

MEMORANDUM

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.
Geotechnical Services Branch

DATE: December 6, 2023

**SUBJECT: Harlan County
Item No. 11-0000.00
Replace Flood Damaged Culvert on KY 522 Approx. MP 12.75
12'x8' RCBC over Bridge Branch on KY 522 at Sta. 11+37
Geotechnical Engineering Structure Foundation Report**

cc: J. Van Zee
C. Van Zee
S. Chappell
D. Fuson
R. Turner
M. Robertson
J. Franchino
D. McElmurray
S. McIntosh (JMT)

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 Geotechnical Office drill crew.

The proposed culvert replacement is located on KY 522 at approximate M.P. 12.75. The structure is located approximately 5.8 miles southwest of Cumberland, KY.

2.0 SITE GEOLOGIC CONDITIONS

This structure is located in the Louellen Geologic Quadrangle (GQ# 1060). The geologic mapping indicates that this site consists of the Grundy Formation.

3.0 FIELD INVESTIGATION

One (1) sample/core hole and one (1) sample hole were taken at this structure's location as part of the structural geotechnical investigation. After drilling, the rock cores and soil samples were delivered to the KYTC Geotechnical Office in Frankfort, KY where a geologist logged the rock core, and the soil samples were classified and tested in the Office's laboratory.

4.0 LABORATORY TESTING

The soil samples obtained from the borings were determined to consist of silty gravel, silty sand, and clayey silty gravel. The soil samples were designated GM, SM, and GC-GM using the Unified Soil Classification System.

5.0 SUBSURFACE CONDITIONS

Depth to rock/refusal varied from 25.1 ft to 35.2 ft. Rock core taken at this site consisted of gray, coarse grain, durable sandstone with shale partings and laminations. The KY RQD values for the rock cores taken at this proposed culvert location ranged from 36% to 96% and core recovery was 100%. The top of rock/refusal elevations at this site varied from 1349.0 ft to 1358.5 ft.

6.0 ENGINEERING ANALYSIS

Due to the rock depths and the proposed flow line elevations the culvert should be designed for a **yielding** foundation.

With the lack of new fill material being placed, settlement is not a concern at this location. Embankment stability at the outlet of the culvert is a geotechnical concern, however. A retaining structure is required to achieve satisfactory factors of safety for this slope. A gabion basket wall or a large block retaining wall without geogrid or geotextile reinforcement is suitable at this location. The design of this wall shall follow the recommendations within this report to satisfy LRFD checks for eccentricity (overturning), bearing capacity, and sliding.

7.0 FOUNDATION RECOMMENDATIONS:

Culvert

- 7.1 Design this culvert for a **yielding** foundation. For a yielding foundation, any bedrock or boulders encountered within 2 ft. of the bottom slab must be excavated and backfilled with soil to the base of the footing elevation.
- 7.2 The culvert wingwalls shall be founded on soil. Size the footing a service limit state using the factored nominal resistance of 7.5 ksf. For checking strength and extreme limit states, the nominal bearing resistance has been determined to be 22.6 ksf. Use a resistance factor of 0.45 for strength limit state analysis and a resistance factor of 1.0 for extreme limit state analysis.
- 7.3 This culvert should be designed with a paved flowline. The paved flowline shall also include the inlet and outlet apron portions of the culvert's flowline. The ends of the aprons shall incorporate a toe-wall designed in accordance with Exhibit 513 of the KYTC Division of Structural Design Guidance Manual.
- 7.4 The wingwalls should be designed using Soil Type 3 of Exhibit 413 in the Division of Structural Design Guidance Manual. It should be noted that the backfill slope being referred to is that which is perpendicular to the wingwall.

