

STRUCTURE GEOTECHNICAL REPORT

U.S. Route 150 over Tributary to Rock Creek

**Existing S.N. 102-1004
Proposed S.N. 102-2030**

**FAS ROUTE 2466
SECTION 11-CR
WOODFORD COUNTY, ILLINOIS
JOB NO. P-94-026-16
PTB 193/024 WO#1
CONTRACT NO. 68D17
KEG NO. 19-1139.01**

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Prepared For:
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**June 05, 2020
REVISED September 30, 2020**



09/30/2020
Exp 11/30/2021



EXECUTIVE SUMMARY

U.S. Route 150 over Tributary to Rock Creek
F.A.S. Route 2466
Section 11-CR
Woodford County, Illinois
Job No. P-94-026-16
PTB 193/024 WO #1
Contract No. 68D17
Existing Structure No. 102-1004
Proposed Structure No. 102-2030

This report summarizes the analysis of the replacement of a reinforced concrete box culvert for US Route 150 over Tributary to Rock Creek located in Woodford County, Illinois.

Slope stability was analyzed for the proposed wingwall side-slope geometry. The required Factor of Safety for the end-of-construction and long-term conditions were met for the proposed side-slopes.

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EXHIBITS

- Exhibit A - Location Map
- Exhibit B - Type, Size, and Location Plan (TS&L)
- Exhibit C - Boring Logs
- Exhibit D - Subsurface Profile
- Exhibit E - Slope/W Slope Stability Analysis
- Exhibit F - Temporary Shoring Spreadsheets

1.0 Project Description and Proposed Structure Information

1.1 Introduction

The geotechnical study summarized in this report was performed by Kaskaskia Engineering Group, LLC (KEG) for the replacement of a reinforced concrete box culvert for US Route 150 over Tributary to Rock Creek located in Woodford County, Illinois. The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project consists of the replacement of a R.C. box culvert (existing SN 102-1004) located at U.S. Route 150 over a Tributary to Rock Creek in Woodford County, Illinois.

The general location of the proposed structure (SN 102-2030) is shown on the Location Map, Exhibit A. The project is located east of Congerville, Illinois along US Route 150. The site lies within the limits of the Third Principal Meridian (T. 25N R. 1W Section 23) within the Bloomington Ridge Plain of the Till Plains Section of the Central Lowland Province.

1.3 Proposed Structure Information

The proposed structure will consist of a cast-in-place (CIP) double box culvert with horizontal cantilever wingwalls on the north and south ends of the structure. The proposed structure will be built on a 90-degree skew and will provide 12-foot wide driving lanes and 4-foot wide outside shoulders. The proposed culvert centerline station will be 845+00.00. The culvert will consist of two 12-foot by 6-foot barrels and will measure 48 feet 0-inches out-to-out of headwalls. A Type, Size, and Location Plan (TS&L) is included in Exhibit B. Class A5 Riprap will be used for channel protection at both the north and south ends of the proposed structure.

Further substructure details will be based on the findings of this Structure Geotechnical Report (SGR).

2.0 Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

2.1 Field Exploration

The site exploration plan was developed and completed by Illinois Department of Transportation (IDOT). Two standard penetration test (SPT) borings, designated B-1 and B-2, were drilled on March 21, 2018. The boring locations are labeled on the TS&L, included in Exhibit B. Detailed information regarding the nature and thickness of the soils encountered and the results of the field sampling and laboratory testing are shown on the Boring Logs attached in Exhibit C. The soil profile for the above mentioned borings can be found on the Subsurface Profile in Exhibit D.

Table 2.0.1 Boring Summary

Boring	Station	Offset (ft.)	Ground Surface Elevation
B-1	844+68	25.5 RT	729.19
B-2	844+89	38.5 LT	728.39

2.1 Subsurface Conditions

From the surface, approximate surface elevation El. 729.2; Boring B-1 encountered a silty clay loam to silty clay to a depth of 6-feet below ground surface (bgs). N-values in this upper soil ranged from 7 to 9 blows per foot (bpf) with field Rimac and penetrometer (Q_u) strength values ranging from 0.4 to 0.8 tons per square foot (tsf) and moisture contents of 29 to 37 percent. Below the silty clays, a layer of coarse sand and gravel continued to a depth approximately 11 feet bgs. The N-values for the sand and gravel layer ranged from 12 to 13 bpf, and moisture contents between 14 and 15 percent. Following the layer of sand and gravel, a clay till was encountered to a depth of 28.5 feet bgs. The N-values of the clay till ranged from 11 to 83 bpf, with Q_u values of 1.7 to 9.2 tsf, and moisture contents between 12 and 14 percent. Below the clay till, a clayey sand was encountered to a depth of 33.5 feet bgs, with an N-value of 50 blows per 4 inches, and a moisture content of 13 percent. Following the clayey sand, a clay till was encountered to the end of the boring at 40 feet bgs. The N-values of the clay till ranged from 36 to 45 bpf, with Q_u values of 3.7 to 10.4 tsf, and a moisture content of 12 percent.

Boring B-2, with an approximate surface elevation El. 728.4, encountered top soil to a depth of 3.5 feet bgs. The N-value in this upper soil was 6 bpf with a moisture content of 27 percent. Below the top soil, a layer of clay loam continued to a depth approximately 6 feet bgs. The N-value for the clay loam was 5 bpf, with a Q_u value of 1.1 tsf, and a moisture content of 30 percent. Following the layer of clay loam, a coarse sand and gravel was encountered to a depth 16 feet bgs. The N-values of the sand and gravel ranged from 11 to 14 bpf, and the moisture contents ranged between 5 and 13 percent. Below the coarse sand and gravel, a clay till was encountered to the end of the boring at a depth of 40 feet bgs, with N-values ranging between 11 and 63 bpf. The Q_u values of the clay till ranged from 1.0 to 10.5 tsf and moisture contents ranged between 11 and 14 percent.

The soil stratigraphy in the vicinity of the proposed culvert consists of medium-stiff clay loams with an underlying coarse sand and gravel. Based off of the TS&L provided, the bearing surface for the proposed culvert will be in these clay loams or the coarse sand and gravels. In KEG's opinion, either of these materials should provide sufficient support for the proposed culvert. The clay loams exhibit moderate strength characteristics with an average Q_u of 0.75 tsf and average moisture content around 30 percent. The coarse sands and gravels are medium-dense and at the time of the subsurface exploration appear to be holding groundwater. Below the coarse sands and gravels, the material transitions into a stiff to very stiff clay till. In general, the clay tills in the project area are stable and should have no impact on the construction of the proposed culvert.

2.2 Groundwater

Groundwater was encountered during drilling at elevations close to the proposed culvert invert elevations. The contractor should be prepared for the potential for groundwater to infiltrate the construction platform. With the coarse sand and gravel layer near the proposed bottom of culvert elevation, sump pumps may not be sufficient and other dewatering efforts may become necessary. The presence of the high groundwater table was taken into consideration for the geotechnical evaluations and recommendations that follow. It should be noted that the groundwater level is subject to seasonal and climatic variations. In addition, without extended periods of observation, measurement of true groundwater levels may not be possible.

Table 2.0.2 Groundwater Summary

Boring	Station	Groundwater Elevation (first encounter)	Groundwater Elevation (After 48 hrs)
B-1	844+68	723.2	724.2
B-2	844+89	722.4	724.4

3.0 Geotechnical Evaluations and Recommendations

3.1 Settlement

Due to the nature of the soils encountered in the borings, settlement calculations were not necessary. Since the bearing material for the proposed culvert is anticipated to consist of granular materials with a stiff to very stiff clay till underneath, any settlement should occur simultaneously with construction activities and with proper preparation and construction the structure should experience settlement of less than 0.5 inches. Therefore, no settlement calculations were performed for the proposed structure.

3.2 Slope Stability

A stability analysis using SLOPE/W was performed using the proposed roadway and culvert geometry on the TS&L and soil characteristics from Borings B-1 and B-2. Two conditions were modeled for each scenario, end-of-construction and long-term stability. A critical factor of safety (FOS) was calculated for each condition. According to current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability. The slope stability analyses indicated that the required minimum FOS for all conditions were met.

In order to model the end-of-construction condition, full cohesion and a friction angle of 0 degrees were assumed. Nominal values for cohesion were used with full friction angle to model the long-term condition to analyze the theoretical condition where pore water pressure has dissipated. Nominal values were 50 psf to 150 psf for the clay loam and clay till, and friction angles ranged from 26 to 30 degrees.

The Bishop Circular Method, which generates circular-shaped failure surfaces, was used to calculate the critical failure surfaces and FOS for the proposed conditions. The FOS obtained in the analysis is shown in Table 3.2.1 SLOPE/W program output from this analysis can be found in SLOPE/W Slope Stability Analysis, Exhibit E.

Table 3.2.1 – Slope Stability Critical FOS

Location	FOS (End of Construction)	FOS (Long-Term)
North End of Culvert Sideslopes (2H:1V)	4.2	2.0
South End of Culvert Sideslopes (2H:1V)	4.8	2.6

3.3 Seismic Considerations

Per the 2015 Geotechnical Manual, seismic parameters are not required for buried structures, including box culverts.

3.4 Scour

The approximate elevation at the upstream invert (TS&L, Exhibit B) is El. 724.49, and at the downstream invert is El. 724.52. Class A4 stone dumped riprap will be placed on both the upstream and downstream end of the double box culvert to reduce the potential for future scour.

4.0 Foundation Recommendations

4.1 Box Culvert

In accordance with the IDOT Culvert Manual and in KEG's opinion, a pre-cast box culvert alternative is deemed unfeasible at this site. The bearing materials are anticipated to consist of sands and gravels which are considered susceptible to scour.

5.0 Construction Considerations

5.1 Construction Activities

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.

Should any design considerations assumed by KEG change, KEG should be contacted to determine if the recommendations stated in this report still apply.

5.2 Temporary Sheet piling and Soil Retention

Temporary sheeting may be required at various stages of this project, due to the proposed staged-construction layout shown in the TS&L. The IDOT Temporary Sheet Piling Design Guide and Charts and Spreadsheet were used to review various retained heights ranging from 5 to 13 feet at the north end of the culvert and 5 to 15 feet on the south end of the culvert below existing grades. Based on these resources, Cantilevered Sheet Piling Systems are feasible for retained heights of 13 feet or less on the north end and 15 feet or less at the south end.

Table 5.2.1 summarizes the retained heights versus required embedment depth and applicable section modulus. The design spreadsheets are included in Exhibit F, for additional information.

