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GEOTECHNICAL EXPLORATION REPORT

BEAL ROAD BRIDGE REPLACEMENT
STATE ROUTE 123 AND BEAL ROAD
FRANKLIN, WARREN COUNTY, OHIO

ATC FILE NUMBER: 241GC00318

Prepared for: CT Consultants
11120 Kenwood Road
Cincinnati, Ohio 45242
Attention: Mr. Scott Campbell, P.E.

Prepared By: ATC Group Services LLC
11121 Canal Road
Cincinnati, Ohio 45241-1861

December 5, 2019

ENVIRONMENTAL • GEOTECHNICAL
BUILDING SCIENCES • MATERIALS TESTING

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December 5, 2019

Mr. Mr. Scott Campbell, P.E.
CT Consultants
11120 Kenwood Road
Cincinnati, Ohio 45242

Re: Geotechnical Exploration Report (r2, 05052020, CT/ODOT Comments)
Beal Road Bridge Replacement
Franklin, Warren County, Ohio
ATC File Number: 241GC00318

Dear Mr. Campbell:

In compliance with your request, ATC Group Services LLC (ATC) has completed a subsurface exploration and evaluation for the above referenced project. It is our pleasure to transmit herewith this report of the result of this exploration.

This work was performed in general accordance with ATC's Proposal No. 241-2019-0366, dated June 20, 2018, and was authorized by email acceptance of ATC's proposal by you on October 9, 2019. If you have any questions regarding the report, please contact this office.

Sincerely,

ATC Group Services LLC

STATE OF OHIO
ROBERT E. SHEETS
E-62324
REGISTERED
PROFESSIONAL ENGINEER

Robert E. Sheets, P.E.
Geotechnical Engineer

John A. Kerr, P.E.
Principal Geotechnical Engineer

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GEOTECHNICAL EXPLORATION REPORT

BEAL ROAD BRIDGE REPLACEMENT
FRANKLIN, WARREN COUNTY, OHIO
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1.0 INTRODUCTION

This report presents the results of a geotechnical exploration and subsurface condition evaluation for a proposed bridge replacement. The exploration was performed in general accordance with ATC's Proposal No. 241-2019-0366, dated June 20, 2018.

The purpose of the exploration was to identify the subsurface profile at the site, to evaluate the suitability of the materials for support of structure foundations, and to develop recommendations relative to the design and construction of the bridge foundations and other project components as outlined in the report. Comments and recommendations regarding earthwork, site preparation, and foundation construction were also developed.

The scope of the exploration included a review of available geologic and subsurface data for the project area, completion of two (2) test borings, field and laboratory testing of recovered soil and samples, and an engineering analysis and evaluation of the subsurface conditions encountered at the site. ATC was provided with a plan and profile drawing of the proposed project.

2.0 PROJECT AND SITE CHARACTERISTICS

The proposed project consists of the replacement of an existing single-span prestressed concrete box beam bridge with a 28 foot span by 8 foot rise precast reinforced concrete 3-sided flat-topped culvert, with a length of approximately 80 feet. From Warren County GIS topographic mapping, it appears the existing bridge deck is approximately 10 feet above the creekbed. It is assumed the height of the new bridge will be similar. This type of structure is typically supported on strip footings beneath each leg of the arch, or on grade beams supported by deep foundation elements. The anticipated foundation loading has not been provided. For the purpose of our analyses and this report, we have assumed a maximum vertical foundation load along the abutments of 10 kips/linear foot, full live plus dead loading. It is assumed that the abutments will be subjected to lateral earth pressures from behind the abutment, and that wingwalls will also be constructed to retain the approach embankments.

The Test Boring Location Plan, included in the Appendix, shows the locations of some of the existing site features and the approximate locations of the borings completed for this study. If any of the information provided or ATC's assumptions are misrepresented and/or incorrect, please contact ATC so that we may review our recommendations.

3.0 GENERAL SUBSURFACE CONDITIONS

Two (2) test borings were completed for the proposed bridge on October 21, 2018. Subsurface material samples were recovered and returned to ATC's Cincinnati, Ohio laboratory for analysis, testing and evaluation. Samples were classified by ATC's engineering staff by visual/manual methods, and boring logs were prepared.

Please note that at the originally selected Boring B-002 (B-2) position, upon the first few hammer strikes to the first sampler driven (1 to 2.5 feet in depth), the sampler and drill rod string were noted to drop several feet into an apparent void. Upon retrieving the drilling tooling, a steel tape measure was advanced into the hole to investigate this void. The steel tape was able to be advanced downward to 25 feet below surface before resistance was encountered. We have no further information or knowledge as to the extent vertically or laterally or possible cause of this void. Subsequently Boring B-002 was offset and redrilled at approximately 11 feet behind the forward abutment, and B-001 was offset to 10 feet behind the forward abutment. Both borings were placed approximately 3'-9" inside the edge-of-pavement.

It should be noted that stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ strata changes could occur at slightly different levels, and/or may transition more gradually. It should also be noted that the borings depict conditions at the particular locations and times indicated on the logs. Some conditions, particularly groundwater levels can change with time. Variations may be present between boring positions. The generalized subsurface and groundwater conditions for each boring are described in detail on the test boring logs located in the Appendix of this report. Approximate surface elevations shown on the test boring logs were estimated from the provided plan and profile drawing.

3.1 Geology

Review of the ODNR Division of Geological Survey's *Surficial Geology Map of the Dayton Quadrangle*, draft format dated 1999, indicates the natural soils in the site locale as being loam glacial till of Wisconsinan geologic age, overlying Ordovician geologic age limestone and shale bedrock. The till soils may contain silt, sand, and gravel lenses, and at depth may contain silt and clay beds. The U.S. Department of Agriculture's *Soil Survey of Warren County, Ohio* indicates soils formed in alluvium along the immediate stream alignment, and soils formed in a silty or loessal mantle overlying Wisconsinan-age loam glacial till. Based on a review of the Survey's *Bedrock Geologic of the Franklin, Ohio Quadrangle* dated 1994 indicate the bedrock at the site to be near the mapped of the Arnheim (informal), Grant Lake Limestone, and Waynesville Formations, indicating a lithology of interbedded shale and limestone, with from 20 to 60 percent shale and 40 to 80 percent limestone. The Survey's *Bedrock Topography of the Franklin, Ohio Quadrangle* map dated 1993 indicates bedrock at the site is present at approximate elevation 700, or roughly 45 feet below roadway elevations at the site.

3.2 Subsurface Profile

The subsurface profile discussed below is a *generalized* summary of the conditions encountered in the recent test borings. The reader should see the attached boring logs for additional detail.

