Subsurface Exploration Report

For the Proposed

North Olmsted Sewer Project
NEC of I-480 and Stearns Road
North Olmsted, Cuyahoga County, Ohio

Prepared for

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Prepared by

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PSI Project No. 0142-2390

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1 PROJECT INFORMATION

1.1 PROJECT AUTHORIZATION

This report presents the results of a geotechnical subsurface exploration and evaluation conducted for CT Consultants, Inc. in connection with the proposed North Olmsted Sewer Project located NEC of I-480 and Stearns Road in the City of North Olmsted, Cuyahoga County, Ohio. PSI's services for this project were performed in accordance with PSI Proposal No. 0142-346374, dated June 16, 2021. Authorization to perform this exploration and analysis was in the form of CT Consultants purchase order No. 917-21, dated August 2, 2021.

1.2 PROJECT DESCRIPTION

Based on the provided information, it is understood that the proposed project includes construction of an equalization tank, pump station building, generator pad, sewer line and new access driveway as describe below:

Equalization Tank (B-8 through B-11):

- The Equalization Tank will measure approximately 125 feet in diameter and have a capacity of approximately 1.5 MG gallons and will be 16 feet deep with interceptor about 20 feet deep.

Pump Station building and Generator Pad (B-5 through B-7):

- The Pump Station building will be a single-story slab on grade building measuring approximately 2,200 square feet in plan area.
- Generator pad bearing on mat/slab foundation.

Other (B-1 through B-4):

- New Access Driveway (B-1 and B-2)
- Connecting Sewer to connect with exiting 30" sewer line bearing the depth of about 8 to 12 feet below surface grades (B-3 and B-4)

No topographic plans were available at the time of this report submittal. However, based on Cuyahoga County topographical information, the site slopes downward from south to north with a maximum elevation difference of about 4 feet (778.0' MSL and 774.0' MSL) within the proposed development area. Based on the provided it is anticipated that maximum cut operations of about 20 feet will be required for the proposed Equalization Tank bearing elevations.

No other information was available at this time.

The geotechnical recommendations presented in this report are based on the available project information, the proposed building and tank location on the site, and the subsurface materials described in this report. If any of the information we have been given or have assumed is incorrect, please contact us so that we may amend the recommendations presented accordingly. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this exploration was to evaluate the soil and groundwater conditions at the site to provide recommendations, from a geotechnical engineering viewpoint, relative to the proposed development. The scope of the exploration and analysis included a reconnaissance of the project site, drilling eleven (11) test borings for the

proposed construction, a laboratory-testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include an environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client.

2 SITE AND SUBSURFACE CONDITIONS

2.1 SITE LOCATION AND DESCRIPTION

The proposed Sewer Project will be located at NEC of I-480 and Stearns Road in the City of North Olmsted, Cuyahoga County, Ohio. Specifically, the proposed development will be located within parcels #23422002, #23422022 and #23422023. See the attached boring location plan for general location of the proposed structures.

The proposed construction area is undeveloped and predominantly wooded. Based on Cuyahoga County topographical information, the site slopes downward from south to north with a maximum elevation difference of about 4 feet (778.0' MSL and 774.0' MSL). Surface drainage was good during the field drilling operations. All utilities should be checked and marked prior to construction activities.

2.2 SUBSURFACE CONDITIONS

The general subsurface conditions at the site were explored with a total of eleven (11) test borings. The test borings were drilled to depths of approximately 10 to 35.5 feet below the existing surface grades. The approximate boring locations are shown on the Boring Location Plan presented in the *Appendix* of this report. The locations for the test borings were selected by PSI and located in the field relative to existing site features and based on site accessibility and the presence of below ground utilities.

The borings were advanced utilizing 3¼ inch inside diameter, hollow-stem auger drilling methods. Soil samples were routinely obtained during the drilling process. Selected soil samples were later tested in the laboratory to obtain soil material properties for the foundation, floor slabs and pavement recommendations. Drilling, sampling, and laboratory testing was accomplished in general accordance with ASTM procedures.

The types of subsurface materials encountered in the test borings have been visually classified. The results of the visual classifications, Standard Penetration tests, moisture contents and water level observations are presented on the boring logs in the *Appendix* of this report. Representative samples of the soils were placed in sample jars and are now stored in the laboratory for further analysis, if requested. Unless notified to the contrary, all samples will be disposed of after 60 days following the date of this report.

The surface of the site at all test boring locations was covered with a 2 to 13-inch-thick layer of topsoil. The thickness of the surface is expected to vary throughout the site.

Underlying the surface materials encountered at test boring locations B-1 and B-2, a layer of fill material was encountered. The fill material extended to depth of about 3.5 to 5 feet below the existing grade. The fill material consisted primarily of lean clay, with varying amounts of sand, silt, gravel, concrete and organics. The fill material exhibited moisture contents ranging from 21 to 37 percent. The depths, composition, and engineering characteristic of the fill materials may be variable.

Underlying the topsoil and fill materials encountered, natural soils were encountered at all test boring locations. The natural soils at test boring location B-1 through B-7 were encountered to the terminal depths of exploration about 10 to 20 feet below the existing surface grades and were extended to the depths about 8.5 to 28 feet below the existing surface grades at the test boring locations B-8 through B-11. The natural soils consisted of lean clay and sandy silt with varying amounts of gravel and rock fragments. Natural soils exhibited moisture contents ranging from about 9 to 28 percent. The natural cohesive soils exhibited a medium stiff to hard consistency and loose to very dense relative density for granular soil, based on the Standard Penetration tests.

The area's bottommost formation consisted of gray, very weak to very strong, highly weathered sandstone. The bedrock formation was encountered at test boring locations B-8 through B-11 below the natural soils at the depth of about 8.5 to 28 feet below the existing surface grade.

The subsurface description is of a generalized nature provided to highlight the major strata encountered. The boring logs included in the Appendix should be reviewed for specific information at the individual boring locations. The stratifications shown on the boring logs represent the conditions only at the actual test positions. Variations may occur and should be expected between the boring locations. The stratifications represent the approximate boundary between the subsurface materials, and the transition may be gradual or not clearly defined.

2.3 GROUNDWATER LEVEL MEASUREMENTS

Groundwater was encountered in test borings B-5 through B-10, at depths ranging from 13 to 19.5 feet below the existing grade during the drilling operations and was only encountered at boring location B-10, at the depth of about 12 feet below the existing grade after completion of drilling operations. Note that groundwater levels fluctuate seasonally as a function of rainfall. During a time of year or weather different from the time of drilling, there may be a considerable change in the water table. Furthermore, the water levels in the boreholes often are not representative of the actual groundwater level, because the boreholes remain open for a relatively short time. Therefore, we recommend that the contractor determine the actual groundwater levels at the time of construction to evaluate groundwater impact on the construction procedures.