Table 5.2.1 – Temporary Sheet Pile Design Parameters

Location	Reference Boring	Retained Height (Feet)	Embedment Depth (Feet)	Section Modulus (IN. ³ /Foot)
North Side of Culvert	B-2	5	9.98	3.42
	B-2	10	16.34	17.02
	B-2	13	20.18	32.80
South Side of Culvert	B-1	5	10.99	3.91
	B-1	10	17.29	19.22
	B-1	15	23.09	52.26

Temporary Soil Retention Systems may be required versus Cantilevered Sheet Piling, depending upon the surcharge loading and retained heights required to be supported during construction. An Illinois-licensed Structural Engineer is required to seal the design of Temporary Soil Retention Systems, if deemed necessary.

5.3 Site and Soil Conditions

Provisions of the Standard Specifications should adequately address site and soil conditions.

6.0 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.

7.0 Geotechnical Data

Soil boring logs can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

8.0 Limitations

The recommendations provided herein are for the exclusive use of Hurst-Rosche, Inc., and IDOT. They are specific only to the project described and are based on the subsurface information obtained by IDOT at two boring locations within the structure area in 2018, 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
LOCATION MAP



LOCATION MAP
US 150 (FAS 2466) over
Tributary to Rock Creek
Section 11-CR
Woodford County, Illinois

Exhibit No.

A

KEG JOB #19-1139.01

EXHIBIT B
TYPE, SIZE, AND LOCATION PLAN (TS&L)

Benchmark: Chiseled square on top of E end the south concrete retaining wall over culvert
Elevation 732.86 @ plan station 845+13, 15' Rt

Existing Structure: SN 102-1004 was built in 1922 under S.B.I. Rte 9.
Existing structure is a 12'X5'-6" R.C. box culvert with a culvert length of 32'-0".
Traffic to be maintained utilizing stage construction.

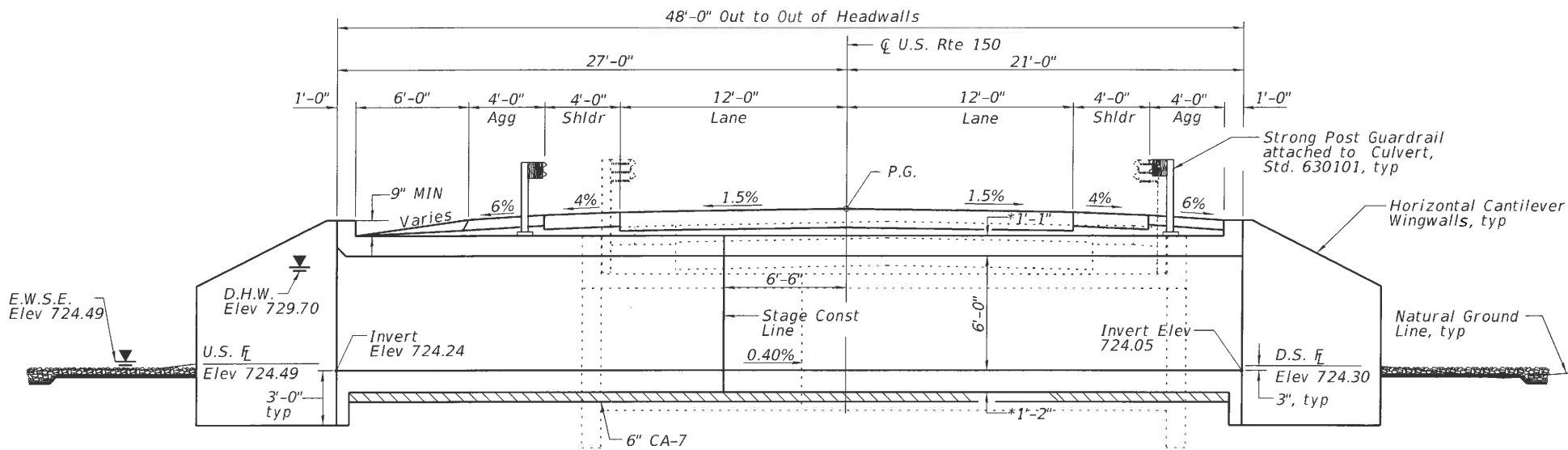
No Salvage
Precast alternative is not allowed.

Note:
Stage construction details and profile grade shown on sheet 2 of 2.

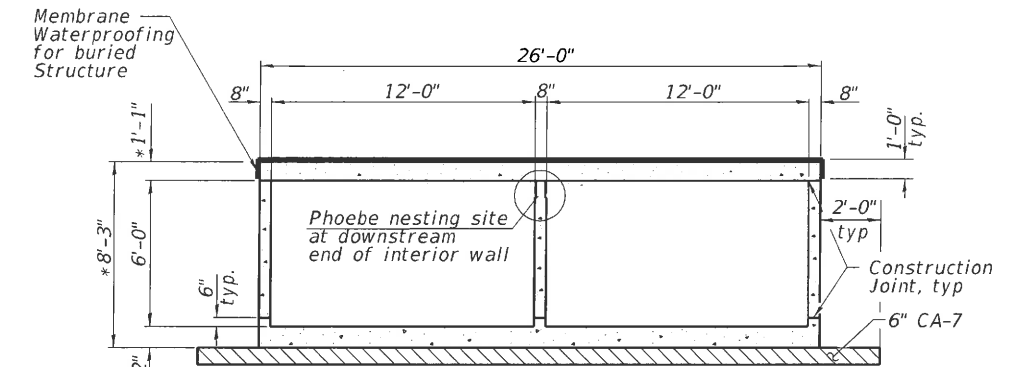
WATERWAY INFORMATION

		Drainage Area = 1.5 sq. mi.		Exist. Overtopping Elev. 731.89 @ Sta. 847+00		Prop. Overtopping Elev. 733.19 @ Sta. 845+00	
Flood Yr.	Freq.	Q C.F.S.	Opening Ft ² Exist.	Nat. H.W.E.	Head - Ft. Exist.	Headwater El. Exist.	Prop. Headwater El. Prop.
Design	10	561	50	108	729.0	2.5	0.1
Base	50	955	58	125	729.7	2.5	0.3
OVT (E)	100	1140	62	132	730.0	2.4	0.9
OVT (P)	11	570	50	N/A	729.0	2.6	N/A
Max. Calc.	300	1440	N/A	137	730.2	N/A	2.4
	500	1590	66	139	730.3	2.2	2.4

10-Year Outlet Velocity from existing Structure = 14.7 fps
10-Year Outlet Velocity from proposed Structure = 5.5 fps

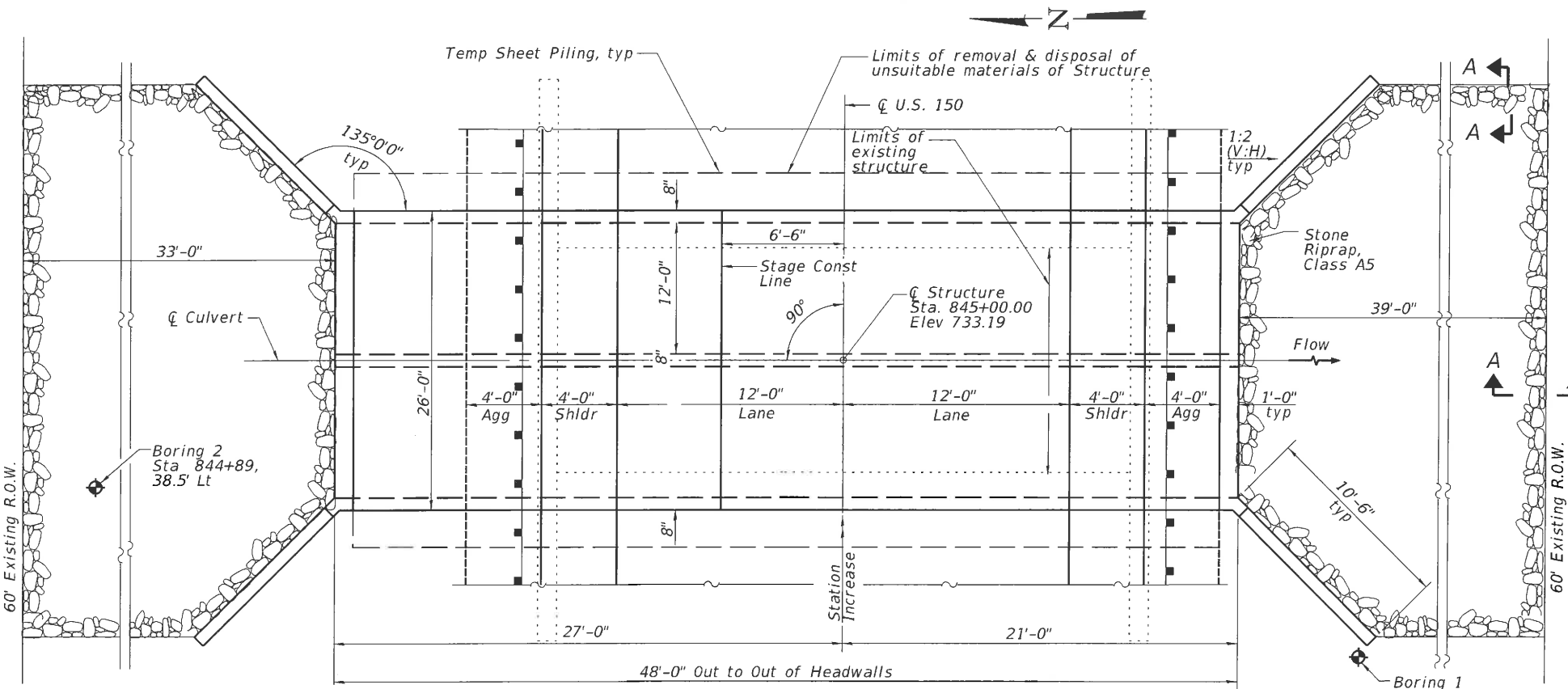


LONGITUDINAL SECTION

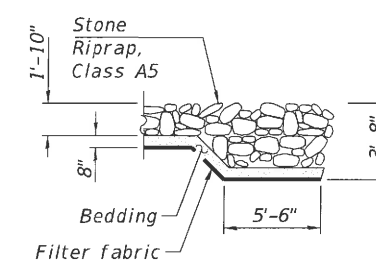


SECTION THRU BARREL

* Slab thickness may be refined in final design.



PLAN



SECTION A-A

HIGHWAY CLASSIFICATION

F.A.S. Rte. 2466 - U.S. 150 Rte.
Functional Class: Major Collector (Non-Urban)
ADT: 3350 (2020); 3760 (2040)
ADTT: 340 (2020); 382 (2040)
DHV: 369 (2020)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.

