M E M O R A N D U M

TO: Michael Carpenter P.E.
Director, Division of Structural Design

FROM: Adam Ross, P.E.
TEBM, Geotechnical Services Branch
Division of Structural Design

BY: Tyler Sheffield, P.E.
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DATE: September 29, 2022

SUBJECT: **Jefferson County**
12F0 FD52 056 0264 021-023 D
I-264 WB
Mars #: 8556402D
Fed #: 00STP2641176
RECONSTRUCT THE WATTERSON EXPRESSWAY INTERCHANGE @US 42 INCLUDING SLIP RAMP TO KY 22
Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50
Item #: 5-804.00
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 development of structure plans. The onsite geotechnical exploration for the project was performed by a contracted drill crew of Horn and Associates.

The proposed sound barrier wall will be a part of the proposed reconstruction of the Watterson Expressway (I-264) and US 42 interchange in Jefferson County. The proposed structure is located along the north side of US 42 and the US 42 to I-264 ramp from approximate US 42 MP 5.85 to I-264 EB MP 22.55. The structure is located in Louisville, KY.

2.0 SITE GEOLOGIC CONDITIONS

This structure is located in the Jeffersonville, New Albany, and Charlestown Geologic Quadrangle (GQ# 1211). The geologic mapping indicates that this site consists of the Sellersburg Limestone Formation.

3.0 FIELD INVESTIGATION

Six (6) sample and core holes and five (5) mechanical rockline soundings were taken at this structure's location as part of the structural geotechnical investigation. After drilling, the soil samples and rock cores were delivered to the KYTC Geotechnical Branch in Frankfort, KY where a geologist logged the rock cores and the soil samples were classified and tested in the Branch's soils laboratory.

4.0 LABORATORY TESTING

The soil samples obtained from the borings were determined to consist of inorganic low plasticity clays and high plasticity silts. The soil samples were designated CL and MH using the Unified Soil Classification System. Unconfined compressive testing was conducting resulting in compressive strength values ranging from 2861 psf to 8074 psf with an average of 5030 psf.

5.0 SUBSURFACE CONDITIONS

Depths to rock/refusal vary from 4.2 ft. to 13.7 ft. Rock cores from this location indicated that bedrock consists mostly of light gray, very fine to fine grained, crystalline, fossiliferous limestone with few vugs and shale partings and laminations. The KY RQD values for the rock cores taken at this proposed bridge location ranged from 20% to 93% and core recoveries ranged from 84% to 100%. Core runs with lower KY RQD and recoveries shown on the attached subsurface data sheet consisted mostly of cored overburden. Top of rock/auger refusal elevations ranged from 564.1 ft to 580.2 ft.

6.0 ENGINEERING ANALYSIS

Use drilled shaft foundations socketed into bedrock for the proposed sound barrier wall. The Idealized Soil and Bedrock Profile sheet and the Drilled Shaft Axial Capacity Tables are attached for use in the design of the drilled shafts.

Because the wall will be founded on bedrock, no settlement analysis is required.

7.0 FOUNDATION RECOMMENDATIONS

7.1 The drilled shaft foundations shall be socketed into sound bedrock a minimum of 3 feet. Lower tip elevations may be necessary in order to satisfy lateral capacity or other structural requirements.

7.2 For Load & Resistance Factor Design (LRFD), evaluate the total factored axial resistances using the attached Drilled Shaft Axial Resistance Tables considering only the capacity developed in the uncased rock sockets. The total factored resistances must exceed the factored loads at the strength limit state.

7.3 Perform lateral load analyses 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 derived from the top 5 feet of overburden soils.

7.4 The drilled shafts shall be constructed in accordance with the Special Note for Drilled Shafts, current edition, except that the subsurface exploration borings in accordance with Section 3.5 of the Special Note are not required.

