STRUCTURE GEOTECHNICAL REPORT

IL 161 over Crooked Creek Overflow Culvert Replacement

Proposed Structure No. 014-2025

Existing Structure No. 014-2001

Route: FAP 805

Section: 7BR, 7BR-1

County: Clinton

Contract No. 76887

Project Number: P-98-001-16

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Foundations and Geotechnical Unit
Bureau of Bridges and Structures
Illinois Department of Transportation

Prepared for:

Bridge Planning Unit and Bridge Design Section
Illinois Department of Transportation

December 28, 2017

Illinois Department of Transportation

Bureau of Bridges and Structures • 2300 South Dirksen Parkway • Springfield, IL 62764

Table of Contents

1 Project Description and Scope of Work

In this report are included the results and recommendations of the geotechnical investigation performed by the Illinois Department of Transportation (IDOT) for the proposed Project. The Project consists of the replacement of a double barrel box culvert, Structure Number (SN) 014-2001, with a triple barrel box culvert, SN 014-2025.

The existing structure, which was built on 1940, is to be replaced with no salvage. The Project is located in District 8, Clinton County, on IL 161 over Crooked Creek (FAP 805), ¼ NE of Section 15, Township 1N, and Range 1W of Principal Meridian 3. The site area is shown the location maps included in Appendix A.

The existing structure is a cast in place box culvert with a length of 47'-11", a width of 26'-10" and a height of 13'. It has a 30 degrees skew to the left and a 264 ft^2 opening area. The proposed structure, which also has a 30 degrees skew to the left, has a length of 83'-1 ⅝", a width of 33'4" and a height of 11'11", as well as a 300 square feet opening area. The proposed profile will be raised approximately 3 feet; however the streambed elevation will remain as is. A Type, Size and Location (TSL) preliminary plan is attached to this report, in Appendix B, as well as a Plan and Profile, in Appendix C.

2 Field Exploration

2.1 Subsurface Exploration and Testing

Two boring logs were provided by personnel of IDOT District 8. These borings were taken on September 5, 2012 for subsurface exploration of the existing structure, using an automatic hammer and a hollow stem auger. Standard Penetration Tests and Unconfined Compressive Strength Tests were conducted and moisture content was reported for the soil samples. Atterberg Limit Tests and Grain Size Analyses were performed on some samples.

The borings were denominated Boring 1 and Boring 2, located near the Southeast and Northeast wing walls, respectively, as shown on the TSL (Appendix B). The centerline of the proposed roadway is located at Station 748+35. Boring 1 was drilled in Station 748+50, 12.5 feet to the right, and Boring 2 was drilled in Station 748+20, 12.5 feet to the left. As shown in the boring logs, the borings were drilled at a depth of 38 feet, with a groundwater elevation of 433 feet. Both boring logs, as well as the laboratory tests results are attached in Appendix D.

2.2 Subsurface Conditions

The soil profile consists mainly of clay, silt and loam with a few layers of sand. Weathered shale and limestone were encountered at an approximate elevation of 415 feet.

The Unconfined Compressive Strength tests results show that most of the cohesive soils below the streambed elevation have Unconfined Compressive Strength (Q_u) values of 1.5 tsf or less, with some exceptions. Boring 2 reflects soils with the lowest values of Q_u near the streambed elevation, fluctuating

between 0.25 tsf and 0.08 tsf. For detailed information, refer to the attached boring logs and laboratory tests results in Appendix D.

3 Geotechnical Evaluations and Recommendations

3.1 Settlement

The proposed culvert is longer and wider than the existing culvert. Consequently, the area of soil that extends outside the footprint of the existing culvert has not been preloaded to the same extent. Additionally, the profile of the road will be raised by approximately 3 feet. Considering this, as well as the loads of both, the existing and the proposed structures, and the different soil properties in the two boring logs, the primary settlement analysis was conducted. As part of this analysis, Boring 1 and Boring 2 were used to represent the subsurface conditions in the southern and northern halves under the culvert, respectively.

An increase in pressure of 0.47 ksf is expected to occur in the area below the existing structure, while an increase of 0.98 ksf is expected in the area outside the footprint of the existing structure. To calculate settlement, the area under the structure was divided into four sections. The purpose of dividing the area was to address the difference in pressure increase, as well as the different soil properties from both boring logs. The settlement was calculated in the center of each section. After a thorough analysis, it was determined that a treatment of soil removal and replacement under the box is required. The settlement on the adjacent embankment was also calculated, using the data of both boring logs (refer to Table 1). This settlement was taken into account when computing the amount of removal required. The recommended treatment will be discussed in Section 4 – Foundation Recommendations.

Table 1: Embankment Expected Settlement

Location	Settlement (in)
Embankment (facing East side of culvert)	0.30
Embankment (facing West side of culvert)	0.52

3.2 Slope Stability

As mentioned in the previous section, the road profile will be raised by approximately 3 feet, and the proposed embankment will have a 2H: 1V slope, as the existing. Since this is not a significant increase in the roadway, no stability problems are expected to occur.

For slope stability during construction, refer to Section 5.1 – Temporary Soil Retention Systems.

3.3 Scour

Design scour elevations for box culverts are not required.

3.4 Seismic Considerations

As per Bridge Manual 2012, Section 2.3.10-*Seismic Issues* as well as page 3-2 of Culvert Manual 2017, culverts and wing walls are considered buried structures; therefore they are not designed for seismic effects.

4 Foundation Recommendations

4.1 Culvert Barrel

As previously mentioned in Section 3.1, the settlement analysis resulted in a recommended treatment of removal and replacement which will be discussed in this section. After careful consideration of the change in loading, below and adjacent to the proposed location of the culvert, as well as the moisture content of the soil, it is concluded that differential settlement is expected to occur; hence, a precast concrete culvert is not recommended.

As mentioned in the previous section, the area below the culvert was divided into four sections (refer to Figure 1). These four sections consist of preloaded and non-preloaded soil. Also, the South half of the soil below the culvert is assumed to have the characteristics of Boring 1 and the North half, those of Boring 2. Considering these differences in the soil, a constant loading throughout the culvert footprint was assumed. In reality, the load carried by the soil under the culvert depends on the stiffness of that soil. The stiffer soil, which has been preloaded by the existing structure, will carry more load; therefore it will settle more and will simultaneously prevent the adjacent soil, with less stiffness, from settling. Refer to Appendix E for settlement computations.

Considering the mentioned characteristics and properties of this particular case, it was determined that removal of the weak soil and replacement with a more suitable material is required. Different combinations of soil removal and replacement were studied. Ultimately, the combination which provided less differential settlement with the minimum required amount of removal was selected. Using this combination of removal, the settlement in each of the four sections below the structure was recalculated. The calculated data points were plotted in a graph to show the settlement along the structure length, from North to South. To address the assumption of constant applied loading, a linear regression was used to estimate the settlement under the box. In conclusion, the expected differential settlement between the shoulders and the embankment ranges between 0.2 in and 0.36 in. Meanwhile, the differential settlement within adjacent sections below the box is up to 0.49 in.

The Foundations and Geotechnical Unit (FGU) recommends the removal combination shown in Table 2, and replacement with coarse aggregate (CA 6) under the box. This removal includes the footprint of the structure plus 3 additional feet to each side of the box. The purpose of this additional removal is to ensure that the applied pressure from the bottom of the culvert is distributed down to the bottom of removal. Consequently, the granular material below the box, which is critical to reduce the settlement, has enough support so it does not bulge out to the weak material that remains around the footprint of the structure. Refer to Figure 1 for an illustration of the sections under the box in which the removal is recommended.

Table 2: Removal Combination

Section	Description	Removal (ft)
1	North (using Boring 2)	6
2	Central (using Boring 2)	3
3	Central (using Boring 1)	3
4	South (using Boring 1)	5

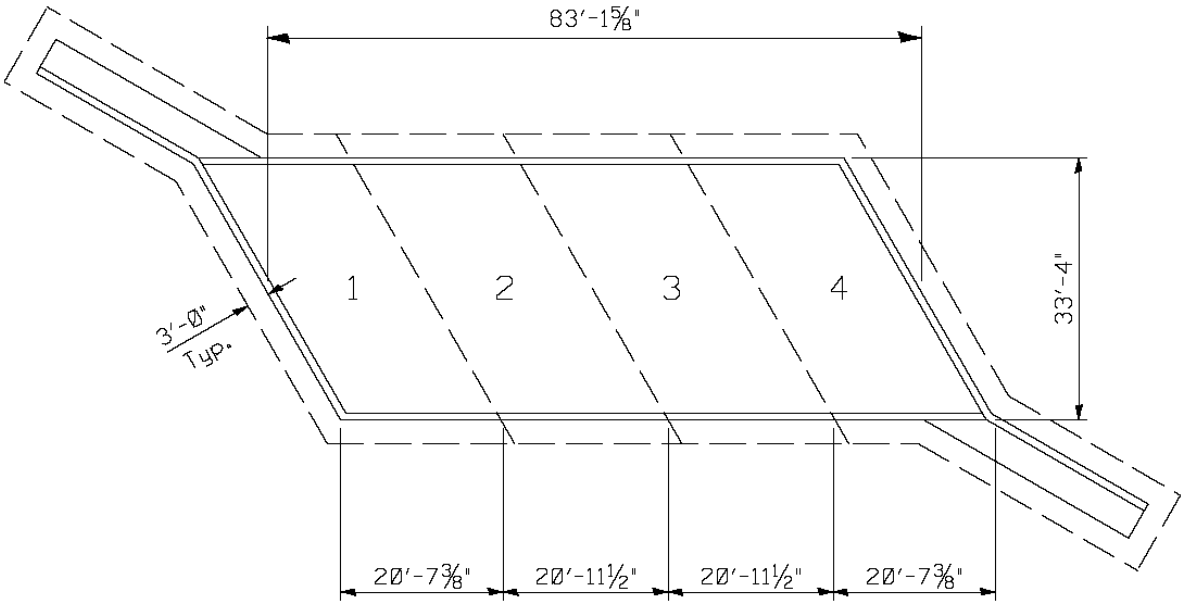


Figure 1: Sections under Proposed Culvert

4.2 Wing Walls

As per 2017 IDOT Culvert Manual, Figure 4.1.3.1-2, considering a design height (H_L) of 11.67 feet and a 30^o skew, the required wing wall lengths for the proposed culvert are 13.5 feet for the Northwest (NW) and Southwest (SW) wings, and 22.5 feet for Northeast (NE) and Southwest (SW) wings. Feasibility analyses of different types of wing walls were conducted and the conclusions are presented below.

- NW and SE Wing Walls:

  The 2017 IDOT Culvert Manual establishes that the preferred wing wall is the horizontal cantilever wing wall. This wing wall type has a maximum allowable length of 16 feet; therefore, it is feasible for the NW and SE wings, since 13.54 feet < 16 feet.

- NE and SW Wing Walls:

  The Two-way cantilevered L-Type is a feasible alternative, as long as the same removal and replacement treatment of the box is implemented. FGU recommends removing 5 and 6 feet below the SW and NE wing wall foundations respectively, to reduce differential settlement, which is expected to occur.

  Since the NE and SW wings have a proposed length that exceeds the limit for horizontal cantilever, the feasibility of the following wing walls options has been evaluated:

  1. Two-way Cantilevered L-type. The Two-way Cantilevered L-type wing is a feasible alternate, as long as the same removal and replacement treatment used for the box is implemented for these wings. The FGU recommends removing 6 feet and 5 feet under the NE and SW wings, respectively.
  2. Horizontal Cantilever Wing (16 ft) with Cantilever Sheet Pile Wall Extension. This option was initially investigated, but as a result of poor soil conditions and lack of attainable embedment due to the close proximity to bedrock, it was considered to be unfeasible.
  3. Horizontal Cantilever Wing (16 ft) with Anchored Sheet Pile Wall Extension. This option is feasible, provided sheets with a minimum published section modulus of 30 in^3/ft are driven to "refusal".
  4. Horizontal Cantilever Wing (16 ft) with Driven Anchored Soldier Pile Wall Extension. This option is also feasible. Note that for this option, along with the previously mentioned anchored sheet pile extension, the wing design will involve a Geotechnical Design Memorandum be issued by the FGU.

