Soil Study for Proposed Raw Water Main, Riverview Avenue, Miamisburg, Ohio

Submitted To:

Arcadis U.S. Inc.
Attn: Mr. Jason Abbott
4665 Cornell Road, Suite 200
Cincinnati, Ohio 45241

Report No. 211648-0124-014
January 25, 2024

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DAYTON ENGINEERING SERVICES
P.O. Box 51
Dayton, Ohio 45401-0051
P. 937.236.8805 **F.** 937.233.2016
www.bowser-morner.com

January 25, 2024

Arcadis U.S. Inc.
4665 Cornell Road
Suite 200
Cincinnati, Ohio 45241

Attention: Mr. Jason Abbott, P.E., CPM,
Principal Engineer

Re: Report No. 211648-0124-014; Soil Study for Proposed Raw Water Main, Riverview Avenue, Miamisburg, Ohio

Dear Mr. Abbott:

Bowser-Morner, Inc. is pleased to submit our report of the soil study for the above-referenced project. The purpose of this study is to determine the physical characteristics of the soil strata for the proposed raw water main, including allowable bearing capacity for the proposed pole barn building. Also noted are other conditions that could affect the design and/or construction of the structures.

The samples collected that were not used to perform the laboratory tests will be kept in our laboratory for 30 days unless you advise us otherwise. If you have any questions or if we can help you in any way on this project or future work, please call us.

Sincerely,
BOWSER-MORNER, INC.

“This document was originally issued by Chris R. Ryan, M.S.C.E., P.E. and Daniel Otieno on January 25, 2024. This document is not considered a sealed document."

Daniel Moses Otieno
Geotechnical Engineer

Chris R. Ryan, M.S.C.E, P.E.
Sr. Geotechnical Engineer

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3-Client
2-File

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Section I

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1.0 INTRODUCTION

The City of Miamisburg proposes to install a raw water main, and a pole barn building, along Riverview Avenue in Miamisburg, Ohio. A vicinity map (Figure 1) is included in Section III of this report. Our findings on the soil conditions and groundwater levels with respect to the potential construction problems, and recommendations for the water main, including allowable bearing capacity for the construction of the pole barn are given in this report.

Authorization to proceed with this soil study was given by Arcadis U.S. Inc. in a signed proposal acceptance sheet dated September 8, 2023. The work was to proceed in accordance with our proposal and agreement, Quotation No. 23-2771-076 dated July 7, 2023.

The draft soil boring logs and preliminary foundation recommendations were emailed to Mr. Jason Abbott, P.E. of Arcadis U.S. Inc. on November 21, 2023.

2.0 WORK PERFORMED

2.1 Field Work

Sixteen soil borings were made at the locations shown on the boring location plan, Figure 2 in Section III. Boring 1 was performed in the proposed pole barn area, while Borings 2 through 16 were performed in the raw water main area. The boring logs and boring location plan are included in Section III. The borings were made with a truck-mounted boring rig using hollow-stem augers and standard penetration resistance methods. The standard penetration tests were performed in accordance with ASTM D1586, which includes a 140-pound hammer, 30-inch drops, and two-inch-O.D. split-spoon samplers driven at maximum depth intervals of five feet or at major changes in stratum, whichever occurred first. The disturbed split-spoon samples were visually classified, logged, sealed in moisture-proof jars, and taken to the Bowser-Morner, Inc. laboratory for study. The depths where these "SS"-type split-spoon samples were collected are noted on the corresponding boring logs.

2.2 Laboratory Work

One (1) Unified Soil Classification soil classification test was performed in accordance with ASTM D422, D2216, D2487, and D4318. The purpose of this type of test is to determine parameters that aid in the evaluation of the general behavior of the soils.

Four (4) Atterberg limits tests were performed in accordance with ASTM D4318 to determine the liquid and plastic limits on the most visibly plastic cohesive soil or as needed for soil classification. In addition, 44 moisture content determinations were made in accordance with ASTM D2216. The moisture contents ranged from 4.7% to 18.4% for the fill, from 2.8% to 15.4% for the brown silty sand or silty sand with gravel, from 10.9% to 29.2% for the brown or gray silty lean clay with sand, and from 6.3% to 13.3% for the gray weathered shale. The results of the laboratory tests are summarized in Table 2-1 and included in Section III of this report.

Table 2-1. Summary of Laboratory Test Results

Boring No.	Depth (ft.)	Moisture Content (%)	% Gravel	% Sand	% Fines	Atterberg Limits LL	PL	PI
1	1.0 – 2.5	13.0						
	6.0 – 7.5	2.8						
	8.5 – 10.0	12.9	29.0	38.9	32.1			
2	1.0 – 2.5	10.0						
	3.5 – 5.0	14.6				41	22	19
	8.5 – 10.0	14.4						
3	3.5 – 5.0	3.9						
	8.5 – 10.0	3.5						
4	1.0 – 2.5	10.7						
	6.0 – 7.5	11.8						
	13.5 – 15.0	5.1						
	23.5 – 25.0	10.3						
5	3.5 – 5.0	6.4						
	8.5 – 10.0	12.3						
	13.5 – 15.0	18.8				24	18	6
	23.5 – 25.0	15.4						
	28.5 – 30.0	10.6						
6	3.5 – 5.0	16.9						
	8.5 – 10.0	5.7						
7	1.0 – 2.5	13.1						
	8.5 – 10.0	6.3						
8	1.0 – 2.5	13.3						
	3.5 – 5.0	19.6						
	6.0 – 7.5	22.2				50	27	23
9	6.0 – 7.5	18.0						
	8.5 – 10.0	21.6						
10	1.0 – 2.5	8.9						
	6.0 – 7.5	9.1						
	13.5 – 15.0	16.7						
11	3.5 – 5.0	17.2						
	8.5 – 10.0	3.5						
	13.5 – 15.0	8.2						
	18.5 – 20.0	22.0						
12	1.0 – 2.5	15.2						
	6.0 – 7.5	17.4						
	13.5 – 15.0	28.5						
13	1.0 – 2.5	11.7						

Table 2-1. Summary of Laboratory Test Results

Boring No.	Depth (ft.)	Moisture Content (%)	% Gravel	% Sand	% Fines	Atterberg Limits		
						LL	PL	PI
	6.0 – 7.5	18.4						
	8.5 – 10.0	27.4				34	22	12
14	3.5 – 5.0	15.2						
	8.5 – 10.0	13.4						
15	1.0 – 2.5	4.7						
16	3.5 – 5.0	9.4						
	8.5 – 10.0	29.2						

3.0 SOIL AND GROUNDWATER CONDITIONS

Based on the information from the sixteen (16) borings made for this study, the subgrade soil conditions are described in descending order below:

- In Boring 1, 16 inches of topsoil.
- In Borings 2 through 16, one to 13.5 feet of undocumented and uncontrolled fill consisting of asphalt, gravel base, topsoil, brown and gray silty sand with gravel, and light brown-to-black silty organic or lean clay. The layer extends to the bottom of the boring at a depth of 3.5 feet below the existing grade in Boring 15. Drilling was halted at that depth due to possible unmarked utility lines.
- In Boring 8 and below the fill layer, two feet of stiff, gray weathered shale.
- In Boring 1 and below the topsoil layer, in Borings 2, 5, 7, 9, 10, 11, 12, 13, 14 and 16 and below the fill layer, and in Boring 8 and below the gray weathered shale layer, 0.6 to 16.5 feet of very soft-to-very stiff, brown or gray, silty lean clay with sand. The layer extends to the bottom of the boring at a depth, below the existing grade, of 10 feet in Borings8, 9, 13, 14 and 16, and 20 feet in Borings 10 and 12.
- In Borings 1, 2, 5, 7 and 11 and below the brown or gray silty lean clay with sand layer, and in Borings 3, 4 and 6 and below the fill layer, 0.5 to 12.5 feet of loose-to-very dense, brown silty sand or silty sand with gravel. The layer extends to the bottom of the boring at a depth, below the existing grade, of 10 feet in Borings 1, 2, 3 and 6, and 30 feet in Boring 5.
- In Borings 4 and 11 and below the brown silty sand with gravel layer, five to 5.5 feet of stiff-to-very stiff, brown or gray, silty lean clay with sand. The layer extends to the bottom of the boring at a depth of 20 feet below the existing grade in Boring 11.
- In Boring 4 and below the gray silty lean clay with sand layer, 2.5 feet of very dense, light brown silty sand with gravel extending to the bottom of the boring at a depth of 30 feet below the existing grade.

- In Boring 7 and below the brown sand with gravel layer, 7.8 feet of stiff-to-very stiff, gray weathered shale extending to the bottom of the boring at a depth of 10 feet below the existing grade.

Free groundwater was encountered during the advancement of the borings at the depths and elevations summarized in Table 3-1.

Table 3-1. Summary of Groundwater Observations

Boring No.	Depth Groundwater First Observed (ft)		Groundwater Observations at Completion of Boring	
	Depth	Elevation*	Depth	Elevation*
1	No Water		No Water	
2	No Water		No Water	
3	No Water		No Water	
4	18.5	683.4	17.5	684.4
5	17.5	684.4	17.0	684.9
6	No Water		No Water	
7	No Water		No Water	
8	No Water		No Water	
9	No Water		No Water	
10	No Water		No Water	
11	18.5	694.1	No Water	
12	13.5	698.8	No Water	
13	No Water		No Water	
14	No Water		No Water	
15	No Water		No Water	
16	No Water		No Water	

*In reference to surface elevation based on Ohio South State Plane Coordinate System.

Free groundwater is defined as water that seeps into an open borehole before it is backfilled. Groundwater observations were made during the boring operations by noting the depth of water on the boring tools and in the open boreholes following withdrawal of the boring augers. However, it should be noted that short-term water level readings are not necessarily a reliable indication of the groundwater level and that significant fluctuations may occur due to variations in rainfall and other factors. For specific questions on the soil conditions, please refer to the individual boring logs in Section III.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Project Description

The City of Miamisburg proposes to install a raw water main along Riverview Avenue in Miamisburg, Ohio. The proposed raw water main will be approximately 8,500 feet long and will extend to the City of Miamisburg's Water Treatment Facility at 302 S. Riverview Ave. We assume the invert of the water line will be approximately 5 to 15 feet deep. A proposed pole barn will also be constructed. No specific design or loading information was provided for this report.

The following recommendations are based on this information. If the above statements are incorrect or changes are made, Bowser-Morner, Inc. should be notified so that the new data can be reviewed and additional recommendations and services can be given if required to meet the needs of your project.

4.2 Foundation Recommendations for Pole Barn Building

4.2.1 Foundation Subgrade Preparation

Based on the subgrade soil conditions indicated in Boring 1 made at the proposed pole barn area, the site is covered with topsoil that extends to the approximate depths outlined in Table 4-1. Based on the results of the standard penetration tests (SPT) in the boring, the recommended net allowable bearing capacities and the depths to bearing strata at the boring is also tabulated in Table 4-1.

Table 4-1. Depths to Bottoms of Unreliable Soils

Boring No.	Depth to Bottom of Unreliable Soil (ft)	Elevation* at Bottom of Unreliable Soil (ft)	Topsoil, and/or Weak Soil	Net Allowable Bearing Capacity (psf)
1	1.4	699.0	Topsoil	4,000

*In reference to surface elevation based on Ohio South State Plane Coordinate System.

The topsoil is unreliable to support the pole barn building foundation or slab on-grade. Within the construction limits, the topsoil should be removed and replaced with compacted backfill. Within the construction limits, the weaker soil can be removed to the suitable depths with the desired allowable bearing capacities as outlined in Table 4-1 and replaced with compacted backfill. The topsoil can also be stockpiled for landscaping purposes.

The excavations within the construction limits should extend to suitable soils. The bottoms of footing foundations should be placed at least 36 inches below the final adjacent grades to protect against frost penetration and heaving. The base of the excavation should extend one lateral foot for every foot of excavation below the bottom of the footing foundation as shown in Figure 3 in Section III. If an excavation will extend more than five feet below the existing grade, a maximum allowable side slope of 1 (horizontal) to 1 (vertical) should be maintained in any excavation for stability and for the safety of the workers.

After the excavations extend to the desired grade, the top foot at the bottom of each excavation should be compacted to at least 90% of the maximum dry-unit weight as determined by the modified Proctor test (ASTM D1557) before any new fill or foundation is placed. Any soft soil pockets should be undercut and replaced with compacted fill.

Any additional soil fill can be placed over the recompacted subgrade. The backfill placed on-site should be placed in maximum, eight-inch-thick, loose lifts and compacted to at least 95% of the maximum dry-unit weight as determined by the modified Proctor test (ASTM D1557). Horizontal benches should be provided on the sloped sides of the excavation for the fill to be keyed into the original soil layer. The additional backfill should be compacted in horizontal lifts in accordance with the recommendations given in Section 4.4. Any lean clay soils to be imported as backfill or removed from the project site probably will have significantly different Proctor values. Consequently, samples to be tested by the Proctor method should be obtained from a representative area and from the same elevation as the design subgrade.

In winter or wet weather, the backfill should be granular material. During good weather, the existing wet soil removed from the site can be spread out to dry and reused as backfill. The silty and clayey soil also can be used as backfill in favorable weather. For the placement of the granular backfill, the bottom of the subgrade below the granular backfill layer should be graded to drain to an underdrain system. The underdrain system should discharge into the storm-drainage system or be “day lighted” away from the footprint of the pole barn building. The groundwater level in the granular-backfill layer should be kept at a depth of 40 inches below the final grade to prevent potential frost penetration and heaving problems.

The footing foundations for the pole barn building can be supported on the original subgrade soil or newly compacted backfill extending to the depths and elevations outlined in Table 4-1. The foundations can be designed with the corresponding net allowable bearing capacities outlined in Table 4-1. For these recommended allowable bearing capacities outlined in Table 4-1 for the original soil layer or for the newly compacted backfill, the total estimated amount of settlement of the foundations will be about one inch.

4.2.2 Site Classification For Seismic Design

Based on the results of the standard penetration tests (SPT) in the boring made for pole barn building, the average “N” value is 33 blows per foot for the soil layer within 10 feet of the existing grade. Based on the results of the average “N” value, it is our opinion that the site will be classified as a “D” type in accordance with the *Ohio Building Code*.

4.3 Pole Barn Floor Slabs On-Grade

The topsoil is also not reliable to support the pole barn floor slab due to the potential for settlement. The floor slabs on-grade can be constructed over a one-foot-thick layer of granular base. This foot of compacted granular base should be a well-graded, granular material such as crushed sand and gravel or crushed stone. To help distribute concentrated loads and equalize moisture conditions under the slab, this granular material should contain less than 5% of fines or particles that can pass through a No. 200 sieve.

We also recommend that slabs on-grade “float” by being fully supported on the ground and not structurally connected to the walls or foundations. Floating will minimize the possibility of cracking and displacement of the slabs on-grade as a result of differential movements between the slabs and the foundations. Although the movements should be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

4.4 Compaction Requirements

Structural fill placed below the foundation bearing elevation should be compacted to at least 95% of the maximum dry unit weight with moisture contents within 2% of the optimum moisture content as determined by the modified Proctor test (ASTM D1557). Fill placed above the bottoms of the foundations or under pavement areas should be compacted to at least 90% of the maximum dry unit weight with moisture contents within 2% of the optimum moisture content as determined by the modified Proctor test (ASTM D1557). The compaction should be accomplished by placing the fill in successive, horizontal, approximately six- to eight-inch-thick loose lifts and mechanically compacting each lift to at least the specified minimum dry density. Field density tests should be performed at a minimum rate of one per 2,500 square feet of fill area and for each lift to verify that adequate compaction is achieved. Backfill for utility trenches, foundation excavations, etc., within structures or paved areas, is considered structural fill and should be placed in accordance with these recommendations.

It must be emphasized that the excavation and compaction of soil fill are highly influenced by weather conditions. Performing the earthwork under wet and frozen conditions is generally very difficult. As a result, compaction of wet silty and clayey soil should be avoided during wet and frozen conditions because the wet soil cannot be compacted to the required unit weight without drying or other soil stabilization methods. Alternatively, granular soil can be used as backfill to facilitate the backfill and compaction work during winter and wet weather conditions. The construction cost during the winter and wet weather conditions will be higher by the purchase of granular soil from the sand and gravel pits.

Puddling or jetting of the backfill material, including the utility trenches, should not be allowed as a compaction method. Silty or clayey soils encountered above foundation depth will often soften, and the bearing capacity may be reduced if water ponds in the excavation.