7.5 Sound barrier walls should not be subjected to differential earth loading. Reinforced panels may shift or crack and the entire wall could potentially have an overturning failure if it is subject to earth loads. Special pane and foundation designs are required in order to safely construct a hybrid Retaining/Sound barrier wall. In walls constructed in newly placed fill areas, it should not be assumed that construction will be phased in a manner to avoid imposing earth loads. The walls should either be designed to withstand the maximum potential earth load or construction phasing must be specified to prevent differential loading conditions. Wall design loads should be determined using Soil Type 3 of Exhibit 413 in the Division of Structural Design Guidance Manual.

7.6 If significant voids are found while drilling for the rock socket, it may be necessary to extend permanent casing beyond the voids to avoid excessive concrete take.

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

8.1 Permanent casing is not required. The contractor may elect to use temporary casing in deeper soil areas. Temporary casing may be omitted if the contractor can demonstrate the ability to maintain an open excavation without collapse of the side walls, fallback of material into the excavation, or fallback into and contamination of freshly placed concrete.

8.2 Permanent casing may be required in the rock socket if significant voids are found during drilling. If permanent casing is required, the rock socket is to be extended below the casing to provide an uncased rock socket length shown on the plans.

8.3 Except as permitted by special design, Sound Barrier Walls shall not be subjected to differential earth loading. Temporary or permanent soil loads placed on the sound barrier walls are only permitted as noted in the sound barrier wall plans.

8.4 Shafts shall have a minimum rock socket depth of 3 feet.

8.5 The drilled shafts shall be constructed in accordance with the Special Note for Drilled Shafts, current edition, except that the subsurface exploration borings in accordance with Section 3.5 of the Special Note are not required.

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.

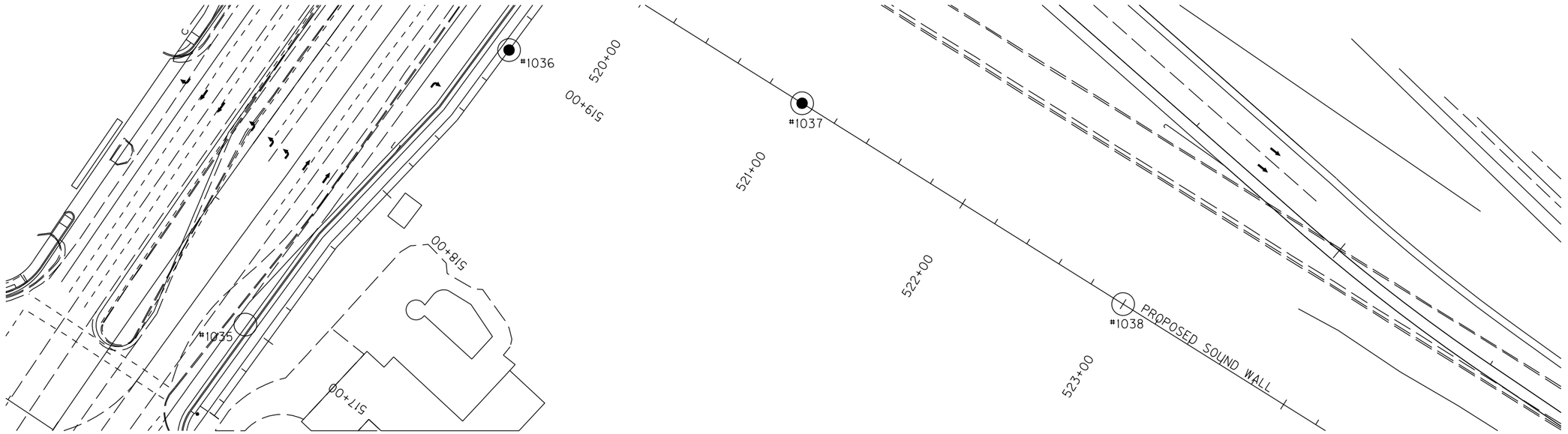
Attachments:

- **Structure Location Map**
- **Subsurface Data Sheet**
- **Idealized Soil and Bedrock Profile**
- **Drilled Shaft Axial Resistance Tables**
- **Coordinate Data Sheet**