LOADING HL-93

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

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES

FIELD UNITS

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

GENERAL PLAN AND ELEVATION

U.S. ROUTE 150 OVER

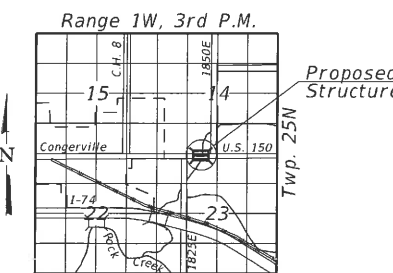
TRIBUTARY TO ROCK CREEK

F.A.S. RTE. 2466 - SECTION 11-CR

WOODFORD COUNTY

STATION 845+00.00

STRUCTURE NO. 102-2030



LOCATION SKETCH

** Note: Boring 1 is not displayed in its correct location.

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

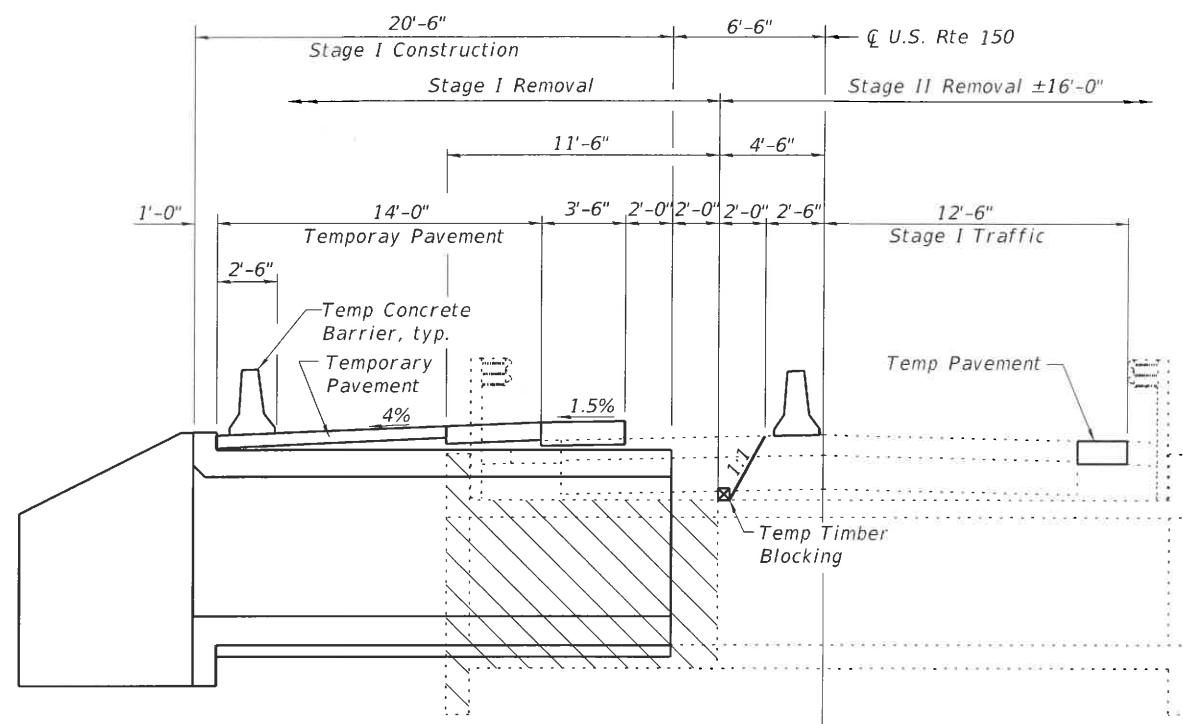
GENERAL PLAN AND ELEVATION
STRUCTURE NO. 102-2030

SHEET 1 OF 2 SHEETS

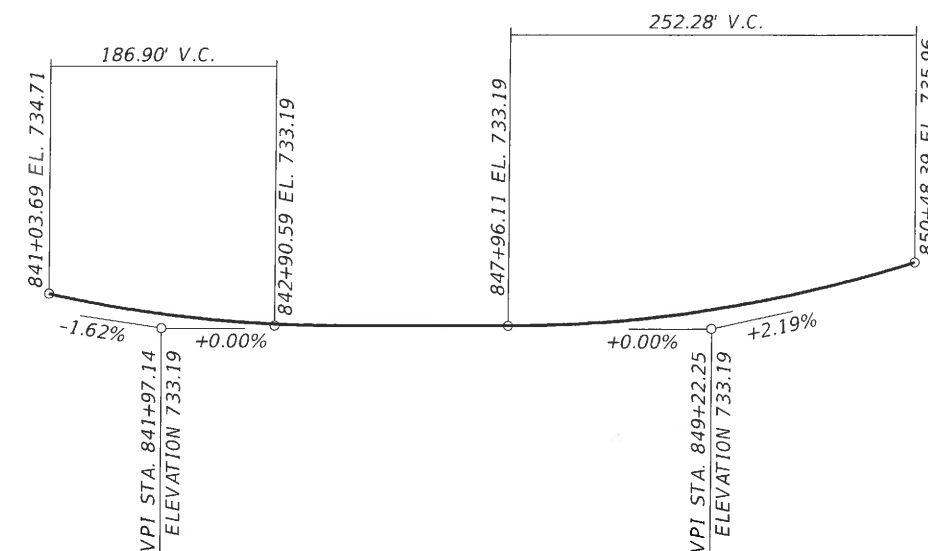
F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2466	11-CR	WOODFORD		
CONTRACT NO. 68D17				
ILLINOIS FED. AID PROJECT				

HR
Hurst-Rosche, Inc.
PROFESSIONAL DESIGN NUMBER: 194-00294
1400 E. TREMONT ST.
HILLSBORO, IL
PH: 217.532.3959

USER NAME =	DESIGNED - JLG	REVISED -
PLOT SCALE =	CHECKED - CJC	REVISED -
PLOT DATE = 08/26/2020	DRAWN - UJ	REVISED -
	CHECKED - JLG	REVISED -

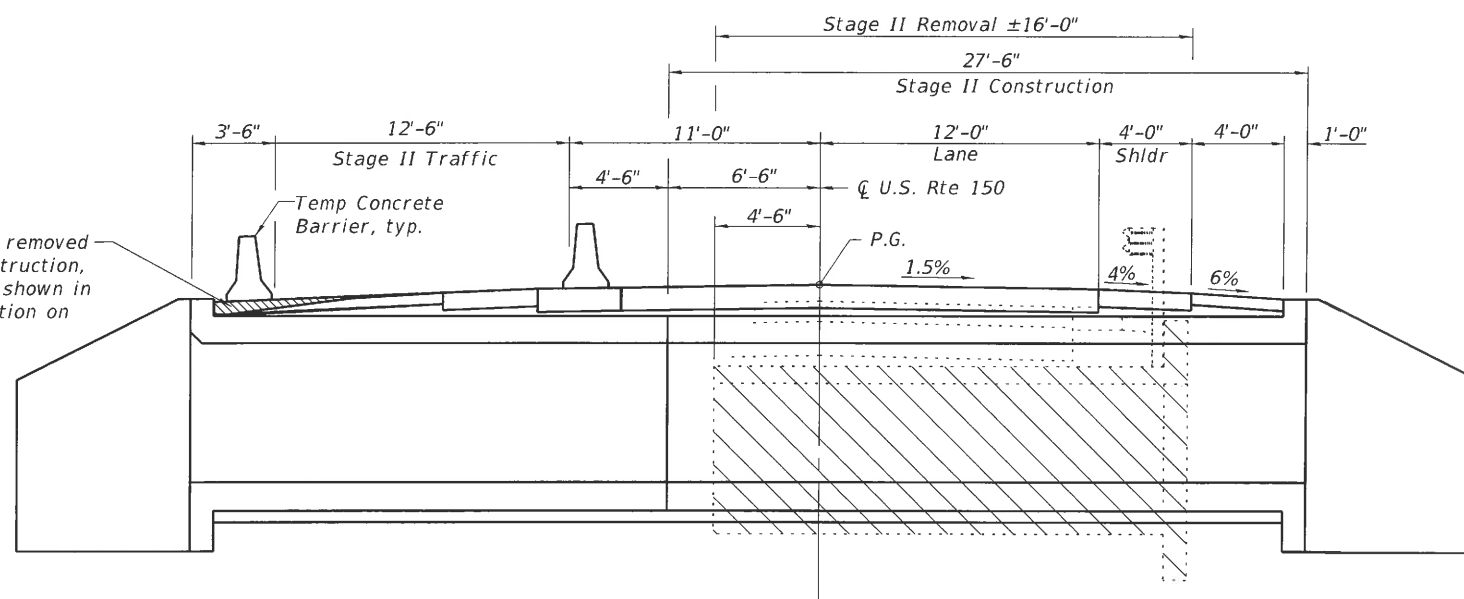


LONGITUDINAL SECTION - STAGE I CONSTRUCTION



PROFILE GRADE
(Along Centerline of U.S. Route 150)

Hatched area to be removed after Stage II Construction, and constructed as shown in the longitudinal section on sheet 1 of 2.



LONGITUDINAL SECTION - STAGE II CONSTRUCTION

DETAILS
U.S. ROUTE 150 OVER
TRIBUTARY TO ROCK CREEK
F.A.S. RTE. 2466 - SECTION 11-CR
WOODFORD COUNTY
STATION 845+00.00
STRUCTURE NO. 102-2030

DEL: \$MODELNAMES
E NAME: \$FILELS



Hurst-Rosche, Inc.
PROFESSIONAL DESIGN NUMBER: 14-000000
1400 E. TREMONT ST.
HILLSBORO, IL
PH: 217.532.3959

USER NAME =	DESIGNED - JLG	REVISED -
PLOT SCALE =	CHECKED - CJC	REVISED -
PLOT DATE = 08/26/2020	DRAWN - UJ	REVISED -
	CHECKED - JLG	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

DETAILS
STRUCTURE NO. 102-2030

SHEET 2 OF 2 SHEETS

F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2466	11-CR	WOODFORD		
CONTRACT NO. 68D17				
ILLINOIS FED. AID PROJECT				

EXHIBIT C
BORING LOGS



SOIL BORING LOG

ROUTE FAS 2466 (US150) DESCRIPTION Structure boring for culvert replacement LOGGED BY JW

SECTION 11 CR LOCATION SEC. 23, TWP. 25N, RNG. 1W, 3rd PM,

Latitude 40d 37' 03" N, Longitude 89d 11' 09" W

COUNTY Woodford DRILLING METHOD HSA HAMMER TYPE AUTO SPT Hammer

STRUCT. NO. Ex 102-1004
 Station 845+00

BORING NO. B-1
 Station 844+68
 Offset 25.5 ft RT
 Ground Surface Elev. 729.19 ft

D E P T H H	B L O W S	U C S Qu	M O I S T
(ft)	(/6")	(tsf)	(%)

Surface Water Elev. _____ ft
 Stream Bed Elev. _____ ft

Groundwater Elev.:
 First Encounter 723.2 ft ▼
 Upon Completion _____ ft
 After 48 Hrs. 724.2 ft ▼

