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July 14, 2023 CT Project No. 22073

Village of Jefferson
335 E Erie St,
Jefferson, OH 44047

Geotechnical Subsurface Investigation
EQ Tank
Village of Jefferson, Ohio

Following is the report of the geotechnical subsurface investigation performed by CT Consultants, Inc. (CT) for the referenced project. This study was performed for the Village of Jefferson in support of design services for the Proposed EQ Tank Project.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, design and construction recommendations for roadway reconstruction, as well as our recommendations for installation and support of the proposed structure.

Soil samples collected during this investigation will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

CT Consultants, Inc.

Imad El Hajjar, EI
Geotechnical Project Manager

Curtis E. Roupe, P.E.
Vice President

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GEOTECHNICAL SUBSURFACE INVESTIGATION
EQ TANK
VILLAGE OF JEFFERSON, OHIO

FOR

VILLAGE OF JEFFERSON
335 E ERIE ST,
JEFFERSON, OH 44047

SUBMITTED

JULY 14, 2023
CT PROJECT NO. 220733

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1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for proposed EQ Tank project in Jefferson, Ohio. We understand that the construction of a 365,000 gallons equalization basin subject to be adjacent the existing tank. It is anticipated that the tank will be approximately 20 feet below existing grades. The general project area is shown on the Site Location Map (Plate 1.0).

This study was performed for the Village of Jefferson in support of design services for the proposed EQ Tank project.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, discusses our evaluations and conclusions, and provides our design and construction recommendations for support of the tank

The purpose of this investigation was to evaluate the subsurface conditions and laboratory data relative to the design and construction of the tank. at the referenced site. This investigation included three (3) test borings, field and laboratory soil and rock testing, and a geotechnical engineering evaluation of the test results. This report includes:

- A description of the subsurface soil, bedrock and groundwater conditions encountered in the borings.
- Design recommendations related to the proposed underground equalization basin.
- Recommendations concerning soil- and groundwater-related construction procedures such as site preparation, earthwork, pavement subgrade preparation, and related field testing.

This investigation did not include an environmental assessment of the subsurface materials at this site.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included three (3) test borings drilled by CT on April 19, 2023. The test borings were located in the field by CT in accordance with a proposed boring location plan submitted with the proposal of this study. An obstruction was encountered in Boring B-3 at 2 feet below exiting grades. An offset boring was drilled roughly 4 feet in the east direction. The approximate locations of the borings are shown on the Test Boring Location Plan (Plate 2.0).

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standard D 1452. The test borings performed during this investigation were drilled with a track-mounted drill rig utilizing 3¼-inch diameter hollow-stem augers. The test borings were drilled to auger refusal encountered at depths ranging from approximately 10 to 19 feet below existing grades. A five-foot core run was completed immediately following auger refusal in Borings B-1 and B-2. Ground Surface Elevations were depicted from Google Earth and are reported to the nearest foot in the field and are reported to the nearest foot.

During auger advancement, soil samples were collected at 2½-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter using 18-inch drives. Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. The samples were sealed in jars and shipped to our laboratory for further classification and testing.

A five-foot core run was completed immediately following auger refusal inBorings B-1 and B-2. Recovery of the core is expressed as the percentage ratio of the recovered rock length to the total length of the core run. The Rock Quality Designation (RQD) is the percentage ratio of the summed length of rock pieces 4 inches long and greater to the total length of the run. The rock core samples are designated as “RC1” on the

Logs of Test Borings. The rock cores were documented in photographic core logs, which are attached to this report.

The samples were sealed in jars and transported to our laboratory for further classification and testing. The pavement and soil conditions encountered in the pavement cores and test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results (and equivalent SPT results for the hand auger borings), water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of soils laboratory classification and testing as well as field logs of the encountered pavements and soils.