The test borings encountered a pavement section consisting of 6 to 8 inches of asphalt pavement overlying 6 to 16 inches of a granular base material.

Beneath the pavement materials, the borings encountered fill consisting of very loose to medium dense, dark brown to black gravel and stone or asphalt fragments (A-2-4 to A-2-6) with varying amounts of sand, silt and clay. These upper fills extended to depths of 8 and 10 feet, respectively at Borings B-001 and B-002. Standard Penetration Test (SPT) N_{60}-values within this fill material ranged from 4 to 15 blows per foot (bpf), indicating a variably very loose to medium dense relative density for non-cohesive soils. It is assumed that this fill material was likely placed as part of the original construction of the roadway and/or bridge.

Beneath the fill materials, except for certain intervening strata as will be discussed below, the borings encountered cohesive glacial till consisting of and brown and gray grading to gray with depth, sandy silt with little to some clay, trace to little gravel and/or rock fragments (A-4a) to depths of approximately 50 feet below the existing pavement surface in both borings. SPT N_{60}-values within this material ranged from 14 to 100+ bpf, typically averaging 30+ bpf, indicating a predominantly very stiff to hard consistency for the cohesive soil. Strength estimates made using a hand penetrometer and/or a calibrated-spring unconfined testing device indicated unconfined compressive strengths ranging from 1.6 to 7.6 tons per sq. ft. (tsf), most generally at or above 4 tsf.

Within the cohesive glacial till, the following intervening strata were noted:

- At Borings B-001 and B-002, between the depths of 25.5 to 30.5 feet and 30.5 to 38 feet, respectively, a brown-gray to gray, varved silty clay (A-6b) with occasional trace sand and gravel was encountered. SPT N_{60} values in this silty clay ranged from 15 to 22, indicating a stiff to very stiff soil consistency. Strength estimates ranged from 1.0 to 2.1 tsf.

- At Boring B-001, a 2.5 foot thick stratum of gravel and stone fragments with sand, trace silt and clay (A-1-b) was encountered. This material was marginally medium dense to dense, and was wet.
- At Boring B-002, an estimated 0.5 foot thick stratum of fine sand, some clay, trace gravel was encountered. This material is estimated to be medium dense to dense, and was wet.

3.3 Groundwater Conditions

Groundwater level observations were made during the drilling operations. Identifiable groundwater was initially encountered in the borings at depths of approximately 30 and 16 at Borings B-001 and B-002, respectively. On completion of drilling water was noted at depths of 20 and 16 feet in Borings 001 and 002 respectively. These final depths are roughly 6 feet or greater below the level of the creek. It should be noted that the observed groundwater levels may fluctuate in response to short-term and seasonal variations in precipitation, surface runoff, and that local pockets of groundwater may be present at shallower depths in the profile during wetter periods.

4.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

Based upon our analysis of the soil conditions and our understanding of the preliminary design details for this project as previously outlined, the following conclusions have been reached, and the following foundation recommendations developed. If the project characteristics are changed from those assumed herein, or if different subsurface conditions are encountered, ATC should be notified so that our recommendations can be reviewed and any necessary modifications provided.

4.1 Bridge Foundations

It is our interpretation of the results of the test borings and laboratory testing, our engineering analyses, and our experience with similar projects and subsurface conditions, that shallow spread footings could be used to support the proposed bridge.

It is our opinion that the proposed bridge abutments and wing walls may be supported using conventional shallow spread footings. Footings should bear below the existing fill and on the stiff to very stiff sandy silt glacial till soil encountered at a of approximately 10 feet below the existing roadway surface. In consideration to limiting the foundation settlement to less than 1 inch, footings bearing on this material should be designed for a maximum net allowable soil bearing pressure of 4,000 pounds per square foot (psf).

The footings should be established at a minimum depth of 30 inches or greater below finished grades for frost protection and/or as required for scour protection. In applying "net" allowable soil bearing pressures during footing design, the weight of the footings and backfill over the footings need not be included in total loads for dimensioning of footings. Footings should be at least twenty (24) inches in width, regardless of the actual contact pressures developed, to minimize the possibility of "punching" shear failure. The previously stated recommended soil bearing capacity should be treated as an upper limit, and lower values may be utilized for foundation system design if desired. If the soil exposed at the base of a footing excavation is not as stiff as expected from the test borings, the foundation area should be undercut to firm bearing and the footing deepened. Alternatively, lean concrete (1000 psi minimum compressive strength at 28 days) may be used to replace any unsuitable soils.

All exposed foundation bearing surfaces should be protected against freezing, flooding by surface water, and undue disturbance, since the foundation soils will tend to soften and lose strength when subjected to these conditions. Footing concrete should be placed the same day that footing excavations are completed. All footing excavations and bearing surfaces should be examined by a representative of ATC to verify that conditions are compatible with the design recommendations before placing concrete.

Erosion protection of the bridge foundations will be critical. Erosion control elements should be installed along the base of the abutments and wingwalls to protect against the deterioration of foundation soils which could undermine the stability of the bridge.

4.2 Lateral Earth Pressures

It is assumed that the bridge abutments and wingwalls will be able to rotate slightly such that they can be designed for active earth pressure conditions. If the abutments and wing wall are backfilled with free-draining crushed aggregate within an imaginary line drawn up and behind the footings at a 45 degree angle, it is recommended that they be designed to resist an active earth pressure computed using a moist soil unit weight of 130 pounds per cubic foot (pcf) and an active earth pressure coefficient, K_A, of 0.30. If granular backfill of the type and/or extent described above is not used, we recommend to design for a K_A of 0.45. If rotation is restrained from occurring, at-rest earth pressure coefficients (K_O) of 0.40 and 0.60 should be used for the granular and non-granular backfill cases, respectively. An ultimate coefficient of friction (between the base of the footing and the underlying soil) of 0.30 can be used in conjunction with the minimum downward load on the base of the footing. It is recommended that a factor of safety of at least 1.5 be used in design related to lateral load resistance.

The aforementioned moist soil unit weight and earth pressure coefficients assume that sufficient provisions to prohibit the buildup of hydrostatic pressures. Internal drainage media of at least a minimum of 2 feet granular backfill behind the abutments and wingwalls should be provided, along with appropriate backfill drainpipe and/or weepholes. Note that the effect of any surcharge behind the abutments and wingwalls, such as from traffic, must be considered in addition to the lateral pressure due to the soil weight. As with the bridge abutment foundations, the wall foundations should be adequately protected from stream scour.

