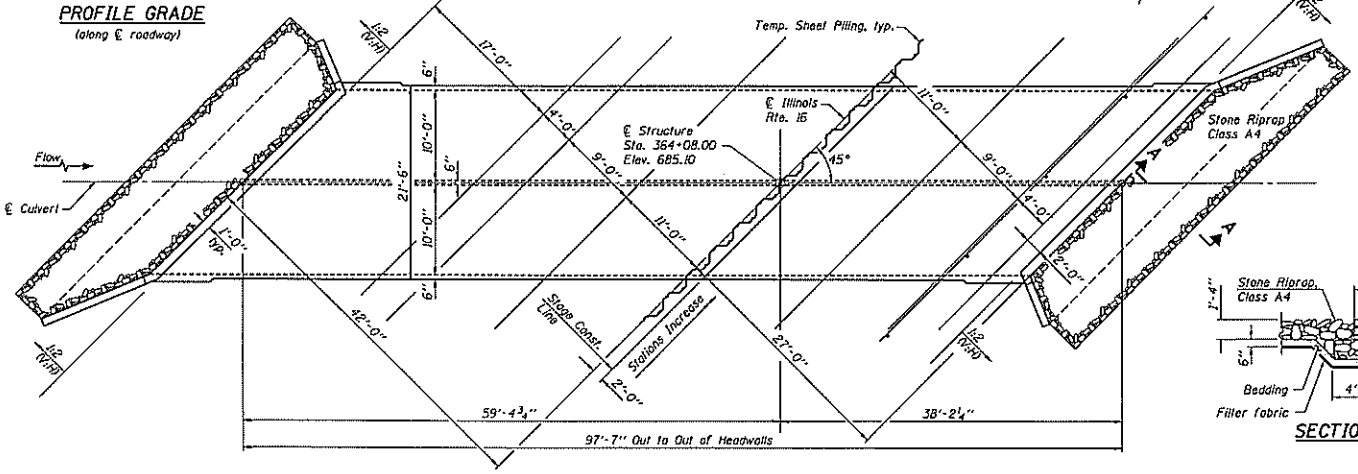

## LONGITUDINAL SECTION

(Horizontal dimension at Rt. 4's to ℄ Roadway)




## PROFILE GRADE

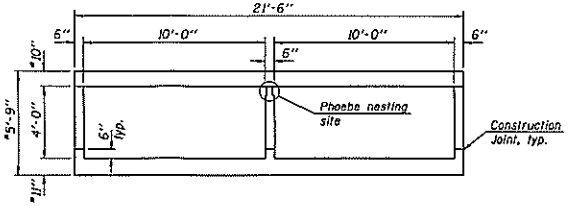
(along ℄ roadway)




## PLAN




## SECTION A-A




## SECTION THRU BARREL

* Slab thickness may be refined in final design

## HIGHWAY CLASSIFICATION

F.A.P. Rte. 325 - Illinois Rte. 16
Functional Class: Other Principal Arterial
ADT: 1550 (2011); 1650 (2032)
ADTT: 11.0%
DHV: 83
Design Speed: 60 m.p.h.
Posted Speed: 55 m.p.h.
Two Way Traffic
Directional Distribution: 50% : 50%

## DESIGN SPECIFICATIONS

2012 AASHTO LRFD Bridge Design Specifications, 6th Edition

## DESIGN STRESSES

FIELD UNITS

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

## LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

## WATERWAY INFORMATION

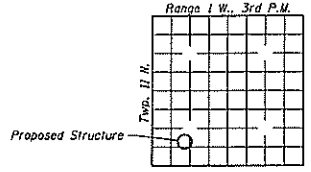
Drainage Area = 0.21 sq. mi.
Existing Low Grade Elevation = 684.7 ft. @ Sta. 364+69
Low Grade Elev. = 684.9 ft. @ Sta. 364+69

| Flood | Freq. Yr. | Q C.F.S. | Opening Sq. Ft. Exist. | Opening Sq. Ft. Prop. | Hdt. H.W.E. | Head - Ft. Exist. | Head - Ft. Prop. | Headwater El. Exist. | Headwater El. Prop. |
|---|---|---|---|---|---|---|---|---|---|
| Min. Calc. | 10 | 188 | 32 | 75 | 683.65 | 0.36 | 0.00 | 684.01 | 683.36 |
| Overtopping | 20 | 227 | 32 | 75 | 683.93 | 0.77 | 0.00 | 684.70 | 683.70 |
| Design | 50 | 326 | 32 | 75 | 684.37 | 0.59 | 0.00 | 684.96 | 684.30 |
| Base | 100 | 391 | 32 | 75 | 684.55 | 0.50 | 0.12 | 685.05 | 684.67 |
| Max. Calc. | 140 | 428 | 32 | 75 | 684.63 | 0.47 | 0.27 | 685.10 | 684.90 |

