SOIL EXPLORATION
PROPOSED BELLEVUE WASTEWATER TREATMENT PLANT IMPROVEMENTS
BELLEVUE, SANDUSKY COUNTY, OHIO

SUBMITTED TO:

CITY OF BELLEVUE
Attention: Mr. Eric MacMichael
500 Great Lakes Parkway
Bellevue, Ohio 44811

BMI Report No. 205231-0622-9479

June 23, 2022

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Report To:	City of Bellevue	**Date:**	June 23, 2022
Attention:	Mr. Eric MacMichael	**Laboratory Job No.:**	205231
	500 Great Lakes Parkway	**BMI Report No.:**	205231-0622-9479
	Bellevue, Ohio 44811	**Report Consists of 33 Pages**	

Report On: SOIL EXPLORATION,
Proposed Bellevue Wastewater Treatment
Plant Improvements
Bellevue, Sandusky County, Ohio

Dear Mr. MacMichael:

Bowser-Morner, Inc. (BMI) has completed the authorized subsurface exploration and geotechnical engineering evaluation at the above referenced project. The following report briefly reviews our exploration procedures, describes existing site and subsurface conditions, and presents our evaluations, conclusions, and recommendations.

1.0 AUTHORIZATION

The purpose of this subsurface exploration and geotechnical engineering evaluation was to determine the subsurface conditions at the project site and to analyze these conditions as they relate to foundation design and construction. All work was performed in accordance with BMI technical proposal No. T-27625-Revised dated April 26, 2022 and its attached *Proposal Acceptance Sheet* between the City of Bellevue and BMI dated April 27, 2022. The scope of the exploration included subsurface drilling and sampling, limited laboratory testing, engineering evaluation of the field and laboratory data, and the preparation of this report.

2.0 WORK PERFORMED

2.1 Field Exploration

During this exploration, one soil test boring was drilled at the approximate location shown on the attached *Boring Location Plan*. The boring was drilled to a depth of 22 feet. Boring location was established in the field by BMI by measuring distances and estimating right angles from existing site features. Boring elevation was interpolated from a site topographic map provided by

Jones & Henry. Since these measurements are not precise, the locations shown on the elevations on the *Boring Logs* should be considered approximate.

All soil sampling and standard penetration testing was conducted in general accordance with American Society for Testing and Materials (ASTM) Standard D1586. The borings were advanced by an all-terrain vehicle (ATV) mounted) drilling rig by mechanically twisting hollow-stem augers into the soil. At regular intervals, soil samples were obtained with a standard 2-inch outside diameter (O.D.) split spoon sampler driven 18 inches into the soil with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and designated the "standard penetration resistance." The standard penetration resistance, or "N" value, when properly evaluated, is an index of the soil's strength, density, and ability to support foundations. The disturbed samples recovered by the split spoon sampler were visually classified in the field, logged, sealed in glass jars, and returned to the laboratory for testing and evaluation by a geotechnical engineer.

Rock coring techniques were used to determine the composition and continuity of the refusal materials encountered in the borings. The core drilling procedure was in general accordance with ASTM D 2113. Initially, a temporary casing was set through the overburden soils and seated into the upper surface of the rock to keep the holes from collapsing and to minimize loss of coring water. Refusal materials were then cored with a diamond-studded bit fastened to the end of a hollow, double-tube core barrel. Rock cuttings were brought to the surface by circulating water. Core samples of the materials penetrated were protected and retained in the swivel-mounted inner tube. After each drill run, the core barrel was brought to the surface and the samples removed and placed in boxes. The samples were then returned to our laboratory where the rock was identified by a staff geologist and the fracture frequency (FF) and rock quality designation (RQD) were determined. Rock descriptions, recovery, FF, and RQD are indicated on the attached Boring Logs.

Boring Log indicating soil descriptions, penetration resistances, and observed groundwater levels are attached.

2.2 Laboratory Testing

In the laboratory, each of the samples recovered from the borings was examined and visually classified by a geotechnical engineer. In addition, samples of cohesive soils from the split spoon samplers were tested to determine the soil's approximate strength using a hand-held, calibrated spring penetrometer. These values were used by the geotechnical engineer to assist in the evaluation of the relative strengths of the subsurface soils and to aid in classification of the samples.

Two unconfined compressive strength tests of rock core were performed on the specimen(s) obtained. The tests were performed in accordance with ASTM D 7012. The results of these tests are tabulated below.

Boring and Sample No.	Sample Depth (ft)	Unconfined Compressive Strength (psi)
1-1D	18.0	8,830
1-2D	21.0	9,800

ft = feet psi = pounds per square inch

One composite soil sample was obtained from depths of 3.5 to 10 feet. The samples were tested for soil resistivity, pH, water-soluble sulfate ion content, water soluble chloride ion content in accordance with ASTM D512, ASTM D516, ASTM D2216, ASTM D4972, ASTM G187. Test results are summarized below.

Test Method	B-1 (3.5'-10') Composite Sample
Moisture Content, As Received, %:	18.3
Resistivity (As Received), ohm-cm:	15,300
Resistivity (100% Saturation), ohm-cm:	5,175
pH:	7.1
Water Soluble Sulfate Ion, mg/kg (ppm):	30
Water Soluble Chloride Ion, mg/kg (ppm)	<10

ohm-cm= ohm centimeters
ppm= parts per million
mg/kg= milligrams per kilogram

The soil resistivity indicated low corrosivity at the as-received moisture content. The table below shows the relative corrosivity as a function of soil resistivity. It should be noted that the relationships given below are approximate and intended as a general reference. Actual field performance can vary based on location specific conditions.

Soil Corrosivity as a Function of Soil Resistivity

Resistivity	Corrosivity
0 to 1,000 ohm-cm	Very corrosive
1,000 to 2,000 ohm-cm	Corrosive
2,000 to 10,000 ohm-cm	Mildly Corrosive
10,000 ohm-cm and above	Progressively Less Corrosive

Natural moisture content determinations were made on 4 split spoon samples recovered from the soil test borings. The results of the moisture content determination tests are shown on the attached Moisture Content Summary Sheet.

Soil samples are normally retained in our laboratory for a period of 60 days before they are discarded. To view the samples or arrange for longer storage of samples, please contact us.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The proposed site is located at the City of Bellevue Wastewater Treatment plant in Bellevue, Sandusky County, Ohio. The new structures will be constructed in the southwest part of the plant adjacent to and north of the existing grit building.

3.2 Soil Profile

Data from the soil test borings are shown on the attached *Boring Logs*. The subsurface conditions discussed in the following paragraphs and those shown on the *Boring Logs* represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Geologically, the project site is situated in a glacial ground moraine consisting of till containing an unsorted, unstratified mixture of clay, silt, sand, and coarser fragments deposited discontinuously by advancing ice.

Topsoil covered the ground surface of the boring location and was recorded by the drillers as 5 inches in thickness. Underlying the topsoil was fill material consisted of brown clay and silt with varying amounts of sand and traces of crushed stone. The fill material extended to a depth of 6 feet where brown clay and silt with varying amounts of sand was found. The lacustrine soil extended to a depth of 8.5 feet. Underlying the lacustrine soil was glacial till. The glacial till consisted of brown clay and silt with some sand and a trace of gravel. The glacial till extended to the top of the weathered rock found at a depth of 13.5 feet. The weathered rock extended to a depth of 17 feet where auger-refusal was encountered.