It is expected that normal soil excavation equipment and techniques will be able to make the necessary excavations in the vicinity of the test boring locations. OSHA requires that previously disturbed earth, such as the existing fill encountered here, be considered an OSHA Type "C" soil, requiring that excavations be sloped back to no steeper than 1.5 horizontal to 1 vertical (1.5H:1V), and/or appropriate shoring and bracing be utilized. It is our opinion that the glacial till soils underlying the fill can be considered an OSHA Type "A" soil, which require temporary excavation slopes no steeper than ¾H:1V and/or appropriate shoring and bracing. Please note that if free water is noted to emanate from any excavated surfaces, by definition, an OSHA Type "C" soil class would apply. A "competent person" as required by OSHA regulations should review all excavation conditions and provide an assessment of the safety and stabilization measures required as appropriate to the field conditions revealed at the time of construction.

4.3 Stream Scour

If the designer determines potential stream scour to be a design consideration, the following parameters should be used in its evaluation:

Table 1: Stream Scour D_{50} Soil Size

Depth Below Bridge Deck (ft)	Boring	Sample	Approximate D_{50} Particle Size (mm)
8.5 – 10	B-001	S-4	0.061
11.5 – 13	B-002	S-6	0.052
14.5 - 16	B-001	S-8	0.055

4.4 Sulfate Analyses

Per ODOT criteria, sulfate content tests were performed on Sample 1 of both borings taken. The results of these analyses are indicated below. In general, these test results indicate that sulfate content of the near-surface soils should not be problematic should chemical stabilization using a carbonate-based admixture be necessary in pavement subgrade stabilization.

Table 2: Sulfate Content Test Results

Boring	Sample	Depth (ft)	Sulfate Content (PPM)
B-001	S-1	1.0 – 2.5	1100
B-002	S-1	1.0 – 2.5	1000

4.5 Seismic Considerations

To establish the Site Class in accordance with ASCE/SEI 7-16, Minimum Design Loads and Associated Criteria for Buildings and other Structures (as referenced by the 2017 Ohio Building Code), the geotechnical engineer is required to characterize the soil profile to a depth of 100 feet. Based on geologic conditions in this area and the boring data obtained during this geotechnical exploration, it is our opinion that conditions at this site meet the definition of Site Class "D" in accordance with Table 20.3-1 of ASCE/SEI 7-16.

5.0 RECOMMENDED EARTHWORK PROCEDURES

Earthwork for this project should follow all pertinent sections of ODOT's latest *Construction and Materials Specifications*. Variations in subsurface conditions could occur at this site. It is recommended that the geotechnical engineer be retained by the owner to provide ongoing review of the phases of the project related to subsurface conditions and to correlate the test boring data with the subsurface conditions that are encountered during construction.

5.1 Excavation

Normal earth excavation equipment should be suitable for the necessary grading and excavation of the overburden soils at this site. Care should be taken to assure that any loose, soft, or wet materials are removed from foundation bearing surfaces and areas to receive structural fill.

All temporary excavations for foundations, utilities or other underground structures should be laid back or braced as required by current Occupational Safety and Health Administration (OSHA) requirements.

5.2 Construction Dewatering

Surface and stream water diversion and/or dewatering will likely be required in excavations that extend below the stream level. Earthen and/or steel sheetpile cofferdams with sump pumping may be required. Although not anticipated, if wellpoints or dewatering wells become necessary, it is recommended that a specialty dewatering contractor be retained to design, install and operate the dewatering system.

5.3 Fill Placement

It is recommended that any fill placed for this project be done so in accordance with Section 203 and any other applicable sections of ODOT's latest *Construction and Materials Specifications*. Particular attention should be paid to site preparation, acceptable fill materials and fill placement and compaction requirements. Granular backfill for the abutments and wing walls should be capped with low-permeability clayey soil to impede surface water infiltration into the backfill zone.

6.0 PLAN REVIEW AND CONSTRUCTION MONITORING

Review of final project plans and specifications and monitoring of the geotechnical and earthwork construction phases of the project should be completed in accordance with ODOT requirements. It is noted that if ATC is not retained for these purposes, we can assume no responsibility for compliance of the work with the design concepts, specifications, or for modifications or recommendations made during construction.

7.0 FIELD AND LABORATORY INVESTIGATIONS

7.1 Field Exploration

Field exploration included the performance of two (2) soil test borings located approximately as shown on the enclosed Test Boring Location Plan. Test borings were performed with a truck-mounted drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Samples of the in-situ soils were obtained employing split-barrel sampling procedures in general accordance with ASTM Standard Methods D1586. Observations regarding groundwater levels, and other pertinent conditions were made at each boring location. Ground surface elevations referenced herein were interpolated from a preliminary Plan & Profile drawing provided by the Client and should be considered approximate.

The encountered materials have been visually classified by the ATC's engineering staff, and are described in detail on the boring logs. The results of the field penetration tests, strength tests, and water level observations and laboratory moisture content determinations are presented on the boring logs in numerical form. Samples of the soils encountered in the field were placed in sealed sample jars and are stored in the laboratory for further analysis, if desired. Unless notified to the contrary, all samples will be disposed of in thirty (30) days from the date of this report.

7.2 Laboratory Testing Program

In conjunction with the field exploration, a laboratory testing program was conducted to determine pertinent engineering characteristics of the subsurface materials as necessary for development of engineering recommendations. The laboratory-testing program included visual classification of all samples. Natural moisture content, plasticity, grain size distribution and hand-held penetrometer and/or calibrated-spring unconfined compressive strength (RIMAC) tests were conducted on selected samples. All phases of the laboratory-testing program were conducted in general accordance with applicable ASTM specifications and procedures.

8.0 LIMITATIONS OF STUDY

8.1 Differing Conditions

Recommendations for this project were developed utilizing soil information obtained from the test borings that were completed at the proposed site. These borings indicate subsurface soil and groundwater conditions at the specific locations and time at which the borings were conducted. Conditions at other locations on the site may differ from those occurring at the boring positions. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the immediate attention of the geotechnical engineer so that recommendations can be reviewed and revised as required.

8.2 Changes in Plans

The conclusions and recommendations herein have been based upon the available soil information and the preliminary design details furnished by a representative of the owner of the proposed project and/or as assumed herein. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to the attention of the geotechnical engineer to determine whether any changes in the foundation or earthwork recommendations are necessary.

8.3 Recommendations vs. Final Design

This report and the recommendations included within are not intended as a final design, but rather as a basis for the final design to be completed by others. It is the client's responsibility to ensure that the recommendations of the geotechnical engineer are properly integrated into the design, and that the geotechnical engineer is provided the opportunity for design input and comment after the submittal of this report, as needed. It is strongly recommended that ATC be retained to review the final construction documents to confirm that the proposed project design sufficiently incorporates the geotechnical recommendations. ATC should be represented at pre-bid and/or pre-construction meetings regarding this project to offer any needed clarifications of the geotechnical information to all involved.