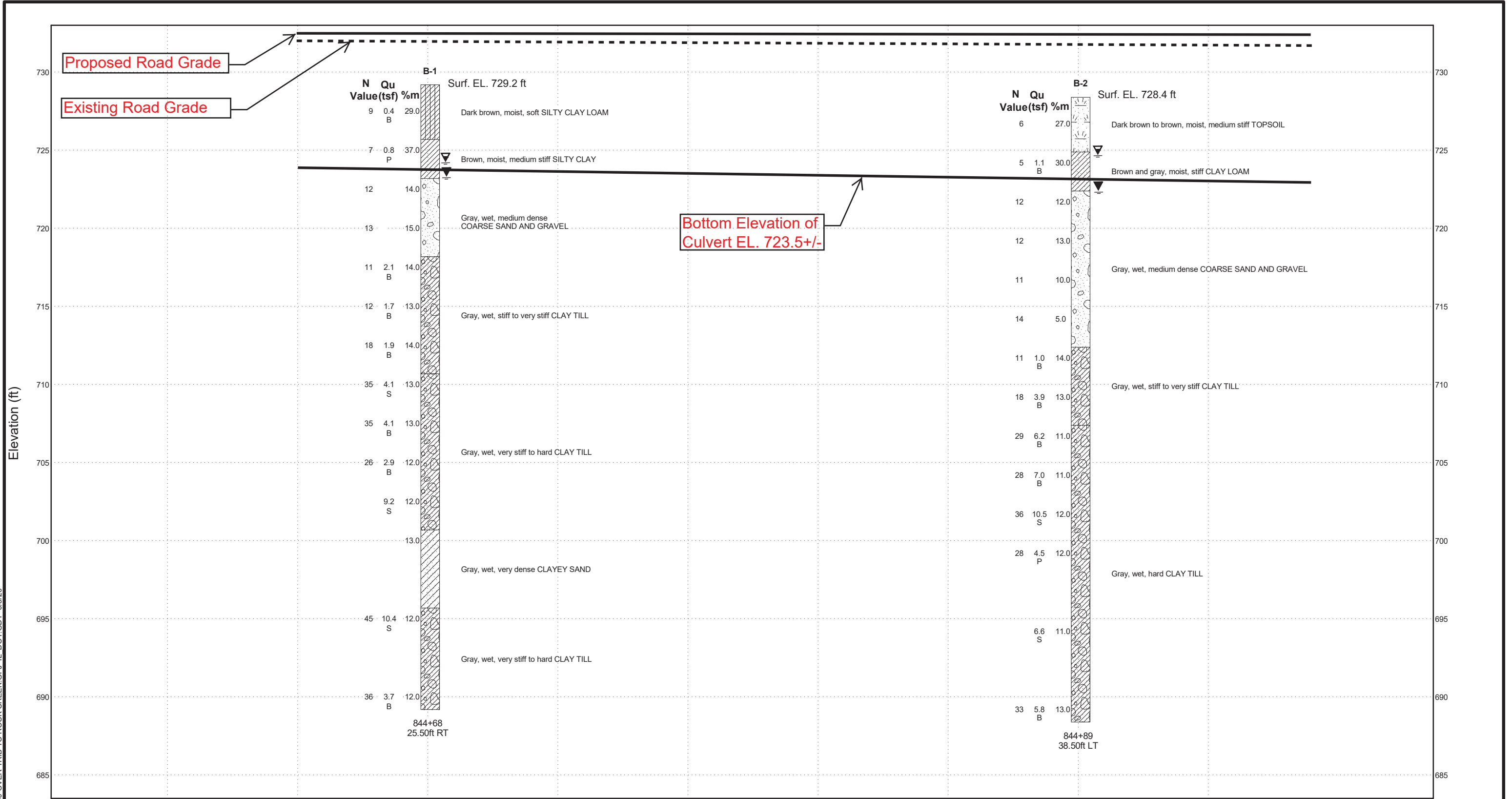
D E P T H H	B L O W S	U C S Qu	M O I S T
(ft)	(/6")	(tsf)	(%)

Dark brown, moist, soft SILTY CLAY LOAM				Gray, wet, very stiff to hard CLAY TILL (continued)			
	3					9	
	4	0.4	29			13	4.1
	5	B				22	B
	725.69						
Brown, moist, medium stiff SILTY CLAY	2					8	
	3	0.8	37			15	2.9
	4	P				11	B
Turns gray							
	723.19 ▼						
Gray, wet, medium dense COARSE SAND AND GRAVEL	3					17	
	5		14			23	9.2
	7					50/5"	S
	5						
	6		15			40	
	7					50/4"	
	-10						
	718.19						
Gray, wet, stiff to very stiff CLAY TILL	6						
	5	2.1	14				
	6	B					
	3						
	5	1.7	13			14	
	7	B				16	10.4
	-15					29	S
	5						
	8	1.9	14				
	10	B					
	710.69						
Gray, wet, very stiff to hard CLAY TILL	5					12	
	16	4.1	13			12	3.7
	19	S				24	B
	-20						
				End of Boring			
						689.19	
						-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)

EXHIBIT D
SUBSURFACE PROFILE

PRINTERMOD 11X17 19-1139.01 IL 150 OVER TRIB TO ROCK CREEK.GPJ IL_DOT.GDT 6/3/20



208 E. Main St., Suite 100
 Belleville, Illinois 62220
 618.233.5877 phone
 618.233.5977 fax
 www.kaskaskiaeng.com

PROFESSIONAL REGISTRATIONS
 Illinois Professional Design Firm
 Professional Engineering Group

LICENSE NO.
 184.004773
 20-5080586

NOT TO HORIZONTAL SCALE

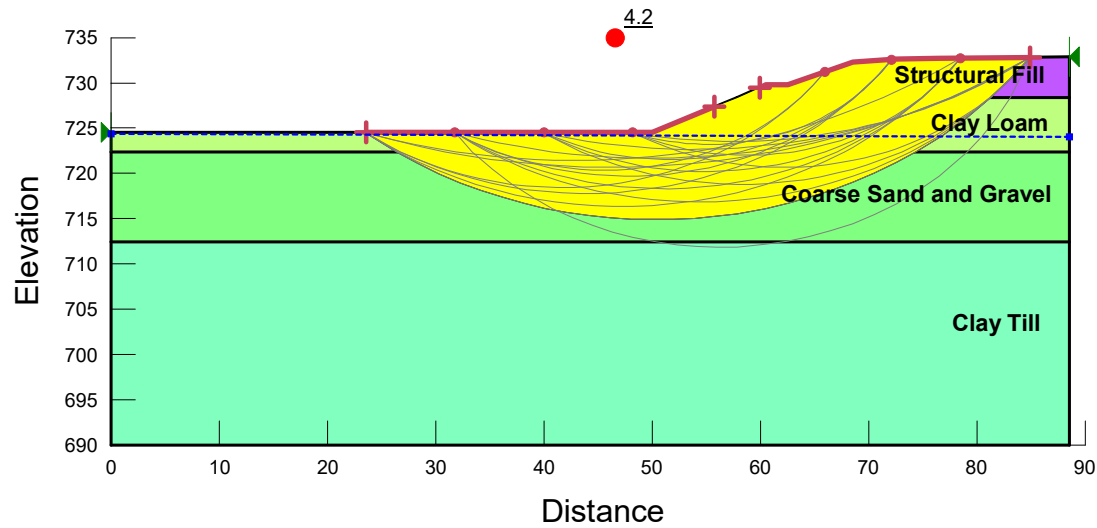
SUBSURFACE DATA PROFILE

Route: FAS 2466 (US 150)
 Section: 11-CR
 County: Woodford County, IL

EXHIBIT E

SLOPE/W SLOPE STABILITY ANALYSIS

**US 150 Over Tributary to Rock Creek - Woodford County
 North Culvert Wingwall Sideslope (2H:1V)
 End-of-Construction (Undrained Analysis)**



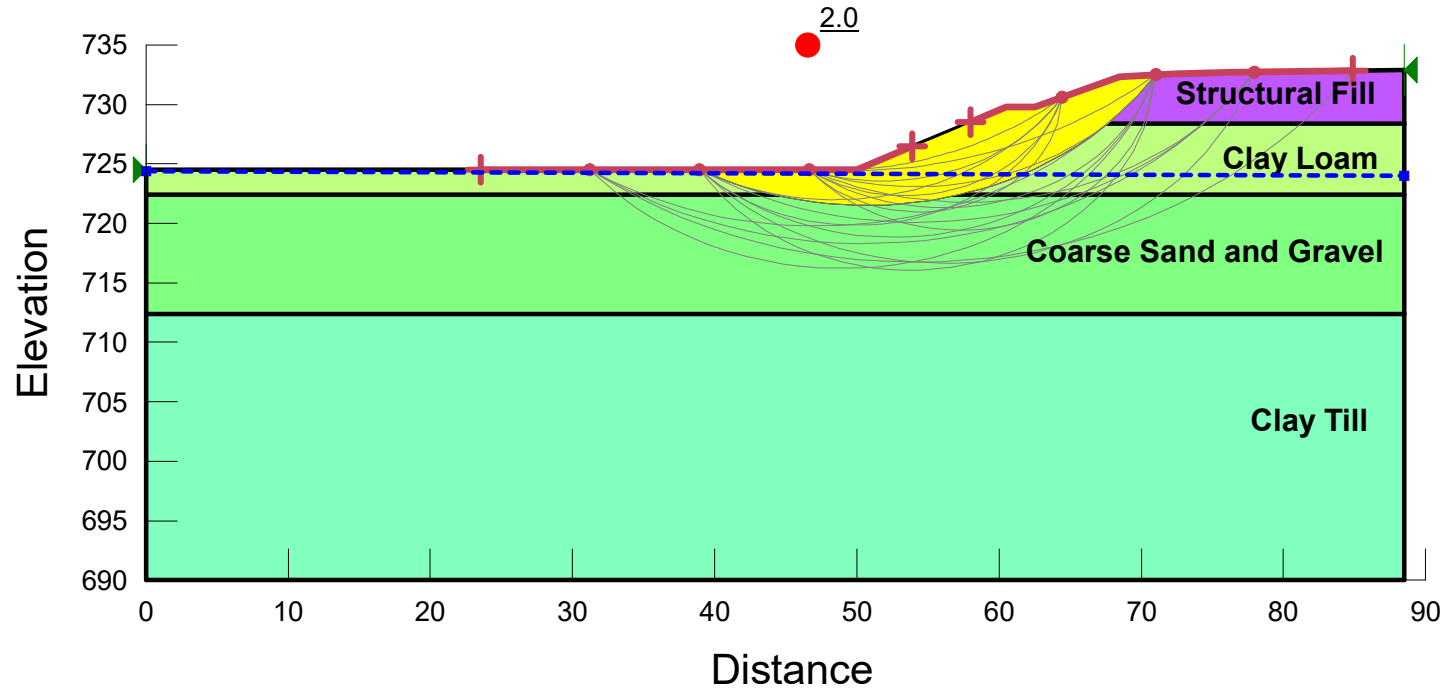
Name: Structural Fill
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1,500 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Loam
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1,100 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