Retaining Structure

- 7.5 The backfill behind the wall may consist of in-situ soil. If additional backfill is required, use granular material meeting the requirements of "granular embankment" in Section 805 of the Standard Specifications, current edition, except that the maximum size is 4 inches. Use material that is classified as non-erodible as defined in Section 805 of the Standard Specifications, current edition. Place a Class 2 Geotextile Fabric for separation between contact points of the soil and granular replacement. The geotextile fabric shall be in accordance with Section 214 and 843 of the Standard Specifications for Road and Bridge Construction, current edition.
- 7.6 The backfill behind the wall shall not exceed a slope of 2H:1V.

Gabion Basket Wall Parameters

- 7.6.1 A gabion basket wall at this location shall have a base width of at least 13 feet.
- 7.6.2 The wall shall be embedded a minimum of 1 basket depth below the final grade at the base of the wall.

Modular Block Wall Parameters

- 7.6.3 The wall shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications, current edition.

- 7.6.4** The following parameters shall be utilized for design of the wall:
- | | |
|--|------------|
| Assumed Traffic Surcharge: | 250 psf |
| Unit weight of backfill: | 120 pcf |
| Friction angle of backfill: | 36° |
| Cohesion of backfill: | 0 psf |
| Unit weight of foundation soil: | 120 pcf |
| Friction angle of foundation soil: | 36° |
| Cohesion of foundation soil: | 0 psf |
| Factored Nominal Bearing Resistance
at the Service Limit State: | 7,500 psf |
| Nominal Bearing Resistance: | 13,600 psf |
- 7.6.5** Drainage systems behind the wall will be necessary. Provide weep holes at specified intervals.
- 7.6.6** The leveling pad of the wall shall be embedded a minimum of 2 feet below final grade at the base of the wall.
- 7.6.7** The wall designer shall verify internal wall stability and global stability based on final wall design dimensions. Global stability must achieve a minimum factor of safety of 1.4.

8.0 Plan Notes

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

Culvert

- 8.1** Solid rock excavation may be required to reach required footing elevations.
- 8.2** Temporary sheeting or shoring/cofferdams and/or a dewatering method will be required for installation of the footings.

Retaining Wall

- 8.3** Include the attached plan sheet, "Geotechnical Notes for Gravity Retaining Wall", at the appropriate location in the roadway plans.