8.4 Construction Issues

Although general constructability issues have been considered in this report, the means, methods, techniques, sequences and operations of construction, safety precautions, and all items incidental thereto and consequences of, are the responsibility of the parties to the project other than ATC. This office should be contacted if additional guidance is needed in these matters.

8.5 Report Interpretation

ATC is not responsible for conclusions, opinions, or recommendations developed by others on the basis of the data included herein. It is the client's responsibility to seek any guidance and clarifications from the geotechnical engineer needed for proper interpretation of this report.

8.6 Environmental Considerations

The scope of services does not include any environmental assessment investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater, or surface water within or beyond the site studies. Any statements in this report or on the test boring logs regarding odors, staining of soils, or other unusual conditions observed are strictly for the information of our client. Unless complete environmental information regarding the site is already available, an environmental assessment is recommended prior to the development of this site.

8.7 Standard of Care

The professional services and engineering recommendations presented in this report have been developed in accordance with generally accepted geotechnical engineering principles and practices in the geographical area of the project at the time of the report. No other warranties, either expressed or implied are offered.

APPENDIX

Test Boring Location Plan

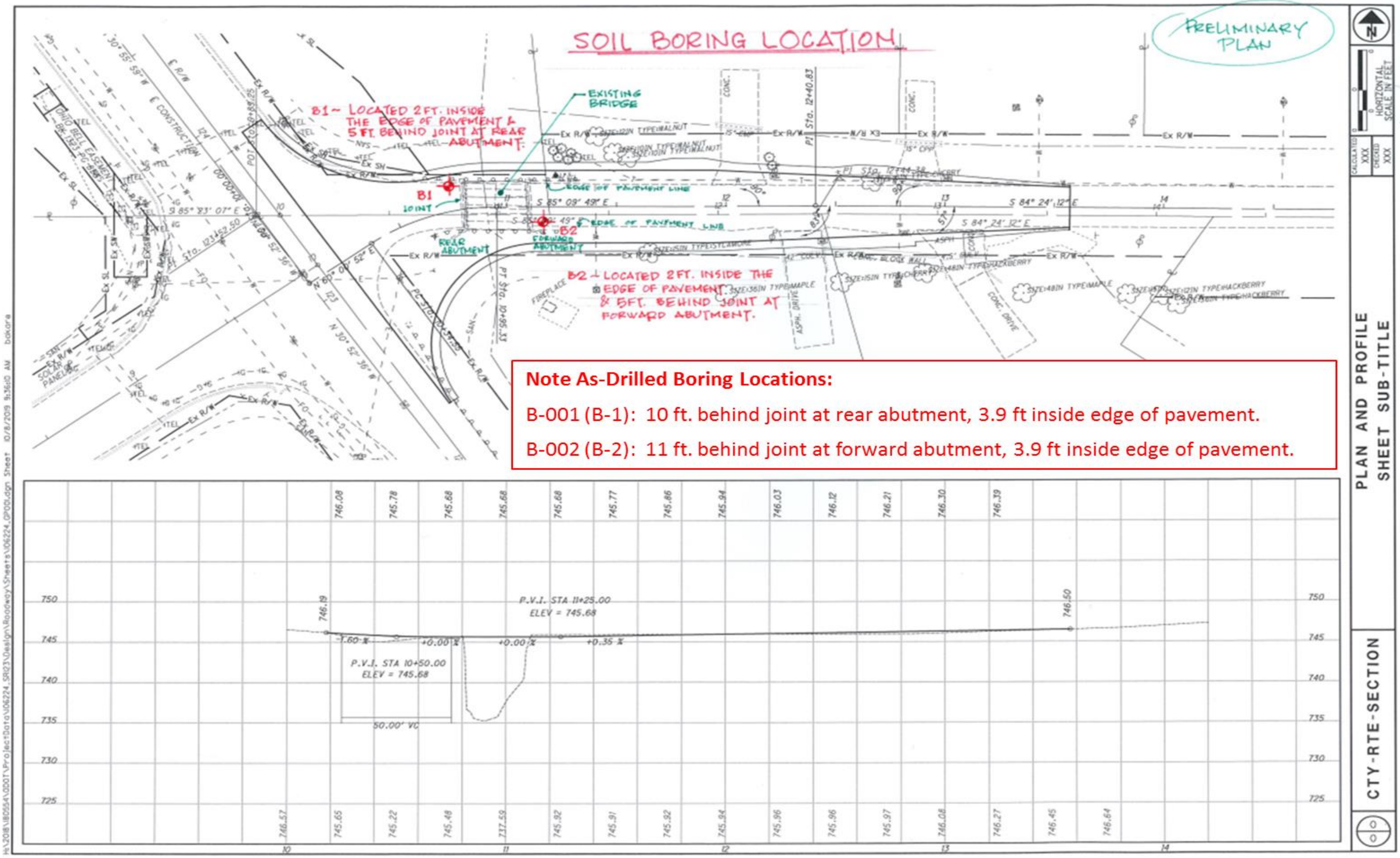
Logs of Borings (2 logs, 4 pages total)

Grain Size Distribution Tests (3 pages)

Atterberg Limits Test Results (1 page)

ODOT Soil Classification Chart

Important Information about Your Report



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Drawing:	FIG. 1 - BORING LOCATION PLAN
Project:	BEAL ROAD BRIDGE
Location:	FRANKLIN, OHIO
Client:	CT CONSULTANTS
ATC Project:	241GC00318

PROJECT: BEAL ROAD BRIDGE	DRILLING FIRM / OPERATOR: CSTAR / TG	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: Sta.10+71,12.75' LT	EXPLORATION ID B-001-0-19
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: ATC / RES	HAMMER: CME AUTOMATIC	ALIGNMENT: BEAL ROAD	
PID: BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/9/17	ELEVATION: 745.5 (MSL) EOB: 49.8 ft.	PAGE 1 OF 2
START: 10/21/19 END: 10/21/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.6	LAT / LONG: 39º 53' 59" / 84º 28' 68"	