The lacustrine soil has an estimated undrained shear strength that varies from about 2,000 to 3,500 pounds per square foot (psf). The glacial till has an estimated undrained shear strength that varies from about 1,500 to 1,750 psf.

During the field exploration, auger refusal was encountered at a depth of 17 feet. Auger refusal is a term given to the condition encountered when a drill rig's power auger is unable to penetrate further into the subsurface profile. Auger refusal is usually indicative of the upper surface of the bedrock; however, it can also be encountered on other hard or very dense materials such as boulders, cobble layers, buried obstructions, etc. To confirm the presence of bedrock, it is necessary to use rock coring techniques to sample the auger refusal materials. Rock coring was performed during this exploration. The apparent rock depth information is summarized below:

Boring Location	Approximate Surface Elevation (ft)	Auger Refusal Depth (ft)	Rock Confirmed by Coring ?	Rock Quality Designation and Fracture Frequency
1	743.0	17.0	Yes	RQD=89.0%, F.F.=1.4/ft

3.3 Groundwater Observations

During the field exploration, the drilling rods and sampling equipment were continuously checked by the drillers for indications of groundwater or seepage. The *Boring Logs* list our driller's observations of groundwater or seepage. Three readings are recorded on the logs. The initial groundwater level indicates the depth(s) at which groundwater or seepage was initially noted by the drillers as the boring was being advanced and the intensity of the seepage. The completion groundwater level represents the depth groundwater was observed in the borehole immediately after the completion of the hole. The last reading on the *Boring Logs* represents the depth groundwater was observed in the borehole after an increment of time has passed. In this case, both the depth and time are listed.

Boring No.	Depth Groundwater First Encountered (ft)		Depth to Groundwater at Completion of Drilling (ft)	
	Depth	Elev.	Depth	Elev.
1	17.0	726.0	16.0	727.0

Groundwater levels fluctuate with seasonal and climatic variations and may be different at other times. More specific information regarding groundwater levels, standard penetration resistances, and soil descriptions are detailed on the attached *Boring Log*.

A BMI representative visited the site on June 3, 2022 to record the water level in the piezometer. The water level measured in the piezometer at the boring location is as follows:

Piezometer Number	Surface Elevation (feet)	Depth Below Ground Surface (feet)	Approximate Elevation (feet)
B-1	743.0	8.0	735.0

4.0 PROPOSED CONSTRUCTION

It is our understanding that the proposed construction is to consist of a new plant expansion that will include a new addition to the grit building. The bottom of the building will be at about 6 feet below grade.

5.0 EVALUATIONS AND CONCLUSIONS

The following evaluations and conclusions are based on our interpretation of the field and laboratory data obtained during the exploration and our experience with similar subsurface conditions. Soil penetration data and laboratory data have been used to estimate allowable bearing pressures using commonly accepted geotechnical engineering practices. Subsurface conditions in uninvestigated locations between borings may vary considerably from those encountered in the borings. If structure location, loadings, or levels are changed, we request we be advised so we may re-evaluate our recommendations.

5.1 Site and Subgrade Preparation

Before proceeding with construction, all vegetation, root systems, topsoil, refuse, and other deleterious non-soil materials should be stripped from proposed construction areas, as indicated by the attached *Model Clearing and Grading Specifications*.

After the completion of clearing, stripping and undercutting, the exposed soils should be thoroughly compacted and areas intended to support floor slabs, pavements, new fill, and foundations should be carefully evaluated by the geotechnical engineer. At that time, the engineer will require proof-rolling of the subgrade with a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The purpose of the proof-rolling is to locate soft, weak, or excessively wet soils present at the time of construction. Any unsuitable materials observed during the evaluation and proof-rolling operations should be undercut and replaced with a compacted fill or stabilized in place.

5.2 Structural Fill

Fill used to replace undercut areas or to achieve finished grades may be select cohesive soils or granular material such as sand, sand and gravel, or crushed stone. If cohesive soils are used as structural fill, they should be low plasticity soils (PI less than 25), and free of organics and rock fragments larger than 3 inches in diameter. Based on our review of the soil samples, the on-site original clay soils will be suitable for use as structural fill, provided they are properly moisture-conditioned and are placed, compacted, and tested in accordance with the recommendations of this report.

Structural fill should be placed in lifts of 6 to 8 inches loose measure. All fill material should be placed in horizontal lifts and adequately keyed into stripped and scarified subgrade soils. In no instance should puddling or jetting of the backfill materials be allowed as a compaction method. Proper drainage should be maintained during and after construction.

Structural fill placed below foundations or other settlement-sensitive structures should be compacted to a minimum of 95 percent of the modified Proctor maximum dry density of the soil, as determined by a laboratory moisture-density relationship test (ASTM D 1557). Cohesive structural fill used above foundation bottoms or beneath pavements and floor slabs should be compacted to a minimum of 90 percent of the modified Proctor maximum dry density. Granular structural fill used in a similar fashion should be compacted to 90 percent of the same standard, except for fine silty sand (a common borrow material in the northwest Ohio-southeast Michigan area), which should be compacted to 95 percent of the modified Proctor dry density whenever it is used. In cut areas, the upper 8 inches of soils intended to support floor slabs or pavements should be scarified and recompacted according to the above recommendations. Note that pavement base material such as crushed stone must be compacted to 95 percent of the maximum modified Proctor dry unit weight (ASTM D 1557).

Structural fill should be moisture-conditioned prior to placement to ±3 percent of the optimum moisture content for the material. No fill material should be placed that is more than 3 percent over optimum.

Compaction equipment and methods used should be appropriate for the types of fill materials being placed. Discing and pulverizing of cohesive soils may be required prior to fill placement. Cohesive soils should generally be compacted using non-vibratory sheepsfoot rollers. Discing and pulverization may be needed to achieve uniform compaction. Granular fill materials should be compacted using vibratory or non-vibratory smooth-drum rollers. In confined areas such as utility trenches, granular fill materials should be used and portable compaction equipment and thin lifts may be required to achieve specified degrees of compaction. In general, it is BMI's experience that hand-operated compaction equipment is typically only effective in compacting the uppermost 3 to 4 inches of a fill lift. Therefore, if hand-operated equipment is used, the lift thickness should be reduced. In no instance should puddling or jetting of the backfill materials be allowed as a compaction method. Proper drainage should be maintained during and after fill placement.

During fill placement, density tests should be performed by a qualified soils technician to determine the degree of compaction and compliance with the project specifications. At least one field density test should be made per 2,500 square yards of fill area for each lift of compacted soil. Testing frequency should be increased in confined areas. Any areas that do not meet the compaction specifications should be re-compacted to achieve compliance.

5.3 Foundation

After the recommended site and subgrade preparation, we recommend the proposed building be supported on a system of conventional spread or continuous foundations. Spread footings bearing on silty clay at a depth below 6 feet (elevation 735.0) may be designed for a net allowable soil bearing capacity of 2,500 psf. Exterior footing bottoms should be at least 3.5 feet below exterior grades for protection against frost damage. Interior footings not subject to frost action may bear at shallower depths below the floor slab, provided they bear on original materials or compacted fill placed in accordance with our recommendations.

5.4 Foundation Construction and Evaluation

Bottoms of foundation excavations should be evaluated by a geotechnical engineer prior to the placement of reinforcing steel and concrete to verify adequate bearing materials are present and all debris, mud, and loose, frozen, or water-softened soils are removed.