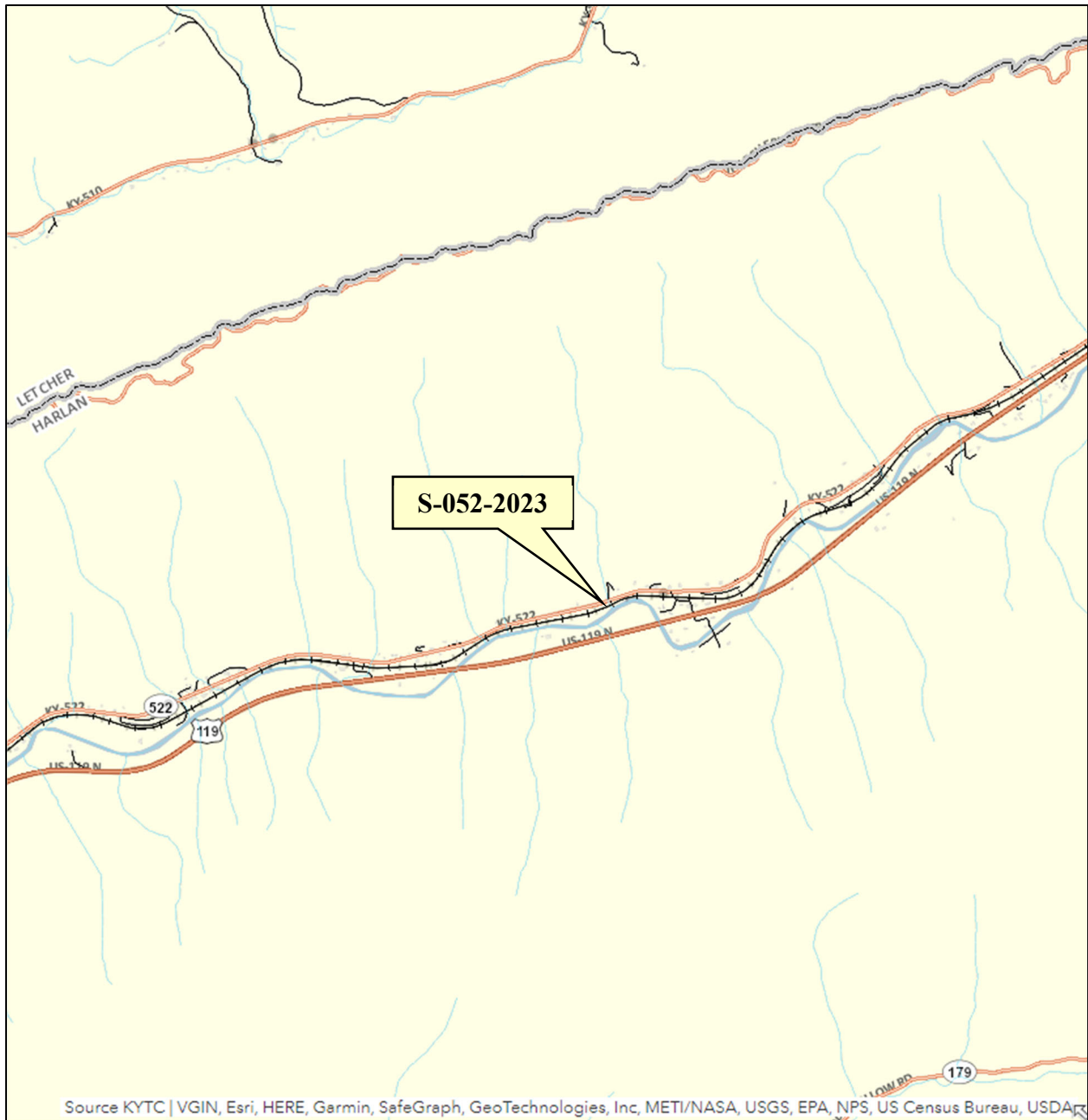
The designer should feel free to contact the Geotechnical Office for further recommendations, or for any additional questions that arise pertaining to this project, at (502)564-2374.

Attachments:

- Structure Location Map
- Subsurface Data Sheet
- Coordinate Data Sheet

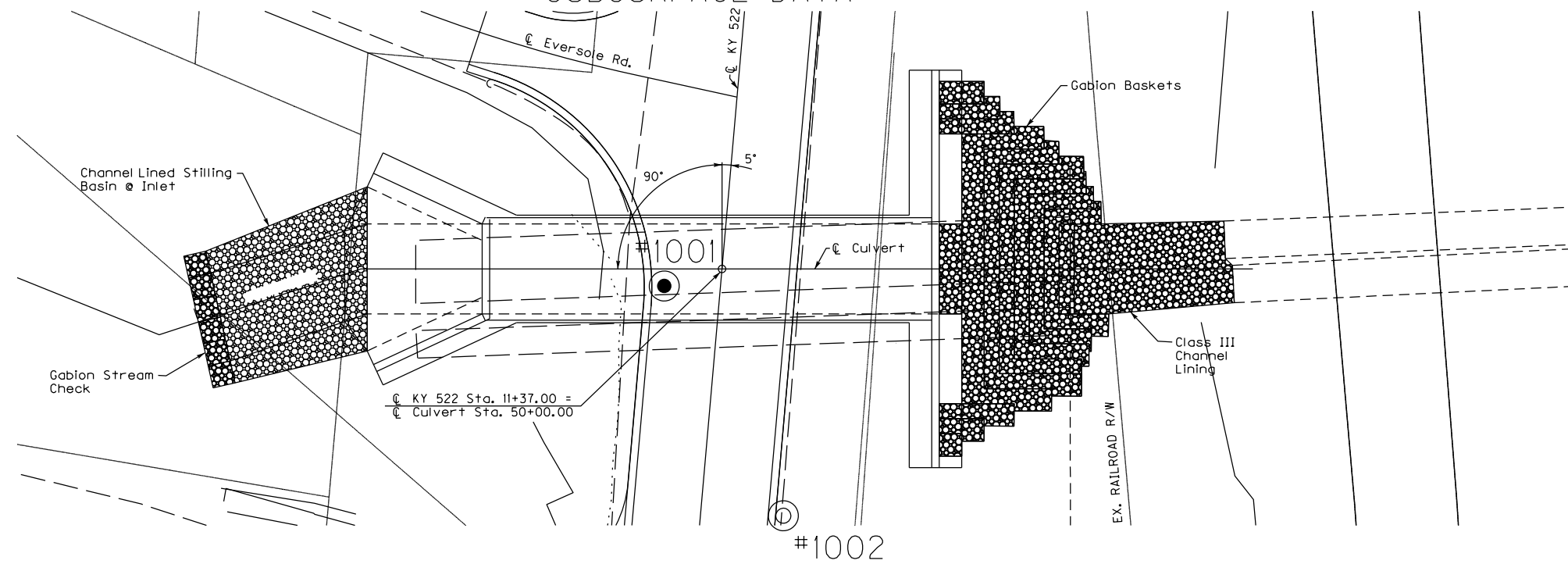
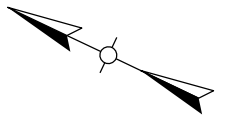
S-052-2023
Harlan Co., KY 522
December 6, 2023
11-0000.00

Structure Location Map:
36.950214, -83.088877



SUBSURFACE DATA

Plan Scale 1" = 10'

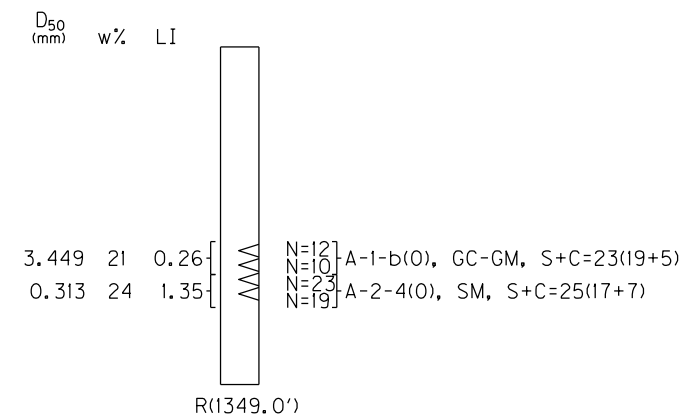
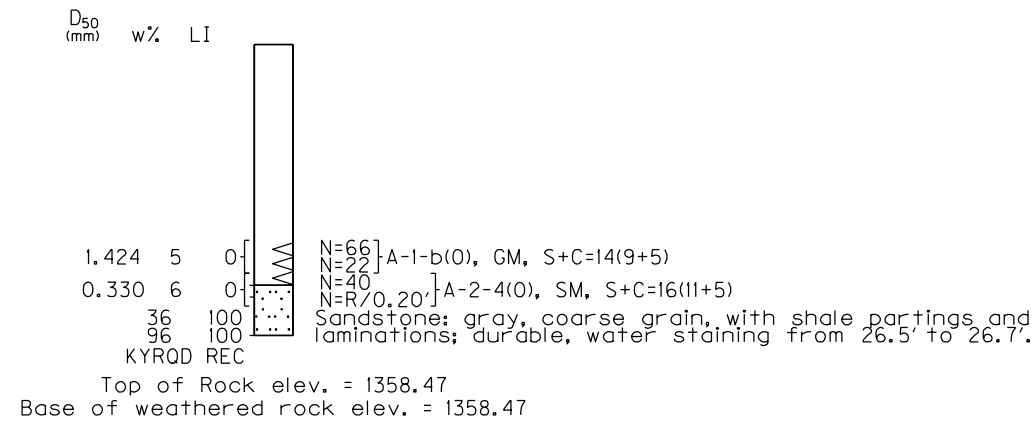