MATERIAL DESCRIPTION AND NOTES	ELEV. 745.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT (6")	745.0																	
AGGREGATE BASE (8")	744.3																	
MEDIUM STIFF, BROWN, DARK BROWN, AND BLACK, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, MOIST [FILL]	742.5	1 – 2	9 5 4	13	56	SS-1	-	28	26	21	15	10	26	17	9	16	A-2-4 (0)	
STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, MOIST [FILL]		3 – 5	1 2 2	6	100	SS-2	-	14	11	23	27	25	33	15	18	19	A-6b (6)	
	737.5	6 – 8	2 2 2	6	100	SS-3	-	-	-	-	-	-	-	-	-	22	A-6b (V)	
STIFF TO HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE CLAY AND GRAVEL, MOIST [GLACIAL TILL]		9 – 10	3 4 6	14	100	SS-4	-	17	9	21	34	19	19	14	5	9	A-4a (4)	
		11	3 11 15	36	100	SS-5	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		12 – 13	13 16 16	45	100	SS-6	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		14	10 12 12	34	100	SS-7	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		15 – 16	10 12 12	34	100	SS-8	-	19	8	20	33	20	20	13	7	10	A-4a (4)	
		17 – 18	12 10 14	34	100	SS-9	-	-	-	-	-	-	-	-	-	9	A-4a (V)	
		19 – 20 ▼	10 14 18	45	100	SS-10	-	-	-	-	-	-	-	-	-	8	A-4a (V)	
		21 – 23	11 12 14	36	100	SS-11	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
	720.0	24 – 25	14 10 13	32	100	SS-12	-	-	-	-	-	-	-	-	-	9	A-4a (V)	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND AND GRAVEL, VARVED, MOIST		26 – 28	6 8 8	22	100	SS-13	-	1	1	1	31	66	37	19	18	23	A-6b (11)	
		29 W	4 4 7	15	100	SS-14	-	-	-	-	-	-	-	-	-	26	A-6b (V)	

PID:	BR ID:	PROJECT: BEAL ROAD BRIDGE	STATION / OFFSET: Sta.10+71,12.75' LT	START: 10/21/19	END: 10/21/19	PG 2 OF 2	B-001-0-19

MATERIAL DESCRIPTION AND NOTES	ELEV. 715.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT AND CLAY, WET	715.0	31–32	5 10 12	31	22	SS-15	-	36	30	22	8	4	NP	NP	NP	15	A-1-b (0)	
HARD, GRAY, **SANDY SILT**, LITTLE CLAY, GRAVEL, AND ROCK FRAGMENTS, MOIST [GLACIAL TILL]	712.5	33–35	11 12 13	35	100	SS-16	-	-	-	-	-	-	-	-	-	9	A-4a (V)	
		38–40	17 24 20	62	67	SS-17	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
		43–45	13 18 27	63	100	SS-18	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
	695.7	48–49.8 EOB	14 31 50/4"	-	100	SS-19	-	-	-	-	-	-	-	-	-	13	A-4a (V)	

NOTES: CAVE-IN AT 46.0 FEET.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PROJECT: BEAL ROAD BRIDGE	DRILLING FIRM / OPERATOR: CSTAR / TG	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: Sta. 11+19, 7' RT	EXPLORATION ID B-002-0-19
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: ATC / RES	HAMMER: CME AUTOMATIC	ALIGNMENT: BEAL ROAD	
PID: BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/9/17	ELEVATION: 745.7 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 10/21/19 END: 10/21/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.6	LAT / LONG: 39º 53' 59" / 84º 28' 66"	

MATERIAL DESCRIPTION AND NOTES	ELEV. 745.7
ASPHALT (8")	745.0
AGGREGATE BASE (16")	743.7
LOOSE, REDDISH BROWN AND DARK BROWN, **GRAVEL AND ASPHALT FRAGMENTS, WITH SAND, SILT, AND CLAY**, MOIST [FILL]	742.7
VERY LOOSE TO MEDIUM DENSE, REDDISH BROWN, **GRAVEL AND ASPHALT FRAGMENTS, WITH SAND, SILT, AND CLAY**, MOIST [FILL]	735.7
VERY STIFF TO HARD, REDDISH BROWN, TAN, AND GRAY, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL AND ROCK FRAGMENTS, MOIST [GLACIAL TILL]	721.2
DENSE, GRAY, **FINE SAND**, SOME CLAY, TRACE GRAVEL, WET	720.7
VERY STIFF, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL AND ROCK FRAGMENTS, MOIST [GLACIAL TILL]	

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)
3 3 4	10	100	SS-1	-	30	27	17	16	10	29	16	13	16	A-2-6 (0)
3 5 6	15	100	SS-2	-	27	23	22	15	13	28	14	14	14	A-2-6 (1)
2 4 4	11	100	SS-3	-	-	-	-	-	-	-	-	-	17	A-2-6 (V)
2 1 2	4	28	SS-4	-	-	-	-	-	-	-	-	-	15	A-2-6 (V)
16 13 14	38	100	SS-5	-	-	-	-	-	-	-	-	-	9	A-4a (V)
10 13 14	38	100	SS-6	-	19	9	18	32	22	20	13	7	9	A-4a (4)
12 12 13	35	100	SS-7	-	-	-	-	-	-	-	-	-	9	A-4a (V)
8 14 16	42	100	SS-8	-	-	-	-	-	-	-	-	-	9	A-4a (V)
10 16 15	43	100	SS-9	-	-	-	-	-	-	-	-	-	9	A-4a (V)
12 16 16	45	100	SS-10	-	-	-	-	-	-	-	-	-	8	A-4a (V)
8 10 10	28	100	SS-11	-	-	-	-	-	-	-	-	-	9	A-4a (V)
10 15 16	43	100	SS-12	-	-	-	-	-	-	-	-	-	14	A-4a (V)
6 7 9	22	100	SS-13	-	8	9	21	40	22	NP	NP	NP	11	A-4a (5)
5 8 8	22	100	SS-14	-	-	-	-	-	-	-	-	-	11	A-4a (V)

PID:	BR ID:	PROJECT: BEAL ROAD BRIDGE	STATION / OFFSET: Sta. 11+19, 7' RT	START: 10/21/19	END: 10/21/19	PG 2 OF 2	B-002-0-19

MATERIAL DESCRIPTION AND NOTES	ELEV. 715.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF, BROWN-GRAY, **SILTY CLAY**, VARVED, MOIST	715.2	31–32	4 5 6	15	100	SS-15	-	-	-	-	-	-	-	-	-	24	A-6b (V)	
		34–35	3 5 6	15	100	SS-16	-	0	0	0	33	67	39	20	19	25	A-6b (12)	
VERY STIFF TO HARD, GRAY TO BLUE-GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL AND ROCK FRAGMENTS, MOIST [GLACIAL TILL]	707.7	39–40	5 15 16	43	100	SS-17	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
		44–45	16 18 50/5"	-	100	SS-18	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
	695.7	EOB 49–50	6 9 10	27	100	SS-19	-	-	-	-	-	-	-	-	-	18	A-4a (V)	