Foundation excavations should be concreted as soon as practical after they are excavated. Water should not be allowed to pond in any excavation. If an excavation is left open for an extended period, a thin mat of lean concrete should be placed over the bottom to minimize damage to the bearing surface from weather or construction activities. Foundation concrete should not be placed on frozen or flooded subgrades.

5.5 Special Inspections

The International Building Code (IBC) requires "Special Inspections." These inspections are required in 14 major categories of work and are over and above the inspections that building officials commonly provide per Section 109. The purpose of the special inspector is to review aspects of construction that require special knowledge and training that the code official does not possess.

For each project, the Ohio Department of Commerce's Division of Industrial Compliance requires the principal designer to identify which materials and contracted work require special inspections and specify the frequency of inspection. The designer is to submit this completed list with the building permit application.

At the completion of the project, a *Final Report of Special Inspections* must be submitted by the registered design professional in responsible charge of the project in order to receive the final occupancy permit.

BMI is capable of providing the special inspection services. Based on our current understanding of your project, we have developed the following summary of the Special Inspections that may be required by the principal designer:

SOILS AND FOUNDATIONS – 1705.6	
Item	**Scope**
1. Shallow Foundations	*Inspect soils below footings for adequate bearing capacity and consistency with geotechnical report.* *Inspect removal of unsuitable material and preparation of subgrade prior to placement of controlled fill.*
2. Controlled Structural Fill	*Perform sieve tests (ASTM D422 and D1140) and modified Proctor tests (ASTM D1557) of each source of fill material.* *Inspect placement, lift thickness, and compaction of controlled fill.* *Test density of each lift of fill by nuclear methods (ASTM D2922).* *Verify extent of fill placement.*
Cast-in-Place Concrete – 1705.3	
1. Mix Design	*Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.* *Mix designs, mix verifications.*
2. Material Certification	
3. Reinforcement Installation	*Inspect size, spacing, cover, positioning, and grade of reinforcing steel. Verify that reinforcing bars are free*

	of form oil or other deleterious materials. Inspect bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters.
4. Post-Tensioning Operations	*Inspect placement, stressing, grouting, and protection of post-tensioning tendons. Verify that tendons are correctly positioned, supported, tied, and wrapped. Record tendon elongations.*
5. Welding of Reinforcing	*Visually inspect all reinforcing steel welds. Verify weldability of reinforcing steel. Inspect preheating of steel when required.*
6. Anchor Rods	*Inspect size, positioning, and embedment of anchor rods. Inspect concrete placement and consolidation around anchors.*
7. Concrete Placement	*Inspect placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.*
8. Sampling and Testing of Concrete	*Test concrete compressive strength (ASTM C31 and C39), slump (ASTM C143), air-content (ASTM C231 or C173), and temperature (ASTM C1064).*
9. Curing and Protection	*Inspect curing, cold weather protection, and hot weather protection procedures.*
Masonry – 1705.4	
1. Material Certification	
2. Mixing of Mortar and Grout	*Inspect proportioning, mixing, and retempering of mortar and grout.*
3. Installation of Masonry	*Inspect size, layout, bonding, and placement of masonry units.*
4. Mortar Joints	*Inspect construction of mortar joints, including tooling and filling of head joints.*
5. Reinforcement Installation	*Inspect placement, positioning, and lapping of reinforcing steel.* *Inspect welding of reinforcing steel.*
6. Prestressed Masonry	*Inspect placement, anchorage, and stressing of prestressing bars.*
7. Grouting Operations	*Inspect placement and consolidation of grout. Inspect masonry clean-outs for high-lift grouting.*
8. Weather Protection	*Inspect cold weather protection and hot weather protection procedures. Verify that wall cavities are protected against precipitation.*

9. Evaluation of Masonry Strength	*Test compressive strength of mortar and grout cube samples (ASTM C780).* *Test compressive strength of masonry prisms.*
10. Anchors and Ties	*Inspect size, location, spacing, and embedment of dowels, anchors, and ties.*
Structural Steel – 1705.2 and 1705.10	
Item	**Scope**
1. Fabricator Certification/Quality Control Procedures ☐ Fabricator Exempt	*Review shop fabrication and quality control procedures.*
2. Material Certification	*Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts, and welding electrodes.*
3. Open Web Steel Joists	*Inspect installation, field welding, and bridging of joists.*
4. Bolting	*Inspect installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.*
5. Welding	*Visually inspect all welds. Inspect pre-heat, post-heat, and surface preparation between passes. Verify size and length of fillet welds.* *Ultrasonic testing of all full-penetration welds.*
6. Shear Connectors	*Inspect size, number, positioning, and welding of shear connectors. Inspect suds for full 360-degree flash. Ring test all shear connectors with a 3-pound hammer. Bend test all questionable studs to 15 degrees.*
7. Structural Details	*Inspect steel frame for compliance with structural drawings, including bracing, member configuration, and connection details.*
8. Metal Deck	*Inspect welding and side-lap fastening of metal roof and floor deck.*
Spray-Applied Fire Resistant Material – 1705.14	
1. Material Specifications	
2. Laboratory Tested Fire Resistance Design	*Review UL fire resistive design for each rated beam, column, or assembly.*

3. Schedule of Thickness	*Review approved thickness schedule.*
4. Surface Preparation	*Inspect surface preparation of steel prior to application of fireproofing.*
5. Application	*Inspect application of fireproofing.*
6. Curing and Ambient Control	*Verify ambient air temperature and ventilation is suitable for application and curing of fireproofing.*
7. Thickness	*Test thickness of fireproofing (ASTM E605). Perform a set of thickness measurements for every 1,000 square feet of floor and roof assemblies and on not less than 25 percent of rated beams and columns.*
8. Density	*Test the density of fireproofing material (ASTM E605).*
9. Bond Strength	*Test the cohesive/adhesive bond strength of fireproofing (ASTM E736). Perform not less than one test for each 10,000 square feet.*

5.6 Soil Seismic Site Classification

We have evaluated the available soil profile data developed during this study to determine the Site Class in accordance with the 2018 IBC. The test boring for this project extended to the top of bedrock. Based on this analysis, we have determined the Site Class is C

5.7 Soil-Supported Slabs

Subject to the site and subgrade preparation recommendations of this report, floor slabs may be soil-supported on the existing soils or engineered fill required to raise the site to grade. Floor slabs should be jointed around columns and along footing-supported walls to minimize cracking as a result of differential movement between the floor slab and the foundation-supported elements. Subdrainage systems are not required beneath slabs, provided that floor slabs are located at least 8 inches above exterior grades and that site grades are oriented to drain stormwater away from the building. Note that footing tiles are recommended, if below slab heating ducts are used.

5.8 Groundwater Control

During the field exploration, groundwater encountered in the boring at a depth of 17 feet during drilling and it was at a depth of 8 feet in the piezometer after a few you day after drilling. It appears that the static groundwater level during our exploration was at an elevation of 735.0. Dewatering is anticipated to be necessary for the structure proposed for this facility. It appears that both wellpoints would be effective in drawing down the groundwater.