Profile Scale:
Vertical 1" = 10'
Horizontal not to scale

Hole No.
Station
Offset
Elev.
(NAVD 88
datum)

1001
11+34.10
7.5' Lt.
1383.6

1002
11+04.80
11.0' Rt.
1384.2



Datum

GEOTECHNICAL NOTES

for Gravity Retaining Wall

- 1) The minimum embedment shall be 1 basket depth from finished grade in front of the wall to bottom of wall for a gabion basket design. Minimum embedment shall be 2 ft to the top of leveling pad for a modular block design.
- 2) Minimum base width for a gabion basket design shall be 13 ft.
- 3) Backfill behind the wall may consist of in-situ soil. If additional backfill is required, use granular material meeting the requirements of "Granular Embankment" in Section 805 of the Standard Specifications, current edition, except that the maximum size is 4 inches. Use material that is classified as non-erodible as defined in Section 805 of the Standard Specifications, current edition.

Bearing Surface	Nominal Bearing Resistance	Factored Nominal Bearing Resistance at the Service Limit State
Existing Soil	13.6 ksf	7.5 ksf

- 4) Use the following soil strength parameters for design:

	Cohesion (psf)	Friction Angle (degrees)	Unit Weight (pcf)
<u>External Backfill</u>			
Granular Embankment (if required)	0	38	115
Existing Soil	0	36	120
<u>Foundation Soils</u>			
Existing Soil	0	36	120
Assumed Traffic Surcharge:	250 psf		

- 5) Backfill behind the wall may not exceed a slope of 2H:1V.
- 6) Place a Class 2 Geotextile Fabric for separation between contact points of the soil and granular embankment. The geotextile fabric shall be in accordance with Section 214 and 843 of the Standard Specifications for Road and Bridge Construction, current edition.
- 7) The wall designer shall verify internal wall stability and global stability based on final wall design dimensions. Global stability must achieve a minimum factor of safety of 1.4.
- 8) Drainage systems behind the wall will be necessary. Provide weep holes at 8 ft intervals.
- 9) Temporary shoring, sheeting, cofferdams, and/or dewatering methods may be required to facilitate wall construction.
- 10) A large block Retaining Wall without Geogrid or Geotextile Reinforcement may be suitable at this location. If this wall type is utilized, size the wall footings at Service Limit State using Factored Nominal Bearing Resistance on this sheet. For checking bearing resistance at Strength and Extreme Limit States, use Resistance Factors of 0.55 and 1, respectively, applied to the Nominal Bearing Resistance.
- 11) Solid rock excavation may be required for installation of this retaining wall. If the bedrock becomes softened at bearing elevation, the softened material shall be undercut to suitable bearing material prior to placing the concrete.
- 12) The wall shall be designed in accordance with AASHTO LRFD Bridge Design Specifications, current edition.



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS



REVISION	DATE

PREPARED BY
**Division of Structural Design
Geotechnical Branch**

DATE: 06-DECEMBER-2023

CHECKED BY

DESIGNED BY:

DETAILED BY:

CROSSING
12'x8' RCBC @ Sta. 11+37.00

ROUTE
KY 522

ITEM NO.
11-0000

SHEET NO.

COUNTY OF
HARLAN

DRAWING NUMBER

S-052-2023B

S-052-2023 11-00000. Kentucky Transportation Cabinet

ID	Latitude	Longitude	Hole	Station	Offset	Elevation(ft)	Comments
1	36.950183	-83.088878	1002	11+04.8	11	1384.227	
3	36.950257	-83.088804	1001	11+34.1	-7.5	1383.574	