5 Construction Considerations

5.1 Temporary Soil Retention Systems

As per the Structure Report, District 8 recommends road closure and a detour route for maintenance of traffic; therefore, no temporary soil retention will be required for traffic maintenance. However, should stage construction be implemented, a Temporary Soil Retention System (TSRS) will be required. To construct the proposed structure, excavation of approximately 13 feet, from the existing roadway to the streambed, is required. All excavations must be performed in accordance with local and federal regulations.

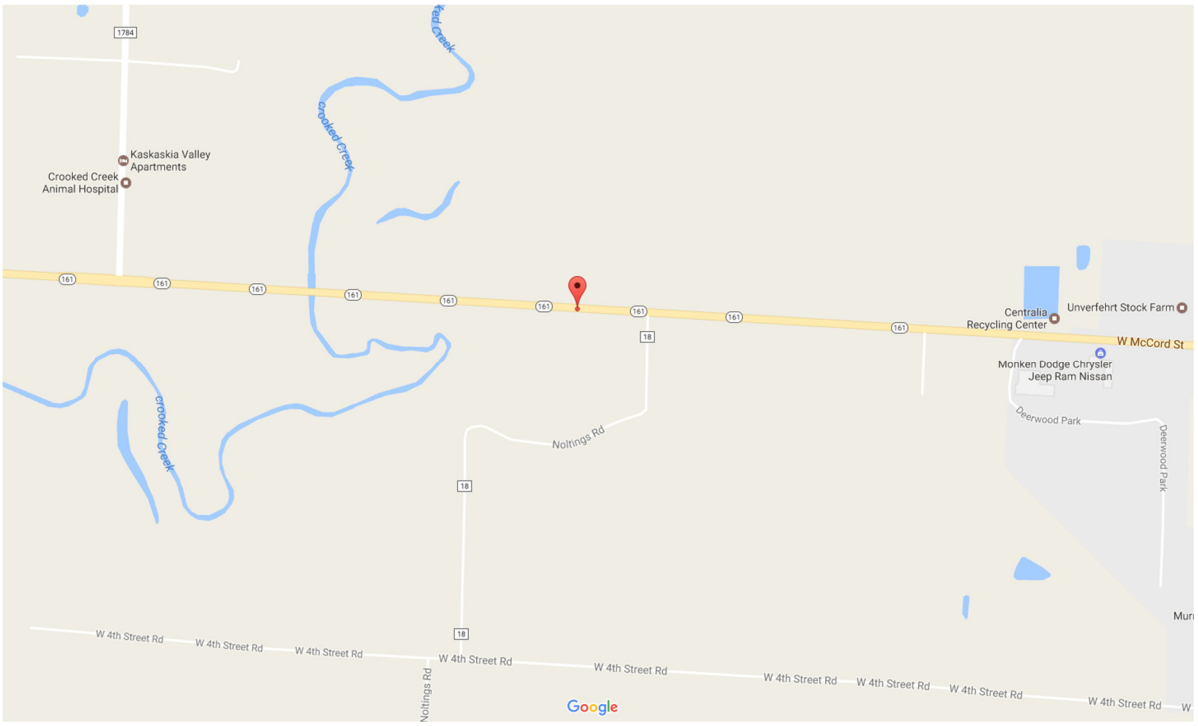
5.2 Stream Diversion

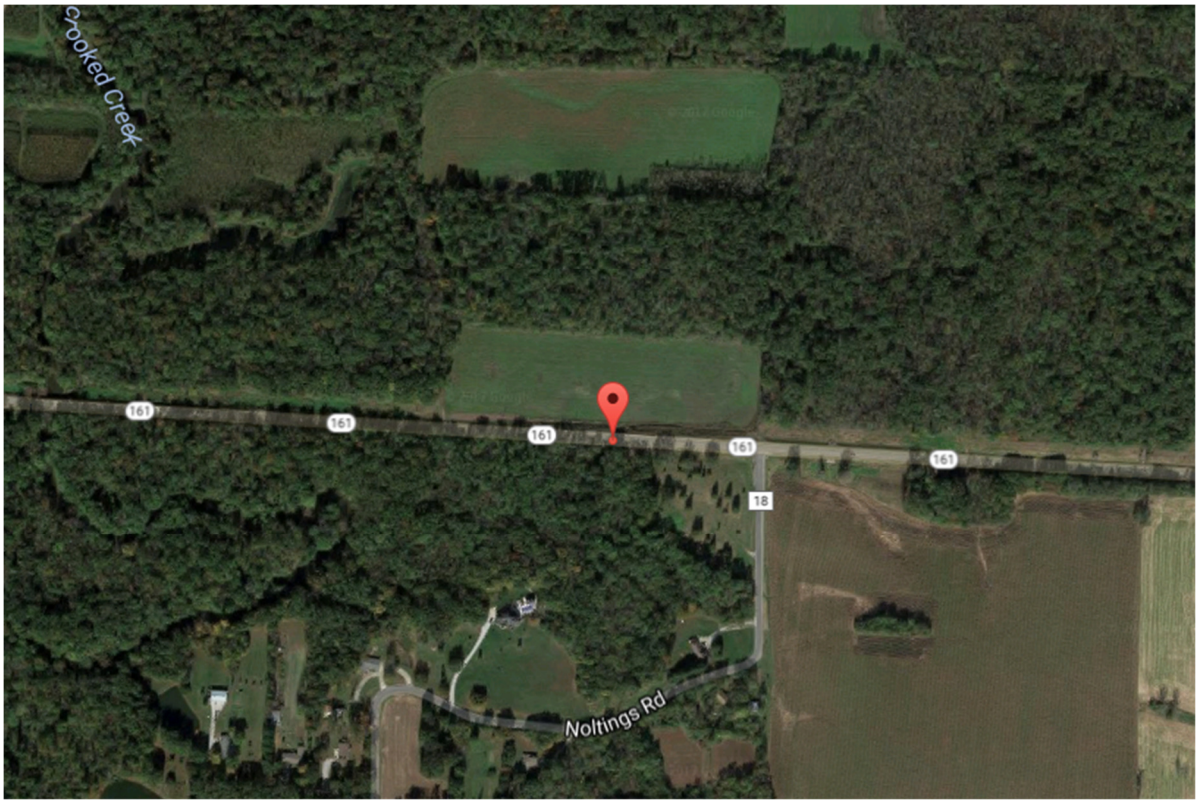
An Estimated Water Surface Elevation (EWSE) of 440.40 feet was provided by the IDOT Planning Unit. Even though the boring logs show some granular soil layers below the water table, most of the soils under the proposed foundation are composed of clay. Considering that the EWSE is less than 4 feet above the streambed elevation, as well as soils composition, maintenance of existing flow will require temporary water diversion and control by the contractor.

Appendices

Appendix A: Site Location Maps

Site Location[1]





[1] Images retrieved from Google Maps 2017.

Appendix B: Type, Size & Location (TSL)

Benchmark: Chiseled box set in the center of the headwall on the south side of IL 161 S.N. 014-2001.

Existing Structure: S.N. 014-2001 was built in 1940 as F.A. Route 150 - Section 7A at Station 748+35 as a cast-in-place 26'-10" W x 13'-0" H x 47'-11" L box culvert with a 30° skew. Existing structure is to be removed and replaced. Traffic maintained utilizing a marked detour route.

No Salvage

No Precast

WATERWAY INFORMATION

Drainage Area = 178.247 sq. mi.

Existing Low Grade Elev. (014-0025) 451.04 @ Sta. 741+32.84

Proposed Low Grade Elev. (014-0080) 454.32 @ Sta. 695+20.48 to 721+22.20 & 738+85.37 to 764+03.26

Flood	Freq. Yr.	Q C.F.S.	Opening Ft² Exist.	Opening Ft² Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	938	264	300	450.8	1.52	1.24	452.32	452.04
Design	50	1161	264	300	451.82	1.84	1.70	453.66	453.52
Base	100	1243	264	300	452.2	2.24	1.88	454.44	454.08
Existing O.T.	2	873	264	--	450.51	0.35	--	450.86	--
Proposed O.T.	100	1243	--	300	452.2	--	1.88	--	454.08
Max. Calc.	500	894	264	300	456.47	0.23	0.15	456.7	456.62

10-Year Outlet Velocity From Existing Structure = 3.97 fps

10-Year Outlet Velocity From Proposed Structure = 3.13 fps

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition with 2015 & 2016 Interims

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi

fy = 60,000 psi (Reinforcement)

HIGHWAY CLASSIFICATION

F.A.P. Rte. 805 - IL Rte. 161

Functional Class: Minor Arterial

ADT: 4900 (2015); 6100 (2038)

ADTT: 665 (2015)

DHV: 490

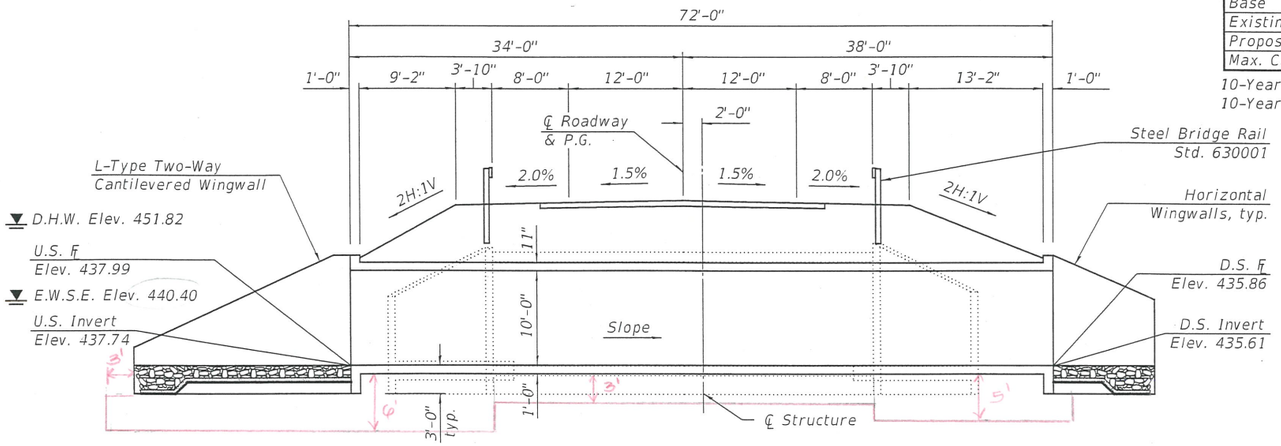
Design Speed: 55 m.p.h.

Posted Speed: 55 m.p.h.