10 yr. velocity thru existing Str. = 5.9 fps, 10 yr. velocity thru proposed structure = 2.5 fps

## DESIGN SCOUR ELEVATION TABLE

| Design Scour Elevation (ft.) | D.S. Invert | U.S. Invert |
|---|---|---|
| | 675.70 | 675.29 |




## LOCATION SKETCH

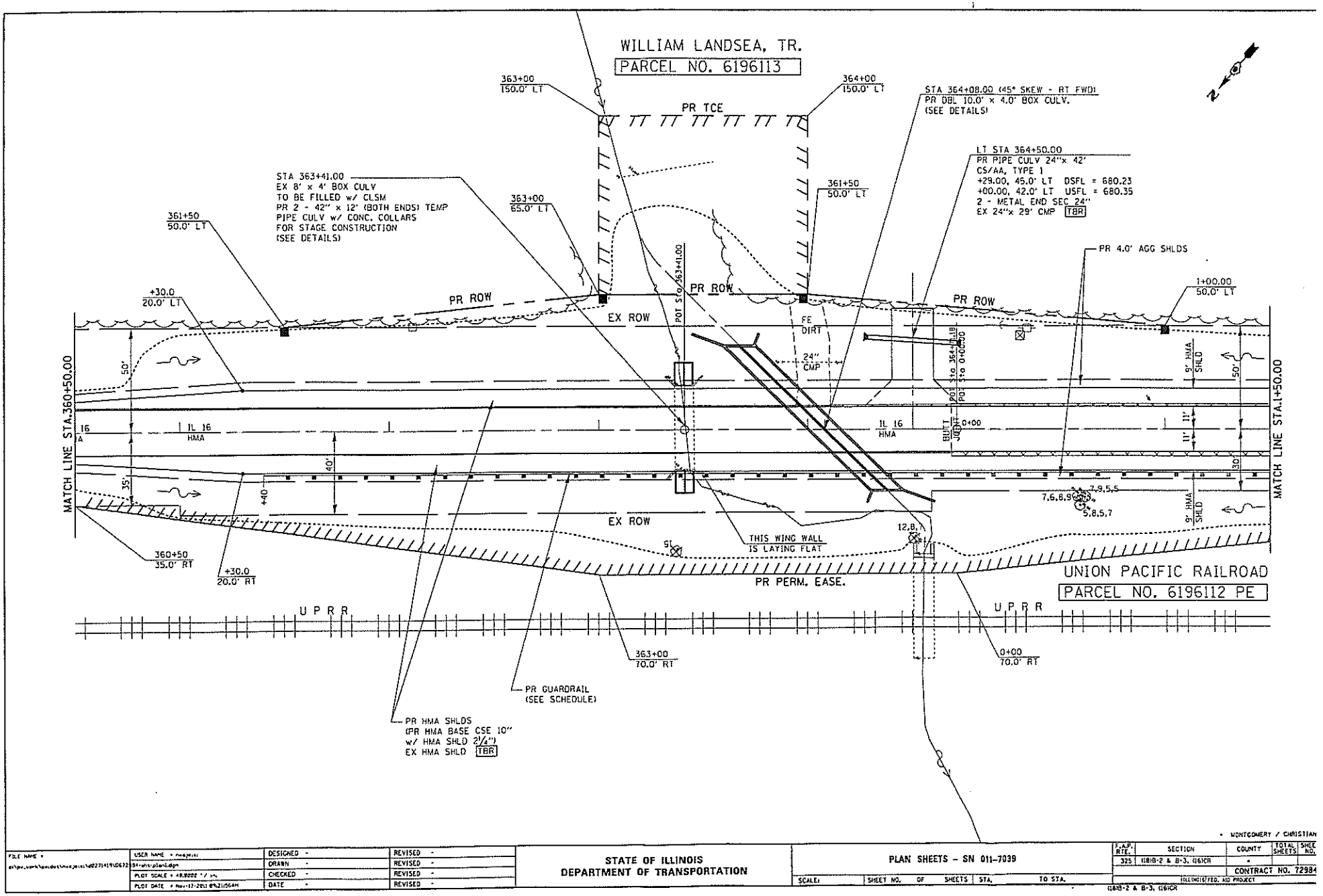
# GENERAL PLAN
# ILLINOIS RTE. 16 OVER TRIBUTARY TO SOUTH FORK SANGAMON RIVER
# F.A.P. RTE. 325 - SEC. 18(B-2, B-3)
# CHRISTIAN COUNTY
# STATION 364+08.00
# STRUCTURE NO. 011-2513