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

5.9 Slopes and Temporary Excavation

The owner and the contractor should make themselves aware of and become familiar with applicable local, state, and federal safety regulations, including current Occupational Safety and Health Administration (OSHA) excavation and trench safety standards. Construction site safety generally is the sole responsibility of the contractor. The contractor shall also be solely responsible for the means, methods, techniques, sequences, and operations of construction operations. BMI is providing the following information solely as a service to the client. Under no circumstances should BMI's provision of the following information be construed to mean BMI is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not implied and should not be inferred.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations such as OSHA Health and Safety Standards for Excavations, Chapter 29 of the Code of Federal Regulations (CFR) Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the owner, the contractor, or earthwork or utility subcontractors could be liable for substantial penalties.

For this site, the overburden soil encountered in our exploration is mostly silty soil. Some fill, estimated at a depth of 6 feet or more, will be encountered. We anticipate OSHA will classify the fill materials as Type C. The underlying naturally occurring undisturbed clay soils would be likely classified as Type B.

Note: Soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in widely spaced borings. The contractor should verify similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, BMI recommends we be contacted immediately to evaluate the conditions encountered.

Excavations ranging from 20 to 25 feet may be needed to construct the below-grade structures. As an alternative to temporary slopes, vertical excavations can be temporarily shored. The contractor or the specialty subcontractor should be responsible for the design of the temporary shoring in accordance with applicable regulatory requirements.

If any excavation, including a utility trench, is extended to a depth of more than 20 feet, OSHA requires the side slopes of such excavation be designed by a Professional Engineer.

5.10 Retaining/Below Grade Walls

Earth pressures on walls below grade are influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction, and the strength of the materials being restrained. The most common conditions assumed for earth retaining wall design are the active and at-rest conditions. Active conditions apply to relatively flexible earth retention structures, such as free-standing walls, where some movement and rotation may occur to mobilize soil shear strength. Walls that are rigidly restrained, such as basement, pit, and tunnel walls, should be designed for the at-rest condition. A third condition, the passive state, represents the maximum possible pressure when a structure is pushed against the soil, and is used in wall foundation design to help resist active or at-rest pressures. Because significant wall movements are required to develop the passive pressure, the total calculated passive pressure should be reduced by one-half to two-thirds for design purposes.

Based on previous experience with similar soils and construction, we recommend the following earth pressure coefficients for design of retaining or below-grade walls:

Design Condition	Earth Pressure Coefficient
At-Rest (K_O)	0.8
Passive (K_P)	3.0

A moist soil unit weight of 125 pounds per cubic foot (pcf) should be used for design calculations. Our recommendations assume the ground surface above the wall is level and that silty soils like those found in our borings will be used for wall backfill.

The recommended earth pressure coefficients assume constantly functioning drainage systems are installed between walls and soil backfill to prevent the accidental buildup of hydrostatic pressures and lateral stresses in excess of those stated. If a functioning drainage system is not installed, lateral earth pressures should be determined using the buoyant weight of the soil (approximately 65 pcf). Hydrostatic pressures calculated with the unit weight of water (62.4 pcf) should be added to these earth pressures to obtain the total stresses for design.

Tractors and other heavy equipment should not operate within 5 feet of below-grade walls to prevent lateral pressures in excess of those cited. If footings or other surcharge loadings are located a short distance outside below-grade walls, they may also exert appreciable additional lateral pressures. If an imaginary line projected downward at a 26-degree angle from the bottom near edge of the surcharge load does not intersect the wall, the effect of the load on the wall may be negligible. Whenever this line intersects the wall, the effect of the surcharge loads should be added to the recommended earth pressures to determine total lateral stresses. Foundation bearing levels may also be lowered to eliminate increased stresses on adjacent retaining walls.

6.0 QUALIFICATIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project, and our experience with similar sites and subsurface conditions. Data used during this exploration included, but was not necessarily limited to:

- one exploratory boring performed during this study;
- observations of the project site by our staff;
- results of limited laboratory soil testing;
- preliminary site plans and drawings furnished by Jones & Henry Engineers, Ltd.;

- limited interaction with Mr. Daniel Yodzis of Jones & Henry Engineers, Ltd.; and
- published soil or geologic data of this area.

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

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

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

Prior to construction, we recommend that BMI:

- work with the designers to implement the recommended geotechnical design parameters into plans and specifications;
- consult with the design team regarding interpretation of this report;
- establish criteria for the construction observation and testing for the soil conditions encountered at this site; and
- review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that BMI:

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

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

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

The scope of our services did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on, within, or beyond the site studied. Our work also did not include anything related to mold. Our scope of services also did not include an evaluation for the presence or absence of wetlands or protected species. Any statements in the report or on the *Boring Log* regarding odors, staining of soils, or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and sampling, including groundwater sampling, may be required. The presence or absence of wetlands or protected species should be determined by a wetlands study. BMI can provide these services and would be pleased to provide a cost proposal to perform these studies, if requested.

This report has been prepared for the exclusive use of the City of Bellevue for specific application to the proposed Bellevue Wastewater Treatment Plant Improvements in Bellevue, Sandusky County, Ohio. Specific design and construction recommendations have been provided in the various sections of the report. The report should, therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. BMI is not responsible for the independent conclusions, opinions, or recommendations made by others based on the field exploration and laboratory test data presented in this report.