Structure Location Map:
Approximate Lat./Long: 38.280755/-85.635851

SUBSURFACE DATA

Plan Scale 1" = 30'



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

Hole No.	1035	1036	1037	1038
Station	517+00.00	520+00.00	521+00.00	523+00.00
Offset	15.00 ft. Lt.	℄	℄	℄
Elev. (NAVD 88 datum)	589.40	588.80	589.40	589.80

Hole No. 1035

R (579.60)

Qu (psf)	D_{50} (mm)	w%	LI	
	0.006	12	-0.62	A-6(15),CL,S+C=95(67+28)
2861	0.004	30	0.66	A-6(18),CL,S+C=94(53+41)

KYROD REC.
88 100
90 100

Limestone: light gray to gray, very fine to fine grain, crystalline, fossiliferous to fossil fragmental, few stylolites, few vugs, w/shale partings & laminations

Top of rock elev.= 577.30
No weathered rock

Hole No. 1038

R (576.10)

Qu (psf)	D_{50} (mm)	w%	LI	
	0.002	19	-1.10	A-7-5(31),MH,S+C=95(45+50)
4594	0.002	24	0.36	A-6(18),CL,S+C=95(48+47)

KYROD REC.
84 100
92 100

Limestone: light gray to gray, very fine to fine grain, crystalline, fossiliferous to fossil fragmental, w/shale partings & laminations

Top of rock elev.= 577.90
No weathered rock

590 580 570 560 550 540 530

Datum

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
KENTUCKY TRANSPORTATION CABINET

REVISION	DATE

PREPARED BY
Division of Structural Design
Geotechnical Branch

DATE: 08-SEPTEMBER-2022
DESIGNED BY:
DETAILED BY: E. BAILEY
CHECKED BY
T. SHEFFIELD

CROSSING
Sound Wall @ Sta. 127+95.43–5138+50.00

ROUTE **I–264**

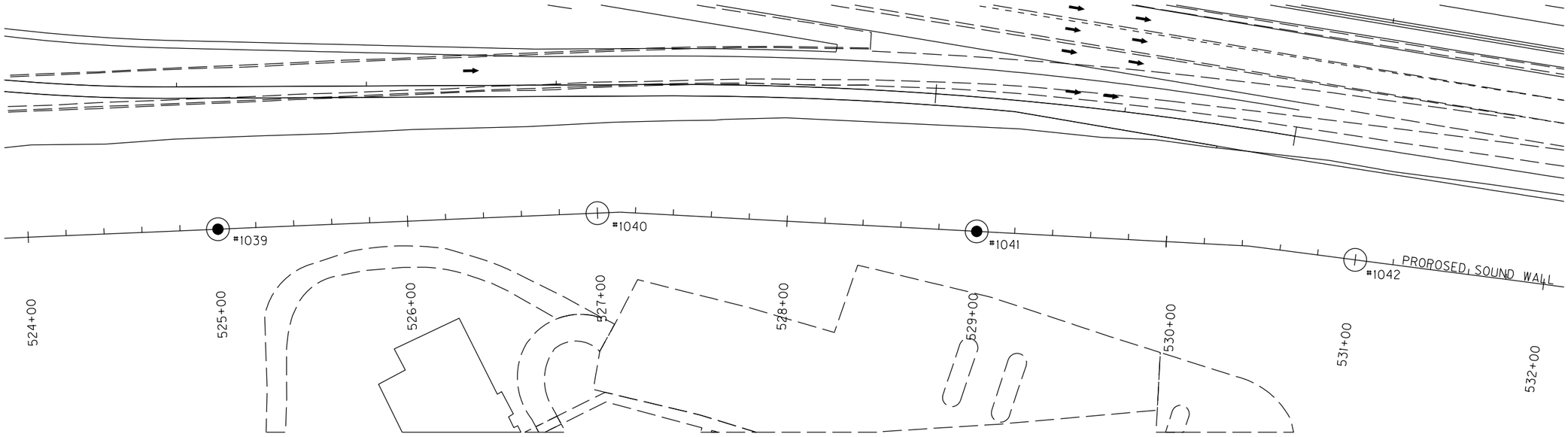
ITEM NO. **5–804.00**
SHEET NO.

