S&ME

November 12, 2014

CTI Engineers, Inc.
220 Market Avenue South, Suite 750
Canton, Ohio 44702

Attention: Mr. William A. Dorman, PE

Reference: **ADDENDUM 1 to REVISED SUBSURFACE INVESTIGATION**
Anaerobic/Anoxic Tanks & PEPS Foundation Recommendations
Massillon WWTP Improvements
Big Indian Drive, SW
Massillon, Ohio
S&ME Project No. 1171-13-059A

Dear Mr. Dorman:

S&ME is pleased to submit this addendum to our September 25, 2014 Revised Subsurface Investigation Report. Our services were provided in general accordance with our Proposal No. 1171-13-059P dated October 12, 2014. Since our report was issued, location plans for the Anaerobic/Anoxic Tanks (An/Ax Tanks) and the Primary Effluent Pump Station (PEPS) have changed. These structures, which were originally to be structurally connected to existing facilities, will now each be a stand-alone structure. As a result, we understand that the structures will be more tolerable to settlement and therefore, our foundation recommendations have been revised.

Background

We presented settlement estimates for the PEPS and An/Ax Tanks in our September 25, 2014 Revised Subsurface Investigation Report for the proposed improvements at the Massillon WWTP. Based on the loading and structure geometries that we were provided, we estimated total settlements of about 2 inches for the PEPS structure and about 3 inches for the An/Ax Tanks. At the time our report was issued, the new structures were to be connected to existing structures and the estimated displacements were considered to be unacceptable. As a result, we provided deep foundation recommendations (i.e., auger cast piles) or recommended that ground improvement be considered.

We now understand that the new PEPS and An/Ax tanks will not be connected to the existing structures and that they can be loaded (leak tested) prior to the connection of piping. Therefore, larger displacements can be accommodated. We have also re-visited our settlement analyses using alternative analytical software and the contact pressure diagrams provided by O'Brien and Gere.

Settlement Analyses

The subsurface conditions consist of generally medium-dense, fine to coarse sands with little to trace silt and little to trace gravel. Although the water was encountered at depths of 5 to 10 ft, the sands will drain quickly and settlement will occur nearly instantaneously as loads are applied. Accordingly, we have used elastic settlement analyses to estimate deformations under loading.

Based on N-value to modulus correlations and the mat contact pressures provided by O'Brien and Gere, we estimate the that An/Ax Tanks will settle on the order of 1 to 3 inches and that the PEPS structure will settle on the order of 1 to 2 inches. The settlement will occur during or soon after (i.e., within several days) loading and long-term consolidation settlement or secondary compression is not expected. As the tanks are loaded and unloaded (i.e., filled and drained), there will be some minor rebound and recompression displacements but such movement should be within the typical range commonly experienced by similar tanks.

Recommendations

Provided the An/Ax Tanks and PEPS structure can now accommodate the predicted settlements during a pre-load or leak testing construction stage prior to making utility connections, we recommend that the structures be supported on mat foundations. This recommendation supersedes our September 25, 2014 deep foundation recommendations. The remainder of the September 25, 2014 report is still valid and applicable.

Closure

S&ME appreciates the opportunity to be of service on this project. If you have any questions, please call.

Sincerely,

S&ME, Inc.

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REVISED SUBSURFACE INVESTIGATION
CITY OF MASSILLON WASTEWATER TREATMENT PLANT IMPROVEMENTS
MASSILLON, OHIO

S&ME Project No. 1171-13-059A

Prepared for:

CTI Engineers, Inc. Canton, Ohio

Prepared by:

S&ME

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September 2014

S&ME

September 25, 2014

CTI Engineers, Inc.
220 Market Avenue South, Suite 750
Canton, Ohio 44702

Attention: Mr. William Dorman, P.E.

Reference: **Revised Subsurface Investigation**
City of Massillon Wastewater Treatment Plant (WWTP) Improvements
Massillon, Ohio
S&ME Project No. 1171-13-059A

Mr. Dorman:

S&ME, Inc. has completed a geotechnical investigation for the above referenced project in general accordance with our revised proposal dated March 10, 2014, which was authorized by your office on March 14, 2014, with the Subcontract Agreement, and our additional services letter dated August 6, 2014, which was authorized by your office on August 7, 2014. This revised report is herewith submitted based on comments received in e-mails from William Dorman of CTI Engineers, Inc. on August 1, 2014, and Colin Lautz of O'Brien & Gere on September 19. This report supersedes our original report dated April 29, 2014, and our revised report dated June 13, 2014. For this project, a total of eight (8) new borings were performed in the field by S&ME personnel. The approximate site location is depicted on the Vicinity Map presented as Plate 1 in Appendix A of this report. Our observations and recommendations associated with the investigation are herewith submitted.

We appreciate having been given the opportunity to be of service on this project. If you require additional assistance or have any questions, please feel free to contact our office at any time.

Respectfully submitted,

S&ME, Inc.
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Submitted: 1 electronic copy (pdf) via email to: **wdorman@ctiengr.com**

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EXECUTIVE SUMMARY

Based on information provided by CTI Engineers, Inc. (CTI), S&ME, Inc. (S&ME) understands that the proposed wastewater treatment plant (WWTP) improvements are to include: 1) Anaerobic/Anoxic Tanks; 2) Primary Effluent Pump Station; 3) Flow Retention Influent Metering Chamber ; 4) Odor Control Building; and, 5) Effluent Distribution Box. Conditions encountered at the site that present challenges to design and construction include:

- Existing fill (or possible existing fill) was encountered in all 8 of the current borings extending to depths ranging between 2 and 12 feet below existing grade. Possible fill encountered in Boring SB-1 contained peat and had an organic content as determined by a Loss On Ignition (LOI) test of 16 percent. The fill material consisted of both soft to very-stiff cohesive soils (silty clay) and loose to medium-dense sand and gravel, with several samples containing construction debris (i.e., brick fragments). In general, existing fill is not considered suitable for foundation support or slab support due to unpredictable differential settlement. Existing fill may remain in place and support pavements provided it proofrolls favorably.

- Thicker layers of loose sand and soft to stiff silty clay (slightly organic in a few borings) were encountered with depth in several of the borings. For most of the shallow proposed structures, these weaker soils are anticipated to be present below the planned bearing elevations. The concern with these deposits is settlement. Settlement in the more granular soils is expected to be immediate upon the addition of load, while in the more cohesive soils, the settlement will occur with time. Settlement will be induced by not only the net loading of the new structures, but also from the weight of any new fill placed in and around the new structures.

- Seepage and/or groundwater were encountered during drilling in all 8 of the borings at depths varying from 5.0 to 14.0 feet below grade (Groundwater elevations varying from El. 67.1 to 75.9 Plant Elevations (mean sea level of El. 917.2 to 926.0). Groundwater was measured at the completion of drilling and, at three of the boring locations; temporary slotted PVC pipe was placed in the boring to allow for extended water level observation. On April 9, 2014, water was observed inside the PVC pipes at depths of approximately 18 to 27 inches below the existing ground surface (elevations varying from El. 73.8 to 74.8). During the same time period water in the adjacent Tuscarawas River was observed to be at approximate El. 73. Based on information provided by CTI, bearing elevations of proposed structures vary from El. 63 (Primary Effluent Pump Station) to El. 80 (Odor Control Building). Dewatering will be needed for construction of the new structures. The groundwater table should be maintained a minimum of 3 feet below the lowest working surfaces during construction including the bottoms of the required over-excavations. Dewatering can induce settlement of adjacent existing structures. These structures should be monitored for settlement during dewatering efforts. The owner should be notified and clearly understand that dewatering may cause existing structures to settle and possibly cause slab and masonry cracking.

1. INTRODUCTION

S&ME, Inc. (S&ME) has completed the geotechnical investigation for the proposed improvements to the existing City of Massillon Wastewater Treatment Plant (WWTP) located in Massillon, Ohio. The location of the site is shown on Plate 1 of Appendix A. The work was performed in general accordance with our revised proposal dated March 10, 2014. The purpose of this exploration was to obtain subsurface information to allow us to characterize the subsurface conditions at the site and to develop recommendations concerning excavation and backfilling operations, foundation design, subgrade modulus, lateral earth pressures for below-grade walls, dewatering and other related construction issues for the current project.

Selected geotechnical data from previous subsurface investigations performed at the site by G. K. Jewell & Associates in 1972 (report dated March 27, 1972, and Addendum Letter Dated May 15, 1972), and by BBC&M Engineering, Inc. in 1999 (report dated September 24, 1999) have been included in Appendix B and Appendix C, respectively. It should be noted that during the construction at this site subsequent to the 1999 report, additional dewatering wells drilled deeper than the initials well were required to complete the construction dewatering. It is understood that the Contractor did not take into account the magnitude of the sand and gravel aquifer under this site (possibly present to a depth of 300 feet), the highly-permeable nature of the aquifer or the impact of the recharge from the adjacent Tuscarawas River.

This report describes our understanding of the project, presents the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations. If the details of the project differ from what is presented in this report, S&ME should be notified in order to amend our recommendations, if necessary.

2. SITE AND PROJECT DESCRIPTION

Based on information provided by CTI Engineers, Inc. (CTI), S&ME understands that improvements to the existing WWTP are to include the following: A Flow Retention Influent Metering Chamber; an Odor Control Building; an Anaerobic/Anoxic Tank;, a Primary Effluent Pump Station; and an Effluent Distribution Box. The anaerobic/anoxic tank and effluent distribution box are anticipated to require demolition of a portion of the existing structure and are anticipated to extend approximately 7 to 20 feet below existing grades. The primary effluent pump station is understood to have a bottom elevation around El. 63 which is below the adjacent anaerobic/anoxic tanks. The odor control building is anticipated to be embedded for frost protection and the flow retention influent metering chamber is anticipated to extend approximately 13 feet below the existing grade. The site is currently developed with many existing above and below grade structures, utilities, and drives associated with the existing wastewater treatment plant. A berm separates the plant from the Tuscarawas River, located immediately northwest of the plant (See Plates 1 and 2 of Appendix A).

Anaerobic/Anoxic Tank – The anaerobic/anoxic tank is proposed to be located in the central portion of the WWTP site between the existing primary clarifiers and the roughing filters. A portion of the existing structure will be demolished as part of the proposed construction. Foundations for the proposed anaerobic/anoxic tank structures are anticipated at approximate El. 68. Existing grades in the area vary from approximately El. 75 to El. 83.

Primary Effluent Pump Station – The Primary Effluent Pump Station (PEPS) is proposed to be located in the central portion of the WWTP site between the existing primary clarifiers and the berm that is generally parallel to the Tuscarawas River filters. Foundations for the proposed PEPS structures are anticipated to be located at two primary elevations approximate El. 68 and El. 62. Existing grades in the area vary from approximately El. 80 to El. 88.

Odor Control Building – An odor control building is proposed to be constructed between the existing grit building and the existing pre-aeration tank. This structure is anticipated to have shallow foundations.

Flow Retention Influent Metering Chamber – An influent metering chamber is proposed north of the main building. The depth of this structure is approximately 13 feet below existing grade.

Effluent Distribution Box – An Effluent distribution structure is planned south of the existing aeration tanks. This structure is anticipated to have a shallow mat foundation located at approximate El. 74. A portion of the existing structure is anticipated to be demolished to allow for construction of this facility.

3. REGIONAL GEOLOGY

Geologic references indicate that this site is located in a portion of Ohio which has been glaciated. This site is within the Akron-Canton Interlobate Plateau section of the Glaciated Allegheny Plateaus physiographic region of Ohio, near the border of the Killbuck-Glaciated Pittsburgh Plateau. The region is characterized as a hummocky area between converging glacial lobes dominated by kames and eskers having moderate relief.

Soil overburden in this general area consists of sandy Wisconsian-age and older drift over Devonian to Pennsylvanian-age sandstones, conglomerates and shales. Fluvial and flood plain deposits of fine grained partly organic soils overlie the coarse grained soils at the site. It is believed that the underlying coarse grained soils were deposited in the ancient larger river valley during higher energy events, while the finer sediments were deposited during more recent flooding of the smaller river. The majority of the Wisconsian age deposits of Hayesville till bas been eroded away by the post glacial Tuscarawas River.

ODNR bedrock topography mapping indicates that the depth to bedrock in the vicinity of this site is likely more than 275 feet below the ground surface. The “Ohio Karst Areas” map published by ODNR does not show any probable karst areas in the immediate vicinity of the site. Based on the Ohio Water Plan Inventory published by ODNR, the thick permeable deposits of sand and gravel anticipated at this site are capable of yielding more than 1,000 gallons per minute.

4. SUBSURFACE CONDITIONS

4.1 Field Exploration Procedures

During the period of March 26, 2014 through March 31, 2014, S&ME was on-site and performed a total of eight (8) soil borings (designated as Borings SB-1 through SB-8) using an all-terrain-vehicle-mounted drill rig at the locations shown on Plate 2 of Appendix A. Boring locations were selected and field located by a group consisting of employees of S&ME, CTI, and the City of Massillon in advance of the drilling rig's arrival on-site. Boring locations were adjusted based on existing or suspected below grade utilities. The borings were extended to depths ranging between 30 feet and 50 feet below existing grades. Surveyed drilled boring locations and ground surface elevations were provided by CTI. CTI also indicated that 850.09 should be added to the plant elevations to get USGS elevations. The approximate locations of the current and historic borings are shown on the Plan of Borings submitted as Plate 2 in Appendix A of this report. Both plant and USGS elevations of the ground surface at the boring locations are included on the boring logs.

All current borings were advanced between sampling attempts using a 3-1/4 inch inside-diameter (I.D.) hollow-stem auger. At regular intervals, disturbed, but representative, samples were attempted by lowering a 2 inch outside-diameter (O.D.) split barrel sampler to the bottom of the hole and driving it into the soil by blows from a 140-pound hammer freely falling 30 inches (Standard Penetration Test, ASTM D1586). Split-barrel samples were examined immediately after recovery and representative portions of each sample were placed in air-tight jars and retained for subsequent laboratory testing. Particular attention was given to the texture, moisture content, and consistency of each sample.

Additionally, the borings were checked for the presence of groundwater during sampling and at the completion of the drilling operations. Following the completion of drilling, PVC standpipe was installed in three (3) of the borings (Borings SB-1, SB-3, and SB-4) to allow for extended groundwater level readings by others. The remaining five (5) borings were backfilled with a combination of soil cuttings and granular bentonite and, where borings penetrated the existing pavement, the surface was repaired with cold-patch asphalt. Please note that these borings were backfilled immediately upon completion of drilling, therefore, no extended groundwater measurements were obtained. All of the samples collected during the field exploration were returned to the laboratory for visual examination and selected laboratory testing.

In an effort to minimize the risk of heave, water was introduced and maintained in the hollow-stem auger in two (2) of the borings performed (Borings B-7 and B-8) at approximate depths of 20 feet beneath the existing ground surface.

4.2 Soil Stratification

In general, 4 to 5 inches of rootmat were encountered in 6 of the 8 current borings. The remaining two borings, Borings SB-5 and SB-8, were located in existing pavement and 9 inches of asphalt over 2 inches of granular base and 3 inches of asphalt with no granular base were encountered in these borings, respectively. Beneath the topsoil or pavement, existing fill or possible fill was encountered in all 8 of the borings extending to depths ranging between 2 and 12 feet below existing grade and consisting of both soft to very-stiff cohesive soils (silty clay) and loose to medium-dense sand and gravel. The natural soils primarily consisted of loose to dense sand and gravel although Boring SB-2 encountered a zone of medium-stiff silty clay between the existing fill and the granular soil. Boring SB-1 encountered an organic layer of possible fill that had an organic content of 16 percent. All of the borings were terminated in medium-dense to dense granular (sand and gravel) soils.

4.3 Water Levels

Groundwater observations were made as each boring was being advanced and measurements were made at the completion of drilling. Seepage and/or groundwater were encountered during the drilling operations in all of the 8 borings performed at depths ranging from 5.0 feet to 14.0 feet below existing grade (elevations where ground-water was encountered varying from El. 67.1 to 74.3). After drilling, groundwater was measured in 6 of the 8 borings at depths ranging between 4.3 feet and 10.2 feet beneath the existing grade (elevations varying from El. 68.0 to 71.0). Accurate “at completion” water level measurements could not be obtained in Borings SB-7 or SB-8 because of the introduction of water into the boreholes to minimize the risk of heave.

Slotted, PVC standpipe was installed in Borings SB-1, SB-3, and SB-4 at the completion of drilling. These temporary standpipes were installed to allow for extended groundwater readings by others. The remaining 5 borings were backfilled immediately upon completion of drilling; therefore, no extended groundwater measurements were obtained. Table 1 on the following page summarizes the groundwater level readings that were recorded in each boring during drilling and at completion. CTI also provided two additional water level measurements recorded on April 9, 2014, and April 11, 2014, that are also included in the table. The measurements obtained on April 9, 2014, observed water approximately 18 inches to 27 inches below the ground surface (elevations ranging from El. 73.8 to 79.6). It should be noted that these observations indicate the ground water table may at times be above the water level in the adjacent Tuscarawas River which was observed at approximate El. 73 at a similar time. The pipes were left in place for additional measurements by others including potential contractors. As part of the proposed construction, the pipes should be removed and the holes should be filled with grout and/or bentonite chips.

TABLE 1: Summary of Groundwater Observations

Boring	Existing Plant El.	Seepage During Drilling (ft)	Water During Drilling (ft)	Water At Completion (ft)	Water 3/28/14 (ft)	Water 3/31/14 (ft)	Water 4/9/14 (ft)	Water 4/11/14 (ft)
B-1*	81.1	5.2	14.0	10.2	9.8	8.0	1.5	7.7
B-2	80.0		9.5	9.0				
B-3*	76.8		9.0	8.5	8.2	4.4	2.0	3.5
B-4*	76.0		8.5	8.0		4.0	2.2	8.2
B-5	75.2		5.0	4.3				
B-6	77.3		7.5	7.0				
B-7**	79.8		7.3					
B-8**	82.8		8.5					

* Slotted, PVC Standpipe installed in boring upon completion.
** Water introduced to boring after 20 feet to minimize risk of heave.

A USGS river gauge station is located adjacent to the plant along the Tuscarawas River. The Gauge Datum is 915.06 feet above NAVD88 (Plant 64.97). Selected data is included as Plates 25 through 27 in Appendix A.

5. LABORATORY TEST RESULTS

In the laboratory, the samples were visually identified and on a few representative samples, moisture contents, liquid and plastic limit determinations, grain size analysis, and organic content (loss on ignition) tests were performed. Results of these tests permit an evaluation of strength and compressibility characteristics of the soil by comparison with similar soils for which these characteristics have been previously determined. Based upon the results of the laboratory testing program, soil descriptions contained on the field logs were modified, if necessary, and laboratory-corrected logs are submitted as Plates 4 through 17 of Appendix A. Results of the laboratory tests are shown graphically on the individual boring logs and a summary of test results is presented on Plate 18 of Appendix A. Results of the grain size analysis are presented on Plates 19 through 24 of Appendix A.

Soils described in this report have been classified generally in accordance with the Unified Soil Classification System. However, the system has been augmented by the use of special adjectives to designate the approximate percentages of minor soil components. An explanation of the symbols and terms used on the boring logs and definitions of the special adjectives used to denote the minor soil components are presented on Plate 3 of Appendix A.

5.1 Results of Soil Classification Testing

Atterberg limit testing was performed to provide engineering classifications of the on-site soils exhibiting cohesion. A total of 3 Atterberg limits were performed with liquid limits ranging from 22 to 49 percent, and plasticity indices ranging from 6 to 23 percent for the soils tested. Grain size distributions were also performed on a total of 6 samples.

5.2 Results of Moisture Testing

Natural moisture content testing was performed on a total of 14 soil samples. The moisture contents of the on-site soils tested ranged from 3.6 percent to 54.1 percent.

5.3 Results of Organic Content Testing

Organic content (Loss On Ignition) testing results varied from1.6 percent to 16.0 percent on samples where organics were suspected. The samples with test results below 5 percent are classified as slightly organic whereas the sample that contained 16 percent is organic and contains peat.

6. DESIGN RECOMMENDATIONS

6.1 Geotechnical Evaluation

Existing fill, weaker granular and cohesive deposits, peat, and high groundwater were all encountered at the site. Concerns regarding construction of the structures include: 1) stability of the excavations during construction; 2) the presence of existing fill, weak/loose soils, organics, or unsuitable soil conditions being present at the proposed bearing elevations; 3) the sensitivity of fine-grained soils to construction activity and; 4) the location of the groundwater table and need for dewatering. Dewatering could induce settlements of the existing structures.

Other items to consider include the following:

- For any excavations performed adjacent to existing structures, measures will have to be taken to protect the integrity of existing adjacent foundations. Where foundation excavations extend beneath existing foundation bearing elevations, the walls of the excavation will need to be adequately braced or anchored in some manner to minimize settlement of the existing adjacent structures. Depending upon the relationship of existing structures to proposed excavations, it may be necessary to underpin the existing structures.

- Based on the subsurface stratigraphy encountered within the borings at the project site, it is the opinion of S&ME that this site is best characterized by 2011 Ohio Building Code site class D.

6.2 Excavation Considerations

Excavations on the order of 7 to 20 feet will be needed for construction of the proposed anaerobic/anoxic tanks and primary effluent pump station. The borings performed in the areas of these proposed structures (SB-5 through SB-8) revealed existing fill and granular soil above the proposed bottom of structure elevations. Excavations on the order of 3 to 13 feet will be needed for construction of the proposed effluent distribution box. The 1972 borings (B-8 and B-9) revealed existing partly organic silty clay, portions of which may have previously been over-excavated. Any remaining silty clay should be over-excavated to natural medium-dense sand and gravel (estimated around El. 68) and the over-excavation should be backfilled with compacted controlled fill. Over-excavations up to approximately 12 feet below the existing ground surface should be anticipated in the area of the shallow structures (SB-2 odor control building) to remove existing fill, organic, weak, and otherwise unsuitable soils. Excavations of approximately 13 feet below the existing ground surface are anticipated for the flow retention influent metering chamber. Although no boring was specifically performed at the location of the influent metering chamber, the closest borings (1972 B-2, 1999 B-16, and SB-1) indicate loose to medium-dense sand and gravel are likely to be present at the bottom of the excavation. Existing fill and organic soils are likely above the sand and gravel. Caving, sloughing, and groundwater infiltration should be anticipated in these excavations.

All excavations, and any corresponding construction, must be performed without endangering the construction workers. In accordance with OSHA Trench/Excavation Regulations (OSHA 29 CFR Part 1926), for any excavations exceeding a depth of 5 feet for which workers will be entering the excavation/trench, the excavation sides must be sloped to the required maximum inclination or flatter (based on the soil type and strength) or braced. S&ME recommends that the excavation slope layback be based upon the soil conditions encountered during the excavation, as evaluated by a "Competent Person" retained by the contractor in accordance with OSHA regulations. Type B and Type C soils are generally anticipated. In areas where excavations are deeper than 20 feet, a registered Professional Engineer must design the excavations in accordance with OSHA regulations. A Professional Engineer should also be involved for any excavation within the influence of existing structures. It is recommended that a qualified Geotechnical Engineer such as S&ME be retained to review these plans during construction before being accepted by Design Engineer or the Owner.

It is likely that site constraints are such that it may not be practical to allow for excavations to have the minimum layback slopes. Additionally, any excavations located near existing structures could either undermine an existing foundation or slab or allow non-desired lateral movement of the existing structure to occur. In general, any existing underground utility or structure within the influence zone of an open cut excavation will be susceptible to potential lateral movements, if the excavation side slopes are not braced or sloped sufficiently. The influence zone of the excavation can be determined by extending an imaginary line from the base of the excavation to the ground surface using an inclination of approximately 45 degrees with the horizontal. Therefore, the lateral distance, depth of existing utilities or foundations, and the planned excavation depth must be known to determine whether an adjacent structure could be affected by the excavation. The risk of lateral movement within the influence zone increases with both the length of the excavation and the time the excavation remains open. Therefore, S&ME recommends that any excavation that is positioned near an adjacent structure, such that the excavation will be within the influence zone of the nearby structure, should include an appropriately designed bracing system.

If a bracing system is required and no lateral movements can occur, we recommend that the bracing/shoring be designed and installed as a rigid system with minimal deflection along the entire height. Further, the system must be constructed "tight" against the retained soil to be effective. For example, the bracing system cannot be installed after the excavation is made. In most cases, an effective bracing system is comprised of sheeting driven prior to the excavation, possibly with tie-backs.

S&ME recommends that any bracing system be designed by a registered Professional Engineer. Additionally, the bracing and/or retention system must account for the concerns presented herein and incorporate all appropriate safety factors. For design of a bracing or temporary retention system, S&ME recommends that the design loads account for "at-rest" conditions where lateral movement of the excavation walls is unacceptable. The braced or shored retaining wall should be considered non-yielding if the allowable movement at the top of the wall is less than 0.1 percent of the height. Also, any surcharge loads as a result of construction equipment or stockpiling of soil/supplies or the adjacent excavation must be included in the design lateral load determination for temporary or permanent bracing. S&ME recommends that the design lateral earth pressures be selected in accordance with the values provided in Table 2 of the "Lateral Earth Pressures" section of this report. It is recommended that a qualified Geotechnical Engineer such as S&ME be retained to review these plans during construction before being accepted by the Design Engineer or the Owner.

6.3 Structure Recommendations

Existing uncontrolled fill, loose/weak soils, organics, and otherwise unsuitable soils should be completely removed and replaced at least 10 feet beyond the perimeter of the proposed structure for shallow structures prior to foundation and floor slab construction. Alternatively, if complete removal and replacement is not desired, extending foundations to suitable soils and structurally supporting slabs or deep foundations and structurally supported slabs could be considered.

6.3.1 Anaerobic/Anoxic Tank

The anaerobic/anoxic tank is proposed to be constructed between the existing primary clarifiers and the roughing filters. The existing structures down to the roughing filters are anticipated to be demolished as part of the construction. These structures are anticipated to extend between approximately 7 and 20 feet below the existing ground surface and be watertight. The anaerobic/anoxic tank is anticipated to bear at approximate El. 68. Existing grades vary from approximately El. 75 to El. 83 in the area of the proposed tanks.

Bearing - The soils encountered in the borings in this area indicate at the proposed bearing elevations of El. 68 in the area of the anaerobic/anoxic tanks were generally described as medium-dense to dense sand and gravel. CTI and O'Brien & Gere have indicated the proposed mat foundation for these structures will have an estimated maximum bearing pressure of 4,000 psf. If weaker soils are encountered, such as loose fine sands or silts, or if soils become disturbed by construction activity or softened by the presence of water at the bearing elevation, S&ME recommends that the exposed disturbed soils be stabilized to provide suitable bearing support for the structure. For stabilization, S&ME recommends that the bearing surface be compacted with a large smooth drum roller. If desired, consideration could be given to placing a mud mat over the bearing surface to minimize construction related disturbance.