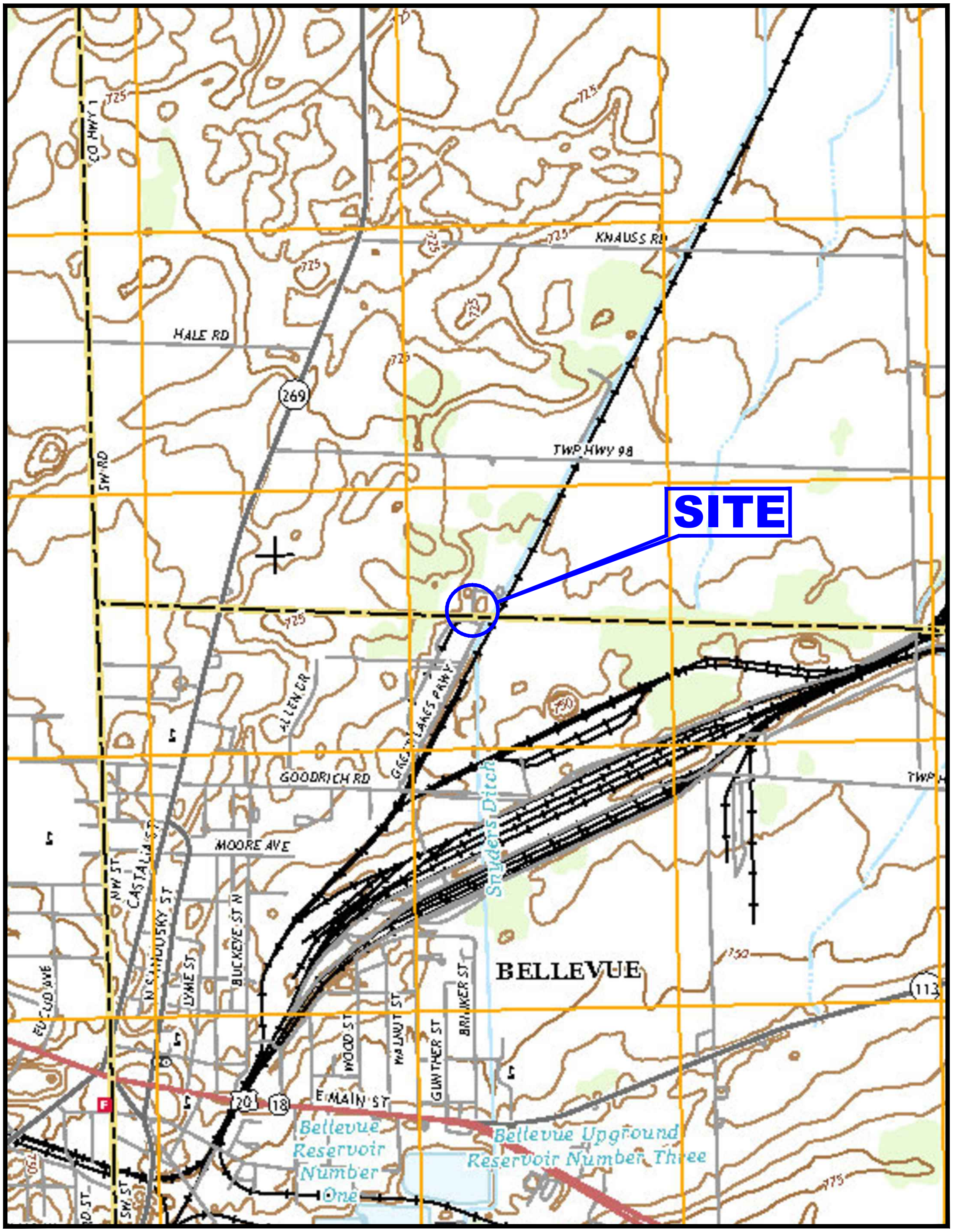
Respectfully submitted,

BOWSER-MORNER, INC.

Ahmad Rashid

Ahmad K. Rashid, P.E.
Chief Geotechnical Engineer
Manager, Toledo Engineering &
Environmental Services

AKR:/kko
Attachments: *Boring Location Plan*
Boring Log Terminology
Boring Logs
Moisture Content Summary Sheets
Model Clearing and Grading Specifications
1-Client (via email to Eric.MacMichael@cityofbellevue.com)
1-Jones & Henry Engineers (via email to dyodzis@jheng.com)



USGS QUAD: Bellevue, Ohio (2016)

Latitude: 41°17'23"N Longitude: 82°49'26"W

VICINITY MAP

Proposed Bellevue Wastewater Treatment Plant Improvements
Bellevue, Sandusky County, Ohio

Client: City of Bellevue

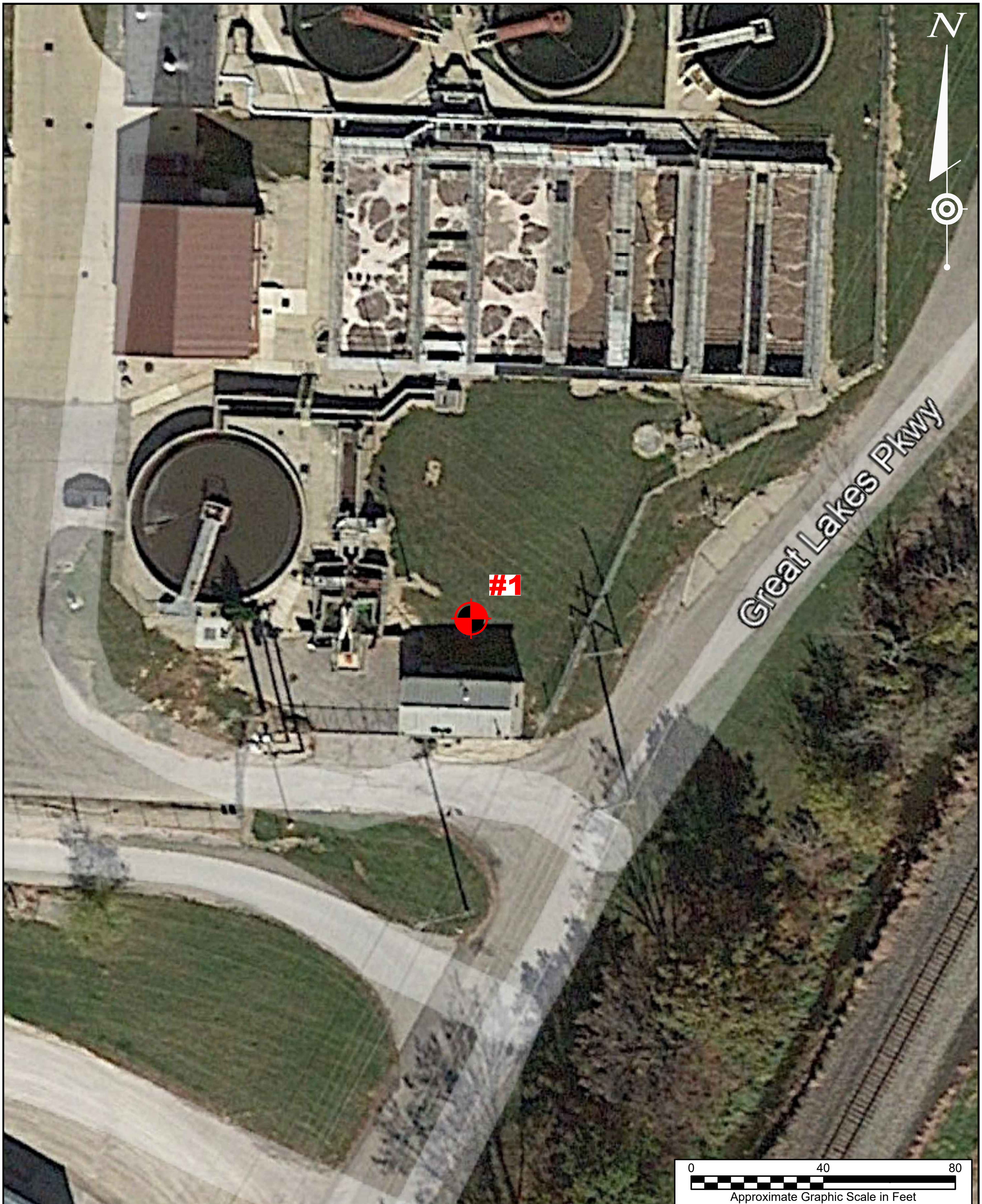
06-2022/SR

PROJECT NO.
205231

SCALE
1"=2000'

FIGURE NO.
1

BOWSER MORNER



BORING LOCATION PLAN

Proposed Bellevue Wastewater Treatment Plant Improvements
Bellevue, Sandusky County, Ohio

Client: City of Bellevue

06-2022/SR

PROJECT NO.
205231

SCALE
GRAPHIC

FIGURE NO.
2

BOWSER MORNER

BORING LOG TERMINOLOGY

Stratum Depth:

Distance in feet and/or inches below ground surface.

Description of Materials:

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

There are two types of visual classification methods currently used by Bowser-Morner, Inc. The first is ASTM D2488. This method results in classifications such as "lean clay". The second method is the ASEE system or Burmister system. This system results in classifications such as "silt and clay, with traces of sand" and is described below.