COUNTY OF **JEFFERSON**
DRAWING NUMBER **S–088–2022**

OpenRoads Designer v10.16.2.267 USER: $$$$USER$$$$ DATE PLOTTED: $$$$DATE$$$$ FILE NAME: $$$$design$file$specification$$$$

SUBSURFACE DATA

Plan Scale 1" = 30'



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

Hole No.	1039	1040	1041	1042
Station	525+00.00	527+00.00	529+00.00	531+00.00
Offset	℄	℄	℄	℄
Elev. (NAVD 88 datum)	589.50	587.60	584.90	583.10

590 / 580 / 570 / 560 / 550 / 540 / 530

1039

Qu (psf)	D_{50} (mm)	w%	LI	
	0.003	13	-0.15	A-6(16),CL,S+C=94(50+44)
4594	0.005	14	-0.40	A-7-6(19),CL,S+C=93(57+36)

KYROD	REC
20	90
32	100
93	100

Limestone: light gray to gray, very fine to fine grain, crystalline, fossiliferous to fossil fragmental, few stylolites, few vugs, w/shale partings & laminations (light petroleum staining from 21.6' to 22.8')

Top of rock elev.= 576.70
No weathered rock

R (580.20)

1042

Qu (psf)	D_{50} (mm)	w%	LI	
	0.006	21	0.01	A-6(14),CL,S+C=95(65+30)
8074	0.006	9	-0.72	A-6(15),CL,S+C=95(66+29)

KYROD	REC
35	45
75	100

Cored Overburden: w/limestone cobbles & boulders, some solutioning
Limestone: light gray to dark gray, very fine to fine grain, crystalline, fossiliferous, few vugs, w/shale partings & laminations

Top of rock elev.= 573.30
No weathered rock

R (572.90)

Datum

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
KENTUCKY TRANSPORTATION CABINET

REVISION	DATE

PREPARED BY
Division of Structural Design
Geotechnical Branch

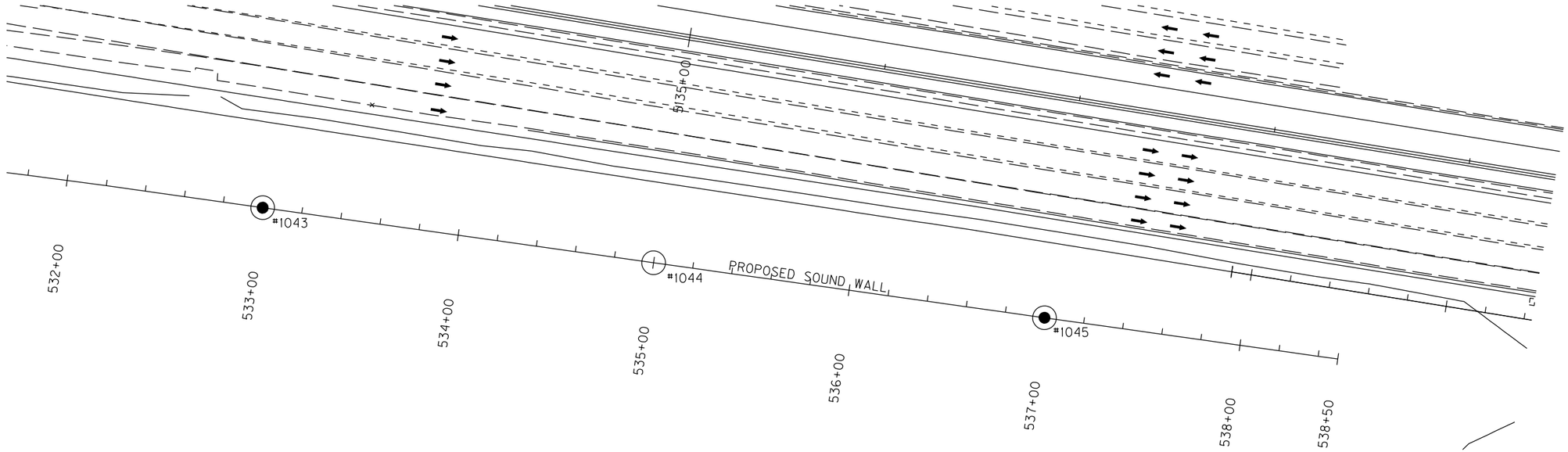
DATE: 08-SEPTEMBER-2022	CHECKED BY	
DESIGNED BY:		
DETAILED BY: E. BAILEY	T. SHEFFIELD	