Settlement – Settlement will occur for two reasons: 1) due to any net loading caused by the proposed tank structures; and 2) due to the weight of any newly placed fill around the tank. Based on the bearing pressure distribution provided by O'Brien & Gere on May 30, 2014 (included as Plate 28 of Appendix A), S&ME analyzed three loading cases and computed anticipated settlements. For a mat with a width of 45 feet and a loading of 3,000 psf settlements are anticipated to be on the order of 2 to 3 inches. For a 15-foot-wide mat and a load of 2,000 psf, settlements are anticipated to be on the order of 1 to 1½ inches. It is estimated that a 5-foot-wide mat loaded to 4,000 psf would settle approximately 1 to 1½ inches. Because the actual mat will be one continuous mat, it is our opinion that the estimates provided are conservative. Based on the anticipated load distribution, total settlements as great as 3 inches and similar differential settlements should be anticipated. Because of the predominantly granular nature of the soils below the proposed structure, the settlement due to the net loading of the tank is expected to occur quickly (likely occur as the structure is constructed and again as water is added). Settlement of mat foundations are largely controlled by the mat width and the supported load. At the time of this report it is anticipated that new fill will be minimal. We understand that it is not possible to design the structure to accommodate the anticipated total and differential settlement. Options to minimize settlement include the use of deep foundations or contacting a specialty Geotechnical Contractor for ground improvement options prior to foundation construction.

6.3.2 Primary Effluent Pump Station

The primary effluent pump station is proposed to be constructed between the existing primary clarifiers and the existing berm. The structure is anticipated to extend up to approximately 26 feet below the existing ground surface and be watertight. The PEPS is anticipated to bear at two primary levels approximate El. 62 and El 68. Existing grades vary from approximately El. 80 to El. 88 in the area of the PEPS.

Bearing - The soils encountered in the borings in this area indicate at the proposed bearing elevations of El. 32 and El. 68 in the area of the PEPS were generally described as medium-dense to dense sand and gravel. CTI indicated the proposed mat foundations for this structure will have an estimated maximum bearing pressure of 3,000 psf. If weaker soils are encountered, such as loose fine sands or silts, or if soils become disturbed by construction activity or softened by the presence of water at the bearing elevation, S&ME recommends that the exposed disturbed soils be stabilized to provide suitable bearing support for the structure. For stabilization, S&ME recommends that the bearing surface be compacted with a large smooth drum roller. If desired, consideration could be given to placing a mud mat over the bearing surface to minimize construction related disturbance.

Settlement – Settlement will occur for two reasons: 1) due to any net loading caused by the proposed structure; and 2) due to the weight of any newly placed fill around the tank. Based on the bearing pressure of 3,000 psf at the two elevations, settlements are anticipated to be on the order of 1-2 to inches. Total settlements up to 2 inches should be anticipated. Because of the predominantly granular nature of the soils below the proposed structure, the settlement due to the net loading of the tank is expected to occur quickly (likely occur as the structure is constructed and loaded). Settlement of mat foundations are largely controlled by the mat width and the supported load. At the time of this report it is anticipated that new fill will be minimal. We understand that it is not possible to design the structure to accommodate the anticipated total and differential settlement. Options to minimize settlement include the use of deep foundations or contacting a specialty Geotechnical Contractor for ground improvement options prior to foundation construction.

Auger Cast In Place Piles

Auger Cast-In-Place (ACIP) Piles are an alternative to limit settlement to tolerable (less than 1 inch) amounts.

The presence of cobbles and granular soils could present constructability issues. The possibility of uncompleted piles must be considered.

S&ME recommends that skin friction be neglected in the upper five feet of all piles. S&ME also recommends that skin friction be neglected in any existing fill of unknown origin or in organic soils. Based on the conditions encountered in the borings, it is anticipated that existing fill and organic soils will be removed prior to attaining the anticipated bearing or top of pile elevation.

Skin friction and end bearing resistance capacities are provided in Table 2 for the Anaerobic/Anoxic Tank and Primary Effluent Pump Station based on existing published methods. These values are based on conditions encountered in Borings SB-5 to SB-8, as well as extrapolating conditions below the bottom of the borings as similar to those encountered in the borings.

Table 2: Anaerobic/Anoxic and PEPS ACIP Pile – Maximum Allowable Capacity

Elevation	Skin Friction (ksf)	End Bearing (ksf)
68-53	0.3	8
53-43	0.4	8
43-0	0.5	8

If the ACIP piles are spaced at center-to-center spacing of 6 or more pile diameters no reduction in pile capacity is required. If piles are spaced closer than 6 diameters the skin friction and end bearing values shown in Table 2 will need to be reduced to account for overlapping zones of influence. For reference purposes, if piles are spaced as close as 3 diameters center-to-center a group factor of 0.7 should be applied reducing the skin friction and end bearing capacity compared to an isolated pile. If a pile group is within 5 pile diameters of another pile group or an existing deep foundation a group efficiency of 0.65 is recommended.

As these recommended values are based on design codes and a desired configuration has not been developed, S&ME has not performed any lateral load analysis. If it is anticipated that any lateral loads will be applied to piles, S&ME recommends a lateral load analysis be performed.

Based on FHWA GEC No. 8 Auger Cast piles are commonly designed to have diameters between 12 and 36 inches. It is common for piles to have length to diameter ratios around 20 although they rarely are the piles designed to be longer than 100 feet.

Because the use of this approach is limited to historical laboratory data and controlled by design codes, the recommended bearing resistance should be considered conservative. If additional capacity is desired for the design, it is recommended that at least two pile load tests be performed at the site to evaluate the potential capacities available at the site. Further options such as increasing the lengths of the piles or the diameters of the piles can significantly increase the capacity of the piles. It has been our experience that the predicted design capacities can be increased by confirming the ultimate capacity of ACIP piles at the site through a static load test. Specialty foundation contractors can be contacted to obtain load test data from similar site conditions which can be used to predict potential capacities for the design. These capacities can then be confirmed by performing the pile load tests prior to installing the production piles. Proof load testing can also be specified for a desired percentage of the production piles.

ACIP piles should be placed no closer than three pile diameters center to center and piles should not be installed within six pile diameters center to center of a pile filled with concrete less than 24 hours old.

During installation, if the concrete level in any completed pile drops, the pile should be rejected and replaced. The auger should not be permitted to stop rotating or reverse direction of rotation during withdrawal and shall be withdrawn in a steady continuous motion. Concrete pumping pressures should be measured and maintained high enough at all times to offset hydrostatic and lateral earth pressure. Concrete volumes should be measured to ensure that the volume of concrete placed in each pile is equal to or greater than the theoretical volume of the hole created by the auger. Grout cubes should be made for each day’s work. Reinforcement should be designed as required and should have a concrete cover of not less than 3 inches.

S&ME recommends that a pre-construction meeting take place with the contractor to discuss the contractor’s specifically proposed construction methods and to develop contingency plans in the event that problems are encountered (i.e., misaligned pile). At least one static load test (ASTM D1143) should be conducted to confirm the design capacity of each size and capacity of pile, and at least 5 % of the production piles should be tested. Piles tests should provide a minimum factor of safety of 2.0.

It is recommended that consideration be given to using either Chapter 8 of FHWA’s GEC No. 8 titled “Guide Construction Specifications for Continuous Flight Auger (CFA) Piles” or the “Guideline Augered Cast-In-Place (ACIP) Pile Specification [and

Commentary]" found in the Augered Cast-In-Place Manual prepared by the Deep Foundations Institute as guidelines for the pile specification.

Tensile or uplift forces could be resisted by the buoyant dead weight of the piles in combination with a maximum of 80% of the allowable skin friction accounting for the pile spacing and any necessary reductions. No uplift resistance from skin friction should be included for existing fill.

6.3.3 Effluent Distribution Box

The effluent distribution box is proposed to be constructed along the western edge of the existing aeration tanks. The existing effluent distribution structure is anticipated to be demolished as part of the construction. The proposed structure is anticipated to extend between approximately 3 and 13 feet below the existing ground surface, be watertight, and is anticipated to bear at approximate El. 74.

Bearing - The soils encountered in the historic borings in this area (1972 B-8 and B-9) indicate at the proposed bearing elevation of El. 74 in the area of the effluent distribution box were generally described as firm to very-stiff silty clay with weak organic zones. Previous reports recommended that the organic and weak portion of the cohesive soil be removed and replaced with controlled fill. It is unknown the extent of the material that was previously over-excavated and replaced with controlled fill. S&ME recommends the over-excavation of all existing cohesive soil present beneath the proposed Effluent Distribution Box (estimated over-excavation to Elevation 68) and the over-excavation is backfilled, compacted and tested as described in the fill and backfill section of this report. S&ME also recommends any over-excavations for this structure be backfilled with a granular material such as ODOT Item 304 to provide a more uniform bearing surface and to reduce differential settlements. CTI and O'Brien & Gere have indicated the proposed mat foundation for the effluent distribution box will have an estimated maximum bearing pressure of 3,000 psi. Medium-denser sand and gravel or newly placed and controlled granular fill soils should be capable of supporting the proposed loads and provide a bearing capacity along with a factor of safety of 3. If weaker soils are encountered, such as loose fine sands or silts, or if soils become disturbed by construction activity or softened by the presence of water at the bearing elevation, S&ME recommends that the exposed disturbed soils be stabilized to provide suitable bearing support for the structure. For stabilization, S&ME recommends that at a minimum the bearing surface be compacted with a large smooth drum roller. If desired, consideration could be given to placing a mud mat over the bearing surface to minimize construction related disturbance.

Settlement – Settlement will occur for two reasons: 1) due to any net loading caused by the proposed tank structure; and 2) due to the weight of any newly placed fill around the tank. Based on the anticipated bearing pressure provided, S&ME analyzed a 5 foot wide section of mat loaded to 3,000 psf and settlement is estimated to be approximately 1 inch or less. Because of the predominantly granular nature of the soils below the proposed structure, the settlement due to the net loading of the tank is expected to occur quickly (likely occur as the structure is constructed and water is added). Settlement of mat foundations are largely controlled by the mat width and the supported load. At the time of this report it is anticipated that new fill will be minimal.

6.3.4 Odor Control Building

It is anticipated that the proposed odor control building will have foundations embedded for frost and a slab near the existing ground surface. Existing ground surface elevation in this area is generally around El. 80.

Bearing – The near surface soils present to approximate elevation El. 68 generally consisted of existing fill or weak soil that is not considered to be suitable for foundation or slab support. It is recommended that any existing fill, organic soil, weak soil, or otherwise unsuitable soil within and 10 feet beyond the proposed structure be removed and replaced with suitable properly compacted fill such as ODOT Item 304. A maximum allowable bearing pressure of 2,500 pounds per square foot (psf) may be used for the design of shallow spread foundations bearing on natural medium-dense sand, natural very-stiff cohesive soil, or newly placed and compacted fill. Exterior shallow spread foundations should be embedded a minimum of 42 inches below the lowest adjacent grade for frost protection or in accordance with local codes. A minimum footing width of 24 inches for wall footings and 36 inches for column footings are recommended, regardless of calculated size. If weaker soils are encountered, such as looser fine sands or silts, or if soils become disturbed by construction activity or softened by the presence of water at the bearing elevation, S&ME recommends that the exposed weak soils be stabilized to provide suitable bearing support for the structure. Prior to placing any fill materials, any accumulation of groundwater should be removed. The backfill should be placed and compacted as recommended in Section 6.6 of this report. Alternatively, if it is not desired to remove and replace the existing fill, weak soils, organic soils, and otherwise unsuitable soils, consideration could be given to extending foundations to bear on natural medium-dense sand or gravel and structurally supporting any slabs or using deep foundations and structurally supporting any slabs. Our office should be contacted to provide additional recommendations if this option is desired.

Settlement – Settlement will result from both the load of the new structure and the load of any newly placed fill. Because of the presence of predominately granular soils, provided any existing unsuitable soils are removed and replaced in a controlled manner, settlements are anticipated to occur quickly and will likely occur during construction. Settlements are anticipated to be within tolerable ranges, generally on the order of an inch or less.

6.3.5 Flow Retention Influent Metering Chamber

The flow retention influent metering chamber is anticipated to be a below ground tank structure with dimensions of approximately 9 feet in each direction. Based on information provided by CTI it is understood that the proposed tank will be placed approximately 13 feet below the existing ground surface. Although there is not a boring that was performed at the proposed location, based on the surrounding borings (1972 B-2, 1999 B-16, and current SB-1) it is anticipated that the excavation and tank will extend into natural medium-dense sand and gravel. Because of the nature of the tank structure, it is anticipated that the material removed will weigh more than the tank and contents so bearing should be adequate and settlement minimal.

S&ME recommends that the metering chamber be designed for an allowable bearing capacity of 4,000 psf. Settlement will be dependent on actual loading, however, because the soils removed are anticipated to weigh more than the proposed structure and contents, settlements are anticipated to be less than one inch.

6.4 Slab Support

If all existing fill is removed and replaced with controlled fill such as ODOT Item 304, it is anticipated that slabs may be supported on either natural medium-dense granular soils or newly placed and compacted fill soils. Concrete floors or mats supported on medium-dense or denser granular soils may be designed as slabs-on-grade utilizing the following Modulus of Subgrade Reaction which are based on anticipated rigidity and structure width:

- Anaerobic/Anoxic Tank Mat 35 pci;
- Primary Effluent Pump Station Mat 36 pci;
- Effluent Distribution Box Mat 49 pci;
- Effluent Distribution Box Slab-on-Grade 150 pci*;
- Influent Metering Chamber Mat 42 pci;
- Odor Control Building Slab-on-Grade 150 pci.

* If all existing soil below the Effluent Distribution Box is over-excavated to El. 68, along with any loose or soft soils encountered at that level, and replaced with ODOT Item 304 that is compacted to 100%, the slab can be designed with a higher modulus value.

The preceding recommendations considers a minimum 6-inch washed gravel or crushed stone base such as #57 Aggregate per ODOT Item 703 is placed directly below the floor slab or mat concrete.

It is recommended that final subgrade preparations be performed immediately prior to the placement of the granular base material to minimize damage to the subgrade from repeated construction traffic and/or exposure to weather. Proofrolling operations should be performed on the final subgrades to expose any soft or unsuitable bearing materials which may have developed during construction as a result of heavy construction traffic. We recommend that the proofrolling operations be performed using a tandem-axle, fully-loaded dump truck. Any soft or unsuitable material exhibiting rutting, yielding, and/or pumping during the proofroll should be either undercut to a firm bearing material and be replaced with engineered fill to re-establish final subgrade or be stabilized in accordance with the recommendations presented in the Fill and Backfill section of this report.

6.5 Lateral Earth Pressures

Below-grade portions of the proposed structure, or walls acting as retaining walls, should be designed to withstand lateral earth pressures, as well as hydrostatic pressures, that may develop behind the walls. If it is anticipated that the walls of the proposed structures will be fixed at both the top and bottom preventing significant lateral deflections or rotations from occurring, then an "at-rest" earth pressure condition exists. If the walls are capable of deflecting a distance of at least 0.1 percent of their height, then an "active" earth pressure condition may be assumed for design purposes. The magnitude of lateral earth pressures varies on the basis of soil type, permissible wall movement, and configuration of backfill. Design parameters for the various conditions are presented in Table 2 on the following page.

Because cohesive soils and granular soils with significant clay content can cause high magnitudes of lateral loads due to creep and swelling pressures, it is recommended that these materials not be used to backfill against below-grade walls. It is recommended that a free-draining granular material such as bank run sand and gravel containing a maximum of 20 percent passing the No. 200 sieve, or a coarse angular gravel such as No. 57 limestone, be used as backfill against below-grade walls. This granular zone should be drained so that hydrostatic pressures do not develop against the wall, otherwise, the wall should be designed for the hydrostatic loading.

To use the equivalent fluid unit weights presented in Table 3 on the following page for the granular backfills, the backfill must be placed in a wedge formed by the back of the wall and a line rising from the base of the wall at a maximum 60-degree angle from the horizontal.

With respect to sliding resistance along the interface between a concrete foundation and cohesive soil, a coefficient of friction of 0.35 may be used. For a granular soil and concrete foundation interface, a coefficient of friction of 0.55 may be used.

TABLE 3: Soil Parameters for Long Term Design of Below-Grade Walls

Backfill: **Parameters:**	**Cohesive Backfill**	**Bank Run Sand & Gravel***	**Coarse Angular Gravel (No. 57 limestone)***
Equivalent Fluid Unit Weights (pcf)			
Drained			
Active Case	63	35	30
Passive Case	250	446	422
At-Rest Case	88	55	45
Undrained			
Active Case	94	84	79
Passive Case	190	288	247
At-Rest Case	107	97	84
Earth Pressure Coefficient			
Active Case	0.5	0.28	0.26
Passive Case	2.0	3.57	3.84
At-Rest Case	0.7	0.43	0.41
Unit Weight (pcf)			
Moist	125	125	105
Saturated	145	145	115
Friction Angle (Φ)	20°	34°	36°

* These design parameters are to be used only if granular backfill is placed in a wedge as described in the text.

6.5.1 Sloped Excavations

If sloped back excavations are utilized for construction and granular backfill is used, the equivalent fluid unit weights for drained conditions may be used for design purposes above the maximum anticipated groundwater level (such as the 100-year flood level). Groundwater observations around the time of drilling are listed in Table 1.

6.5.2 Sheeted and Braced Excavations

The type of natural soils encountered in the construction excavation will govern the magnitude of the horizontal pressure to be used for structural design. Lateral pressures of a relatively low magnitude will be developed by natural granular soils, whereas a cohesive soil will result in creep and the development of much higher pressures with time. Table 3 provides the appropriate design parameters for design of lateral soil loads on below-grade structure walls. Hydrostatic and surcharge effect due to adjacent sloped backfill or adjacent structural loads should also be considered when designing the below-grade structures.

6.6 Fill and Backfill Placement

In areas where new fill or trench backfill will be required for the support of new structures, it is recommended that the fill be placed in uniform, thin lifts (8-inches maximum loose thickness) and be compacted to a dry unit weight of no less than 100 percent of the Standard Proctor maximum dry density (ASTM D 698). In areas where new fill will be required for the support of only lawn areas, pavements and/or sidewalks, it is recommended that the fill be placed in uniform, thin lifts (8-inches maximum loose thickness) and be compacted to a dry unit weight of no less than 98 percent of the Standard Proctor maximum dry density (based on ASTM D 698).

Based on the results of the borings performed for this investigation, portions of the on-site soils may be reusable as structural fill provided the soils are properly moisture conditioned and free of debris. The moisture content of all soil that is used as structural fill should be maintained within 2 percentage points of the optimum moisture content. All soil that is to be used as structural fill should consist of non-organic soil free of miscellaneous debris, cobbles (3 inches or larger), and boulders. The fill should not be in a frozen condition during placement and should not be placed on a frozen subgrade.

In areas where new fill will be placed as backfill behind below-grade structure walls, the backfill should be compacted to a dry unit weight of no less than 95% (ASTM D 698). Over-compaction in areas directly behind the wall should be avoided as this might cause damage to the structure. For cases where new foundations will bear immediately behind below-grade walls, proper compaction is critical. To achieve this without damaging the wall, we would recommend requiring the use of No. 57 limestone (crushed) or other very clean material that can easily be compacted. This material will achieve a high level of compaction without a significant amount of energy. A walk behind plate compactor should be used within 5 feet (laterally) of the below-grade walls and a smooth drum roller can be used beyond that point. For ease of footing construction near below-grade walls, the top of the stone could be choked off with ODOT Item No. 304 or a similar material. Refer to the “Lateral Earth Pressures” section of this report for soil parameters to be used in the design of below-grade walls. An alternative to placing No. 57 stone would be to place a low strength flowable fill.

6.7 Seismic Site Classification

Based on the subsurface stratigraphy encountered within the borings at the project site and the estimated stratigraphy between the bottoms of the borings and 100 feet below existing grades, it is the opinion of S&ME that this site is best characterized by 2011 Ohio Building Code site class D.

6.8 Groundwater and Uplift Considerations

6.8.1 Groundwater Control

Seepage and/or groundwater were encountered during drilling in all of the 8 borings at depths varying from 5.0 to 14.0 feet below grade (elevations varying from El. 67.1 to 75.9). Slotted temporary PVC pipe was placed in three of the borings for extended groundwater observations. On April 9, 2014, water was observed inside the pipe at depths of approximately 18 to 27 inches below the ground surface (elevations ranging from El. 73.8 to 97.6). These observed elevations were higher than the water level observed in the adjacent Tuscarawas River at a similar time when water was observed at approximate Elevation 73. **Groundwater levels will fluctuate throughout the year and with the level of the adjacent Tuscarawas River.**

It should be noted that during previous construction at this site, additional dewatering wells drilled deeper than the initials well were required to complete the construction dewatering.

Bearing elevations are anticipated to vary from El. 62 (primary effluent pump station) to El. 76 (odor control building). Over-excavation for the odor control building and equipment pad could result in excavation down to approximate elevation 68. Dewatering will be needed for construction of the new structures. The groundwater table should be maintained a minimum of 3 feet below the lowest working surface during construction, including over-excavations required to reach a stable subgrade.

Shallow excavations may encounter minor amounts of seepage. Deeper excavations, such as excavations for the anaerobic/anoxic tank, primary effluent pump station, effluent distribution box, flow retention influent metering chamber, over-excavation of existing fill or organic/unsuitable soils, and others or deep utilities, extending through granular seams, pockets/lenses, or layers will likely encounter larger groundwater flows. Excavations will likely require more extensive dewatering techniques, such as continuous pumping from deep dewatering wells installed around the proposed construction area.

We recommend that the project specifications require that the contractor submit a detailed dewatering plan prepared by a registered engineer or geologist with experience in designing dewatering systems for review by a qualified Geotechnical Engineer such as S&ME prior to the installation of any dewatering. The Dewatering System Designer should be provided with this subsurface investigation report, and be made aware of the previous problems in attaining sufficient dewatering at the site. The site could contain sand and gravel to a depth of about 300 feet, which would constitute a very thick, permeable aquifer. The river will serve to recharge the aquifer in the immediate vicinity of the site. In addition, the specifications could include the requirement that the contractor drill a test well at the site, perform an aquifer test, compute appropriate aquifer characteristics and compute the number, and locations of the proposed dewatering wells and to estimate dewatering pumping rates.

Existing structures that could be subject to settlement due to the lowering of the groundwater levels during construction should be defined prior to construction, with special attention in the project specifications addressing contractor requirements to install dewatering methods which will minimize settlement. The project surveyor should provide occasional surveying of the structure during construction, and S&ME should be contacted if excessive settlements are detected.

The Dewatering Contractor should be required to provide additional (back-up) pumps and provide generators to power the pumps in the event of a power outage. The Contractor should be required monitor the dewatering system, and to make the necessary adjustments to maintain the groundwater level at least 3 feet below the lowest working surface. The Contractor should be required to maintain the lower groundwater levels until structures have reached design strength and are in the completed form including any required backfill to be placed and compacted to the final grades. This report does not include explicit or implicit recommendations for specific dewatering approaches.

The foundation excavations should be free of loose soil and debris, as well as free of water at the time of the concrete placement. Surface water infiltration can be minimized by grading the ground surface adjacent to the foundation excavations to prevent surface runoff from entering the foundation excavations. Soils softened by standing water or disturbed by construction activities should be removed from excavations before concrete is placed.

6.8.2 Uplift Considerations

It is recommended that any underground water-tight structures be designed to resist the potential buoyant forces assuming a static groundwater level at the 100-year flood level. To resist any potential uplift pressures created by groundwater, the foundations should be designed for uplift pressures resulting from the difference in elevation between the maximum anticipated hydrostatic head around the structure and the bottom of the structure. The structure dead weight must provide an adequate factor of safety against the anticipated hydrostatic uplift force. Uplift resistance may be increased by adding additional dead weight to the structure (foundation and/or walls), cantilevering the foundations beyond the perimeter walls, or anchoring the foundations to the underlying soil strata using piles or soil anchors. All floors and walls must be designed to resist the hydrostatic pressures. The walls must also be designed to resist the lateral soils pressures presented in Section 6.4.

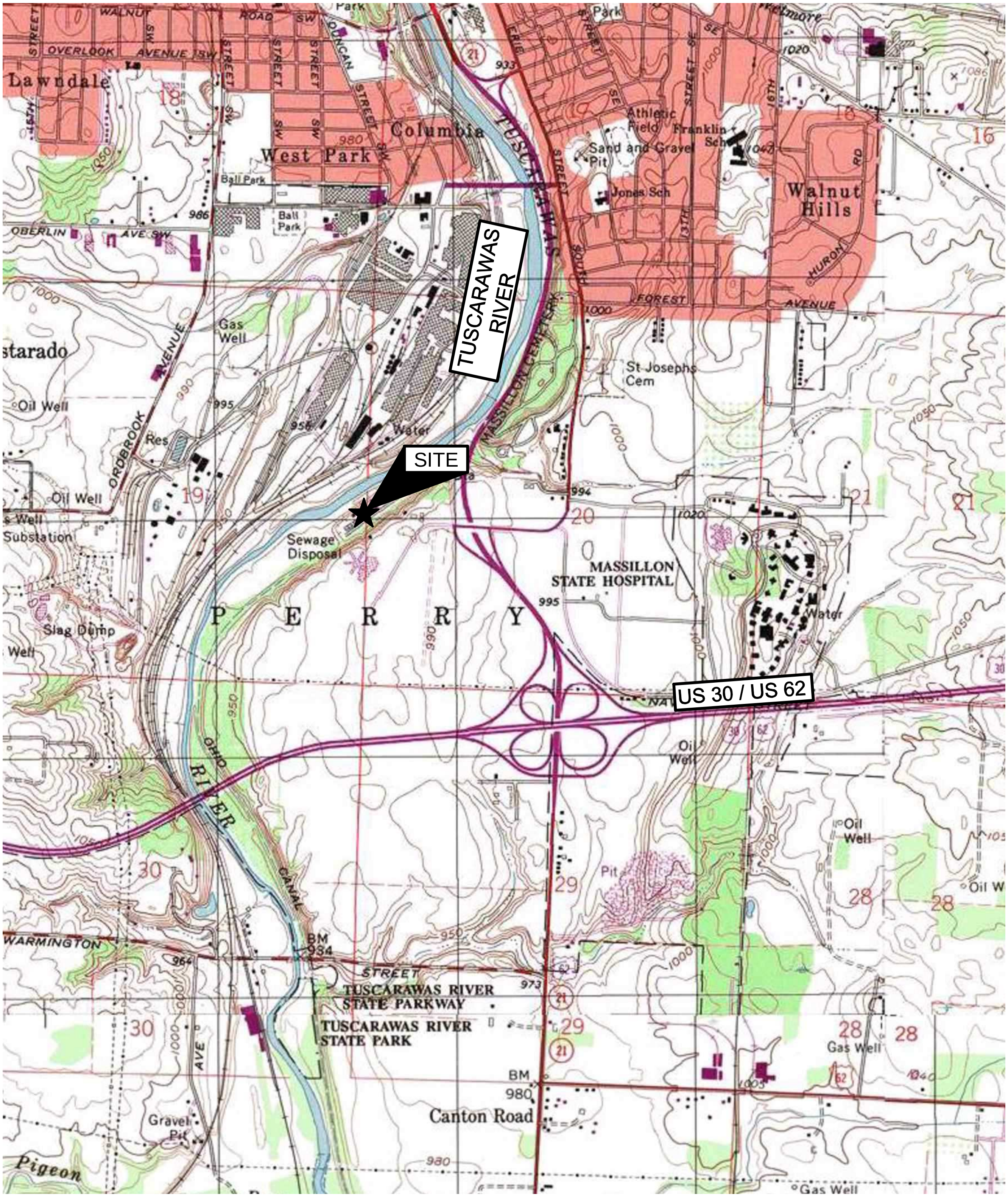
7. FINAL CONSIDERATIONS

The analyses, conclusions and recommendations discussed in this report are based on conditions as they exist at the time of our field investigation and further on the consideration that the exploratory borings are representative of subsurface conditions throughout the areas investigated. It is noted that groundwater levels vary based on the time of the year, the previous precipitation levels and water levels in the Tuscarawas River. Actual subsurface conditions between and beyond the borings might differ from those encountered at the boring locations. If subsurface conditions are encountered during construction that vary from those discussed in this report, S&ME should be notified immediately so that we may evaluate the effects, if any, on the design and construction.

