M E M O R A N D U M **S-085-2018**

cc: J. VanZee
C. VanZee
B. Bottoms
B. Warren
T. Thompson
V. Forsythe
D. Gesso
C. Smith
D. McElmurray

TO: Bart Asher, P.E., P.L.S.
Director, Division of Structural Design

FROM: Michael Carpenter, P.E.
TEBM, Geotechnical Branch
Division of Structural Design

BY: Tyler Sheffield, P.E.
Geotechnical Branch, Structure Foundations Section

DATE: July 9, 2019

SUBJECT: **Hardin County**
FD52 12F0 047 0062 000-029D; STPBRZ5038109
MARS No. 9213101D
Item No. 4-1093.00
Replace bridge on US 62 over Rolling Fork at Hardin-Nelson Co. Line
7 Span Bridge (554') at Sta. 39+50.00
(US 62 over Rolling Fork)
Geotechnical Engineering Structure Foundation Report

1.0 LOCATION AND DESCRIPTION

The geotechnical investigation for this structure has been completed. The DGN file for the subsurface data sheet has been made available on ProjectWise and through email for use in the development of structure plans. The drilling for this project was performed by the consulting firm of HDR Inc.

The proposed bridge replacement project is on US 62 at approximate mile point 28.1 on the Hardin-Nelson county line. The project is located approximately 9.5 miles northeast of Elizabethtown, KY.

2.0 SITE GEOLOGIC CONDITIONS

This structure is located in the Lebanon Junction Geologic Quadrangle (GQ# 603). The geologic mapping indicates that the bedrock at this site consists primarily of the Louisville Limestone formation, which has medium karst potential. The bedrock also consists of the New Albany Shale and Beachwood Limestone formations in parts.

3.0 FIELD INVESTIGATION

Thirteen (13) borings were taken for this structure. Six (6) of the borings were sample and core holes, one (1) was a sample hole, and six (6) were mechanical rockline soundings. The drill crew delivered the rock core and soil samples to the KYTC Geotechnical Branch in Frankfort where a geologist logged the rock cores and the soil samples were classified and tested in the Branch's laboratory. Observation wells were also installed in 3 of the boring to monitor groundwater elevations. The observation well readings can be found in the following table.

Hole #	Date of Reading	Static Groundwater Elev. (ft)
1004	4/5/2019	425.10
1011A	4/5/2019	433.70
1013	4/14/2019	433.50

4.0 LABORATORY TESTING

The laboratory soil testing was completed by the Geotechnical Branch. The soil samples obtained from the borings were determined to consist of inorganic low and high plasticity clays, silty sands, clayey sands, well-graded sands with silt, clayey-silty sands, low and high plasticity silts, silty gravels, and clayey gravels. The soil samples were designated CL, CH, SM, SC, SW-SM, SC-SM, ML, MH, GM, and GC using the Unified Soil Classification System.

5.0 SUBSURFACE CONDITIONS

Depths to rock/refusal vary from 48.0 ft. to 74.8 ft. Rock cores from this location indicated that bedrock consists mostly of brown-gray and gray with brown fine to medium crystalline dolomitic limestone with fossil fragments, vugs, and trace stylolites. Rock core from End Bent 1 contained some black shale at the bedrock/soil interface. The KY RQD values for the rock cores taken at this proposed bridge location ranged from 0% to 98% and core recoveries ranged from 88% to 100%. Unconfined compression test results of rock core samples ranged from 3460 psi to 6860 psi. The variations in top of rock/auger refusal elevations at the substructure units are provided below.

Substructure Unit	Refusal Elev. Range
• End Bent 1	382.5 to 382.7 ft.
• Pier 1	380.3 to 382.6 ft.
• Pier 4	379.4 to 379.6 ft.
• Pier 5	379.5 to 380.0 ft.
• Pier 6	378.8 to 379.5 ft.
• End Bent 2	379.3 to 380.0 ft.

*the two main piers of the existing structure will remain in place to serve as Piers 2 and 3 of the proposed structure.

6.0 ENGINEERING ANALYSIS

6.1 End Bent 1 &End Bent 2

Use end bearing steel **H-Pile foundations** driven to bedrock. A wave equation analysis was performed for this location and it is estimated that it will be possible to drive 12" or 14" H-piles to bedrock and practical refusal without encountering excessive blow counts or damaging the pile. The contractor shall submit the proposed pile driving system to the Department for approval prior to the installation of the first pile. Approval of the pile driving system by the Engineer will be subject to satisfactory field performance of the pile driving procedures. For **12" and 14" H-piles**, a hammer with a rated energy between **48.5 and 96.5 kip-ft** will be required to drive the H-piles to practical refusal

without encountering excessive blow counts or damaging the piles.

6.2 Settlement at End Bent 2

Settlement analysis indicated approximately 20 inches of settlement with 90% of the predicted consolidation occurring approximately 11 years after completion of the embankment. Waiting this long to build the bridge is not feasible. Therefore, the installation of wick drains is recommended to accelerate the settlement to a workable waiting period. The following table provides waiting period lengths for varying levels of consolidation with different wick drain spacing. The district indicated that it is preferred to minimize the waiting period so as to minimize the amount of time the roadway is closed to traffic. Because of this, a wick drain spacing of 5 ft. is recommended.

Wick Drain Spacing:	7 ft.	6 ft.	5 ft.
Time to 90% Consolidation:	4.3 Months	3.2 Months	2.2 Months
Time to 95% Consolidation:	5.9 Months	4.3 Months	3.0 Months
Time to 99% Consolidation:	10.1 Months	7.4 Months	5.1 Months

Downdrag Loads at End Bent 2

The downdrag loads anticipated for 12” and 14” H-piles driven after 90% and 95% consolidation occurs, are summarized below.

	after 90% Consolidation		after 95% Consolidation	
	12” Piles	14” Piles	12” Piles	14” Piles
Downdrag per pile (kips)	44	51	29	34

6.3 Piers

Use drilled shafts constructed in accordance with the Special Note for Drilled Shafts. The shaft tips shall extend a minimum of two shaft diameters below the bottom of permanent casing. Drilled shafts were evaluated for axial loading, and the attached tables provide the resulting capacities and resistances for LRFD methods. The elevations in the following table are needed to both complete the design and determine plan quantities for the drilled shafts. These elevations will be verified after construction phase drilling has been performed. The final shaft tip elevations and quantities may be adjusted based on actual field conditions. The highest tip elevation noted below is based on a 3.5 ft. shaft diameter.

	Pier 1	**Pier 4**	**Pier 5**	**Pier 6**
Estimated Top of Rock	381.5	379.5	379.7	379.6
Estimated Bottom of Permanent Casing/Top of Rock Socket	380.5	378.5	378.7	378.6
Highest Allowable Shaft Tip	373.5	371.5	371.7	371.6

6.4 Scour Considerations

Scour estimates have not been provided to this office at the time of this report, but they will be provided to the structural engineer for design. The following measures should be taken to mitigate the proposed scour at this location.