Lean concrete that is placed below the bottom of foundation should have a minimum 28-day compressive strength of 2,000 pounds per square inch (psi).

4.5 Foundation Excavations

During the foundation excavations, the subsurface conditions should be verified. Changes in subsurface conditions other than what are shown on the boring logs warrant additional subsurface investigation before the pole barn building foundations are constructed.

The foundation excavations should be observed to ensure that the loose, soft, or otherwise undesirable materials are removed and that the foundations will be supported directly on an acceptable surface. At the time of this observation, it may be necessary to use a hand penetration device in the base of the foundation excavation to ensure that the soils immediately below the foundation base are satisfactorily prepared to support the foundations. Please note that such shallow observations do not replace an adequate deep-boring program and structural fill compaction QA/QC records. The overall performance of the foundations is governed by the soils below the bottom of the footing foundation.

If pockets of soft, loose, or otherwise unsuitable materials are encountered in the footing excavations and it is inconvenient to lower the footings, the proposed footing elevations may be reestablished by backfilling after the undesirable materials have been removed. The excavation under each footing should extend to suitable soils, and the base of the excavation should extend one lateral foot for every foot of excavation below the bottom of the footing foundation as shown in Figure 3 in Section III. The entire excavation should then be refilled with well-compacted, engineered fill. Special care should be taken to remove the sloughed, loose, or soft materials near the base of the excavation slopes. Extra care should also be taken to tie-in the compacted fill with the excavation slopes, with benches as necessary, to ensure that no pockets of loose or soft materials are left along the excavation slopes below the foundation bearing level. The contractor should maintain temporary cut slopes in accordance with the current OSHA regulations governing trenching and slope stability.

Soils exposed at the bases of satisfactory foundation excavations should be protected against any detrimental change in condition such as from construction disturbances, rain, and freezing. Surface runoff should be drained away from the excavation and not allowed to pond. If possible, foundation concrete should be placed the same day the excavation is made. If this is not practical, the foundation excavations should be adequately protected. Also, for this reason, proper drainage should be maintained after construction. It must be emphasized that all excavations must conform to all state, federal, and local regulations relative to slope geometry.

4.6 Bear Creek and SR 725 Pipe Installations

We understand that beneath the Bear Creek (in the vicinity of Borings 4 and 5), installation of the proposed raw water main will be performed via horizontal directional drilling (HDD). We understand that the invert will be approximately 5 to 15 feet deep. Based on the information from Borings 4 and 5 made for this study in the vicinity of the Bear Creek, the subgrade soil conditions are described in descending order below:

- 8.5 to 13.5 feet of undocumented and uncontrolled fill consisting of asphalt, brown silty sand with gravel, and dark brown, silty organic clay.

- In Boring 4 and below the fill layer, 8.5 feet of medium dense, brown sand with gravel.

- In Boring 4 and below the brown silty sand with gravel layer and in Boring 5 and below the fill layer, 5.5 to nine feet of soft-to-very stiff gray or brown silty lean clay with sand.

- In Boring 4 and below the gray, silty lean clay with sand layer, 2.5 feet of very dense, light brown silty sand with gravel extending to the bottom of the boring at a depth of 30 feet below the existing grade.

- In Boring 5 and below the gray and brown , silty lean with sand layer, 12.5 feet of loose-to-medium dense, brown silty sand extending to the bottom of the boring at a depth of 30 feet below the existing grade.

Based on the subgrade soil conditions in Borings 4 and 5, the subgrade soil at a depth of 5 to 15 feet consists of undocumented and uncontrolled fill consisting of medium dense, brown silty sand with gravel and stiff, dark brown, silty organic clay. The fill layer is underlain by medium dense brown silty sand with gravel in Boring 4 and by soft, gray and brown silty lean clay with sand in Boring 5. The STP "N" blow counts in Boring 4 between depths of 5 to 10 feet is from 14 to 17. The STP "N" blow counts in Boring 4 between depths of 10 to 20 feet is from 12 to 25. The STP "N" blow counts in Boring 5 between depths of 5 to 10 feet is from 5 to 19. The STP "N" blow counts in Boring 5 between depths of 10 to 20 feet is from 5 to 9.

We also understand that beneath SR 725 (in the vicinity of Borings 10, 11 and 12), installation of the proposed raw water main will be performed via jack and bore. Again, we understand that the invert will be approximately 5 to 15 feet deep. Based on the information from Borings 10, 11, and 12 made for this study in the vicinity of SR 725, the subgrade soil conditions are described in descending order below:

- 1.1 to 8.5 feet of undocumented and uncontrolled fill consisting of topsoil, asphalt, gravel base, and light brown-to-black silty organic clay or silty lean clay.
- Below the fill layer, 6.9 to 16.5 feet of medium stiff-to-stiff, brown or gray, silty lean clay with sand. The layer extends to the bottom of the boring at a depth of 20 feet below the existing grade in borings 10 and 12.
- In Boring 11 and below the brown and gray silty lean clay with sand layer, seven feet of medium dense, brown silty sand with gravel underlain by five feet of stiff, brown, silty lean clay with sand. The layer extends to the bottom of the boring at a depth of 20 feet below the existing grade.

Based on the subgrade soil conditions in Borings 10,11 and 12, the subgrade soil at a depth of 5 to 15 feet consists of undocumented and uncontrolled fill; medium stiff-to-stiff, brown, silty lean clay; and medium dense brown silty sand with gravel. The fill consists of hard, gray silty lean clay. The STP "N" blow counts in Boring 10 between depths of 5 to 10 feet is from 8 to 31. The STP "N" blow counts in Boring 10 between depths of 10 to 20 feet is from 8 to 10. The STP "N" blow counts in Boring 11 between depths of 5 to 10 feet is from 11 to 24. The STP "N" blow counts in Boring 11 between depths of 10 to 20 feet is from 5 to 11. The STP "N" blow counts in Boring 12 between depths of 5 to 10 feet is from 8 to 14. The STP "N" blow counts in Boring 12 between depths of 10 to 20 feet is from 7 to 10.

4.7 Subgrade Soil Classification for Trench Excavation

Based on Occupational Safety and Health Administration (OSHA) Subpart P-Excavations (29 CFR PART 1926), cohesive soil with an unconfined compressive strength of 3,000 pounds per square foot (psf) or greater can be classified as Type "A" soil. Cohesive soil with an unconfined compressive strength greater than 1,000 psf but less than 3,000 psf can be classified as Type "B" soil, and cohesive soil with an unconfined compressive strength of 1,000 psf or less can be classified as Type "C" soil. Dense or very dense granular soil with no water can be classified as Type "B" soil; the other granular soils should be classified as Type "C" soil. Previously disturbed soil (fill) should not be classified as Type "A" soil. Soil that is fissured shall not be classified as Type

"A" soil. Based on the standard penetration test (SPT) results from this study, the subgrade soils along the proposed water main river crossings alignment are classified as shown in Table 4-2.

Table 4-2. Subgrade Soil Classification (OSHA)

Boring No.	Depth (ft.)	OSHA Soil Type
1	0.0 – 6.0	C
	6.0 – 10.0	B
2	0.0 – 3.5	C
	3.5 – 6.5	B
	6.5 – 10.0	C
3	0.0 – 3.5	B
	3.5 – 10.0	C
4	0.0 – 22.0	C
	22.0 – 27.5	A
	27.5 – 30.0	B
5	0.0 – 8.5	C
	8.5 – 17.5	B
	17.5 – 30.0	C
6	0.0 – 7.0	B
	7.0 – 8.5	C
	8.5 – 10.0	B
7	0.0 – 2.3	B
	2.3 – 10.0	A
8	0.0 – 10.0	B
9	0.0 – 10.0	B
10	0.0 – 20.0	B
11	0.0 – 6.0	A
	6.0 – 8.0	B
	8.0 – 15.0	C
	15.0 – 20.0	B
12	0.0 – 20.0	B
13	0.0 – 10.0	C
14	0.0 – 3.5	B
	3.5 – 10.0	A
15	0.0 – 3.5	C
16	0.0 – 8.5	C
	8.5 – 10.0	B

If weaker soil is encountered below stronger soil, the classifications of all of the stronger soil above the weaker soil layer will have to be lowered to the weaker soil classification. At the time of our study, free groundwater was encountered at depths of 13.5 to 18.5 feet below the existing ground surface. The groundwater should be lowered to the bottom of the maximum excavation during the installation of the raw water main. Otherwise, the bottoms of the trench excavation will be very soft due to the groundwater seepage. All submerged soil or soil from which water is freely seeping should be classified as Type "C" soil.

The side slopes of the trench excavations should be maintained in accordance with OSHA trench excavation regulations for stability and for safety of the worker. The sloping and benching method can be used during the installation of the steam line. For type “A” soil, a side slope of 3/4 (horizontal) to 1 (vertical) should be provided; For type “B” soil, a side slope of 1 (horizontal) to 1 (vertical) should be provided; and For type “C” soil, a side slope of 1-1/2 (horizontal) to 1 (vertical) should be provided.

As an alternative to the sloping and benching method, a trench box can be used to keep the side walls from caving in and for the safety of the workers. The trench box should be rated in accordance with OSHA regulations. Tabulated data for the trench box that identify the registered professional engineer who approved the data should be kept on the job site. For more detailed information on the OSHA regulations, please refer to OSHA Subpart P-Excavations (29 CFR PART 1926).

During the trench excavations, the subsurface conditions should be verified. A “competent person” as defined by OSHA should be present throughout the water main river crossing trench excavations to verify the soil types and soil conditions. The sloping and benching or trench box design should be adjusted with changes in the subgrade soil in accordance with OSHA regulations.

4.8 Trench Excavation

During any trench excavations, the subsurface conditions should be verified. Changes in subsurface conditions other than what are shown on the boring logs warrant additional subsurface investigation before the pipe installation.

The trench excavations should be observed to ensure that the loose, soft, or otherwise undesirable materials are removed and that any structures will be supported directly on an acceptable surface. At the time of this observation, it may be necessary to use a hand penetration device in the base of the trench excavation to ensure that the soils immediately below the base are satisfactorily prepared to support the structures. Please note that such shallow observations do not replace an adequate deep-boring program and structural fill compaction QA/QC records. The overall performance of the structures is governed by the soils below the bottom of the base.

If pockets of soft, loose, or otherwise unsuitable materials are encountered at the bottom of the trench excavation, the proposed water main elevations may be reestablished by backfilling after the undesirable materials have been removed. The excavation should extend to suitable soils, and the base of the excavation should extend one lateral foot for every foot of excavation below the bottom of the base. The entire excavation should then be refilled with well-compacted, engineered fill. Special care should be taken to remove the sloughed, loose, or soft materials near the base of the excavation slopes. Extra care should also be taken to tie-in the compacted fill with the excavation slopes, with benches as necessary, to ensure that no pockets of loose or soft materials are left along the excavation slopes below the bearing level. The contractor should maintain temporary cut slopes in accordance with the current OSHA regulations governing trenching and slope stability.

Soils exposed at the bases of satisfactory excavations should be protected against any detrimental change in condition such as from construction disturbances, rain, and freezing. Surface runoff should be drained away from the excavation and not allowed to pond. It must be emphasized that all excavations must conform to all state, federal, and local regulations relative to slope geometry.

4.9 Construction Dewatering

At the time of our study, free groundwater was encountered at depths of 13.5 to 18.5 feet below the existing grade as outlined in Table 3-1. No free groundwater was encountered in the boring performed at the site of the proposed pole barn. Any groundwater or surface water that accumulates in the excavations should be lowered by sumps and pumps during the excavations for the construction of the proposed pole ban and raw water main. The groundwater will have to be lowered to the bottoms of the excavations and to the top of the clay layer, and to three feet below the bottom of the excavation in the granular soil layer. However, care must be exercised when pumping from sumps that extend into silts or other granular soils since general deterioration of the bearing soils and a localized “quick” condition could result. If the raw water main will be placed under the groundwater, the water main pipes, and fittings should be designed with watertight connections to reduce the amount of groundwater seeping into the pipe. If significant groundwater influxes are noted within the excavations, other dewatering techniques should be determined at the time of construction.

The amount and type of dewatering required during construction will depend on the weather and groundwater levels at the time of construction, and the effectiveness of the contractor’s techniques in preventing surface runoff from entering open excavations. Typically, groundwater levels are highest during winter and spring, and lower in summer and early fall.

5.0 CLOSURE

5.1 Basis of Recommendations

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. Data used during this exploration included, but were not necessarily limited to:

- Sixteen exploratory borings performed during this study.
- Observations of the project site by our staff.
- The results of the laboratory soil tests.
- The site plan provided by Arcadis U.S. Inc.
- Limited interaction with Mr. Jason Abbott, P.E., CPM, Principal Engineer of Arcadis U.S. Inc.

- Published soil or geologic data of this area.

In the event that changes in the project characteristics are planned, or if additional information or differences from the conditions anticipated in this report become apparent, Bowser-Morner, Inc. should be notified so that the conclusions and recommendations contained in this report can be reviewed and, if necessary, modified or verified in writing.

5.2 Limitations and Additional Services

The subsurface conditions discussed in this report and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by designers, or that the construction process has altered the soil conditions. As variations in the soil profile are encountered, additional subsurface sampling and testing may be necessary to provide data required to reevaluate the recommendations of this report. Consequently, after submission of this report, it is recommended that Bowser-Morner, Inc. be authorized to perform additional services to work with the designer(s) to minimize errors and omissions regarding the interpretation and implementation of this report.

Before construction begins, we recommend that Bowser-Morner, Inc.:

- Work with the designers to implement the recommended geotechnical design parameters into plans and specifications.
- Consult with the design team regarding interpretation of this report.
- Establish criteria for the construction observation and testing for the soil conditions encountered at this site.
- Review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that Bowser-Morner, Inc.:

- Observe the construction, particularly the site preparation, fill placement, and foundation excavation or installation.
- Perform in-place density testing of all compacted fill.
- Perform materials testing of soil and other materials as required.
- Consult with the design team to make design changes in the event that differing subsurface conditions are encountered.

If Bowser-Morner, Inc. is not retained for these services, we shall assume no responsibility for construction compliance with the design concepts, specifications or recommendations.

5.3 Warranty

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, express or implied, is made.

The scope of this study did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, within or beyond the site studied. Any statements in the report or on the boring logs regarding odors, staining of soils or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and sampling, including groundwater sampling, may be required. Bowser-Morner, Inc. can provide this service and would be pleased to provide a cost proposal to perform such a study, if requested.

This report has been prepared for the exclusive use of Arcadis U.S. Inc. for specific application to the raw water main on Riverview Avenue in Miamisburg, Ohio (see Figure 1 in Section III of this report). Specific design and construction recommendations have been provided in the various sections of the report. The report shall therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. Bowser-Morner, Inc. is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

Section II

Specifications

CLEARING AND GRADING SPECIFICATIONS

I. GENERAL CONDITIONS

The contractor shall furnish all labor, materials, and equipment, and perform all work and services necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction and grading as shown on the plans and as described therein.

This work shall consist of all clearing and grading, removal of existing structures unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications.

This work is to be accomplished under the constant and continuous supervision of the Owner or his designated representative.

In these specifications the terms "approved" and "as directed" shall refer to directions to the Contractor from the Owner or his designated representative.

II. SUBSURFACE CONDITIONS

Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including, without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site; and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work. Borings and/or soil investigations shall have been made. Results of these borings and studies will be made available by the Owner to the Contractor upon his request, but the Owner is not responsible for any interpretations or conclusions with respect thereto made by the Contractor on the basis of such information, and the Owner further has no responsibility for the accuracy of the borings and the soil investigations.

If conditions other than those indicated are discovered by the Contractor, the Owner should be notified immediately. The material which the Contractor believes to be a changed condition should not be disturbed so that the Owner can investigate the condition.

III. SITE PREPARATION

Within the specified areas, all trees, brush, stumps, logs, tree roots, and structures scheduled for demolition shall be removed and disposed of.

All cut and fill areas shall be properly stripped. Topsoil will be removed to its full depth and stockpiled for use in finish grading. Any rubbish, organic and other objectionable soils, and other deleterious material, shall be disposed of off the site, or as directed by the Owner or his designated representative if on site disposal is provided. In no case shall such objectionable material be allowed in or under the fill unless specifically authorized in writing.