All foundation excavations should be observed by a qualified Geotechnical Engineer such as an S&ME representative to verify suitable bearing soils are present and capable of supporting the foundation loads as designed, and to minimize the amount of overexcavation required during excavation if weak/unsuitable soils are encountered. If another qualified Geotechnical Engineer is retained for construction observations they become the Geotechnical Engineer of Record. It is recommended that S&ME be provided with the opportunity to review the dewatering specifications for this project.

This report was written for our client, CTI Engineers, Inc. for the construction of Anaerobic/anoxic tanks, Primary Effluent Pump Station, Odor Control Building, Flow Retention Influent Metering Chamber, and the Effluent Distribution Box. This report may not be relied upon for use in other projects, additions to the current project, or any other purpose for which the material was not strictly intended by S&ME without S&ME's express written permission.

APPENDIX A



USGS Mapping:
Massilion Quad

0 2000 4000
SCALE IN FEET

VICINITY MAP

MASSILLON WWTP
STARK CO., MASSILLON, OHIO

Project: 1171-13-059A
Drawing Date: 4-24-2014
Last Updated: 4-25-2014
Drawn By: PRR
Approved By: NDA
Scale: GRAPHIC 1:1

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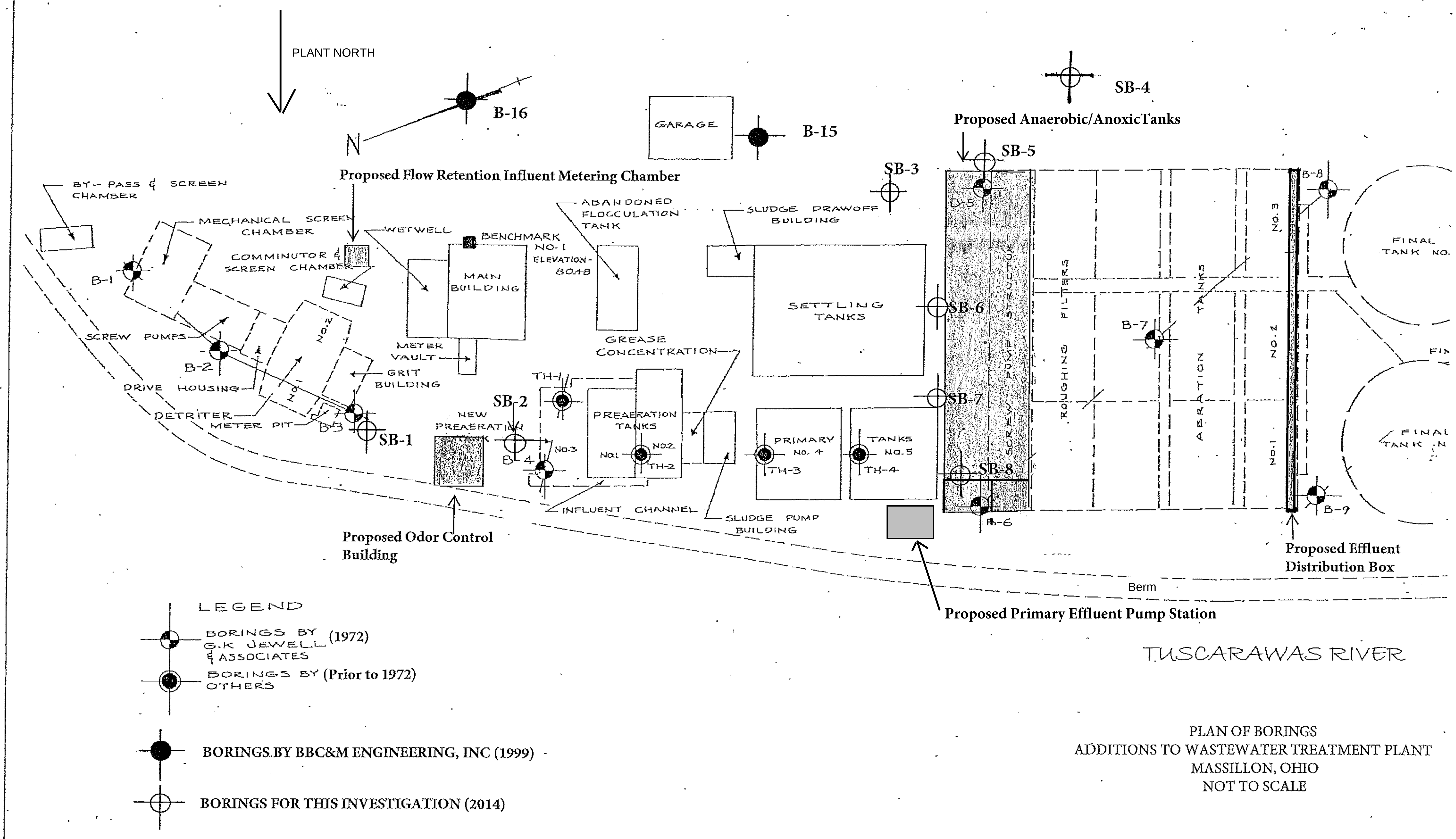
ENGINEERING FIRM. 03530

PLATE 1

Images: ~ Massillon TOPO!map.TIF
Xrefs:
File Last Updated: Apr 25, 2014
Plot Info: 4–25–2014 @ 1:37pm By: prock
S&ME Filename: I:\DEPTS\cadd\Drawings\BST Projects\1171-Geotechnical\1171-13-059\1171-13-059A\PLANS\VMAP.dwg Layout: V-Map



PLAN OF BORINGS
ADDITIONS TO WASTEWATER TREATMENT PLANT
MASSILLON, OHIO
NOT TO SCALE

PLATE 2

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

▮ - Blocked-in “SAMPLES” column indicates sample was attempted and recovered within this depth interval.

▯ - Sample was attempted within this interval but not recovered.

2/5/9 - The number of blows required for each 6-inch increment of penetration of a “Standard” 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches. The raw “blowcount” or “N” is equal to the sum of the second and third 6-inch increments of penetration. Addition of one of the following symbols indicates the use of a split-barrel other than the 2” O.D. sampler:

- $\boxed{2S}$ - 2½"O.D. split-barrel sampler
- $\boxed{3S}$ - 3" O.D. split-barrel sampler

N_{60} - Corrected Blowcount = [(S&ME Drill Rod Energy Ratio) / (0.60 Standard)] X N_{raw}

P - Shelby tube sampler, 3” O.D., hydraulically pushed.

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.

50-2” - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment.

SD - Split-barrel sampler (S) advanced by weight of drill rods (D).

SH - Split-barrel sampler (S) advanced by combined weight of rods and drive Hammer (H).

SOIL DESCRIPTIONS

All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components, as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
“and”	36 to 50

The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot (N_{60})
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

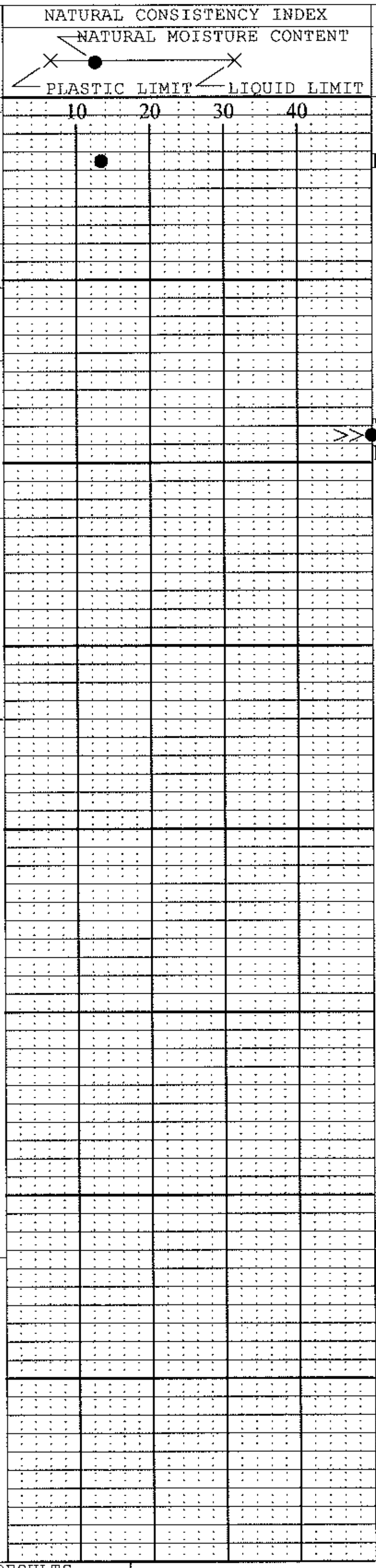
Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

LOG OF BORING NO. SB-1
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.**
ELEVATION: **81.1**
DATE: **3/26/14 - 3/27/14**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger**
COMPLETION DEPTH: **50.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
80.7	0					ROOTMAT - 5 INCHES	
		1	3/4/5	12	67	FILL: Very-stiff brown, dark-brown and gray silty clay, some fine to coarse sand, little fine gravel.	H=3.0-3.25
77.1						FILL: Loose to medium-dense brown fine to coarse sand, "and" clayey silt, trace fine gravel.	
75.9	5	2A 2B	6/6/4	13	100 88	FILL: Medium-dense brown fine to coarse sand, some fine to coarse gravel, little silt.	
73.9						POSSIBLE FILL: Very-stiff dark gray organic silty clay, some fine sand, trace medium to coarse sand, trace fine gravel, contains peat. LOI = 16%	
	10	3	3/5/4	12	73		WC=54.1 H=2.5-3.5
69.6						Medium-dense brown and gray fine to coarse gravel, "and" fine to coarse sand, little silt.	
	15	4	3/4/12	21	53		
64.1						Medium-dense to dense brown fine to coarse sand, little to some fine to coarse gravel, trace silt.	
	20	5	2/7/9	21	60		
	25	6	9/9/10	24	67		
	30	7	9/11/14	32	100		
49.4						Medium-dense brown fine to coarse sand, trace fine to coarse gravel, trace silt.	
	35	8	8/7/3	13	100		
	40	9	2/4/6	13	53		



WATER LEVEL:	▽ 10.2'	▼ 9.8'
WATER NOTE:	At Completion	
DATE:	3/27/2014	3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

2010 NEW DEFAULT BORING LOG-W/ N60

-CONTINUED-

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LOG OF BORING NO. SB-1
MASSILLON WWTP
MASSILLON, OH

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **81.1** DATE: **3/26/14 - 3/27/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX (NATURAL MOISTURE CONTENT, PLASTIC LIMIT, LIQUID LIMIT) 10 20 30 40	TEST RESULTS
	40						Medium-dense brown fine to coarse sand, trace fine to coarse gravel, trace silt. (continued)		
39.7							Medium-dense grayish brown fine to coarse gravel, some fine to coarse sand, trace silt.		
		10	■	8/7/6	17	47			
	45								
34.8							Medium-dense brown fine to coarse sand, trace fine to coarse gravel, trace silt, contains coal fragments.		
		11	■	4/4/6	13	80			
31.1	50								
	55								
	60								
	65								
	70								
	75								
	80								

- USGS 931.2'.
- Encountered seepage at 5.2'.
- Encountered water at 14.0'.
- Placed temporary slotted PVC in boring for extended water level monitoring.

- 3/31/14 water 923.2' - 8.0' below surface
- 4/09/14 water 929.7' - 1.5' below surface
- 4/11/14 water 923.5' - 7.7' below surface

2010 NEW DEFAULT BORING LOG-W/ N60

	∇	▼
WATER LEVEL:	10.2'	9.8'
WATER NOTE:	At Completion	
DATE:	3/27/2014	3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

JOB: 1171-13-059A

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LOG OF BORING NO. SB-2
MASSILLON WWTP
MASSILLON, OH

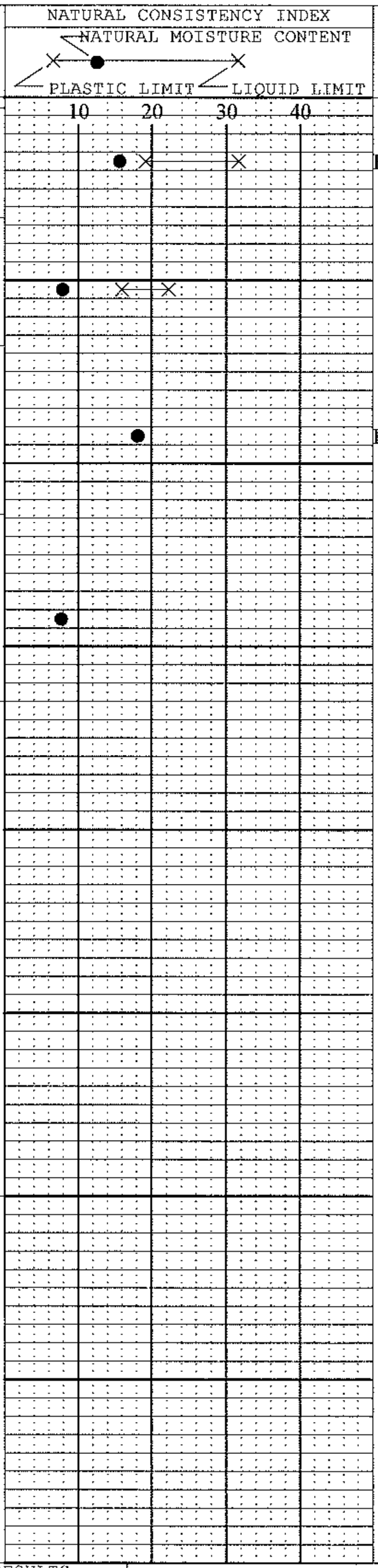
S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **80.0** DATE: **3/27/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **30.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
79.7	0					ROOTMAT - 4 INCHES	
76.7		1	2/2/3	6	53	FILL: Stiff to very-stiff brown mixed with gray silty clay, some fine to coarse sand, little fine to coarse gravel, few roots.	H=1.75-2.5
73.2	5	2	1/2/2	5	33	FILL: Loose brown fine to coarse sand, some fine to coarse gravel, "and" clayey silt, contains few brick fragments.	
68.6	10	3	SH/SH/1	0	53	Medium-stiff dark-brown and dark-gray silty clay, "and" fine to coarse sand, little fine to coarse gravel.	H=0.5-0.75
63.5	15	4	2/12/27	50	73	Dense brown fine to coarse gravel, "and" fine to coarse sand, trace silt, organic odor. LOI = 1.6%	
	20	5	9/9/12	27	87	Medium-dense brown fine to coarse sand, little to some fine to coarse gravel, trace silt.	
	25	6	11/10/10	26	67		
50.0	30	7	11/17/7	31	40		
	35					- USGS 930.1'. - Encountered water at 9.5'. - Boring backfilled immediately after drilling. No long term water levels obtained.	
	40						



WATER LEVEL:	∇ 9.0'	▼	
WATER NOTE:	At Completion	Caved at 14.5'	
DATE:	3/27/2014	3/27/2014	

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol. — See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

2010 NEW DEFAULT BORING LOG-W/ N60

JOB: 1171-13-059A

PLATE 6

LOG OF BORING NO. SB-3
MASSILLON WWTP
MASSILLON, OH

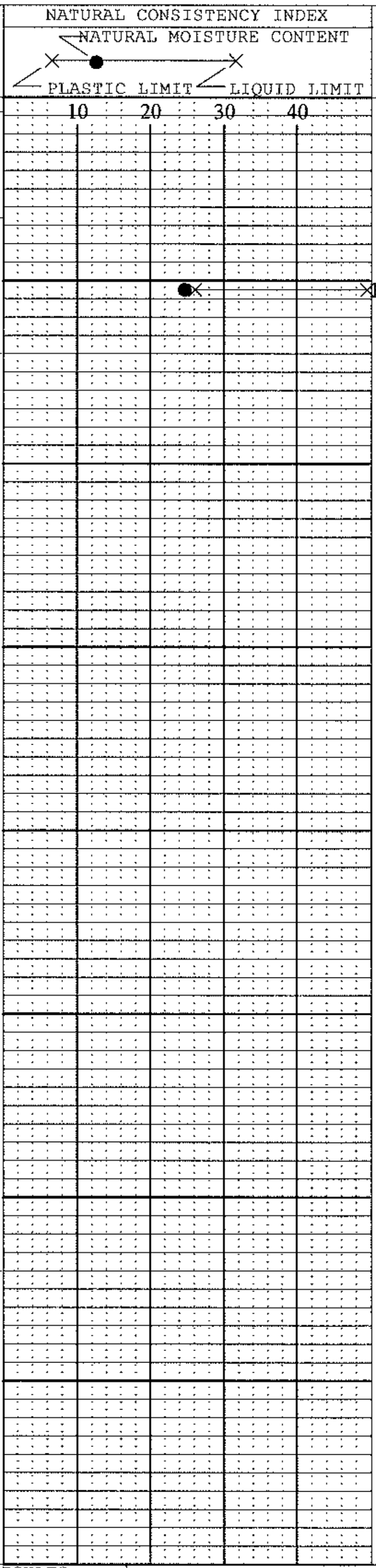
S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **76.8** DATE: **3/27/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
76.4	0						ROOTMAT - 5 INCHES	
		1	■	7/7/5	15	73	FILL: Medium-dense brown fine to coarse sand, some fine to coarse gravel, some silty clay.	
73.5	5	2	■	1/3/2	6	67	FILL: Soft to medium-stiff dark-brown and gray silty clay, some fine to coarse sand, trace fine gravel.	H=0.25-1.0
69.8	10	3	■	9/11/12	30	40	Medium-dense brown fine to coarse gravel, some fine to coarse sand, little silt.	
64.8	15	4	■	12/12/13	32	100	Medium-dense to dense brown fine to coarse sand, little to some fine to coarse gravel, trace silt.	
	20	5	■	12/11/9	26	93		
	25	6	■	18/9/7	21	80		
	30	7	■	8/6/8	18	73		
44.8	35	8	■	7/10/11	27	100	Medium-dense brown fine to coarse sand, trace fine gravel, trace silt.	
	40	9	■	10/12/7	24	67		



WATER LEVEL: ▽ 8.5' ▼ 8.2'
WATER NOTE: At Completion
DATE: 3/27/2014 3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

2010 NEW DEFAULT BORING LOG-W/ N60

-CONTINUED-

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LOG OF BORING NO. SB-3
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **76.8** DATE: **3/27/14**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (10 20 30 40)	TEST RESULTS
	40						Medium-dense brown fine to coarse sand, trace fine gravel, trace silt. (continued)		
		10	■	6/8/10	23	47			
	45								
		11	■	7/9/8	22	33			
26.8	50								
	55								
	60								
	65								
	70								
	75								
	80								

- USGS 926.9'.
- Encountered water at 9.0'.
- Placed temporary slotted PVC in boring for extended water level monitoring.

- 3/31/14 water 922.5' - 4.4' below surface
- 4/09/14 water 924.9' - 2.0' below surface
- 4/11/14 water 923.4' - 3.5' below surface

2010 NEW DEFAULT BORING LOG-W/ N60

	∇	▼
WATER LEVEL:	8.5'	8.2'
WATER NOTE:	At Completion	
DATE:	3/27/2014	3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

JOB: 1171-13-059A

LOG OF BORING NO. SB-4
MASSILLON WWTP
MASSILLON, OH

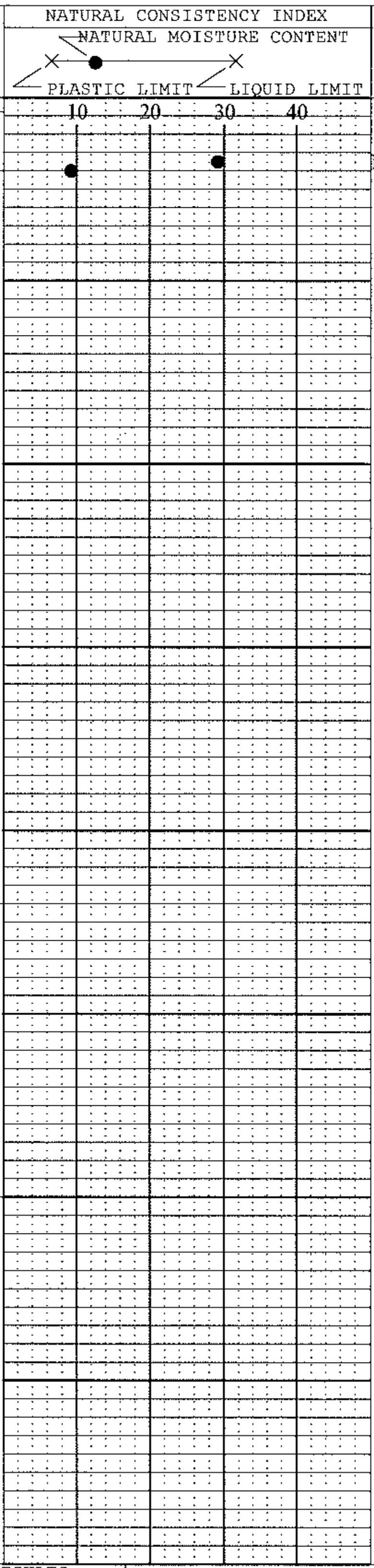
LOCATION: **See Plate 2 of Appendix.** ELEVATION: **76.0** DATE: **3/28/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **30.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
75.6	0						ROOTMAT - 5 INCHES	
74.0		1	■	3/3/4	9	87	POSSIBLE FILL: Stiff to very-stiff brown mixed with gray silty clay, little fine to coarse sand, trace fine gravel.	H=1.5-2.75
							Medium-dense brown fine to coarse sand, little fine to coarse gravel, trace silt.	
	5	2	■	1/3/6	12	73		
		3	■	6/6/7	17	100		
	10							
		4	■	6/8/10	23	80		
	15							
		5	■	9/7/7	18	40		
	20							
54.0							Medium-dense brown and gray fine to coarse sand, little to some fine to coarse gravel, trace silt.	
	25	6	■	4/4/11	19	40		
		7	■	4/4/6	13	53		
46.0	30						- USGS 926.1'. - Encountered water at 8.5'. - Placed temporary slotted PVC in boring for extended water level monitoring. - 4/09/14 water 923.9' - 2.2' below surface - 4/11/14 water 917.9' - 8.2' below surface	
	35							
	40							



WATER LEVEL:	∇ 8.0'	▼ 4.0'	
WATER NOTE:	At Completion		
DATE:	3/28/2014	3/31/2014	

SYMBOLS USED TO INDICATE TEST RESULTS

- G - Gradation
- Q - Uncon Comp
- T - Triax Comp
- C - Consol.