All of the recovered samples of the subsoils were visually or manually classified in accordance with the Ohio Department of Transportation (ODOT) soil classification system and were tested in our laboratory for moisture content (ASTM D 2216). Dry density of soils was determined, and unconfined compressive strength estimates (ASTM D 2166) were obtained for the intact cohesive samples using a calibrated hand penetrometer. A particle size analysis (ASTM D 6913 and D 7928) and an Atterberg limits test (ASTM D 4318) were performed on representative samples from Boring B-1 (SS-4), and B-3 (SS-4) to determine soil classification and soil index properties. The test results are presented on the Logs of Test Borings, Tabulation of Test Data sheets, and Grain Size Distribution sheet attached to this report.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of pavement cores and test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of

3.0 PROPOSED CONSTRUCTION

The proposed project consists of a proposed underground 365,000 gallons concrete EQ tank in Jefferson, Ohio adjacent the existing tank. It is anticipated that the tank will be approximately 20 feet below existing grades and will be supported on a thickened slab having a 3 foot wide thickened edge

We have assumed that final grades will approximate existing grades present at the time of this investigation.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

At the time of our investigation, the project area consisted of primarily landscaped area covered with grass. Ground surface elevations at the boring locations ranged from Elevs. 876 to 873 feet, generally sloping down from north to south.

The surface materials encountered at all the boring locations consisted of a roughly 5 to 6 inch-thick-layer of topsoil. **Undocumented fill materials** were encountered in Borings B-3 and B-3a underlying the surface material and extended to 5 feet below existing grades. The upper portion of the fills were predominately cohesive and consisted of silty clay mixed with varying portions of crushed stone, sand, wood fragments and shale fragments. An SPT N-value of 14 blows per foot (bpf) was recorded and is indicative of stiff consistency. Unconfined compressive strengths ranged from 3,000 to 4,000 pound per square foot (psf). Moisture contents ranged from 14 to 18 percent. The materials transitioned to more granular in the lower portions that consisted of a layer of wood fragments and pea gravel overlying an 18-inch thick layer of clayey sand. An SPT N-value of 34 bpf was noted and is indicative of dense compactness. A moisture content of 13 percent was recorded for the one recovered sample for this layer.

4.2 General Site Geology

Published geologic maps from the Ohio Department of Natural Resources (ODNR) indicate that the project site is located within the glaciated portion of Ohio. Quaternary soil deposits within the southern portion of the site consisted of ground moraine (G-4). These soils consist of a clayey till and are flat to gently undulating.

Bedrock at the site consist of Upper Devonian aged shale of the Ohio shale formation. Seams of siltstone, and very fine-grained sandstone could be found Interbedded within the shale bedrock. Weathered shale bedrock was encountered in borings B-2 and B-3 at approximately 9 and 17½ feet below existing grades (Elev. 865± and 855±), respectively. Auger refusal on apparent sound bedrock occurred in all the borings at depths approximately 10 to 19 ½ feet below existing grades (Elev. 864± to 853±).

4.3 General Soil and Rock Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface and fill materials consisted of predominantly a layer of medium stiff cohesive soils overlying stiff to hard cohesive till soils overlying shale bedrock. However, a zone of cohesive soils exhibiting **very soft** consistency were encountered in Boring B-2.

Stratum I consisted of medium stiff native cohesive soils encountered underlying the surface materials in Borings B-1 and B-2 to depths of 3 and 6 feet below existing grades (Elevs. 868± and 873±), respectively. The cohesive soils consisted of lean clay (CL) or silty clay (CL-ML), and were mixed with sand and trace amount of gravel. Trace amounts of organics were noted for the surface samples. SPT N-values were on the order of 5 to 6 blows per foot (bpf). A layer exhibiting **very soft** consistency (SPT N-value = 2) was encountered in Boring B-2 underlaying the surface material and extended to 3 feet. Unconfined compressive strengths ranged from 840 pounds per square foot (psf) to 2,800 psf. Moisture contents ranged from 16 to 23 percent.

Stratum II consisted of very stiff to hard native cohesive till soils encountered underlying Stratum I in Borings B-1 and B-2 and the fill soils in Boring B-3. These deposits extended to depths ranging from 9 to 17½ feet (Elevs. 873± to 855±). The cohesive soils consisted predominately of silty clay (CL-ML) mixed with sand and trace amount of gravel or shale fragments, lean clay (CL) mixed with trace amounts sand varying amounts of shale fragments, as well as sandy silt (ML) mixed with varying amounts of shale fragments and gravel. SPT N-values ranged from 16 to 53 bpf. A layer exhibiting stiff constituency (SPT N value = 14 bpf) was encountered in Boring B-3.