Two-Way Traffic

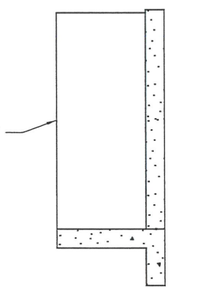
LOADING HL-93

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



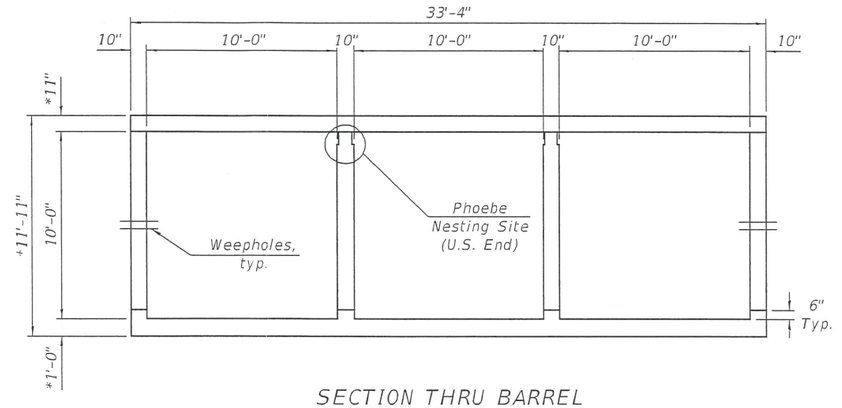
LONGITUDINAL SECTION

(Looking North)



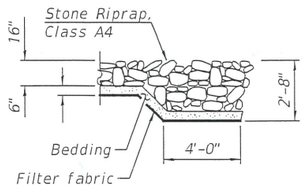
SECTION B-B

L-Type Two-Way Cantilevered Wingwall

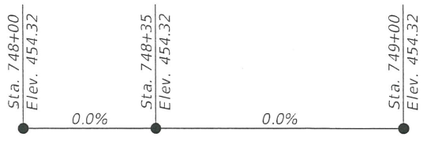


SECTION THRU BARREL

* Slab Thickness may be refined in final design

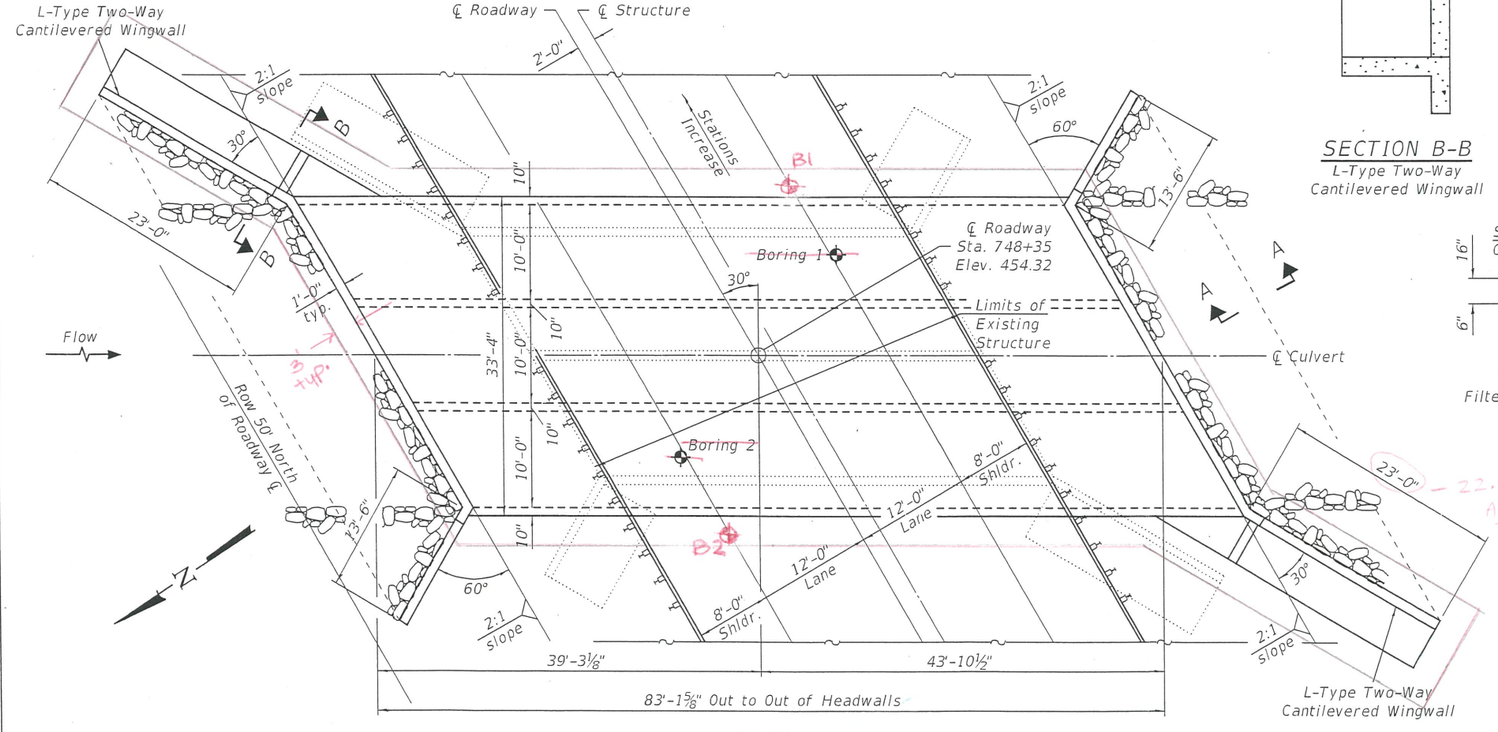


SECTION A-A

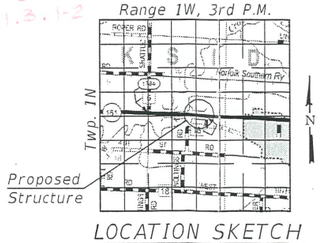


PROFILE GRADE

(along ℄ F.A.P. Rte. 805)



PLAN



LOCATION SKETCH

GENERAL PLAN & ELEVATION
ILLINOIS ROUTE 161 OVER
CROOKED CREEK OVERFLOW
F.A.P. RTE. 805 - SEC. 7BR, 7BR-1
CLINTON COUNTY
STATION 748+35
STRUCTURE NO. 014-2025

DESIGNED -	CRYSTAL D. STONE
CHECKED -	AL-BARRAE R. SHEBIB
DRAWN -	IAN J. ANDREWS
CHECKED -	RICHARD J. CHAPUT

DATE - JUNE 12, 2017

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 1 SHEETS

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
805	7BR, 7BR-1	CLINTON	--	--
		CONTRACT NO. 76887		
	ILLINOIS FED. AID PROJECT			

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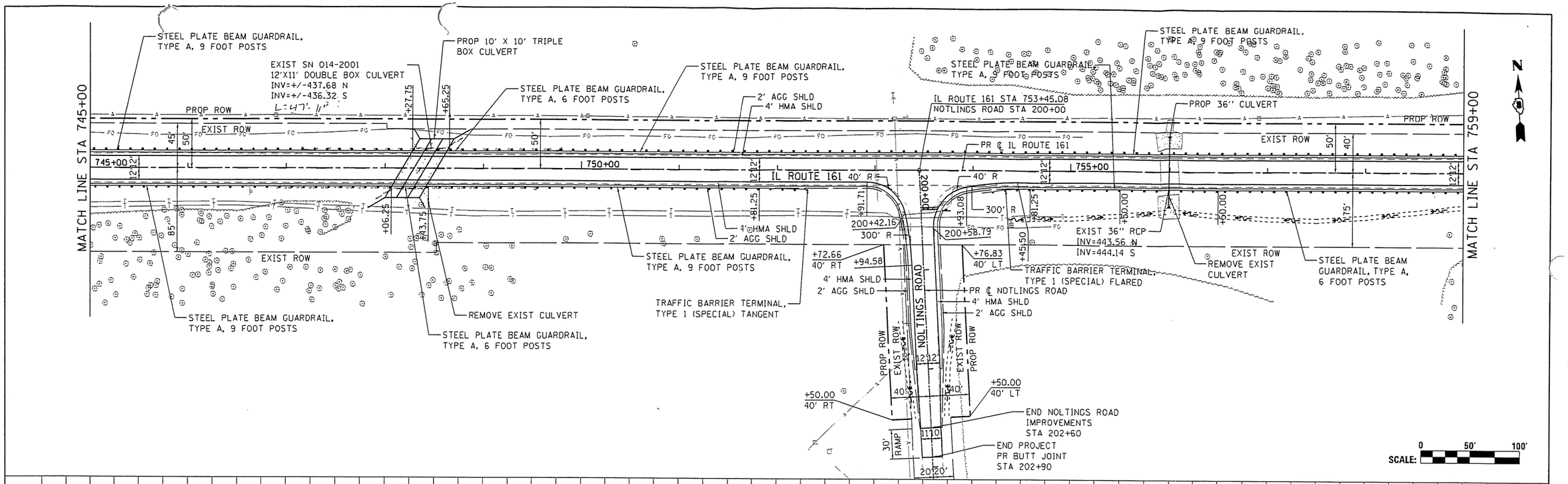
Appendix C: Plan and Profile



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	PLOT DATE = 2/10/2017	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

ILLINOIS ROUTE 161
PLAN AND PROFILE

SCALE: 1" = 50' | SHEET 5 OF 8 SHEETS | STA. 745+00 | TO STA. 759+00

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
805	7BR, 7BR-1	CLINTON	8	5
		CONTRACT NO.		
	ILLINOIS FED. AID PROJECT			

Appendix D: Boring Logs

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 9/4/12

ROUTE FAP 805 **DESCRIPTION** IL 161 over Crooked Creek Overflow **LOGGED BY** JAS (TSi)

SECTION 7BR, 7BR-1 **LOCATION** NE 1/4, **SEC.** 15, **TWP.** 1N, **RNG.** 1W, 3 **PM**

COUNTY Clinton **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. 014-2001 (E) / 014-2025 (P)
Station 748+35

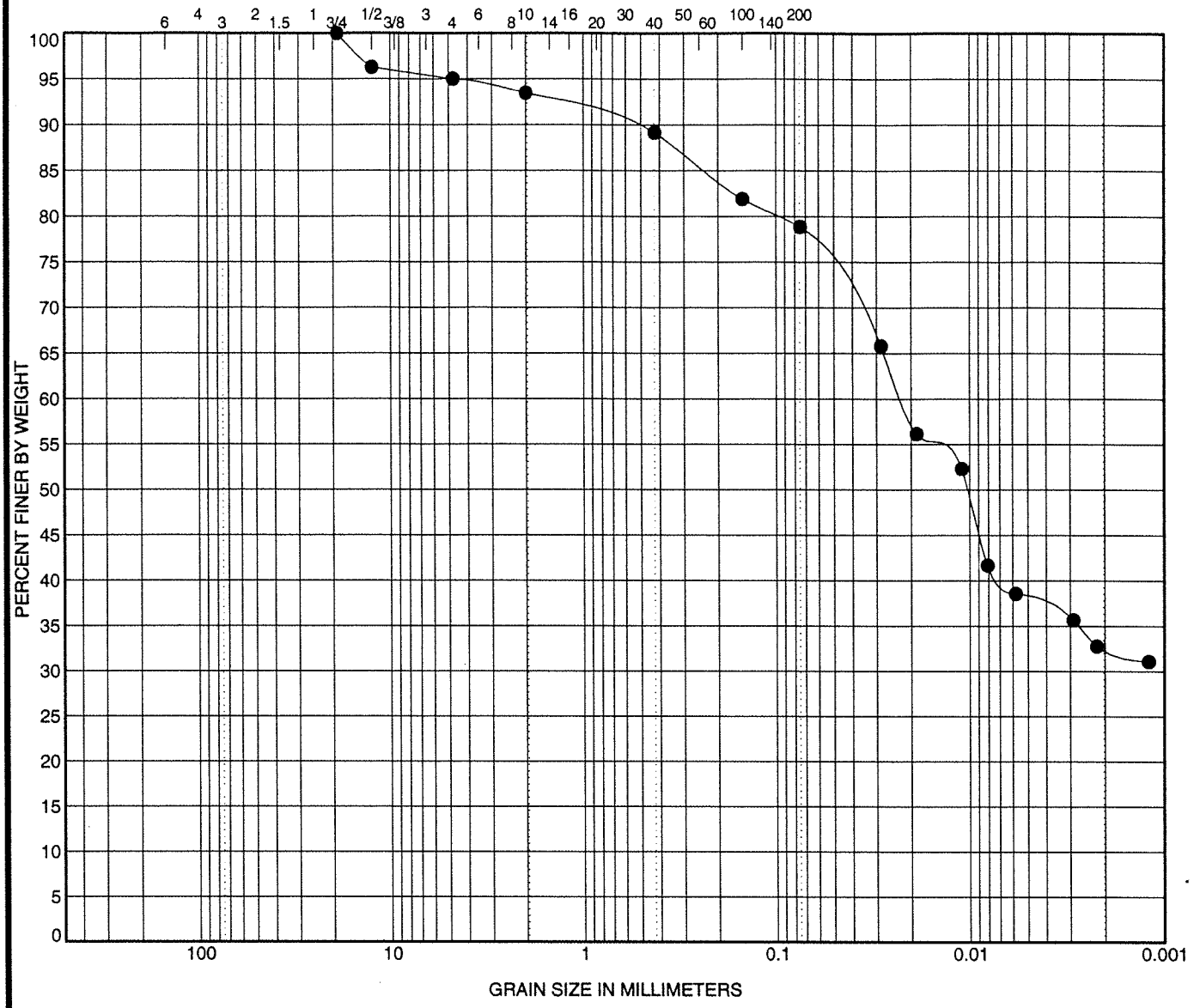
BORING NO. 1 SE Wingwall
Station 748+50
Offset 12.50ft Right
Ground Surface Elev. 451.2 ft

