



April 21, 2026

ms consultants, inc.
2221 Schrock Road
Columbus, Ohio 43229

Attention: Mr. Sean Jenq, PhD, P.E. – Project Manager

Reference: **Geotechnical Exploration – Final Report**
Proposed Culvert Replacement
PIK-CR72-00.54, California Pike over Tributary of Glade Run
Marion Township, Pike County, Ohio
CTL Project No. 21050046CIN

Dear Mr. Jenq:

CTL Engineering, Inc. (CTL) has completed the geotechnical exploration for the above referenced project. Enclosed is the digital (pdf) copy of the Final report.

It is noted that the headwall design shown on the final plans differs from the standard full height headwall design presented in ODOT Design Data Sheets HWDD-1. In particular, the footing widths shown on sections X-X and Y-Y on Sheet 5 of 10 are significantly narrower than the standard footing widths shown on HWDD-1 for headwalls of comparable height. In addition, the foundation soil shear strength indicated by the internal angle of friction (drained) recommended in this report (reference Table 3) is less than the standard design value of 28 degrees listed on HWDD-1 due to the highly plastic clay foundation soils encountered in the boring. Considering the reduced footing width and the lower recommended design shear strength of foundation soils, it is recommended that the Designer verify the external stability of the proposed headwalls/wingwalls (i.e. sliding, overturning/eccentricity, overall/global stability). These evaluations fall outside the scope of CTL's services on this project.

Thank you for the opportunity to be of service to you on this project. If you have any questions, please contact me at our office.

Respectfully Submitted,

CTL ENGINEERING, INC.

A handwritten signature in black ink, appearing to read "H. Jason Hughes". The signature is stylized with a large "H" and a long horizontal stroke.

H. Jason Hughes, P.E.
Senior Geotechnical Engineer
Regional Service Line Manager

GEOTECHNICAL EXPLORATION - FINAL REPORT

**CULVERT REPLACEMENT
PIK-CR72-00.54, CALIFORNIA PIKE OVER TRIBUTARY OF GLADE RUN
MARION TOWNSHIP, PIKE COUNTY, OHIO**

CTL PROJECT NO.: 21050046CIN

PREPARED FOR:

**MS CONSULTANTS, INC.
2221 SCHROCK ROAD
COLUMBUS, OHIO 43229**

PREPARED BY

**CTL ENGINEERING, INC.
2105 SCHAPPELLE LANE
CINCINNATI, OHIO 45240**

April 21, 2026



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I. PROJECT INFORMATION

The project is located on California Pike Road (CR72) over a tributary of Glade Run at mile post 0.54 in Marion Township, Pike County, Ohio. The project involves the replacement of the existing 10-foot single-span, steel girder bridge that is supported by cast-in-place concrete abutments and wingwalls with a 10-foot (clear span) by 8-foot (rise) precast reinforced concrete box culvert, Type A. Based on final plans dated 03/02/2023 provided to CTL Engineering, Inc. (CTL) by ms consultant, inc. (MS), the invert/flowline elevations of the proposed culvert are 729.40 feet (inlet) and 728.40 feet (outlet). The approximate cross section dimensions of the existing bridge at the outlet (based on the topographic site plan) are 10 feet wide (span) by 9.75 feet in height.

II. GEOLOGY AND OBSERVATIONS OF THE PROJECT

A. Geology

According to the Ohio Department of Natural Resources (ODNR), Physiographic Regions of Ohio, the site lies on the unglaciated portion of Ohio, within Shawnee-Mississippian Plateau.

According to the mapping of bedrock geology in the area, (Ohio Geology Interactive Map, *ODNR GIS & Mapping Services*, <https://ohiodnr.gov/>), the surficial soil deposits on the site are underlain by Mississippian age sedimentary bedrock identified as Logan and Cuyahoga Formations Undivided.

Logan Formation: This formation consists of sandstone, siltstone, and minor shale; brown in color, weathers light brown to reddish brown; thin to thick bedded, planar to lenticular.

Cuyahoga Formation: This formation consists of shale interbedded with minor sandstone and siltstone grading to massive sandstone; gray to brown in color, weathers light gray to light brown; thin to thick bedded, planar to lenticular.