Prior to the addition of fill, the original ground shall be compacted to job specifications as outlined below. Special notice shall be given to the proposed fill area at this time. If wet spots, spongy conditions, or ground water seepage is found, corrective measures must be taken before the placement of fill.

IV. FORMATION OF FILL AREAS

Fills shall be formed of satisfactory materials placed in successive horizontal layers of not more than eight (8) inches in loose depth for the full width of the cross section. The depth of lift may be increased if the Contractor can demonstrate the ability to compact a larger lift. If compaction is accomplished using hand-tamping equipment, lifts will be limited to 4-inch lose lifts.

All material entering the fill shall be free of organic matter such as leaves, grass, roots, and other objectionable material.

The operations on earth work shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions. The Contractor shall keep the work areas graded to provide the drainage at all times.

The fill material shall be of the proper moisture content before compaction efforts are started. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. The moisture content of the fill material should be no more than two (2) percentage points higher or lower than optimum unless otherwise authorized. Sprinkling shall be done with equipment that will satisfactorily distribute the water over the disced area.

Compaction operations shall be continued until the fill is compacted to not less than 90% above foundation elevation and 95% below foundation elevation, of the maximum density as determined in accordance with the latest ASTM D-1557 (Modified). Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers. The equipment shall be operated in such a manner that hardpan, cemented gravel, clay or other chunky soil material will be broken up into small particles and become incorporated with the other material in the layer.

In the construction of filled areas, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, additional layers shall be constructed in horizontal planes. If directed, original slopes shall be continuously, vertically benched to provide horizontal fill planes. The size of the benches shall be formed so that the base of the bench is horizontal and the back of the bench is vertical. As many benches as are necessary to bring the site to final grade shall be constructed. Filling operations shall begin on the lowest bench, with the fill being placed in horizontal eight (8) inch loose lifts unless otherwise authorized. The filling shall progress in this manner until the entire first bench has been filled, before any fill is placed on the succeeding benches. Proper drainage shall be maintained at all times during benching and filling of the benches, to insure that all water is drained away from the fill area.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portion of the areas. Stones or fragmentary rock larger than four (4) inches in their greatest dimensions will not be allowed in the fill unless specifically authorized in writing. Rock fill shall be brought up in layers as specified or as directed, and every effort shall be exerted to fill the voids with the finer material to form a dense, compact mass. Rock or boulders shall be disposed of as deleterious material per Item III.

Frozen material shall not be placed in the fill nor shall the fill be placed upon frozen material.

The Contractor shall be responsible for the stability of all fills made under the contract, and shall replace any portion, which in the opinion of the Owner or his designated representative, has become displaced due to carelessness or negligence on the part of the Contractor. Fill damaged by inclement weather shall be repaired at the Contractor's expense.

V. SLOPE RATIO AND STORM WATER RUN-OFF

Slopes shall not be greater than 2 (horizontal) to 1 (vertical) in both cut and fill, and storm water shall not be drained over the slopes.

VI. GRADING

The Contractor shall furnish, operate, and maintain such equipment as is necessary to construct uniform layers, and control smoothness of grade for maximum compaction and drainage.

VII. COMPACTING

The compaction equipment shall be approved equipment of such design, weight, and quantity to obtain the required density in accordance with these specifications.

VIII. TESTING AND INSPECTION SERVICES

Testing and inspection services will be provided by the Owner.

IX. SPECIAL CONDITIONS

Section III

Boring Log Terminology, Boring Logs, Laboratory Data, And Prints

BORING LOG TERMINOLOGY

Stratum Depth:

Distance in feet and/or inches below ground surface.

Stratum Elevation:

Elevation in feet below ground surface elevation.

Description of Materials:

Major types of soil material existing at boring location. Soil classification based on one of the following systems: Unified Soil Classification System., Ohio State Highway Classification System, Highway Research Board Classification System, Federal Aviation Authority Classification System, Visual Classification.

Sample No.:

Sample numbers are designated consecutively, increasing with depth for each boring.

Sample Type:

"A" Split spoon, 2" O.D., 1-3/8" I.D., 18" in length.

"B" Rock Core

"C" Shelby Tube 3" O.D. except where noted

"D" Soil Probe

"E" Auger Cuttings

"F" Sonic

Sample Depth:

Depth below top of ground at which appropriate sample was taken.

Blows per 6" on Sampler:

The number of blows required to drive a 2" O.D., 1-3/8" I.D., split spoon sampler, using a 140 pound hammer with a 30-inch free fall, is recorded for 6" drive increments. (Example: 3/8/9).

"N" Blows/Ft.:

Standard penetration resistance. This value is based on the total number of blows required for the last 12" of penetration. (Example: 3/8/9: N = 8 + 9 = 17)

Water Observations:

Depth of water recorded in test boring is measured from top of ground to top of water level. Initial depth indicates water level during boring, completion depth indicates water level immediately after boring, and depth after “X” number hours indicates water level after letting water rise or fall over a time period. Water observations in pervious soil are considered reliable ground water levels for that date. Water observations in impervious soils can not be considered accurate ground water measurements for that date unless records are made over several days’ time. Factors such as weather, soil porosity, etc., will cause the ground water level to fluctuate for both pervious and impervious soils.

SOIL DESCRIPTION

Color:

When the color of the soil is uniform throughout, the color recorded will be such as brown, gray, or black and may be modified by adjectives such as light and dark. If the soil’s predominant color is shaded by a secondary color, the secondary color precedes the primary color, such as: gray-brown, yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled, such as: mottled brown and gray.

Particle Size		**Visual**
Boulders		Larger than 8”
Cobbles		8” to 3”
Gravel	– Coarse	3” to 3/4”
	– Fine	2 mm. To 3/4”
Sand	– Coarse	2 mm. – 0.6 mm. (Pencil lead size)
	– Medium	0.6 mm. – 0.2mm. Table sugar and salt size)
	– Fine	0.2 mm. – 0.06 mm. (Powdered sugar and human hair size)
Silt		0.06 mm. – 0.002 mm.
Clay		0.002 and smaller (Particle size of both Silt and Clay not visible To naked eye

Soil Components

Major Component:	**Minor Component Term**
Gravel	Trace 1-10%
Sand	Some 11-35%
Silt	And 36-50%
Clay	

Moisture Content

Term	**Relative Moisture**
Dry	Powdery
Damp	Moisture content below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content Above liquid limit

Condition of Soil Relative to Compactness Granular Material

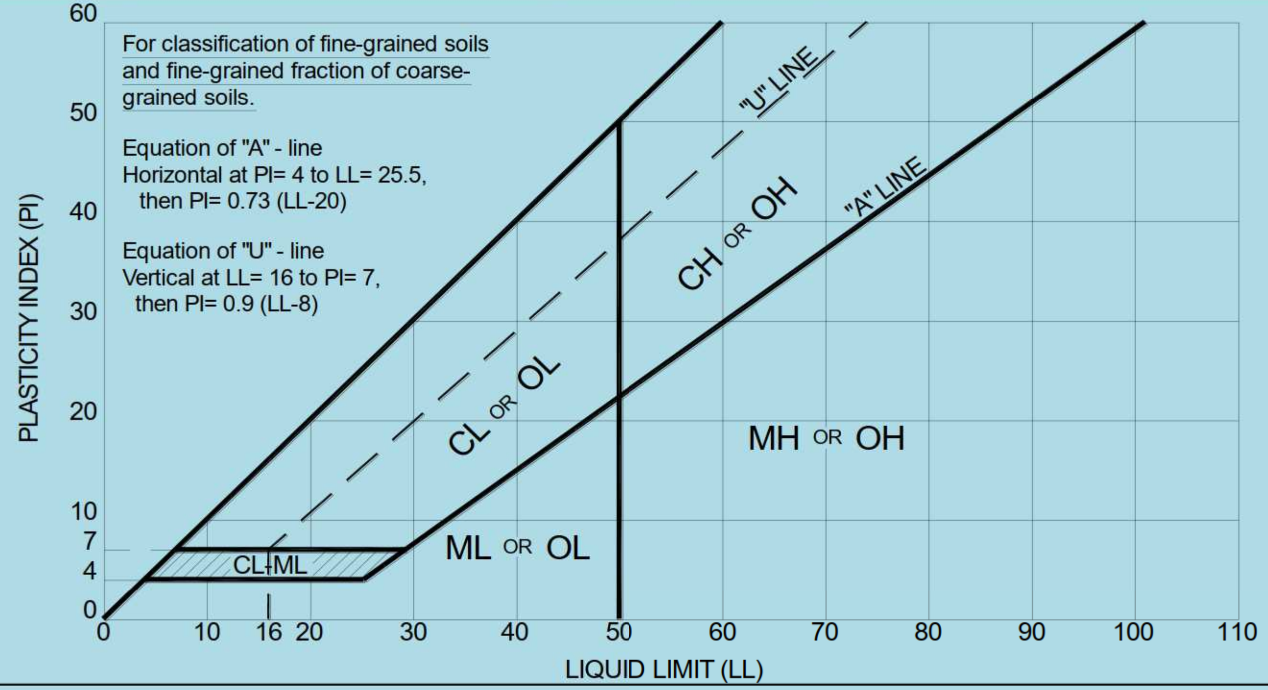
Very Loose	5 blows/ft. or less
Loose	6 to 10 blows/ft.
Medium Dense	11 to 30 blows/ft.
Dense	30 to 50 blows/ft.
Very Dense	51 blows/ft. or more

Condition of Soil Relative to Consistency Cohesive Material

Very Soft	3 blows/ft. or less
Soft	4 to 5 blows/ft.
Medium Stiff	6 to 10 blows/ft.
Stiff	11 to 15 blows/ft.
Very stiff	16 to 30 blows/ft.
Hard	31 blows/ft. or more

UNIFIED CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	▨	GW	WELL-GRADED GRAVEL WELL-GRADED GRAVEL WITH SAND
			▨	GP	POORLY GRADED GRAVEL POORLY GRADED GRAVEL WITH SAND
		GRAVELS WITH FINES APPRECIABLE AMT. OF FINES)	▨	GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
			▨	GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)	▨	SW	WELL-GRADED SAND WELL-GRADED SAND WITH GRAVEL
			▨	SP	POORLY GRADED SAND POORLY GRADED SAND WITH GRAVEL
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMT. OF FINES)	▨	SM	SILTY SAND SILTY SAND WITH GRAVEL
			▨	SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILT AND CLAYS	LIQUID LIMIT LESS THAN 50	▨	ML	SILT, SILT WITH SAND, SANDY SILT GRAVELLY SILT, GRAVELLY SILT WITH SAND
			▨	CL	LEAN CLAY WITH SAND, SANDY LEAN CLAY GRAVELLY LEAN CLAY WITH SAND
			▨	OL	ORGANIC CLAY, SANDY ORGANIC CLAY ORGANIC SILT, SANDY ORGANIC SILT WITH GRAVEL
	SILT AND CLAYS	LIQUID LIMIT GREATER THAN 50	▨	MH	ELASTIC SILT WITH SAND, SANDY ELASTIC SILT GRAVELLY ELASTIC SILT WITH SAND
			▨	CH	FAT CLAY WITH SAND, SANDY FAT CLAY GRAVELLY FAT CLAY WITH SAND
			▨	OH	ORGANIC CLAY WITH SAND, SANDY ORGANIC CLAY, ORGANIC SILT, SANDY ORGANIC SILT
	HIGHLY ORGANIC SOILS		▨	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

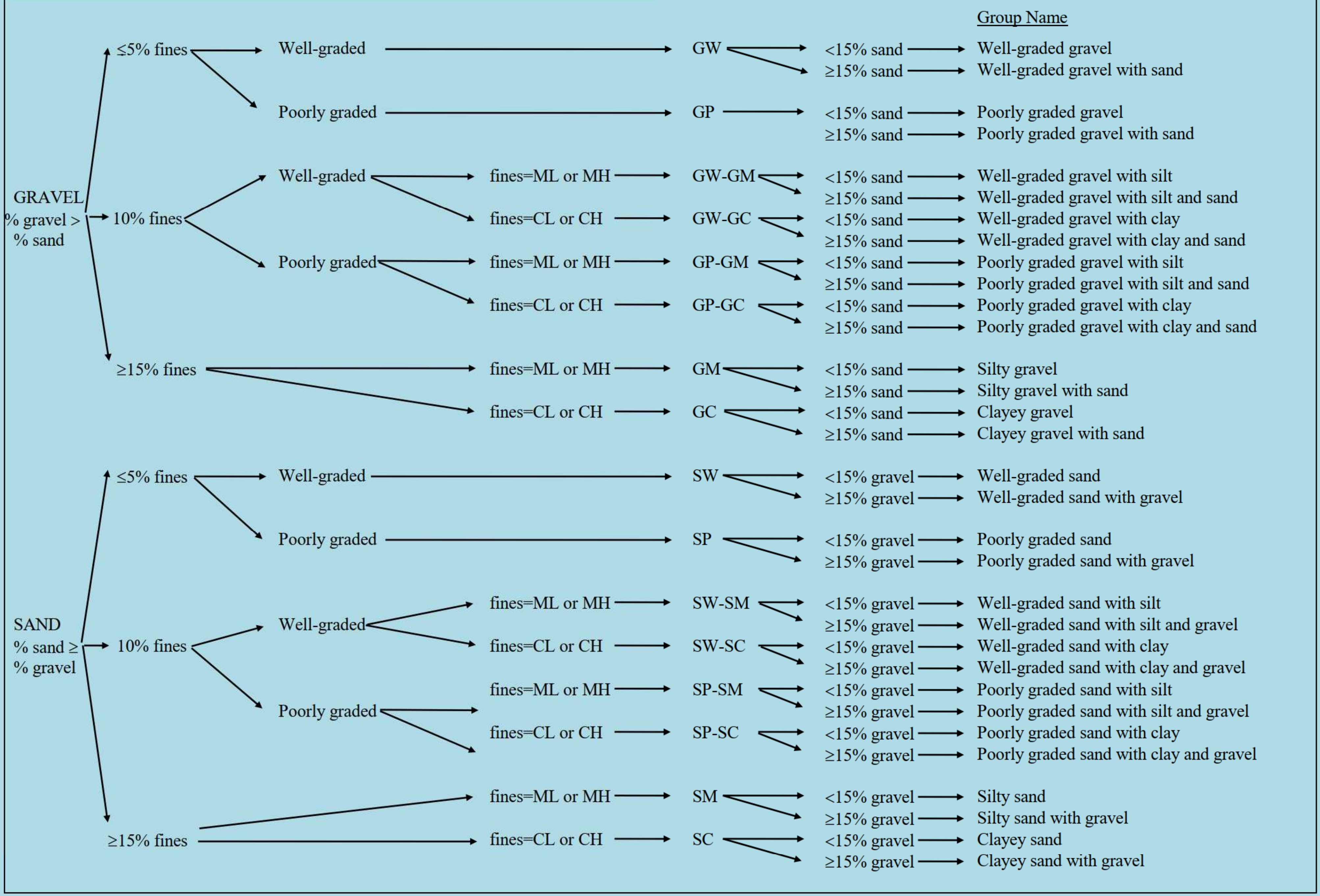


For classification of fine-grained soils and fine-grained fraction of coarse-grained soils.