3 EVALUATION AND RECOMMENDATIONS

3.1 SITE PREPARATION AND EARTHWORK CONSTRUCTION

Prior to placing concrete floors or engineered fill on this site, general site area clearing should be carried out. All topsoil, grass, trees, roots, excessively wet soils, highly organic soils, and soft/loose or obviously compressible materials, should be completely removed from the proposed construction areas. *Additionally, the unsuitable fill material as evidenced at the test boring locations B-1 and B-2 should be completely removed from the building/foundation area and removed to a depth of 18 inches below proposed pavement subgrade elevations and replaced with compacted engineered fill.* The precise extent of required cut and fill should be determined in the field by a representative of PSI following observation of the exposed subgrades and proof rolling operations.

Following the site clearing, stripping and undercutting, and prior to placing engineered fill, the exposed subgrades should be critically proof rolled with a loaded 20-ton tandem-axle dump truck until the grade offers a relatively unyielding surface. Areas of excessive yielding, as observed by a PSI representative, should be excavated and backfilled with compacted engineered fill and/or the unstable soils can be stabilized by choking the exposed bearing surface with crushed limestone or similar coarse aggregate. After the existing subgrade materials are excavated to design grade, proper control of subgrade compaction and the placement and compaction of new fill materials should be observed and tested by a representative of PSI.

It is recommended that the site preparation, proof rolling, and earthwork activities should be performed during a period of dry weather, which can significantly reduce the required extent of soil stabilization, drainage and surface repairs.

During site preparation, fill piles, burn pits, trash pits or other isolated disposal areas may be encountered. All too frequently such buried material occurs in isolated areas outside boring locations. Any such material encountered during site work, or foundation, floor slab or pavement construction should be excavated, removed from the site, and backfilled with compacted structural fill.

3.2 ENGINEERED FILL

Materials selected for use as structural fill should not contain more than 5 percent by weight of organic matter, waste construction debris, or other deleterious materials. Fill materials should have a standard Proctor maximum dry density of greater than 110 pounds per cubic foot (pcf), an Atterberg Liquid Limit of less than 40, a Plasticity Index of less than 15, and a maximum particle size of 3 inches or less. Structural fill should consist of non-expansive materials. Pyritic and/or potentially expansive materials, such as mine tailings, shales and slag should not be used as structural fill.

Fill materials should be placed and compacted in individual lifts of 8 inches or less loose measurement. Within small excavations such as in utility trenches, around manholes, or behind retaining walls, we recommend the use of smaller, hand or remote-guided equipment. Loose lift thicknesses of 4 inches or less are recommended when using such equipment.

We recommend that structural fill be compacted to a minimum of 98 percent of the maximum dry density and within 2% of the optimum moisture content, as determined by ASTM D-698. The upper 24 inches of floor slab subgrade soils should be compacted to at least 100 percent of the maximum dry density and within 2% of the optimum moisture content, as determined by ASTM D-698. A representative of PSI should observe fill placement operations and perform density tests concurrently to indicate if the specified compaction is being achieved.

Representative samples of the proposed fill materials should be collected at least one week prior to the start of the filling operations. The samples should be tested to determine the maximum dry density, optimum moisture content, particle size distribution and plasticity characteristics. These tests are needed to determine if the material is acceptable as structural fill and for quality control during the compaction process.

3.3 FOUNDATION RECOMMENDATIONS

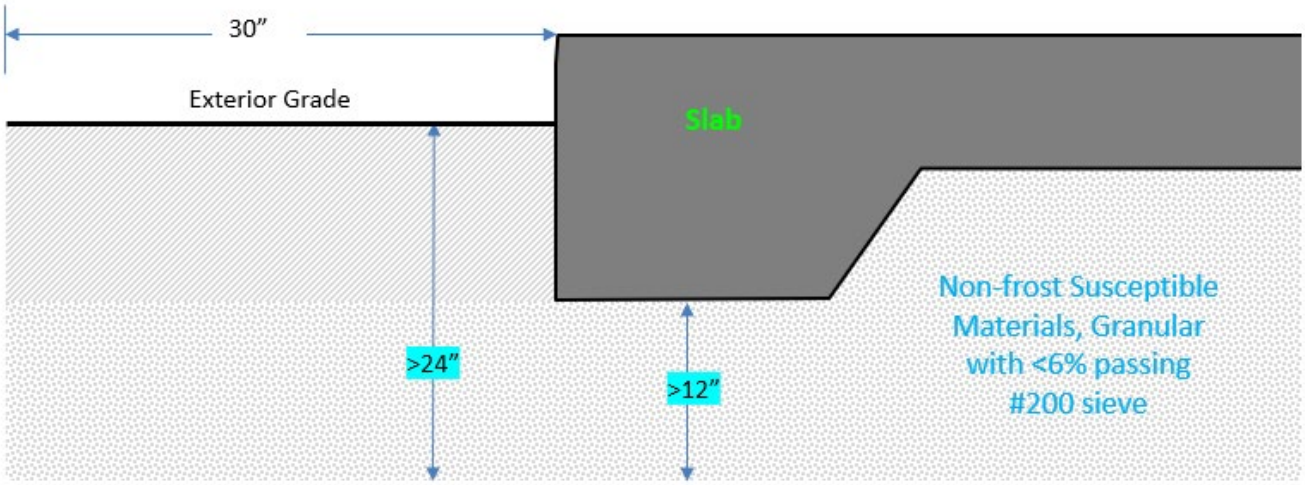
The results of the test borings indicate that the proposed pump station foundation will be bearing within the area's natural soil formation. A maximum allowable soil bearing pressure of 2,000 psf and subgrade modulus reaction (k) of 80 pci can be used for the mat/slab foundation design. A representative of PSI should be present at the site during foundation excavation and construction.

A gravel layer (such as AASHTO #57 or equivalent) should be provided between the mat/slab foundation and the approved bearing surfaces. The gravel layer should have a minimum thickness of 12-inches and be properly compacted. Additionally, the building floor slab should be structurally separated from the proposed foundation areas

The calculated total and differential settlement will be less than 1.0-inch for the total loads for the recommended bearing pressure. The above recommended allowable bearing pressure is based on a minimum safety factor of 3.0 and is intended for dead loads and sustained live loads.

3.4 UNHEATED SLAB RECOMMENDATIONS

Grade supported pump station and generator pad foundation in unheated areas shall have a minimum of 12 inches of non-frost susceptible materials to a depth of 24 inches below the exterior grade with at least 12 inches below the bottom of the slab or perimeter footings. These materials shall extend at least 30 inches from the outside limits of the grade supported slab. The 30-inch dimension can be reduced by 1.25 inches for every additional inch below 24 inches that the non-frost susceptible material is extended below grade. Non-frost susceptible soil is defined as drained, granular material with less than 6% passing the #200 sieve. The non-frost susceptible soils shall be graded and gravity drained such that it will not impound or trap water within the frost protected area.