See Separate Curves

- H - Penetrometer (tsf)
- W - Unit Dry Wt (pcf)
- D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77

Last Calibration Date : 2/19/2013

Drill Rig Number : S&ME D50

JOB: 1171-13-059A

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LOG OF BORING NO. SB-5
MASSILLON WWTP
MASSILLON, OH

S&ME

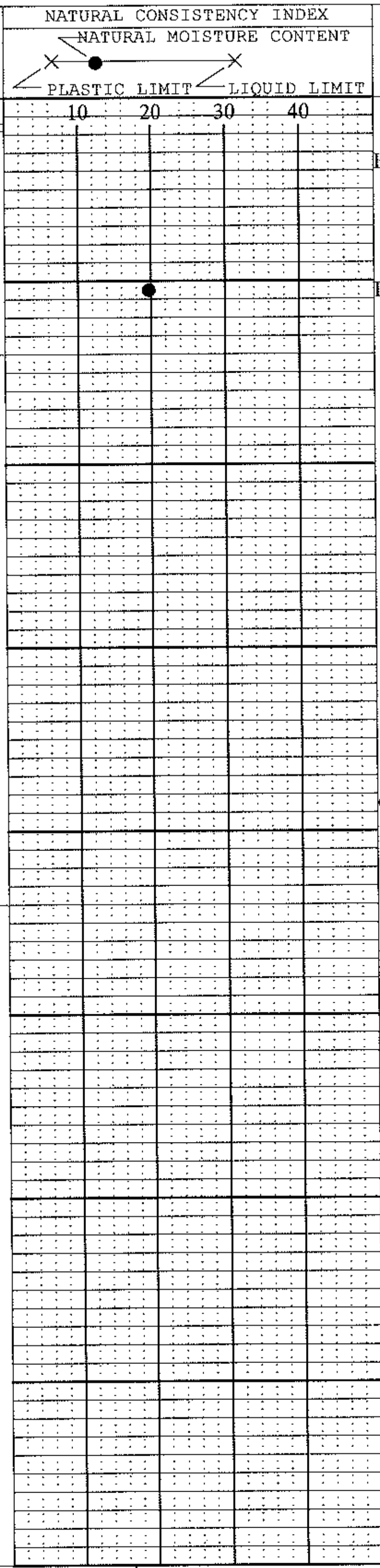
LOCATION: **See Plate 2 of Appendix.** ELEVATION: **75.2** DATE: **3/27/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
74.5	0						ASPHALT - 9 INCHES	
74.3							GRANULAR BASE - 2 INCHES	
		1	■	4/6/6	15	80	FILL: Stiff to very-stiff brown and gray silty clay, some fine to coarse sand, little fine gravel, contains few coal fragments.	H=3.5-3.75
	5	2	■	1/1/2	4	80		H=1.25-3.0
68.2							Medium-dense brown fine to coarse sand, little to some fine to coarse gravel, trace silt.	
	10	3	■	3/4/7	14	73		
	15	4	■	8/8/8	21	93		
	20	5	■	9/9/12	27	47		G
53.2							Medium-dense brown fine to coarse sand, trace to little fine to coarse gravel, trace silt.	
	25	6	■	4/7/9	21	47		
	30	7	■	7/8/9	22	60		
	35	8	■	5/7/12	24	67		
	40	9	■	8/10/10	26	53		



WATER LEVEL: ∇ 4.3' ▼

WATER NOTE: At Completion | Caved at 8.0'

DATE: 3/27/2014 | 3/27/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

-CONTINUED-

LOG OF BORING NO. SB-5
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **75.2** DATE: **3/27/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX NATURAL MOISTURE CONTENT PLASTIC LIMIT — LIQUID LIMIT 10 20 30 40	TEST RESULTS
	40						Medium-dense brown fine to coarse sand, trace to little fine to coarse gravel, trace silt. (continued)		
		10	■	6/6/8	18	40			
	45								
		11	■	10/10/12	28	33			G
25.2	50								
							- USGS 925.3'. - Encountered water at 5.0'. - Boring backfilled immediately after drilling. No long term water level obtained.		
	55								
	60								
	65								
	70								
	75								
	80								

2010 NEW DEFAULT BORING LOG-W/ N60

	▽	▼
WATER LEVEL:	4.3'	
WATER NOTE:	At Completion	Caved at 8.0'
DATE:	3/27/2014	3/27/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

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LOG OF BORING NO. SB-6
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **77.3** DATE: **3/28/14**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX NATURAL MOISTURE CONTENT PLASTIC LIMIT — LIQUID LIMIT 10 20 30 40	TEST RESULTS
77.0	0						ROOTMAT - 4 INCHES		
		1	■	2/6/6	15	33	POSSIBLE FILL: Medium-dense brown fine to coarse sand, trace to little fine to coarse gravel, trace silt.		
	5	2	■	3/5/7	15	40			
70.0							Medium-dense brown fine to coarse gravel, some fine to coarse sand, little silt.		
	10	3	■	4/9/16	32	33			
	15	4	■	7/11/12	30	47			
60.3							Medium-dense brown fine to coarse sand, trace fine gravel, trace silt.		
	20	5	■	5/8/7	19	53			
	25	6	■	6/6/6	15	40			
50.8							Medium-dense brown fine to coarse sand, "and" fine to coarse gravel, trace silt.		
	30	7	■	7/8/9	22	67			G
45.3							Medium-dense brown fine to coarse sand, trace fine to coarse gravel, trace silt.		
	35	8	■	15/10/14	31	60			
	40	9	■	8/10/8	23	47			

WATER LEVEL:	∇ 7.0'	▼
WATER NOTE:	At Completion	Caved at 8.1'
DATE:	3/28/2014	3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
} See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

JOB: 1171-13-059A

-CONTINUED-

LOG OF BORING NO. SB-6
MASSILLON WWTP
MASSILLON, OH

LOCATION: **See Plate 2 of Appendix.** ELEVATION: 77.3 DATE: 3/28/14

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX NATURAL MOISTURE CONTENT PLASTIC LIMIT — LIQUID LIMIT 10 20 30 40	TEST RESULTS
	40						Medium-dense brown fine to coarse sand, trace fine to coarse gravel, trace silt. (continued)		
		10	■	8/9/10	24	80			
	45								
30.7							Medium-dense gray fine to coarse sand, trace fine to coarse gravel, trace silt.		
		11	■	8/10/10	26	40			
27.3	50						- USGS 927.4'. - Encountered water at 7.5'. - Boring backfilled immediately after drilling so no long term water measurements obtained.		
	55								
	60								
	65								
	70								
	75								
	80								

	∇	▼
WATER LEVEL:	7.0'	
WATER NOTE:	At Completion	Caved at 8.1'
DATE:	3/28/2014	3/28/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

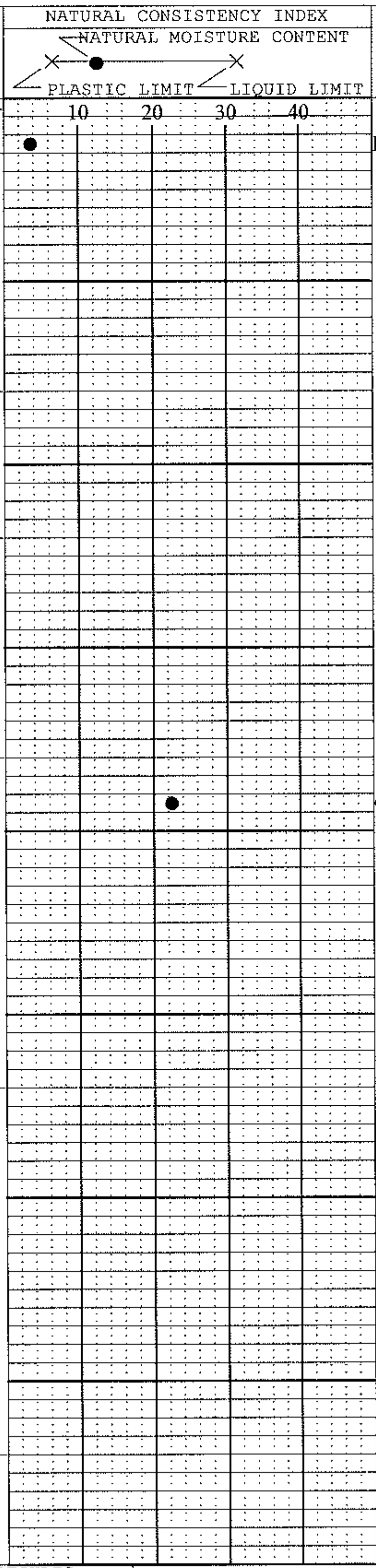
2010 NEW DEFAULT BORING LOG-W/ N60

LOG OF BORING NO. SB-7
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.**
ELEVATION: **79.8**
DATE: **3/31/14**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger**
COMPLETION DEPTH: **50.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
79.5	0						ROOTMAT - 4 INCHES	
78.3		1A 1B	■	5/24/18	54	100 50	FILL: Very-stiff brown, gray and dark-brown silty clay, some fine to coarse sand, little fine to coarse gravel.	H=0.5
	5	2	■	15/21/21	54	100	FILL: Very-dense brown fine to coarse gravel, some to "and" fine to coarse sand, trace to little silt.	
71.8	10	3 2S	■	2/3/8 3	14	100	POSSIBLE FILL: Medium-dense brown fine to coarse gravel, "and" fine to coarse sand, little silt.	
67.8	15	4	■	9/23/23	59	100	Very-dense brown fine to coarse gravel, some fine to coarse sand, trace silt.	
61.8	20	5	■	19/20/16	46	100	Medium-dense to dense brown fine to medium sand, trace coarse sand, trace fine gravel, trace silt, trace clay.	G
	25	6	■	4/8/9	22	100		
52.8	30	7	■	4/5/7	15	100	Medium-dense brown fine to coarse sand, some fine to coarse gravel, trace silt.	
	35	8	■	12/9/11	26	100		
42.8	40	9	■	5/6/6	15	100	Medium-dense brown fine to coarse sand, trace fine gravel, trace silt.	



2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ 12.0'
WATER NOTE: Inside HSA
DATE: 3/31/2014

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

-CONTINUED-

LOG OF BORING NO. SB-7
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **79.8** DATE: **3/31/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N₆₀	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX NATURAL MOISTURE CONTENT PLASTIC LIMIT — LIQUID LIMIT 10 20 30 40	TEST RESULTS
	40						Medium-dense brown fine to coarse sand, trace fine gravel, trace silt. (contains)		
		10	■	7/11/12	30	100			
	45								
		11	■	5/10/14	31	67			
29.8	50								
							- USGS 929.9'. - Encountered water at 7.3'. - Added water at 20 feet to minimize sand heave. - Boring backfilled immediately after drilling so no long term water levels obtained.		
	55								
	60								
	65								
	70								
	75								
	80								

2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ∇ 12.0' ▼

WATER NOTE: Inside HSA

DATE: 3/31/2014

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77

Last Calibration Date : 2/19/2013

Drill Rig Number : S&ME D50

JOB: 1171-13-059A

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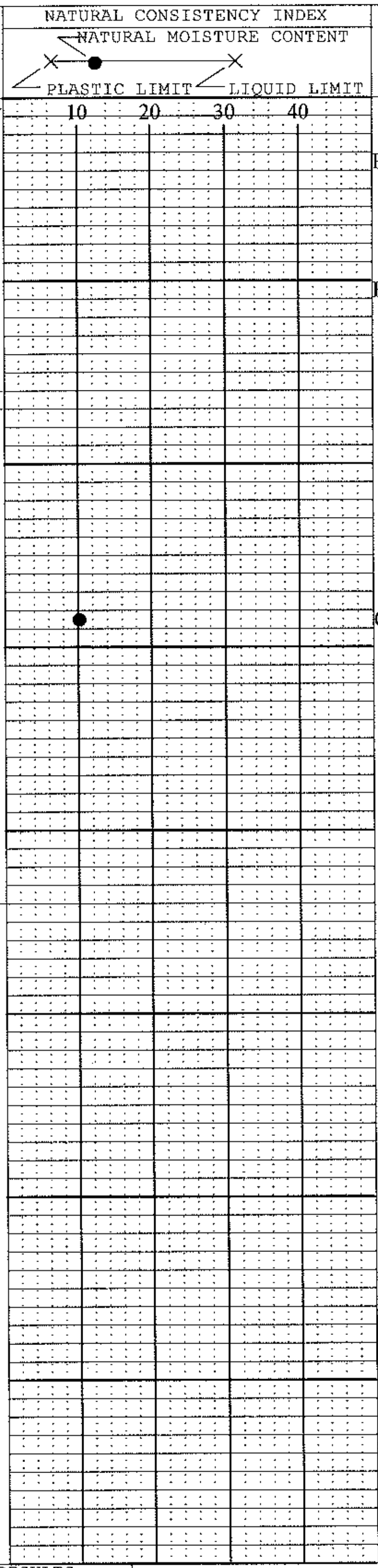
LOG OF BORING NO. SB-8
MASSILLON WWTP
MASSILLON, OH

S&ME

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **82.8** DATE: **3/31/14**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
82.5	0					ASPHALT - 3 INCHES	
		1	4/6/7	17	100	FILL: Very-stiff dark-brown and gray silty clay, some fine to coarse sand, little to some fine to coarse gravel.	H=2.0-4.0
	5	2	5/6/8	18	100		H=2.25
74.8						FILL: Medium-dense brown fine to coarse gravel, some fine to coarse sand, little silt, few brick fragments.	
74.3	10	3	6/6/5	14	67	Medium-dense brown fine to coarse sand, some fine to coarse gravel, trace silt, trace clay, contains zones of predominately gravel.	
	15	4	6/6/8	18	67		G
	20	5	3/10/10	26	67		
60.8						Dense brown fine to coarse sand, trace fine to coarse gravel, trace silt, trace clay.	
	25	6	9/10/14	31	100		
	30	7	10/12/12	31	100		
	35	8	7/9/14	30	100		
	40	9	9/11/14	32	100		



WATER LEVEL: ∇ ▼
WATER NOTE:
DATE:

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77
Last Calibration Date : 2/19/2013
Drill Rig Number : S&ME D50

JOB: 1171-13-059A

-CONTINUED-

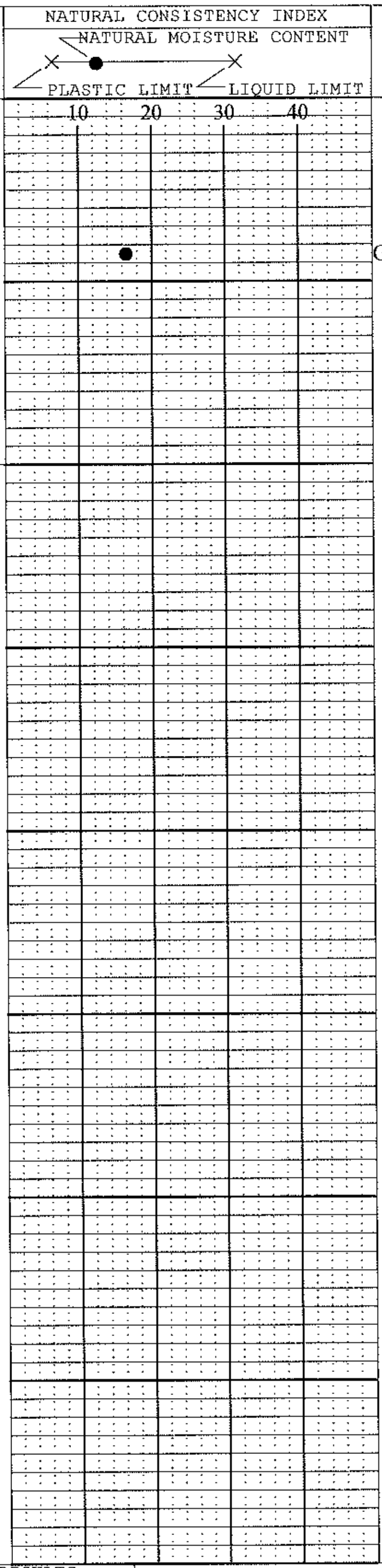
LOG OF BORING NO. SB-8
MASSILLON WWTP
MASSILLON, OH

LOCATION: **See Plate 2 of Appendix.** ELEVATION: **82.8** DATE: **3/31/14**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **50.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	40						Dense brown fine to coarse sand, trace fine to coarse gravel, trace silt, trace clay. (continued)	
		10	■	7/9/14	30	67		G
	45							
		11	■	7/12/14	33	100		
32.8	50							
	55						- USGS 932.9' - Encountered water at 8.5'. - Added water at 20 feet to minimize sand heave. - Boring backfilled immediately after drilling so no long term water levels obtained.	
	60							
	65							
	70							
	75							
	80							



WATER LEVEL: ∇ ▼

WATER NOTE:

DATE:

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.77

Last Calibration Date : 2/19/2013

Drill Rig Number : S&ME D50

2010 NEW DEFAULT BORING LOG-W/ N60

JOB: 1171-13-059A

SUMMARY OF LABORATORY TEST RESULTS

BORING	G'int Id.	MC	LL	PL	PI	GRADATION			COMPACTION		TRIAXIAL			DIRECT SHEAR			UNCONFIN COMPRESS	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY				RELATIVE DENSITY	LOI	ROCK CORE	SHELBY TUBE	pH
						sieve	Hydrometer short	Hydrometer long	standard	modified	uncons. undrain	consolid undrain w/pores	drained	drained	undrain	residual						cohesive	non/cohes	rigid wall	flexible wall					
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES														PCF						%	%			
SB-1	1.75	13.4																												
SB-1	9.25	54.1																									16.0			
SB-2	1.75	15.7	32	19	13																									
SB-2	5.25	7.9	22	16	6																									
SB-2	9.25	18.2																												
SB-2	14.25	7.7																									1.6			
SB-3	5.25	24.7	49	26	23																									
SB-4	1.75	29.2																												
SB-4	2.00	9.2																												
SB-5	5.25	19.7																									3.1			
SB-5	19.25					*																								
SB-5	49.25					*																								
SB-6	29.25					*																								
SB-7	1.25	3.6																												
SB-7	19.25	22.5				*	*																							
SB-8	14.25	10.2				*	*																							
SB-8	44.25	16.5				*	*																							

SUM REG

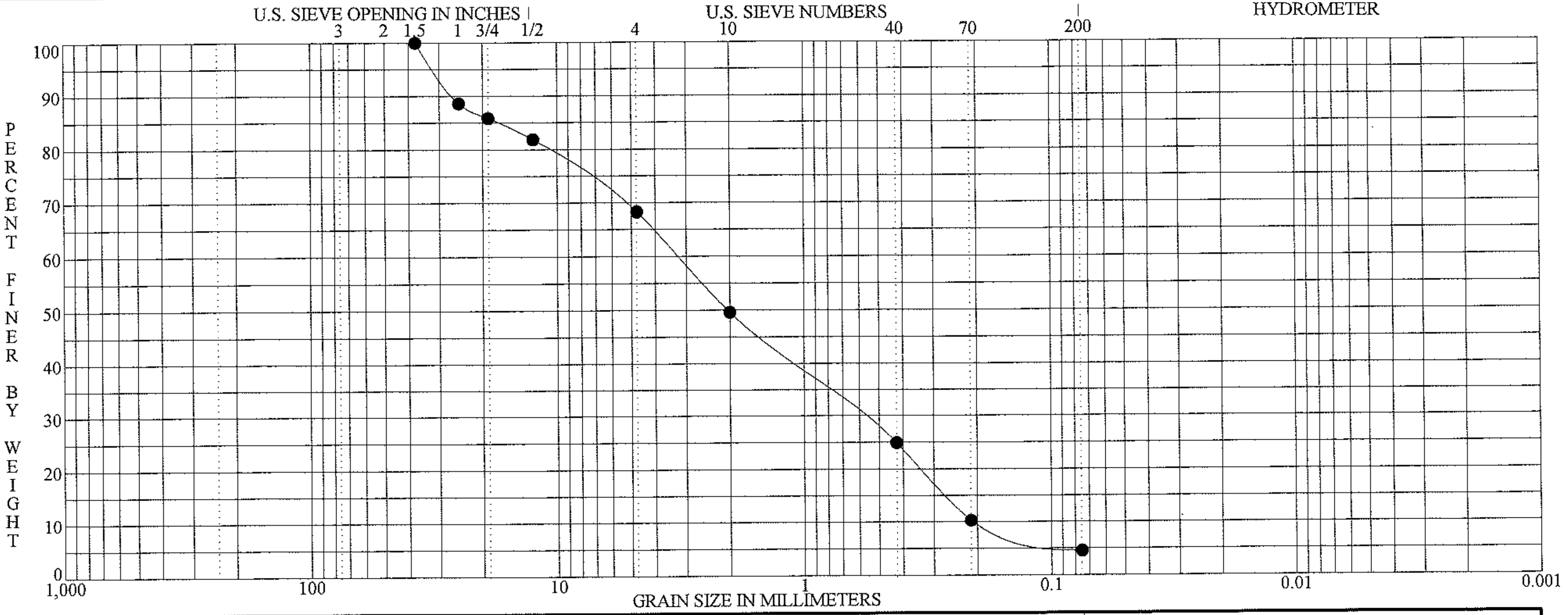
S&ME

TESTING SUMMARY - STANDARD

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A DATE 6/5/14

GRN-REG W/ASTM DESC.

S&ME



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**SB-5 S-5 18.5' to 19.2'**	**Brown fine to coarse sand, some fine to coarse gravel, trace silt.**					**0.522**	**15.978**
		POORLY GRADED SAND with GRAVEL SP						

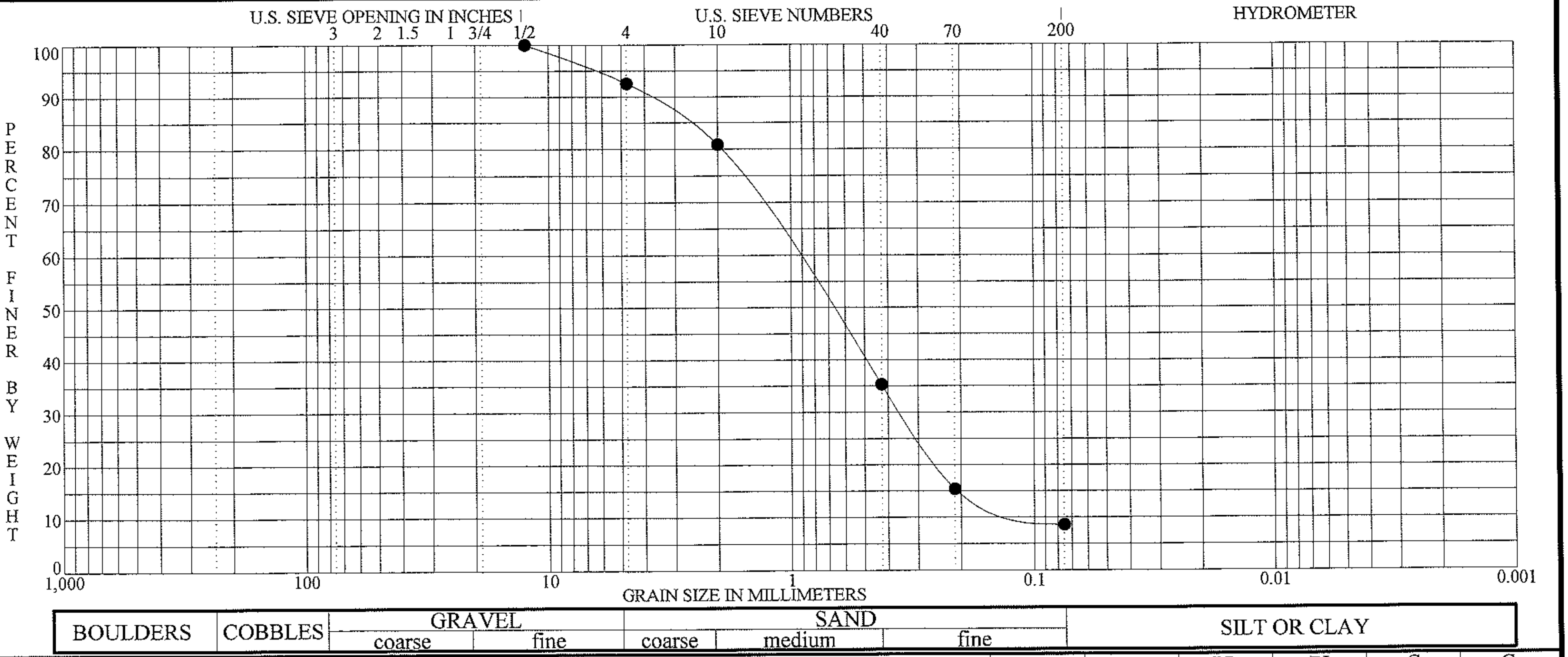
	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-5 S-5 18.5' to 19.2'**	**37.5000**	**31.4012**	**3.2377**	**2.0369**	**0.2026**	**31.7**	**63.7**	**4.5**	

ASTM D422

GRADATION CURVE

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A **DATE** 6/5/14

GRN-REG W/ASTM DESC.



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**SB-5 S-11 48.5' to 49.0'**	**Brown fine to coarse sand, trace fine gravel, trace silt.**					**1.358**	**10.523**

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-5 S-11 48.5' to 49.0'**	**12.5000**	**6.5409**	**0.9843**	**0.7009**	**0.0935**	**7.5**	**84.0**	**8.6**	

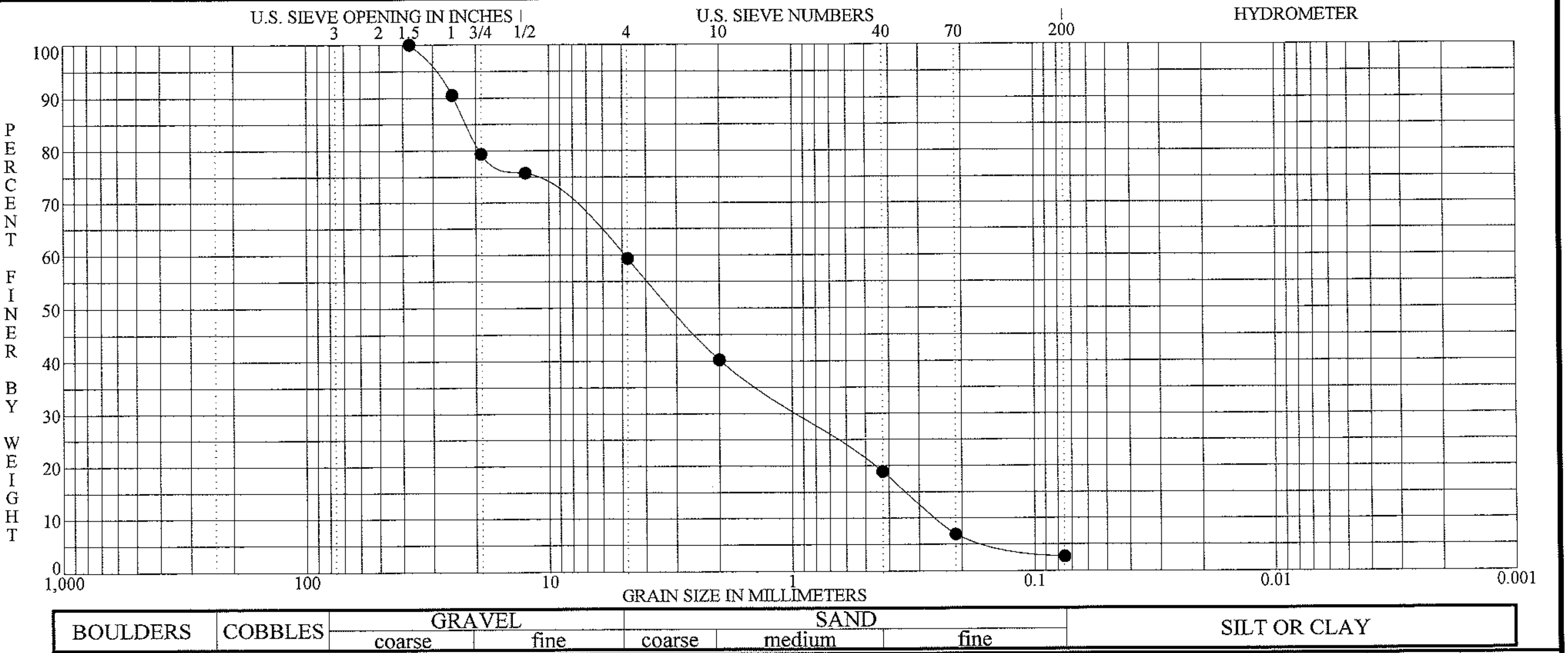
ASTM D422

GRADATION CURVE

PROJECT **MASSILLON WWTP**
LOCATION **MASSILLON, OH**
JOB NO. **1171-13-059A** **DATE** **6/5/14**

PLATE 20

S&ME



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	SB-6 S-7 28.5' to 29.5'	**Brown fine to coarse sand, "and" fine to coarse gravel, trace silt.** **POORLY GRADED SAND with GRAVEL SP**					**0.725**	**19.376**

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	SB-6 S-7 28.5' to 29.5'	37.5000	30.2770	4.9198	3.1067	0.2539	40.6	56.7	2.7	

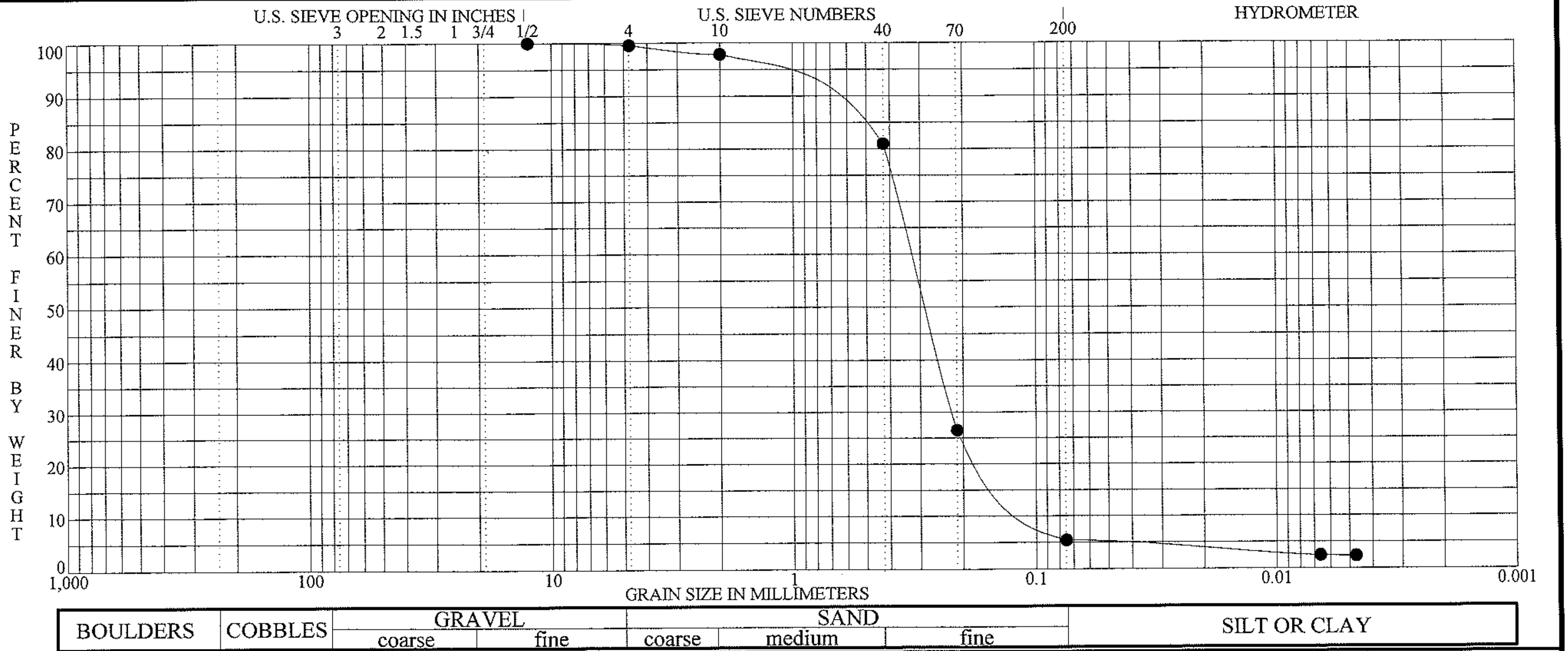
ASTM D422

GRADATION CURVE

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A
DATE 6/5/14

GRN-REG W/ASTM DESC.