NOTES: CAVE-IN AT 44.5 FEET.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/6/19 10:22 - S:\GEOTECHNICAL ENGINEERING\GEOTECH\REPORTS\ENGRPTS1910-1912\241GC00318 CT CONSULTANTS - BI

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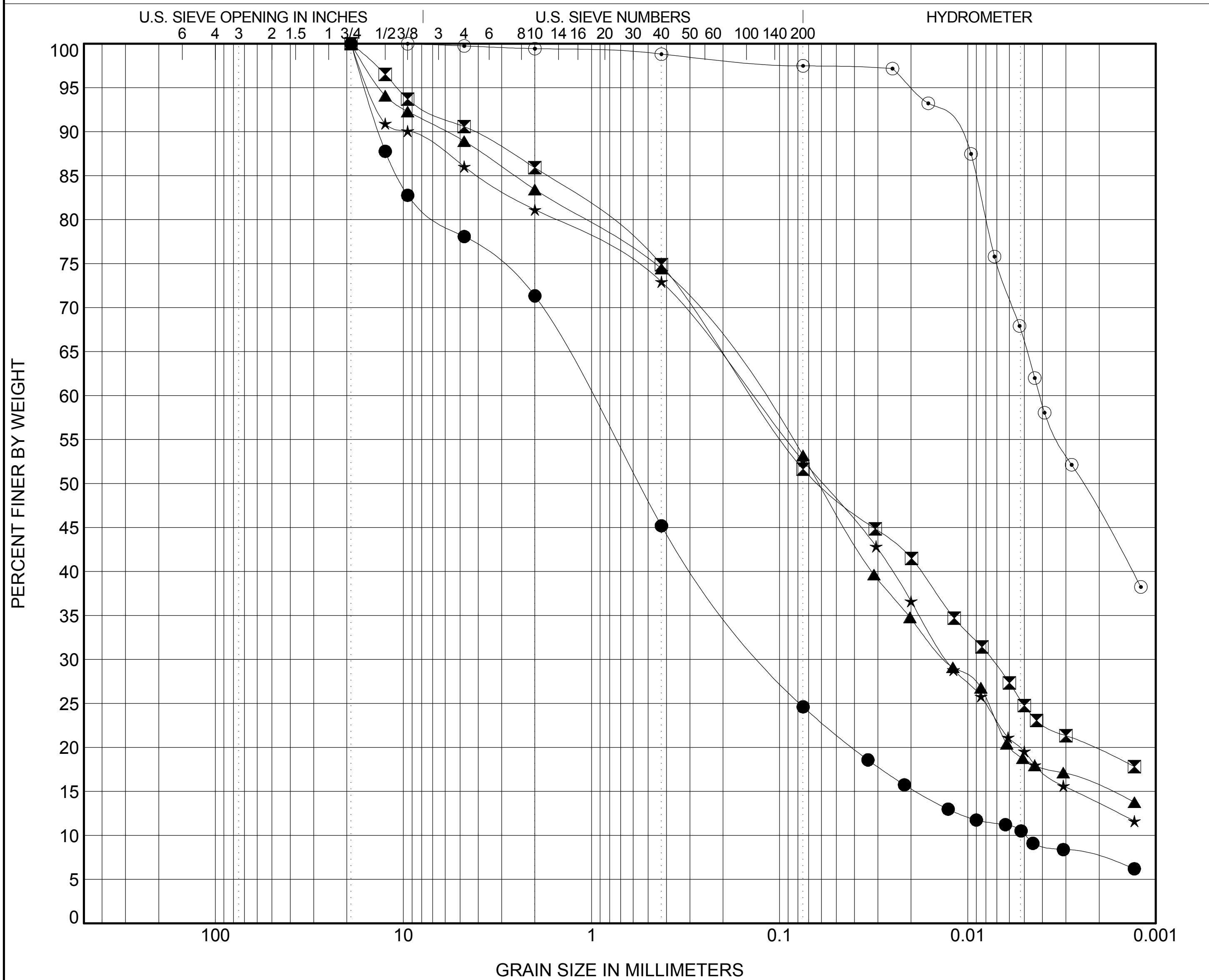
GRAIN SIZE DISTRIBUTION

PROJECT BEAL ROAD BRIDGE **PID**

OGE NUMBER 241GC00318 **PROJECT TYPE** Bridge Replacement



COBBLES	GRAVEL		SAND		SILT	CLAY
	coarse	fine	coarse	fine		

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**B-001-0-19**	**1.0**	**A-2-4**	**26**	**17**	**9**	**2.76**	**206.96**
⧗	**B-001-0-19**	**3.5**	**A-6b**	**33**	**15**	**18**		
▲	**B-001-0-19**	**8.5**	**A-4a**	**19**	**14**	**5**		
★	**B-001-0-19**	**14.5**	**A-4a**	**20**	**13**	**7**		
⊙	**B-001-0-19**	**26.0**	**A-6b**	**37**	**19**	**18**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-001-0-19**	**1.0**	**19**	**1.022**	**0.118**	**0.005**	**28**	**47**	**15**	**10**
⧗	**B-001-0-19**	**3.5**	**19**	**0.14**	**0.007**		**14**	**34**	**27**	**25**
▲	**B-001-0-19**	**8.5**	**19**	**0.131**	**0.013**		**17**	**30**	**34**	**19**
★	**B-001-0-19**	**14.5**	**19**	**0.141**	**0.013**		**19**	**28**	**33**	**20**
⊙	**B-001-0-19**	**26.0**	**9.5**	**0.004**			**1**	**2**	**31**	**66**