For subgrade prepared as recommended and properly compacted fill, a modulus of subgrade reaction, *k* value, of 50 pounds per cubic inch (pci) may be used in the grade slab design based on correlation to values typically resulting from a 12-inch diameter plate load test. However, depending on how the slab load is applied, the value will have to be geometrically modified. The value should be adjusted for larger areas using the following expression for cohesive and cohesionless soil:

Modulus of Subgrade Reaction; $k_s = (\frac{k}{B})$ for cohesive soil and

$k_s = k\,(\frac{B+1}{2B})^2$ for cohesionless soil

where: k_s = coefficient of vertical subgrade reaction for loaded area,
k = coefficient of vertical subgrade reaction for 1 square foot area, and
B = effective width of area loaded, in feet

The precautions listed below should be followed for construction of slab-on-grade pads. These details will not reduce the amount of movement but are intended to reduce potential damage should some settlement of the supporting subgrade take place. Some increase in moisture content is inevitable as a result of development and associated landscaping. However, extreme moisture content increases can be largely controlled by proper and responsible site drainage, building maintenance, and irrigation practices.

- Cracking of slab-on-grade concrete is normal and should be expected. Cracking can occur not only as a result of heaving or compression of the supporting soil and/or bedrock material, but also as a result of concrete curing stresses. The occurrence of concrete shrinkage crack, and problems associated with concrete curing may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement, finishing, and curing, and by the placement of crack control joints at frequent intervals, particularly where re-entrant slab corners occur. PSI also recommends that the slab be independent of the foundations. Using fiber reinforcement in the concrete can also control shrinkage cracking.
- The American Concrete Institute (ACI) recommends a maximum panel size (in feet) equal to approximately three times the thickness of the slab (in inches) in both directions. For example, joints are recommended at a maximum spacing of 12 feet based on having a 4-inch thick slab.
- Areas supporting slabs should be properly moisture conditioned and compacted. Backfill in all interior and exterior utility line trenches should be properly compacted to reduce the shear stress in the concrete extending over these areas.

3.5 EQUALIZATION TANK FOUNDATION RECOMMENDATION

The results of the test boring B-8 through B-11 indicate that the proposed Equalization Tank foundation will be bearing within the area's natural soil formation or stepped down to bedrock, and can be designed utilizing a maximum allowable soil/rock bearing pressure of 5,000 psf. Foundation bearing surface evaluations should be performed by a representative of PSI during excavation prior to placement of reinforcing steel.

A gravel layer (such as AASHTO #57 or equivalent) should be provided between the slab foundations and the approved bearing surfaces. The gravel layer should have a minimum thickness of 12 inches and be properly compacted. Alternatively, a layer of mud mat can be installed between the bearing surface and slab foundation.

Construction specifications are to specifically preclude the possibility of long-term inundation of excavations and mechanical disturbance of the proposed bearing surfaces. In addition, it is recommended that concreting operations occur immediately after foundation excavation and that wherever practical, concrete be poured "neat" i.e., employing soil as forms.

Precautions must be taken in the design of the proposed structures to assure that the systems are flexible enough to absorb some settlement without impairment of its proper function. It is anticipated that maximum total foundation settlement will be less than 1.0 inch based on the total allowable loads.

3.6 SEISMIC SITE CLASS

The project site is located within a municipality that employs the International Building Code. As part of this code, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site. As part of the procedure to evaluate seismic forces, the code requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface.

To define the Site Class for this project, we have interpreted the results of soil test borings drilled with the project site and estimated appropriate soil properties below the base of the borings to a depth of 100 feet, as permitted by Section 1615.1.1 of the code. The estimated soil properties were based upon data available in published geologic reports as well as our experience with subsurface conditions in the general site area.

Based on table 1615.1.1 of the OBC Building Code, the test boring results and review of the geology in vicinity to the project area, a Site Classification of 'C' can be utilized for the seismic design.

3.7 BELOW GRADE WALL MEMBERS

Exterior walls for the proposed Equalization Tank and interceptor will be supporting soils to depths of about 16 to 20 feet; therefore, these wall members should be designed as earth retaining structures. It is unlikely that significant lateral deflections will occur, permitting active earth pressure to develop from the structure walls. Therefore, the walls should be designed for at rest earth pressure conditions. If granular material is used for backfilling, an equivalent fluid at rest pressure value of 60 pounds per cubic foot can be used for drained backfill condition. It is further recommended that due allowance be given for any surcharge loads. Surcharge loads should be taken as an equivalent uniform load having a rectangular distribution with depth and a lateral earth pressure coefficient of 0.50. If granular material is not utilized as backfill, then an equivalent fluid at rest pressure value of 68 pounds per cubic foot and lateral earth pressure coefficient of 0.56 can be used for drained conditions. If no drainage is provided, the effects of saturated soil conditions need to be included in the design. This would increase the equivalent fluid values to 92 pounds per cubic foot if granular backfill is utilized and 95 pounds per cubic foot if granular backfill is not utilized under saturated soil conditions.

Once the below grade walls are built, over compaction of the materials against its back face is to be avoided under all circumstances to prevent undue lateral earth pressures.

3.7.1 UPLIFT CONSIDERATIONS

The results of the test boring B-5 through B-10 indicate that the ground water table was 13 to 19.5 feet below the existing surface grades. It must be recognized that, over a time period, the backfill against the below grade structure will be saturated. Under this circumstance it is possible that the bottom slab will be subjected to hydrostatic uplift, which should be considered in the design. Uplift may be resisted by assuring that the dead load of the proposed structure counterbalances the buoyant forces with an appropriate factor of safety. Enough waterproofing and water stops should be used to prevent in-flow seepage into the wet pump station.

3.7.2 EXCAVATION SUPPORT

Based on the information provided by CT Consultants, Inc., it appears that the proposed tank and sewer line will bear within the area's rock formation or natural soil formation. In view of the results of the test boring operations,

laboratory test studies, analysis and provided information, consideration should be given to the following factors in the design and installation of the proposed structures.

Per OSHA excavation regulations, open cut excavation is possible up to a maximum depth of twenty (20) feet. However, considerations should be given to existing underground utilities and structures, which may be affected due to the open cut excavations. The excavation slopes should follow OSHA guidelines for type 'C' soils. If temporary excavation support is required, the contractor or specialty subcontractor should be responsible to design and install the required system. For the various subsurface formations encountered, the following soil parameters may be adopted for determining lateral earth pressures:

Type of Soil	Unit Weight (pcf)	Undrained Shear Strength	Drained Shear Strength
Lean Clay/Sandy Silt	120 to 125	C = 1,000 psf	ϕ' = 24°, C' = 100 psf
Silty Sand	135	ϕ = 30°	ϕ' = 32°, C' = 0 psf
Weathered Sandstone	130	C = 8,000 psf	ϕ' = 36°, C' = 0 psf

The design groundwater depth should be determined based on the actual groundwater conditions encountered in the field during construction.