S&ME



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	SB-7 S-5 18.5' to 20.0'	**Brown fine to medium sand, trace coarse sand, trace fine gravel, trace silt, trace clay.**	22				1.606	3.456

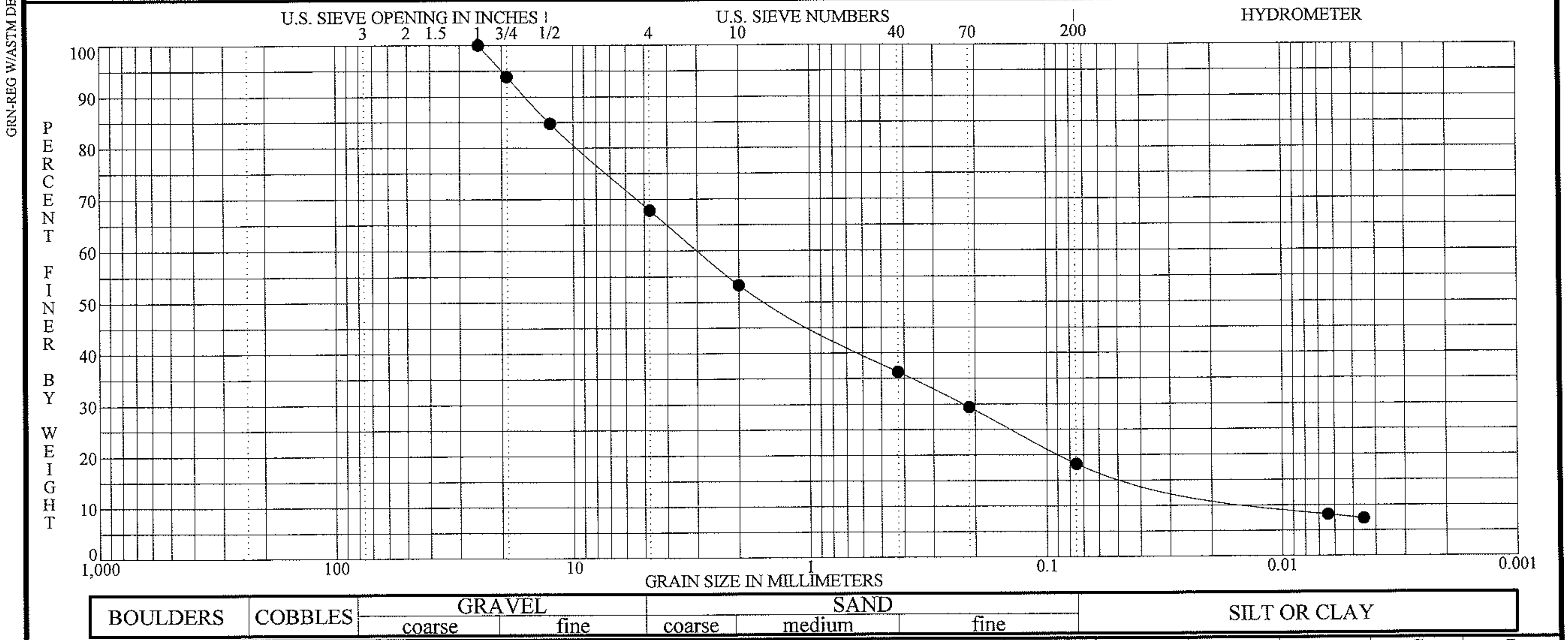
	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	SB-7 S-5 18.5' to 20.0'	12.5000	1.5439	0.3251	0.2861	0.0941	0.5	94.1	3.1	2.3

ASTM D422

GRADATION CURVE

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A
DATE 6/5/14

GRN-REG W/ASTM DESC.



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**SB-8 S-4 13.5' to 14.5'**	**Brown fine to coarse sand, some fine to coarse gravel, little silt, trace clay.**	**10**				**1.686**	**294.490**

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-8 S-4 13.5' to 14.5'**	**25.0000**	**19.9777**	**2.9755**	**1.4779**	**0.0101**	**32.2**	**49.6**	**10.6**	**7.6**

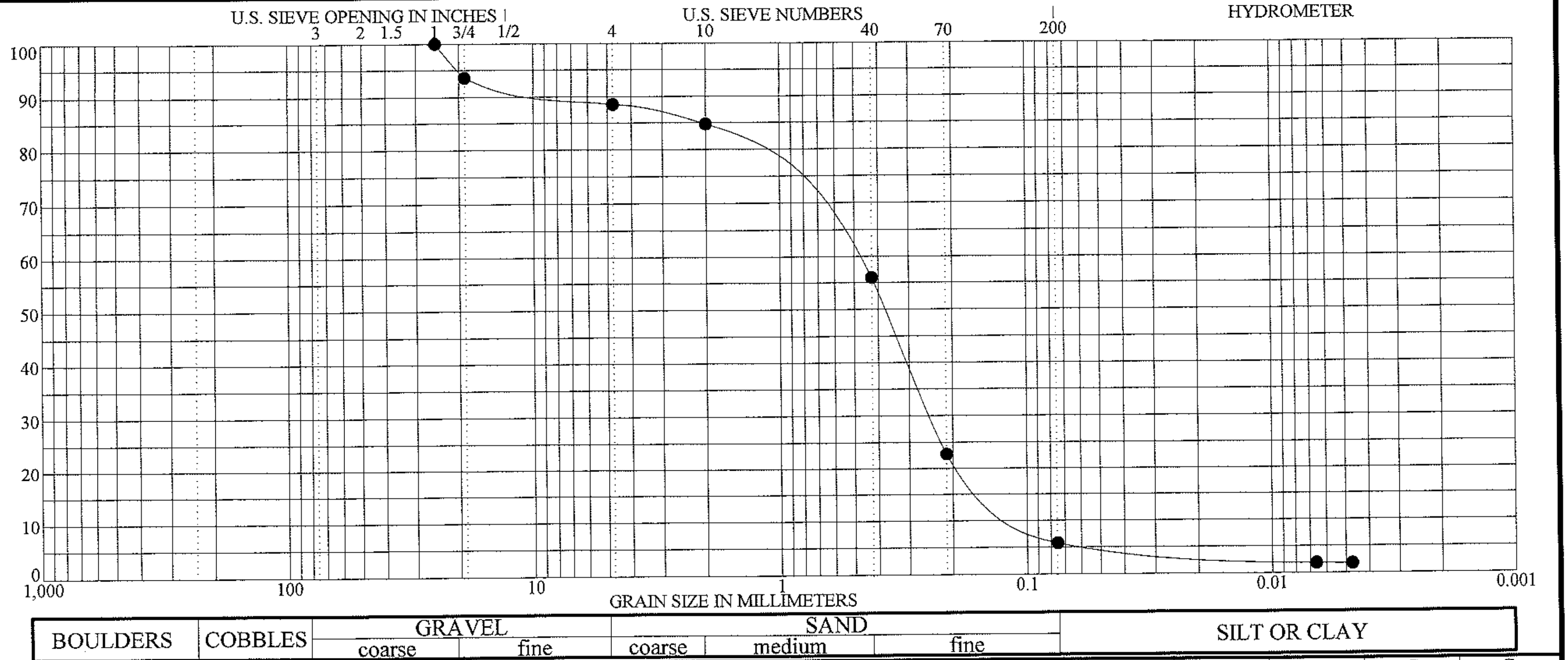
ASTM D422

GRADATION CURVE

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A
DATE 6/5/14

S&ME

GRN-REG W/ASTM DESC.



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	SB-8 S-10 48.5' to 50.0'	**Brown fine to coarse sand, little fine to coarse gravel, trace silt, trace clay.**	17				1.186	5.435

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	SB-8 S-10 48.5' to 50.0'	25.0000	20.2359	0.5283	0.3752	0.0972	11.5	82.8	4.0	1.7

ASTM D422

GRADATION CURVE

PROJECT MASSILLON WWTP
LOCATION MASSILLON, OH
JOB NO. 1171-13-059A
DATE 6/5/14

Tuscarawas River at Massillon Ohio WWTP

Date	USGS Gauge Datum	River Stage (12:00) Depth (ft.)	USGS River Elev.	Plant River Elev.
3/27/2014	915.06	1.6	916.66	66.57
3/28/2014	915.06	1.86	916.92	66.83
3/31/2014	915.06	5.78	920.84	70.75

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Data Category: Current Conditions ▾   Geographic Area: Ohio ▾   GO

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- **May 27, 2014** - There are problems accessing NWIS Mapper. We will have the connections fixed soon.
- Read the Mobile Site Tutorial Try it (http://m.waterdata.usgs.gov) from your mobile device!
- Full News

Click to hide state-specific text
Ohio

USGS 03117000 Tuscarawas River at Massillon OH

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site   Time-series: Current/Historical Observations ▾   GO

Click to hidestation-specific text

Station operated in cooperation with the Ohio Water Development Authority.

```
03117000 Tuscarawas River at Massillon, OH
LOCATION.--Lat 40°46'13", long 81°31'27", Stark County, OH, Hydrologic
    Unit 05040001, on left bank at sewage-treatment works, 0.7 mi south of Massillon,
    and 3 mi downstream from Newman Creek.
DRAINAGE AREA.--518 mi².
PERIOD OF RECORD.--October 1937 to current year. Prior to April 1938 monthly discharge
    only, published in WSP 1305.
REVISED RECORDS.--WSP 1907: Drainage area.
REMARKS.--Some water diverted through the Portage Lakes into the Ohio Canal at Long
    Lake, 28 mi and 3 mi south of Akron. Part of the diverted water flows through the
    Ohio Canal into the Cuyahoga River basin. Flow affected by industrial plants upstream
    from station and supplemented at times by diversion from Nimisila Reservoir, capacity,
    6,500 acre-ft, since 1939. Water-quality data formerly collected at this site.
```

Boating safety tips
This station managed by the New Philadelphia Field Office.

Available Parameters	Available Period
☐ All 2 Available Parameters for this site	
☑ 00065 Gage height	2014-01-28 2014-05-28
☑ 00060 Discharge	2007-10-01 2014-05-28

Output format
○ Graph
○ Graph w/ stats
○ Graph w/o stats
● Graph w/ (up to 3) parms
○ Table
○ Tab-separated

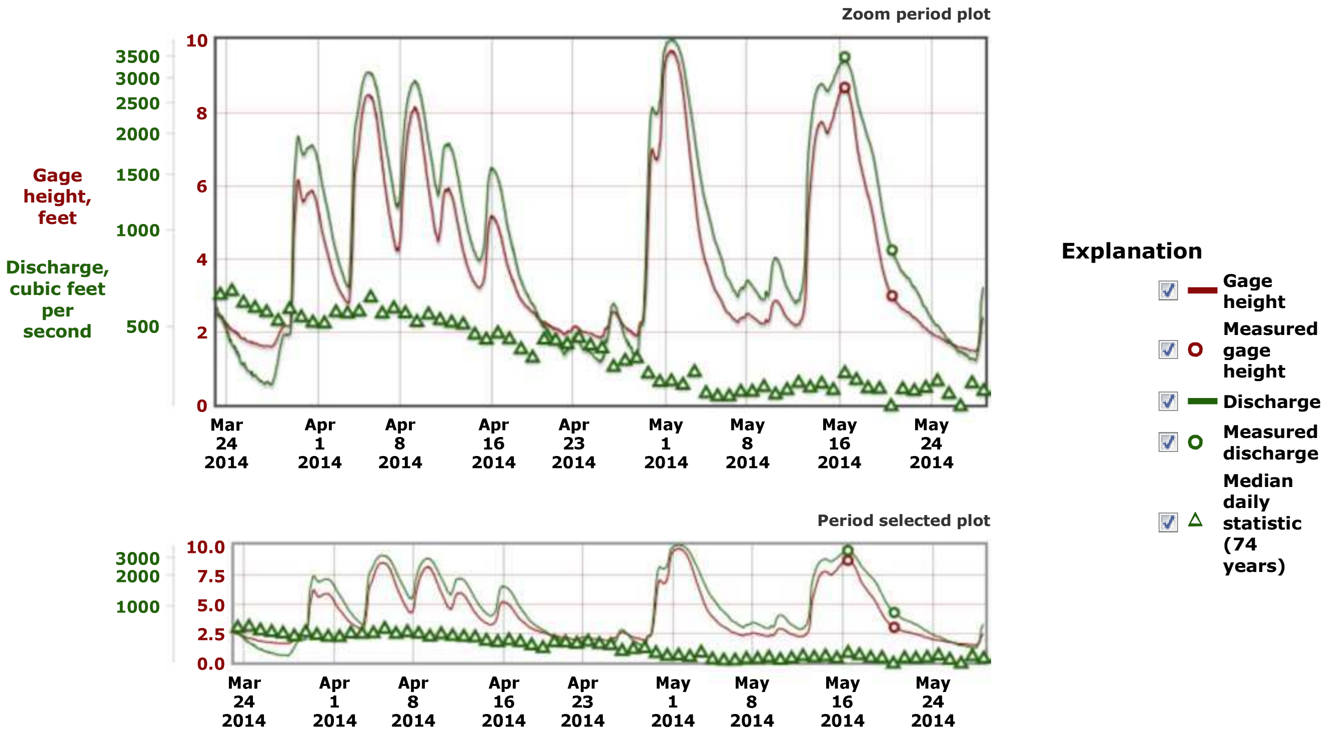
Days (66)   **Summary of all available data for this site**   GO
Instantaneous-data availability statement
-- or --
Begin date
2014-03-23

PLATE 26

End date

2014-05-28

USGS 03117000 Tuscarawas River at Massillon OH



☐

?

Enable tooltip

☐

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Enable approval and provisional periods

Tip: To reset zoom period to period selected, double left-click in the "Period selected" plot.
Tip: To zoom to a shorter period, left-click and drag over the period of interest in either graph.

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U.S. Department of the Interior | U.S. Geological Survey
Title: USGS Current Conditions for Ohio
URL: http://waterdata.usgs.gov/oh/nwis/uv?

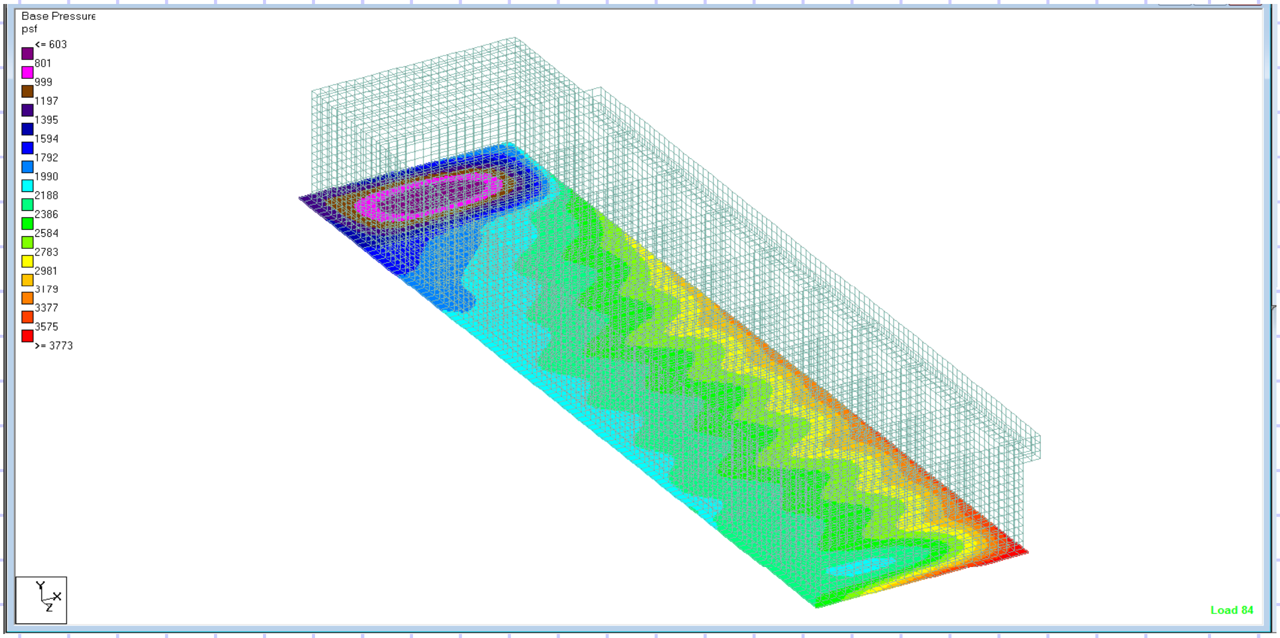
Page Contact Information: Ohio Water Data Support Team
Page Last Modified: 2014-05-28 12:19:52 EDT
2.78 2.5 sdww02

PLATE 27

Client Name/Number: City of Massillon
Project Number/Name: 51633 / Massillon WWTP Upgrade
Project Location: Massillon, OH
File Path:

Description of Work: Anoxic-Anerobic Tank Base Pressure

Engineer's Name: TRL
Date: 5/30/2014
Checker's Name: CHL
Date:
Page Number/Pages: 1



Notes:

1. Load Combination Shown: 1.0D + 1.0F
2. Base pressure shown above does not include live loads, soil loads, or equipment loads.

APPENDIX B

EXPLANATION OF NOTES ON BORING LOGS

▮ Sample recovered. ▯ Sample not recovered.

9/9/9 - The number of blows 9/9/9 of a 140-pound hammer falling 30 inches to drive a "standard" split-barrel sampler (1-3/8" I.D., 2" O.D.) for each 6 inches of penetration.

S - Split-barrel sampler - 2" O.D. - (standard)

2S - Split-barrel sampler - 2-1/2" O.D.

3S - Split-barrel sampler - 3" O.D.

9/9/9
2S - The number of blows 9/9/9 to drive a split-barrel sampler other than the "standard" split-barrel sampler.

P - Shelby tube sampler - 3" O.D.

R - Refusal - sampler could not be advanced further.

30-2" - Number of blows (30) to drive a "standard" split-barrel sampler a certain number of inches (2).

P/400 - Hydraulic pressure (400) in pounds per square inch to push a Shelby tube (P) for the last foot of penetration.

P/400
10"R - Sampler (P) pushed for a certain number of inches (10) and then could not be advanced further (R) hydraulically.

P/D - Sampler (P) advanced by the weight of the drill rods (D).

S/H - Sampler (S) advanced by the weight of the drill rods and 140-pound hammer.

Pist. - Piston sampler - using 3" O.D. Shelby tube.

NX - Rock core attempted with NX double tube core barrel. Approximate diameter of core 2-1/8 inches.

BX - Rock core attempted with BX core barrel. Approximate diameter of core 1-5/8 inches.

AX - Rock core attempted with AX core barrel. Approximate diameter of core 1-1/8 inches.

50% - Percentage (50) of rock core recovered.

Definitions of Adjectives Used in Soil Descriptions

Adjective	Per Cent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
"and"	36 to 50

LOG OF BORING NO. B-1

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch O.D. Split-barrel
2¼-inch O.D. Split-barrel

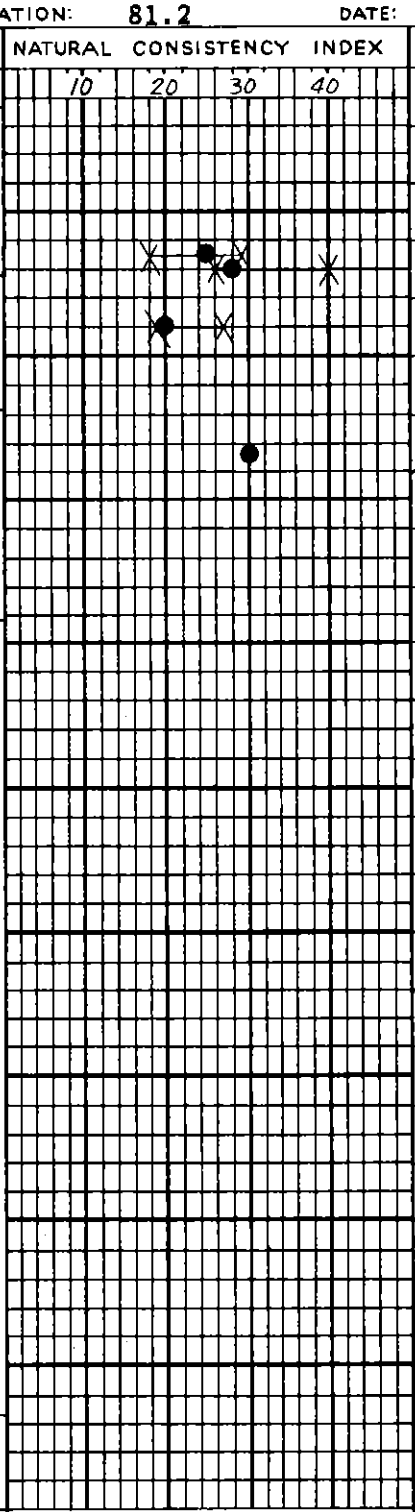
LOCATION: See Plate 1

ELEVATION: 81.2

DATE: 1/18/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0			Topsoil = 8"	
	1A	1/2/4	Firm dark-brown silty clay, little fine sand, ~~trace medium to coarse sand~~, little fine to coarse gravel. - @ 3.3' to 3.6', firm dark gray and brown organic clayey silt.	H=0.5-0.7 H=0.7
5	1B 1C		Stiff brown mottled with gray silty clay, some fine to medium sand, trace coarse sand to fine gravel.	H=1.5-1.7
	2	3/4/4	Stiff to very-stiff brown mottled with gray and black silty clay, little fine to coarse sand, trace fine gravel, with few thin seams of organic silty clay.	H=1.0-2.2
10	3	6/8/8	Medium-dense brown fine to coarse sand, some to "and" fine to coarse gravel, little clayey silt. - @ 15.2' to 15.5', cobble	
15	4	18/39/26		
20	5	12/14/15		
25	6	10/9/11	Medium-dense brown fine to coarse sand, little fine to coarse gravel, little silt.	

Used 3-1/8" tricone bit, 0.0' to 23.5'.
Used bentonitic drilling fluid, 0.0' to 23.5'.