CROSSING
Sound Wall @ Sta. 127+95.43–5138+50.00

ROUTE	ITEM NO.	COUNTY OF
I–264	5–804.00	JEFFERSON
	SHEET NO.	DRAWING NUMBER
		S–088–2022

SUBSURFACE DATA

Plan Scale 1" = 30'



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

Hole No.	1043	1044	1045
Station	533+00.00	535+00.00	537+00.00
Offset	℄	℄	℄
Elev. (NAVD 88 datum)	580.60	581.70	568.30

590 580 570 560 550 540 530

D_{50} (mm) | w% | LI

0.007 | 17 | -0.30 — A-6(15), CL, S+C=95(67+28)

0.018 | 28 | -0.80 — A-7-5(14), MH, S+C=62(30+32)

0.005 | 29 | -0.65 — A-7-5(25), MH, S+C=79(39+40)

KYROD REC. N=50/0.1
84 96
42 100
Limestone: light gray to (stained) brownish gray, very fine to fine grain, crystalline, fossiliferous to fossil fragmental, few stylolites, few vugs, w/shale partings & laminations (light to moderate petroleum staining from 15.9' to 17.9')

Top of rock elev.= 567.00
No weathered rock

R
(572.30)

KYROD REC. N=50/0.1
52 84
80 96
Cored Overburden: w/limestone cobbles & pebbles
Limestone: light gray to gray, very fine to fine grain, crystalline, fossiliferous to fossil fragmental, few stylolites, few vugs, w/shale partings & laminations

Top of rock elev.= 564.10
No weathered rock

Datum

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
KENTUCKY TRANSPORTATION CABINET

REVISION	DATE

PREPARED BY
Division of Structural Design
Geotechnical Branch

DATE: 08-SEPTEMBER-2022	CHECKED BY	
DESIGNED BY:		
DETAILED BY: E. BAILEY	T. SHEFFIELD	

CROSSING
Sound Wall @ Sta. 127+95.43–5138+50.00

ROUTE	ITEM NO.	COUNTY OF
I-264	**5-804.00**	**JEFFERSON**
	SHEET NO.	DRAWING NUMBER
		S-088-2022

IDEALIZED SOIL AND BEDROCK PROFILE

Jefferson Co., Item# 5-804.00, I-264 and US 42 Interchange
S-088-2022: Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50

TQS 8/30/22

Elev. (ft.)

Top of Shaft

Overburden, Neglect top 5' for Support

Stiff Clay w/ Free Water

Effective Unit Weight,	**γ_e (lb/ft^3) =**	**58**
Undrained Cohesion,	**c (lb/ft^2) =**	**2500**
Strain Factor,	**E50 =**	**0.005**
Soil Modulus,	**k (lb/in^3) =**	**1000**

Top of Rock Socket

*

Strata		**Parameters for Lateral Load Analyses**		
Limestone		**Strong Rock (Vuggy Limestone)**		
γ_t (lb/ft^3) =	**150**	**Effective Unit Weight,**	**γ_e (lb/in^3) =**	**0.087**
q_u (psi) =	**4000**			
q_{eb} (ksf) =	**90**	**Uniaxial Compressive Strength,**	**q_u (psi) =**	**4000**
f_s (ksf) =	**32.7**			