| | | | |
|---|---|---|---|
| FILE NAME = | USER NAME = | DESIGNED - TCH | REVISED - |
| | | CHECKED - MMM | REVISED - |
| | PLOT SCALE = | DRAWN - DAP | REVISED - |
| | PLOT DATE = 04/20/12 | CHECKED - | REVISED - |

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 1 OF 1 SHEETS

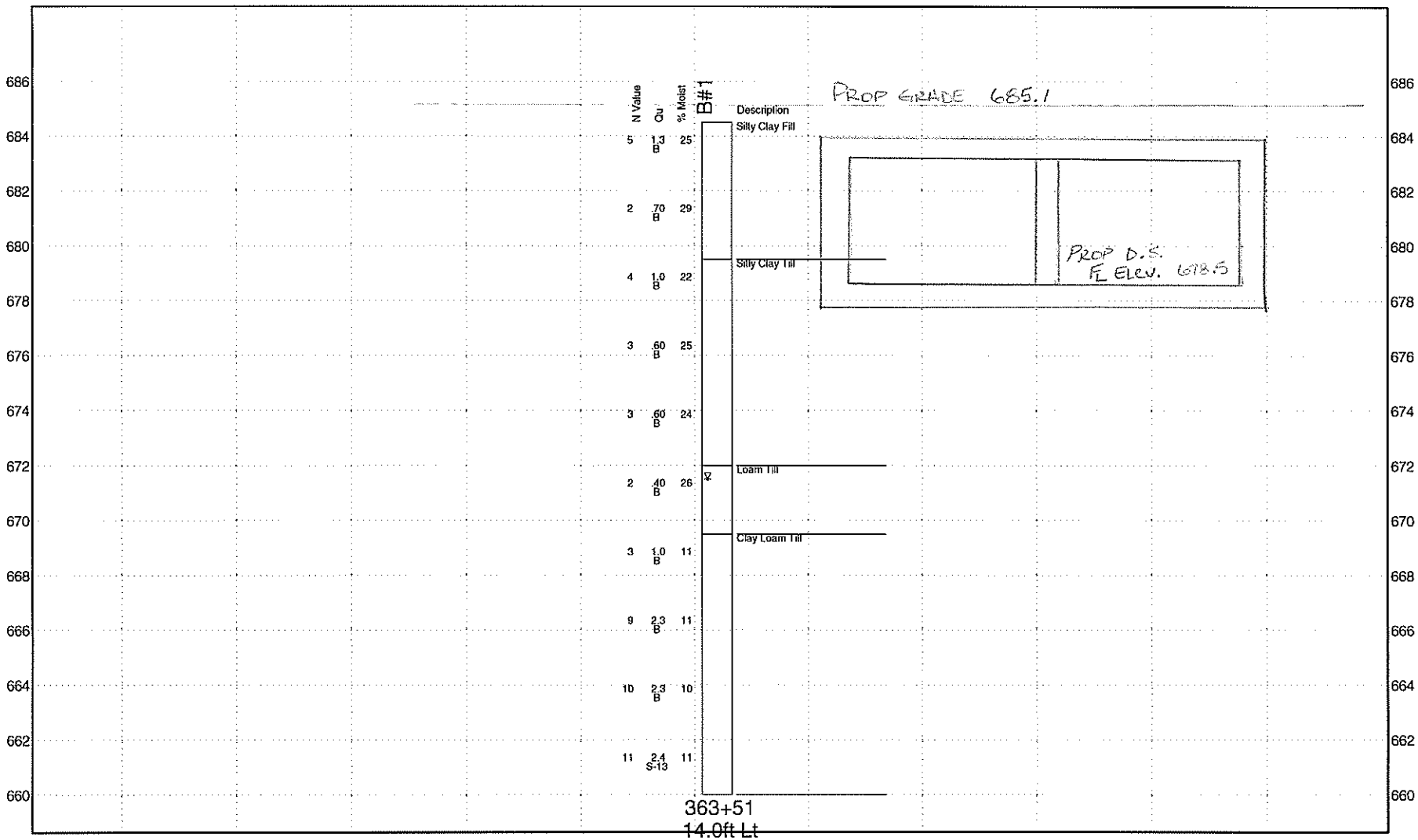
| F.A.P. RTE. | SECTION | COUNTY | TOTAL SHEETS | SHEET NO. |
|---|---|---|---|---|
| 325 | 18(B-2, B-3) | CHRISTIAN | | |
| | | CONTRACT NO. | | |
| | | ILLINOIS FED. AID PROJECT | | |