Particle Size		Visual
Boulders		Larger than 8"
Cobbles		8" to 3"
Gravel:	Coarse	3" to 3/4"
	Fine	3/4" to 2 mm
Sand:	Coarse	2 mm to 0.6 mm (pencil size)
	Medium	0.6 mm to 0.2 mm (table sugar & salt size)
	Fine	0.2 mm to 0.06 mm (powdered sugar size)
Silt		0.06 mm to 0.002 mm
Clay		0.002 mm and smaller (particles of silt and clay size are not visible to the naked eye)

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

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

Condition of Soil Relative to Compactness (Granular Material)	
Condition	**N**
Very Loose	5 blows/ft or less
Loose	6 to 10 blows/ft
Medium Dense	11 to 30 blows/ft
Dense	31 to 50 blows/ft
Very Dense	51 blows/ft of more

Condition of Soil Relative to Consistency (Cohesive Material)	
Condition	**Approximate Undrained Shear Strength**
Very Soft	Less than 250 psf
Soft	250 to 500 psf
Medium Stiff	500 to 1,000 psf
Stiff	1,000 to 2,000 psf
Very Stiff	2,000 to 4,000 psf
Hard	Greater than 4,000 psf

BOWSER MORNER

Sample Number:

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

Sample Type:

"A" Split spoon, 2-inch O.D., 1-3/8-inch I.D., 18 inches in length.
"B" One of the following:
- Power Auger Sample
- Piston Sample
- Liner Sample
- Denison Sample
- Sonic Sample

"C" Shelby Tube 3-inch O.D., except where noted.

Sample Depth:

The depth below top of ground at which the sample was taken.

Blows per 6 inches on Sampler:

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

"N" Blows/Feet:

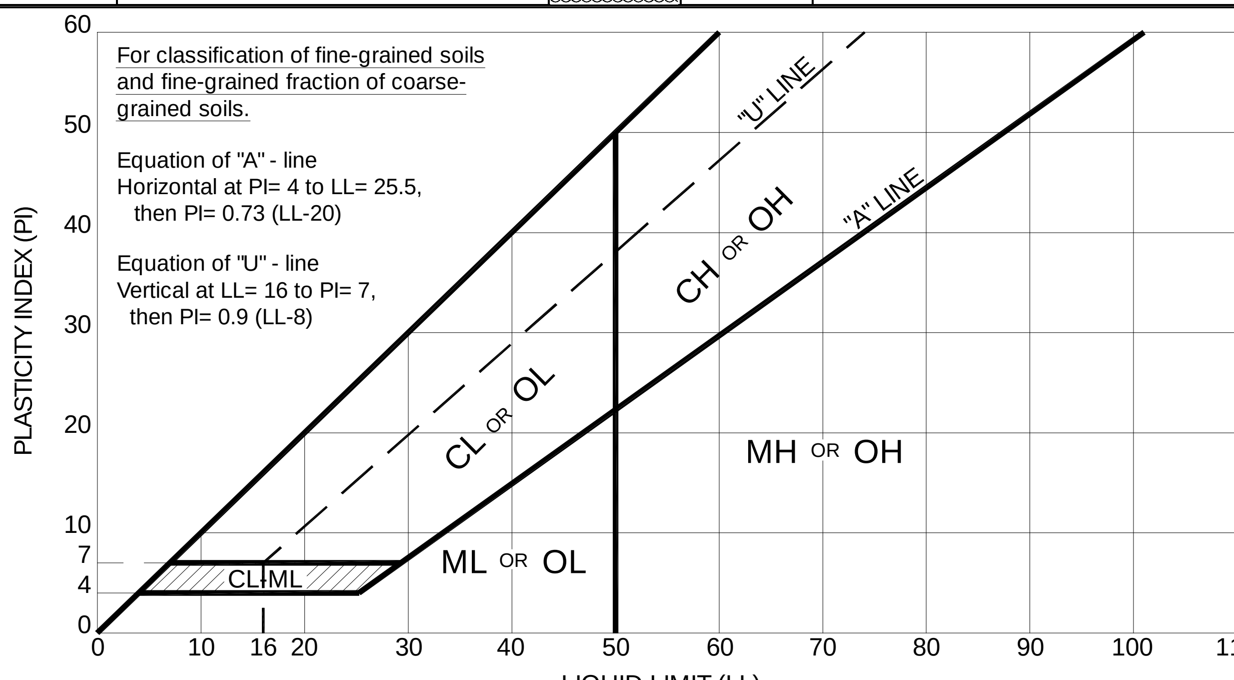
Standard penetration resistance. This value is based on the total number of blows required for the last 12 inches of penetration. (Example: 3/8/9 : N = 8 + 9 = 17)

Water Observations:

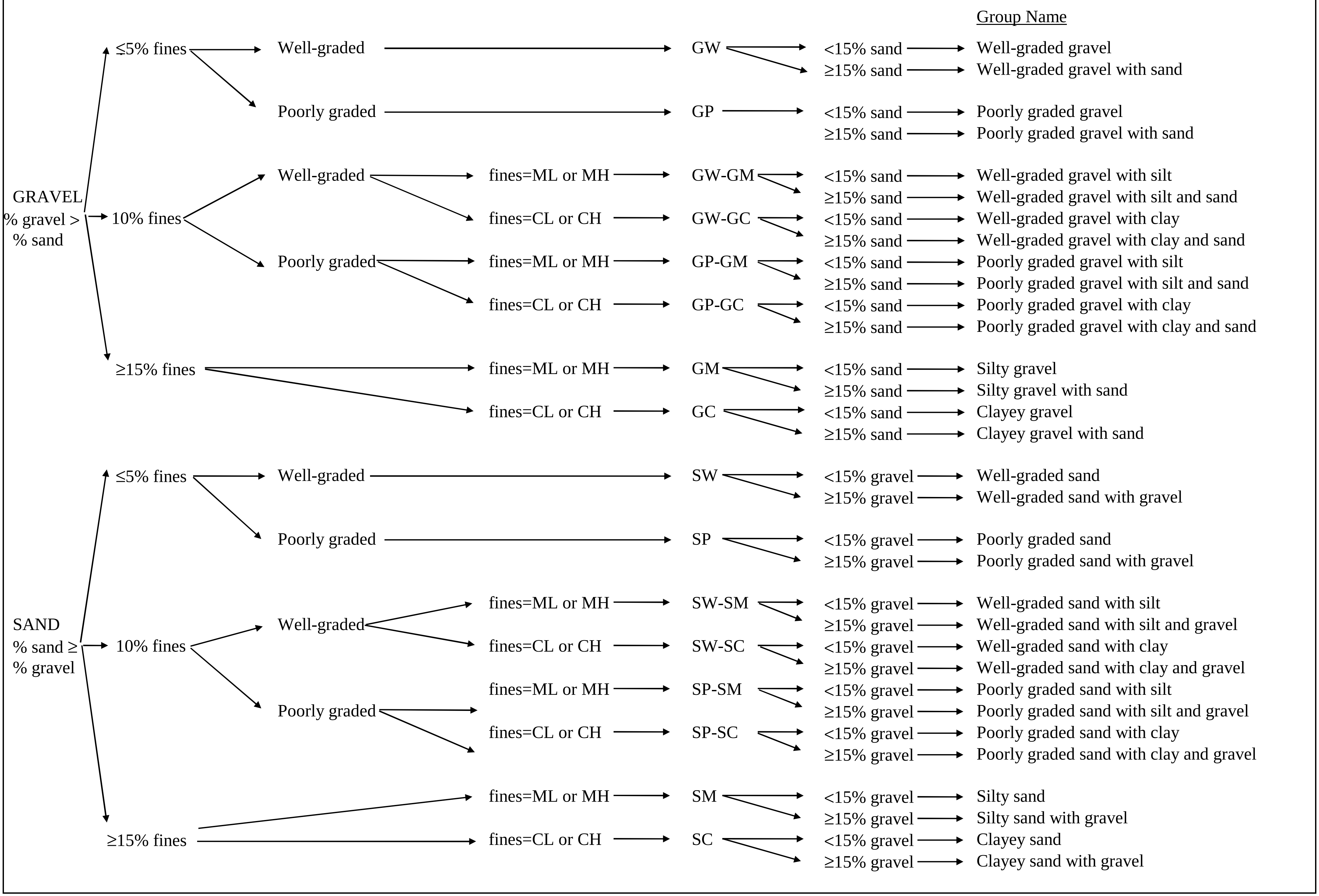
The depth of water recorded in the test boring is measured from the top of ground to the top of the water level. Initial depth indicates the water level during boring, completion depth indicates the water level immediately after boring, and depth after "X" number of hours indicates the water level after letting the water rise or fall over a time period. Water observations in pervious (sand and gravel) soils are considered reliable ground water levels for that date, Water observations in impervious (silt and clay) soils cannot be considered accurate unless records are made over a time period of several days to a month. Factors such as weather, soil porosity, etc. will cause the ground water level to fluctuate for both pervious and impervious soils.