(Side friction limited by Concrete Strength to fs = 32.7 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
Jefferson Co., Item# 5-804.00, I-264 and US 42 Interchange
S-088-2022: Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50

Rock Socket Diameter = 1.5 feet
Rock Socket Diameter = 18 inches **TQS 8/30/22**

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	32.7	90	154	159	77	80	157	62
2.0	32.7	90	308	159	154	80	234	123
>>> 3.0	32.7	90	462	159	231	80	311	185
4.0	32.7	90	616	159	308	80	388	246
5.0	32.7	90	770	159	385	80	465	308
6.0	32.7	90	924	159	462	80	542	370
7.0	32.7	90	1078	159	539	80	619	431
8.0	32.7	90	1232	159	616	80	696	493
9.0	32.7	90	1386	159	693	80	773	555
10.0	32.7	90	1540	159	770	80	850	616
11.0	32.7	90	1694	159	847	80	927	678
12.0	32.7	90	1848	159	924	80	1004	739
13.0	32.7	90	2002	159	1001	80	1081	801
14.0	32.7	90	2157	159	1078	80	1158	863
15.0	32.7	90	2311	159	1155	80	1235	924
16.0	32.7	90	2465	159	1232	80	1312	986
17.0	32.7	90	2619	159	1309	80	1389	1047
18.0	32.7	90	2773	159	1386	80	1466	1109
19.0	32.7	90	2927	159	1463	80	1543	1171
20.0	32.7	90	3081	159	1540	80	1620	1232
AASHTO Table 10.5.5.2.4-1			Resistance Factor, ϕ		0.50	0.50		0.40

>>> = Min. Socket Length

D (ft.) = 1.5

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE
Jefferson Co., Item# 5-804.00, I-264 and US 42 Interchange
S-088-2022: Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50

Rock Socket Diameter = 2.0 feet
Rock Socket Diameter = 24 inches **TQS 8/30/22**

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	32.7	90	205	283	103	141	244	82
2.0	32.7	90	411	283	205	141	347	164
>>> 3.0	32.7	90	616	283	308	141	449	246
4.0	32.7	90	822	283	411	141	552	329
5.0	32.7	90	1027	283	513	141	655	411
6.0	32.7	90	1232	283	616	141	758	493
7.0	32.7	90	1438	283	719	141	860	575
8.0	32.7	90	1643	283	822	141	963	657
9.0	32.7	90	1848	283	924	141	1066	739
10.0	32.7	90	2054	283	1027	141	1168	822
11.0	32.7	90	2259	283	1130	141	1271	904
12.0	32.7	90	2465	283	1232	141	1374	986
13.0	32.7	90	2670	283	1335	141	1476	1068
14.0	32.7	90	2875	283	1438	141	1579	1150
15.0	32.7	90	3081	283	1540	141	1682	1232
16.0	32.7	90	3286	283	1643	141	1784	1314
17.0	32.7	90	3491	283	1746	141	1887	1397
18.0	32.7	90	3697	283	1848	141	1990	1479
19.0	32.7	90	3902	283	1951	141	2093	1561
20.0	32.7	90	4108	283	2054	141	2195	1643
AASHTO Table 10.5.5.2.4-1			Resistance Factor, ϕ		0.50	0.50		0.40

>>> = Min. Socket Length

D (ft.) = 2.0

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE
Jefferson Co., Item# 5-804.00, I-264 and US 42 Interchange
S-088-2022: Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50