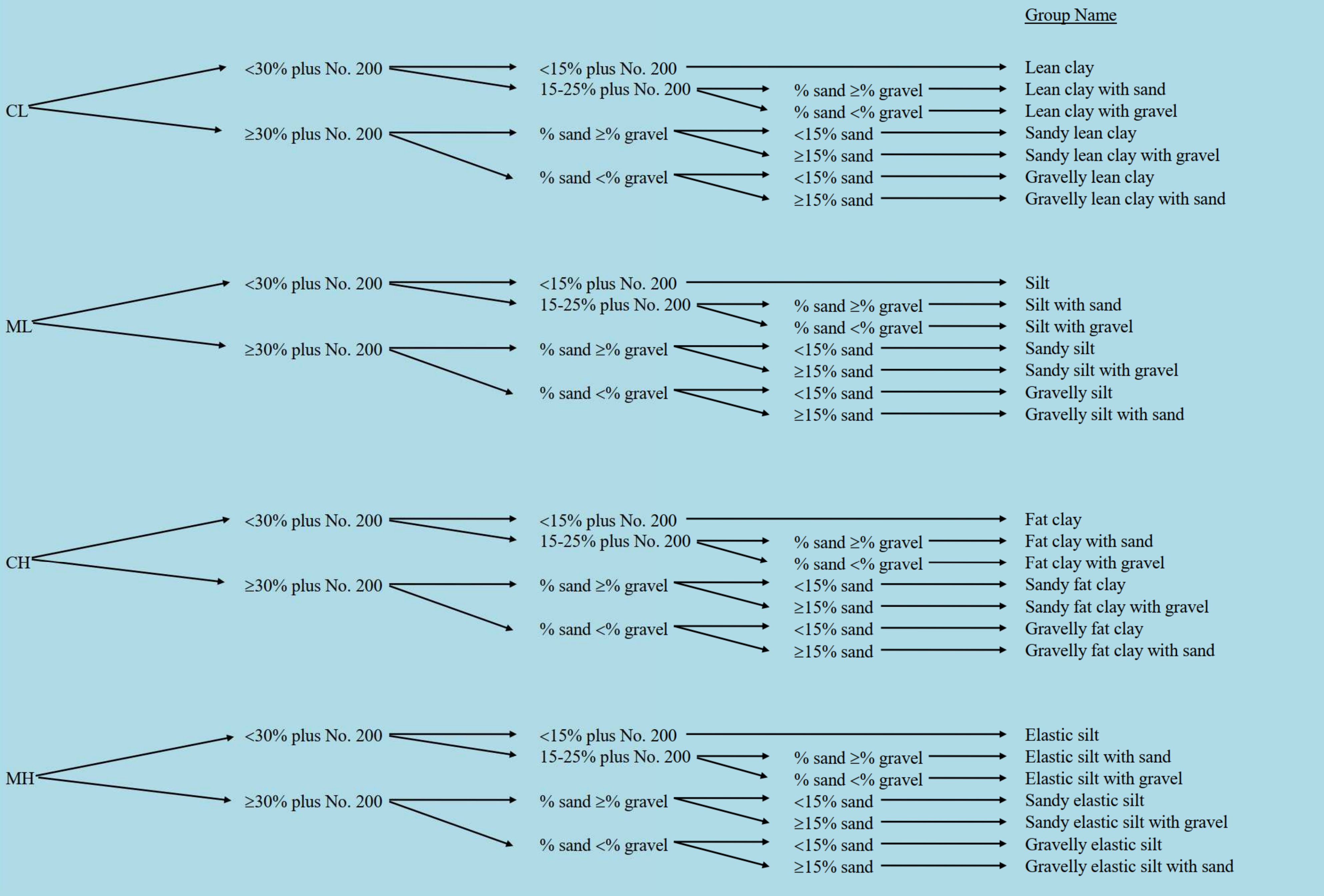
Equation of "A" - line
Horizontal at PI= 4 to LL= 25.5,
then PI= 0.73 (LL-20)

Equation of "U" - line
Vertical at LL= 16 to PI= 7,
then PI= 0.9 (LL-8)

Flow Chart for Visually Identifying Soils Based on ASTM D-2488



Flow Chart for Visually Identifying Soils Based on ASTM D-2488



STANDARD PENETRATION RESISTANCE (ASTM D1586)

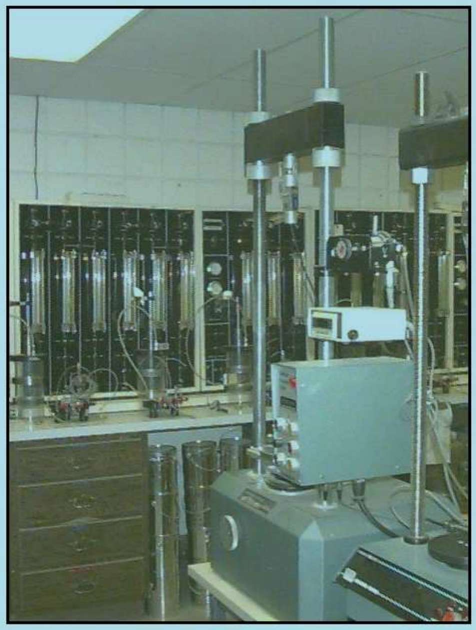
The purpose of this test is to determine the relative consistency of the soils in a boring, or from boring over the site. This method consists of making a hole in the ground and driving a 2-inch O.D. split spoon sampler into the soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6 inches of penetration. Values of standard penetration (N) are determined in blows per foot, summarizing the flows required for the last two 6-inche increments of penetration.

Example : 2-6-8; N = 14

THIN-WALLED SAMPLER (ASTM D1587)

The purpose of the thin-walled sampler is to recover a relatively undisturbed soil sample for laboratory tests. The sampler is a thin-walled seamless tube with a 3-inch outside diameter, which is hydraulically pressed into the ground, at a constant rate. The ends are then sealed to prevent soil moisture loss, and the tube is returned to the laboratory for tests.

UNCONFINED COMPRESSION OR TRIAXIAL TESTS (ASTM D 2166)



The unconfined compression test and the triaxial tests are performed to determine the shearing strength of the soil, to use in establishing its safe bearing capacity. In order to perform the unconfined compression test, it is necessary that the soil exhibit sufficient cohesion to stand in an unsupported cylinder. These tests are normally performed on samples which are 6.0 inches in height and 2.85 inches in diameter. In the triaxial test, various lateral stresses can be applied to more closely simulate the actual field conditions. There are several different types of triaxial tests. These are, however, normally performed on constant strain apparatus with a deformation rate of 0.05 inches per minute.

CONSOLIDATION TEST (ASTM D 2435)

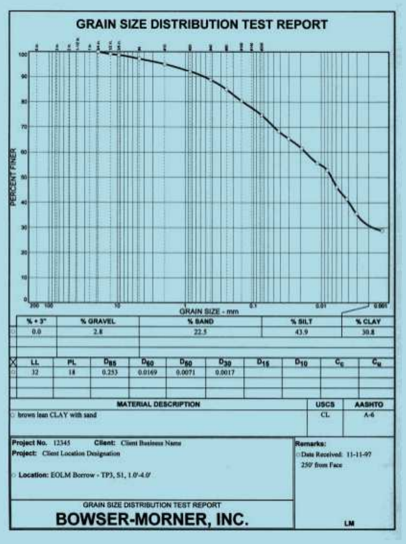
The purpose of this test is to determine the compressibility of the soil. This test is performed on a sample of soil which is 2.5 inches in diameter and 1.0 inch in height, and has been trimmed from relatively "undisturbed" samples. The test is performed with a lever system or an air activated piston for applying load. The loads are applied in increments and allowed to remain on the sample for a period of 24 hours. The consolidation of the sample under each individual load is measured and a curve of void ratio vs. Pressure is obtained. From the information obtained in this manner and the column loads of the structure, it is possible to calculate the settlement of each individual building column. This information, together with the shearing strength of the soil, is used to determine the safe bearing capacity for a particular structure.

REVISED TO ASTM D4318
ATTERBERG LIMITS (ASTM D423 AND D424)

These tests determine the liquid and plastic limits of soils having a predominant percentage of fine particle (silt and clay) sizes. The liquid limit of a soil is the moisture content expressed as a percent at which the soil changes from a liquid to a plastic state, and the plastic limit is the moisture content at which the soil changes from a plastic to a semi-solid state. Their difference is defined as the plasticity index (P.I. = L.L. - P.L.), which is the change in moisture content required to change the soil from a "semi-solid" to a liquid. These tests furnish information about the soil properties which is important in determining their relative swelling potential and their classifications.

MECHANICAL ANALYSIS (ASTM D422)

This test determines the percent of each particle size of a soil. A sieve analysis is conducted on particle sizes greater than a No. 200 sieve (0.074 mm), and a hydrometer test on particles smaller than the No.200 sieve. The gradation curve is drawn through the points of cumulative percent of particle size, and plotted on semi-logarithmic paper for the combined sieve and hydrometer analysis. This test, together with the Atterberg Limits tests, is used to classify a soil.



GRAIN SIZE DISTRIBUTION TEST REPORT

% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.8	22.5	43.9	30.8

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
32	18	0.253	0.0169	0.0071	0.0017				

MATERIAL DESCRIPTION	USCS	AASHTO
○ brown lean CLAY with sand	CL	A-6

Project No. 12345 **Client:** Client Business Name
Project: Client Location Designation
○ **Location:** EOLM Borrow - TP3, S1, 1.0'-4.0'

Remarks:
○ Date Received: 11-11-97
250' from Face

GRAIN SIZE DISTRIBUTION TEST REPORT
BOWSER-MORNER, INC.

LM

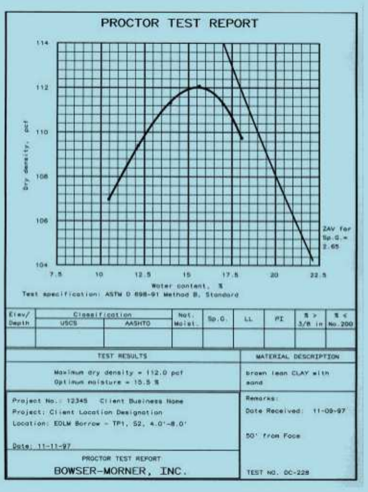
BOWSER
MORNER.

NATURAL MOISTURE CONTENT (ASTM D2216)

The purpose of this test is to indicate the range of moisture contents present in the soil. A wet sample is weighed, placed in the constant temperature oven at 105° for 24 hours, and re-weighed. The moisture content is the change in weight divided by the dry weight.

PROCTOR TESTS

The purpose of these tests is to determine the maximum density and optimum moisture content of a soil. The Modified Proctor test is performed in accordance with ASTM D1557. The test is performed by dropping a 10-pound hammer 25 times from an 18-inch height on each of 5 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 56,250 foot pounds per cubic foot. The moisture content is then raised, and this procedure is repeated. A moisture density curve is then plotted, with the density on the ordinate axis and the moisture on the abscissa axis. The moisture content at which the maximum density requirement can be achieved with a minimum compactive effort is designated as the optimum moisture content (O.M.C.). The Standard Proctor test is performed in accordance with ASTM D698. This test is similar to the Modified Proctor test and is performed by dropping a 5.5 pound hammer 25 times from a height of 12 inches on 3 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 12,375 foot pounds per cubic foot. This test gives proportionately lower results than the Modified Proctor test.



PROCTOR TEST REPORT

Test specification: ASTM D 698-91 Method B, Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						

TEST RESULTS

Maximum dry density = 112.0 pcf
Optimum moisture = 15.5 %

MATERIAL DESCRIPTION

brown lean CLAY with sand

Project No.: 12345 Client Business Name
Project: Client Location Designation
Location: EDLM Borrow - TP1, S2, 4.0'-8.0'

Date: 11-11-97

Remarks:
Date Received: 11-09-97

50' from Face

PROCTOR TEST REPORT
BOWSER-MORNER, INC.

TEST NO. DC-228

CLIENT **Arcadis U.S., Inc.**	JOB NO. **211648**
PROJECT **Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.**	BORING STARTED **10/31/23** BORING COMPLETED **10/31/23** DRILLER **Cindrill** METHOD **2 1/4" HSA** TYPED BY **dmo**
	1 Boring No. **Sheet 1 of 1**

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **700.4***
BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0			TOPSOIL (16")			
1.0–2.5	SS1	SS	Very stiff, brown, silty lean CLAY with sand (some gravel) - moist	6 8 8	16	
2.5			Medium dense, brown silty SAND with gravel (trace cobbles) - moist			
3.5–5.0	SS2	SS		13 11 12	23	
6.0–7.5	SS3	SS	(Becomes dense at 6.0')	11 21 18	39	
7.5			Dense, brown, fine silty SAND - moist-to-very moist (Becomes very dense at 8.5')			
8.5–10.0	SS4	SS	Very dense, brown silty SAND with gravel (trace cobbles) - moist	6 17 40	57	
10.0			Bottom of boring at 10.0 feet			

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	▽	10/31/2023
AT COMPLETION	NONE	▼	10/31/2023
OTHER	N/A	▼	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⬚ SC— SONIC

BOWSER MORNER.

CLIENT **Arcadis U.S., Inc.**	JOB NO. **211648**		**2** Boring No.
PROJECT **Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.**	BORING STARTED **11/1/23**	BORING COMPLETED **11/1/23**	
	DRILLER **Cindrill**	METHOD **2 1/4" HSA**	
	TYPED BY **dmo**		**Sheet 1 of 1**

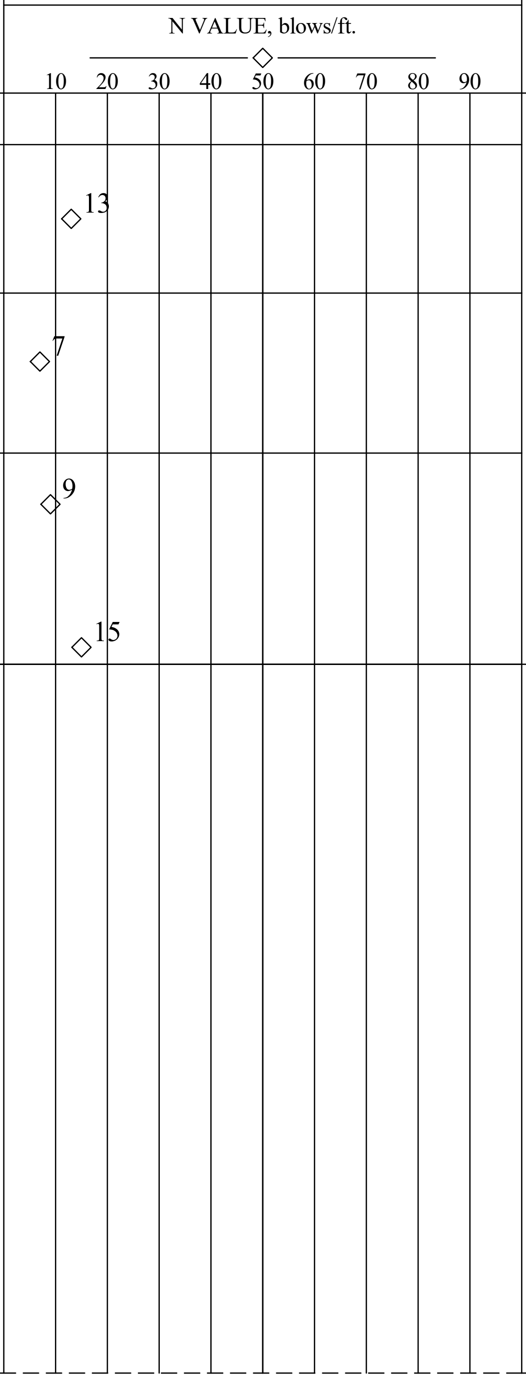
PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **700.4***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0–0.9		(FILL) ASPHALT (10")			
0.9–3.5	SS1	(FILL) Medium dense, brown silty SAND with gravel (some clay) - moist	11 5 8	13	
3.5–6.3	SS2	(ORIGINAL) Medium stiff, brown, silty lean CLAY with sand - moist	3 2 5	7	
6.3–10.0	SS3	Loose, brown silty SAND with gravel (some clay) - moist	3 5 4	9	
	SS4	(Becomes medium dense at 8.5')	7 7 8	15	
10.0		Bottom of boring at 10.0 feet			



WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/1/2023
AT COMPLETION	NONE	▼	11/1/2023
OTHER	N/A	▼	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
░ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**
BORING COMPLETED **11/1/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

3
Boring No.
Sheet 1 of 1

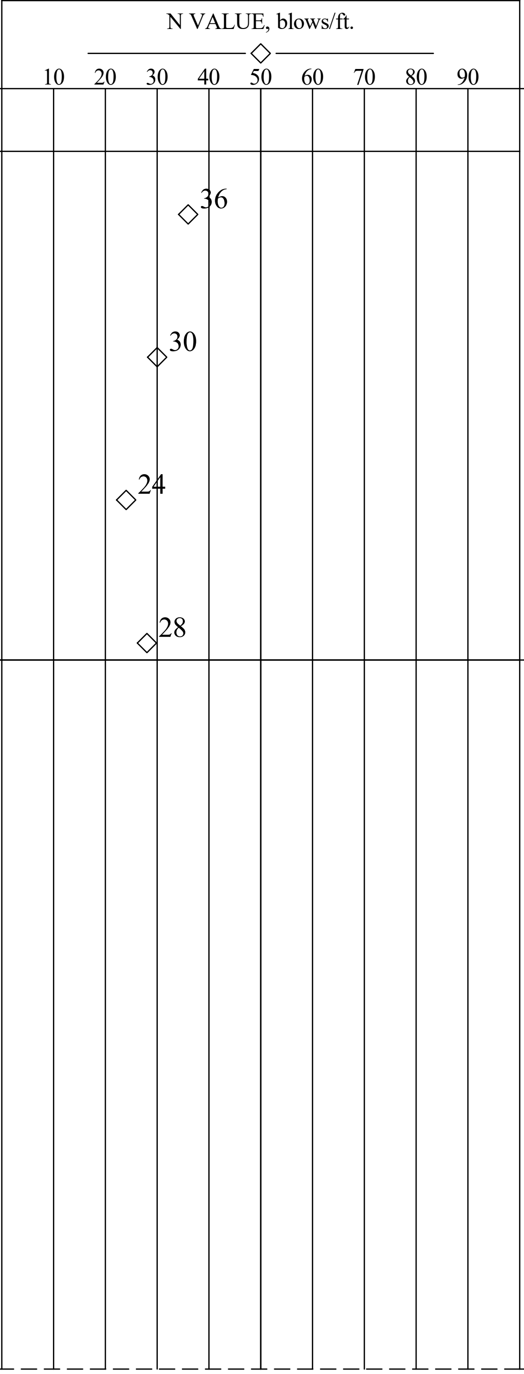
PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **704.3***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS
		(FILL) ASPHALT (13")	
1.0	SS1	(ORIGINAL) Dense, brown silty SAND with gravel - moist	10 14 22
3.5	SS2	(Becomes medium dense at 3.5')	12 13 17
6.0	SS3		7 11 13
8.5	SS4		15 13 15
10.0		Bottom of boring at 10.0 feet	

DEPTH (ft. BGL): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0

SAMPLER TYPE · RECOVERY · GRAPHIC LOG · REMARKS



WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	⊻	11/1/2023
AT COMPLETION	NONE	⊻	11/1/2023
OTHER	N/A	⊻	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◧ AS — AUGER CUTTINGS
⬚ SC— SONIC

BOWSER MORNER.