Surface Water Elev. ____ ft
Stream Bed Elev. ____ ft

Groundwater Elev.:
First Encounter 433.2 ft ▼
Upon Completion ____ ft
After ____ **Hrs.** ____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Asphalt & Base Course
				450.5
	3			Brown and Gray (Soft, Moist) CLAY (Fill) A-7-6(19) See Class @ 5 ft
	2	1.26	20	
	2	S		
	1			
	2		--	
-5	1	NS		
	1			
	2	1.68	26	
	2	S		
	-			
	2	0.20	27	Gray
-10	2	B		
				440.7
	1			Gray (Medium Stiff, Moist) CLAY (Alluvial)
	2	1.14	28	
	3	S		
				438.2
	WH			Gray (Soft, Moist) Silty CLAY (Alluvial)
	1	2.04	26	
-15	3	S		
	1			Brown and Gray
	2	0.20	23	
	2	S		
▼				Wet
	WH			
	1	0.25	26	
-20	1	P		
				Gray (Soft, Moist) Silty CLAY (Alluvial) *(continued)*
	WH			
	2	0.50	25	
	3	P		Trace Fine Sand
				428.2
	2			Brown and Gray (Dense, Wet) Sandy Clay LOAM (Alluvial) See Gradation @ 25 ft
	3		22	
-25	3	NC		
				425.7
	7			Brown (Stiff, Wet) SILT (Alluvial)
	11		23	424.2
	14	NC		
				Brown (Dense, Wet) Silty LOAM with Trace Limeston Gravel (Till)
	5			422.2
	13	2.00	17	
-30	16	P		Brown (Very Stiff) Silty Clay LOAM with Trace Gravel and Shale Pieces (Till)
				419.7
	10			
	19		--	Gray Weathered SHALE
	8	NR		
	3			
	10	4.00	20	
-35	13	P		
	26			Limestone Layers
	15	--	12	
	50/3"			413.5
				Auger Refusal - END OF BORING
-40				

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



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 1	5.00	**A-7-6 (19) CLAY**	**42.5**	**15.9**	**26.6**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 1	5.00	**19**	**0.022**			**6.5**	**14.6**	**46.4**	**32.5**

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

IDH GRAIN SIZE DISTRIBUTION

Route: FAP 805
Section: 7BR, 7BR-1
County: Clinton

GRAIN_SIZE_IDH_3-18-11 014-2001.GPJ IL_DOT.GDT 9/18/12

9/18/2012 3:16:25 PM
EV0000
Illinois Department of Transportation
Version 8.30.003

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PointID,Depth, 1, 5

Reading	Soil Tare	Percent Finer
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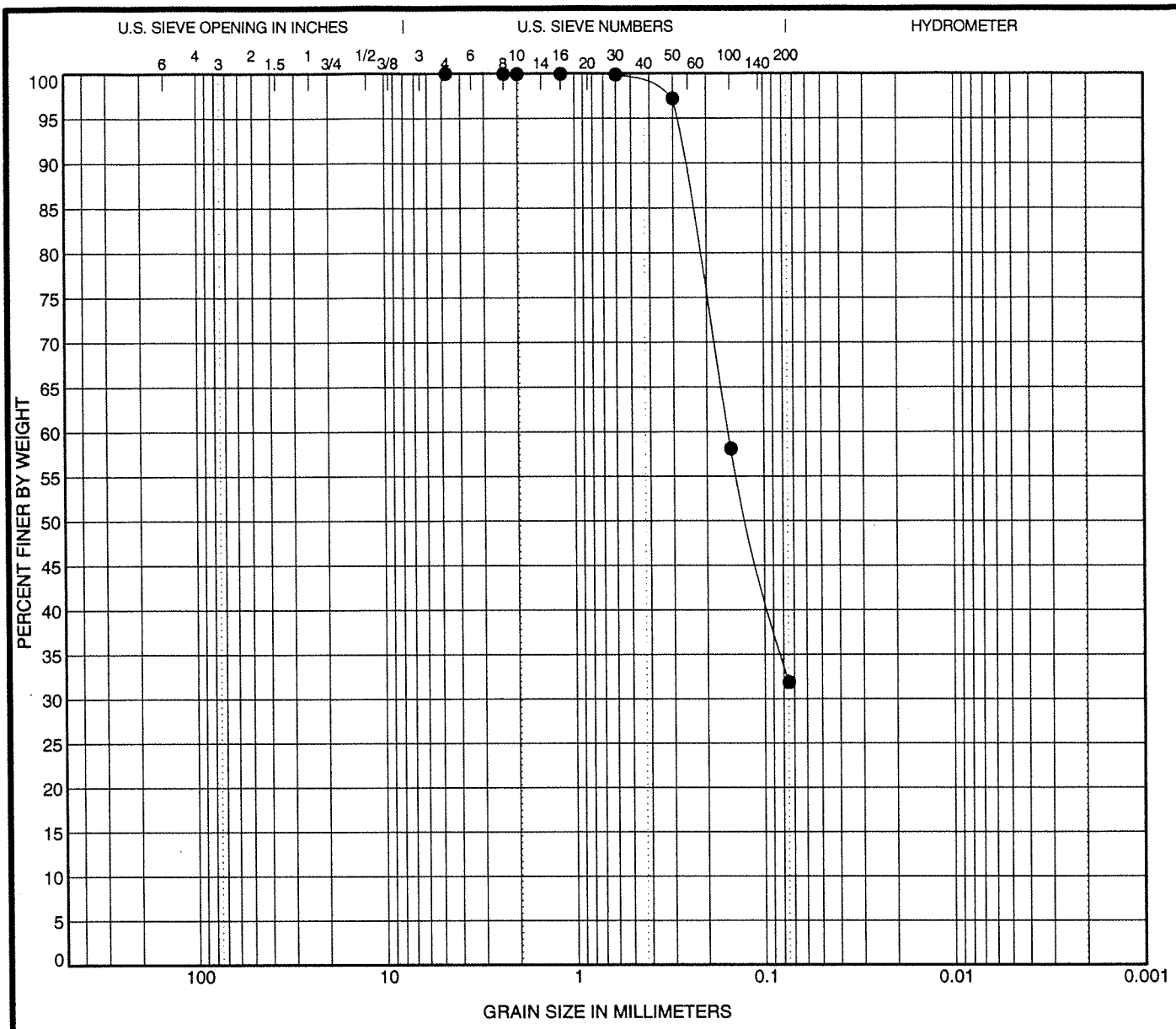
12.5	21.5	96.27576
4.75	7.2	95.02858
2	8.9	93.48692
0.425	2.336	89.17101
0.15	3.926	81.91745
0.075	1.642	78.88375



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 1	25.00						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 1	25.00	4.75	0.155			0.0	68.1	31.9	

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

IDH GRAIN SIZE DISTRIBUTION

Route: FAP 805
Section: 7BR, 7BR-1
County: Clinton

GRAIN_SIZE_IDH_3-18-11 014-2001.GPJ IL_DOT.GDT 9/18/12

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EV0000
Illinois Department of Transportation
Version 8.30.003

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PointID,Depth, 1, 25

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4.75	0	100
2.36	0.1	99.95812
2	0	99.95812
1.18	0	99.95812
0.6	0.2	99.87437
0.3	6.4	97.19431
0.15	93.3	58.12395
0.075	62.7	31.86767

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Date 9/5/12

ROUTE FAP 805 **DESCRIPTION** IL 161 over Crooked Creek Overflow **LOGGED BY** JAS (TSi)

SECTION 7BR, 7BR-1 **LOCATION** SE 1/4, **SEC.** 10, **TWP.** 1N, **RNG.** 1W, 3 **PM**

COUNTY Clinton **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. 014-2001 (E) / 014-2025 (P)
Station 748+35

BORING NO. 2 NW Wingwall
Station 748+20
Offset 12.50ft Left
Ground Surface Elev. 451.2 ft

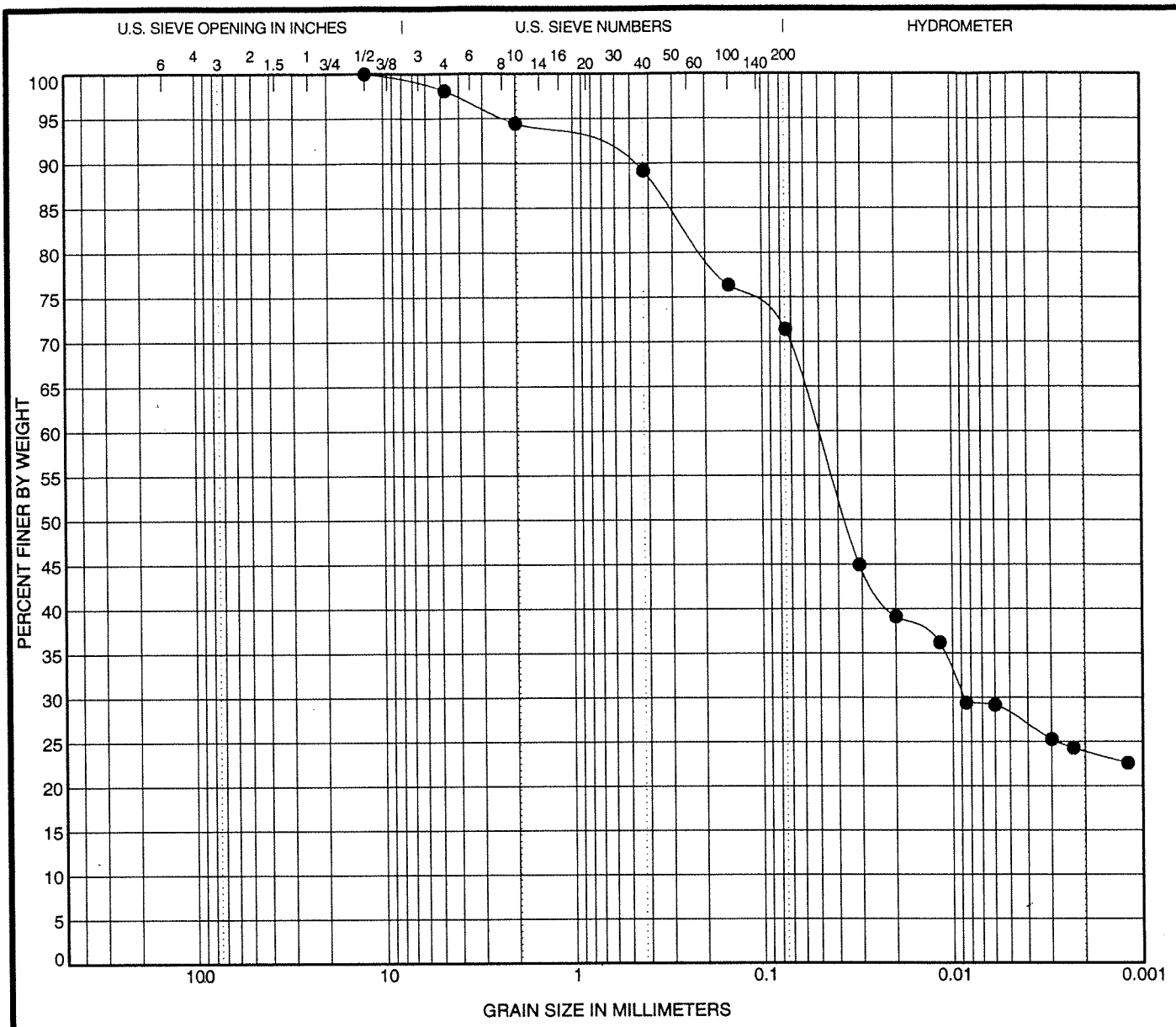
Surface Water Elev. ____ ft
Stream Bed Elev. ____ ft