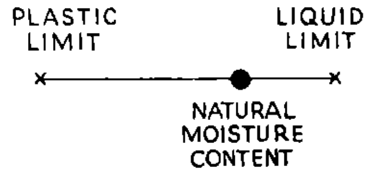


COMPLETION DEPTH: 25.0'

RECORD OF WATER LEVEL READINGS

DATE: 1/18

READING: 4.0'



W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1 B1

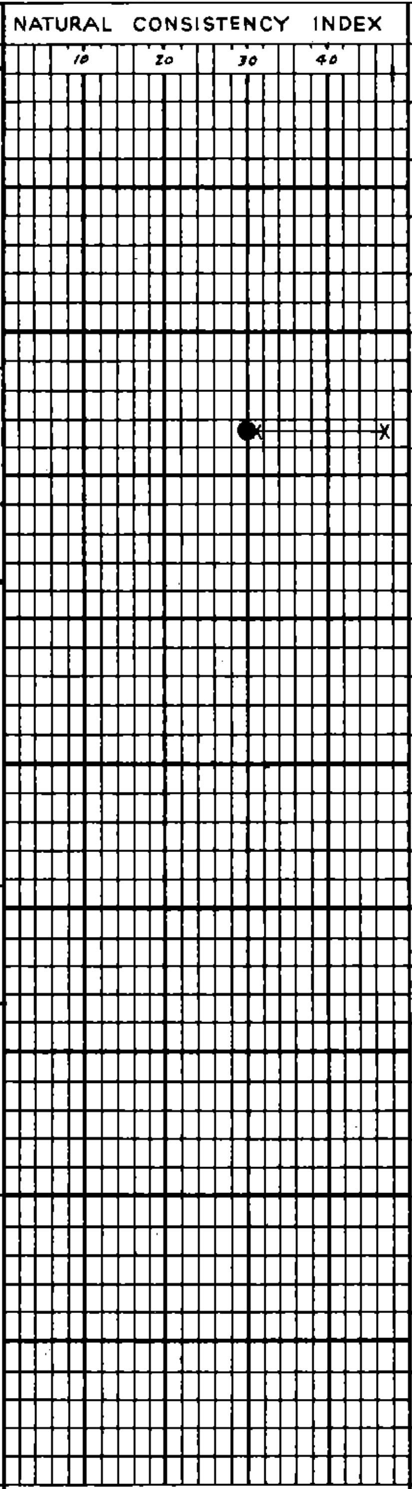
JOB: 1516

PLATE 6

LOG OF BORING NO. B-2
ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch O.D. Split-barrel
3-inch O.D. Shelby Tube
LOCATION: See Plate 1
ELEVATION: 80.4
DATE: 1/18/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0	1A	2/7/11	Topsoil = 4"	H=4.5+
	1B		Loose to medium-dense brown fine to coarse gravel "and" fine to coarse sand, little silty clay. - @ 0.3' to 0.6', cobble.	
	2	3/3/5		G
5	3	P/500	Stiff dk-brown mottled w/dk-gray organic clayey silt w/thin ¼" to ½" seams of brown silty clay, trace fine to coarse sand.	H=1.2-2.0
	4A	P/400		H=1.0 LL=133% PL=87%
	4B		Medium-dense gray and brown fine to medium sand "and" clayey silt, trace coarse sand to fine gravel.	NMC=64%
	5A	4/5/7		H=1.0-1.2
10	5B		Medium-dense brown fine to coarse gravel, some fine to coarse sand, "and" clayey silt.	
15	6	37/55/40	Dense brown and gray fine to coarse gravel "and" fine to coarse sand, little clayey silt, many cobbles.	
	7	10/18/18	Dense brown fine to coarse sand, some fine to coarse gravel, trace clayey silt.	
20			Used 4-3/4" tricone bit, 0.0' to 6.0'; 3-1/8" tricone bit, 6.0' to 18.5'. Used water, 0.0' to 10.5' and bentonitic drilling fluid, 10.5' to 20.0'. Used 5' of 4" O.D. casing.	
25				

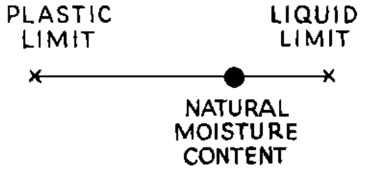


COMPLETION DEPTH: 20.0'

RECORD OF WATER LEVEL READINGS

DATE: 1/18/72

READING: 2.6'



W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

JOB: 1516

FORM: F-1 B-2

LOG OF BORING NO. B-3

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

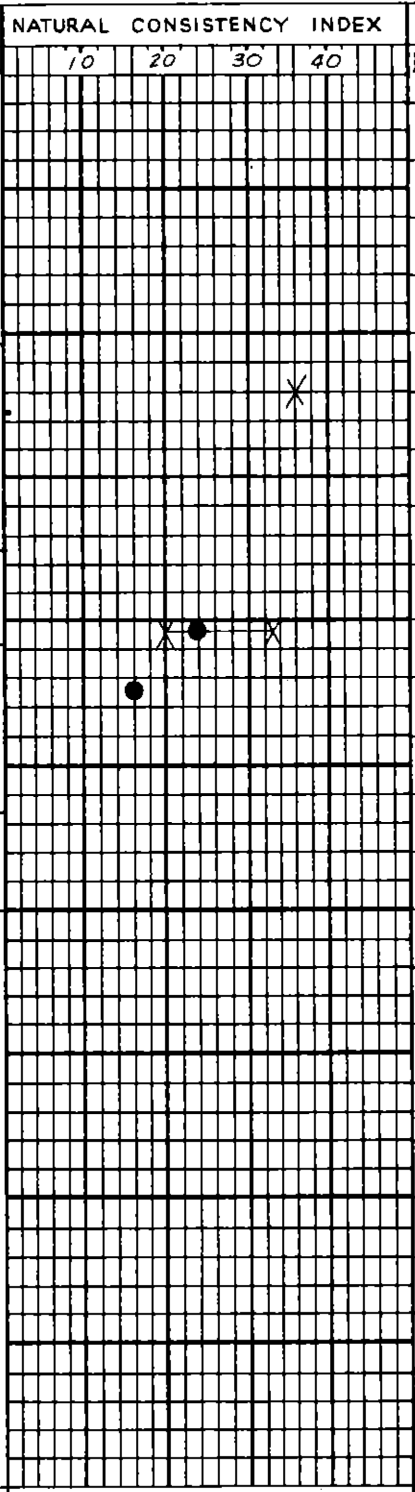
TYPE: 2-inch and 2½-inch O.D. Split-barrel
3-inch O.D. Shelby Tube

LOCATION: See Plate 1

ELEVATION: 80.2

DATE: 1/18/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0	1A 1B	1/5/5	Topsoil = 5" Loose to medium-dense brown fine to coarse sand, little fine to coarse gravel, little silty clay.	H=4.5+
		4/3/3		
5		25 6-6"		
	2A 2B	P/700	Stiff black organic clayey silt, trace fine to medium sand, few roots.	LL=55% NMC=51% H=1.2-1.7
			Stiff brown mottled with gray silty clay, some fine to medium sand, trace coarse sand to fine gravel, few decayed roots.	
10	3A	1/2/7		H=1.5-2.2
	3B		Stiff brown clayey silt, some fine to coarse sand, little fine to coarse gravel.	H=2.2
	4	37/35/36	Dense brown and gray fine to coarse gravel "and" fine to coarse sand, little clayey silt.	
15			Used 4-3/4" tricone bit, 0.0' to 3.0'; 3-1/8" tricone bit, 3.0' to 13.5'. Used water, 0.0' to 13.5'. Used 13.5' of 4" O.D. casing.	
20				
25				

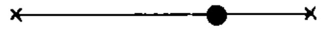


COMPLETION DEPTH: 15.0'

RECORD OF WATER LEVEL READINGS

DATE: 1/18

READING: 4.9'



W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1 B3

JOB: 1516

PLATE 8

LOG OF BORING NO. B-4
ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

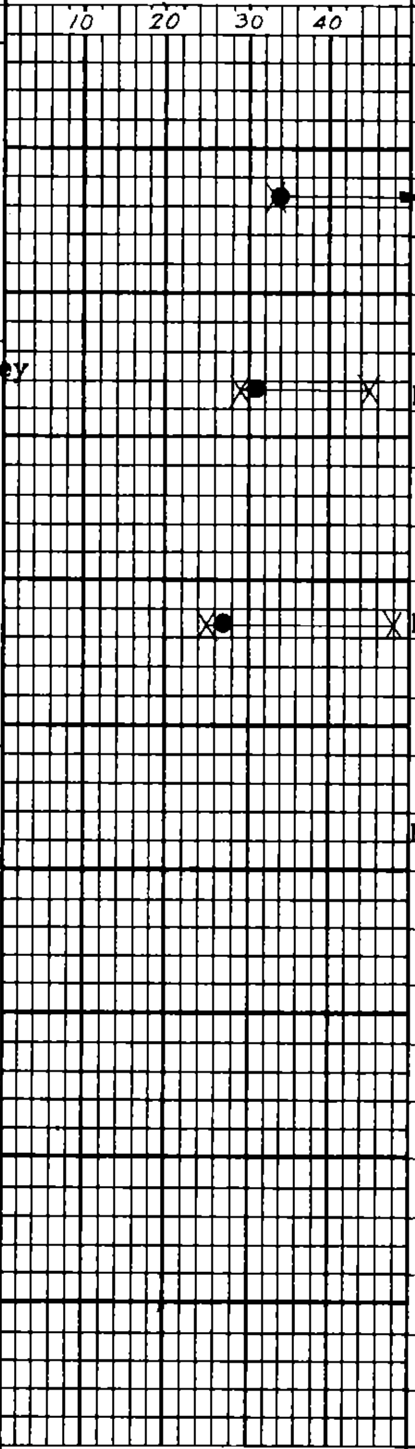
TYPE: 2-inch O.D. Split-barrel LOCATION: See Plate 1

ELEVATION: 81.2 DATE: 1/17/72

DEPTH, FEET	SAMPLE NO.	SAMPLES	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0				Topsoil = 8"	
	1		1/2/2	Firm to stiff dark-gray organic clayey silt intermixed with very-stiff silty clay, little fine sand, trace fine gravel, few roots and decayed wood.	LL=55% H=0.7-1.7
5	2		1/2/2	Firm to stiff dark-gray organic clayey silt, trace fine to coarse sand, trace fine gravel with thin 1/8" to 1/2" seams of dark gray fine to coarse sand.	H=0.7-1.7
10	3		1/3/5		H=1.0
	4		6/8/12	Medium-dense brown fine to coarse sand, "and" clayey silt, some fine to coarse gravel.	H=1.0
15					
20					
25					

Used 4-3/4" tricone bit, 0.0' to 6.0'; 3-1/8" tricone bit, 6.0' to 13.5'.
Used water, 0.0' to 13.5'.
Used 13.5' of 4" O.D. casing.

NATURAL CONSISTENCY INDEX

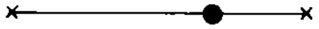


COMPLETION DEPTH: 15.0'

RECORD OF WATER LEVEL READINGS

DATE: 1/17

READING: 1.8'



W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

JOB: 1536

FORM: F-1 83

LOG OF BORING NO. B-5

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch and 2½-inch O.D. Split-barrel

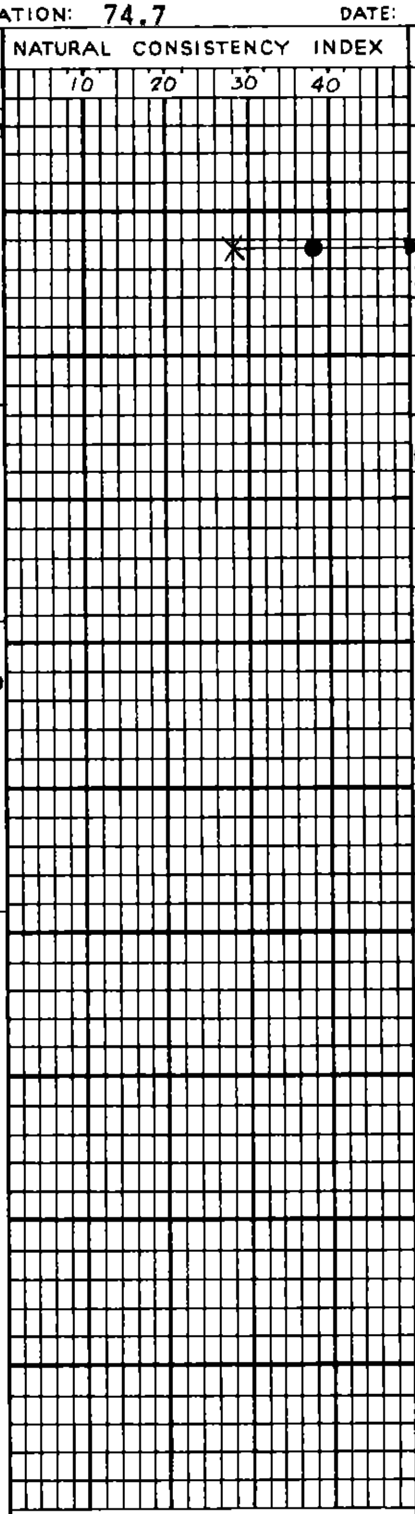
LOCATION: See Plate 1

ELEVATION: 74.7

DATE: 1/13/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0			Topsoil = 8"	
	1	1/2/1	Firm to stiff dark-gray mottled with brown organic silty clay, little fine to coarse sand, trace fine gravel, contains decayed wood pieces and roots. - @ 0.7' to 2.5', many cobbles.	LL=53% H=0.7
5	2	4/8/11	Medium-dense brown and gray fine to coarse sand, some fine to coarse gravel, little clayey silt.	G
10	3A 3B	8/22/27	Dense brown fine sand, trace medium to coarse sand, tr fine gravel, trace silt. - @ 10.8' to 11.0', brown fine to coarse gravel "and" fine to coarse sand, trace silt.	
15	4	10/12/13 25 19-6"	Medium-dense brown and gray fine to coarse sand, some fine to coarse gravel, trace silt. - @ 21.5', cobble.	
20	5	15/13/17 25 14-6"		
25	6	8/8/6 25 11-6"		

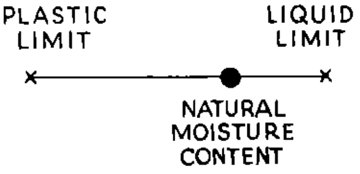
Used 4-3/4" tricone bit, 0.0' to 6.0'; 3-1/8" tricone bit, 6.0' to 23.5'.
Used 23.5' of 4" O.D. casing.
Used water, 0.0' to 25.0'.



COMPLETION DEPTH: 26.0'

RECORD OF WATER LEVEL READINGS

DATE:	1/13	1/14
READING:	13.1'	Caved, dry @ 12.2'



W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1[illegible]

JOB: 1516

LOG OF BORING NO. B-6

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch & 2½-inch O.D. Split-barrel

LOCATION: See Plate 1

ELEVATION: 78.3

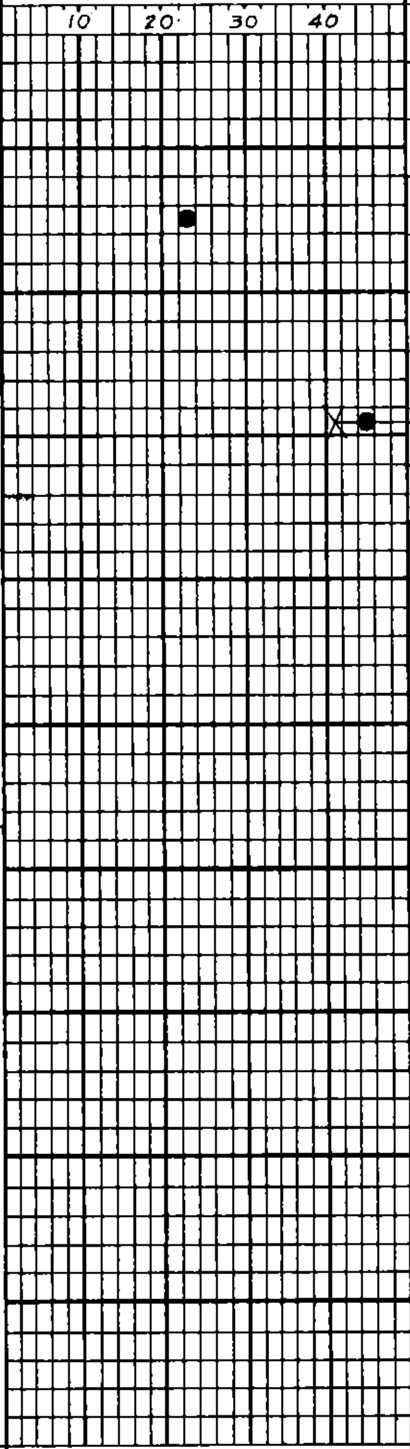
DATE: 1/14/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0			Topsoil = 7"	
			Medium-dense brown fine to coarse gravel, some fine to coarse sand, some silty clay, many cobbles and boulders.	
	1	3/4/11	Stiff to very-stiff dark-gray to black mottled with brown organic silty clay intermixed with clayey silt, little fine to coarse sand, trace fine to coarse gravel.	H=1.3
5				H=2.2
	2A	4/5/6	- @ 6.0' to 6.2', very-stiff brown silty clay, some fine to medium sand.	H=1.2-2.9
	2B *			LL=74%
10	3	3/5/6 25 12-6"	Medium-dense brown fine to coarse sand, "and" fine to coarse gravel, little clayey silt.	G
15	4	9/26/22	Medium-dense brown fine to coarse sand, some fine to coarse gravel, trace silt.	
20	5	13/12/19		
	6	8/13/12		
25				

Used 3-1/8" tricone bit, 0.0' to 23.5'.
Used water, 0.0' to 4.5'; used bentonitic drilling fluid, 4.5' to 23.5'.
Used 3.0' of 4" O.D. casing.

*Sample intermixed with drilling fluid.

NATURAL CONSISTENCY INDEX



COMPLETION DEPTH: 25.0'

RECORD OF WATER LEVEL READINGS

DATE:	1/14	1/17
READING:	12.3'	Caved, dry @ 5.8'

PLASTIC LIMIT ×———●———× LIQUID LIMIT

NATURAL MOISTURE CONTENT

W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1 86   JOB: 1516

LOG OF BORING NO. B-7

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch & 2½-inch O.D.
O Split-barrel
3-inch O. D. Shelby Tube

LOCATION: See Plate 1

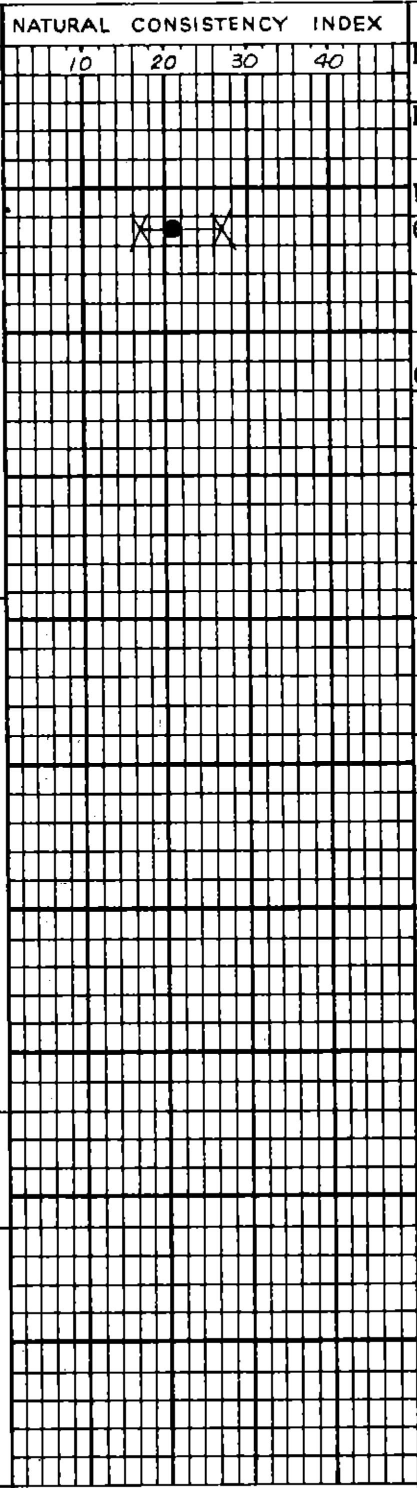
ELEVATION: 74.9

DATE: 1/13/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0	1A	1/2/5	Topsoil = 7"	H=0.5-0.7
	1B		Stiff brown mottled with gray clayey silt, some fine sand, trace medium sand to fine gravel, contains decayed roots and desiccation cracks.	H=3.0 W=105 Q=0.64
	2A	P/900		
	2B		Medium-dense brown and gray fine to coarse sand "and" fine to coarse gravel, trace clayey silt, few cobbles.	
5	3	4/6/11		G
10	4	29/27/22	Dense brown fine to coarse sand, some to "and" fine to coarse gravel, trace clayey silt.	
15	5	13/14/16		
	6	9/8/10	Medium-dense brown fine sand, trace medium to coarse sand, trace fine gravel, trace silt.	
20		25 14-6"		
25				

Used 4-3/4" tricone bit, 0.0' to 5.0'; 3-1/8" tricone bit, 5.0' to 18.5'.
Used water, 0.0' to 20.5'.
Used 18.5' of 4" O.D. casing.
Placed 21.0' of perforated pipe.

NATURAL CONSISTENCY INDEX



COMPLETION DEPTH: 20.5'

RECORD OF WATER LEVEL READINGS

DATE:	1/13	1/14	1/18	1/19	2/24
READING:	12.7'	14.7'	13.5'	13.4	13.4'

PLASTIC LIMIT ×———●——× LIQUID LIMIT

NATURAL MOISTURE CONTENT

W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION-tsf
D=RELATIVE DENSITY-%
H=PENETROMETER-tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1 B7

JOB: 1516

PLATE 12

LOG OF BORING NO. B-8
ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch O.D. Split-barrel
3-inch O.D. Shelby Tube

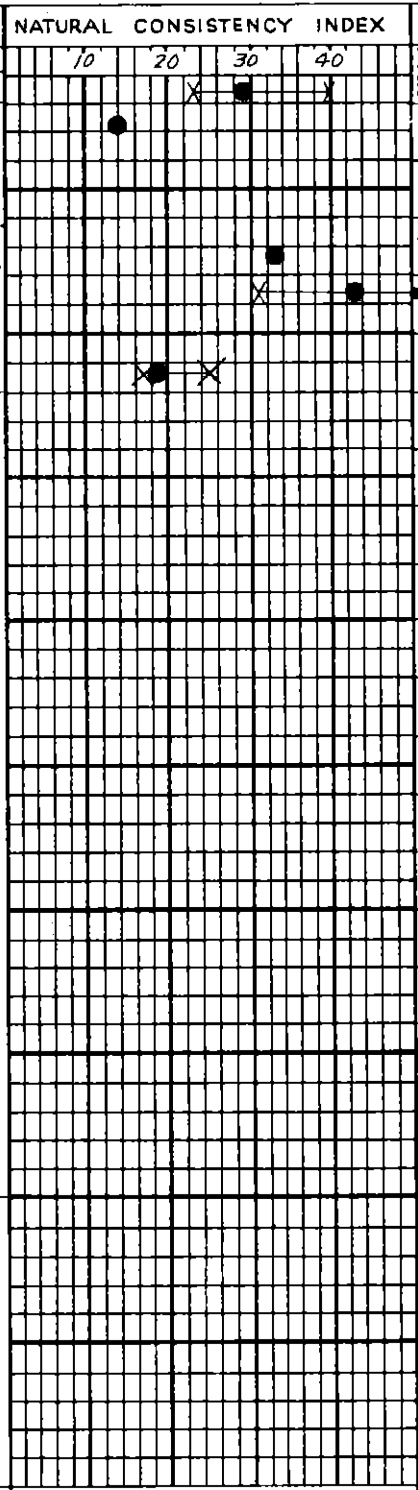
LOCATION: See Plate 1

ELEVATION: 74.6

DATE: 1/11-12/72

DEPTH, FEET	SAMPLE NO.	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0	1A	1/5/7	Topsoil = 5"	H=2.2
	1B		V-stiff dark-gray to black silty clay, sm f-c sa, lit f-c grav. few rts, slightly org.	H=2.6
	1C			H=2.7-2.8
			Firm to v-stiff brown silty clay, some fine to coarse sand, some fine gravel.	
	2A	3-24"	Firm to stiff gray and brown mottled with black, organic silty clay, little fine to coarse sand, trace fine gravel. Contains decayed wood and roots and few sand seams.	H=0.8 H=0.7
	2B			LL=57%
5	3A	P/800		G
	3B		~ @ 5.0' to 5.9', black and gray f-c sand, some f-c grav, sm org cl si.	
			Medium-dense to dense brown fine to coarse sand, some fine to coarse gravel, trace clayey silt, few cobbles.	
10	4	14/22/22		G
15	5	9/13/13		
	6	9/9/11		
20			Used 4-3/4" tricone bit, 0.0' to 5.0'; 3-1/8" tricone bit, 5.0' to 18.5'. Used water, 0.0' to 20.0'. Used 18.5' of 4" O.D. casing.	
25				

NATURAL CONSISTENCY INDEX



COMPLETION DEPTH: 20.0'

RECORD OF WATER LEVEL READINGS

DATE:	1/12	1/13	1/14	1/17
READING:	12.8'	4.7'	7.6'	Caved, dry @ 9.5'

PLASTIC LIMIT ×———●———× LIQUID LIMIT

NATURAL MOISTURE CONTENT

W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

JOB: 1516

FORM: F-1 B5

LOG OF BORING NO. B-9

ADDITION TO WASTEWATER TREATMENT PLANT, MASSILLON, OHIO

TYPE: 2-inch & 2½-inch O.D. Split-barrel
3-inch O.D. Shelby Tube

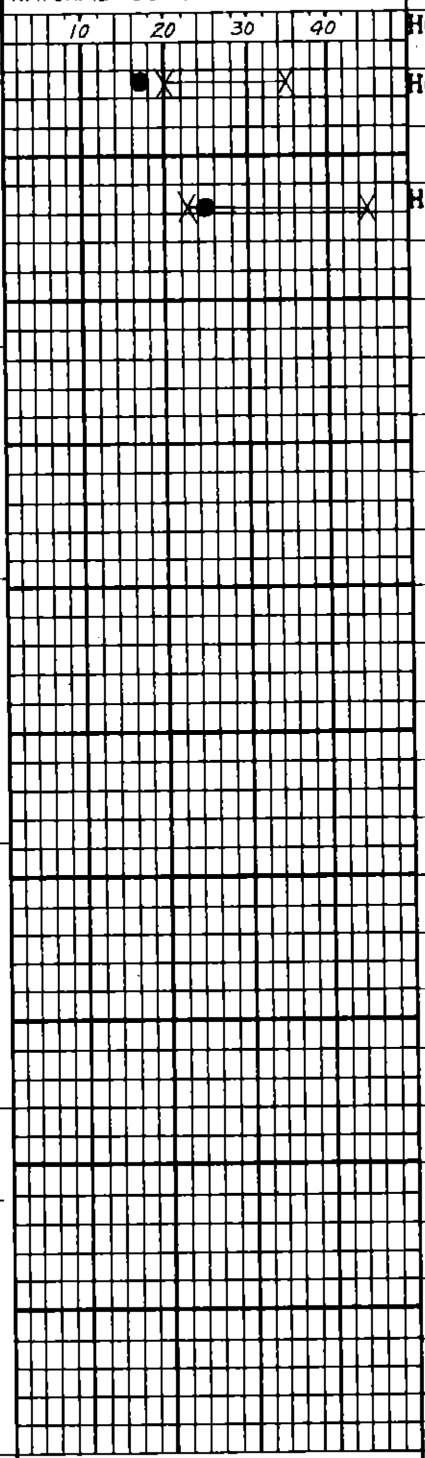
LOCATION: See Plate 1

ELEVATION: 76.6

DATE: 1/17/72

DEPTH, FEET	SAMPLE NO.	SAMPLES	SAMPLING EFFORT	DESCRIPTION	TEST RESULTS
0	1A		1/5/4	Topsoil = 10"	H=1.2
	1B			Very-stiff brown mottled with gray and dark-gray silty clay, trace fine to coarse sand, trace fine to coarse gravel, few roots, few thin seams of black organic silty clay.	H=3.5
	2A		P/1200		H=1.7-2.2
	2B				
5					
	3		6/6/7	Medium-dense brown fine to coarse sand, some fine to coarse gravel, some clayey silt.	
10	4		22/25/39	Dense brown fine to coarse gravel, "and" fine to coarse sand, trace clayey silt.	
15	5		14/17/29	Dense brown fine to medium sand, trace coarse sand, little fine to coarse gravel, trace silt.	
	A		10/10/11	Medium-dense brown f-c sand, some fine to coarse gravel, trace silt.	
20	B		25 15-6"		
25					

NATURAL CONSISTENCY INDEX



Used 4-3/4" tricone bit, 0.0' to 6.0'; 3-1/8" tricone bit 6.0' to 18.5'.
Used water, 0.0' to 18.5'.
Used 18.5' of 4" O.D. casing.