GINT Report Used: NEWLOGIN Report No.: 211648.GPJ GINT Template Used: OH DOT.GDT Date Printed: 1/8/24

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**

BORING COMPLETED **11/1/23**

DRILLER **Cindrill**

METHOD **2 1/4" HSA**

TYPED BY **dmo**

4
Boring No.
Sheet 1 of 2

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**

SURFACE ELEVATION **701.9***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	BLOW COUNTS	N VALUE, blows/ft. ◇	VISUAL CLASSIFICATION OF THE MATERIAL	REMARKS
				(FILL) ASPHALT (12")	
1.0	SS1	5 4 4	8	(FILL) Loose gray and brown silty SAND with gravel, and CLAY - moist	
2.0					
3.0					
4.0	SS2	3 9 11	20	(Becomes medium dense at 3.5')	
5.0					
6.0	SS3	7 7 10	17		
7.0					
8.0					
9.0	SS4	8 7 7	14	(FILL) Stiff, dark brown, silty organic CLAY - moist	
10.0					
11.0					
12.0					
13.0					
14.0	SS5	4 12 13	25	(ORIGINAL) Medium dense, brown silty SAND with gravel - moist	
15.0					
16.0					
17.0					▼
18.0					▽
19.0	SS6	7 6 6	12	(Trace water encountered at 18.5')	
20.0					
21.0					
22.0					

Continued Next Page

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	18.5	▽	11/1/2023
AT COMPLETION	17.5	▼	11/1/2023
OTHER	N/A	▼	N/A

▩	SS — SPLIT SPOON
▥	SL — SPLIT SPOON W/SOIL LINER
◧	NQ— ROCK CORE
☒	ST — SHELBY TUBE
◨	AS — AUGER CUTTINGS
⬚	SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**
BORING COMPLETED **11/1/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

4
Boring No.
Sheet 2 of 2

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **701.9***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL): 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0, 41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0

SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft. (10 20 30 40 50 60 70 80 90)	REMARKS
SS7	Very stiff, gray, silty lean CLAY with sand (some gravel) - moist	7 8 13	21	
SS8	Very dense, light brown silty SAND with gravel - wet	17 24 36	60	
	Bottom of boring at 30.0 feet			

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO.	**211648**
BORING STARTED	**11/1/23**
BORING COMPLETED	**11/1/23**
DRILLER	**Cindrill**
METHOD	**2 1/4" HSA**
TYPED BY	**dmo**

5
Boring No.
Sheet 1 of 2

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **701.9***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0

SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
	(FILL) ASPHALT (11")			
SS1	(FILL) Stiff, gray and brown, silty lean CLAY with sand (some gravel) - moist	4 5 6	11	
SS2	(FILL) Very dense, brown silty SAND with gravel (some organic clay) - dry	17 45 40	85	
SS3	(Becomes medium dense at 6.0')	5 8 11	19	
SS4	(ORIGINAL) Soft, gray and brown, silty lean CLAY with sand - moist	2 2 3	5	
SS5		1 2 3	5	▼ ▽
SS6	Loose, brown silty SAND (some gravel) - moist	3 4 5	9	

Continued Next Page

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	17.5	▽	11/1/2023
AT COMPLETION	17.0	▼	11/1/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◫ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ⬚ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**

BORING COMPLETED **11/1/23**

DRILLER **Cindrill**

METHOD **2 1/4" HSA**

TYPED BY **dmo**

5
Boring No.

Sheet 2 of 2

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**

SURFACE ELEVATION **701.9***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
		Loose, brown silty SAND (some gravel) - moist			
23.5–25.0	SS7	(Becomes medium dense at 23.5')	7 8 10	18	
28.5–30.0	SS8		8 10 8	18	
30.0		Bottom of boring at 30.0 feet			

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**

BORING COMPLETED **11/1/23**

DRILLER **Cindrill**

METHOD **2 1/4" HSA**

TYPED BY **dmo**

6
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**

SURFACE ELEVATION **698.8***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
		(FILL) ASPHALT (10")			
1.0		(FILL) Dark brown-to-black, silty organic CLAY (some gravel) - moist	6		
2.0	SS1		7 7	14	
3.0					
4.0	SS2	(Becomes light brown at 3.5')	4 2 4	6	
5.0					
6.0			3		
7.0	SS3	(ORIGINAL) Medium dense, brown silty SAND with gravel - moist	3 9	12	
8.0					
9.0	SS4	(Becomes dense at 8.5')	7 23 35	58	
10.0		Bottom of boring at 10.0 feet			
11.0					
12.0					
13.0					
14.0					
15.0					
16.0					
17.0					
18.0					
19.0					
20.0					
21.0					
22.0					

N VALUE scale: 10 20 30 40 50 60 70 80 90

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/1/2023
AT COMPLETION	NONE	▼	11/1/2023
OTHER	N/A	▼	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◧ AS — AUGER CUTTINGS
░ SC— SONIC

BOWSER MORNER.

GINT Report Used: NEWLOGIN Report No.: 211648.GPJ GINT Template Used: OH DOT.GDT Date Printed: 1/8/24

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

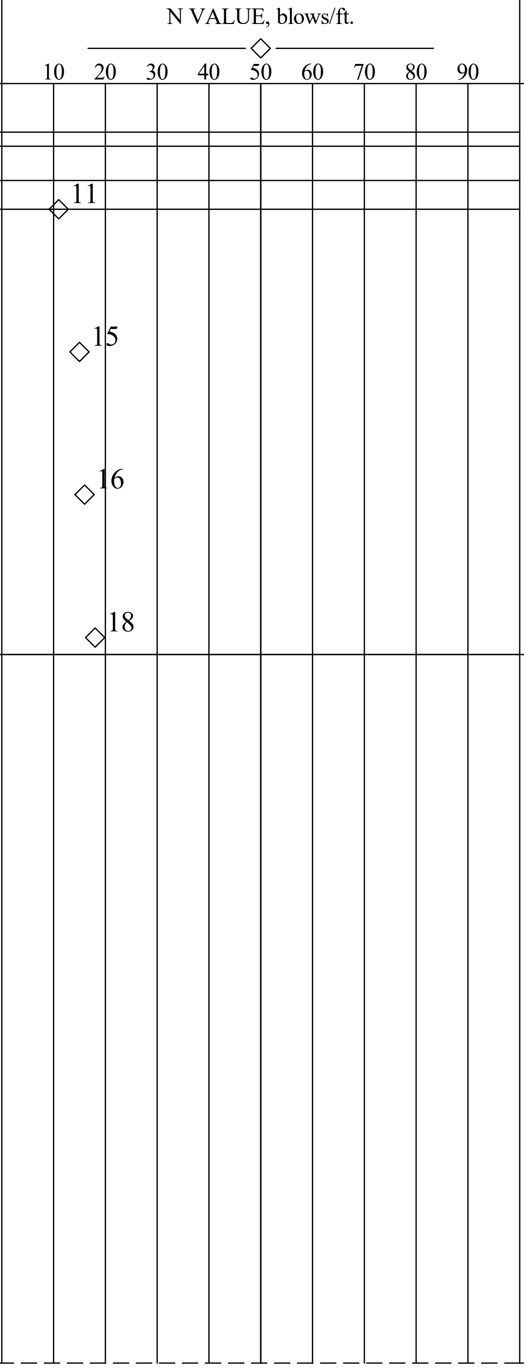
JOB NO. **211648**
BORING STARTED **11/1/23**
BORING COMPLETED **11/1/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

7
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **709.4***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0		(FILL) ASPHALT (10.3")			
1.0		(FILL) GRAVEL Base (3")			
	SS1	(ORIGINAL) Stiff, brown, silty lean CLAY with sand - moist	4 3 8	11	
2.0		Medium dense brown SAND with gravel - moist			
		Stiff, gray weathered SHALE - moist			
4.0	SS2		7 8 7	15	
6.0		(Becomes very stiff at 6.0')			
7.0	SS3		8 8 8	16	
9.0	SS4		13 8 10	18	
10.0		Bottom of boring at 10.0 feet			



WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/1/2023
AT COMPLETION	NONE	▼	11/1/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◧ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ░ SC— SONIC

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/1/23**
BORING COMPLETED **11/1/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

8
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°39'38"N** LONG. **84°17'23"W**
SURFACE ELEVATION **699.8***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0–0.75					(FILL) ASPHALT (9")			
0.75–1.5	SS1	▩	■		(FILL) Medium dense brown SAND with gravel (some clay) - moist	7		
1.5–3.5					(ORIGINAL) Stiff, gray weathered SHALE - moist	5 7	12	
3.5–10.0	SS2	▩	■		Stiff, brown, silty lean CLAY with sand (trace gravel) - moist	4 5 7	12	
	SS3	▩	■			4 4 7	11	
	SS4	▩	■		(Becomes medium stiff at 8.5')	4 5 5	10	
10.0					Bottom of boring at 10.0 feet			

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/1/2023
AT COMPLETION	NONE	▼	11/1/2023
OTHER	N/A	▼	N/A

▩	SS — SPLIT SPOON
▥	SL — SPLIT SPOON W/SOIL LINER
◨	NQ— ROCK CORE
☒	ST — SHELBY TUBE
◧	AS — AUGER CUTTINGS
⁙	SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

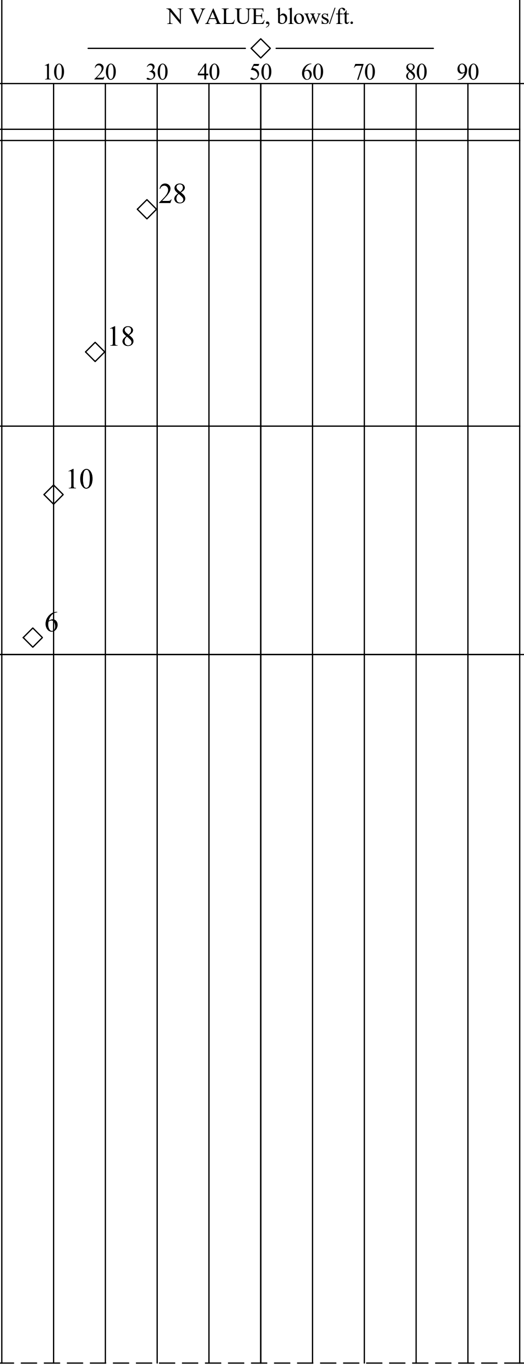
JOB NO. **211648**
BORING STARTED **11/1/23**
BORING COMPLETED **11/1/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

9
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **702.8***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0–0.8			(FILL) ASPHALT (10")			
0.8–1.0			(FILL) GRAVEL Base (2")			
1.0–6.0	SS1	SS	(FILL) Very stiff, brown and gray, silty lean CLAY with sand (some sand, some gravel, some organics, trace gray limestone) - moist	7 8 20	28	
	SS2	SS		9 9 9	18	
6.0–10.0	SS3	SS	(ORIGINAL) Medium stiff, brown, silty lean CLAY - moist	5 5 5	10	
	SS4	SS		2 2 4	6	
10.0			Bottom of boring at 10.0 feet			



WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	⊻	11/1/2023
AT COMPLETION	NONE	⊻	11/1/2023
OTHER	N/A	⊻	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⬚ SC— SONIC

BOWSER MORNER.