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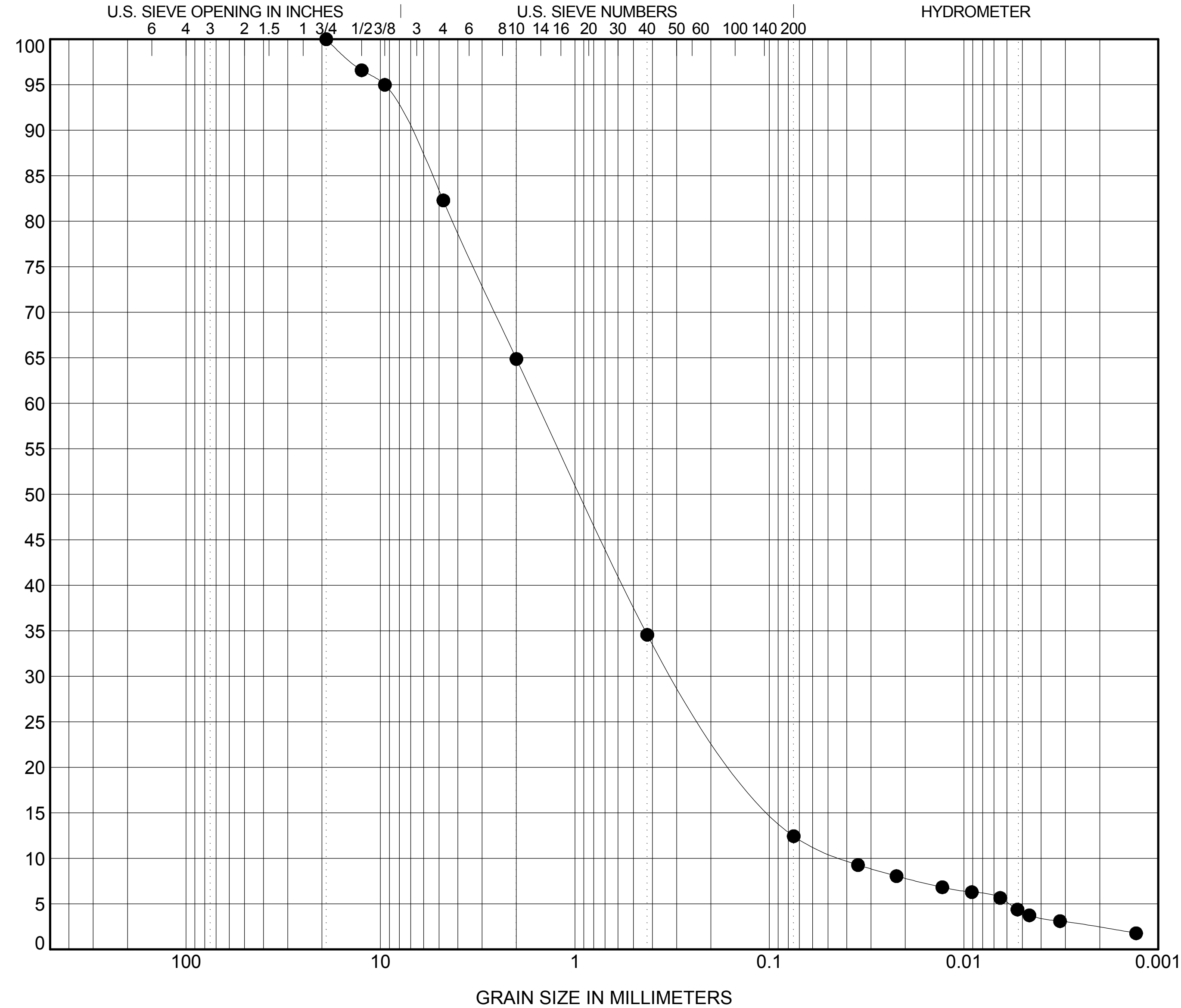
GRAIN SIZE DISTRIBUTION

PROJECT BEAL ROAD BRIDGE **PID**

OGE NUMBER 241GC00318 **PROJECT TYPE** Bridge Replacement



COBBLES	GRAVEL		SAND		SILT	CLAY
	coarse	fine	coarse	fine		

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-001-0-19**	**31.0**	**A-1-b**	**NP**	**NP**	**NP**	**1.36**	**37.36**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-001-0-19**	**31.0**	**19**	**1.559**	**0.297**	**0.042**	**36**	**52**	**8**	**4**

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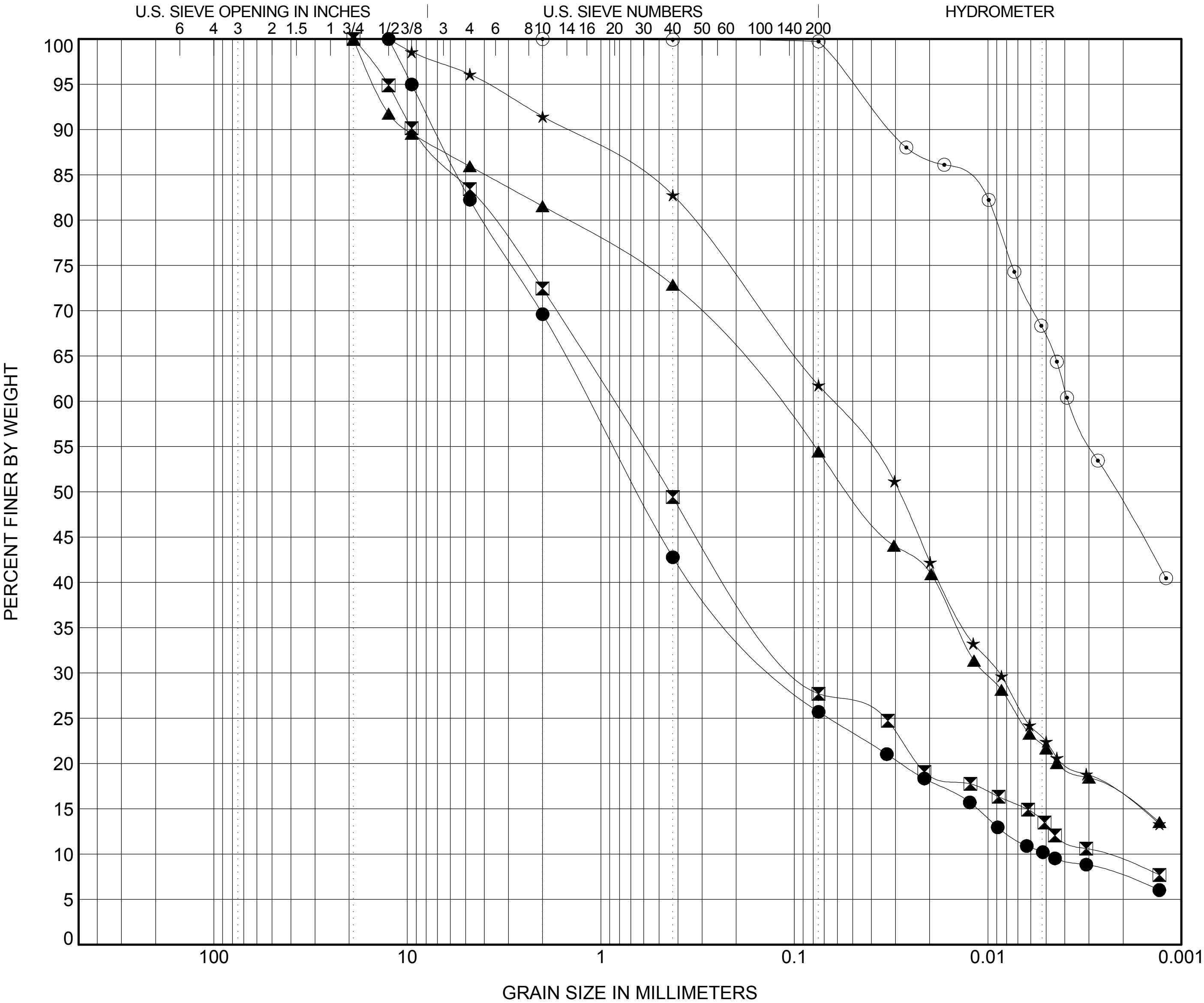
GRAIN SIZE DISTRIBUTION