UNIFIED CLASSIFICATION SYSTEM

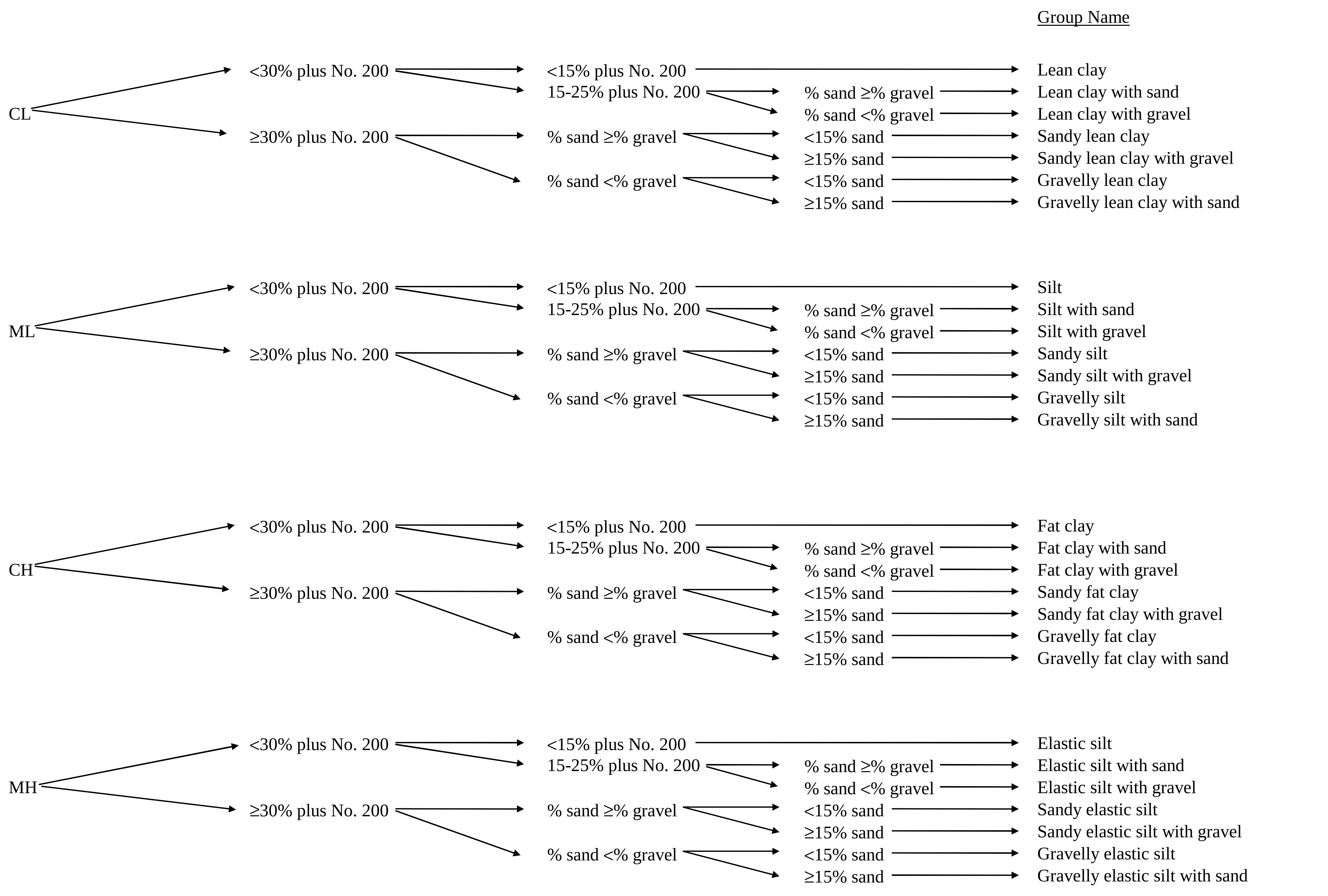
MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVEL WELL-GRADED GRAVEL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



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



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



STANDARD PENETRATION RESISTANCE (ASTM D1586)

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

Example : 2-6-8; N = 14

THIN-WALLED SAMPLER (ASTM D1587)

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

UNCONFINED COMPRESSION OR TRIAXIAL TESTS (ASTM D 2166)

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

CONSOLIDATION TEST (ASTM D 2435)

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

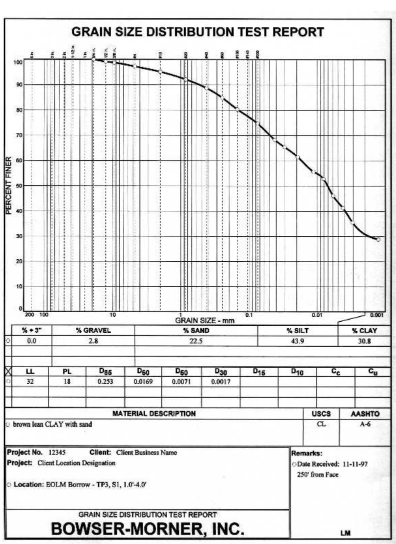
REVISED TO ASTM D4318

ATTERBERG LIMITS (ASTM D423 AND D424)

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

MECHANICAL ANALYSIS (ASTM D422)

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



GRAIN SIZE DISTRIBUTION TEST REPORT

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

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

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

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

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

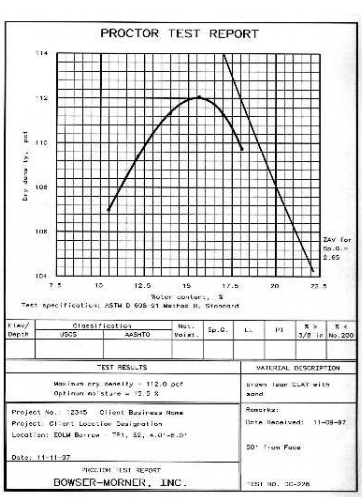
GRAIN SIZE DISTRIBUTION TEST REPORT
BOWSER-MORNER, INC.
LM

NATURAL MOISTURE CONTENT (ASTM D2216)

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

PROCTOR TESTS

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



PROCTOR TEST REPORT

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

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

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 112.0 pcf Optimum moisture = 15.5 %	brown lean CLAY with sand
Project No.: 12345 Client Business Name Project: Client Location Designation Location: EOLM Borrow - TP1, S2, 4.0'-8.0' Date: 11-11-97	Remarks: Date Received: 11-08-97 30' from Face
PROCTOR TEST REPORT BOWSER-MORNER, INC.	TEST NO. SC-228

BOWSER MORNER.