Based on the subsurface exploration data, it appears that the top 2 to 3 feet of the area's weathered sandstone bedrock formation could be rippable with conventional excavation equipment. However, the more competent formation may require rock rippers or controlled blasting. The limits and characteristics of the bedrock formations should be defined by the contractor prior to bidding and construction. The individual boring logs and laboratory data in the Appendix should be reviewed relative to the engineering characteristics of the encountered rock formation.

3.7.3 PIPE SUPPORT

For the structural and functional integrity of the utilities, it is imperative that the pipes have adequate foundation, i.e., the subsurface materials should have adequate support capabilities and be able to provide uniform bedding to the pipe. The bedding may be provided either with shaped bottom and tamped backfill, or by compacted granular bedding with tamped backfill. The granular bedding should meet the specification for Type 2 bedding (i.e., ODOT's Construction and Material Specifications Item #603.04). The bedding shall extend up around the pipe for a depth of 6 inches or 30 percent of the outside diameter of the pipe, whichever is greater. The remainder of the backfill should be compacted soil. Granular bedding not only provides firm uniform support for the pipe but also stabilizes the trench bottom.

3.7.4 MANHOLE STRUCTURES

Within the area's overburdened soils, freestanding excavations will not be possible for the proposed manhole structures. Therefore, a lateral support system will be required for the manhole excavations. The magnitude of the lateral earth pressures may be calculated utilizing the previously outlined soil parameters.

It is recommended that the maximum soil bearing pressures resulting from the above-discussed loading conditions, as well as the weight of the manhole and other facilities associated with the structure should not exceed 2,500 psf. Based on the recommended bearing pressure, the anticipated settlement will be less than 1.0-inch. It is recommended that suitability of the bearing surfaces be verified by the project's geotechnical engineer.

3.7.5 BACKFILL OPERATIONS

Any backfill required against the manhole structures and utility trench should consist of freely draining granular materials. The backfill is to be placed on a controlled lift-by-lift basis. Individual fill lifts are to be of maximum 8-inch loose measure thickness, and each individual lift is to be adjusted in moisture content to within plus or minus 2 percent of the optimum moisture content as determined by ASTM D-698. The fill materials are to be systematically compacted, such that an in-place density of at least 98 percent of the maximum laboratory density as determined by the above-referenced ASTM method is achieved.

It must be recognized that, over a time period, the backfill against the manholes will be saturated. Under this circumstance it is possible that the bottom slab for the manhole will be subjected to hydrostatic uplift that should be considered in the design. Uplift may be resisted either by assuring that the dead loads of the proposed structure counterbalance the buoyancy forces or by providing a system of pressure relief valves. Lateral pressures acting on the manholes can be defined based on the effective strength parameters recommended in a previous section plus hydrostatic pressure. Specifications should require that the resulting fill materials' densities be verified by test measurements conducted by the geotechnical engineer.

3.8 PAVEMENT CONSTRUCTION

Prior to the pavement reconstruction, it is recommended that all existing topsoil, soft/loose and deleterious surface materials should be completely removed. The required pavement/base thickness should be evaluated utilizing an average **California Bearing Ratio (CBR) value of 4**.

Design for drainage is of the utmost importance to minimize detrimental effects that may shorten the service life of the pavements. The pavement should be crowned or sloped in order to promote effective surface drainage and reduce the risk of water ponding. We recommend a minimum slope of 1.5 percent. In addition, the subgrade should be similarly sloped to promote effective subgrade drainage. We recommend "stub" or "finger" drains be provided around catch-basins and in other low areas of the proposed pavements to limit the accumulation of water on the frost susceptible subgrade soils. Subsurface edge drains should be provided at curbs. Where no curbs are proposed, ditches should be provided and the pavement base course should be daylighted through the ditch side slope to facilitate drainage of the base course.

Subsurface "stub" or "finger" drains should be perforated corrugated plastic pipe or an equivalent. The pipe should be surrounded by a minimum of 4 inches of free draining aggregate, with the aggregate fully encased in a non-woven geotextile filter fabric.

All materials to be employed and field operations required in connection with the pavement reconstruction should follow recommendations and procedural details as per the Ohio Department of Transportation, Asphalt Institute, and/or American Concrete Institute.

4 CONSTRUCTION CONSIDERATIONS

4.1 GROUNDWATER CONTROL AND DRAINAGE

Free groundwater was encountered in test borings B-5 through B-10, at depths ranging from 13 to 19.5 feet below the existing grade during the drilling operations and was only encountered at boring location B-10, at the depth of about 12 feet below the existing grade after completion of drilling operations. Accordingly, a gravity drainage system, sump pump or other conventional dewatering procedure, as deemed necessary by the field conditions, should be implemented throughout construction such that the groundwater is always controlled and maintained at an elevation of at least 2 feet below the excavation bottom. Every effort should be made to keep the excavations dry if water is encountered.

4.2 EXCAVATIONS

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P." This document was issued to better ensure the safety of workers entering trenches or excavations. It is mandated by this federal regulation that all excavations, whether they be utility trenches, basement excavations or foundation excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced. If they are not followed closely, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person" as defined in "CFR Part 1926," should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. PSI is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred. If the excavations are left open and exposed to the elements for a significant length of time, desiccation of the clays may create minute shrinkage cracks which could allow large pieces of clay to collapse or slide into the excavation.

Materials removed from the excavation should not be stockpiled immediately adjacent to the excavation, inasmuch as this load may cause a collapse of the embankment.

4.3 WEATHER CONSIDERATIONS

The soils encountered at this site are known to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. Care should be exercised during the grading operations at the site. Due to the fine-grained nature of the surficial soils, the traffic of heavy equipment, including heavy compaction equipment, may very well create pumping and a general deterioration of those soils in the presence of water. Therefore, the grading should, if possible, be performed during a dry season. A layer of crushed stone may be required to allow the movement of construction traffic over the site during the rainy season. The contractor should maintain positive site drainage and if wet/pumping conditions occur, the contractor will be responsible to over excavate the wet soils and replace them with a properly compacted engineered fill. During wet seasons, limestone stabilization may be required to place engineered fill.

5 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. Site exploration identifies actual subsurface conditions only at those points where samples are taken. A geotechnical report is based on conditions that existed at the time of the subsurface exploration. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding sections constitute PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

6 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by CT Consultants, Inc. If there are any revisions to the plans for the proposed structures and pavement, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be retained to determine if changes in the recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that PSI be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and recommendations are properly interpreted and implemented. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of CT Consultants, Inc. for the specific application to the proposed North Olmsted Sewer Project located NEC of I-480 and Stearns Road in the City of North Olmsted, Cuyahoga County, Ohio.