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE NAME = | USER NAME = mepatel | DESIGNED - | REVISED - | STATE OF ILLINOIS<br>DEPARTMENT OF TRANSPORTATION | PLAN SHEETS – SN 011-7039 | | | | F.A.P. RTE. | SECTION | COUNTY | TOTAL SHEETS | SHEET NO. |
| | PLOT SCALE = 48.0000 ' / in. | DRAWN - | REVISED - | | SCALE: | SHEET NO. OF SHEETS | STA. | TO STA. | 325 | 11BI8-2 & B-3, 11G1CR | MONTGOMERY / CHRISTIAN | | |
| | PLOT DATE = Nov-17-2011 @ 12:05AM | CHECKED - | REVISED - | | | | | | | | CONTRACT NO. 72984 | | |
| | | DATE - | REVISED - | | | | | | | ILLINOIS FED. AID PROJECT | | | |

11BI8-2 & B-3, 11G1CR

Structure Number 011-7039ex 011-2513pr over Unnamed Ditch
Located in the SW 1/4 of Section 33, Township 11N, Range 1W of the 3 P.M.




**NOT TO HORIZONTAL SCALE**

**Illinois Department of Transportation**
Division of Highways
I DOT

**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 325 (IL-16)

Section: 18(B-2, B-3)

County: Christian

SUBSURFACE DATA PROFILE IL-16 SN 011-7039.GPJ D6TEMPLT.GDT 9/23/14

SUBSURFACE DATA PROFILE IL-16 SN 011-7039.GPJ D6TEMPLT.GDT 9/23/14

**Illinois Department of Transportation**
Division of Highways
Illinois Department of Transportation

# SOIL BORING LOG



Date 10/11/11

ROUTE IL-16 DESCRIPTION over Unnamed Ditch LOGGED BY M. Tappan

SECTION ? LOCATION SW 1/4, SEC. 33, TWP. 11N, RNG. 1W, 3 PM

COUNTY Christian DRILLING METHOD HSA HAMMER TYPE 140# Auto

STRUCT. NO. 011-7039
Station 363+41

BORING NO. 1
Station 363+51
Offset 14.0ft Lt
Ground Surface Elev. 684.5 ft

Surface Water Elev. 681.0(Dry) ft
Stream Bed Elev. 681.0 ft

Groundwater Elev.:
▽ First Encounter 671.5 ft
▽ Upon Completion Dry ft
▼ After ____ Hrs. Plugged ft

| DEPTH (ft) | BLOWS /6" | UCS Qu (tsf) | MOIST (%) | Description |
|---|---|---|---|---|
| | 1 | | | Very Dark Gray Moist SILTY CLAY (Fill) |
| | 2 3 | 1.3 B | 25 | |
| | 1 | | | |
| | 1 1 | .70 B | 29 | |
| 679.50 -5 | | | | |
| | 0 | | | Brown and Gray Moist SILTY CLAY (Till) |
| | 2 2 | 1.0 B | 22 | |
| | 0 | | | |
| | 1 2 | .60 B | 25 | Very Moist |
| -10 | | | | |
| | 0 | | | |
| | 1 2 | .60 B | 24 | Olive Brown and Gray Very Moist |
| 672.00 | | | | |
| | 0 | | | Gray Very Moist LOAM (Till) with 6" Seam Wet Dirty Coarse Sand ▽ Free Water |
| | 1 1 | .40 B | 26 | |
| 669.50 -15 | | | | |
| | 0 | | | Gray Moist CLAY LOAM (Till) |
| | 1 2 | 1.0 B | 11 | |
| | 1 | | | |
| | 4 5 | 2.3 B | 11 | |
| -20 | | | | |

| DEPTH (ft) | BLOWS /6" | UCS Qu (tsf) | MOIST (%) | Description |
|---|---|---|---|---|
| | 2 | | | Gray Moist CLAY LOAM (Till) *(continued)* |
| | 4 6 | 2.3 B | 10 | |
| | 3 | | | |
| | 4 7 | 2.4 S-13 | 11 | |
| 660.00 | | | | |
| -25 | | | | Boring Completed |
| -30 | | | | Ref. STA to CL of Ex. Structure= 363+41. STA increase to South (SW) Ref. Elev. to Chsld Square on South Headwall = 683.8 |
| -35 | | | | |
| -40 | | | | |