Liquid limits of 31 and 33 percent, and a plasticity index of 13 percent were determined for two Stratum II samples obtained from Borings B-1 (SS-4), B-3a (SS-4) respectively. These values, along with gradation results, are indicative of Lean Clay (CL) in accordance with USCS Soil Classification System.

Bedrock consisting of shale was encountered in all the borings at approximately 9 to 17½ Feet (Elev. 865± to 855±). Weathered rock that was able to be penetrated with the augers was encountered in Boring B-2 and B-3. This weathered portion of the bedrock was severely weathered and decomposed such that it was augerable and was found to range in thickness from 1 to 2 feet of the bedrock. Within the weathered rock, the SPT generally resulted in SSR. Moisture contents ranged from 6 to 10 percent for the recovered samples.

The depths of encountered rock are summarized in the following table. Rock core runs were obtained upon auger refusal in Borings B-1 and B-2 starting at 12.8 and 10 feet, respectively (Elev. 863± and 864±). Rock core data and unconfined compressive strength test results for selected intact specimens are summarized in the following table.

Table 4.2.B Summary of Rock Quality Information

Boring No.	Ground Surface Elev. (feet)	Depth to Corable Bedrock (feet)	Top of Bedrock Elev. (feet)	Rock Core Run No.	Recovery (%)	RQD (%)	Unconfined Compressive Strength (psi)
B-1	876	12.8	863.2	RC-1	100	47	7,450
B-2	874	10	864	RC-1	100	72	15,310
B-3a	873	19.5	853.5	N/A	N/A	N/A	N/A

Evaluations of rock mass quality and rock strength were made based on the cored bedrock. The rock core recovery was 100 percent for the cores obtained. RQD values for the core runs ranged from 15 to 47 percent, indicating the rock mass quality of the bedrock can be generally described as poor to fair. The retrieved rock specimens exhibited nearly horizontal bedding; fractures in the core were generally nearly horizontal. Two intact specimens were tested for compressive strength, and those test results (summarized in the table above) are indicative of moderately strong to strong characterization. Rock core photographic logs are attached to this report in Appendix E.

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

4.4 Groundwater Conditions

Groundwater was only encountered during drilling in Boring B-1 and B-3a. Groundwater was encountered upon completion of the rock coring or drilling operations in all the borings. It should be noted all the boreholes were drilled and backfilled within the same day, and stabilized water levels are not likely to have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels. The depths and elevations at which groundwater was encountered in the borings are summarized in the following table.

Table 4.3. Groundwater Conditions

Boring Number	Groundwater Initially Encountered During Drilling		Groundwater Observed Upon Completion of Drilling/Rock Coring[1]	
	Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
B-1	9	867	3.8	872.2
B-2	N.E.	N.E.	4.8	869.2
B-3a	17.5	855.5	11.3	861.7

N.E. – Not Encountered.

1: Water introduced during the rock coring operations in Boring B-1 and B-2.

Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the "normal" long-term groundwater table will be generally encountered at depths on the order of 8 to 10 feet below existing grade.

However, groundwater elevations can fluctuate with seasonal and climatic influences. In particular, "perched" groundwater may be encountered within the fill materials as well as at the soil/bedrock interface. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this exploration.

5.0 DESIGN RECOMMENDATIONS

The following conclusions and recommendations are based on our understanding of the proposed construction and on the data obtained during the field investigation. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by CT. These recommendations are subject to the satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in Section 6.0, “Construction Recommendations”.

5.1 Structure Foundations

The proposed equalization basin tank structure will be constructed underground, with a base slab bearing at approximately 20 feet below existing grade (Elevs. 856± to 853±). Based on the results of the field and laboratory testing for the borings performed for this investigation, the soils encountered at the anticipated foundation bearing depth are expected to consist of shale bedrock. The rock core data indicated generally suitable bearing conditions for support of the proposed foundations.