At the proposed **End Bent 1** and **End Bent 2** locations, slope protection will be required at the bridge meeting the requirements of Sections 703 & 805 of the Standard Specifications for Road and Bridge Construction, current edition. Place a Geotextile Fabric, in accordance with Section 843 of the Standard Specifications for Road and Bridge Construction, current edition, between the embankment and the slope protection.

The effects of local scour on the end bents can be negated through the use of the aforementioned cyclopean protection. The effects of local scour at the piers can be negated through the use of drilled shaft foundations socketed into bedrock and designing for the unsupported length exposed by the proposed scour.

Evaluated contraction scour as described in the KYTC Geotechnical Manual, Section GT-606-1. To do this, construct a vertical line from the toe of the spill-thru slope where the stone slope protection terminates, down to the contraction scour depth, for the respective end bent. Then construct a 1:1 (45º) line back towards the end bent until it intercepts the pile line. To mitigate this scour, the piles can be designed for the unsupported length, the pile caps can be set down below this interception point, or a combination of lowering the pile cap and designing for unsupported length.

6.5 Embankment Analysis

Embankment stability analyses were performed as part of this geotechnical investigation. These analyses indicated that the proposed 2H:1V slopes resulted in satisfactory factors of safety.

7.0 FOUNDATION RECOMMENDATIONS

7.1 End Bent 1 & End Bent 2

7.1.1 Use end bearing steel H-Piles with pile tip elevations of **382.0 ft. for End Bent 1 and 379.0 ft. for End Bent 2.** We recommend a resistance factor (f_c) of 0.3 to determine the maximum nominal resistance of the pile due to karstic uncertainties.

7.1.2 For determining practical refusal for point-bearing steel H-Piles, we recommend using Case 1.

7.2 Wick Drains

7.2.1 Wick drains placed with **5 ft.** spacing in an equilateral triangle pattern are recommended for the approach embankment at **End Bent 2** to reduce the consolidation time to approximately 3 months. This waiting period length should allow for 95% of the estimated settlement to occur before pile driving for End Bent 2. However, the data obtained from the settlement

platform and analyzed by the Geotechnical Branch will determine when consolidation has occurred and pile driving can begin. A Wick Drain Layout Sheet is attached showing the wick drain details.

7.2.2 If a waiting period of 3 months is not feasible, the project team can reduce the waiting period to 2 months. However, it should be noted that this shortened waiting period will lead to increased settlement after End Bent 2 is constructed and will increase the "bump at the end of the bridge".

7.3 Piers

7.3.1 Use Drilled Shaft foundations with estimated top of rock socket elevations as noted in Section 6.3 of this report.

7.3.2 Permanent casing is required in the overburden. It should be noted in the plans that the permanent casing is incidental to the unit bid price for Drilled Shaft, Common or Solid Rock, as applicable. Use permanent casing that is 6 inches larger in diameter than the proposed shaft diameter to the "Bottom of Permanent Casing" elevations noted above. Casings shall meet the requirements of Section 2.3 of the Special Note for Drilled Shafts.

7.3.3 Permanent casing may need to be extended through any significant void, should they be encountered. Shaft tip elevations may also need to be lowered if significant voids are encountered.

7.3.4 Require a 6-inch minimum rebar cover in the uncased rock sockets.

7.3.5 For Load & Resistance Factor Design (LRFD), evaluate the total factored axial resistances using the attached Drilled Shaft Axial Resistance Tables considering the capacity developed in the uncased rock sockets. The total factored resistances must exceed the factored loads at the strength limit state. The highest allowable tip elevations are provided in Section 6.3 of this report. Longer uncased sockets may be required to satisfy axial or lateral load design criteria.

7.3.6 Perform lateral load analysis using the geotechnical parameters provided in the attached Idealized Soil and Bedrock Profile. These parameters may be used to perform analyses using LPILE or other similar software. Some of the parameters may not be required to input, depending on the version of software utilized. Design the substructure units neglecting any lateral resistance above the estimated scour elevations.

7.3.7 Additional drilling will be required at each drilled shaft location as noted in Section 3.5, Subsurface Investigation of the Special Note for Drilled Shafts. Estimates of the amount of Rockline Sounding may be made by taking the difference between the ground surface and the rockline at each shaft location. For estimating the amount of Rock Coring at this location, we recommend that the subsurface exploration extend a minimum depth of three (3) shaft diameters (but not less than 10 feet) below the bottom of the anticipated tip elevation of each drilled shaft.

7.3.8 Use the elevations in Section 6.3 of this report to determine plan quantities

as follows:

- Drilled Shaft - *-inch (Common) - Top of shaft to Top of Rock
- Drilled Shaft - *-inch (Solid Rock) - Top of Rock to Bottom of Permanent Casing
- Drilled Shaft - **-inch (Solid Rock) - Bottom of Permanent Casing to Shaft Tip
- * - Insert diameter 6-inches larger than shaft diameter chosen
- ** - Shaft diameter (Rock Socket diameter) chosen
- The final shaft tip elevations and quantities may be adjusted based on the actual conditions encountered in the field.

8.0 PLAN NOTES

(Include the notes below at appropriate locations in the plans, if applicable.)

8.1 Dewatering methods may be required to facilitate foundation construction of pile caps.

8.2 Temporary sheeting and/or shoring may be required for installation of pile caps.

8.3 PRACTICAL REFUSAL: Drive point bearing piles to practical refusal. For this project, minimum blow requirements are reached after total penetration becomes ¼ inch or less for 5 consecutive blows, practical refusal is obtained after the pile is struck an additional 5 blows with total penetration of ¼ inch or less. Advance the production piling to the driving resistances specified above and to depths determined by test pile(s) and subsurface data sheet(s). Immediately cease driving operations if the pile visibly yields or becomes damaged during driving. If hard driving is encountered because of dense strata or an obstruction, such as a boulder before the pile is advanced to the depth anticipated, the Engineer will determine if more blows than the average driving resistance specified for practical refusal is required to further advance the pile. Drive additional production and test piles if directed by the Engineer.

8.4 HAMMER CRITERIA: For **12" and 14" H-piles**, a hammer with a rated energy between **48.5 and 96.5 kip-ft.** will be required to drive the H-piles to practical refusal without encountering excessive blow counts or damaging the piles. The contractor shall submit the proposed pile driving system to the Department for approval prior to the installation of the first pile. Approval of the pile driving system by the Engineer will be subject to satisfactory field performance of the pile driving procedures.

8.5 Slope protection will be required at the bridge meeting the requirements of Sections 703 & 805 of the Standard Specifications for Road and Bridge Construction, current edition. Place Geotextile Fabric between the embankment and the slope protection, in accordance with Section 843 of the Standard Specifications for Road and Bridge Construction, current edition.

8.6 Dewatering methods and/or cofferdams may be required to facilitate foundation construction of drilled shafts.

8.7 Temporary sheeting and/or shoring may be required for installation of drilled

shafts.

8.8 Permanent casing is required in the overburden. Permanent casing will also be required through portions of solid rock where voids or karst features may be found. Permanent casing is incidental to the unit bid price for "Drilled Shaft -___-inch (Common)" or "Drilled Shaft - ___-inch (Solid Rock) as applicable. (Insert shaft sizes 6" larger than the chosen drilled shaft rock socket diameter as noted in Section 7.3.8 of this report.)