Groundwater Elev.:
First Encounter 433.7 ft ▼
Upon Completion ____ ft
After ____ **Hrs.** ____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Asphalt 450.7
	1			Brown (Medium Stiff, Moist) Clay LOAM with Trace Limestone Gravel (Fill) A-6(9) See Class @ 3 ft
	3 5	2.58 S	16	
	1			Brown and Gray
-5	2 3	1.23 S	18	
				445.7
	1			Gray (Medium Stiff, Moist) Silty CLAY (Fill)
	2 3	1.43 S	27	
				443.2
	1			Brown and Gray (Soft, Moist) CLAY with Trace Limestone Pieces (Fill)
-10	1 3	0.16 S	26	
				440.7
	1			Gray (Soft, Moist) Silty CLAY with Trace Roots (Alluvial)
	1 2	0.16 S	35	
	WH			
-15	1 1	0.08 S	29	
	1			Brown and Gray Trace Sand
▼	1 1	0.12 S	25	
				433.2
	1			Gray (Soft, Wet) LOAM (Alluvial) A-4(1) See Class @ 20 ft
-20	1 3	NC	25	

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Gray (Soft, Wet) LOAM (Alluvial) *(continued)*
	1			Brown and Gray
	1 2	0.25 P	24	
				428.2
	WH			Brown and Gray (Soft, Wet) Silty CLAY (Alluvial)
	1			426.7
-25	3	0.25 P	26	Brown (Soft, Wet) Sandy CLAY (Alluvial)
				425.7
	1			Brown (Loose, Wet) SAND (Alluvial) See Gradation @ 26.5 ft
	2 2	NC	22	
				423.7
	2			Gray (Soft, Wet) CLAY (Alluvial) Brown and Gray Sand Seams
-30	2 2	1.23 S	23	
				419.2
	3			Brown and Gray (Dense, Wet) SILT (Alluvial)
	2			416.7
-35	4	NC	23	Gray Weathered SHALE
				414.2
	50/3"	--	11	Gray Weathered LIMESTONE with Trace Shale
				413.0
-40				END OF BORING

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)



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 2	3.00	**A-6 (9) CLAY LOAM**	**33.6**	**18.5**	**15.1**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 2	3.00	**12.5**	**0.051**	**0.009**		**5.5**	**23.0**	**47.5**	**23.9**

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

IDH GRAIN SIZE DISTRIBUTION

Route: FAP 805
Section: 7BR, 7BR-1
County: Clinton

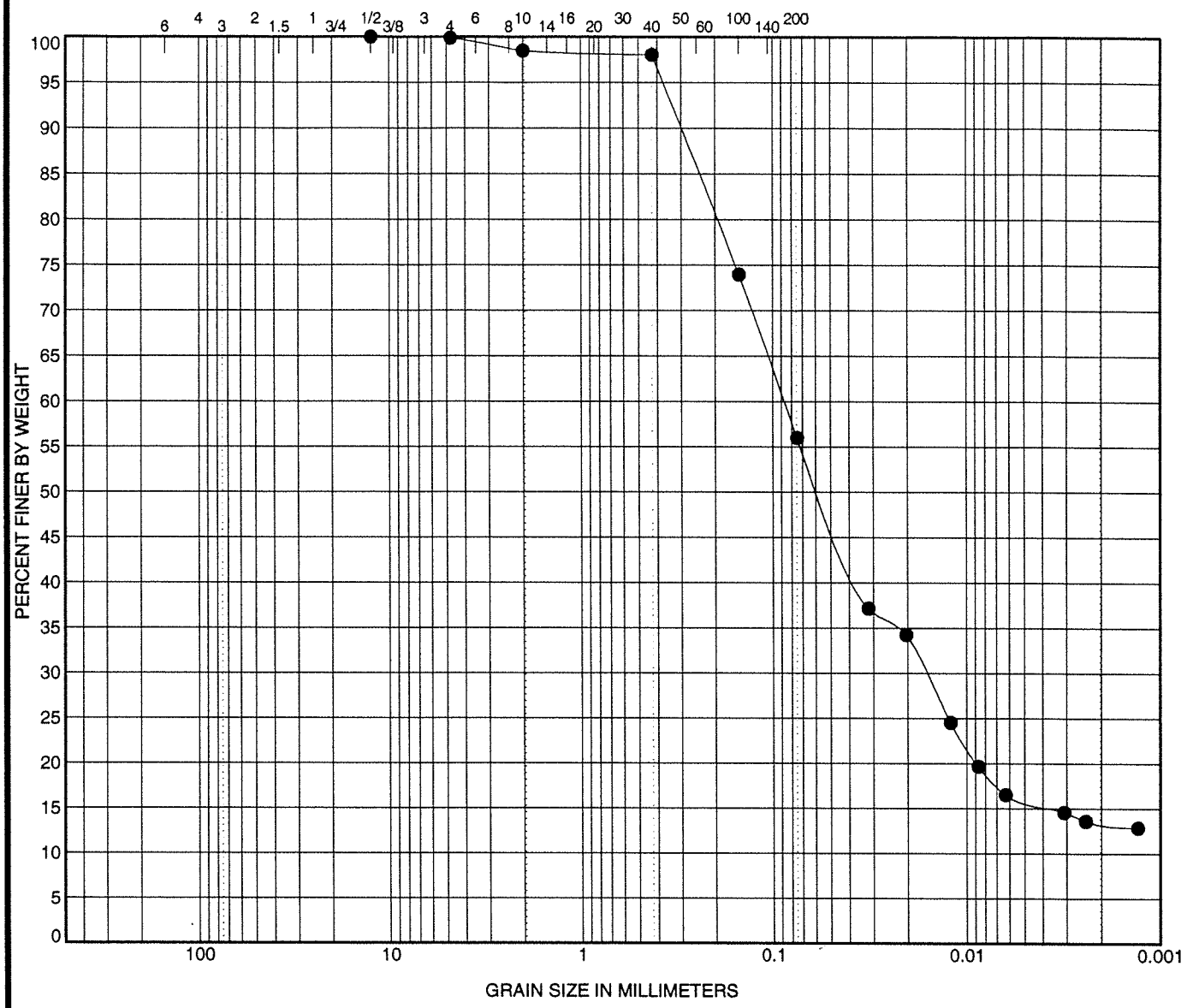
GRAIN_SIZE_IDH_3-18-11 014-2001.GPJ IL_DOT.GDT 9/18/12

9/18/2012 3:15:58 PM
EV0000
Illinois Department of Transportation
Version 8.30.003

INPUT - s:\materials geotechnical unit\gint\projects\clinton\structures\014-2001.gpj Sv Readings table Library: s:\materials geotechnical unit\gint\library.glb

PointID,Depth, 2, 3

Reading	Soil Tare	Percent Finer
12.5	0	100
4.75	12.9	98.09256
2	24.6	94.45512
0.425	2.814	89.16037
0.15	6.797	76.37129
0.075	2.631	71.42087



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● 2	20.00	**A-4 (1) LOAM**	**22.2**	**16.1**	**6.1**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● 2	20.00	**12.5**	**0.087**	**0.016**		**1.5**	**42.5**	**42.6**	**13.4**

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

IDH GRAIN SIZE DISTRIBUTION

Route: FAP 805
Section: 7BR, 7BR-1
County: Clinton

GRAIN_SIZE_IDH_3-18-11 014-2001.GPJ IL_DOT.GDT 9/18/12

9/18/2012 3:16:06 PM
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Illinois Department of Transportation
Version 8.30.003

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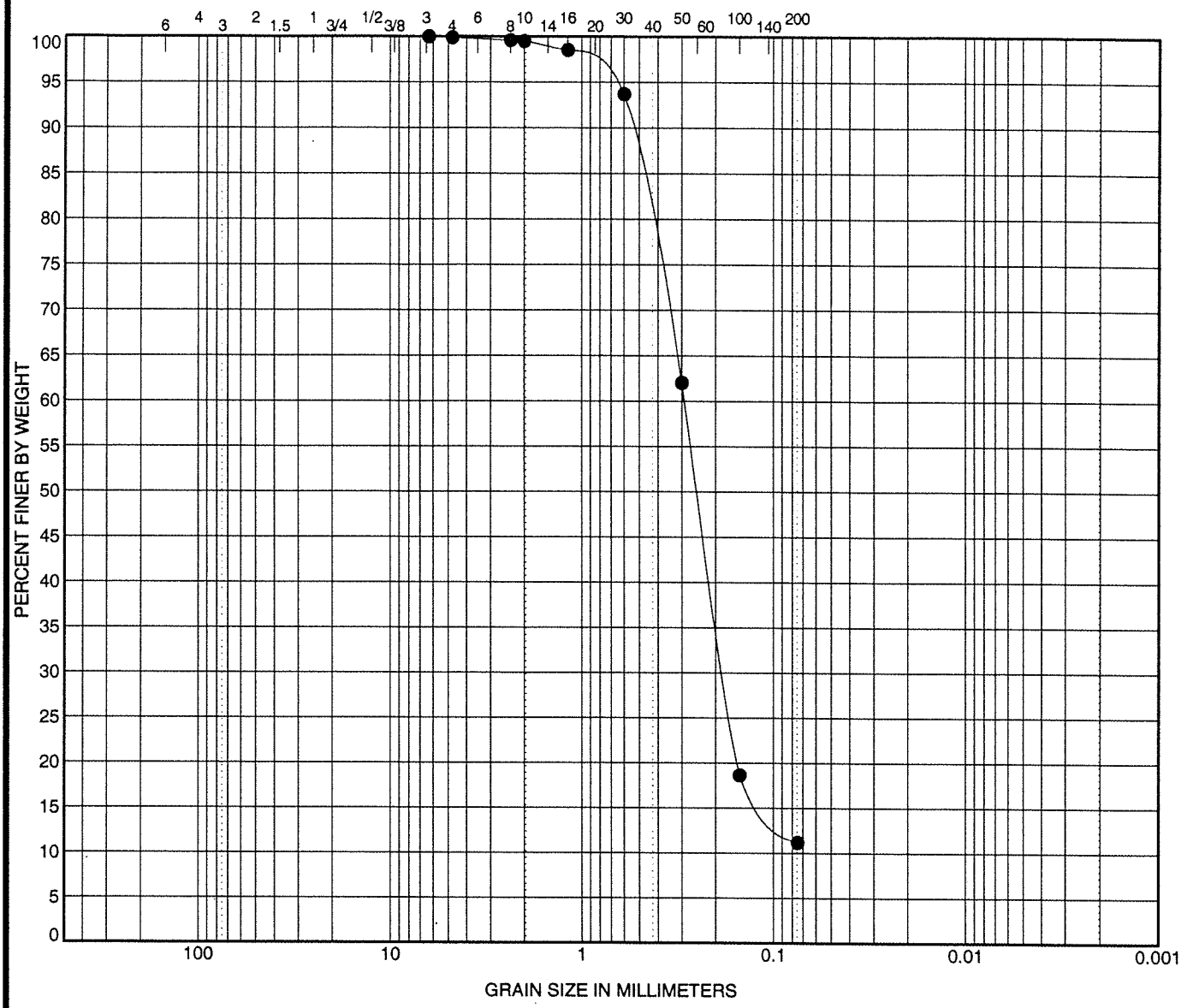
PointID,Depth, 2, 20