Name: Coarse Sand and Gravel
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 5,000 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

**US 150 Over Tributary to Rock Creek - Woodford County
 North Culvert Wingwall Sideslope (2H:1V)
 Long Term Analysis (Drained Analysis)**



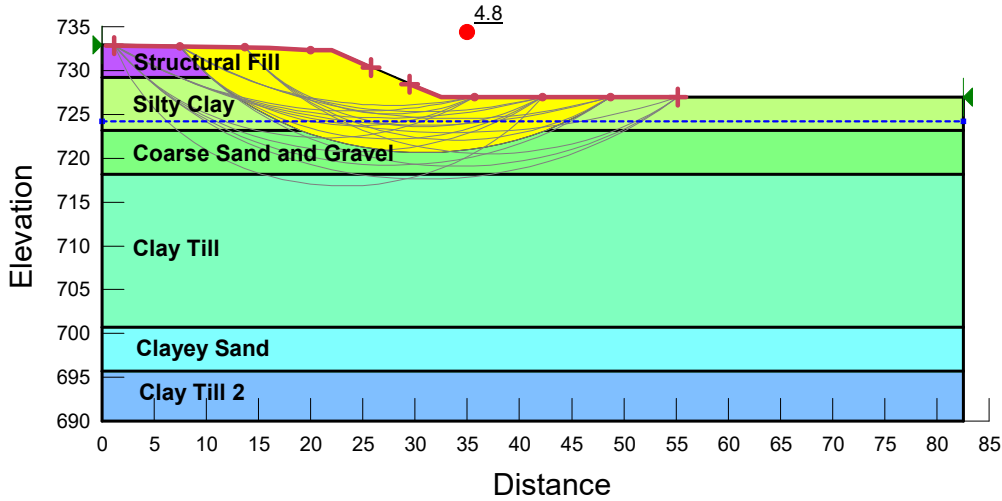
Name: Structural Fill
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Loam
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 50 psf
Phi': 27 °
Phi-B: 0 °
Piezometric Line: 1

Name: Coarse Sand and Gravel
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 28 °
Phi-B: 0 °
Piezometric Line: 1

**US 150 Over Tributary to Rock Creek - Woodford County
 South Culvert Wingwall Sideslope (2H:1V)
 End-of-Construction (Undrained Analysis)**



Name: Structural Fill
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1,500 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

Name: Silty Clay
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 400 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

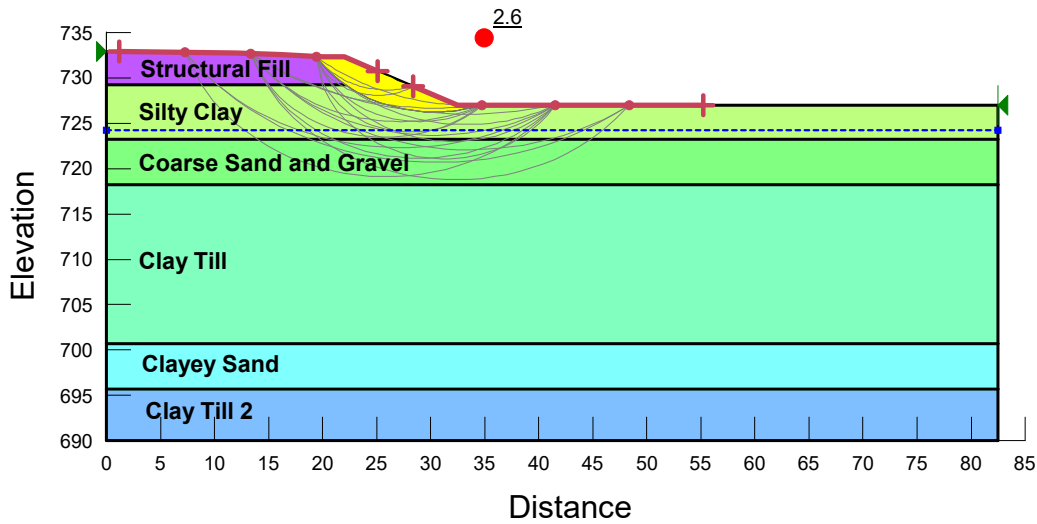
Name: Coarse Sand and Gravel
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till 1
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1,900 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clayey Sand
Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till 2
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 10,000 psf
Phi: 0 °
Phi-B: 0 °
Piezometric Line: 1

**US 150 Over Tributary to Rock Creek - Woodford County
 South Culvert Wingwall Sideslope (2H:1V)
 Long Term Analysis (Drained Analysis)**



Name: Structural Fill
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 26 °
Phi-B: 0 °
Piezometric Line: 1

Name: Silty Clay
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 26 °
Phi-B: 0 °
Piezometric Line: 1

Name: Coarse Sand and Gravel
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till 1
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clayey Sand
Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Name: Clay Till 2
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 28 °
Phi-B: 0 °
Piezometric Line: 1

EXHIBIT F

TEMPORARY SHORING SPREADSHEETS

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMP. STRENGTH Qu (TSF)
5	3.5	9	0.4
	2.5	7	0.8
	2.5	12	
	2.5	13	
	2.5	11	2.1
	2.5	12	1.7
	2.5	18	1.9
	2.5	35	4.1
	2.5	35	4.1
	2.5	26	2.9

STRUCTURE ===== Route 150 over Tributary to Rock Creek
SUBSTRUCTURE & REFERENCE BORING ===== B-1 (South End of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 10.99 FT

AND REQUIRES A SECTION MODULUS OF: 3.91 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	4	0.4	4.00						0.40					
1.75	0.875	4	0.4	4.00						0.40					
2.63	0.875	4	0.4	4.00	4.00	12.07	4.00		1.00	0.40	0.40	6.47	0.40		1.00
3.50	0.875	4	0.4	4.00	4.00	12.07	4.00		1.00	0.40	0.40	6.47	0.40		1.00
3.81	0.3125	8	0.8	4.33	4.00	12.07	4.00		1.00	0.43	0.40	6.47	0.40		1.00
4.13	0.3125	8	0.8	4.61	4.00	12.07	4.00		1.00	0.46	0.40	6.47	0.40		1.00
4.44	0.3125	8	0.8	4.85	4.00	12.07	4.00		1.00	0.48	0.40	6.47	0.40		1.00
4.75	0.3125	8	0.8	5.05	4.00	12.07	4.00		1.00	0.51	0.40	6.47	0.40		1.00
5.06	0.3125	8	0.8	5.23	4.00	12.07	4.00		1.00	0.52	0.40	6.47	0.40		1.00
5.38	0.3125	8	0.8	5.40	4.00	12.07	4.00		1.00	0.54	0.40	6.47	0.40		1.00
5.69	0.3125	8	0.8	5.54	4.00	12.07	4.00		1.00	0.55	0.40	6.47	0.40		1.00
6.00	0.3125	8	0.8	5.67	4.00	12.07	4.00		1.00	0.57	0.40	6.47	0.40		1.00
6.31	0.3125	12	0	5.98	4.00	12.07	4.00		1.00	0.54	0.40		0.40		1.00
6.63	0.3125	12	0	6.26	4.00	12.07	4.00		1.00	0.51	0.40		0.40		1.00
6.94	0.3125	12	0	6.52	4.00	12.07	4.00		1.00	0.49	0.40		0.40		1.00
7.25	0.3125	12	0	6.76	4.14	12.07	4.00		1.00	0.47	0.41		0.40		1.00
7.56	0.3125	12	0	6.98	4.30	11.96	4.00		1.00	0.45	0.43		0.40		1.00
7.88	0.3125	12	0	7.17	4.44	11.84	4.00		1.00	0.43	0.44		0.40		1.00
8.19	0.3125	12	0	7.36	4.58	11.72	4.00		1.00	0.42	0.46		0.40		1.00
8.50	0.3125	12	0	7.53	4.71	11.61	4.00		1.00	0.40	0.47		0.40		1.00
8.81	0.3125	13	0	7.72	4.82	11.51	4.00		1.00	0.39	0.48		0.40		1.00
9.13	0.3125	13	0	7.90	4.93	11.41	4.00		1.00	0.37	0.49		0.40		1.00
9.44	0.3125	13	0	8.07	5.03	11.33	4.00		1.00	0.36	0.50		0.40		1.00
9.75	0.3125	13	0	8.23	5.13	11.25	4.00		1.00	0.35	0.51		0.40		1.00
10.06	0.3125	13	0	8.38	5.22	11.19	4.00		1.00	0.34	0.52		0.40		1.00
10.38	0.3125	13	0	8.52	5.30	11.14	4.00		1.00	0.33	0.53		0.40		1.00
10.69	0.3125	13	0	8.65	5.38	11.09	4.07		1.04	0.32	0.54		0.41		1.04
11.00	0.3125	13	0	8.77	5.45	11.04	4.18		1.09	0.31	0.55		0.42		1.09
11.31	0.3125	21	2.1	9.11	5.52	10.99	4.29	3.91	1.14	0.36	0.55		0.43		1.14

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMPRESSIVE STRENGTH Qu (TSF)
10	3.5	9	0.4
	2.5	7	0.8
	2.5	12	
	2.5	13	
	2.5	11	2.1
	2.5	12	1.7
	2.5	18	1.9
	2.5	35	4.1
	2.5	35	4.1
	2.5	26	2.9

STRUCTURE ===== Route 150 over Tributary to Rock Creek
 SUBSTRUCTURE & REFERENCE BORING ===== B-1 (South End of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 17.29 FT