8.9 Drilled shafts shall be constructed in accordance with the Special Note for Drilled Shafts. Include all costs (labor, equipment, and materials including spiral and longitudinal reinforcement, reinforcement splices, mechanical couplers, concrete, and temporary or permanent casing) associated with the drilled shafts in the unit price bid for Drilled Shaft, Common or Solid Rock, as applicable.

8.10 The Contractor will be responsible for providing subsurface exploration drilling during construction to finalize the drilled shaft tip elevations. Additional drilling will be required at each drilled shaft location in accordance with the Special Note for Drilled Shafts, current edition.

8.11 The approach embankment for End Bent 2 shall be placed as one of the first efforts of construction due to the anticipated settlement concerns. This embankment should be built to full height within the limits specified in the plans. A minimum of 3 months waiting period will be required following completion of the embankment before installation of the piles can begin. Based upon the results of the settlement data, KYTC Geotechnical Branch will determine when enough settlement has occurred to permit installation of the piles. The waiting period may be increased or decreased as required.

8.12 A settlement platform shall be placed behind End Bent 2, on top of the embankment, at a location that it can be left in place for future readings after the project has been completed. The settlement platform shall be furnished and installed by the Contractor prior to the placement of the embankment. The settlement platform shall be in accordance with Section 216 of the current Standard Specifications for Road and Bridge Construction and Standard Drawing RGX-015. The Engineer will be responsible for reading the instrumentation. A pre-qualified Geotechnical Engineer or the KYTC Geotechnical Branch shall be responsible for evaluation of the settlement data. The Contractor shall be responsible for replacing all damaged platforms at no extra cost.

8.13 A 2 foot rock drainage blanket will be required prior to installing the wick drains. The drainage blanket shall extend from toe to toe of the slope to assure positive drainage. The rock drainage blanket shall consist of Kentucky Coarse Aggregate # 2's, 3's or 23's in accordance with Section 805 of the current Standard Specifications. The drainage blanket shall be underlain with Geotextile Fabric in accordance with Section 214 & 843 of the current Standard Specifications. This drainage blanket will also serve as a working platform and may need to be adjusted in thickness as determined by the Engineer during construction. After completion of the wick drains a Geotextile Fabric shall be placed on top of the drainage blanket. The Geotextile Fabric shall be in accordance with Section 214

& 843 of the current Standard Specifications.

8.14 Wick drains shall be installed through the overburden down to the layer of sand and gravel at an approximate depth of 45 feet in accordance with Section 711 of the current Standard Specifications for Road and Bridge Construction. The drainage blanket shall be constructed prior to the installation of the wick drains to serve as a working platform. The wick drains and drainage blanket details, intended for inclusion in the structure and roadway plans, are shown on an attached typical layout sheet.

8.15 All soil, mud, and other deleterious material shall be removed from the top of the working platform after wick drains are installed and prior to construction of the remaining embankment. Any granular material removed during this operation shall be replaced at no additional cost. The working platform shall be completely wrapped in Geotextile Fabric in accordance with Section 214 & 843 of the current Standard Specifications. The fabric on top of the working platform shall not be placed until after the wicks have been installed and the working platform cleared of deleterious material.

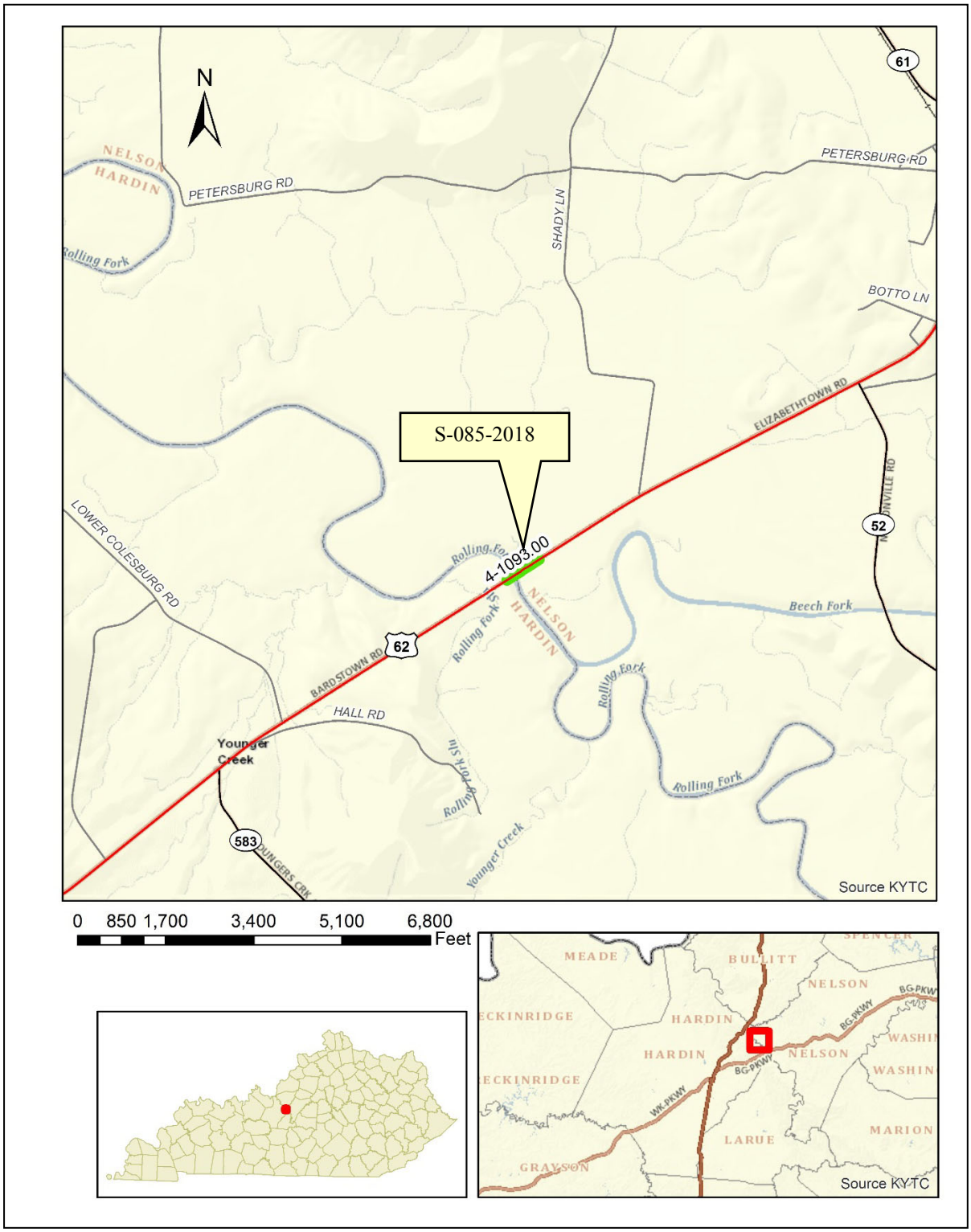
The designer should feel free to contact the Geotechnical Branch at 502-564-2374 for further recommendations or if any questions arise pertaining to this project.