CLIENT	**Arcadis U.S., Inc.**
PROJECT	**Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.**
JOB NO.	**211648**
BORING STARTED	**10/31/23**
BORING COMPLETED	**10/31/23**
DRILLER	**Cindrill**
METHOD	**2 1/4" HSA**
TYPED BY	**dmo**
Boring No.	**10**
	Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **709.3***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	VISUAL CLASSIFICATION OF THE MATERIAL
0.0	(FILL) TOPSOIL (4")
	(FILL) Hard, dark brown-to-black, silty lean CLAY (some sand, some gravel, trace cobbles) - moist
3.5	(Becomes stiff at 3.5')
6.0	(Becomes gray and hard at 6.0')
8.5	(ORIGINAL) Medium stiff, brown, silty lean CLAY with sand (trace gravel) - moist
20.0	Bottom of boring at 20.0 feet

SAMPLE NO.	SAMPLER TYPE	BLOW COUNTS	N VALUE, blows/ft.
SS1	▩	7 17 17	34
SS2	▩	9 7 8	15
SS3	▩	26 10 21	31
SS4	▩	4 4 4	8
SS5	▩	6 5 3	8
SS6	▩	3 4 6	10

DEPTH (ft. BGL) · SAMPLE NO. · SAMPLER TYPE · RECOVERY · GRAPHIC LOG · BLOW COUNTS · N VALUE, blows/ft. ◇ 10 20 30 40 50 60 70 80 90 · REMARKS

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	⊻	10/31/2023
AT COMPLETION	NONE	⊻	10/31/2023
OTHER	N/A	⊻	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◧ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ░ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **10/31/23**
BORING COMPLETED **10/31/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

11
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **712.6***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
		(FILL) ASPHALT (8")			
		(FILL) GRAVEL Base (5")			
	SS1	(ORIGINAL) Very stiff, brown and gray, silty lean CLAY with sand (some gravel) - moist	7 12 8	20	
	SS2		5 7 9	16	
	SS3	(Becomes stiff at 6.0')	9 7 4	11	
8.0	SS4	Medium dense, brown silty SAND with gravel - moist	12 12 12	24	
	SS5		8 7 4	11	
15.0		Stiff, brown, silty lean CLAY with sand (trace gravel) - moist			
	SS6	(Trace water encountered. Becomes soft at 18.5')	2 2 3	5	▽
20.0		Bottom of boring at 20.0 feet			

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	18.5	▽	10/31/2023
AT COMPLETION	NONE	▼	10/31/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◧ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ⬚ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **10/31/23**
BORING COMPLETED **10/31/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

12
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **712.3***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
		(FILL) TOPSOIL (6")			
1.0		(FILL) Stiff, brown, silty lean CLAY with sand (some gravel, trace concrete, trace bricks) - moist			
2.0	SS1		6 6 7	13	
3.0					
4.0	SS2	(ORIGINAL) Very stiff, brown, silty lean CLAY with sand (some gravel) - moist	7 8 8	16	
5.0					
6.0		(Becomes medium stiff at 6.0')			
7.0	SS3		4 4 4	8	
8.0					
9.0	SS4	(Becomes stiff at 8.5')	4 5 9	14	
10.0					
11.0					
12.0					
13.0					▽
14.0	SS5	(Trace water encountered. Becomes medium stiff at 13.5')	9 5 5	10	
15.0					
16.0					
17.0					▼
18.0					
19.0	SS6		3 3 4	7	
20.0		Bottom of boring at 20.0 feet			
21.0					
22.0					

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	13.5	▽	10/31/2023
AT COMPLETION	16.8	▼	10/31/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◨ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◧ AS — AUGER CUTTINGS
- ⬚ SC— SONIC

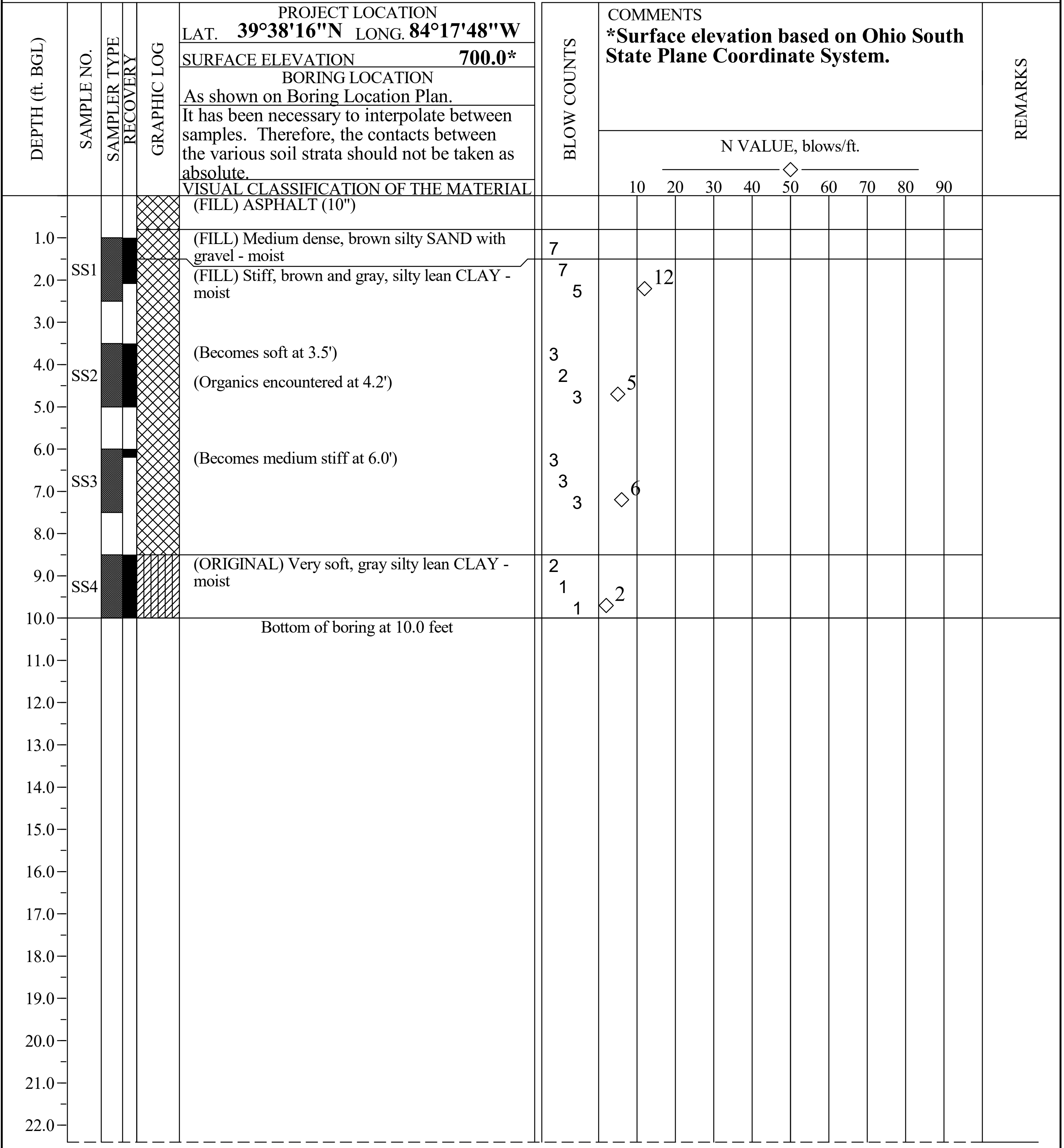
CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**			**13** Boring No.
BORING STARTED **11/2/23**	BORING COMPLETED **11/2/23**		
DRILLER **Cindrill**	METHOD **2 1/4" HSA**		
TYPED BY **dmo**			**Sheet 1 of 1**

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **700.0***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**



DEPTH (ft. BGL)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE
0.0–0.8		(FILL) ASPHALT (10")		
0.8–1.5	SS1	(FILL) Medium dense, brown silty SAND with gravel - moist	7	
1.5–8.5	SS1	(FILL) Stiff, brown and gray, silty lean CLAY - moist	7 5	12
	SS2	(Becomes soft at 3.5') (Organics encountered at 4.2')	3 2 3	5
	SS3	(Becomes medium stiff at 6.0')	3 3 3	6
8.5–10.0	SS4	(ORIGINAL) Very soft, gray silty lean CLAY - moist	2 1 1	2
10.0		Bottom of boring at 10.0 feet		

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	▽	11/2/2023
AT COMPLETION	NONE	▼	11/2/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◧ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ⬚ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

BORING STARTED **11/2/23**

BORING COMPLETED **11/2/23**

DRILLER **Cindrill**

METHOD **2 1/4" HSA**

TYPED BY **dmo**

14
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**

SURFACE ELEVATION **706.8***

BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
				▩	(FILL) ASPHALT (11")			
1.0 2.0 3.0	SS1	▓	■	▩	(FILL) Medium dense, brown silty SAND with gravel (some clay) - moist	23 23 24	47	
4.0 5.0	SS2	▓	■	▨	(ORIGINAL) Stiff, brown, silty lean CLAY with sand (some gravel, trace gray) - moist	7 6 6	12	
6.0 7.0 8.0	SS3	▓	■	▨		7 6 6	12	
9.0 10.0	SS4	▓	■	▨		7 7 8	15	
11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0					Bottom of boring at 10.0 feet			

N VALUE scale: 10 20 30 40 50 60 70 80 90

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	▽	11/2/2023
AT COMPLETION	NONE	▼	11/2/2023
OTHER	N/A	▼	N/A

▓ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⛆ SC— SONIC

BOWSER MORNER.

CLIENT **Arcadis U.S., Inc.**	JOB NO. **211648**		
PROJECT **Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.**	BORING STARTED **11/2/23**	BORING COMPLETED **11/2/23**	**15** Boring No.
	DRILLER **Cindrill**	METHOD **2 1/4" HSA**	
	TYPED BY **dmo**		**Sheet 1 of 1**

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **705.6***
BORING LOCATION
As shown on Boring Location Plan.

It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft. ◇	REMARKS
0.0–0.9				▨	(FILL) ASPHALT (10.5")			
0.9–3.5	SS1	▩	■	▨	(FILL) Medium dense, light brown SAND with gravel - moist	9 7 6	◇13	
					(Drilling halted at 3.5' due to possible unmarked utility lines) Bottom of boring at 3.5 feet			

Depth scale: 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0

N value scale: 10 20 30 40 50 60 70 80 90

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/2/2023
AT COMPLETION	NONE	▼	11/2/2023
OTHER	N/A	▼	N/A

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◨ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◧ AS — AUGER CUTTINGS
- ░ SC— SONIC

BOWSER MORNER.

CLIENT
Arcadis U.S., Inc.

PROJECT
Soil Study for Proposed Production Well and Raw Water Main, Riverview Avenue, Miamisburg, Ohio.

JOB NO. **211648**

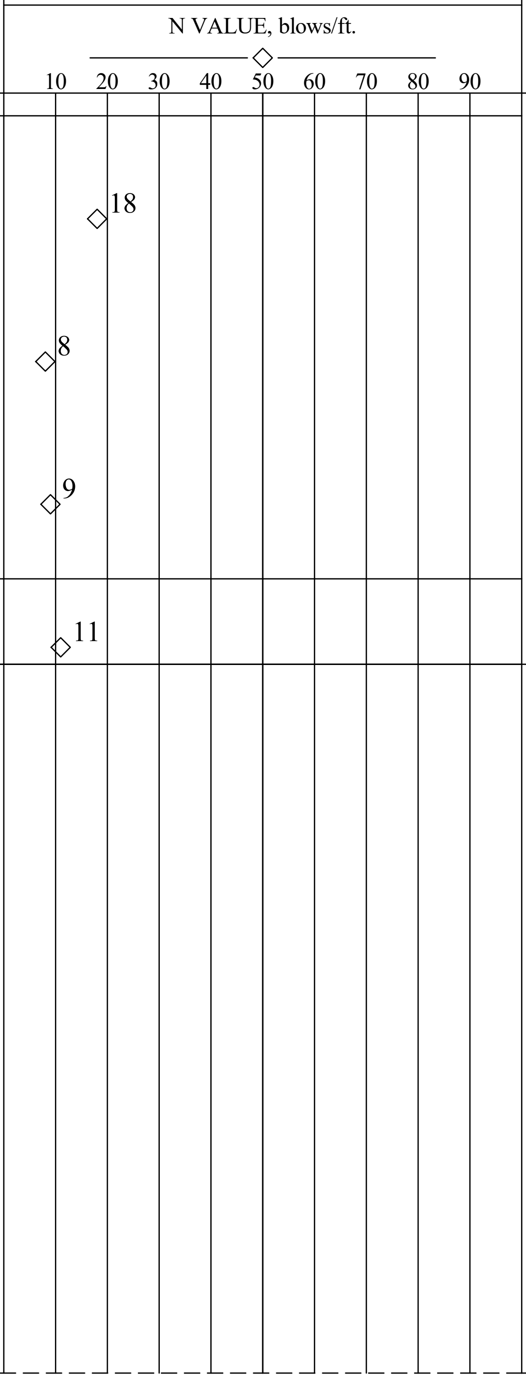
BORING STARTED **11/2/23**
BORING COMPLETED **11/2/23**
DRILLER **Cindrill**
METHOD **2 1/4" HSA**
TYPED BY **dmo**

16
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. **39°38'16"N** LONG. **84°17'48"W**
SURFACE ELEVATION **697.1***
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

COMMENTS
***Surface elevation based on Ohio South State Plane Coordinate System.**

DEPTH (ft. BGL)	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0–0.4					(FILL) TOPSOIL (5")			
0.4–8.5	SS1	SS			(FILL) Medium dense, brown and black, silty SAND with gravel (some clay, some concrete, some bricks) - moist	4 10 8	18	
	SS2	SS			(Becomes loose at 3.5')	4 5 3	8	
	SS3	SS				2 5 4	9	
8.5–10.0	SS4	SS			(ORIGINAL) Stiff, gray, silty lean CLAY with sand - moist	4 5 6	11	
10.0					Bottom of boring at 10.0 feet			



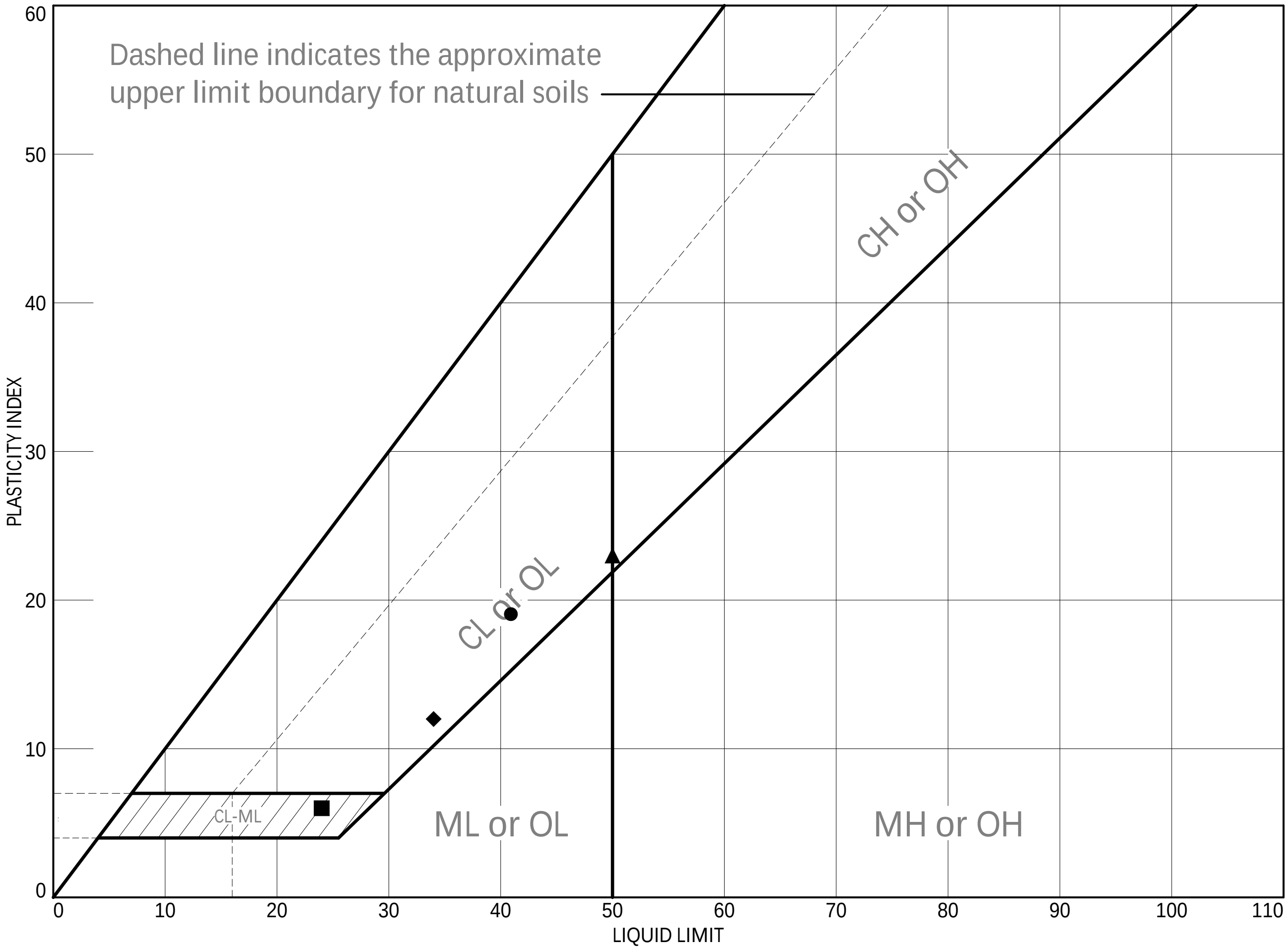
WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	11/2/2023
AT COMPLETION	NONE	▼	11/2/2023
OTHER	N/A	▼	N/A

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⬚ SC— SONIC

BOWSER MORNER.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	brown silty sand and gravel (visual description)	41	22	19			
■	dark brown lean clay (visual description)	24	18	6			
▲	brown sandy clay (visual description)	50	27	23			
◆	brownish gray sandy lean clay (visual description)	34	22	12			

Project No. 211648 Client: Arcadis U.S. Inc.