According to the mapping of karst features (Known and Probable Karst in Ohio, *ODNR Geological Survey Map EG-1, 1999; Revised 2002, 2006*), there are no mapped karst features in the general vicinity of the project area.



B. Observations

The existing bridge carries California Pike Road (CR72) over an unnamed tributary which flows north to south beneath the roadway. The existing bridge and wingwalls appear to be in poor condition with severe corrosion of the steel girders and large vertical cracks and lateral displacement within the abutment walls and wingwalls. Severe scour was observed at both the inlet and outlet which exposed the footings supporting the abutments. Sloughing of the roadway embankment was observed on the north side (upstream) slope and immediately east of the bridge.

III. EXPLORATION

One (1) soil test boring, designated as B-001-0-22 was drilled for this project along south roadway berm, west of the bridge's west abutment. The test borings was advanced down to a depth of 30.0 feet below the existing ground surface (bgs).

The test boring was drilled on January 20, 2022 utilizing 3.25-inch I.D. hollow-stem augers powered by a track mounted drill rig. Split-barrel (spoon) samples and Standard Penetration Tests (SPTs) were conducted in the test boring using a 140-pound automatic hammer falling 30 inches to drive a 2-inch O.D. split barrel sampler for 18 inches. The automatic hammer was calibrated at energy ratios of 89.3 percent.

The soil materials recovered from the split spoon samples obtained during the drilling operations were preserved in glass jars. Recovered soil were visually classified in the field, and delivered to CTL's soil laboratory for classification, testing and analysis. All soil samples were tested for natural moisture content. Representative soil samples were subjected to laboratory testing including Atterberg Limits and grain size distribution. Appropriate soil samples were subjected to hand penetrometer testing.

Drilling, soil sampling field and laboratory testing were performed according to standard geotechnical engineering practices, ODOT and current AASHTO/ASTM procedures. Results from field and laboratory tests are shown on the enclosed test boring records in Appendix B of this report.

IV. FINDINGS

A. General Stratigraphy

A general description of the soils encountered during our subsurface exploration is presented below. Further details of the subsurface conditions encountered during CTL's exploration are presented in the Test Boring Record in Appendix B.

The test boring encountered approximately 9 inches of topsoil at the ground surface. Below topsoil, the test boring encountered gravel with sand, silt and clay (A-2-4) soils down to 5.5 feet bgs, underlain by fine-grained cohesive soils down



to the boring termination depth. The fine-grained soils consist of brown to gray, stiff to very stiff sandy silt (A-4a) and clay (A-7-6). Highly plastic clay (i.e. fat clay) soils were encountered below a depth of 8 feet bgs to the termination depth of the boring. Standard Penetration Test (SPT) N_{60} -values determined within the fine-grained soils ranged from 9 blows per foot (bpf) to 21 bpf with moisture content values ranging from 19 percent to 37 percent. The coarse-grained soils were described as brown, loose to medium dense gravel with sand, silt and clay (A-2-4). N_{60} -values determined within the coarse-grained material ranged from 10 bpf to 15 bpf with moisture content values ranging from 10 percent to 18 percent.

Groundwater was encountered at a depth of 6.0 feet bgs during drilling and at a depth of 9.4 feet at the completion of drilling. It should be noted that the groundwater depths recorded during this subsurface investigation are generally not a reliable indication of long-term ground water levels. Fluctuations in groundwater levels can occur with seasonal and weather conditions and water level of the stream.

B. Laboratory Tests Results

Laboratory testing consisting of Atterberg Limits and grain size distribution selected soil samples. A summary of the classification index test results are presented in Table 1 below.

Table 1. Summary of Laboratory Test Results

Boring No.	Sample No.	Sample Depth, feet	ODOT Classification	Atterberg Limits (%)		Grain-Size Distribution (%)		
				LL	PI	Sa/Gr	Si	Cl
B-001-0-22	SS-3	6.0-7.5	A-4a	24	10	58	23	19
B-001-0-22	SS-5	11.0-12.5	A-7-6	55	27	1	8	91
B-001-0-22	SS-8	18.5-20.0	A-7-6	54	27	0	5	95