Attachments:

- **Project Location Map**
- **Subsurface Data Sheet**
- **Proposed Bridge Layout Sheet**
- **Idealized Soil and Bedrock Profile**
- **Drilled Shaft Axial Resistance Table**
- **Wick Drain Layout Sheet**
- **Coordinate Data Sheet**

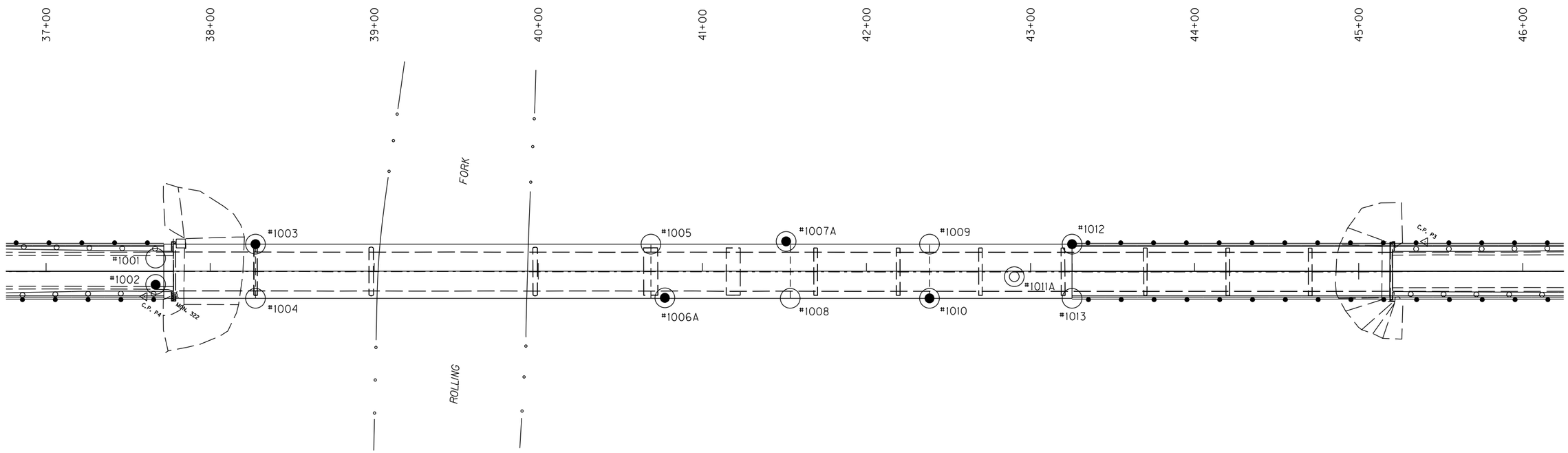
S-085-2018
Hardin Co., US-62
July 9, 2019
Item #: 4-1093.00

Project Location Map:



SUBSURFACE DATA

Plan Scale 1" = 30'



DATE: 28-MAY-2019	CHECKED BY
DESIGNED BY:	
DETAILED BY: E. BAILEY	T. SHEFFIELD

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
HARDIN

ROUTE	CROSSING
US 62	Bridge over Rolling Fork

SUBSURFACE DATA

S–085–18

ITEM NUMBER

4–1093.00

PREPARED BY
Division of Structural Design
GEOTECHNICAL BRANCH

SHEET NO.

DRAWING NO.
00000

SHEET LOCATION:
FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

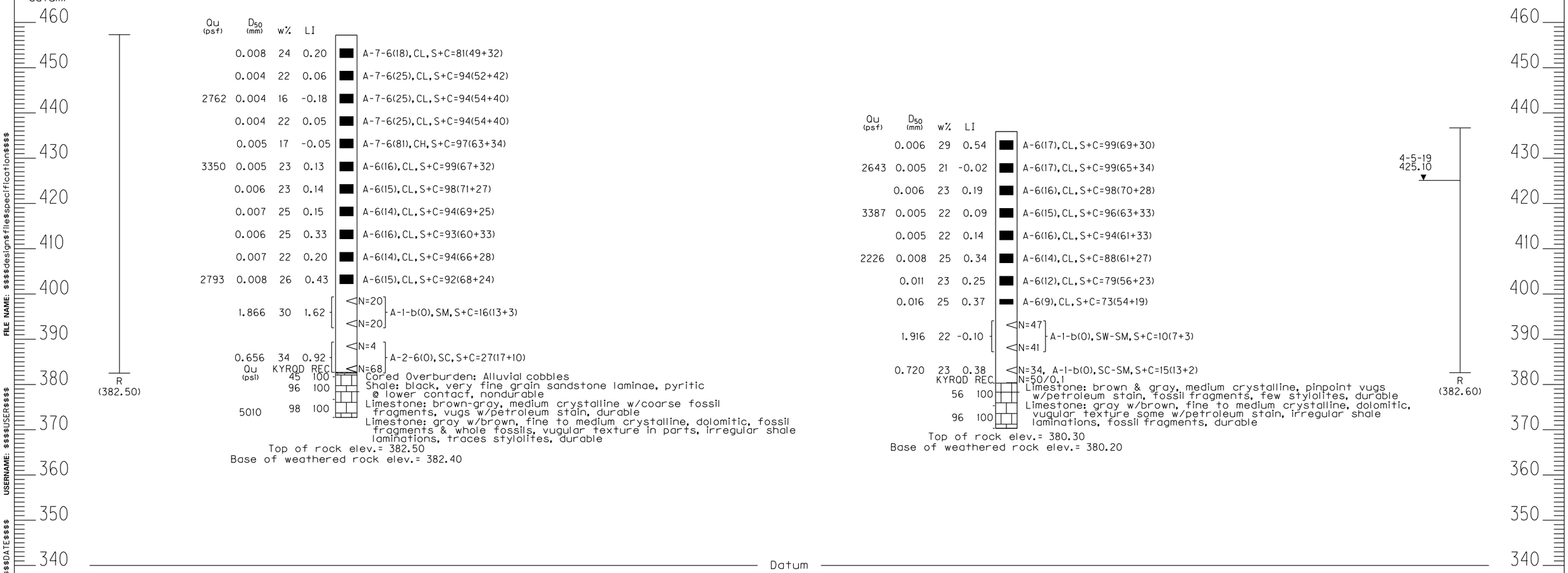
SUBSURFACE DATA

Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

END BENT ONE — PIER ONE

APPROXIMATE ROADWAY GRADE ELEV. = 458.19

Hole No.	1001	1002	1003	1004
Station	37+66.63	37+66.63	38+27.64	38+27.64
Offset	8.00 ft. Lt.	8.00 ft. Rt.	16.50 ft. Lt.	16.50 ft. Rt.
Elev. (NAVD 88 datum)	457.30	457.20	435.90	436.70



DATE: 28-MAY-2019		CHECKED BY
DESIGNED BY:		
DETAILED BY: E. BAILEY		T. SHEFFIELD

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
HARDIN

ROUTE	CROSSING
US 62	Bridge over Rolling Fork

SUBSURFACE DATA

S–085–18

ITEM NUMBER	PREPARED BY	SHEET NO.
4–1093.00	Division of Structural Design *GEOTECHNICAL BRANCH*	DRAWING NO. 00000