COMPLETION DEPTH: 20.5'

RECORD OF WATER LEVEL READINGS

DATE: 1/17

READING: 15.9'

PLASTIC LIMIT ×———●———× LIQUID LIMIT

NATURAL MOISTURE CONTENT

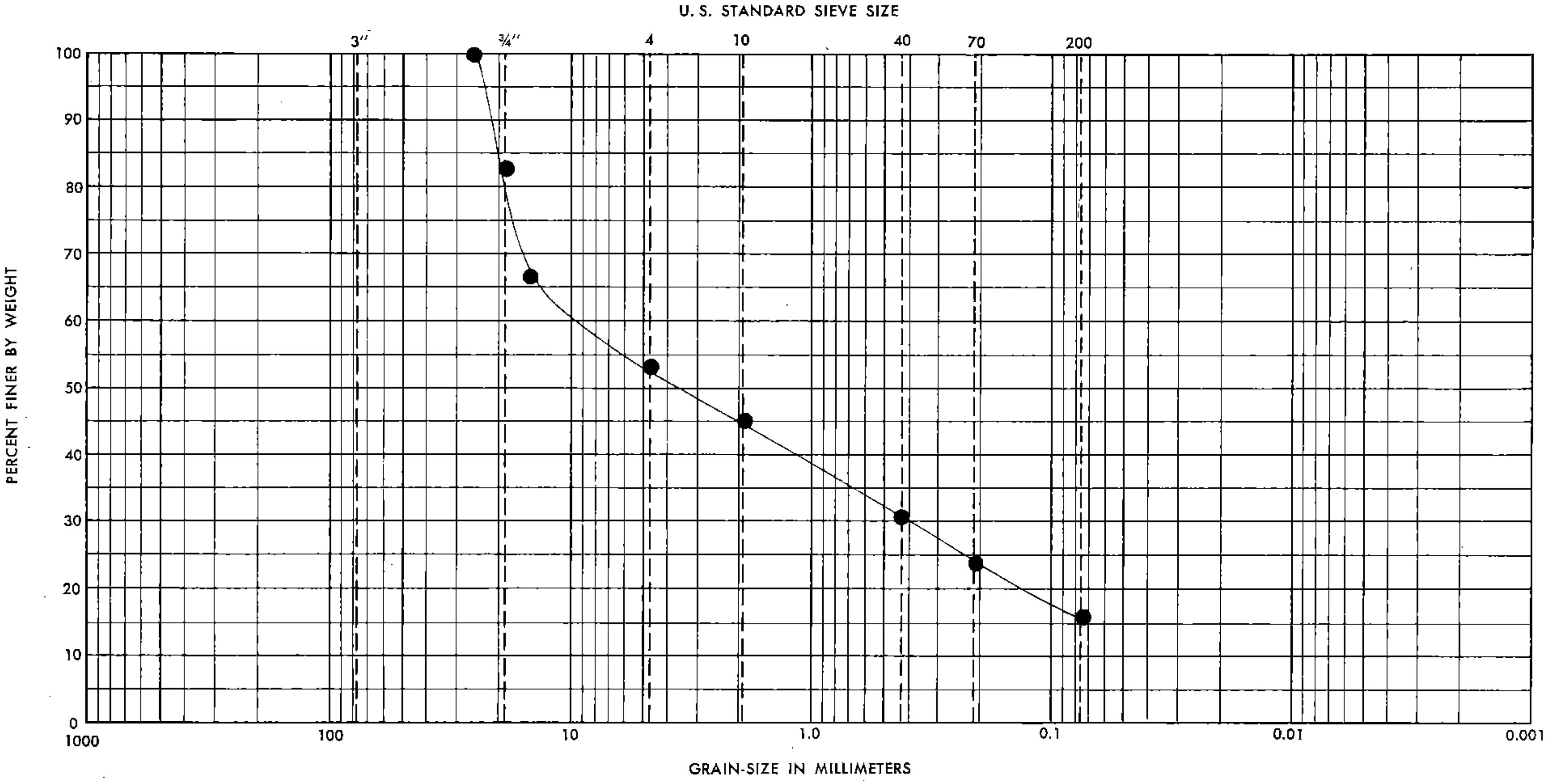
W=UNIT DRY WEIGHT - pcf
Q=UN. COMPRESSION - tsf
D=RELATIVE DENSITY - %
H=PENETROMETER - tsf
G=GRADATION CURVE
T=TRIAXIAL CURVE
C=CONSOLIDATION CURVE

FORM: F-1 B-9

JOB: 1516

FORM: L-4 JOB: 1516

GRADATION CURVES

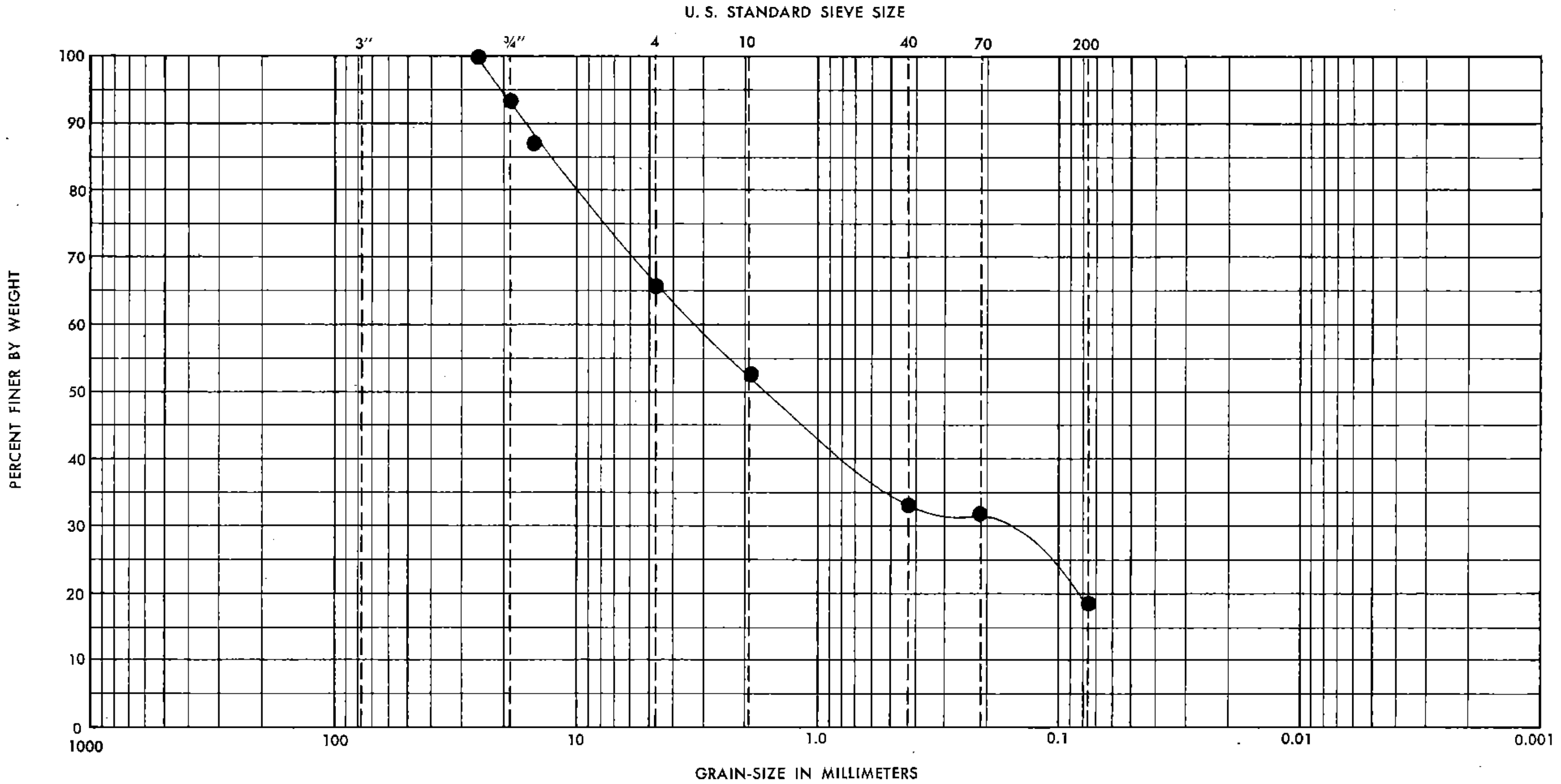


COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
2	3.0' to 3.4'	Brown fine to coarse gravel "and" fine to coarse sand, little silty clay.		

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO
BORING: B-2

GRADATION CURVES

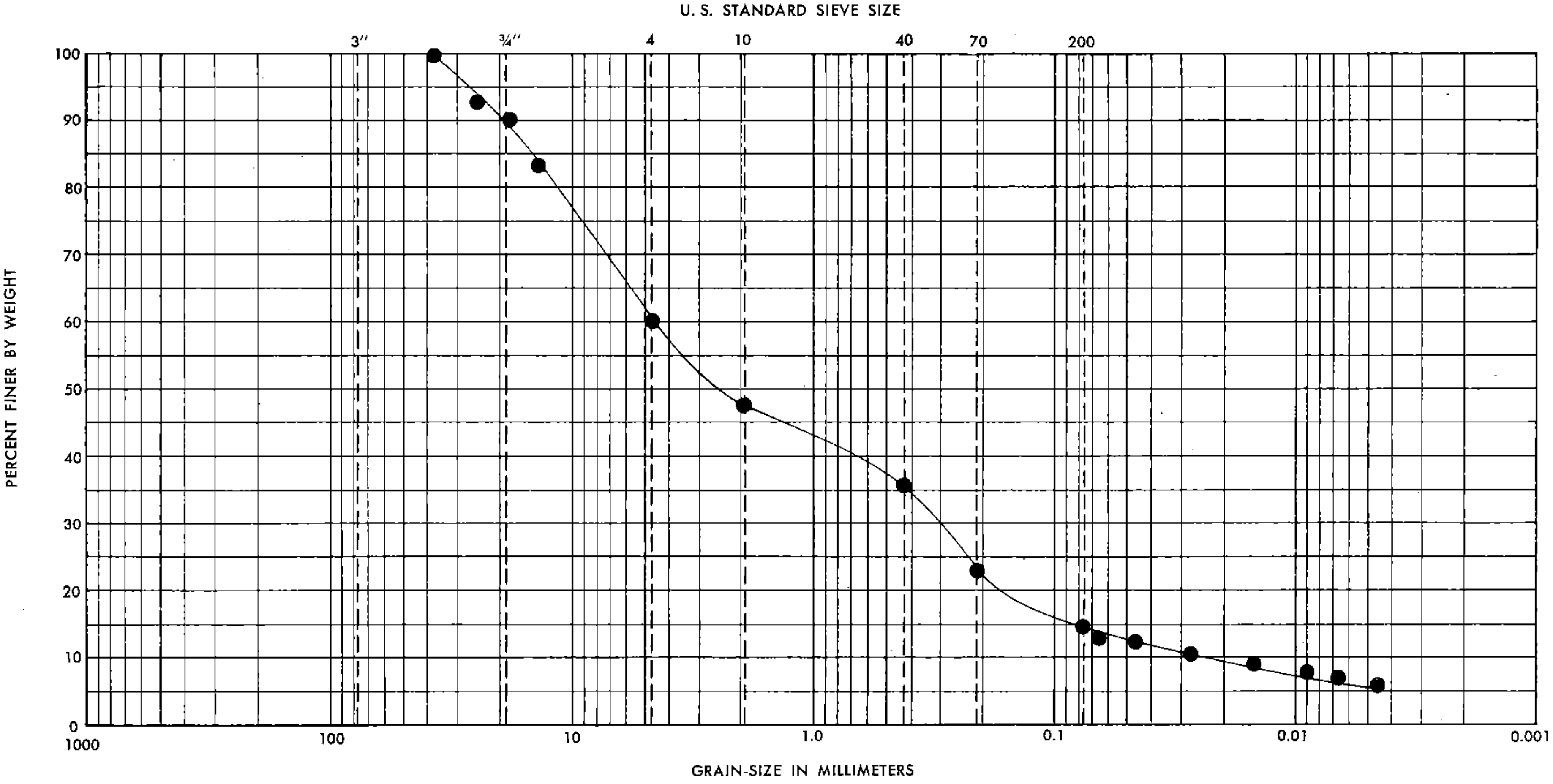


COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
2	6.0' to 6.6'	Brown and gray fine to coarse sand, some fine to coarse gravel, little clayey silt.		

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO
BORING: B-5

GRADATION CURVES



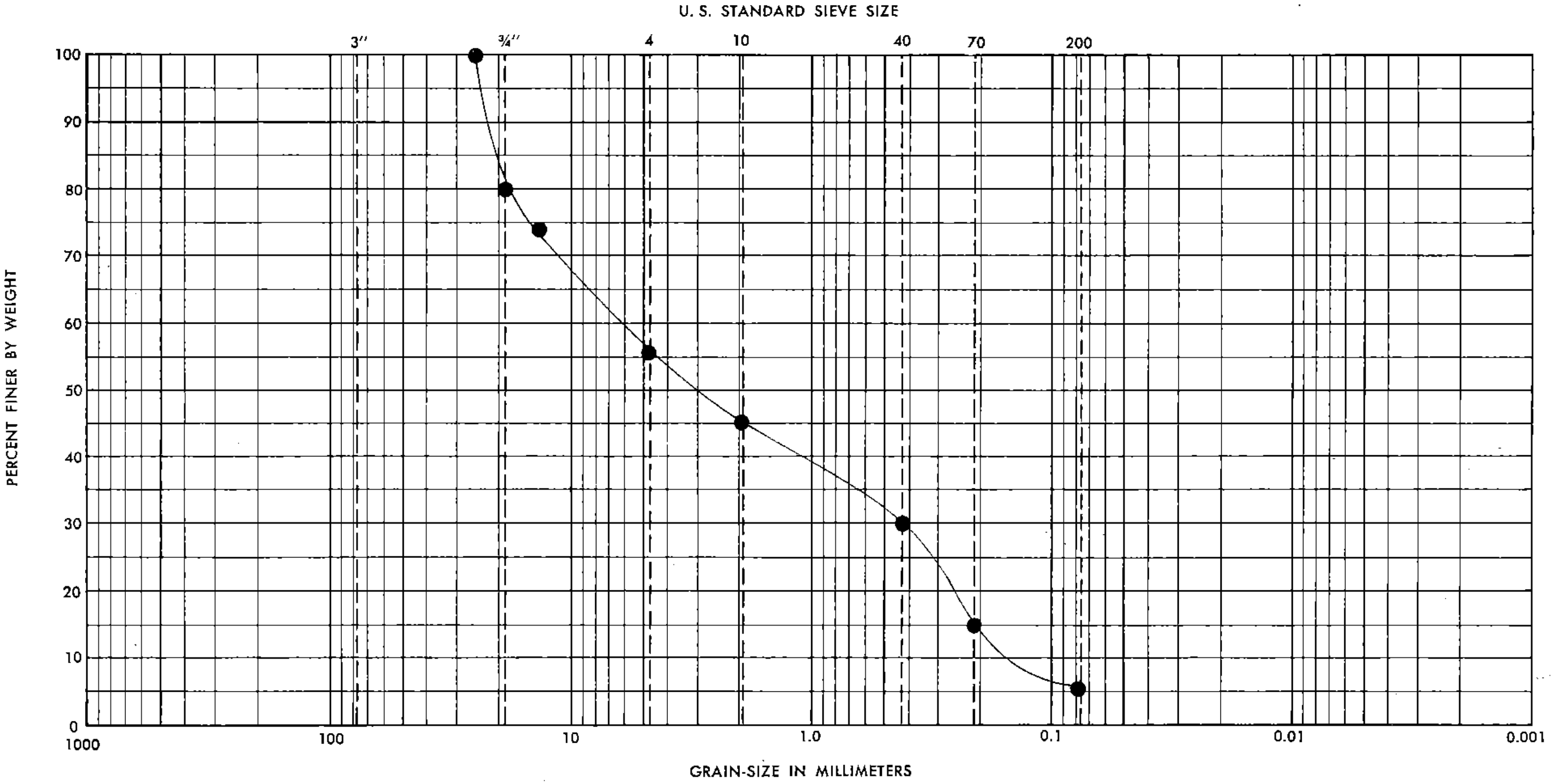
COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
3	10.0' to 10.6'	Brown fine to coarse sand, "and" fine to coarse gravel, little clayey silt.		

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO
BORING: B-6

FORM: L-4 JOB: 1516

GRADATION CURVES



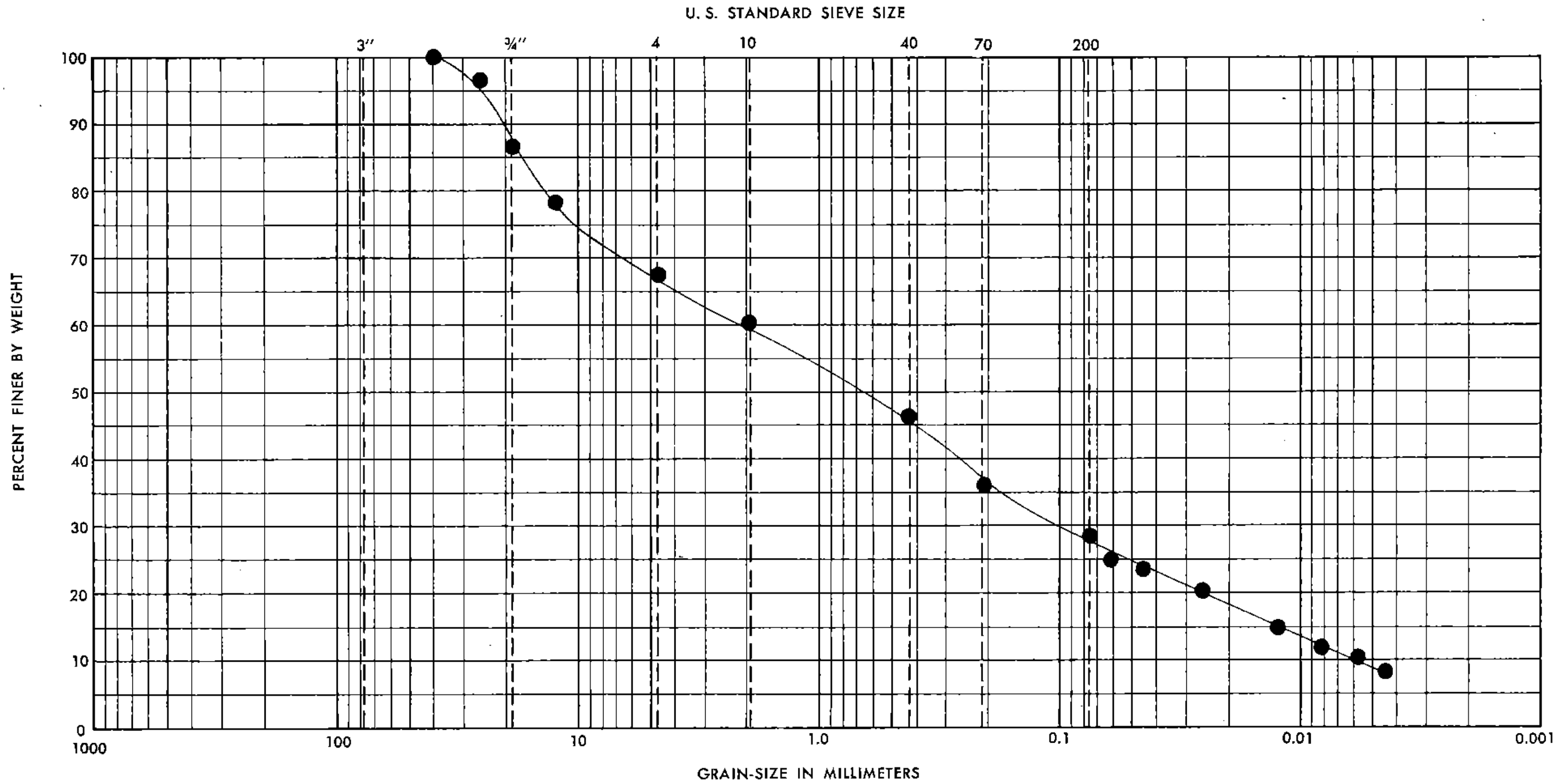
COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
3	5.0' to 5.8	Brown and gray fine to coarse sand "and" fine to coarse gravel, trace clayey silt.		

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO

BORING: B-7

GRADATION CURVES



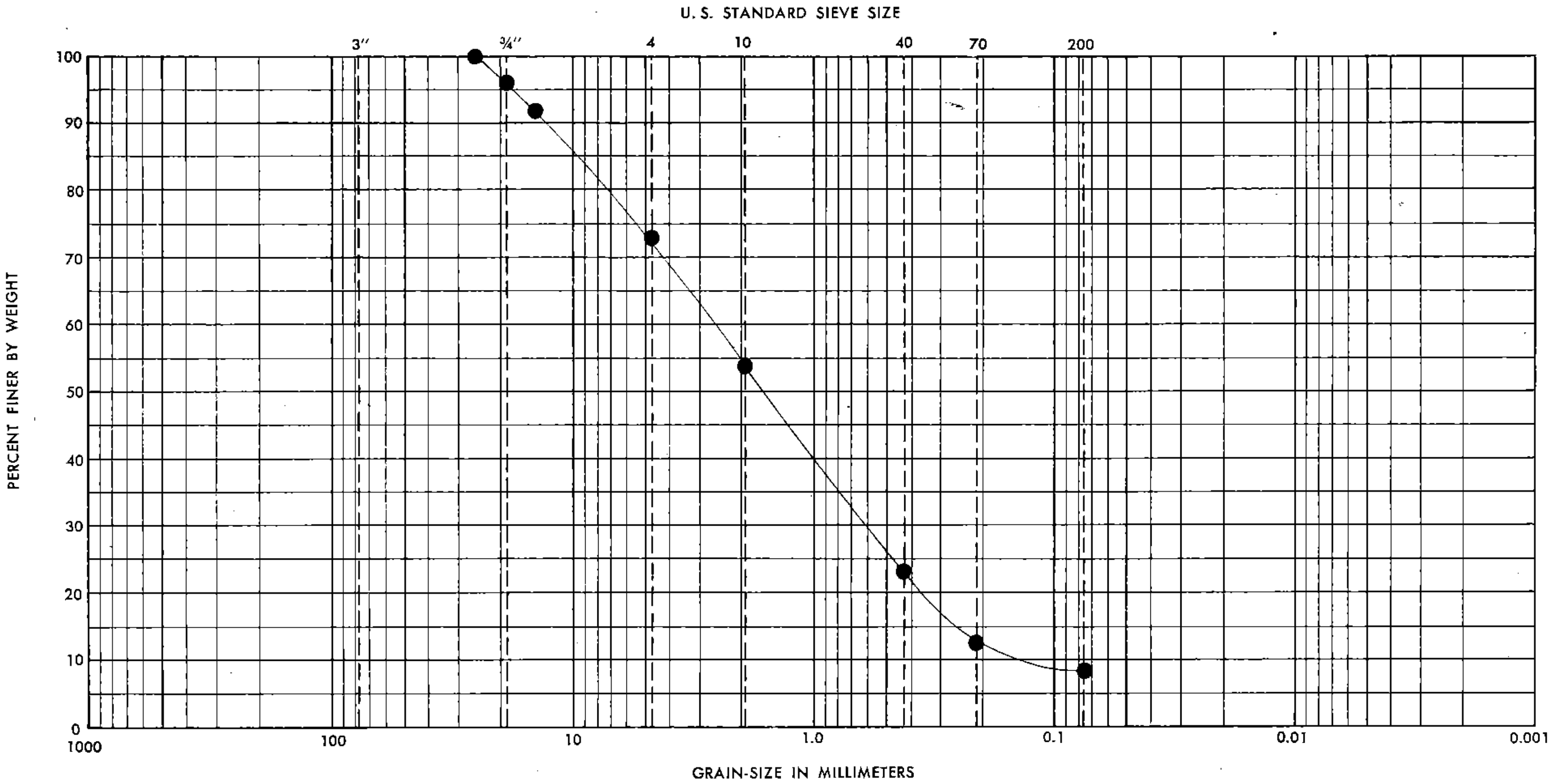
COBBLES	GRAVEL		SAND			SILT–CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
3A	5.0' to 6.4'	Black and gray fine to coarse sand, some fine to coarse gravel, some organic clayey silt.	25	17

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO

BORING: B-8

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT—CLAY
	Coarse	Fine	Coarse	Medium	Fine	

Sample	Depth	IDENTIFICATION	LL	PL
4	10.0' to	Brown fine to coarse sand, some fine to coarse gravel,		
	10.8'	trace clayey silt.		