Care must be taken wherever a foundation must be supported by two strata with significantly different stiffness, such as the soils and bedrock encountered at this site, to prevent excessive differential settlement and areas of high stress concentrations within the foundation system. We recommend that foundations bare solely on rock.

In foundation excavations with rock sloping less than 10 percent, rock need not be undercut or flattened, except as required to remove an asperity or undulation to meet the minimum thickness of concrete indicated for structural design of the foundation. Should the slope of the foundation excavation exceed 10 percent after removal of any weathered or loose rock, the rock surface must be undercut to create a flatter and more uniform bearing surface. Otherwise, stepped footings or doweling should be used to avoid excessive rock excavation. Additionally, for foundations supported on bedrock, the bedrock surface should be cleared of loose/fractured rock.

We recommend a net allowable bearing capacity (q_u) of 20 tons per square foot (tsf) for foundations bearing on intact shale bedrock. The bearing materials should be field-verified as being stable bedrock. Settlement of foundations bearing on rock is expected to be negligible

Due to the existing shallow bedrock **and** possible **varying bearing materials, we strongly recommend that the bearing surface at the bottom of all footing excavations be inspected during construction by a** CT **geotechnical engineer or qualified representative.** Inspection should be performed to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings and are suitable for foundation bearing. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions.

5.2 Lateral Earth Pressure

Based on the conditions encountered in the borings performed for this investigation, the soils along below-grade walls are anticipated to consist of native cohesive soils underlain by the shale bedrock. We recommend the soil profile be modeled simply as a predominantly cohesive soil layer for lateral earth pressure considerations due for the potential for the shale bedrock to weather and induce lateral loading on the tank walls as well as the likelihood of the presence of backfill material due to construction operations and excavation considerations.

Below-grade structure walls are anticipated to be restrained from rotation and are considered rigid and non-yielding. As such, lateral earth pressures should be assumed for “at-rest” conditions. For the encountered subsurface soils, an at-rest lateral earth pressure coefficient (k_O) of 0.5 should be used along with a total soil unit weight of 130 pounds per cubic foot (pcf) in determining the lateral pressure acting on the walls. Alternately, an equivalent fluid weight of 65 pcf may be used for the at-rest case design.

Lateral loading due to hydrostatic pressures below the design groundwater depth should be included in design of below-grade walls, unless drainage is provided as discussed below. Depending on the design methodology, total lateral pressures would be the resultant of the hydrostatic pressures in combination with submerged (or “effective”) unit weights of the soil. An effective unit weight of 70 pcf should be used for lateral earth pressure design below the design groundwater depth.

It should be noted that the above k-parameter may be used for general design of subsurface structures associated with the project. However, certain types of braced excavations may account for method-specific earth pressure distributions, for which the above parameters should be reviewed and utilized in the proper context of the design method/system.

It should also be noted that the above earth pressure coefficient is based on a level backfill condition behind the retaining wall. In areas where appreciable sloping materials behind the top of the wall, surcharge loading or equivalent higher earth pressure coefficients should be evaluated, based on the sloping material, backfill slope, and proximity to the wall. In general, 50 percent of the vertical surcharge load should be used for lateral loading in the design of the wall. Additionally, design should include surcharge loads associated with shallower bearing footings as well as traffic, if present in close proximity to the walls.

In order to alleviate the build-up of hydrostatic pressure behind the walls, a minimum of 2 feet of clean free-draining granular fill (i.e., #57 gravel) is typically should be placed full depth behind the walls. As discussed in Section 4.4, the “normal” groundwater level may be on the order of 8 to 10 feet below existing grades. The below grade walls are anticipated to extend below the groundwater table, so more significant pumping would be required to allow for design without hydrostatic pressures. In this case, it may not be economical to provide drainage and design should instead consider hydrostatic pressures.