SHEET LOCATION:
FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

SUBSURFACE DATA

Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

SHEET LOCATION:

PIER FOUR | PIER FIVE

Hole No.	1005	1006A	1007A	1008
Station	40+68.63	40+77.14	41+51.04	41+53.53
Offset	16.50 ft. Lt.	16.20 ft. Rt.	18.00 ft. Lt.	16.50 ft. Rt.
Elev. (NAVD 88 datum)	427.40	427.80	434.00	433.30

460 450 440 430 420 410 400 390 380 370 360 350 340

R (379.40)

Qu (psf)	D_{50} (mm)	w%	LI		
	0.007	70	2.70		A-7-6(19), CL, S+C=99(76+23)
1760	0.006	30	0.35		A-7-6(20), CL, S+C=98(71+27)
1719	0.006	45	1.43		A-6(18), CL, S+C=99(70+29)
	0.005	28	0.44		A-6(17), CL, S+C=99(68+31)
	0.008	41	0.86		A-7-6(17), CL, S+C=90(66+24)
	0.008	44	0.73		A-7-5(21), ML, S+C=93(70+23)
3.911		16	-1.22	N=46, N=45	A-1-b(0), GM, S+C=16(10+6)
1.649		13	-0.87	N=29, N=50/0.5	A-2-4(0), SC-SM, S+C=26(17+9)

KYROD REC

0 100 Limestone: brown-gray, coarse crystalline, pinpoint vugs, fossil fragments, traces stylolites, traces petroleum stain, durable

84 96 Limestone: gray w/brown, fine to medium crystalline, dolomitic, vugular texture, fossiliferous, traces quartz crystal filled vugs, races stylolites, durable

96 96

Top of rock elev.= 379.80
No weathered rock

R (379.50)

Qu (psf)	D_{50} (mm)	w%	LI		
	0.006	28	0.26		A-6(17), CL, S+C=97(69+28)
	0.009	26	0.15		A-6(16), CL, S+C=97(79+18)
1209	0.006	30	0.31		A-7-6(21), CL, S+C=99(71+28)
	0.007	33	0.47		A-7-6(21), CL, S+C=98(74+24)
1043	0.008	33	0.47		A-7-6(21), CL, S+C=93(71+22)
	0.007	36	0.64		A-7-6(19), CL, S+C=93(64+29)
	0.011	38	0.07		A-7-5(17), MH, S+C=82(60+22)
3.178		76		N=15, N=50/0.5	A-1-a(0), SW-SM, S+C=10(8+2)
1.488		20	-0.55	N=16, N=11	A-1-b(0), SM, S+C=18(12+6)

Qu (psi) KYROD REC

0 88 Limestone: brown-gray, medium crystalline w/some coarse crystalline, fossiliferous, traces pinpoint vugs, few stylolites, durable

60 100 Limestone: gray w/brown, fine to medium crystalline, dolomitic, vugular texture in parts, fossil fragments, irregular shale laminae, trace stylolites, argillaceous @ base, durable

6860 80 100

Top of rock elev.= 380.00
Base of weathered rock elev.= 379.60

Datum

FILE NAME: $$$$design$file$specification$$$$
USERNAME: $$$$USER$$$$
DATE: $$$$DATE$$$$
E-SHEET NAME:

DATE: 28-MAY-2019		CHECKED BY
DESIGNED BY:		
DETAILED BY: E. BAILEY		T. SHEFFIELD

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: **HARDIN**

ROUTE: **US 62**

CROSSING: **Bridge over Rolling Fork**

SUBSURFACE DATA

S-085-18

ITEM NUMBER: **4-1093.00**

PREPARED BY: **Division of Structural Design**
GEOTECHNICAL BRANCH

SHEET NO.

DRAWING NO. **00000**

SUBSURFACE DATA

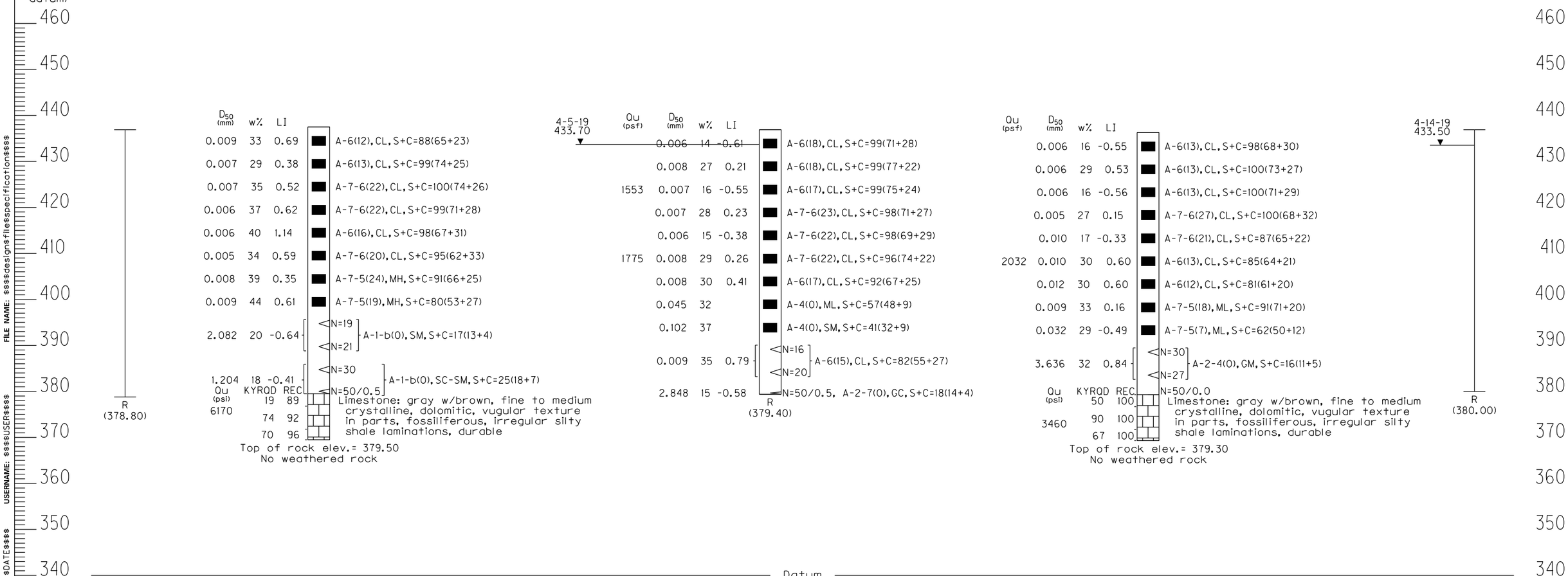
Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

SHEET LOCATION:

PIER SIX — END BENT TWO

APPROXIMATE ROADWAY GRADE ELEV. = 457.08

Hole No.	1009	1010	1011A	1012	1013
Station	42+38.43	42+38.43	42+90.11	43+25.29	43+25.29
Offset	16.50 ft. Lt.	16.50 ft. Rt.	3.30 ft. Rt.	16.50 ft. Lt.	16.50 ft. Rt.
Elev. (NAVD 88 datum)	436.90	437.50	436.90	436.30	436.90



DATE: 28-MAY-2019		CHECKED BY
DESIGNED BY:		
DETAILED BY: E. BAILEY		T. SHEFFIELD

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: HARDIN

ROUTE: US 62 — CROSSING: Bridge over Rolling Fork

SUBSURFACE DATA

S–085–18

ITEM NUMBER: 4–1093.00

PREPARED BY: Division of Structural Design
GEOTECHNICAL BRANCH

SHEET NO.