V. ANALYSIS AND RECOMMENDATIONS

A. Structure Support (Culvert)

The proposed culvert has a flowline elevation of 729.4 at the inlet and 728.4 at the outlet corresponding to bearing elevations of 728.57 and 727.57, respectively. Stiff to very stiff clay (A-7-6) soils were encountered in the test boring at the bearing elevation and below. Depending on the time of construction and fluctuation of weather and groundwater condition, soft or wet soils may be encountered at the culvert bearing elevation. In such an event, these soils shall be excavated down to the competent stiff to very stiff clay soils followed by backfilling with compacted crushed stone aggregate up to the culvert bearing elevation. The plans include a 2'-0" undercut and fill with Item 304 below a 1'-0" thick plain concrete slab and 6" thick aggregate cushion with Item 304 beneath



the box culvert (i.e. 4.0-foot cut below the proposed bearing elevation of the culvert).

Considering the severe erosion exhibited along the existing wingwalls and bridge foundations, the proposed culvert and headwalls/wingwalls should be protected against the scour. Placement of the proposed culvert should be in accordance with ODOT specifications. It is assumed that sufficient scour protection will be provided at both the inlet and outlet of the culvert replacement structure. Plans call for extensive 3.0-foot thick rock channel protection, Type A with geotextile fabric, adjacent and beyond the proposed culvert and headwalls/wingwalls.

Provided the above recommendations are implemented, the proposed culvert may be supported using the parameters presented in Table 2. Total settlement of the culvert foundation is estimated to be less than 1 inch.

Table 2. Recommended Culvert Bearing Resistance

Nominal Bearing Resistance, psf (Strength Limit)	Resistance Factor (Strength Limit)	Factored Bearing Resistance, psf (Strength Limit)
8,000	0.45	3,600

B. Headwall/Wingwall Support

1. The proposed headwalls/wingwalls may be supported on spread footings constructed at a minimum depth of 2.8 feet below the adjacent grade or below the anticipated scour depth, whichever is lower in elevation. Note that frost depth at the site is 24 inches according to Figure 305-3 of the ODOT BDM. Plans indicate the headwall/wingwall footings will bear at elevations of 726.57 feet and 725.57 feet at the inlet and outlet, respectively above a 2.0-foot thick undercut and fill with Item 304. Headwall/wingwall foundations bearing at these elevations or below on the designed 2.0-foot thick undercut and fill with Item 304 can utilize factored bearing resistance value of 3,600 psf at the strength limit. According to information provided on the plans, the wingwall and culvert footings, as designed, produce a maximum service load pressure of 1.73 kips per square foot and a maximum strength load pressure of 2.18 kips per square foot.

If soft, loose or wet soils are encountered at the foundation bearing elevation, these soils should be over-excavated followed by backfilling with Item 304 up to the proposed footing bearing elevation. As previously indicated, the plans include a 2.0-foot planned undercut. Additional soil parameters required for headwall/wingwall construction are provided below in Table 3.



2. Settlements may vary across the footing due to variations in soil composition and loading. However, it is estimated that total and differential settlements will be less than 1 inch and ½ inch, respectively based on the maximum service load pressure of 1.73 kips per square foot indicated on the plans.
3. The design of the foundation units should consider the influence of loads that will be applied adjacent to the walls. The zone of influence should extend for a horizontal distance equal to the height of the wall. Lateral pressure equivalent to the applied loading should be added to the design of these walls.
4. Fluctuations in groundwater levels should be expected over time due to variations in precipitation. Groundwater was encountered above the anticipated excavation depths. Groundwater and/or seepage water should be anticipated to be encountered during excavation and construction of the footings and dewatering will be required. The dewatering system shall be designed and maintained by the Contractor as approved by the Engineer.
5. Excavations more than 4.0 feet in depth should be sloped and/or shored in accordance with OSHA requirements. Temporary excavations in the soil overburden should be sloped at a rate no steeper than 2H:1V. During construction, the slopes should be observed on a regular basis and approved by a qualified engineer.
6. Backfill type, backfill placement and installations of the structure and headwalls/wingwalls shall be in accordance with ODOT Standard Specifications. **Backfill along the headwalls/wingwalls should consist of free draining granular material.** Weep holes in the walls and/or a proper drainage system behind the walls should be provided to limit accumulation of water, which would increase lateral loads.