PROJECT BEAL ROAD BRIDGE **PID**

OGE NUMBER 241GC00318 **PROJECT TYPE** Bridge Replacement



COBBLES	GRAVEL		SAND		SILT	CLAY
	coarse	fine	coarse	fine		

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**B-002-0-19**	**1.0**	**A-2-6**	**29**	**16**	**13**	**2.36**	**230.86**
⧗	**B-002-0-19**	**3.5**	**A-2-6**	**28**	**14**	**14**	**3.64**	**335.52**
▲	**B-002-0-19**	**11.5**	**A-4a**	**20**	**13**	**7**		
★	**B-002-0-19**	**26.0**	**A-4a**	**NP**	**NP**	**NP**		
⊙	**B-002-0-19**	**33.5**	**A-6b**	**39**	**20**	**19**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-002-0-19**	**1.0**	**12.5**	**1.148**	**0.116**	**0.005**	**30**	**44**	**16**	**10**
⧗	**B-002-0-19**	**3.5**	**19**	**0.865**	**0.09**	**0.003**	**27**	**45**	**15**	**13**
▲	**B-002-0-19**	**11.5**	**19**	**0.126**	**0.01**		**19**	**27**	**32**	**22**
★	**B-002-0-19**	**26.0**	**12.5**	**0.065**	**0.009**		**8**	**30**	**40**	**22**
⊙	**B-002-0-19**	**33.5**	**2**	**0.004**			**0**	**0**	**33**	**67**

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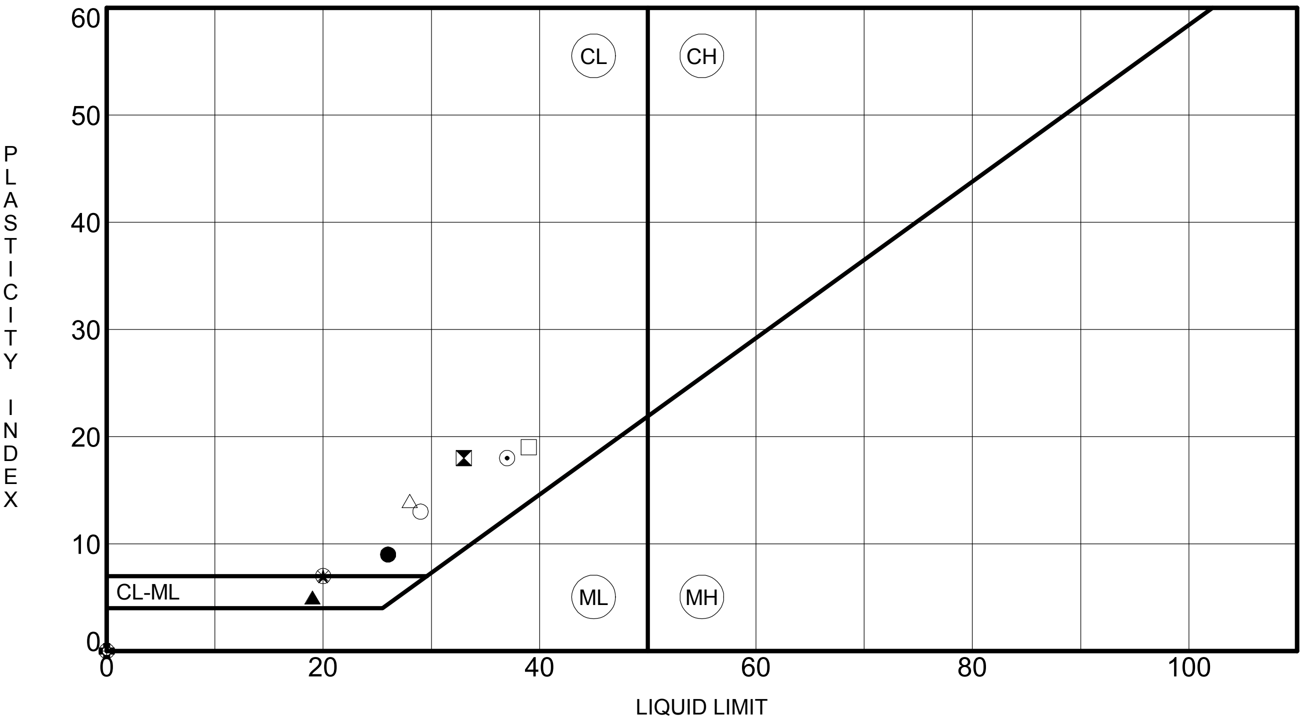
ATTERBERG LIMITS' RESULTS

PROJECT BEAL ROAD BRIDGE **PID**

OGE NUMBER 241GC00318 **PROJECT TYPE** Bridge Replacement



Specimen Identification		LL	PL	PI	Fines	Classification
● B-001-0-19	1.0	26	17	9	25	A-2-4
⧗ B-001-0-19	3.5	33	15	18	52	A-6b
▲ B-001-0-19	8.5	19	14	5	53	A-4a
★ B-001-0-19	14.5	20	13	7	53	A-4a
⊙ B-001-0-19	26.0	37	19	18	97	A-6b
✪ B-001-0-19	31.0	NP	NP	NP	12	A-1-b
○ B-002-0-19	1.0	29	16	13	26	A-2-6
△ B-002-0-19	3.5	28	14	14	28	A-2-6
⊗ B-002-0-19	11.5	20	13	7	54	A-4a
⊕ B-002-0-19	26.0	NP	NP	NP	62	A-4a
□ B-002-0-19	33.5	39	20	19	100	A-6b

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart. The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classifcation AASHTO	Classifcation OHIO	LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
F.S.	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC	NON-PLASTIC	0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	75 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	75 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		75 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	75 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	75 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		75 Min.		36 Min.	41 Min.	≦LL-30	20	
	Clay	A-7-6		75 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	74 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	74 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

- Sod and Topsoil
- Pavement or Base
- Uncontrolled Fill (Describe)
- Bouldery Zone
- P Peat

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

Figure 600-1. ODOT Soil Classification Chart

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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