LIST OF APPENDICES

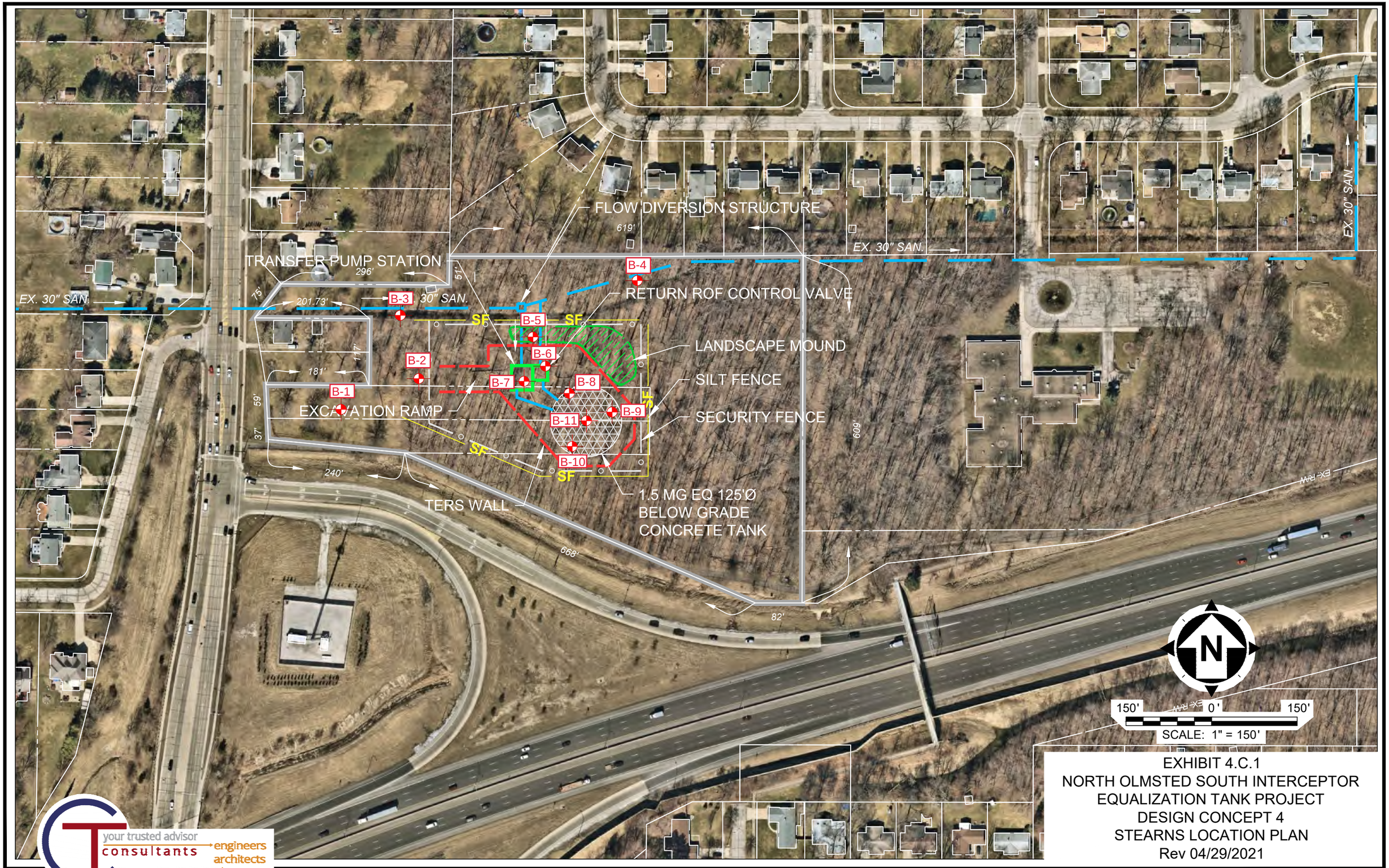


EXHIBIT 4.C.1
NORTH OLMSTED SOUTH INTERCEPTOR
EQUALIZATION TANK PROJECT
DESIGN CONCEPT 4
STEARNS LOCATION PLAN
Rev 04/29/2021

your trusted advisor
consultants
engineers
architects
planners

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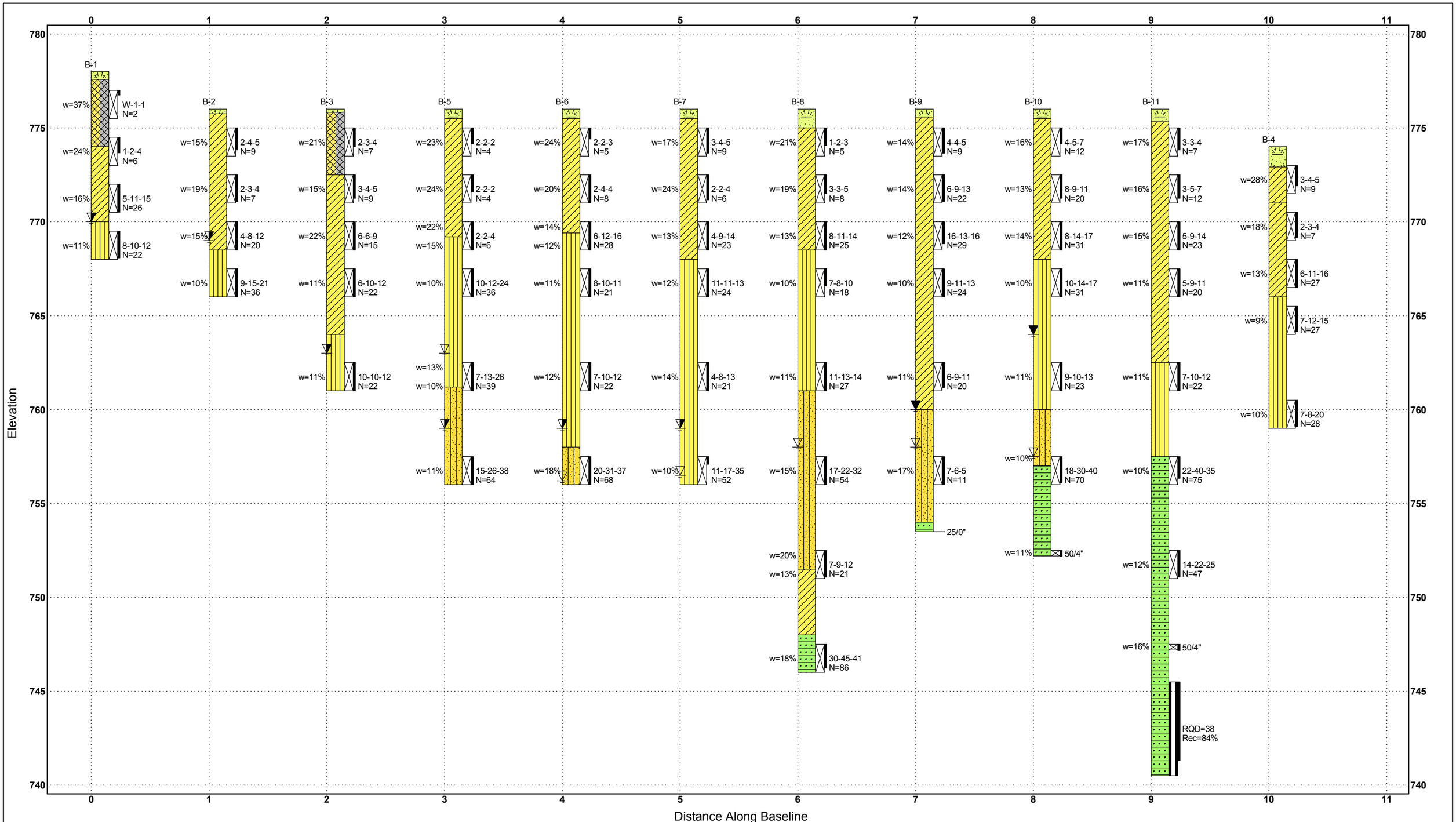