DRAWING NO. 00000

DATE: $$$$DATE$$$$ USERNAME: $$$$USER$$$$ FILE NAME: $$$$design$file$specification$$$$ E-SHEET NAME:

COUNTY OF	ITEM NO.	SHEET NO.
HARDIN	4-1093	---

WILLIAM M. NEWTON, SUE NEWTON,
JESSE NEWTON & DEBBIE NEWTON
DB 1241 PG 382

FRANKLIN J. MORENO
DB 516 PG 71
PARCEL 1

BARDSTOWN MUNICIPAL WATER DISTRICT - 4"PVC

BLUEGRASS NETWORK

WINDSTREAM

588.66'

87.15'

1800' S57°31'23"W

953.34'

II' LANES + 4' SHOULDERS
CLOSE BRIDGE FOR CONSTRUCTION

ROAD CLOSED

ROAD CLOSED

1800' N57°31'23"E
94.27'

709.99'

743.74'

THOMAS N. COLLINGS
DB 645 PG 494

AARON & ASHLEY REDING
DB 504 PG 574

BILLY M. HUDSON
DB 229 PG 65

BEGIN CONSTRUCTION
STA 35+60

END CONSTRUCTION
STA 46+63.46

L 240.00 FT
SD 1254.61 FT

VPI 35+60.00
Elev 456.28

VPI 37+71.12
Elev 458.18

PVC 38+40.35
Elev 458.48

VPI 39+60.35
Elev 458.99

PVT 40+80.35
Elev 458.36

VPI 46+63.46
Elev 455.31

0.90%

0.43%

-0.52%

EX BRIDGE

USE EXISTING
PIERS 1 & 2

35+50 36+00 36+50 37+00 37+50 38+00 38+50 39+00 39+50 40+00 40+50 41+00 41+50 42+00 42+50 43+00 43+50 44+00 44+50 45+00 45+50 46+00 46+50 47+00

SCALE: 1"= 40'

US 62 ROLLING FORK CROSSING
BRIDGE REPLACEMENT
STRUCTURE PLAN SHEET

MicroStation v8.11.7.443 | E-SHEET NAME: | USER: tyler.sheffield | DATE PLOTTED: May 31, 2019 | FILE NAME: U:\GEOTECH\4-1093 ROLLING FORK\DGN FILES\STRUCTURE PLAN.DGN

IDEALIZED SOIL AND BEDROCK PROFILE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

TQS 6/26/2019

Parameters for Lateral Load Analyses

Top of Shaft

Elev. (ft.)

* **Overburden**

(IGNORE OVERBURDEN ABOVE ESTIMATED SCOUR DEPTH FOR LATERAL SUPPORT)

Stiff Clay with Free Water	**Effective Unit Weight,**	**γ_e (lb/ft^3) =**	**57.6**
	Undrained Cohesion,	**c (lb/ft^2) =**	**960**
	Strain Factor,	**E50 =**	**0.01**
	Soil Modulus,	**k (lb/in^3) =**	**100**
395			
Sand	**Effective Unit Weight,**	**γ_e (lb/ft^3) =**	**57.6**
	Friction Angle,	**(deg.) =**	**35**
	Soil Modulus,	**k (lb/in^3) =**	**60**

Top of Rock Socket

*

Strata

Limestone — **Strong Rock (Vuggy Limestone)**

γ_t (lb/ft^3) =	**150**	**Effective Unit Weight,**	**γ_e (lb/in^3) =**	**0.087**
q_u (psi) =	**5375**	**Uniaxial Compressive Strength,**	**q_u (psi) =**	**5375**
q_{eb} (ksf) =	**84**			
f_s (ksf) =	**40.5**			

(Side friction limited by Concrete Strength to fs = 21.1 ksf)

*

Shaft Tip

* **Elevations vary and are provided in the report body.**

ADDITIONAL DATA FOR GEOTECHNICAL CALCULATIONS ONLY:	
min. f'$_c$ (psi) =	**3500**
p_a (psi) =	**14.7**

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 3.5 feet
Rock Socket Diameter = 42 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	232	808	116	404	520	93
2.0	21.1	84	464	808	232	404	636	186
3.0	21.1	84	696	808	348	404	752	278
4.0	21.1	84	928	808	464	404	868	371
5.0	21.1	84	1160	808	580	404	984	464
6.0	21.1	84	1392	808	696	404	1100	557
>>> 7.0	21.1	84	1624	808	812	404	1216	650
8.0	21.1	84	1856	808	928	404	1332	742
9.0	21.1	84	2088	808	1044	404	1448	835
10.0	21.1	84	2320	808	1160	404	1564	928
11.0	21.1	84	2552	808	1276	404	1680	1021
12.0	21.1	84	2784	808	1392	404	1796	1114
13.0	21.1	84	3016	808	1508	404	1912	1206
14.0	21.1	84	3248	808	1624	404	2028	1299
15.0	21.1	84	3480	808	1740	404	2144	1392
16.0	21.1	84	3712	808	1856	404	2260	1485
17.0	21.1	84	3944	808	1972	404	2376	1578
18.0	21.1	84	4176	808	2088	404	2492	1670
19.0	21.1	84	4408	808	2204	404	2608	1763
20.0	21.1	84	4640	808	2320	404	2724	1856
AASHTO Table 10.5.5.2.4-1				Resistance Factor *, ϕ	0.50	0.50		0.40

*** Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.**

>>> = Min. Socket Length

D (ft.) = 3.5

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 4.0 feet
Rock Socket Diameter = 48 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	265	1056	133	528	660	106
2.0	21.1	84	530	1056	265	528	793	212
3.0	21.1	84	795	1056	398	528	926	318
4.0	21.1	84	1061	1056	530	528	1058	424
5.0	21.1	84	1326	1056	663	528	1191	530
6.0	21.1	84	1591	1056	795	528	1323	636
7.0	21.1	84	1856	1056	928	528	1456	742
>>> 8.0	21.1	84	2121	1056	1061	528	1588	848
9.0	21.1	84	2386	1056	1193	528	1721	955
10.0	21.1	84	2652	1056	1326	528	1854	1061
11.0	21.1	84	2917	1056	1458	528	1986	1167
12.0	21.1	84	3182	1056	1591	528	2119	1273
13.0	21.1	84	3447	1056	1723	528	2251	1379
14.0	21.1	84	3712	1056	1856	528	2384	1485
15.0	21.1	84	3977	1056	1989	528	2516	1591
16.0	21.1	84	4242	1056	2121	528	2649	1697
17.0	21.1	84	4508	1056	2254	528	2782	1803
18.0	21.1	84	4773	1056	2386	528	2914	1909
19.0	21.1	84	5038	1056	2519	528	3047	2015
20.0	21.1	84	5303	1056	2652	528	3179	2121
AASHTO Table 10.5.5.2.4-1				Resistance Factor *, ϕ	0.50	0.50		0.40

* Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.