Project: Production Well & Raw Water Main

●Location: B-2 Depth: 3.5' - 5.0' Sample Number: SS 2
■Location: B-5 Depth: 13.5' - 15.0' Sample Number: SS 5
▲Location: B-8 Depth: 6.0' - 7.5' Sample Number: SS 3
◆Location: B-13 Depth: 8.5' - 10.0' Sample Number: SS 4

Remarks:

●As Received Moisture Content: 14.6%
■As Received Moisture Content: 18.8%
▲As Received Moisture Content: 22.2%
◆As Received Moisture Content: 27.4%

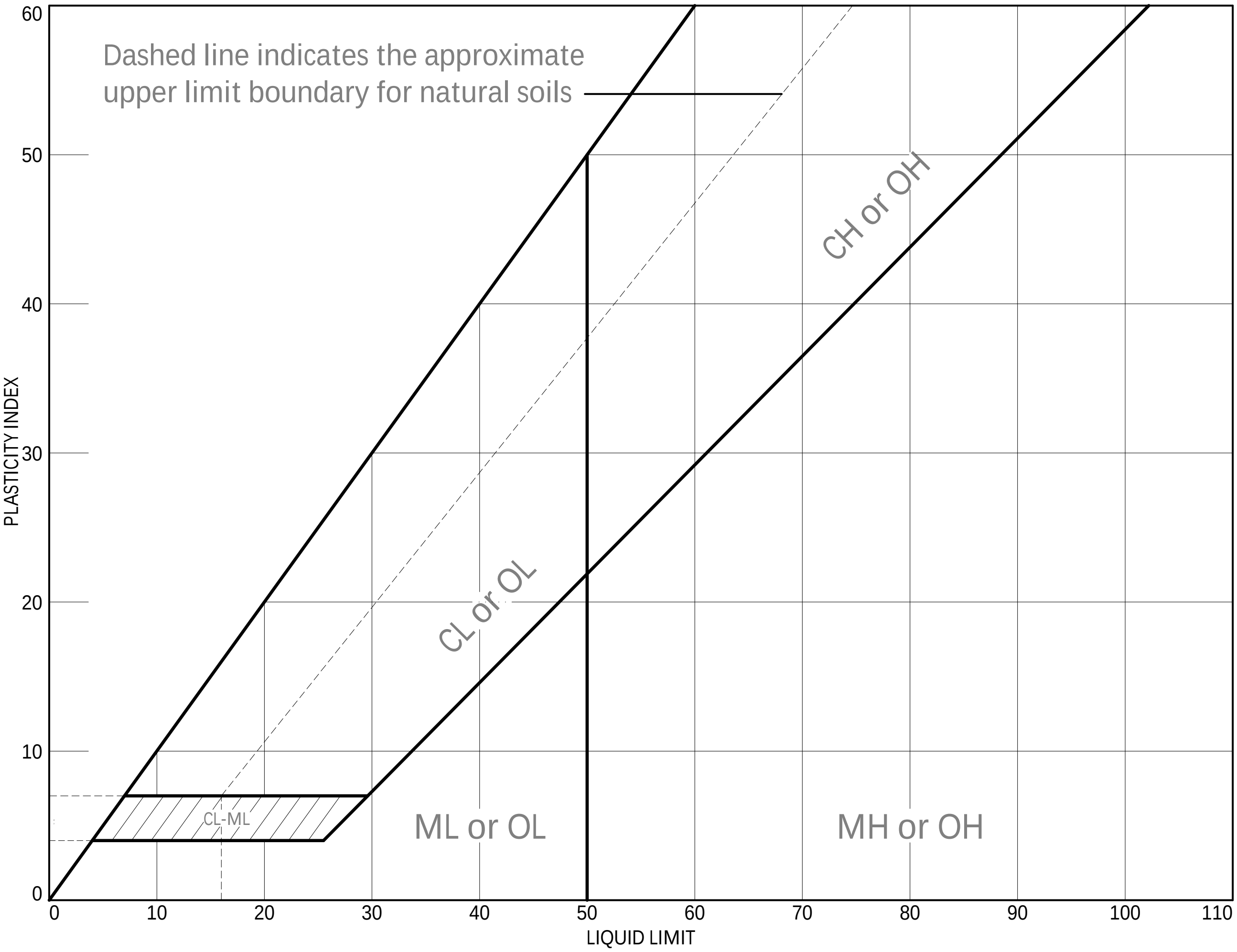
BOWSER-MORNER, INC.

Dayton, Ohio

Tested By: MR

Checked By: BLC

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	brown silty SAND with gravel	NV	NP	NP	46.5	32.1	SM

Project No. 211648 Client: Arcadis U.S. Inc.

Project: Production Well & Raw Water Main

● Location: B-1 Depth: 8.5' - 10.0' Sample Number: SS 4

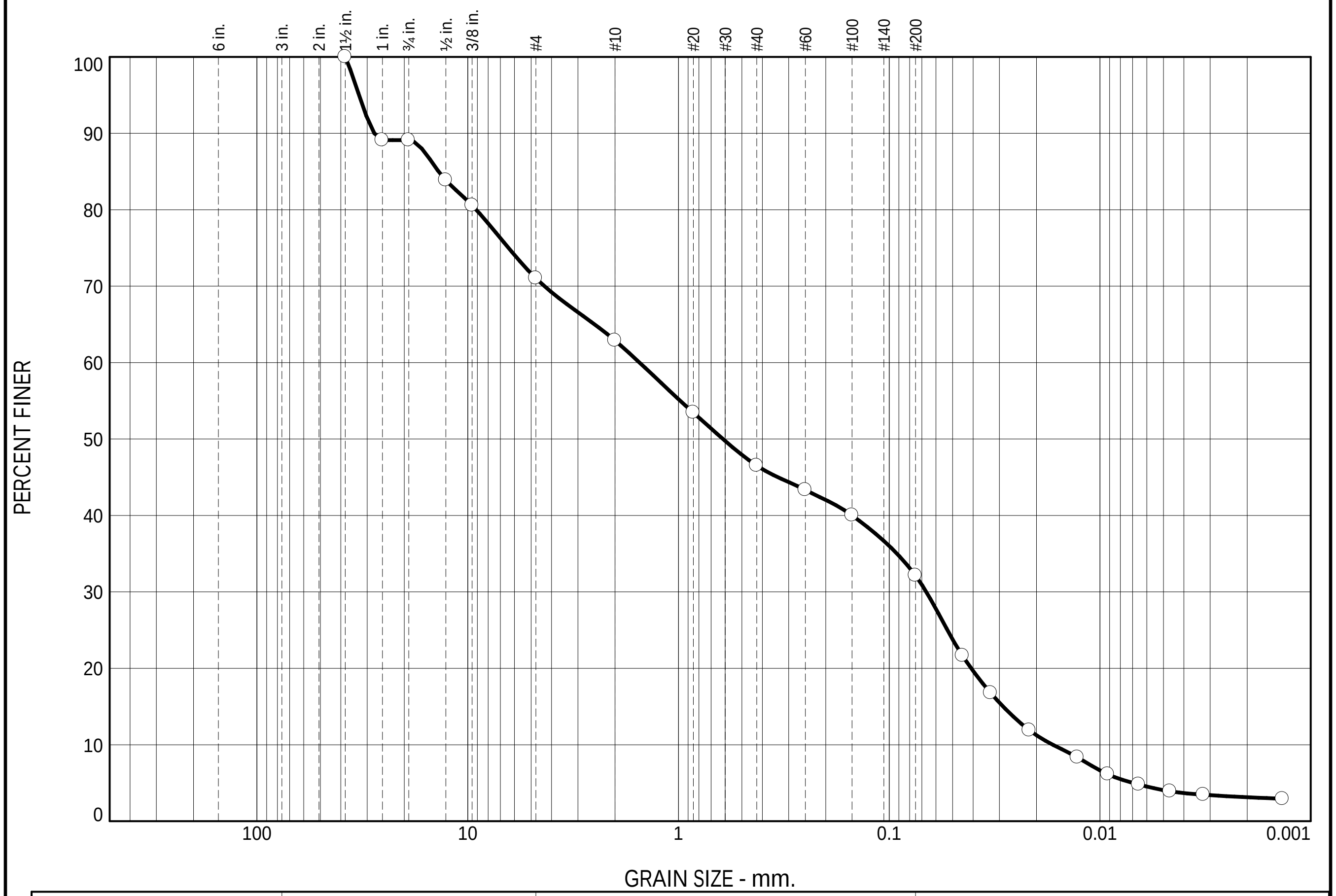
Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

GRAIN SIZE DISTRIBUTION REPORT

ASTM D422



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.9	18.1	8.1	16.4	14.4	29.0	3.1

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	13.7460	1.5287	0.6147	0.0667	0.0288	0.0167	0.17	91.36

Material Description	Test Date	USCS	NM
○ brown silty SAND with gravel	11/15/23	SM	

Project No. 211648 Client: Arcadis U.S. Inc.

Project: Production Well & Raw Water Main

○Location: B-1 Depth: 8.5' - 10.0' Sample Number: SS 4

Remarks:

○As Received Moisture Content: 12.9%

BOWSER-MORNER, INC.

Dayton, Ohio

Tested By: MR Checked By: BLC

GRAIN SIZE DISTRIBUTION TEST DATA

12/8/2023

Client: Arcadis U.S. Inc.
Project: Production Well & Raw Water Main
Project Number: 211648
Location: B-1
Depth: 8.5' - 10.0'
Sample Number: SS 4
Material Description: brown silty SAND with gravel
Liquid Limit: NV
Plastic Limit: NP
Test Date: 11/15/23
Checked by: BLC

Sieve Test Data (ASTM D422)

Test Date: 11/15/23 Technician: MR
Test remarks: As Received Moisture Content: 12.9%

Sample #1

Total Specimen Weights
Dry specimen+tare (gms.) = 681.90
Tare (gms.) = 98.64

Cumulative pan tare (gms.) = 0.00

Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Passing
1.5	0.00	100.0
1.0	63.55	89.1
.75	63.55	89.1
.50	94.18	83.9
.375	113.36	80.6
#4	168.91	71.0
#10	216.43	62.9

Sample #2

Specimen Weights
Dry specimen+tare (gms.) = 70.94
Tare (gms.) = 0.00

Cumulative pan tare (gms.) = 0.00

Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Passing	Percent of Fines
#20	10.65	53.5	85.0
#40	18.47	46.5	74.0
#60	22.06	43.3	68.9
#100	25.82	40.0	63.6
#200	34.69	32.1	51.1

Hydrometer Test Data (ASTM D422)

Test Date: 11/15/23   Technician: MR

Percent passing #10 based upon complete sample = 62.9

Weight of hydrometer specimen (gms.) = 70.94

Hygroscopic moisture correction:

Moist weight and tare = 58.11
Dry weight and tare = 58.10
Tare weight = 37.64
Hygroscopic moisture = 0.0%

Automatic temperature correction

Composite correction (fluid density and meniscus height) at 20 deg. C = -6.0

Meniscus correction only = 0.00

Specific gravity of solids = 2.65

Hydrometer type = 152H

Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.0	30.00	24.41	11.4	0.0449	21.7
2.00	22.0	24.50	18.91	12.3	0.0330	16.8
5.00	22.0	19.00	13.41	13.2	0.0216	11.9
15.00	22.0	15.00	9.41	13.8	0.0128	8.3
30.00	22.0	12.50	6.91	14.2	0.0092	6.1
60.00	22.0	11.00	5.41	14.5	0.0065	4.8
120.00	22.0	10.00	4.41	14.7	0.0047	3.9
250.00	22.0	9.50	3.91	14.7	0.0032	3.5
1440.00	21.5	9.00	3.29	14.8	0.0014	2.9

Results

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	10.9	18.1	29.0	8.1	16.4	14.4	38.9	29.0	3.1	32.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0070	0.0167	0.0288	0.0408	0.0667	0.1500	0.6147	1.5287	9.1149	13.7460	27.7088	32.7657

Fineness Modulus

3.04

Coefficient of Uniformity (C_u)

91.36

Coefficient of Concavity (C_c)

0.17

Moisture Content of Soil

ASTM (D-2216)

BOWSER MORNER

Client: Arcadis U.S., Inc.
Project: Production Well and Raw Water Main

Work Order No.: 211648
Date: 12/08/23

Boring Number	Sample Number	Depth, (ft)	Depth, (m)	Moisture Content, (%)
B-1	SS 1	1.0 - 2.5	0.3 - 0.8	13.0
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	2.8
	SS 4	8.5 - 10.0	2.6 - 3.0	12.9
B-2	SS 1	1.0 - 2.5	0.3 - 0.8	10.0
	SS 2	3.5 - 5.0	1.1 - 1.5	14.6
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	14.4
B-3	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	3.9
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	3.5
B-4	SS 1	1.0 - 2.5	0.3 - 0.8	10.7
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	11.8
	SS 4	8.5 - 10.0	2.6 - 3.0	Not Tested
	SS 5	13.5 - 15.0	4.1 - 4.6	5.1
	SS 6	18.5 - 20.0	5.6 - 6.1	Not Tested
	SS 7	23.5 - 25.0	7.2 - 7.6	10.3
	SS 8	28.5 - 30.0	8.7 - 9.1	Not Tested
B-5	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	6.4
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	12.3
	SS 5	13.5 - 15.0	4.1 - 4.6	18.8
	SS 6	18.5 - 20.0	5.6 - 6.1	Not Tested
	SS 7	23.5 - 25.0	7.2 - 7.6	15.4
	SS 8	28.5 - 30.0	8.7 - 9.1	10.6
B-6	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	16.9
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	5.7
B-7	SS 1	1.0 - 2.5	0.3 - 0.8	13.1
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	6.3

Moisture Content of Soil

ASTM (D-2216)

Client: Arcadis U.S., Inc.
Project: Production Well and Raw Water Main

Work Order No.: 211648
Date: 12/08/23

Boring Number	Sample Number	Depth, (ft)	Depth, (m)	Moisture Content, (%)
B-8	SS 1	1.0 - 2.5	0.3 - 0.8	13.3
	SS 2	3.5 - 5.0	1.1 - 1.5	19.6
	SS 3	6.0 - 7.5	1.8 - 2.3	22.2
	SS 4	8.5 - 10.0	2.6 - 3.0	Not Tested
B-9	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	18.0
	SS 4	8.5 - 10.0	2.6 - 3.0	21.6
B-10	SS 1	1.0 - 2.5	0.3 - 0.8	8.9
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	9.1
	SS 4	8.5 - 10.0	2.6 - 3.0	Not Tested
	SS 5	13.5 - 15.0	4.1 - 4.6	16.7
	SS 6	18.5 - 20.0	5.6 - 6.1	Not Tested
B-11	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	17.2
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	3.5
	SS 5	13.5 - 15.0	4.1 - 4.6	8.2
	SS 6	18.5 - 20.0	5.6 - 6.1	22.0
B-12	SS 1	1.0 - 2.5	0.3 - 0.8	15.2
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	17.4
	SS 4	8.5 - 10.0	2.6 - 3.0	Not Tested
	SS 5	13.5 - 15.0	4.1 - 4.6	28.5
	SS 6	18.5 - 20.0	5.6 - 6.1	Not Tested
B-13	SS 1	1.0 - 2.5	0.3 - 0.8	11.7
	SS 2	3.5 - 5.0	1.1 - 1.5	Not Tested
	SS 3	6.0 - 7.5	1.8 - 2.3	18.4
	SS 4	8.5 - 10.0	2.6 - 3.0	27.4
B-14	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	15.2
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	13.4
B-15	SS 1	1.0 - 2.5	0.3 - 0.8	4.7