Rock Socket Diameter = 2.5 feet
Rock Socket Diameter = 30 inches **TQS 8/30/22**

	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	32.7	90	257	442	128	221	349	103
	2.0	32.7	90	513	442	257	221	478	205
>>>	3.0	32.7	90	770	442	385	221	606	308
	4.0	32.7	90	1027	442	513	221	734	411
	5.0	32.7	90	1284	442	642	221	863	513
	6.0	32.7	90	1540	442	770	221	991	616
	7.0	32.7	90	1797	442	899	221	1119	719
	8.0	32.7	90	2054	442	1027	221	1248	822
	9.0	32.7	90	2311	442	1155	221	1376	924
	10.0	32.7	90	2567	442	1284	221	1505	1027
	11.0	32.7	90	2824	442	1412	221	1633	1130
	12.0	32.7	90	3081	442	1540	221	1761	1232
	13.0	32.7	90	3337	442	1669	221	1890	1335
	14.0	32.7	90	3594	442	1797	221	2018	1438
	15.0	32.7	90	3851	442	1925	221	2146	1540
	16.0	32.7	90	4108	442	2054	221	2275	1643
	17.0	32.7	90	4364	442	2182	221	2403	1746
	18.0	32.7	90	4621	442	2311	221	2531	1848
	19.0	32.7	90	4878	442	2439	221	2660	1951
	20.0	32.7	90	5135	442	2567	221	2788	2054
AASHTO Table 10.5.5.2.4-1				Resistance Factor, ϕ		0.50	0.50		0.40

>>> = Min. Socket Length

D (ft.) = 2.5

Load and Resistance Factor Design (LRFD)

DRILLED SHAFT AXIAL RESISTANCE TABLE
Jefferson Co., Item# 5-804.00, I-264 and US 42 Interchange
S-088-2022: Sound Barrier Wall at Northfield #1, US 42 127+95.43 to I-264 EB Sta. 5138+50

Rock Socket Diameter = 3.0 feet
Rock Socket Diameter = 36 inches **TQS 8/30/22**

	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	32.7	90	308	636	154	318	472	123
	2.0	32.7	90	616	636	308	318	626	246
>>>	3.0	32.7	90	924	636	462	318	780	370
	4.0	32.7	90	1232	636	616	318	934	493
	5.0	32.7	90	1540	636	770	318	1088	616
	6.0	32.7	90	1848	636	924	318	1242	739
	7.0	32.7	90	2157	636	1078	318	1396	863
	8.0	32.7	90	2465	636	1232	318	1550	986
	9.0	32.7	90	2773	636	1386	318	1704	1109
	10.0	32.7	90	3081	636	1540	318	1858	1232
	11.0	32.7	90	3389	636	1694	318	2012	1356
	12.0	32.7	90	3697	636	1848	318	2167	1479
	13.0	32.7	90	4005	636	2002	318	2321	1602
	14.0	32.7	90	4313	636	2157	318	2475	1725
	15.0	32.7	90	4621	636	2311	318	2629	1848
	16.0	32.7	90	4929	636	2465	318	2783	1972
	17.0	32.7	90	5237	636	2619	318	2937	2095
	18.0	32.7	90	5545	636	2773	318	3091	2218
	19.0	32.7	90	5853	636	2927	318	3245	2341
	20.0	32.7	90	6161	636	3081	318	3399	2465
AASHTO Table 10.5.5.2.4-1				Resistance Factor, ϕ		0.50	0.50		0.40

>>> = Min. Socket Length

D (ft.) = 3.0

S-088-2022 05-0804.00 Kentucky Transportation Cabinet

ID	Latitude	Longitude	Hole	Station	Offset	Elevation(ft)	Comments
1	38.2812445	-85.6351576	1035	517+00	-15	589.435	First rock @ 9.3 ft
2	38.2808522	-85.6356433	1036	520+00	0	588.756	
3	38.2809644	-85.6361725	1037	521+00	0	589.385	
4	38.2812934	-85.6367304	1038	523+00	0	589.791	First rock @ 13.5 ft
5	38.2816225	-85.6372882	1039	525+00	0	589.519	
6	38.2819515	-85.6378461	1040	527+00	0	587.577	First rock @ 7.2 ft
7	38.2823103	-85.6383533	1041	529+00	0	584.9	
8	38.2826968	-85.6388689	1042	531+00	0	583.082	First rock @ 10.0 ft
9	38.2830977	-85.6393452	1043	533+00	0	580.628	
10	38.2835009	-85.6398183	1044	535+00	0	581.655	First rock @ 9.2 ft
11	38.2839041	-85.6402914	1045	537+00	0	568.32	