>>> = Min. Socket Length

D (ft.) = 4.0

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 4.5 feet
Rock Socket Diameter = 54 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	298	1336	149	668	817	119
2.0	21.1	84	597	1336	298	668	966	239
3.0	21.1	84	895	1336	447	668	1115	358
4.0	21.1	84	1193	1336	597	668	1265	477
5.0	21.1	84	1491	1336	746	668	1414	597
6.0	21.1	84	1790	1336	895	668	1563	716
7.0	21.1	84	2088	1336	1044	668	1712	835
8.0	21.1	84	2386	1336	1193	668	1861	955
>>> 9.0	21.1	84	2685	1336	1342	668	2010	1074
10.0	21.1	84	2983	1336	1491	668	2159	1193
11.0	21.1	84	3281	1336	1641	668	2309	1312
12.0	21.1	84	3580	1336	1790	668	2458	1432
13.0	21.1	84	3878	1336	1939	668	2607	1551
14.0	21.1	84	4176	1336	2088	668	2756	1670
15.0	21.1	84	4474	1336	2237	668	2905	1790
16.0	21.1	84	4773	1336	2386	668	3054	1909
17.0	21.1	84	5071	1336	2536	668	3203	2028
18.0	21.1	84	5369	1336	2685	668	3353	2148
19.0	21.1	84	5668	1336	2834	668	3502	2267
20.0	21.1	84	5966	1336	2983	668	3651	2386
AASHTO Table 10.5.5.2.4-1			Resistance Factor *, ϕ		0.50	0.50		0.40

*** Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.**

>>> = Min. Socket Length

D (ft.) = 4.5

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 5.0 feet
Rock Socket Diameter = 60 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	331	1649	166	825	990	133
2.0	21.1	84	663	1649	331	825	1156	265
3.0	21.1	84	994	1649	497	825	1322	398
4.0	21.1	84	1326	1649	663	825	1488	530
5.0	21.1	84	1657	1649	829	825	1653	663
6.0	21.1	84	1989	1649	994	825	1819	795
7.0	21.1	84	2320	1649	1160	825	1985	928
8.0	21.1	84	2652	1649	1326	825	2150	1061
9.0	21.1	84	2983	1649	1491	825	2316	1193
>>> 10.0	21.1	84	3314	1649	1657	825	2482	1326
11.0	21.1	84	3646	1649	1823	825	2648	1458
12.0	21.1	84	3977	1649	1989	825	2813	1591
13.0	21.1	84	4309	1649	2154	825	2979	1723
14.0	21.1	84	4640	1649	2320	825	3145	1856
15.0	21.1	84	4972	1649	2486	825	3310	1989
16.0	21.1	84	5303	1649	2652	825	3476	2121
17.0	21.1	84	5634	1649	2817	825	3642	2254
18.0	21.1	84	5966	1649	2983	825	3808	2386
19.0	21.1	84	6297	1649	3149	825	3973	2519
20.0	21.1	84	6629	1649	3314	825	4139	2652
AASHTO Table 10.5.5.2.4-1			Resistance Factor *, ϕ		0.50	0.50		0.40

* Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.

>>> = Min. Socket Length

D (ft.) = 5.0

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 5.5 feet
Rock Socket Diameter = 66 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	365	1996	182	998	1180	146
2.0	21.1	84	729	1996	365	998	1362	292
3.0	21.1	84	1094	1996	547	998	1545	437
4.0	21.1	84	1458	1996	729	998	1727	583
5.0	21.1	84	1823	1996	911	998	1909	729
6.0	21.1	84	2187	1996	1094	998	2092	875
7.0	21.1	84	2552	1996	1276	998	2274	1021
8.0	21.1	84	2917	1996	1458	998	2456	1167
9.0	21.1	84	3281	1996	1641	998	2638	1312
10.0	21.1	84	3646	1996	1823	998	2821	1458
>>> 11.0	21.1	84	4010	1996	2005	998	3003	1604
12.0	21.1	84	4375	1996	2187	998	3185	1750
13.0	21.1	84	4740	1996	2370	998	3368	1896
14.0	21.1	84	5104	1996	2552	998	3550	2042
15.0	21.1	84	5469	1996	2734	998	3732	2187
16.0	21.1	84	5833	1996	2917	998	3915	2333
17.0	21.1	84	6198	1996	3099	998	4097	2479
18.0	21.1	84	6562	1996	3281	998	4279	2625
19.0	21.1	84	6927	1996	3464	998	4461	2771
20.0	21.1	84	7292	1996	3646	998	4644	2917
AASHTO Table 10.5.5.2.4-1			Resistance Factor *, ϕ		0.50	0.50		0.40

*** Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.**

>>> = Min. Socket Length

D (ft.) = 5.5

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE

Hardin Co., Item# 4-1093.00, US 62 over Rolling Fork
Piers 1, 4, 5, and 6

Rock Socket Diameter = 6.0 feet
Rock Socket Diameter = 72 inches **TQS 6/26/2019**

Rock Socket Length (ft.)	Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal Side Resistance R_{sr} (kips)	Nominal End Bearing Resistance R_{eb} (kips)	Factored Side Resistance ϕR_{sr} (kips)	Factored End Bearing Resistance ϕR_{eb} (kips)	Total Factored Axial Resistance ϕR_t (kips)	Total Factored Uplift Resistance ϕR_{tu} (kips)
0.0								
1.0	21.1	84	398	2375	199	1188	1386	159
2.0	21.1	84	795	2375	398	1188	1585	318
3.0	21.1	84	1193	2375	597	1188	1784	477
4.0	21.1	84	1591	2375	795	1188	1983	636
5.0	21.1	84	1989	2375	994	1188	2182	795
6.0	21.1	84	2386	2375	1193	1188	2381	955
7.0	21.1	84	2784	2375	1392	1188	2580	1114
8.0	21.1	84	3182	2375	1591	1188	2778	1273
9.0	21.1	84	3580	2375	1790	1188	2977	1432
10.0	21.1	84	3977	2375	1989	1188	3176	1591
11.0	21.1	84	4375	2375	2187	1188	3375	1750
>>> 12.0	21.1	84	4773	2375	2386	1188	3574	1909
13.0	21.1	84	5170	2375	2585	1188	3773	2068
14.0	21.1	84	5568	2375	2784	1188	3972	2227
15.0	21.1	84	5966	2375	2983	1188	4170	2386
16.0	21.1	84	6364	2375	3182	1188	4369	2545
17.0	21.1	84	6761	2375	3381	1188	4568	2705
18.0	21.1	84	7159	2375	3580	1188	4767	2864
19.0	21.1	84	7557	2375	3778	1188	4966	3023
20.0	21.1	84	7955	2375	3977	1188	5165	3182
AASHTO Table 10.5.5.2.4-1			Resistance Factor *, ϕ		0.50	0.50		0.40