Table 3. Soil Parameters for Headwall/Wingwall Design

Parameter	Estimated Value
Minimum Footing Width, feet	3
Factored Bearing Resistance, psf (Service Limit)	2,400
Factored Bearing Resistance, psf (Strength Limit)	3,600
Friction Angle between Footing and Item 304 Undercut Backfill (δ_{UC}), degrees	21
Friction Angle between Item 304 Undercut Backfill and Foundation Soil (δ_f), degrees	17
Internal Angle of Friction Item 304 Undercut Backfill (ϕ_{UC}), degrees	32
Internal Angle of Friction (Drained) Foundation Soil (ϕ_f), degrees	26



Table 3. Soil Parameters for Headwall/Wingwall Design

Parameter	Estimated Value
Undrained Shear Strength (Cohesive) Foundation Soil (S_{uf}), psf	1500
Internal Angle of Friction of Wall Backfill (ϕ_{bf}), degrees	30
Friction Angle between Wall and Backfill (δ_f), degrees	20
Total Unit Weight of Foundation Soil, pcf	125
Total Unit Weight of Wall Backfill, pcf	120

Note: A bearing elevation of 726.7 feet or lower is assumed for the parameters.

C. Site Preparation and Earthwork Recommendations

1. Site preparation and earthwork should be performed in accordance with the ODOT Construction and Materials Specifications, and applicable sections of the ODOT Geotechnical Design Manual.
2. Embankment side slopes should be seeded and vegetation growth permitted to limit erosion, sloughing and slope failure.
3. Temporary excavations in excess of 4.0 feet in depth should be sloped, benched or shored in accordance with OSHA regulations.

VI. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL should be notified so that our recommendations can be modified, if required.

VII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final



plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.



VIII. CLOSING

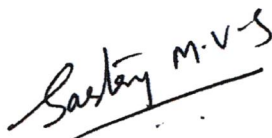
The report was prepared by CTL Engineering, Inc. (Consultant) solely for the use of Client in accordance with an executed contract. The Client's use of or reliance on this report is limited by the terms and conditions of the contract and by the qualifications and limitations stated in the report. It is also acknowledged that the Client's use of and reliance of this report is limited for reasons which include: actual site conditions that may change with time; hidden conditions, not discoverable within the scope of the assessment, may exist at the site; and the scope of the investigation may have been limited by time, budget and other constraints imposed by the Client.

Neither the report, nor its contents, conclusions or recommendations, are intended for the use of any party other than the Client. Consultant and the Client assume no liability for any reliance placed on this report by such party. The rights of the Client under contract may not be assigned to any person or entity, without the consent of the Consultant which consent shall not be unreasonably withheld. This geotechnical report does not address the environmental conditions of the site. The Consultant is not responsible for consequences or conditions arising from facts that were concealed, withheld, or not fully disclosed at the time the assessment was conducted.

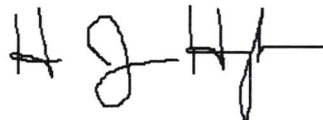
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The Consultant's services have been provided consistent with its professional standard of care. No other warranties are made, either expressed or implied.

Respectfully Submitted,
CTL ENGINEERING, INC.



Sastry Malladi, P.E.
Principal





H. Jason Hughes, P.E.
Senior Geotechnical Engineer
Regional Service Line Manager
Licensed Ohio E-68827



APPENDIX A
BORING LOCATION PLANS





LEGEND				BORING LOCATION PLAN	
 Approximate Test Boring Location	Date 5/27/2022	NOTE:		Culvert Replacement PIK-CR72-00.54, California Pike Pike County, Ohio	
	Scale As Shown				
 CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING • INSPECTION LABORATORY SERVICES	Drawn By AG	Reviewed By DB	Page 1 of 2	CTL Project No. 21050046CIN	


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TESTING • INSPECTION
LABORATORY SERVICES

APPENDIX B
TEST BORING RECORD



APPENDIX C
LABORATORY TEST RESULTS





OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF GEOTECHNICAL ENGINEERING

GRAIN SIZE DISTRIBUTION

PROJECT PIK-CR72-00.54

PID

OGE NUMBER PIK-CR72-00.54

PROJECT TYPE STRUCTURE FOUNDATION

PERCENT FINER BY WEIGHT