Reading	Soil Tare	Percent Finer
12.5	0	100
4.75	0.7	99.89159
2	9	98.49776
0.425	0.228	98.05039
0.15	12.269	73.97731
0.075	9.156	56.01226



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	2	26.50	**SAND**				**1.66**	**4.32**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	2	26.50	**6.3**	**0.29**	**0.18**		**0.5**	**88.3**	**11.2**	

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation

IDH GRAIN SIZE DISTRIBUTION

Route: FAP 805
Section: 7BR, 7BR-1
County: Clinton

GRAIN_SIZE_IDH_3-18-11 014-2001.GPJ IL_DOT.GDT 9/18/12

9/19/2012 11:18:29 AM
EV0000
Illinois Department of Transportation
Version 8.30.003

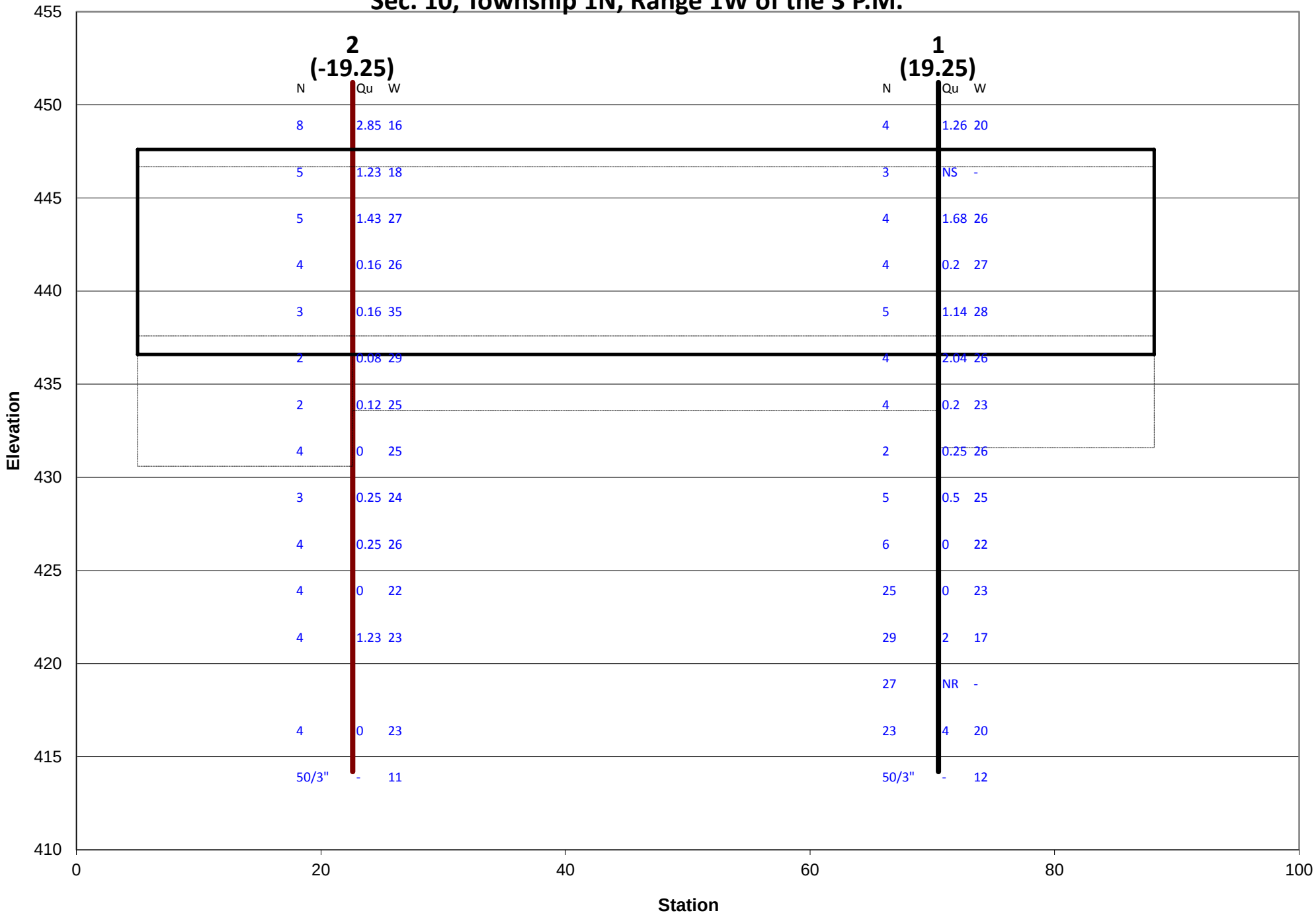
INPUT - s:\materials geotechnical unit\gint\projects\clinton\structures\014-2001.gpj Sv Readings table Library: s:\materials geotechnical unit\gint\library.glb

PointID,Depth, 2, 26.5

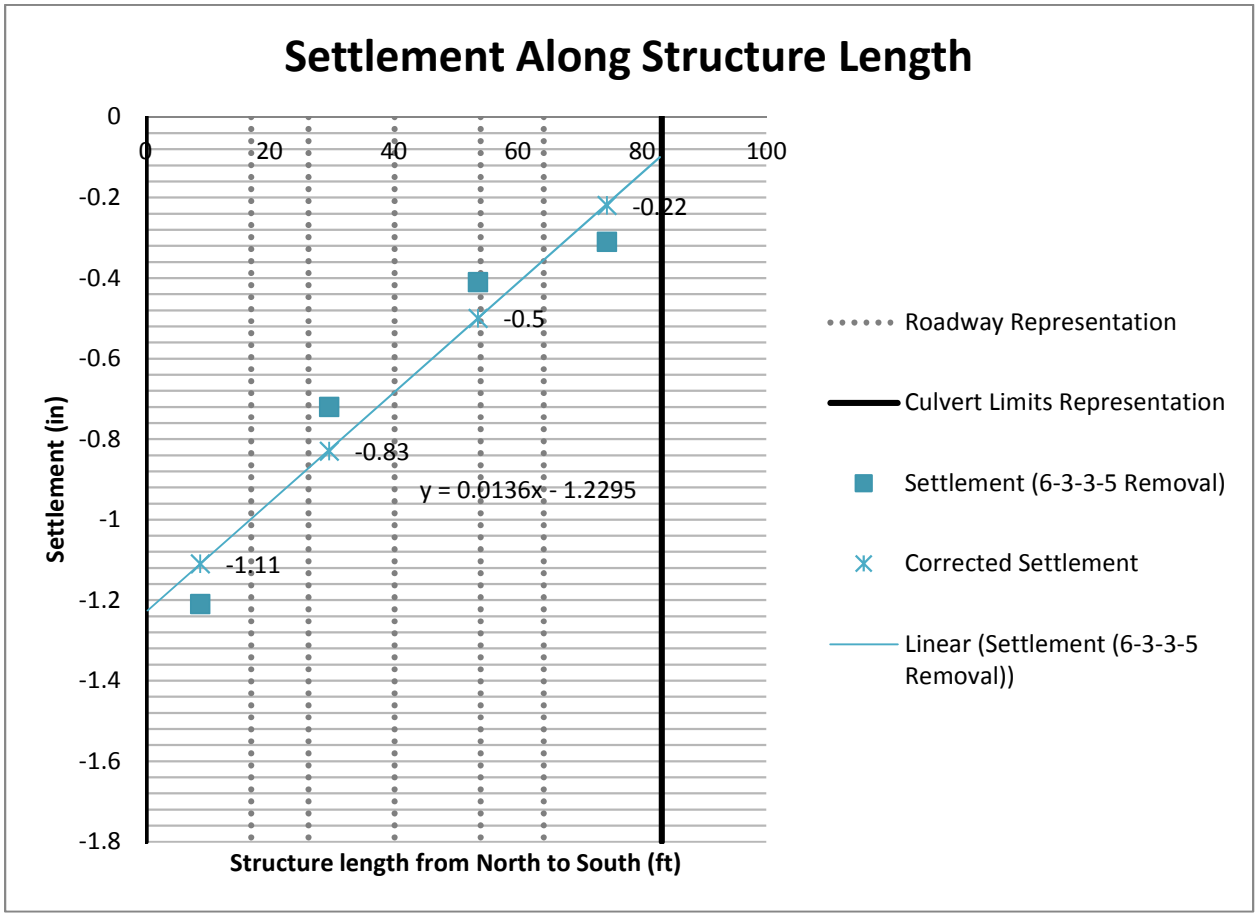
Reading	Soil Tare	Percent Finer
6.3	0	100
4.75	0.6	99.89207
2.36	1.7	99.58626
2	0.5	99.49632
1.18	5.4	98.52492
0.6	26.8	93.7039
0.3	176	62.04353
0.15	241.2	18.65443
0.075	41.5	11.18906

Appendix E: Subsurface Data Profile Plot

SN 014-2025 Box Culvert - IL 161 over Crooked Creek Overflow Located in the SE 1/4 of Sec. 10, Township 1N, Range 1W of the 3 P.M.



Appendix F: Settlement Computations


Settlement Along Structure Length
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
Settlement (in)
0
20
40
60
80
100
Structure length from North to South (ft)
-0.22
-0.5
-0.83
-1.11
y = 0.0136x - 1.2295
Roadway Representation
Culvert Limits Representation
Settlement (6-3-3-5 Removal)
Corrected Settlement
Linear (Settlement (6-3-3-5 Removal))

COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== Roadway / Boring B1
TYPE OF SURCHARGE ========== 2 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 15.16 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 18.32 FT
- PROPOSED WIDTH AT TOP ========== 47.67 FT
- PROPOSED WIDTH AT BOTTOM ========== 120.95 FT (which is a 2.0:1 slope)