intertek psi
Professional Service Industries, Inc.
5555 Canal Road
Cleveland, OH 44125

Profile

North Olmsted Sewer Project
PSI Project Number: 0142-2390

Stearns Road
North Olmsted, Cuyahoga County, OH

BORING B-1

DATE STARTED:	9/14/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/14/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	10.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	778 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	8 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	0					**5" Topsoil**	Topsoil				
				1	3	Soft, Moist, Brown to Gray **Lean CLAY** with Organics, Trace Gravel, Trace Sand @ 2 feet ; Concrete Slab	Fill	W-1-1 N=2	37		
775											
				2	10	Medium Stiff to Very Stiff, Moist, Brown to Gray **Lean CLAY**, Trace Gravel, Trace Sand, Trace Organics	CL	1-2-4 N=6	24		
	5										
				3	18			5-11-15 N=26	16		
770						Very Stiff, Moist, Gray **SILT**, Trace Sand, Travel Gravel	ML				
				4	17			8-10-12 N=22	11		
	10										

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Professional Service Industries, Inc.
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Telephone: (216) 447-1335

PROJECT NO.: 0142-2390
PROJECT: North Olmsted Sewer Project
LOCATION: Stearns Road
North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-2

DATE STARTED:	9/14/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/14/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	10.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV

REMARKS:

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	7 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0, 25, 50) STRENGTH, tsf Qu ▲ Qp ✳ (0, 2.0, 4.0)	Additional Remarks
775	0			1	14	**3" Topsoil** Stiff to Medium Stiff, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics	Topsoil	2-4-5 N=9	15		
				2	17		CL	2-3-4 N=7	19		LL = 30 PL = 17 Fines=75.8%
770	5			3	18 ▼			4-8-12 N=20	15		
				4	18	Hard, Moist, Gray **SILT**, Trace Sand, Trace Gravel	ML	9-15-21 N=36	10		
	10										

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PROJECT NO.: 0142-2390
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LOCATION: Stearns Road
North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-3

DATE STARTED:	9/14/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/14/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	15.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV

REMARKS:

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	13 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0, 25, 50) STRENGTH, tsf Qu ▲ Qp ✳ (0, 2.0, 4.0)	Additional Remarks
775	0			1	12	**2" Topsoil** Medium Stiff, Moist, Dark Brown/Black **Lean CLAY**, Trace Gravel, Trace Sand, Trace Organics and Roots	Topsoil Fill	2-3-4 N=7	21		
				2	15	Stiff to Very Stiff, Moist, Dark Brown to Brown **Lean CLAY**, Trace Gravel, Trace Sand, Trace Organics		3-4-5 N=9	15		
770	5			3	18		CL	6-6-9 N=15	22		
				4	18			6-10-12 N=22	11		LL = 24 PL = 15 Fines=70.7%
765	10			5	18	Very Stiff, Moist, Gray **Sandy SILT**, Trace Gravel	ML	10-10-12 N=22	11		
	15										

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North Olmsted, Cuyahoga County, OH

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BORING B-4

DATE STARTED:	9/16/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/16/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	15.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	774 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	N/A
Upon Completion	N/A
Caved Depth	N/A

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
	0					**13" Topsoil**	Topsoil		
				1	13	Stiff, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics (Possible Fill)	CL	3-4-5 N=9	28
770				2	16	Medium Stiff to Very Stiff, Moist, Brown **Lean CLAY** with Sand, Trace Gravel	CL	2-3-4 N=7	18
	5			3	18			6-11-16 N=27	13
765				4	16	Very Stiff, Moist, Gray **Sandy SILT**, Trace Gravel	ML	7-12-15 N=27	9
	10								
760				5	17			7-8-20 N=28	10
	15								

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

Additional Remarks

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PROJECT NO.: 0142-2390
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North Olmsted, Cuyahoga County, OH

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BORING B-5

DATE STARTED:	9/15/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/15/21	**DRILLER:** JJ	**LOGGED BY:** SP
COMPLETION DEPTH	20.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	13 feet
Upon Completion	N/A
Caved Depth	17 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
775	0	1	10	**6" Topsoil**	Topsoil	2-2-2 N=4	23
				Soft to Medium Stiff, Moist, Brown and Gray **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics (Possible Fill)	CL		
	5	2	11			2-2-2 N=4	24
770		3	18	Loose to Dense, Moist, Gray **SILT**, Trace Sand, Travel Gravel		2-2-4 N=6	22 15
	10	4	18		ML	10-12-24 N=36	10
765		5	18			7-13-26 N=39	13 10
	15			Dense to Very Dense, Moist to Wet, Gray **Silty SAND**, Trace Gravel, Trace Clay	SM		
760		6	18			15-26-38 N=64	11 >>
	20						

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

Additional Remarks

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PROJECT NO.: 0142-2390
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North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-6