AND REQUIRES A SECTION MODULUS OF: 19.22 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	4	0.4	4.00						0.40					
1.75	0.875	4	0.4	4.00						0.40					
2.63	0.875	4	0.4	4.00	4.00	21.03	4.00		1.00	0.40	0.40	#####	0.40		1.00
3.50	0.875	4	0.4	4.00	4.00	21.03	4.00		1.00	0.40	0.40	#####	0.40		1.00
3.81	0.3125	8	0.8	4.33	4.00	21.03	4.00		1.00	0.43	0.40	#####	0.40		1.00
4.13	0.3125	8	0.8	4.61	4.00	21.03	4.00		1.00	0.46	0.40	#####	0.40		1.00
4.44	0.3125	8	0.8	4.85	4.00	21.03	4.00		1.00	0.48	0.40	#####	0.40		1.00
4.75	0.3125	8	0.8	5.05	4.00	21.03	4.00		1.00	0.51	0.40	#####	0.40		1.00
5.06	0.3125	8	0.8	5.23	4.00	21.03	4.00		1.00	0.52	0.40	#####	0.40		1.00
5.38	0.3125	8	0.8	5.40	4.00	21.03	4.00		1.00	0.54	0.40	#####	0.40		1.00
5.69	0.3125	8	0.8	5.54	4.00	21.03	4.00		1.00	0.55	0.40	#####	0.40		1.00
6.00	0.3125	8	0.8	5.67	4.00	21.03	4.00		1.00	0.57	0.40	#####	0.40		1.00
6.31	0.3125	12	0	5.98	4.00	21.03	4.00		1.00	0.54	0.40		0.40		1.00
6.63	0.3125	12	0	6.26	4.00	21.03	4.00		1.00	0.51	0.40		0.40		1.00
6.94	0.3125	12	0	6.52	4.00	21.03	4.00		1.00	0.49	0.40		0.40		1.00
7.25	0.3125	12	0	6.76	4.14	21.03	4.00		1.00	0.47	0.41		0.40		1.00
7.56	0.3125	12	0	6.98	4.30	20.84	4.00		1.00	0.45	0.43		0.40		1.00
7.88	0.3125	12	0	7.17	4.44	20.62	4.00		1.00	0.43	0.44		0.40		1.00
8.19	0.3125	12	0	7.36	4.58	20.42	4.00		1.00	0.42	0.46		0.40		1.00
8.50	0.3125	12	0	7.53	4.71	20.24	4.00		1.00	0.40	0.47		0.40		1.00
8.81	0.3125	13	0	7.72	4.82	20.06	4.00		1.00	0.39	0.48		0.40		1.00
9.13	0.3125	13	0	7.90	4.93	19.90	4.00		1.00	0.37	0.49		0.40		1.00
9.44	0.3125	13	0	8.07	5.03	19.75	4.00		1.00	0.36	0.50		0.40		1.00
9.75	0.3125	13	0	8.23	5.13	19.62	4.00		1.00	0.35	0.51		0.40		1.00
10.06	0.3125	13	0	8.38	5.22	19.52	4.00		1.00	0.34	0.52		0.40		1.00
10.38	0.3125	13	0	8.52	5.30	19.43	4.00		1.00	0.33	0.53		0.40		1.00
10.69	0.3125	13	0	8.65	5.38	19.34	4.07		1.04	0.32	0.54		0.41		1.04
11.00	0.3125	13	0	8.77	5.45	19.25	4.18		1.09	0.31	0.55		0.42		1.09
11.31	0.3125	21	2.1	9.11	5.52	19.17	4.29		1.14	0.36	0.55		0.43		1.14
11.63	0.3125	21	2.1	9.43	5.59	19.10	4.39		1.19	0.41	0.56		0.44		1.19
11.94	0.3125	21	2.1	9.73	5.65	19.03	4.48		1.24	0.45	0.57		0.45		1.24
12.25	0.3125	21	2.1	10.02	5.80	18.96	4.57		1.29	0.49	0.56		0.46		1.29
12.56	0.3125	21	2.1	10.29	5.95	18.84	4.66		1.33	0.53	0.54		0.47		1.33
12.88	0.3125	21	2.1	10.55	6.10	18.64	4.74		1.37	0.57	0.53		0.47		1.37
13.19	0.3125	21	2.1	10.80	6.24	18.54	4.82		1.41	0.61	0.52		0.48		1.41
13.50	0.3125	21	2.1	11.04	6.37	18.39	4.89		1.44	0.64	0.50		0.49		1.44
13.81	0.3125	17	1.7	11.17	6.50	18.27	4.96		1.48	0.66	0.49		0.50		1.48
14.13	0.3125	17	1.7	11.30	6.62	18.16	5.03		1.51	0.69	0.48		0.50		1.51
14.44	0.3125	17	1.7	11.42	6.74	18.06	5.09		1.55	0.71	0.47		0.51		1.55
14.75	0.3125	17	1.7	11.54	6.85	17.96	5.15		1.58	0.73	0.46		0.52		1.58
15.06	0.3125	17	1.7	11.66	6.95	17.86	5.21		1.61	0.75	0.45		0.52		1.61
15.38	0.3125	17	1.7	11.76	7.06	17.77	5.27		1.63	0.77	0.44		0.53		1.63
15.69	0.3125	17	1.7	11.87	7.16	17.69	5.32		1.66	0.79	0.43		0.53		1.66
16.00	0.3125	17	1.7	11.97	7.25	17.62	5.38		1.69	0.81	0.43		0.54		1.69
16.31	0.3125	19	1.9	12.10	7.34	17.55	5.43		1.71	0.83	0.42		0.54		1.71
16.63	0.3125	19	1.9	12.23	7.43	17.49	5.47		1.74	0.85	0.41		0.55		1.74
16.94	0.3125	19	1.9	12.36	7.51	17.42	5.52		1.76	0.87	0.40		0.55		1.76
17.25	0.3125	19	1.9	12.48	7.61	17.36	5.57		1.78	0.89	0.39		0.56		1.78
17.56	0.3125	19	1.9	12.59	7.70	17.29	5.61	19.22	1.80	0.90	0.39		0.56		1.80



TEMPORARY SHEET PILE DESIGN CHARTS

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMP. STRENGTH Qu (TSF)
15	3.5	9	0.4
	2.5	7	0.8
	2.5	12	
	2.5	13	
	2.5	11	2.1
	2.5	12	1.7
	2.5	18	1.9
	2.5	35	4.1
	2.5	35	4.1
	2.5	26	2.9

STRUCTURE -----Route 150 over Tributary to Rock Creek
 SUBSTRUCTURE & REFERENCE BORING =====B-1 (South End of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 23.09 FT
 AND REQUIRES A SECTION MODULUS OF: 52.26 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART SECT. MOD. W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART SECT. MOD. W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	4	0.4	4.00						0.40					
1.75	0.875	4	0.4	4.00						0.40					
2.63	0.875	4	0.4	4.00	4.00	29.97	4.00		1.00	0.40	0.40	#####	0.40		1.00
3.50	0.875	4	0.4	4.00	4.00	29.97	4.00		1.00	0.40	0.40	#####	0.40		1.00
3.81	0.3125	8	0.8	4.33	4.00	29.97	4.00		1.00	0.43	0.40	#####	0.40		1.00
4.13	0.3125	8	0.8	4.61	4.00	29.97	4.00		1.00	0.46	0.40	#####	0.40		1.00
4.44	0.3125	8	0.8	4.85	4.00	29.97	4.00		1.00	0.48	0.40	#####	0.40		1.00
4.75	0.3125	8	0.8	5.05	4.00	29.97	4.00		1.00	0.51	0.40	#####	0.40		1.00
5.06	0.3125	8	0.8	5.23	4.00	29.97	4.00		1.00	0.52	0.40	#####	0.40		1.00
5.38	0.3125	8	0.8	5.40	4.00	29.97	4.00		1.00	0.54	0.40	#####	0.40		1.00
5.69	0.3125	8	0.8	5.54	4.00	29.97	4.00		1.00	0.55	0.40	#####	0.40		1.00
6.00	0.3125	8	0.8	5.67	4.00	29.97	4.00		1.00	0.57	0.40	#####	0.40		1.00
6.31	0.3125	12	0	5.98	4.00	29.97	4.00		1.00	0.54	0.40		0.40		1.00
6.63	0.3125	12	0	6.26	4.00	29.97	4.00		1.00	0.51	0.40		0.40		1.00
6.94	0.3125	12	0	6.52	4.00	29.97	4.00		1.00	0.49	0.40		0.40		1.00
7.25	0.3125	12	0	6.76	4.14	29.97	4.00		1.00	0.47	0.41		0.40		1.00
7.56	0.3125	12	0	6.98	4.30	29.70	4.00		1.00	0.45	0.43		0.40		1.00
7.88	0.3125	12	0	7.17	4.44	29.38	4.00		1.00	0.43	0.44		0.40		1.00
8.19	0.3125	12	0	7.36	4.58	29.19	4.00		1.00	0.42	0.46		0.40		1.00
8.50	0.3125	12	0	7.53	4.71	28.83	4.00		1.00	0.40	0.47		0.40		1.00
8.81	0.3125	13	0	7.72	4.82	28.58	4.00		1.00	0.39	0.48		0.40		1.00
9.13	0.3125	13	0	7.90	4.93	28.36	4.00		1.00	0.37	0.49		0.40		1.00
9.44	0.3125	13	0	8.07	5.03	28.14	4.00		1.00	0.36	0.50		0.40		1.00
9.75	0.3125	13	0	8.23	5.13	27.96	4.00		1.00	0.35	0.51		0.40		1.00
10.06	0.3125	13	0	8.38	5.22	27.81	4.00		1.00	0.34	0.52		0.40		1.00
10.38	0.3125	13	0	8.52	5.30	27.68	4.00		1.00	0.33	0.53		0.40		1.00
10.69	0.3125	13	0	8.65	5.38	27.55	4.07		1.04	0.32	0.54		0.41		1.04
11.00	0.3125	13	0	8.77	5.45	27.43	4.18		1.09	0.31	0.55		0.42		1.09
11.31	0.3125	21	2.1	9.11	5.52	27.32	4.29		1.14	0.36	0.55		0.43		1.14
11.63	0.3125	21	2.1	9.43	5.59	27.21	4.39		1.19	0.41	0.56		0.44		1.19
11.94	0.3125	21	2.1	9.73	5.65	27.11	4.48		1.24	0.45	0.57		0.45		1.24
12.25	0.3125	21	2.1	10.02	5.80	27.02	4.57		1.29	0.49	0.56		0.46		1.29
12.56	0.3125	21	2.1	10.29	5.95	26.80	4.66		1.33	0.53	0.54		0.47		1.33
12.88	0.3125	21	2.1	10.55	6.10	26.57	4.74		1.37	0.57	0.53		0.47		1.37
13.19	0.3125	21	2.1	10.80	6.24	26.38	4.82		1.41	0.61	0.52		0.48		1.41
13.50	0.3125	21	2.1	11.04	6.37	26.24	4.89		1.44	0.64	0.50		0.49		1.44
13.81	0.3125	17	1.7	11.17	6.50	26.04	4.96		1.48	0.66	0.49		0.50		1.48
14.13	0.3125	17	1.7	11.30	6.62	25.89	5.03		1.51	0.69	0.48		0.50		1.51
14.44	0.3125	17	1.7	11.42	6.74	25.74	5.09		1.55	0.71	0.47		0.51		1.55
14.75	0.3125	17	1.7	11.54	6.85	25.60	5.15		1.58	0.73	0.46		0.52		1.58
15.06	0.3125	17	1.7	11.66	6.95	25.46	5.21		1.61	0.75	0.45		0.52		1.61
15.38	0.3125	17	1.7	11.76	7.06	25.33	5.27		1.63	0.77	0.44		0.53		1.63
15.69	0.3125	17	1.7	11.87	7.16	25.22	5.32		1.66	0.79	0.43		0.53		1.66
16.00	0.3125	17	1.7	11.97	7.25	25.12	5.38		1.69	0.81	0.43		0.54		1.69
16.31	0.3125	19	1.9	12.10	7.34	25.02	5.43		1.71	0.83	0.42		0.54		1.71
16.63	0.3125	19	1.9	12.23	7.43	24.93	5.47		1.74	0.85	0.41		0.55		1.74
16.94	0.3125	19	1.9	12.36	7.51	24.84	5.52		1.76	0.87	0.40		0.55		1.76
17.25	0.3125	19	1.9	12.48	7.61	24.75	5.57		1.78	0.89	0.39		0.56		1.78
17.56	0.3125	19	1.9	12.59	7.70	24.66	5.61		1.80	0.90	0.39		0.56		1.80
17.88	0.3125	19	1.9	12.71	7.80	24.56	5.65		1.83	0.92	0.38		0.57		1.83
18.19	0.3125	19	1.9	12.81	7.89	24.47	5.73		1.87	0.94	0.37		0.56		1.80
18.50	0.3125	19	1.9	12.92	7.97	24.37	5.84		1.92	0.95	0.37		0.55		1.76
18.81	0.3125	41	4.1	13.39	8.06	24.29	5.94		1.97	1.01	0.36		0.54		1.71
19.13	0.3125	41	4.1	13.84	8.14	24.24	6.04		2.02	1.06	0.36		0.53		1.67
19.44	0.3125	41	4.1	14.27	8.22	24.14	6.14		2.07	1.11	0.35		0.52		1.62
19.75	0.3125	41	4.1	14.70	8.29	24.07	6.23		2.11	1.15	0.34		0.52		1.58
20.06	0.3125	41	4.1	15.11	8.36	24.04	6.32		2.16	1.20	0.34		0.51		1.54
20.38	0.3125	41	4.1	15.50	8.44	23.94	6.40		2.20	1.24	0.33		0.50		1.50
20.69	0.3125	41	4.1	15.89	8.50	23.88	6.49		2.24	1.29	0.33		0.49		1.47
21.00	0.3125	41	4.1	16.26	8.57	23.82	6.57		2.29	1.33	0.32		0.49		1.43
21.31	0.3125	41	4.1	16.62	8.64	23.76	6.65		2.28	1.37	0.32		0.48		1.36
21.63	0.3125	41	4.1	16.98	8.70	23.74	6.73		2.27	1.41	0.31		0.47		1.29
21.94	0.3125	41	4.1	17.32	8.76	23.65	6.80		2.26	1.45	0.31		0.46		1.23
22.25	0.3125	41	4.1	17.65	8.91	23.60	6.88		2.26	1.48	0.33		0.46		1.17
22.56	0.3125	41	4.1	17.98	9.08	23.47	6.95		2.25	1.52	0.35		0.45		1.11
22.88	0.3125	41	4.1	18.29	9.24	23.33	7.02		2.24	1.56	0.38		0.45		1.06
23.19	0.3125	41	4.1	18.60	9.40	23.24	7.08		2.24	1.59	0.40		0.44		1.01
23.50	0.3125	41	4.1	18.89	9.55	23.09	7.15	52.26	2.23	1.62	0.42		0.43		0.96