For removal of groundwater and the associated hydrostatic pressure, we recommend the granular fill be wrapped with a geotextile separation fabric (ODOT Item 712.09, Type A, or approved equal) to reduce the potential for migration of fines into the free-draining material. If granular fill other than #57 gravel is used, it should not have more than 8% (by weight) passing the #200 screen, and should be compacted to 95% of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Where below-grade structures can be suitably “drained” behind the wall, a perforated corrugated drain tile, wrapped with filter fabric, should be placed along the perimeter at the base of the wall(s). A clay cap (minimum 1-foot thick) should be placed overtop granular backfill, if utilized, to deter inflow of the surface water. The drainage system should properly outlet to a sewer, a properly sized sump pump system, or daylight to an adequate drainage channel.

Where gravity drainage or a sump/pump system is operational, the 2 feet of free-draining material placed behind the wall alleviates the formation of hydrostatic pressures. However, unless this free-draining granular backfill is placed beyond the slip plane associated with the at-rest or active earth pressure, it has little influence on the overall lateral earth pressure acting on the wall which will be governed by the general soil type. If free-draining granular fill is to be placed beyond the slip plane (β=45° for at-rest conditions), a design total unit weight of 130 pcf could be used with the values presented above, thus lowering the earth pressures on the wall. Such excavation may not be feasible in some areas due to the proximity of the new construction to existing structures and roadways.

The sides of the temporary excavations for underground utilities installation should be adequately sloped to provide stable sides and safe working conditions. If the proposed underground utilities alignment requires working in close proximity to existing underground utilities or other structures, this may not be possible. Where sloped excavations will not be used, the excavation must be properly braced against lateral movements. In any case, applicable OSHA safety standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and equipment prior to commencement of work, and to obtain the services of a geotechnical engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria. While not anticipated, any excavations greater than 20 feet deep should be evaluated by a registered professional engineer.

5.3 Design Groundwater Table

As mentioned in Section 4.3, based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the “normal” groundwater level may be generally encountered at Elevs. 868± to 863±, corresponding to depths ranging from 8 to 10 feet below existing grades at the boring locations performed in this area. It should be noted that these water levels are for long-term, stabilized post-construction conditions. This does not mean that excessive groundwater seepage will occur as soon as construction excavations extend below the noted ground water elevation. In general, the soil profile consists of predominantly cohesive soils which were not found to be freely draining.

Consideration should also be given to buoyancy to evaluate whether the slabs constructed below the “normal” water level will resist hydrostatic pressures due to groundwater conditions, if underdrains and foundation drains are not incorporated into design.

5.4 Groundwater Control and Subgrade Considerations

As previously mentioned, the “normal” groundwater level may be present on the order of Elevs. 868± to 863±, corresponding to depths ranging from 8 to 10 feet below existing grades at the boring locations performed in this area. Even for normal groundwater conditions, installation of the proposed below grade walls is expected to require excavation below the “normal” groundwater level. Although the soils below the groundwater table are expected to be predominantly native cohesive soils with very low permeabilities, some groundwater seepage into excavations should be anticipated at the soil/rock interface.

Management of groundwater is generally anticipated to be feasible by pumping from prepared sumps. In any case, it is our experience that adequate control of groundwater seepage or surface water run-off into shallow excavations that do not extend more than a couple feet below the water level in predominantly clay profiles should be achievable by minor dewatering systems, such as pumping from prepared sumps.

Bedrock is expected to be encountered at the proposed subgrade elevation; the bedrock surface should be cleared of loose/fractured rock.

As stated previously, consideration should also be given to buoyancy to evaluate whether the slabs constructed below the "normal" water level will resist hydrostatic pressures due to groundwater conditions, if underdrains and foundation drains are not incorporated into design.

5.5 Excavations and Slopes

The sides of the temporary excavations for tank installation should be adequately sloped to provide stable sides and safe working conditions. If the proposed tank requires working in close proximity to existing underground utilities or other structures, this may not be possible. Where sloped excavations will not be used, the excavation must be properly braced against lateral movements. In any case, applicable OSHA safety standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and equipment prior to commencement of work, and to obtain the services of a geotechnical engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria. While not anticipated, any excavations greater than 20 feet deep should be evaluated by a registered professional engineer.