**The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated) Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating 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)**

File Name C:\PROGRAM FILES\BENTLEY\GINT\IL-16 SN 011-7039.GPJ Data Template D6TEMPLT.GDT Date Printed 10/18/11
Latitude 39.21.090N Longitude 89.12.558W Datum NADB3 Job Number D-96-522-05

**GRANULAR CULVERT BACKFILL** 6M6 10/15/13

This work consists of backfilling box culverts or three-sided structures with granular materials. This work shall be performed at locations shown on the plans or as directed by the Engineer.

Backfilling shall be performed according to Article 502.10. The backfill material shall meet the requirements of Article 1004.05, except the gradation shall be CA-06 or CA-10. This work satisfies select granular backfill (porous granular material) requirements of ASTM C 1577.

Granular Culvert Backfill will be measured for payment in cubic yards compacted in place. Additional material required to backfill excavation outside the limits shown on the plans will not be measured for payment. This work shall be paid for at the contract unit price per cubic yard for GRANULAR CULVERT BACKFILL.

**TEMPORARY SOIL RETENTION SYSTEM**
Effective: December 30, 2002
Revised : May 11, 2009

Description. This work shall consist of designing, furnishing, installing, adjusting for stage construction when required and subsequent removal of the temporary soil retention system according to the dimensions and details shown on the plans and in the approved design submittal.

General. The temporary soil retention system shall be designed by the Contractor as a minimum, to retain the exposed surface area specified in the plans or as directed by the Engineer.

The design calculations and details for the temporary soil retention system proposed by the Contractor shall be submitted to the Engineer for approval. The calculations shall be prepared and sealed by an Illinois Licensed Structural Engineer. This approval will not relieve the Contractor of responsibility for the safety of the excavation. Approval shall be contingent upon acceptance by all involved utilities and/or railroads.

Construction. The Contractor shall verify locations of all underground utilities before installing any of the soil retention system components or commencing any excavation. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor's operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additional cost to the Department. The soil retention system shall be installed according to the Contractor's approved design, or as directed by the Engineer, prior to commencing any related excavation. If unable to install the temporary soil retention system as specified in the approved design, the Contractor shall have the adequacy of the design re-evaluated. Any reevaluation shall be submitted to the Engineer for approval prior to commencing the excavation adjacent to the area in question. The Contractor shall not excavate below the maximum excavation line shown in the approved design without the prior permission of the Engineer. The temporary soil retention system shall remain in place until the Engineer determines it is no longer required.

The temporary soil retention system shall be removed and disposed of by the Contractor when directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the temporary soil retention system leaving the remainder in place. The remaining temporary soil retention system shall be removed to a depth which will not interfere with the new construction, and as a minimum, to a depth of 12 in. (300 mm) below the finished grade, or as directed by the Engineer. Removed system components shall become the property of the Contractor.

When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to, boulders, logs, old foundations etc.) where its presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven or installed through or around, with normal driving or installation procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

Method of Measurement. The temporary soil retention system furnished and installed according to the Contractor's approved design or as directed by the Engineer will be measured for payment in place, in square feet (square meters). The area measured shall be the vertical exposed surface area envelope of the excavation supported by temporary soil retention system. Portions of the temporary soil retention system left in place for reuse in later stages of construction shall only be measured for payment once.

Any temporary soil retention system installed beyond those dimensions shown on the contract plans or the approved contractor's design without the written permission of the Engineer, shall not be measured for payment but shall be done at the contractor's own expense.

Basis of Payment. This work will be paid for at the contract unit price per square foot (square meter) for TEMPORARY SOIL RETENTION SYSTEM.

Payment for any excavation, related solely to the installation and removal of the temporary soil retention system and/or its components, shall not be paid for separately but shall be included in the unit bid price for TEMPORARY SOIL RETENTION SYSTEM. Other excavation, performed in conjunction with this work, will not be included in this item but shall be paid for as specified elsewhere in this contract.

Obstruction mitigation shall be paid for according to Article 109.04 of the Standard Specifications.