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMP. STRENGTH Qu (TSF)
5	3.5	6	
	2.5	5	1.1
	2.5	12	
	2.5	12	
	2.5	11	
	2.5	14	
	2.5	11	1
	2.5	18	3.9

STRUCTURE ===== Route 150 over Tributary to Rock Creek
SUBSTRUCTURE & REFERENCE BORING ===== B-2 (North Side of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 9.98 FT

AND REQUIRES A SECTION MODULUS OF: 3.42 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	6	0	6.00						0.00					
1.75	0.875	6	0	6.00						0.00					
2.63	0.875	6	0	6.00	6.00	10.65	6.00		1.00	0.00	0.00	#####	0.00		#DIV/0!
3.50	0.875	6	0	6.00	6.00	10.65	6.00		1.00	0.00	0.00		0.00		#DIV/0!
3.81	0.3125	11	1.1	6.41	6.00	10.65	6.00		1.00	0.09	0.00		0.00		#DIV/0!
4.13	0.3125	11	1.1	6.76	6.00	10.65	6.00		1.00	0.17	0.00		0.00		#DIV/0!
4.44	0.3125	11	1.1	7.06	6.00	10.65	6.00		1.00	0.23	0.00		0.00		#DIV/0!
4.75	0.3125	11	1.1	7.32	6.00	10.65	6.00		1.00	0.29	0.00		0.00		#DIV/0!
5.06	0.3125	11	1.1	7.54	6.00	10.65	6.00		1.00	0.34	0.00		0.00		#DIV/0!
5.38	0.3125	11	1.1	7.74	6.00	10.65	6.00		1.00	0.38	0.00		0.00		#DIV/0!
5.69	0.3125	11	1.1	7.92	6.00	10.65	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.00	0.3125	11	1.1	8.08	6.00	10.65	6.00		1.00	0.46	0.00		0.00		#DIV/0!
6.31	0.3125	12	0	8.28	6.00	10.65	6.00		1.00	0.44	0.00		0.00		#DIV/0!
6.63	0.3125	12	0	8.45	6.00	10.65	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.94	0.3125	12	0	8.61	6.00	10.65	6.00		1.00	0.40	0.00		0.00		#DIV/0!
7.25	0.3125	12	0	8.76	6.17	10.65	6.00		1.00	0.38	0.04		0.00		#DIV/0!
7.56	0.3125	12	0	8.89	6.37	10.56	6.00		1.00	0.36	0.08		0.00		#DIV/0!
7.88	0.3125	12	0	9.02	6.56	10.46	6.00		1.00	0.35	0.12		0.00		#DIV/0!
8.19	0.3125	12	0	9.13	6.73	10.37	6.00		1.00	0.34	0.16		0.00		#DIV/0!
8.50	0.3125	12	0	9.24	6.88	10.29	6.00		1.00	0.32	0.19		0.00		#DIV/0!
8.81	0.3125	12	0	9.33	7.03	10.21	6.00		1.00	0.31	0.23		0.00		#DIV/0!
9.13	0.3125	12	0	9.42	7.16	10.14	6.00		1.00	0.30	0.26		0.00		#DIV/0!
9.44	0.3125	12	0	9.51	7.29	10.08	6.00		1.00	0.29	0.28		0.00		#DIV/0!
9.75	0.3125	12	0	9.59	7.41	10.03	6.00		1.00	0.28	0.31		0.00		#DIV/0!
10.06	0.3125	12	0	9.66	7.52	9.98	6.00	3.42	1.00	0.27	0.33		0.00		#DIV/0!

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMP. STRENGTH Qu (TSF)
10	3.5	6	
	2.5	5	1.1
	2.5	12	
	2.5	12	
	2.5	11	
	2.5	14	
	2.5	11	1
	2.5	18	3.9

STRUCTURE ===== Route 150 over Tributary to Rock Creek
SUBSTRUCTURE & REFERENCE BORING ===== B-2 (North Side of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 16.34 FT

AND REQUIRES A SECTION MODULUS OF: 17.02 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	6	0	6.00						0.00					
1.75	0.875	6	0	6.00						0.00					
2.63	0.875	6	0	6.00	6.00	18.59	6.00		1.00	0.00	0.00	#####	0.00		#DIV/0!
3.50	0.875	6	0	6.00	6.00	18.59	6.00		1.00	0.00	0.00		0.00		#DIV/0!
3.81	0.3125	11	1.1	6.41	6.00	18.59	6.00		1.00	0.09	0.00		0.00		#DIV/0!
4.13	0.3125	11	1.1	6.76	6.00	18.59	6.00		1.00	0.17	0.00		0.00		#DIV/0!
4.44	0.3125	11	1.1	7.06	6.00	18.59	6.00		1.00	0.23	0.00		0.00		#DIV/0!
4.75	0.3125	11	1.1	7.32	6.00	18.59	6.00		1.00	0.29	0.00		0.00		#DIV/0!
5.06	0.3125	11	1.1	7.54	6.00	18.59	6.00		1.00	0.34	0.00		0.00		#DIV/0!
5.38	0.3125	11	1.1	7.74	6.00	18.59	6.00		1.00	0.38	0.00		0.00		#DIV/0!
5.69	0.3125	11	1.1	7.92	6.00	18.59	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.00	0.3125	11	1.1	8.08	6.00	18.59	6.00		1.00	0.46	0.00		0.00		#DIV/0!
6.31	0.3125	12	0	8.28	6.00	18.59	6.00		1.00	0.44	0.00		0.00		#DIV/0!
6.63	0.3125	12	0	8.45	6.00	18.59	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.94	0.3125	12	0	8.61	6.00	18.59	6.00		1.00	0.40	0.00		0.00		#DIV/0!
7.25	0.3125	12	0	8.76	6.17	18.59	6.00		1.00	0.38	0.04		0.00		#DIV/0!
7.56	0.3125	12	0	8.89	6.37	18.44	6.00		1.00	0.36	0.08		0.00		#DIV/0!
7.88	0.3125	12	0	9.02	6.56	18.27	6.00		1.00	0.35	0.12		0.00		#DIV/0!
8.19	0.3125	12	0	9.13	6.73	18.11	6.00		1.00	0.34	0.16		0.00		#DIV/0!
8.50	0.3125	12	0	9.24	6.88	17.97	6.00		1.00	0.32	0.19		0.00		#DIV/0!
8.81	0.3125	12	0	9.33	7.03	17.83	6.00		1.00	0.31	0.23		0.00		#DIV/0!
9.13	0.3125	12	0	9.42	7.16	17.71	6.00		1.00	0.30	0.26		0.00		#DIV/0!
9.44	0.3125	12	0	9.51	7.29	17.61	6.00		1.00	0.29	0.28		0.00		#DIV/0!
9.75	0.3125	12	0	9.59	7.41	17.52	6.00		1.00	0.28	0.31		0.00		#DIV/0!
10.06	0.3125	12	0	9.66	7.52	17.44	6.00		1.00	0.27	0.33		0.00		#DIV/0!
10.38	0.3125	12	0	9.73	7.63	17.36	6.00		1.00	0.27	0.36		0.00		#DIV/0!
10.69	0.3125	12	0	9.80	7.73	17.28	6.09		1.03	0.26	0.38		0.02		#DIV/0!
11.00	0.3125	12	0	9.86	7.82	17.21	6.23		1.08	0.25	0.40		0.05		#DIV/0!
11.31	0.3125	11	0	9.90	7.91	17.14	6.36		1.12	0.24	0.42		0.08		#DIV/0!
11.63	0.3125	11	0	9.92	7.99	17.08	6.48		1.16	0.24	0.44		0.11		#DIV/0!
11.94	0.3125	11	0	9.95	8.07	17.02	6.60		1.20	0.23	0.45		0.13		#DIV/0!
12.25	0.3125	11	0	9.98	8.16	16.97	6.71		1.24	0.22	0.45		0.16		#DIV/0!
12.56	0.3125	11	0	10.00	8.26	16.92	6.82		1.27	0.22	0.44		0.18		#DIV/0!
12.88	0.3125	11	0	10.03	8.35	16.86	6.92		1.31	0.21	0.43		0.20		#DIV/0!
13.19	0.3125	11	0	10.05	8.44	16.80	7.02		1.34	0.21	0.42		0.22		#DIV/0!
13.50	0.3125	11	0	10.07	8.52	16.75	7.11		1.37	0.20	0.41		0.24		#DIV/0!
13.81	0.3125	14	0	10.16	8.60	16.70	7.20		1.40	0.20	0.40		0.26		#DIV/0!
14.13	0.3125	14	0	10.25	8.67	16.65	7.28		1.43	0.19	0.39		0.28		#DIV/0!
14.44	0.3125	14	0	10.33	8.74	16.61	7.36		1.45	0.19	0.38		0.30		#DIV/0!
14.75	0.3125	14	0	10.41	8.81	16.56	7.44		1.48	0.19	0.37		0.32		#DIV/0!
15.06	0.3125	14	0	10.48	8.88	16.52	7.51		1.50	0.18	0.37		0.33		#DIV/0!
15.38	0.3125	14	0	10.55	8.94	16.48	7.59		1.53	0.18	0.36		0.35		#DIV/0!
15.69	0.3125	14	0	10.62	9.00	16.44	7.65		1.55	0.18	0.35		0.36		#DIV/0!
16.00	0.3125	14	0	10.69	9.06	16.41	7.72		1.57	0.17	0.34		0.38		#DIV/0!
16.31	0.3125	10	1	10.67	9.12	16.37	7.78		1.59	0.19	0.34		0.39		#DIV/0!
16.63	0.3125	10	1	10.66	9.17	16.34	7.84	17.02	1.61	0.20	0.33		0.41		#DIV/0!