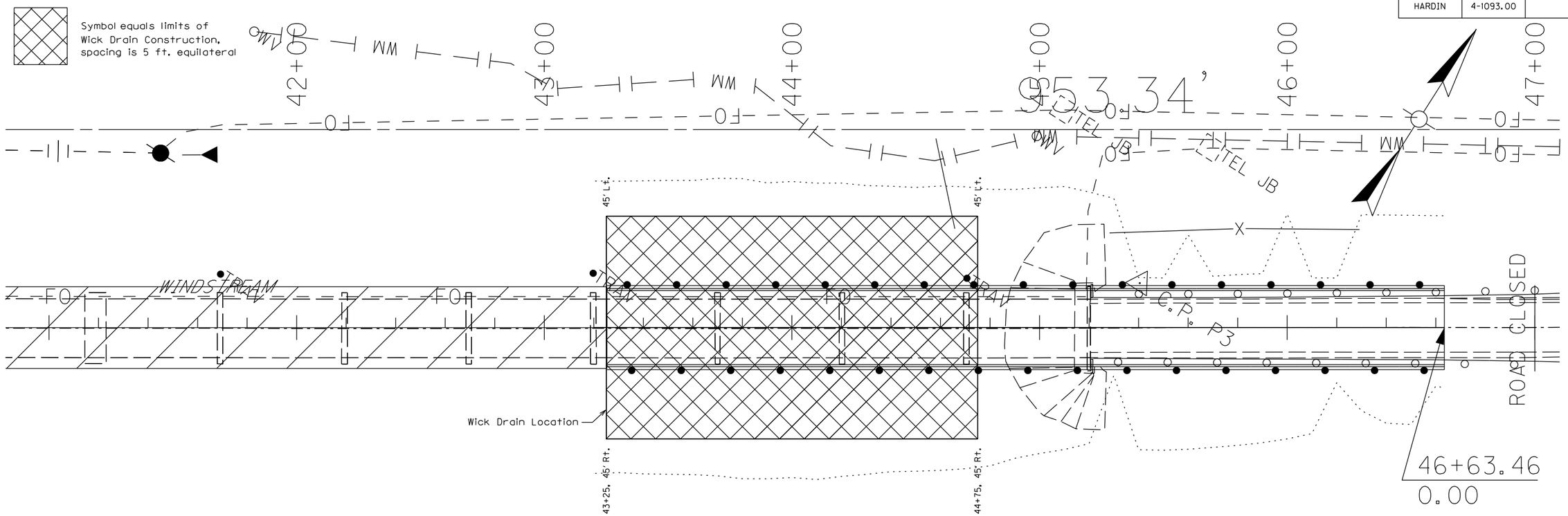
* Where the resistance factors provided are to be applied to a single shaft supporting a bridge pier, the resistance factor values should be reduced by 20%.

>>> = Min. Socket Length

D (ft.) = 6.0

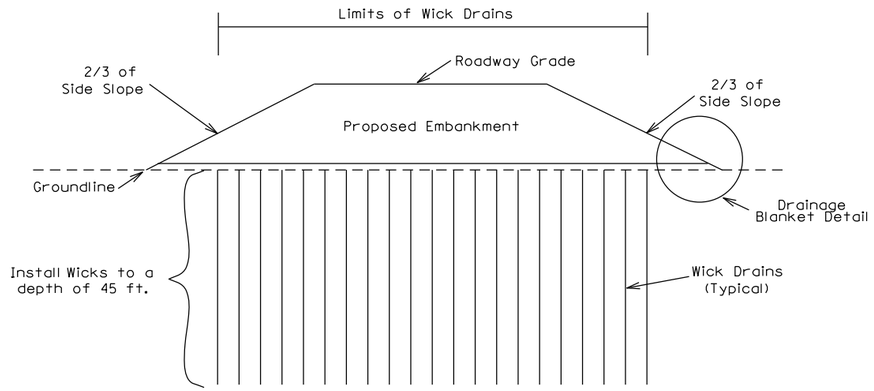
COUNTY OF	ITEM NO.	SHEET NO.
HARDIN	4-1093.00	

Symbol equals limits of Wick Drain Construction, spacing is 5 ft. equilateral



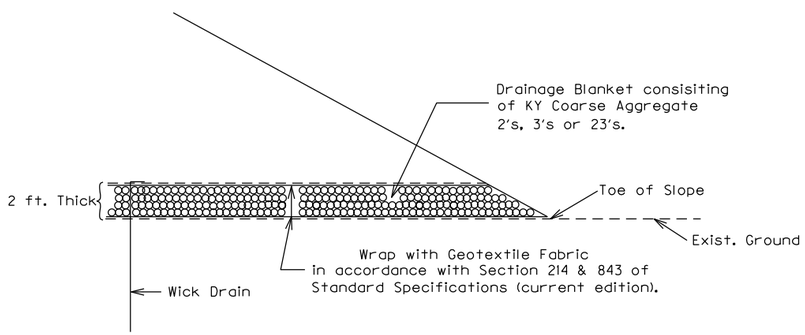
TYPICAL SECTION - WICK DRAINS

Not To Scale



DRAINAGE BLANKET DETAIL

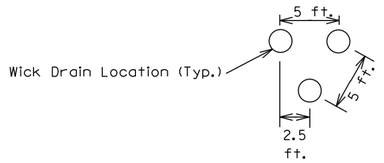
Not To Scale



PLAN VIEW - WICK DRAIN LOCATIONS

DETAIL - TRIANGULAR SPACING

NOT TO SCALE



WICK DRAIN DETAIL
END BENT 2

FILE NAME:
USER:
DATE
E-SHEET NAME:
MicroStation v8.11.7.443

S-085-2018 04-1093.00 Kentucky Transportation Cabinet

ID	Latitude	Longitude	Hole	Station	Offset	Elevation(ft)	Comments
1	37.76678773	-85.70429806	1001	37+66.63	-8	457.311	Embankment fill to 25.0'.
2	37.76675059	-85.70426829	1002	37+66.63	8	457.183	Embankment fill to 24.7'.
3	37.76689743	-85.70413588	1003	38+27.64	-16.5	435.866	Lost circulation at 57.7'.
4	37.76682094	-85.70407448	1004	38+27.64	16.5	436.685	
5	37.76725243	-85.70343235	1005	40+68.63	-16.5	427.389	
6	37.76718928	-85.70334673	1006A	40+77.14	16.16	427.819	Boring relocated due to underground utilities and bridge pier.
7	37.76737736	-85.70319439	1007A	41+51.042	-18	434.027	Boring relocated due to underground utilities.
8	37.76730106	-85.70312307	1008	41+53.53	16.5	433.301	Wet return at 15.0'.
9	37.76750268	-85.70293663	1009	42+38.43	-16.5	436.884	Wet return at 20.0'.
10	37.76742615	-85.70287526	1010	42+38.43	16.5	437.512	
11	37.76753301	-85.70274891	1011A	42+90.108	3.254	436.886	
12	37.76763065	-85.70268279	1012	43+25.29	-16.5	436.32	
13	37.76755413	-85.70262152	1013	43+25.29	16.5	436.921	Wet return from 15.0'-20.0'.