DATE STARTED:	9/14/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/14/21	**DRILLER:** JJ	**LOGGED BY:** SP
COMPLETION DEPTH	20.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	19.8 feet
Upon Completion	N/A
Caved Depth	17 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0, 25, 50) STRENGTH, tsf Qu ▲ Qp ✳ (0, 2.0, 4.0)	Additional Remarks
775	0					**6" Topsoil**	Topsoil				
				1	7	Medium Stiff to Very Stiff, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics		2-2-3 N=5	24		
				2	18		CL	2-4-4 N=8	20		
770	5			3	18	Dense, Moist, Gray **Sandy SILT**, Travel Gravel		6-12-16 N=28	14 12		
				4	18			8-10-11 N=21	11		
765	10						ML				
				5	18			7-10-12 N=22	12		
760	15										
				6	18	Very Dense, Moist to Wet, Gray **Silty SAND**, Trace Gravel, Trace Clay (Possible Bedrock)	SM	20-31-37 N=68	18	>>◎	
	20										

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PROJECT NO.: 0142-2390
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North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-7

DATE STARTED:	9/14/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/14/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	20.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV

REMARKS:

Water

While Drilling	19.5 feet
Upon Completion	N/A
Caved Depth	17 feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
775	0					**6" Topsoil**	Topsoil				
				1	16	Stiff to Medium Stiff to Very Stiff, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics		3-4-5 N=9	17		
				2	16		CL	2-2-4 N=6	24		
770	5			3	18			4-9-14 N=23	13		
				4	18	Very Stiff to Hard, Moist, Gray **Sandy SILT**, Trace Gravel		11-11-13 N=24	12		
765	10										
				5	18		ML	4-8-13 N=21	14		
760	15										
				6	5	▽ @ 19 feet ; Gray Till (Possible Bedrock)		11-17-35 N=52	10	>>◎	
	20										

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PROJECT NO.: 0142-2390
PROJECT: North Olmsted Sewer Project
LOCATION: Stearns Road
North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-8

DATE STARTED:	9/15/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/15/21	**DRILLER:** JJ	**LOGGED BY:** SP
COMPLETION DEPTH	30.0 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV

REMARKS:

Water

While Drilling	18 feet
Upon Completion	N/A
Caved Depth	N/A

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
775	0			**12" Topsoil**	Topsoil			
		1	11	Medium Stiff to Very Stiff, Moist, Gray and Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Roots, Trace Organics		1-2-3 N=5	21	
		2	12		CL	3-3-5 N=8	19	
770	5	3	18			8-11-14 N=25	13	
		4	11	Dense, Moist, Dark Gray **Sandy SILT**, Travel Gravel, Trace Clay		7-8-10 N=18	10	
765	10				ML			
		5	18			11-13-14 N=27	11	
760	15			Very Dense to Dense, Moist to Wet, Gray **Silty SAND**, Trace Gravel, Trace Silt, Trace Clay				
		6	18		SM	17-22-32 N=54	15	>> Non-Plastic Fines=14.9%
755	20							
		7	17			7-9-12 N=21	20	
	25			Very Stiff, Moist, Gray **Sandy CLAY**, Trace Gravel			13	
750					CL			
		8	15	Very Weak, Gray **Highly Weathered SANDSTONE**	Rock	30-45-41 N=86	18	>>
	30							

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
Moisture ×
PL ◪
LL ✚
0 25 50

STRENGTH, tsf
Qu ▲
Qp ✳
0 2.0 4.0

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PROJECT: North Olmsted Sewer Project
LOCATION: Stearns Road
North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-9

DATE STARTED:	9/16/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/16/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	22.5 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	18	feet
Upon Completion	16	feet
Caved Depth	N/A	

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
775	0	1	16	**5" Topsoil**	Topsoil		
				Stiff to Very Stiff, Moist, Brown **Lean CLAY**, Trace Gravel and Rock Fragments, Trace Sand		4-4-5 N=9	14
				@ 0 to 8 feet ; Trace Organics			
	5	2	17			6-9-13 N=22	14
770		3	14			16-13-16 N=29	12
					CL		
		4	18			9-11-13 N=24	10
765	10						
		5	16			6-9-11 N=20	11
760	15			Medium Dense, Wet, Gray **Silty SAND**, Trace Gravel, Trace Clay			
		6	18		SM	7-6-5 N=11	17
755	20						
		7	0	Very Strong, Gray **Weathered SANDSTONE**	Rock	25/0"	
				@ 22.5 feet ; Auger Refusal			

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
Moisture ✕ 0 25 50
PL ◪
LL ✚
STRENGTH, tsf
Qu ▲ 0 2.0 4.0
Qp ✳

Additional Remarks

LL = 29
PL = 17
Fines=62.8%

>>◎

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The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-10

DATE STARTED:	9/16/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/16/21	**DRILLER:** TS	**LOGGED BY:** SP
COMPLETION DEPTH	23.8 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water

While Drilling	18.5 feet
Upon Completion	12 feet
Caved Depth	N/A

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
775	0	1	10	**6" Topsoil**	Topsoil		
				Stiff to Very Stiff to Hard, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel		4-5-7 N=12	16
		2	15		CL	8-9-11 N=20	13
770	5	3	18			8-14-17 N=31	14
		4	18	Hard to Very Stiff, Moist, Gray **Sandy SILT**, Trace Gravel		10-14-17 N=31	10
765	10				ML		
		5	18			9-10-13 N=23	11
760	15			Very Dense, Moist, Gray **Silty SAND**, Trace Gravel, Trace Clay	SM		10
		6	17	Moderately Strong, Gray, **Highly Weathered SANDSTONE**		18-30-40 N=70	>>
755	20				Rock		
		7	4			50/4"	11

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

Additional Remarks

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PROJECT NO.: 0142-2390
PROJECT: North Olmsted Sewer Project
LOCATION: Stearns Road
North Olmsted, Cuyahoga County, OH

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BORING B-11

DATE STARTED:	9/15/21	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	9/15/21	**DRILLER:** JJ	**LOGGED BY:** SP
COMPLETION DEPTH	35.5 ft	**DRILL RIG:**	ATV CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	776 ft	**SAMPLING METHOD:**	2-in SS
LATITUDE:		**HAMMER TYPE:**	Automatic
LONGITUDE:		**EFFICIENCY**	93%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AV
REMARKS:			

Water		
	While Drilling	N/A
	Upon Completion	N/A
	Caved Depth	N/A

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
775	0	1	14	**8" Topsoil** Medium Stiff to Very Stiff, Moist, Brown **Lean CLAY**, Trace Sand, Trace Gravel, Trace Organics	Topsoil	3-3-4 N=7	17	
	5	2	15			3-5-7 N=12	16	
770		3	18		CL	5-9-14 N=23	15	
	10	4	18			5-9-11 N=20	11	LL = 24 PL = 16 Fines=68.1%
765		5	18	Very Stiff, Moist, Gray **Sandy SILT**, Trace Gravel	ML	7-10-12 N=22	11	
760	15							
	20	6	14	Weak to Moderately Strong, Gray, **Moderately Weathered SANDSTONE**		22-40-35 N=75	10	>>@
755								
	25	7	17			14-22-25 N=47	12	
750					Rock			
		8	4			50/4"	16	>>@
	30							
745		9	51	@ 34 ft; Unconfined Compression = 3,137 Psi		RQD=38 Rec=84%		>>@
	35							