SOIL PROPERTIES BELOW EXCAVATION LINE

RETAINED HEIGHT (FT)	LAYER THICKNESS (FT)	SPT N-VALUE (BPF)	UNCONFINED COMP. STRENGTH Qu (TSF)
13	3.5	6	
	2.5	5	1.1
	2.5	12	
	2.5	12	
	2.5	11	
	2.5	14	
	2.5	11	1
	2.5	18	3.9

STRUCTURE ===== Route 150 over Tributary to Rock Creek
SUBSTRUCTURE & REFERENCE BORING ===== B-2 (North Side of Culvert)

GRANULAR CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 20.18 FT

AND REQUIRES A SECTION MODULUS OF: 32.80 IN.³/FT

DEPTH BELOW EXCAV. (FT)	SPLIT LAYER THICKNESS (FT)	SPLIT N AT DEPTH (BPF)	SPLIT Qu AT DEPTH (TSF)	AVG. N ABOVE DEPTH (BPF)	AVG. N IN UPPER 50% (BPF)	REQ'D CHART EMBED. DEPTH (FT)	AVG. N IN UPPER 33% (BPF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO LOWER/UPPER 1/3 N	AVG. Qu ABOVE DEPTH (TSF)	AVG. Qu IN UPPER 50% (TSF)	REQ'D EMBED. DEPTH (FT)	AVG. Qu IN UPPER 33% (TSF)	REQ'D CHART W/ AMP. (IN. ³ /FT)	RATIO OF LOWER/UPPER 1/3 Qu
0.88	0.875	6	0	6.00						0.00					
1.75	0.875	6	0	6.00						0.00					
2.63	0.875	6	0	6.00	6.00	23.35	6.00		1.00	0.00	0.00	#####	0.00		#DIV/0!
3.50	0.875	6	0	6.00	6.00	23.35	6.00		1.00	0.00	0.00		0.00		#DIV/0!
3.81	0.3125	11	1.1	6.41	6.00	23.35	6.00		1.00	0.09	0.00		0.00		#DIV/0!
4.13	0.3125	11	1.1	6.76	6.00	23.35	6.00		1.00	0.17	0.00		0.00		#DIV/0!
4.44	0.3125	11	1.1	7.06	6.00	23.35	6.00		1.00	0.23	0.00		0.00		#DIV/0!
4.75	0.3125	11	1.1	7.32	6.00	23.35	6.00		1.00	0.29	0.00		0.00		#DIV/0!
5.06	0.3125	11	1.1	7.54	6.00	23.35	6.00		1.00	0.34	0.00		0.00		#DIV/0!
5.38	0.3125	11	1.1	7.74	6.00	23.35	6.00		1.00	0.38	0.00		0.00		#DIV/0!
5.69	0.3125	11	1.1	7.92	6.00	23.35	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.00	0.3125	11	1.1	8.08	6.00	23.35	6.00		1.00	0.46	0.00		0.00		#DIV/0!
6.31	0.3125	12	0	8.28	6.00	23.35	6.00		1.00	0.44	0.00		0.00		#DIV/0!
6.63	0.3125	12	0	8.45	6.00	23.35	6.00		1.00	0.42	0.00		0.00		#DIV/0!
6.94	0.3125	12	0	8.61	6.00	23.35	6.00		1.00	0.40	0.00		0.00		#DIV/0!
7.25	0.3125	12	0	8.76	6.17	23.35	6.00		1.00	0.38	0.04		0.00		#DIV/0!
7.56	0.3125	12	0	8.89	6.37	23.47	6.00		1.00	0.36	0.08		0.00		#DIV/0!
7.88	0.3125	12	0	9.02	6.56	22.95	6.00		1.00	0.35	0.12		0.00		#DIV/0!
8.19	0.3125	12	0	9.13	6.73	22.76	6.00		1.00	0.34	0.16		0.00		#DIV/0!
8.50	0.3125	12	0	9.24	6.88	22.57	6.00		1.00	0.32	0.19		0.00		#DIV/0!
8.81	0.3125	12	0	9.33	7.03	22.40	6.00		1.00	0.31	0.23		0.00		#DIV/0!
9.13	0.3125	12	0	9.42	7.16	22.25	6.00		1.00	0.30	0.26		0.00		#DIV/0!
9.44	0.3125	12	0	9.51	7.29	22.13	6.00		1.00	0.29	0.28		0.00		#DIV/0!
9.75	0.3125	12	0	9.59	7.41	22.02	6.00		1.00	0.28	0.31		0.00		#DIV/0!
10.06	0.3125	12	0	9.66	7.52	21.94	6.00		1.00	0.27	0.33		0.00		#DIV/0!
10.38	0.3125	12	0	9.73	7.63	21.84	6.00		1.00	0.27	0.36		0.00		#DIV/0!
10.69	0.3125	12	0	9.80	7.73	21.74	6.09		1.03	0.26	0.38		0.02		#DIV/0!
11.00	0.3125	12	0	9.86	7.82	21.63	6.23		1.08	0.25	0.40		0.05		#DIV/0!
11.31	0.3125	11	0	9.90	7.91	21.54	6.36		1.12	0.24	0.42		0.08		#DIV/0!
11.63	0.3125	11	0	9.92	7.99	21.46	6.48		1.16	0.24	0.44		0.11		#DIV/0!
11.94	0.3125	11	0	9.95	8.07	21.39	6.60		1.20	0.23	0.45		0.13		#DIV/0!
12.25	0.3125	11	0	9.98	8.16	21.33	6.71		1.24	0.22	0.45		0.16		#DIV/0!
12.56	0.3125	11	0	10.00	8.26	21.25	6.82		1.27	0.22	0.44		0.18		#DIV/0!
12.88	0.3125	11	0	10.03	8.35	21.18	6.92		1.31	0.21	0.43		0.20		#DIV/0!
13.19	0.3125	11	0	10.05	8.44	21.14	7.02		1.34	0.21	0.42		0.22		#DIV/0!
13.50	0.3125	11	0	10.07	8.52	21.05	7.11		1.37	0.20	0.41		0.24		#DIV/0!
13.81	0.3125	14	0	10.16	8.60	20.98	7.20		1.40	0.20	0.40		0.26		#DIV/0!
14.13	0.3125	14	0	10.25	8.67	20.92	7.28		1.43	0.19	0.39		0.28		#DIV/0!
14.44	0.3125	14	0	10.33	8.74	20.87	7.36		1.45	0.19	0.38		0.30		#DIV/0!
14.75	0.3125	14	0	10.41	8.81	20.84	7.44		1.48	0.19	0.37		0.32		#DIV/0!
15.06	0.3125	14	0	10.48	8.88	20.76	7.51		1.50	0.18	0.37		0.33		#DIV/0!
15.38	0.3125	14	0	10.55	8.94	20.74	7.59		1.53	0.18	0.36		0.35		#DIV/0!
15.69	0.3125	14	0	10.62	9.00	20.66	7.65		1.55	0.18	0.35		0.36		#DIV/0!
16.00	0.3125	14	0	10.69	9.06	20.64	7.72		1.57	0.17	0.34		0.38		#DIV/0!
16.31	0.3125	10	1	10.67	9.12	20.57	7.78		1.59	0.19	0.34		0.39		#DIV/0!
16.63	0.3125	10	1	10.66	9.17	20.54	7.84		1.61	0.20	0.33		0.41		#DIV/0!
16.94	0.3125	10	1	10.65	9.23	20.50	7.90		1.63	0.22	0.32		0.42		#DIV/0!
17.25	0.3125	10	1	10.64	9.28	20.47	7.96		1.65	0.23	0.32		0.43		#DIV/0!
17.56	0.3125	10	1	10.63	9.32	20.43	8.01		1.67	0.25	0.31		0.44		#DIV/0!
17.88	0.3125	10	1	10.62	9.37	20.40	8.06		1.69	0.26	0.31		0.45		#DIV/0!
18.19	0.3125	10	1	10.60	9.42	20.37	8.12		1.71	0.27	0.30		0.45		#DIV/0!
18.50	0.3125	10	1	10.59	9.46	20.34	8.19		1.73	0.28	0.30		0.45		#DIV/0!
18.81	0.3125	39	3.9	11.07	9.50	20.34	8.25		1.75	0.34	0.29		0.44		#DIV/0!
19.13	0.3125	39	3.9	11.52	9.54	20.28	8.31		1.77	0.40	0.29		0.43		#DIV/0!
19.44	0.3125	39	3.9	11.96	9.58	20.26	8.37		1.79	0.46	0.28		0.42		#DIV/0!
19.75	0.3125	39	3.9	12.39	9.62	20.23	8.43		1.81	0.51	0.28		0.42		#DIV/0!
20.06	0.3125	39	3.9	12.81	9.66	20.20	8.49		1.83	0.57	0.27		0.41		#DIV/0!
20.38	0.3125	39	3.9	13.21	9.69	20.18	8.54	32.80	1.85	0.62	0.27		0.40		#DIV/0!