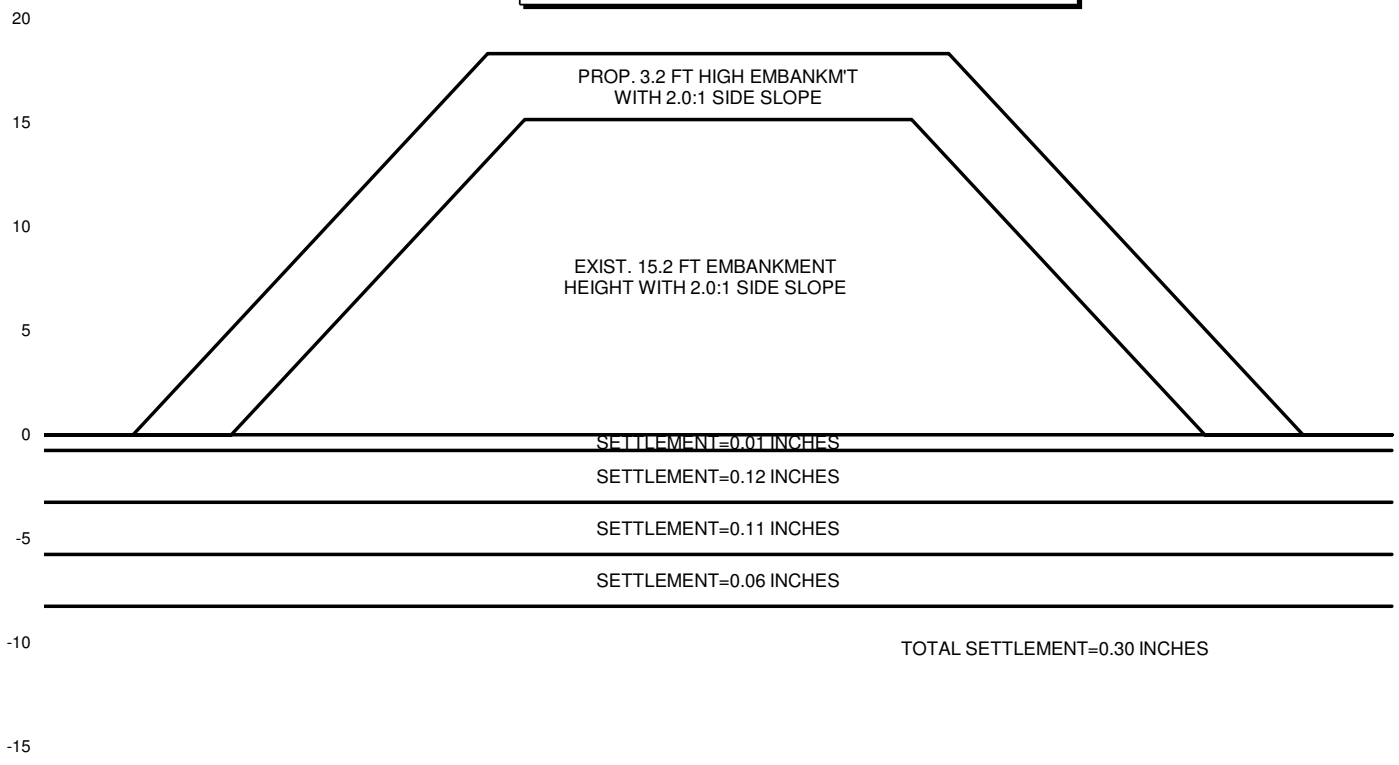
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 15.16 FT
- EXISTING WIDTH AT TOP ========== 40 FT
- EXISTING WIDTH AT BASE ========== 100.64 FT (which is a 2.0:1 slope)

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
0.8	128	2.04	26	1.844	0.379	0.702	0.144	0.109	**0.01**
2.5	128	0.20	23	1.950	0.379	0.621	0.117	0.700	**0.12**
2.5	128	0.25	26	2.112	0.380	0.702	0.144	0.625	**0.11**
2.5	128	0.50	25	2.270	0.382	0.675	0.135	0.361	**0.06**

TOTAL SETTLEMENT UNDER CENTER OF CONTINUOUS EMBANKMENT = 0.30 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== Roadway / Boring B2
TYPE OF SURCHARGE ========== 2 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 15.16 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 18.32 FT
- PROPOSED WIDTH AT TOP ========== 47.67 FT
- PROPOSED WIDTH AT BOTTOM ========== 120.95 FT (which is a 2.0:1 slope)

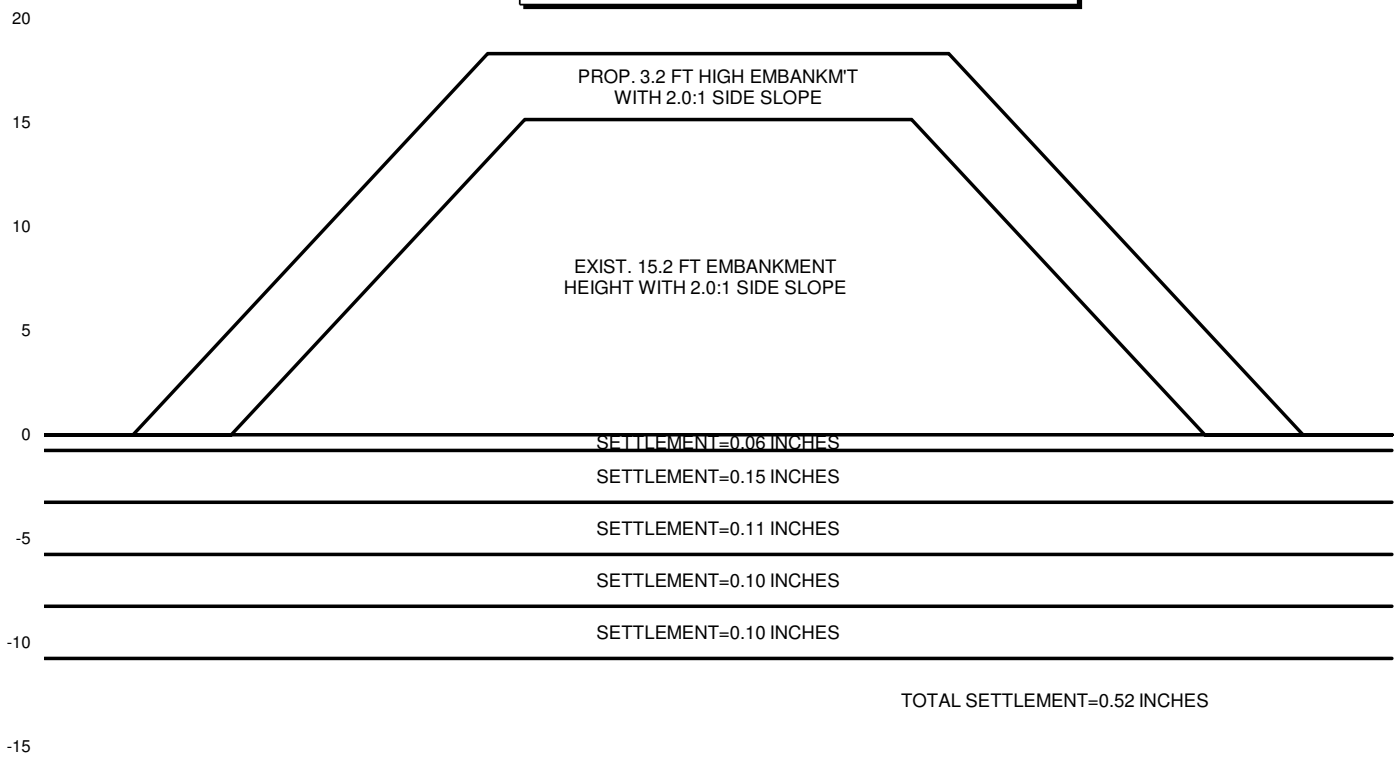
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 15.16 FT
- EXISTING WIDTH AT TOP ========== 40 FT
- EXISTING WIDTH AT BASE ========== 100.64 FT (which is a 2.0:1 slope)

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
0.8	128	0.08	29	1.844	0.379	0.783	0.171	0.880	**0.06**
2.5	128	0.12	25	1.950	0.379	0.675	0.135	0.820	**0.15**
2.5	128	0.25	25	2.112	0.380	0.675	0.135	0.625	**0.11**
2.5	128	0.25	24	2.270	0.382	0.648	0.126	0.625	**0.10**
2.5	128	0.25	26	2.423	0.384	0.702	0.144	0.625	**0.10**

TOTAL SETTLEMENT UNDER CENTER OF CONTINUOUS EMBANKMENT = 0.52 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== North Area w/o Preloading / Boring B2
TYPE OF SURCHARGE ========== 3 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 1 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 9.17 FT
- PROPOSED WIDTH AT TOP ========== 83.14 FT
- PROPOSED WIDTH AT BOTTOM ========== 83.14 FT (which is a MUST EQU
- PROPOSED LENGTH OF RECTANGULAR SURCHARGE=== 33.33 FT

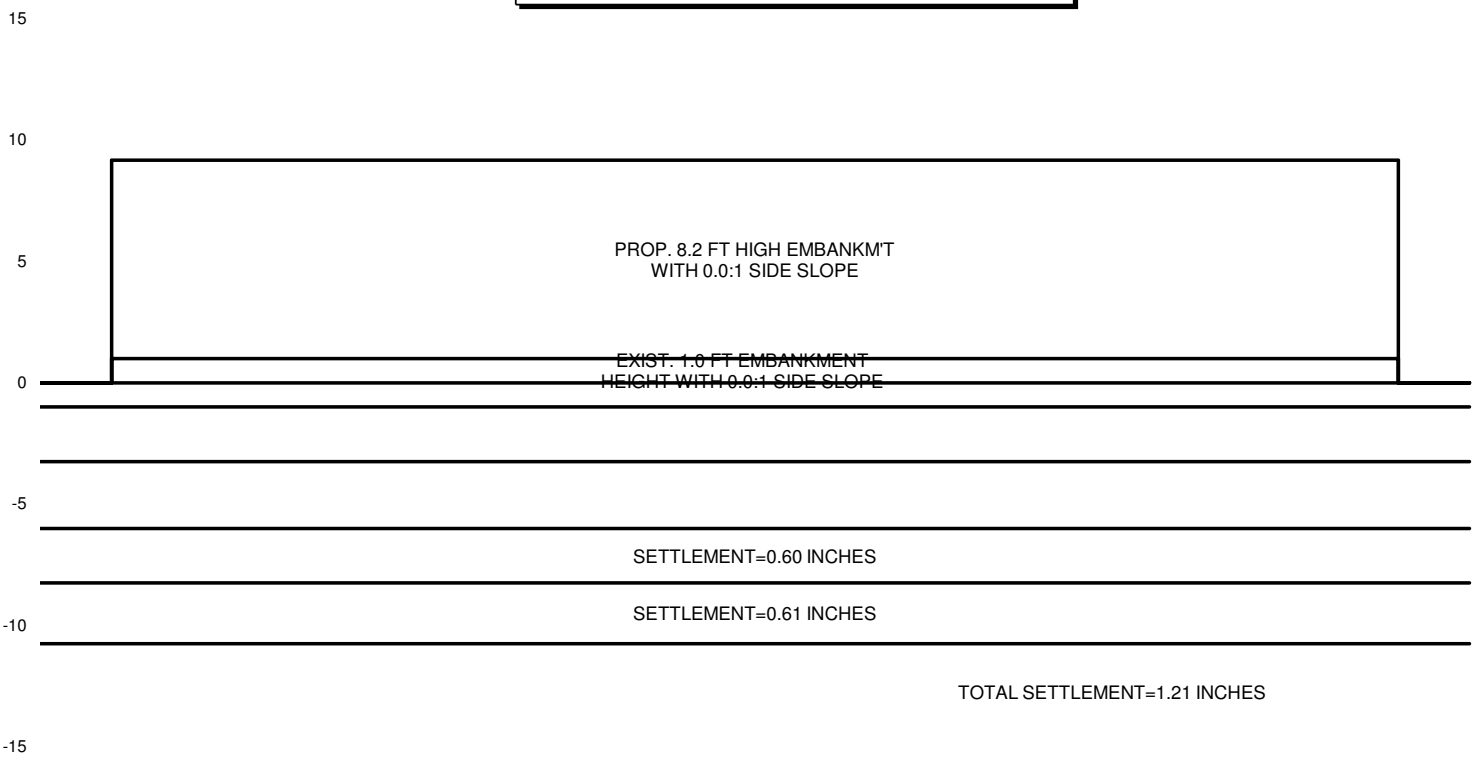
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 65.5 PCF
- EXISTING EMBANKMENT HEIGHT ========== 1 FT
- EXISTING WIDTH AT TOP ========== 83.14 FT
- EXISTING WIDTH AT BASE ========== 83.14 FT (which is a 0.0:1 slope)
- EXISTING LENGTH OF RECTANGULAR SURCHARGE===== 33.33 FT

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
1.0	128	0.00	29	0.098	1.035	0.783	0.171	1.000	**Granular**
2.3	128	0.00	25	0.205	1.034	0.675	0.135	1.000	**Granular**
2.8	128	0.00	25	0.368	1.026	0.675	0.135	1.000	**Granular**
2.3	128	0.25	24	0.531	1.006	0.648	0.126	0.625	**0.60**
2.5	128	0.25	26	0.685	0.975	0.702	0.144	0.625	**0.61**