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

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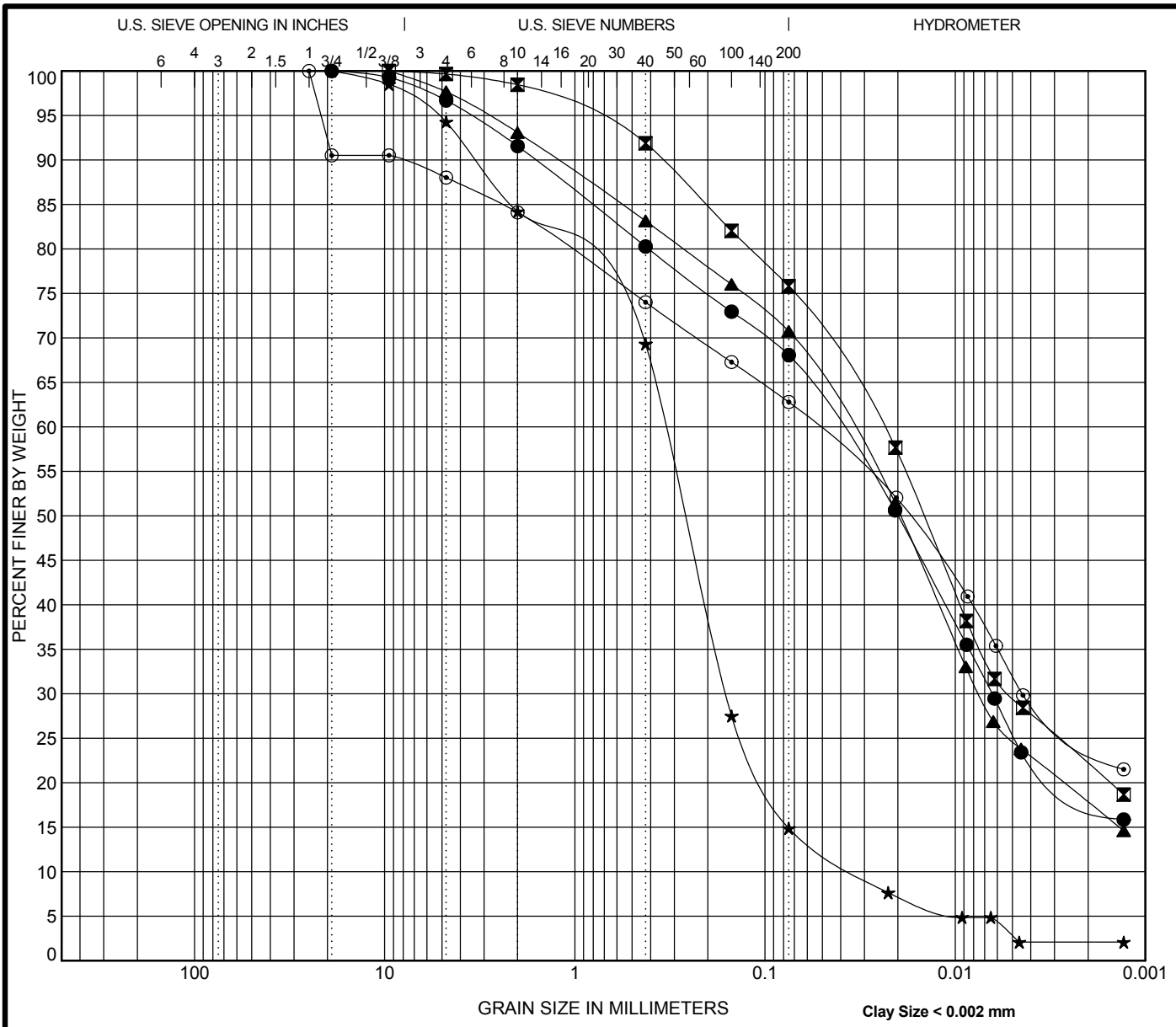
PROJECT NO.:	0142-2390
PROJECT:	North Olmsted Sewer Project
LOCATION:	Stearns Road North Olmsted, Cuyahoga County, OH

The stratification lines represent approximate boundaries. The transition may be gradual.

Bore No.: B-11	Run No.: 1 of 1	Run Depth: 30.5' to 35.5'	Recovery: 50.5" (84%)	RQD: 23" (38%)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-11	9.3	Lean CLAY (CL)	24	16	8		
⊠	B-2	4.3	Lean CLAY (CL)	30	17	13		
▲	B-3	9.3	Lean CLAY (CL)	24	15	9		
★	B-8	19.3	Silty SAND (SM)	NP	NP	NP	2.27	10.11
⊙	B-9	6.8	Lean CLAY (CL)	29	17	12		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-11	9.3	19	0.041	0.006		3.3	28.6	49.6	18.5
⊠	B-2	4.3	9.5	0.024	0.005		0.3	23.8	53.7	22.1
▲	B-3	9.3	9.5	0.037	0.007		2.3	26.9	53.0	17.8
★	B-8	19.3	19	0.337	0.16	0.033	5.7	79.4	12.8	2.1
⊙	B-9	6.8	25	0.053	0.004		12.0	25.2	38.3	24.5

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GRAIN SIZE DISTRIBUTION

Project: North Olmsted Sewer Project
PSI Job No.: 0142-2390
Location: Stearns Road
North Olmsted, Cuyahoga County, OH

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
Q_u: Unconfined compressive strength, TSF
Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼ Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.002 mm to 0.075 mm
Clay:	<0.002mm to <0.005 mm depending on agency

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

Description	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

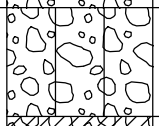
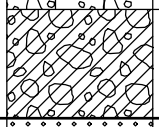
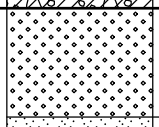
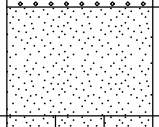
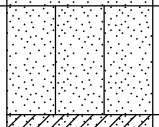
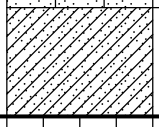
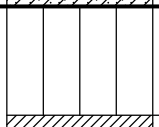
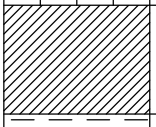
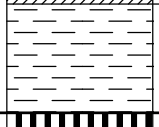
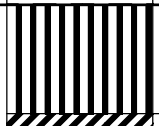
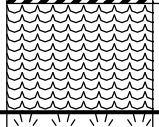
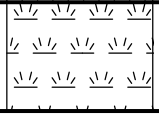
Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.

Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

Highly Weathered: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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