CLIENT	JOB NO.		
CITY OF BELLEVUE	**205231**		**B-1** Boring No.
PROJECT **PROPOSED BELLEVUE WASTEWATER TREATMENT PLANT IMPROVEMENTS, BELLEVUE, SANDUSKY COUNTY, OHIO**	BORING STARTED **5/25/22**	BORING COMPLETED **5/25/22**	
	DRILLER **SE, CRR, CR**	METHOD **3 1/4" HSA**	
	TYPED BY **kko**		**Sheet 1 of 1**

PROJECT LOCATION
LAT. LONG.
SURFACE ELEVATION **743±**
BORING LOCATION
As shown on Boring Location Plan.
It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute.

DEPTH (ft)	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
0.0–0.4		Topsoil			
0.4–6.0	SS-1 (1.0–2.5)	(FILL) Very stiff brown clay and silt, trace of sand, trace of crushed stone, moist	5 5 4	9	
	SS-2 (3.5–5.0)		3 4 4	8	
6.0–8.5	SS-3 (6.0–7.5)	Stiff brown clay and silt, trace of sand, moist	4 5 7	12	
8.5–13.5	SS-4 (8.5–10.0)	Stiff brown clay and silt, some sand, trace of gravel, moist	3 4 4	8	
13.5–17.0	SS-5	Weathered rock	50/2"	100	
		(Auger refusal at 17')			▼ 16.0; ▽ 17.0
17.0–22.0	NQ-1	Hard gray slightly weathered limestone RQD = 89% F.F. = 1.4/ft Formation: Devonian Columbus Limestone			
22.0		Bottom of boring at 22.0 feet			

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	17.0	▽	5/25/2022
AT COMPLETION	16.0	▼	5/25/2022
OTHER		▼	

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

BOWSER MORNER

MOISTURE CONTENT SUMMARY SHEET

Job No. 205231

Boring No.	Sample No.	Depth (Feet)	Moisture (%)
1	SS-1	1.0-2.5	19.8
	SS-2	3.5-5.0	18.0
	SS-3	6.0-7.5	17.5
	SS-4	8.5-10.0	23.0
	SS-5	13.5-15.0	*

* Stone

BOWSER MORNER®

MODEL CLEARING AND GRADING SPECIFICATIONS

I. GENERAL CONDITIONS

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

This work shall consist of all clearing and grading, removal of existing structures unless otherwise stated, proper and approved disposal of materials not reused for the project, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications.

This work is to be accomplished under the constant and continuous observation of Bowser-Morner, Inc. Bowser-Morner's presence on-site, and the fact that they may conduct observations and tests for the benefit of the Owner, in no way releases or reduces the Contractor's obligation to perform the work in strict accordance with the plans and specifications.

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

II. SUBSURFACE CONDITIONS

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

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

III. SITE PREPARATION

Within the specified areas, all trees, brush, stumps, logs, tree root balls, roots larger than one-inch in diameter, and structures scheduled for demolition shall be removed and disposed of according to requirements of applicable governing agencies. Demolition shall consist of the removal and proper disposal of all building materials, slabs, foundations, refuse, and unsuitable backfill materials.

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

Objectionable material is defined as those materials which cannot be altered or utilized according to project specifications. In no circumstances can an organic material be utilized.

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

IV. FORMATION OF FILL AREAS

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

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

Frozen material shall not be placed in the fill nor shall the fill be placed upon frozen material. The operations on earthwork shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions. The Contractor shall keep the work areas graded to provide drainage at all times.

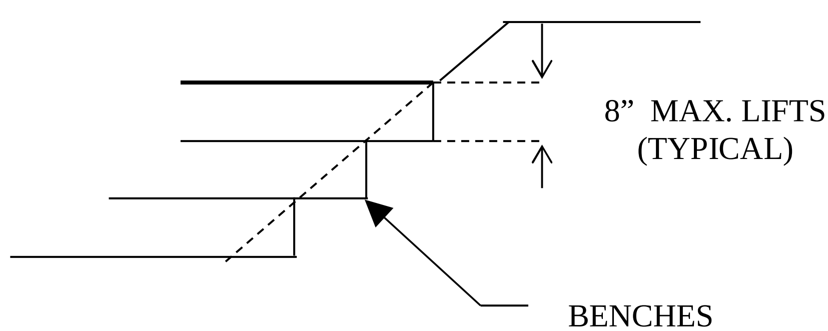
The fill material shall be of the specified moisture content range before compaction efforts are started. Wetting or drying of the material and manipulation to secure uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. The moisture content of the fill material should be no more than two (2) percentage points higher or lower than optimum when using clay or silt material, nor three (3) when using granular material unless otherwise authorized. Sprinkling shall be done with equipment that will satisfactorily distribute the water over the disced area.

Compaction operations shall be continued until the fill is compacted to not less than (*refer to recommendations found in report text*) percent above foundation elevation and (*refer to recommendations found in report text*) percent below foundation elevation of the maximum density, as determined in accordance with the most current version of ASTM (*refer to report text*) Proctor. Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers. The equipment shall be operated in such a manner that hardpan, cemented gravel, clay, or other chunky soil material will be broken up into small particles and become incorporated with the other material in the layer.

In the construction of filled areas, starting layers shall be placed in the deepest portion of the fill and, as placement progresses, additional layers shall be constructed in horizontal planes as illustrated in Figure IV-1. If directed, original slopes shall be continuously vertically benched to provide horizontal fill planes. The size of the benches shall be formed so that the base of the bench is horizontal and the back of the bench is vertical. As many benches as are necessary to bring the site to final grade shall be constructed. Filling operations shall begin on the lowest bench, with the fill being placed in horizontal eight (8) inch loose lifts unless otherwise authorized. The filling shall progress in this manner until the entire first bench has been filled, before any fill is placed on the succeeding benches. Proper drainage shall be maintained at all times during benching and filling of the benches, to insure that all water is drained away from the fill area.

FIGURE IV-1

TYPICAL LIFT PLACEMENT



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

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

V. SLOPE RATIO AND SURFACE WATER RUN-OFF

Temporary construction slopes less than 20 feet deep should not be steeper than 2 (horizontal) to 1 (vertical) in either cut or fill, and surface water shall not be drained over the slopes.

VI. GRADING

The Contractor shall furnish, operate, and maintain such equipment as is necessary to construct uniform layers and control smoothness of grade for maximum compaction and drainage. It is recommended that finish grades and intermediate grades subject to inclement weather condition be rolled with a smooth-drum roller to seal the compacted surface. Smooth surfaces should be "roughed up" by equipment cleats or sheeps-foot rollers prior to placement of the successive loose lift.

VII. COMPACTING

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

VIII. TESTING AND OBSERVATION SERVICES

Testing and observation services will be provided by the Owner.

IX. SPECIAL CONDITIONS