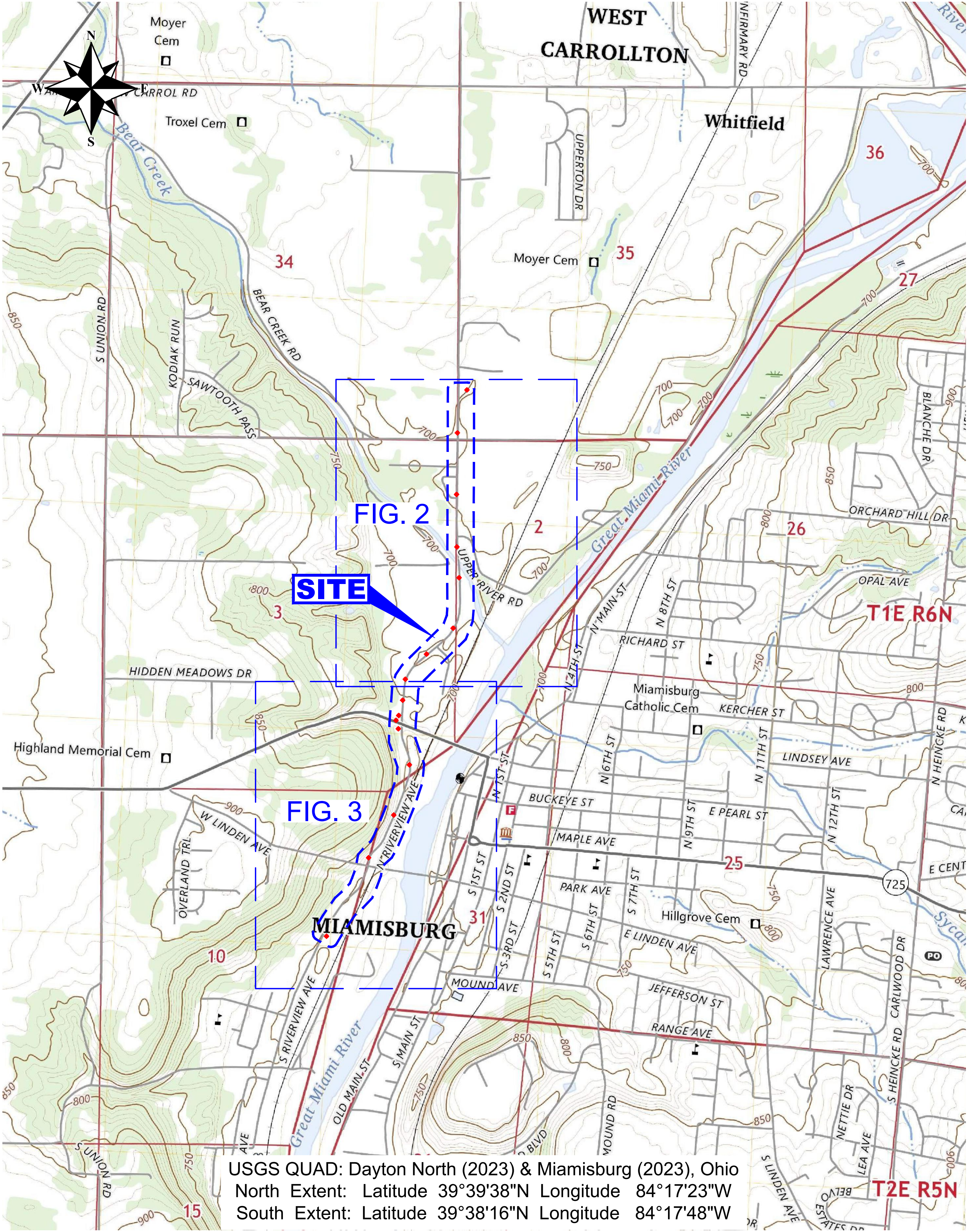
Moisture Content of Soil

ASTM (D-2216)

Client: Arcadis U.S., Inc.
Project: Production Well and Raw Water Main

Work Order No.: 211648
Date: 12/08/23

Boring Number	Sample Number	Depth, (ft)	Depth, (m)	Moisture Content, (%)
B-16	SS 1	1.0 - 2.5	0.3 - 0.8	Not Tested
	SS 2	3.5 - 5.0	1.1 - 1.5	9.4
	SS 3	6.0 - 7.5	1.8 - 2.3	Not Tested
	SS 4	8.5 - 10.0	2.6 - 3.0	29.2



USGS QUAD: Dayton North (2023) & Miamisburg (2023), Ohio

North Extent: Latitude 39°39'38"N Longitude 84°17'23"W

South Extent: Latitude 39°38'16"N Longitude 84°17'48"W

VICINITY MAP

Soil Study for Proposed Production Well and Raw Water Main
Riverview Avenue
Miamisburg, Montgomery County, Ohio

For: Arcadis U.S., Inc.

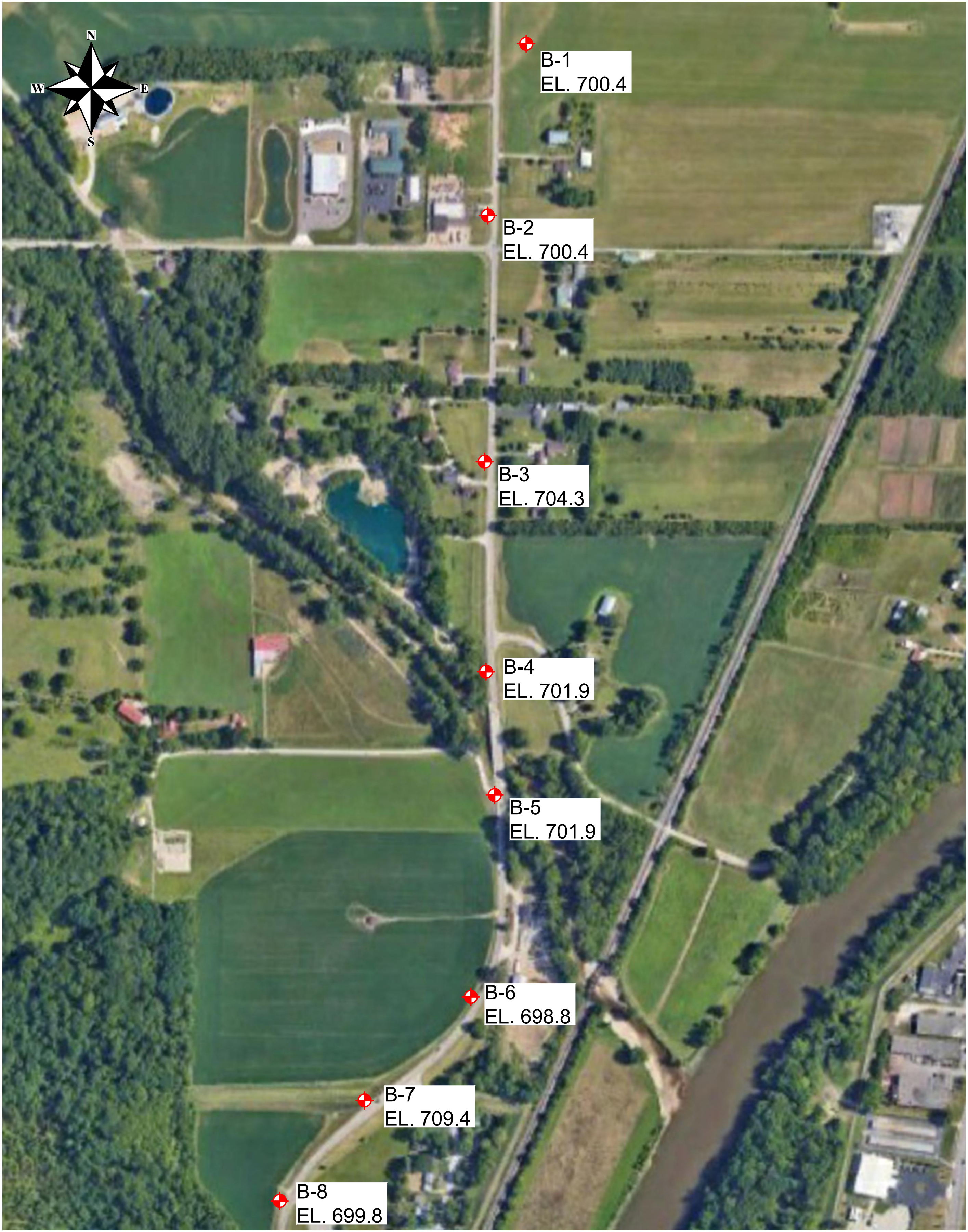
01-2024 EM

PROJECT NO.
211648

SCALE
1" = 2000'

FIGURE NO.
1

BOWSER MORNER.



BORING LOCATION PLAN

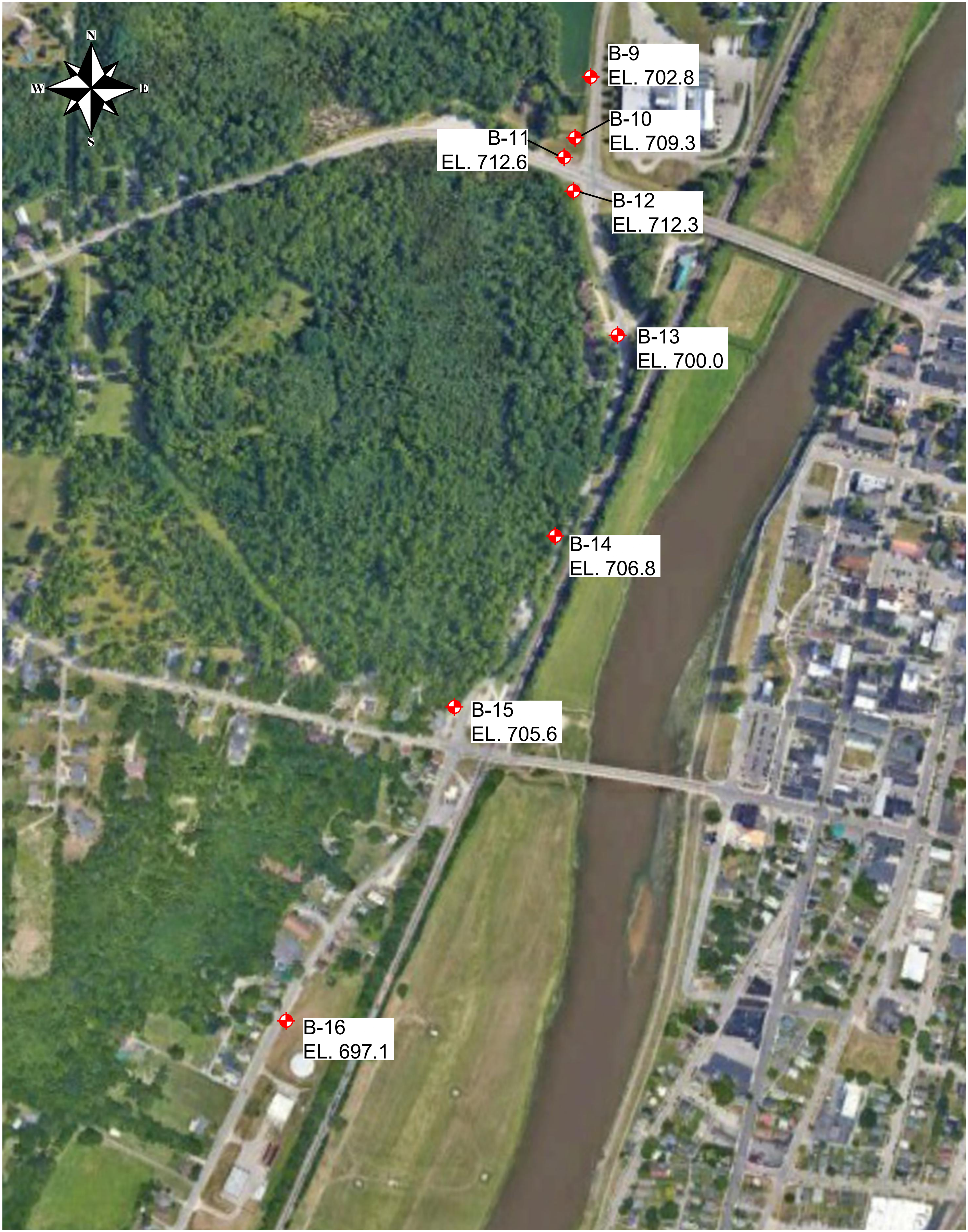
Soil Study for Proposed Production Well and Raw Water Main
Riverview Avenue
Miamisburg, Montgomery County, Ohio

For: Arcadis U.S., Inc.

01-2024 EM

PROJECT NO.	211648
SCALE	1" = 500'
FIGURE NO.	2a

BOWSER MORNER.



BORING LOCATION PLAN

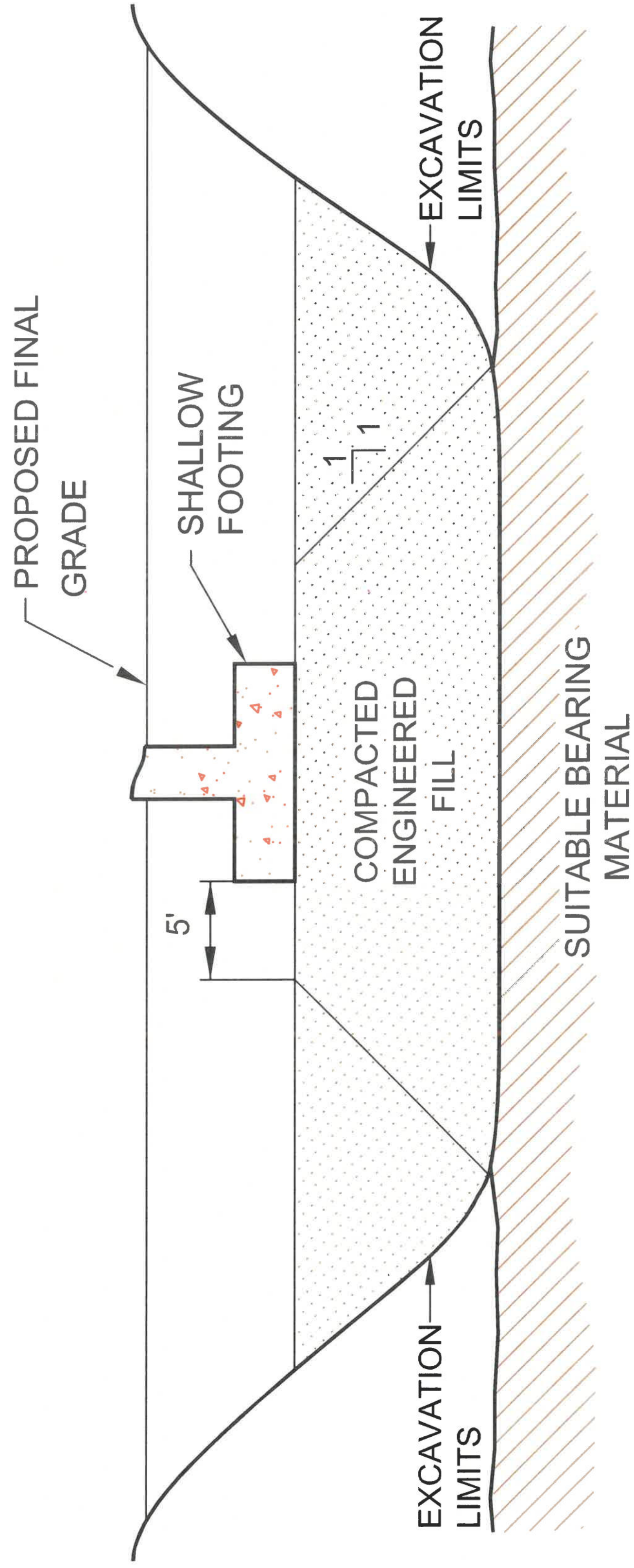
Soil Study for Proposed Production Well and Raw Water Main
Riverview Avenue
Miamisburg, Montgomery County, Ohio

For: Arcadis U.S., Inc.

01-2024 EM

PROJECT NO.	211648
SCALE	1" = 400'
FIGURE NO.	2b

BOWSER MORNER.



DESIGN ILLUSTRATION SHALLOW FOOTINGS IN AN UNDERCUT AREA

SCALE
NONE

FIGURE NO.
3

BOWSER
MORNER

ENGINEERING & ENVIRONMENTAL SERVICES:

- Geotechnical Engineering
- Subsurface Exploration
- Civil Engineering
- Environmental Services
- Due Diligence
- Permitting

LABORATORY SERVICES:

- Geotechnical Laboratories
- Construction Materials Laboratories
- Mineral Aggregates
- Concrete
- Stone & Masonry
- Asphalt
- Analytical Services Laboratories
- Industrial Minerals
- Product Testing
- Mechanical/Metallurgical Testing
- Calibration Services
- Chemistry Laboratory
- Consulting Geology
- Radon Reference Laboratory

CONSTRUCTION SUPPORT SERVICES:

- General Construction
- Construction Quality Assurance
- Building Code Special Inspections
- Transportation Projects:
    - Contractor QA/QC
    - Material Supplier QA/QC
    - Owner Quality Assurance
- Materials Consulting:
    - Construction Engineering

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