TOTAL SETTLEMENT UNDER CENTER OF RECTANGULAR FOOTING = 1.21 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== Central Area w/ preloading / Boring B2
TYPE OF SURCHARGE ========== 3 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 5.23 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 9.17 FT
- PROPOSED WIDTH AT TOP ========== 83.14 FT
- PROPOSED WIDTH AT BOTTOM ========== 83.14 FT (which is a MUST EQUA
- PROPOSED LENGTH OF RECTANGULAR SURCHARGE=== 33.33 FT

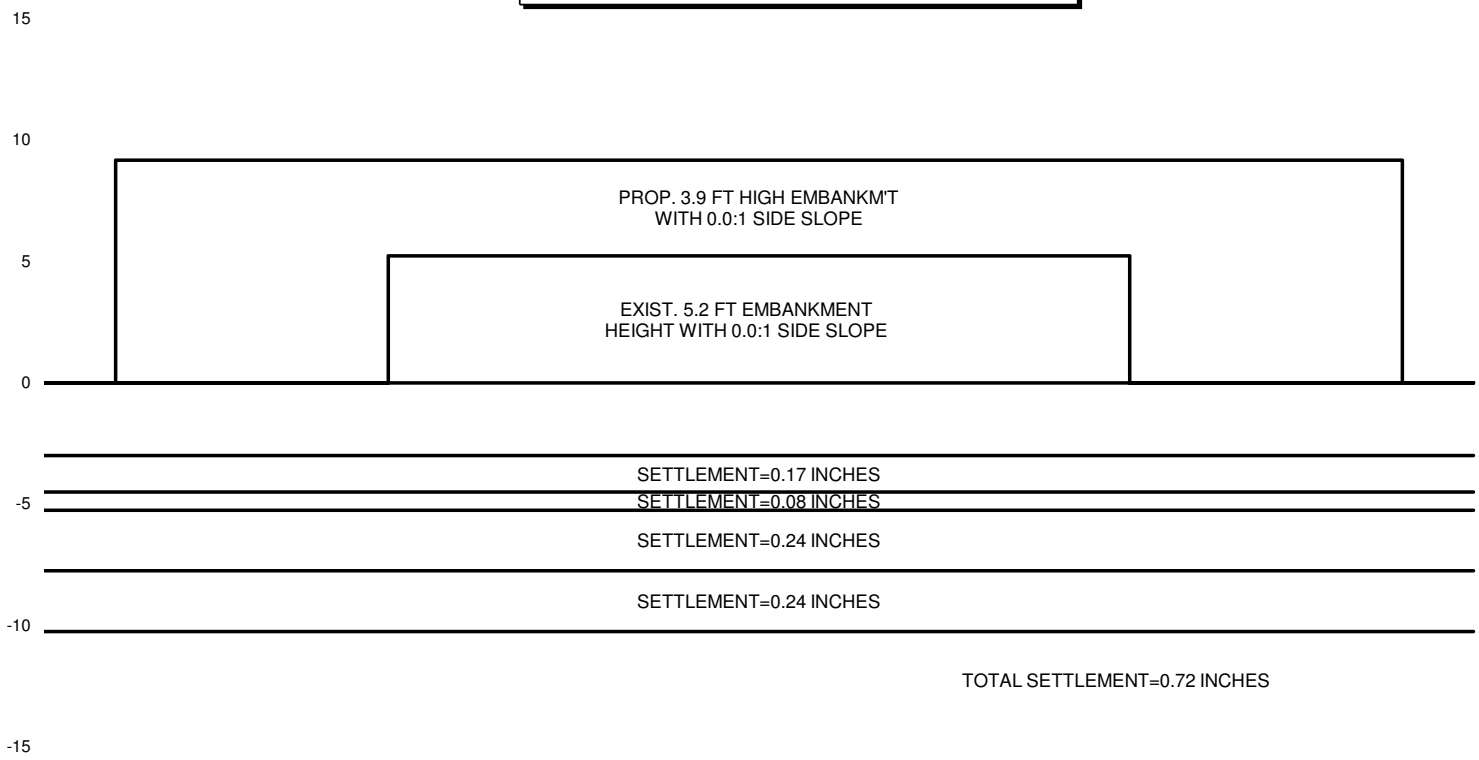
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 5.23 FT
- EXISTING WIDTH AT TOP ========== 47.92 FT
- EXISTING WIDTH AT BASE ========== 47.92 FT (which is a 0.0:1 slope)
- EXISTING LENGTH OF RECTANGULAR SURCHARGE===== 26.83 FT

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
3.0	128	0.00	25	0.726	0.473	0.675	0.135	1.000	**Granular**
1.5	128	0.25	25	0.868	0.473	0.675	0.135	0.625	**0.17**
0.8	128	0.25	25	0.935	0.474	0.675	0.135	0.625	**0.08**
2.5	128	0.25	24	1.028	0.475	0.648	0.126	0.625	**0.24**
2.5	128	0.25	26	1.161	0.474	0.702	0.144	0.625	**0.24**

TOTAL SETTLEMENT UNDER CENTER OF RECTANGULAR FOOTING = 0.72 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== Central Area w/ preloading / Boring B1
TYPE OF SURCHARGE ========== 3 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 5.23 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 9.17 FT
- PROPOSED WIDTH AT TOP ========== 83.14 FT
- PROPOSED WIDTH AT BOTTOM ========== 83.14 FT (which is a MUST EQUA
- PROPOSED LENGTH OF RECTANGULAR SURCHARGE=== 33.33 FT

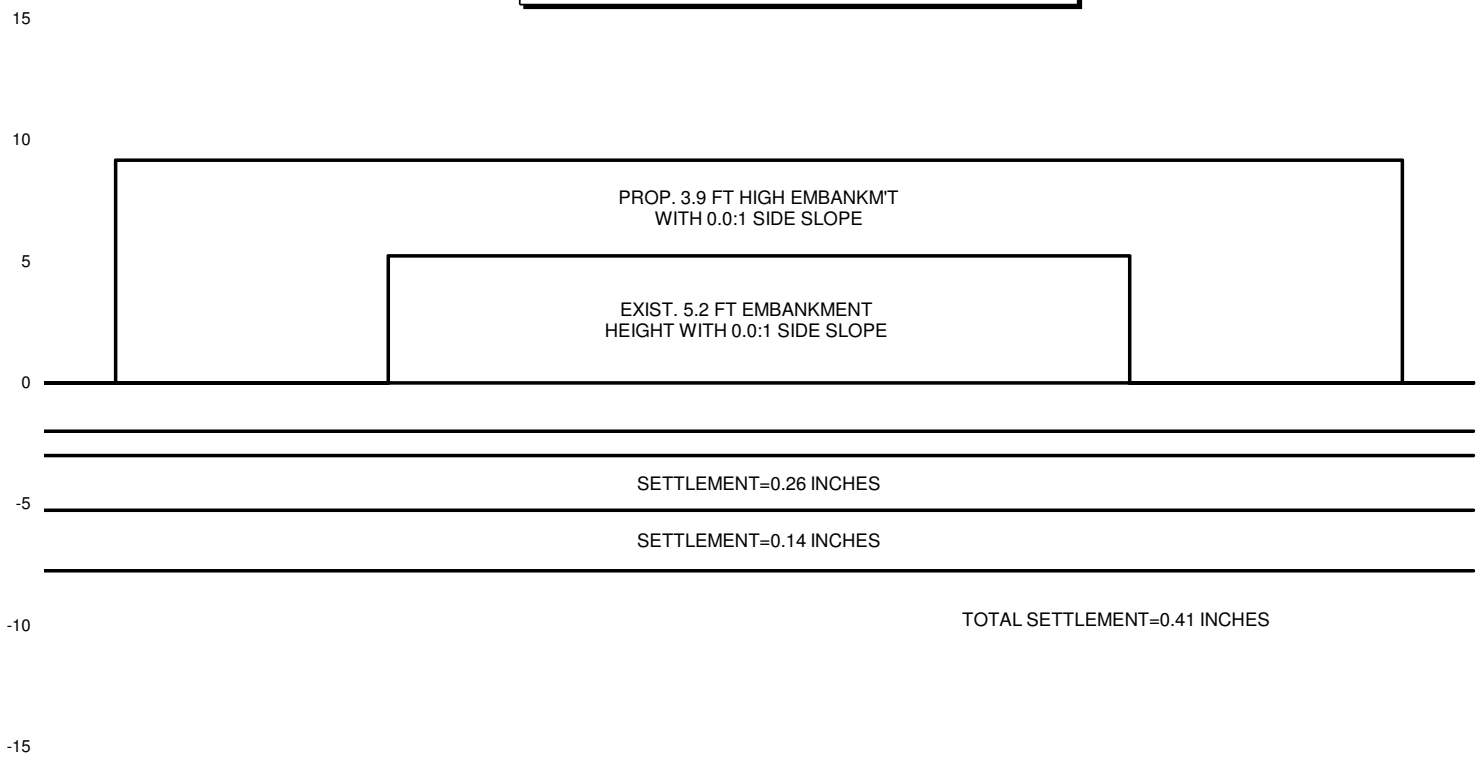
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 5.23 FT
- EXISTING WIDTH AT TOP ========== 47.92 FT
- EXISTING WIDTH AT BASE ========== 47.92 FT (which is a 0.0:1 slope)
- EXISTING LENGTH OF RECTANGULAR SURCHARGE===== 26.83 FT

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
2.0	128	0.00	23	0.693	0.473	0.621	0.117	1.000	**Granular**
1.0	128	0.00	23	0.790	0.473	0.621	0.117	1.000	**Granular**
2.3	128	0.25	26	0.891	0.474	0.702	0.144	0.625	**0.26**
2.5	128	0.50	25	1.028	0.475	0.675	0.135	0.361	**0.14**

TOTAL SETTLEMENT UNDER CENTER OF RECTANGULAR FOOTING = 0.41 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT — Modified on 12/9/14

LOCATION AND BORING USED ==== South Area w/o Preloading / Boring B1
TYPE OF SURCHARGE ========== 3 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 1 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 120 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 9.17 FT
- PROPOSED WIDTH AT TOP ========== 83.14 FT
- PROPOSED WIDTH AT BOTTOM ========== 83.14 FT (which is a MUST EQU
- PROPOSED LENGTH OF RECTANGULAR SURCHARGE=== 33.33 FT

EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 65.6 PCF
- EXISTING EMBANKMENT HEIGHT ========== 1 FT
- EXISTING WIDTH AT TOP ========== 83.14 FT
- EXISTING WIDTH AT BASE ========== 83.14 FT (which is a 0.0:1 slope)
- EXISTING LENGTH OF RECTANGULAR SURCHARGE==== 33.33 FT

Soil Deposit is Normally Consolidated
Cohesive Layers are Saturated
Soils have a Low Sensitivity
Liquid Limit (LL)=Moist. Content (MC%)
Initial Void Ratio (Eo)=2.7*(MC%)/100
Comp. Index (Cc)=0.009*(LL-10)
Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	TOTAL UNIT WT. (PCF)	UNCONF. COMP. STRENGTH (Qu) (TSF)	MOIST. CONTENT (%)	EXISTING PRESSURE (KSF)	PRESSURE INCREASE (KSF)	INITIAL VOID RATIO	COMPRESSION INDEX (Cc)	Qu CORRECTION FACTOR	LAYER SETTLEMENT (IN.)
1.7	128	0.00	23	0.123	1.035	0.621	0.117	1.000	**Granular**
2.5	128	0.00	26	0.262	1.032	0.702	0.144	1.000	**Granular**
0.8	128	0.00	25	0.368	1.026	0.675	0.135	1.000	**Granular**
1.8	128	0.50	25	0.449	1.018	0.675	0.135	0.361	**0.31**

TOTAL SETTLEMENT UNDER CENTER OF RECTANGULAR FOOTING = 0.31 IN.

EMBANKMENT AND SOIL PROFILE