ADDITION TO WASTEWATER TREATMENT
PLANT, MASSILLON, OHIO

BORING: B-8

UNCONFINED COMPRESSION TEST

Project: Addition to Wastewater Treatment Plant

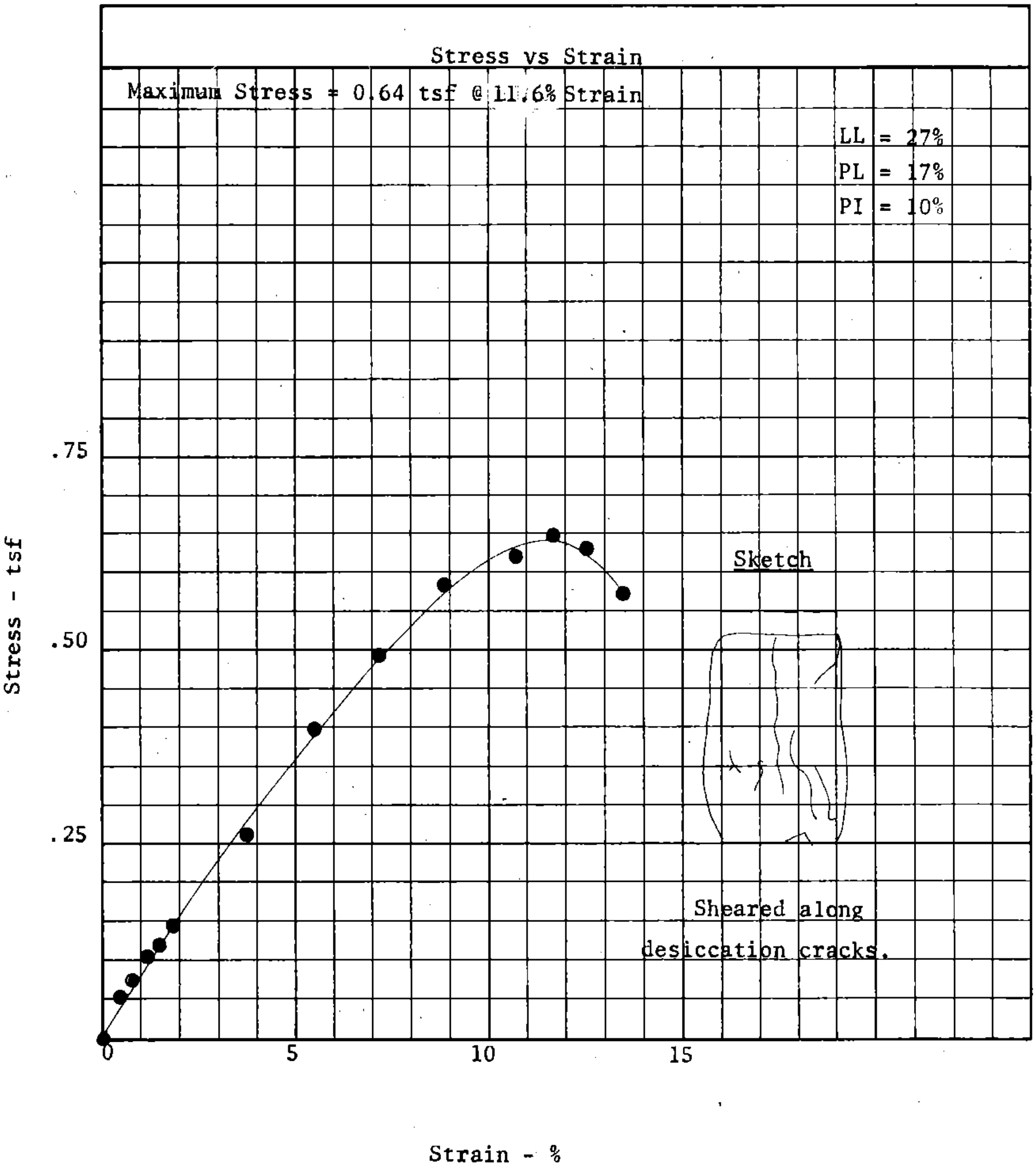
Location: Massillon, Ohio

Boring: B-7 Sample: 2A Depth: 3.0' to 4.7'

Material: Stiff brown mottled with gray clayey silt, some fine sand, trace medium sand to fine gravel, contains decayed roots and desiccation cracks.

Moisture Content: 21% Unit Dry Weight: 105 pcf

Size: 5.60" x 2.87" dia. Unit Wet Weight: 127 pcf



FORM: L-3 JOB: 1510

LAKE DRILLING CO.
151 Meadowlane Rd., Cleveland 31, Ohio

TEST BORING RECORD

Form O-108 – 5M–9-57

Driller Marvin Collihue
Ground Water
Date Time Depth
Casing Hammer Wt. 380 lbs. Drop 30 in.
Sampler Hammer Wt. 140 lbs Drop 30 in.
Sampler Size 3 in. O. D. Casing Size 4 & 3 in.

Hole No. 1 Surface Elevation 78.9 Sheet No. 1 of 1 shee
For Floyd G. Browne & Associates
Plant Site
Location Massillion, Ohio
Started 3-23-59 Completed 3-23-59 Job No. 5910

ELEVATION 78.9	DEPTH	Casing Hammer Blows	Driller's Log ☒ Geologist's Log ☐ Mechanical Analysis ☐	Remarks	Sample Depth	Blo on Sam
74.9	4.0		loose, brown sand with many small gravel	moist	3.0	4
72.9	6.0		soft, black clay		6.0	3
68.9	10.0		soft, gray to brown clay		9.0	6
65.9	13.0		medium hard, brown sandy clay with small to large gravel		12.0	20
60.9	18.0		compact, brown to gray sand and small to large gravel, with trace of clay	wet	15.0 18.0	42 38
53.9	25.0	20 15 12 9 13 12 9		wet	21.0 24.0	12 12
50.4	23.5	8 7 5	loose, gray sand and gravel		27.0	7
47.9	31.0	6 7 11	loose, gray sand		30.0	7
44.9	34.0	14 14 13	loose gray sand and gravel		33.0 34.0	14 13

Water at 10.1 0-hours
Water at 4.9 24-hours

Note: Used 3" casing from 18.0 to 34.0; blows were on 3" casing using 380# hammer with 30" drop.

Sand came up into 4" casing from 8 to 10 feet every time the 3" casing was pulled.

LAKE DRILLING CO.
151 Meadowlane Rd., Cleveland 31, Ohio

TEST BORING RECORD

Form O-108—5M—9-57

Driller Marvin Gollihue
Ground Water
Date Time Depth
Casing Hammer Wt. 300 lbs. Drop 30 in.
Sampler Hammer Wt. 140 lbs Drop 30 in.
Sampler Size 3 in. O. D. Casing Size 4 & 3

Hole No. 2 Surface Elevation 78.9 Sheet No. 1 of 1 sheets
For Floyd G. Browne & Associates
Plant Site
Location Massillion, Ohio
Started 3-21-59 Completed 3-23-59 Job No. 5910

ELEVATION 78.9	DEPTH	Casing Hammer Blows	Driller's Log ☒ Geologist's Log ☐ Mechanical Analysis ☐	Remarks	Sample Depth	Blows on Sample
74.4	4.5		loose, brown sand with many small gravel	moist	3.0	3
68.9	10.0		soft, brown clay with black streaks		6.0 9.0	8 6
65.9	13.0		medium, brown sand and gravel with some clay	wet	12.0	14
61.9	17.0				15.0	42
44.9	34.0	26 24 16 20 11 9 11 5 6 6 11 12 16 15 17 16 12	compact, brown to gray sand and small to large gravel	moist	18.0 21.0 24.0 27.0 30.0 33.0 34.0	26 20 11 6 16 16 12

Water at 13.2 0-hours
Water at 12.6 24-hours

Note: Used 3" casing from 17.0 to 34.0; blows were on 3" casing using 380# hammer with 30" drop.

Sand came up into 4" casing from 8 to 10 feet every time the 3" casing was pulled.

LAKE DRILLING CO.

151 Meadowlane Rd., Cleveland 31, Ohio

TEST BORING RECORD

Form O-108—5M—9-57

Driller Marvin Collihus

Ground Water

Date Time Depth

Casing Hammer Wt. 300 lbs. Drop 30 in.

Sampler Hammer Wt. 140 lbs Drop 30 in.

Sampler Size 3 in. O. D. Casing Size 3 & 4 in.

Hole No. 3 Surface Elevation 78.8 Sheet No. 1 of 2 sheet

For Floyd G. Browne & Ass.

Plant Site

Location Massillon, Ohio

Started 3-17-59 Completed 3-19-59 Job No. 5910

ELEVATION	DEPTH	Casing Hammer Blows	Driller's Log ☒ Geologist's Log ☐ Mechanical Analysis ☐	Remarks	Sample Depth	Blows on Sampl
78.8						
74.8	4.0		loose, brown sand with many small gravel	damp	3.0	5
68.8	10.0		soft, brown to gray, silty clay Encountered water	moist	6.0 9.0	14 7
65.8	13.0		compact, gray sandy clay with many small gravel		12.0	29
44.8	34.0	11	very compact, gray sand with many small to medium gravel	wet	15.0 18.0 21.0 24.0 27.0 30.0 34.0	50 34 50 41 33 48 34
		12 16 19 25 10 15 9 15 16 14 15 15 21 23 23 21 10 7	medium compact, gray sand and small to medium gravel with trace of silt	wet	37.0 39.0 42.0 45.0 48.0 51.0	19 10 15 15 23 10

LAKE DRILLING CO.
151 Meadowlane Rd., Cleveland 31, Ohio

TEST BORING RECORD

Form O-108—5M—9-57

Driller Marvin Gollihue
Ground Water
Date Time Depth
Casing Hammer Wt. 300 lbs. Drop 30 in.
Sampler Hammer Wt. 140 lbs Drop 30 in.
Sampler Size 3 in. O. D. Casing Size 3 & 4 in.

Hole No. 3 Surface Elevation 78.8 Sheet No. 2 of 2 sheet
For Floyd G. Browne & Associates
Plant Site
Location Massillion, Ohio
Started 3-17-59 Completed 3-20-59 Job No. 5910

ELEVATION	DEPTH	Casing Hammer Blows	Driller's Log ☒ Geologist's Log ☐ Mechanical Analysis ☐	Remarks	Sample Depth	Blow on Sampl
		10	medium compact, gray, sand and small to medium gravel with trace of silt	wet	53.0	10
		14				
		12				
		14			56.0	14
		8				
		8				
		10			59.0	10
		12				
		14				
		16			62.0	16
		12				
		14				
		14			65.0	14
		16				
		15				
10.8	68.0	11			68.0	11

Water at 12.6 3-hours
Water at 10.6 24-hours

Note: Used 3" casing from 34.0 to 68.0;
Blows were on 3" casing using 380#
hammer and 30" drop.
Sand worked back up inside casing
after each pull from 20' to bottom
of hole.

LAKE DRILLING CO.
151 Meadowlane Rd., Cleveland 31, Ohio

TEST BORING RECORD

Form O-108—5M—9-57

Driller Marvin Gollihue
Ground Water
Date Time Depth
Casing Hammer Wt. 380 lbs. Drop 30 in.
Sampler Hammer Wt. 140 lbs Drop 30 in.
Sampler Size 3 in. O. D. Casing Size 4 & 3 in.

Hole No. 4 Surface Elevation 78.5 Sheet No. 1 of 1 shee
For Floyd G. Browne & Associates
Plant Site
Location Massillion, Ohio
Started 3-21-59 Completed 3-21-59 Job No. 5910

Driller's Log ☒ Geologist's Log ☐ Mechanical Analysis ☐

ELEVATION 78.5	DEPTH	Casing Hammer Blows	Driller's Log	Remarks	Sample Depth	Blow on Samp
74.5	4.0		loose, brown sand with some small gravel	damp	3.0	9
71.5	7.0		stiff, brown to gray clay		6.0	19
66.5	12.0	28	medium compact, gray to brown sandy clay with many small to medium gravel	moist	9.0 12.0	15 51
60.5 58.5 56.5	18.0 20.0 22.0	85 63 23 25 27 17 17 16 17 12	compact, brown sand and small to large gravel		15.0 18.0 21.0	31 28 17
44.5	34.0	13 12 10 15 17 17 15 16 15 21 22 24	compact gray sand and small to medium gravel	wet	24.0 27.0 30.0 33.0 34.0	12 17 15 22 24

Water at 13.1 0-hours
Hole caved to 11.5, no water 48-hours
Note: Used 4" casing 12.0 to 22.0, 380 # hammer; used 3" casing 22.0 to 34.0, 380 # hammer, casing blows, and casing samples.

Sand came up into 4" casing from 8 to 10 feet every time the 3" casing was pulled.

APPENDIX C

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS

SAMPLING DATA

▮ - Blocked-in "SAMPLES" column indicated sample was attempted and recovered within this depth interval.

▯ - Sample was attempted within this interval but not recovered.

2/5/9 - The number of blows required for each 6-inch increment of penetration of a "Standard" 2" O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches. Addition of one of the following symbols indicates the use of a split-barrel other than the 2" O.D. sampler:

[2S] - 2-1/2" O.D. split-barrel sampler.

[3S] - 3" O.D. split-barrel sampler.

P - Shelby tube sampler, 3" O.D., hydraulically pushed.

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.

50-2" - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment.

S/D - Sampler (split-barrel) advanced by weight of drill rods (D), or combined weight of
S/H - rods and drive hammer (H).

SOIL DESCRIPTIONS - All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
"and"	36 to 50

The following terms are used to describe density and consistency of soils:

Terms (Granular Soils)	Blows per Foot *
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

BBC&M ENGINEERING, INC.

LOG OF BORING NO. B-15
MASSILLON WASTE WATER TREATMENT PLANT
MASSILLON, OHIO

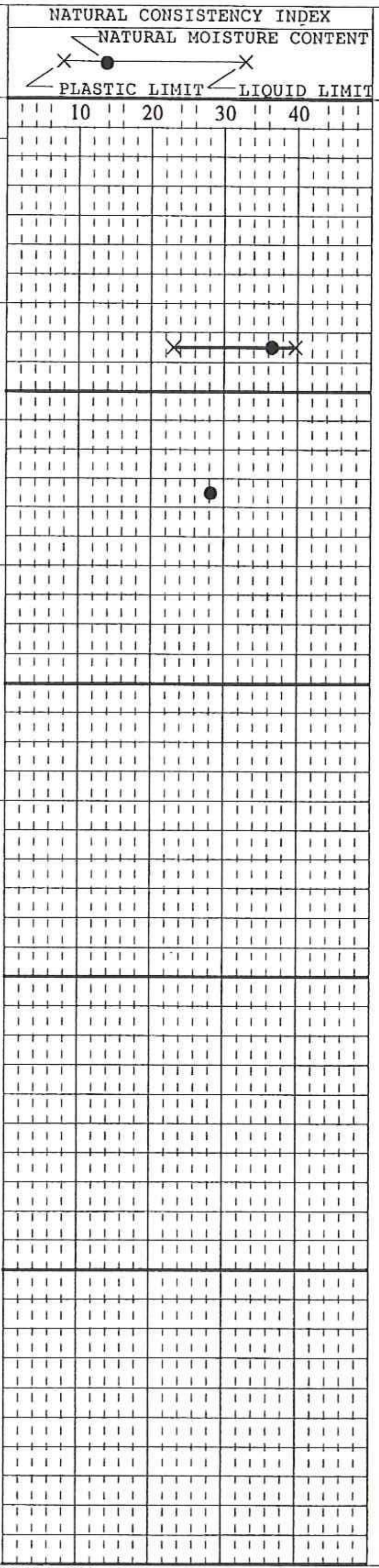
Page 1 of 1

LOCATION: **See Plate 2** ELEVATION: **78.0** DATE: **8/24/99**

DRILLING METHOD: **2-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **15.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	DESCRIPTION	TEST RESULTS
0			8" ASPHALT	
	1	3/3/4	FILL: Stiff dark-gray and black clayey silt, "and" fine to coarse sand, little fine to coarse gravel (trace organics).	H=1.5
5	2	2/2/1	Very-soft to stiff gray intermixed with brown (partly organic) silty clay, little fine to coarse sand, trace fine to coarse gravel.	H=0.2-1.5
	3	W/H=6"/1/2	Soft to medium-stiff brown clayey silt, little to some fine to coarse sand, trace organic.	H=0.3-0.6
▽ 10	4	6/8/14	Medium-dense gray and brown fine to coarse gravel, "and" fine to coarse sand, trace silt.	
15	5	7/10/11	Medium-dense brown fine to coarse sand, some fine to coarse gravel.	
20			Encountered water at 9.5' while drilling	
25				



WATER LEVEL: ▽ 8.5 ▼ ▽

WATER NOTE: Caved at 9.5'

DATE: 08/24/99

SYMBOLS USED TO INDICATE TEST RESULTS

G - GRADATION
Q - UNCONFINED COMPR
T - TRIAXIAL COMPR
C - CONSOLIDATION

SEE SEPARATE CURVES

H - PENETROMETER (tsf)
W - UNIT DRY WEIGHT (pcf)
D - RELATIVE DENSITY (%)

BBC&M ENGINEERING, INC.

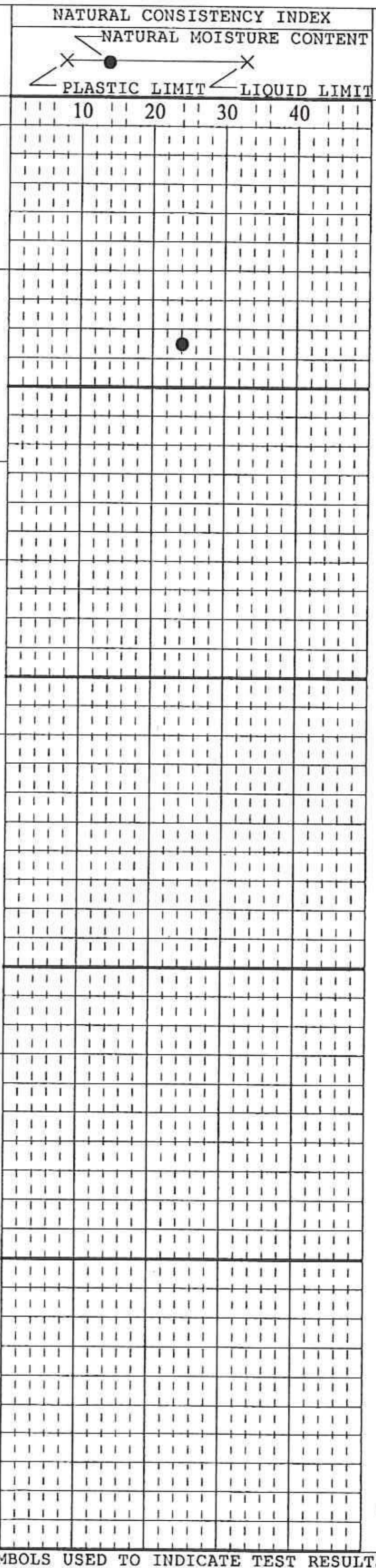
LOG OF BORING NO. B-16
MASSILLON WASTE WATER TREATMENT PLANT
MASSILLON, OHIO

LOCATION: **See Plate 2** ELEVATION: **79.6** DATE: **8/24/99**

DRILLING METHOD: **2-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **25.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	DESCRIPTION	TEST RESULTS
0			6" TOPSOIL	
	1	2/3/3	PROBABLE FILL: Loose brown fine to coarse sand, little clayey silt, little fine to coarse gravel,e contains decayed wood.	
	2	3/3/5	Very-stiff to hard brown mottled with gray silty clay, little fine to medium sand.	H=3.3-4.2
5				
	3A	2/4/7		H=3.4
	3B		Medium-dense brown fine to coarse sand, some to little clayey silt, some fine to coarse gravel.	
	4	8/10/10	Medium-dense brown fine to coarse sand, some to "and" fine to coarse gravel, contains few cobbles.	
10 ▼				
			Loose brown fine to medium sand, little coarse sand, trace fine gravel.	
	5	3/4/5		
15				
			Loose to medium-dense brown fine to coarse sand, some to "and" fine to coarse gravel, trace silt.	
	6	3/3/4		G
20				
			Moved B-16 approximately 6' north (same elevation). Encountered Water at 11.0' while drilling 2" monitoring well placed	
	7	5/6/7		G
25				

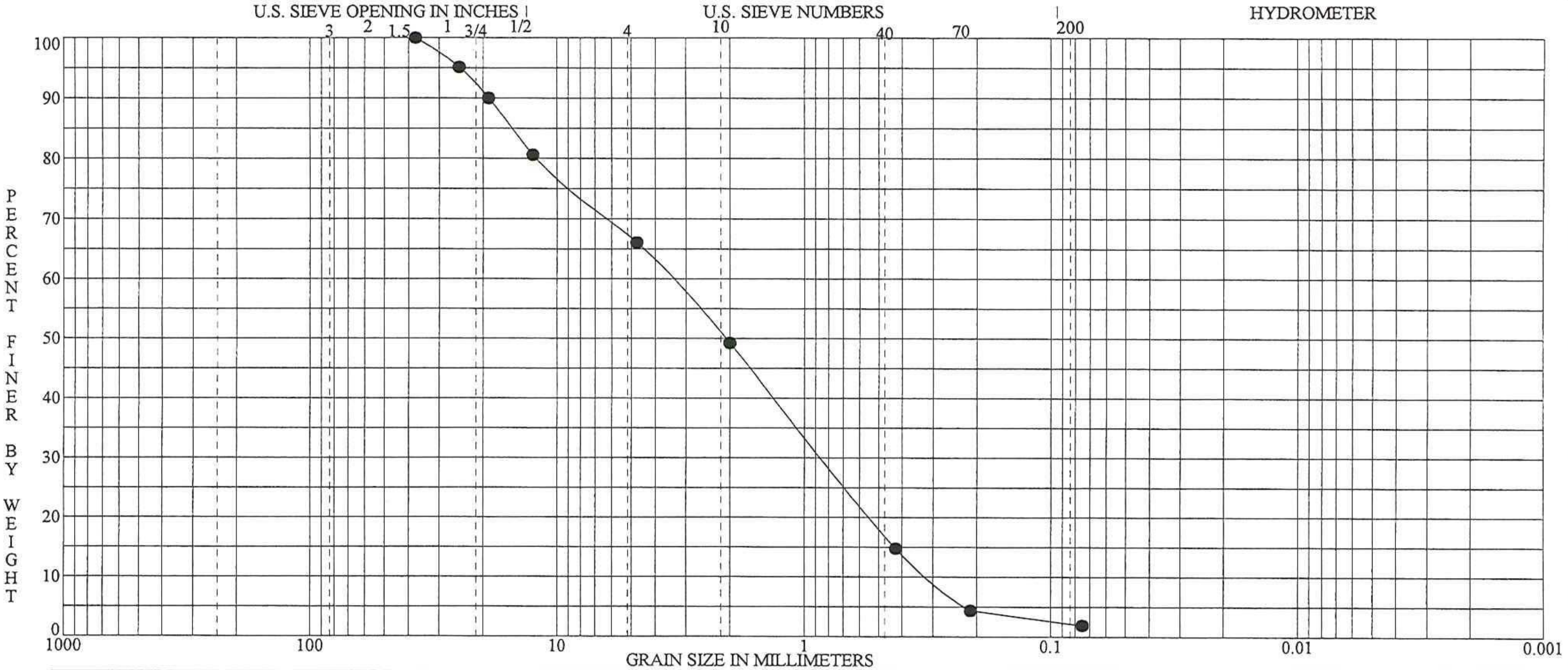


	▽	▼	▽̲
WATER LEVEL:		10.4	
WATER NOTE:			
DATE:		09/14/99	

SYMBOLS USED TO INDICATE TEST RESULTS

G - GRADATION
Q - UNCONFINED COMPR
T - TRIAXIAL COMPR
C - CONSOLIDATION
SEE SEPARATE CURVES

H - PENETROMETER (tsf)
W - UNIT DRY WEIGHT (pcf)
D - RELATIVE DENSITY (%)



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		coarse	fine	coarse	medium	fine	

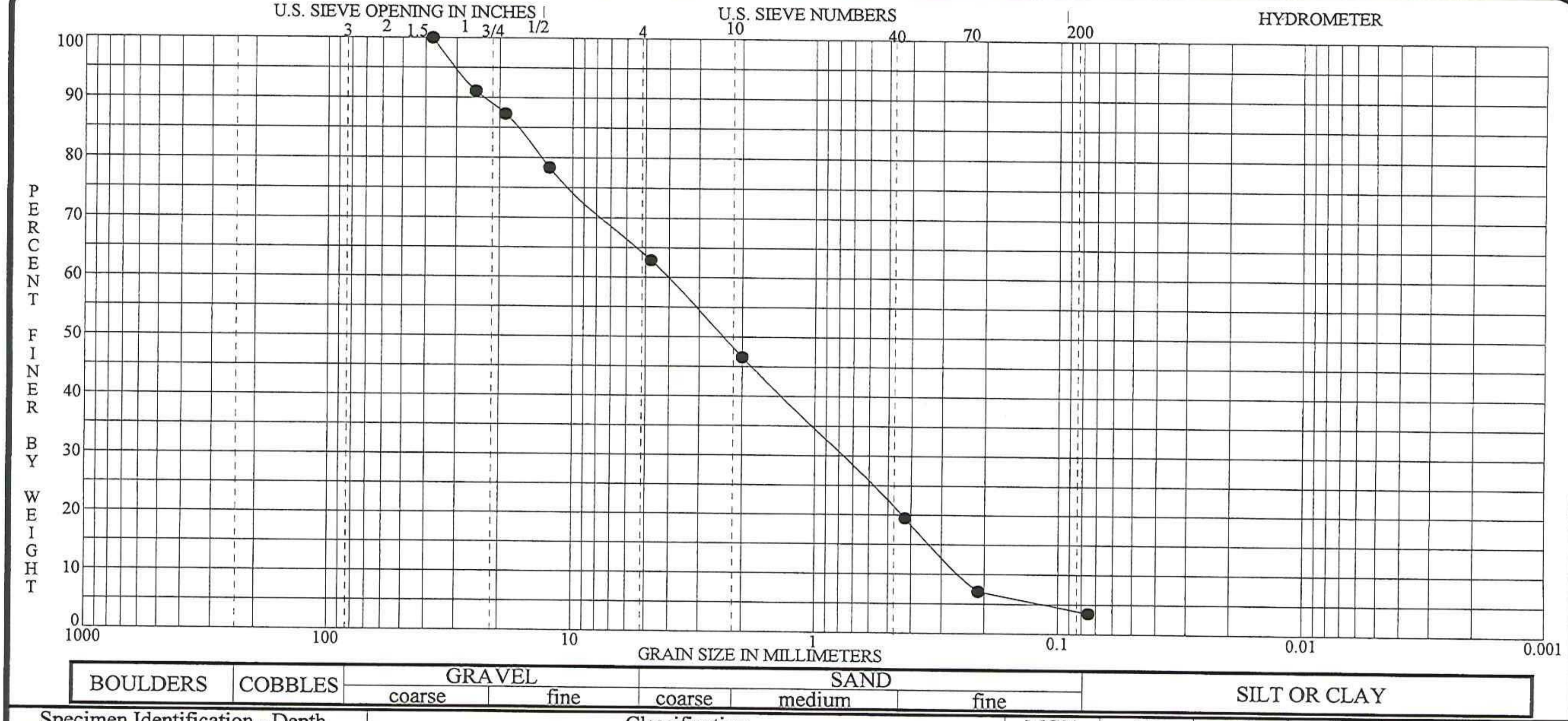
	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	**B-16 S-6 18.5'-20.0'**	**Brown fine to coarse sand, some fine to coarse gravel, trace silt.**						

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-16 S-6 18.5'-20.0'**	**37.5000**	**3.4767**	**0.8427**	**0.3086**	**33.9**	**64.1**	**1.9**	

BBC&M ENGINEERING, INC.

GRADATION CURVE

PROJECT **MASSILLON WASTE WATER TREATMENT PLANT**
LOCATION **MASSILLON, OHIO**
JOB NO. **0266CL** DATE **9/24/99**



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	opt mc %	max pcf
●	**B-16 S-7 23.5'-24.3'**	**Brown fine to coarse sand, "and" fine to coarse gravel, trace silt.**						

	Specimen Identification - Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-16 S-7 23.5'-24.3'**	**37.5000**	**4.0788**	**0.7755**	**0.2495**	**37.1**	**59.4**	**3.5**	

BBC&M ENGINEERING, INC.

GRADATION CURVE

PROJECT **MASSILLON WASTE WATER TREATMENT PLANT**
LOCATION **MASSILLON, OHIO**
JOB NO. **0266CL** DATE **9/24/99**