If the excavation is to be performed with sloped banks, adequate stable slopes must be provided. Based on the borings drilled for this investigation, soils encountered in trench excavations may include one or more of the following:

- Stable Rock (rock that can be excavated with vertical sides and remain intact while exposed),
- OSHA Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- OSHA Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf and dry rock), and
- OSHA Type C soils (fill materials).

Vertical side slopes are acceptable for temporary excavations in stable rock. Based on the RQD values of the cored rock of only 15 to 47 percent, we recommend that temporary excavations in bedrock be considered borderline material and treated as Type B materials unless test excavations are performed to substantiate use of the Stable Rock designation.

For temporary excavations in Type A, B and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil (including excavation through cohesive soils that are underlain by granular soils or bedrock), the slope of the entire excavation is governed by that required for the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavations and slopes, we recommend that grades be no steeper than 3H:1V without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

Based on the conditions encountered in the test borings, the probable method of excavation within the “weathered shale” zone which was penetrable with augers is expected to consist of conventional excavation equipment such as a backhoe or track excavator, with some assistance from pneumatic chippers, jackhammers, or hydraulic wedging equipment. However, excavation into the more intact bedrock beyond the depth of auger refusal is expected to be unproductive and uneconomical with conventional excavation equipment. Excavations that must extend into this zone will likely require use of hard rock removal methods. Based on the limited rock coring and unconfined compressive strength testing performed, it is anticipated that equipment including pneumatic chippers, jackhammers, or hydraulic wedging equipment will be sufficient to rip and dig the rock. However, there may be some areas beyond the depth of auger refusal that require drilling and use of expansive chemicals to fracture and loosen the rock.

5.6 Construction (General)

Construction traffic and excavated material stockpiles should be kept away from the excavation a minimum distance equal to the full depth of the excavation. In all cases, pertinent OSHA requirements must be followed, and adequate protection for workers must be provided.

Where existing buildings or structures, including underground utilities, are located within a distance from the excavation equal to approximately twice its depth, an adequate system of sheet piling and/or lateral bracing may be required to prevent lateral movements that could cause settlement. Any retaining system proposed by the contractor should be reviewed by a registered professional engineer prior to approval for installation and use.

It is also suggested that a condition survey (i.e., preconstruction documentation) of any existing structures and transportation infrastructure located in the vicinity of the proposed underground utilities alignment be completed. For general below-grade underground utilities installation, we recommend the condition survey extend a distance from the proposed installation extents equal to the depth of the excavation, but not less than 50 feet. The condition survey should be extended to 100 feet from the underground utilities alignment in areas where driving of sheetpiling or H-piling, or compaction of granular material will be performed for braced excavations. The condition survey should identify existing cracks and other forms of distress to the structures before the start of construction operations. This procedure will be helpful to evaluate possible effects the construction operations may have on nearby structures and to mitigate potential disputes with property owners.

The construction excavation should not be left open any longer than necessary. As soon as a section of the underground utilities is completed, the area should be backfilled to final grade. After the specified bedding material has been provided below and around the pipe, backfill material placed above the pipes should be compacted sufficiently to achieve stable backfill and avoid undesirable settlements.

The backfill material should be placed in uniform layers not more than 8 inches thick and compacted to 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Backfill placed in pavement areas should consist of dense-graded aggregate, such as ODOT Item 304 material. In order to achieve the desired compaction, the backfill material should be within 3 percent of the optimum moisture content. Alternatively, flowable controlled-density fill could be used to backfill the excavated trenches.

We emphasize the need for placing the fill in lifts and compacting each lift to the specified density, especially where the trench will be directly beneath roadway pavement. The installation contractor should not be allowed to push or end-dump several feet of backfill into the trench as a single layer or lift, because the lower portion of a thick lift will not achieve proper densification from compaction equipment operating at the surface of that lift. If backfill is not properly placed and compacted, undesirable trench backfill settlement may occur.

It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a CT geotechnical engineer or qualified representative.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of foundation and below grade walls design and construction conditions has been based on our understanding of the site and project information and the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data at specific boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. This is especially true for previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, CT assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

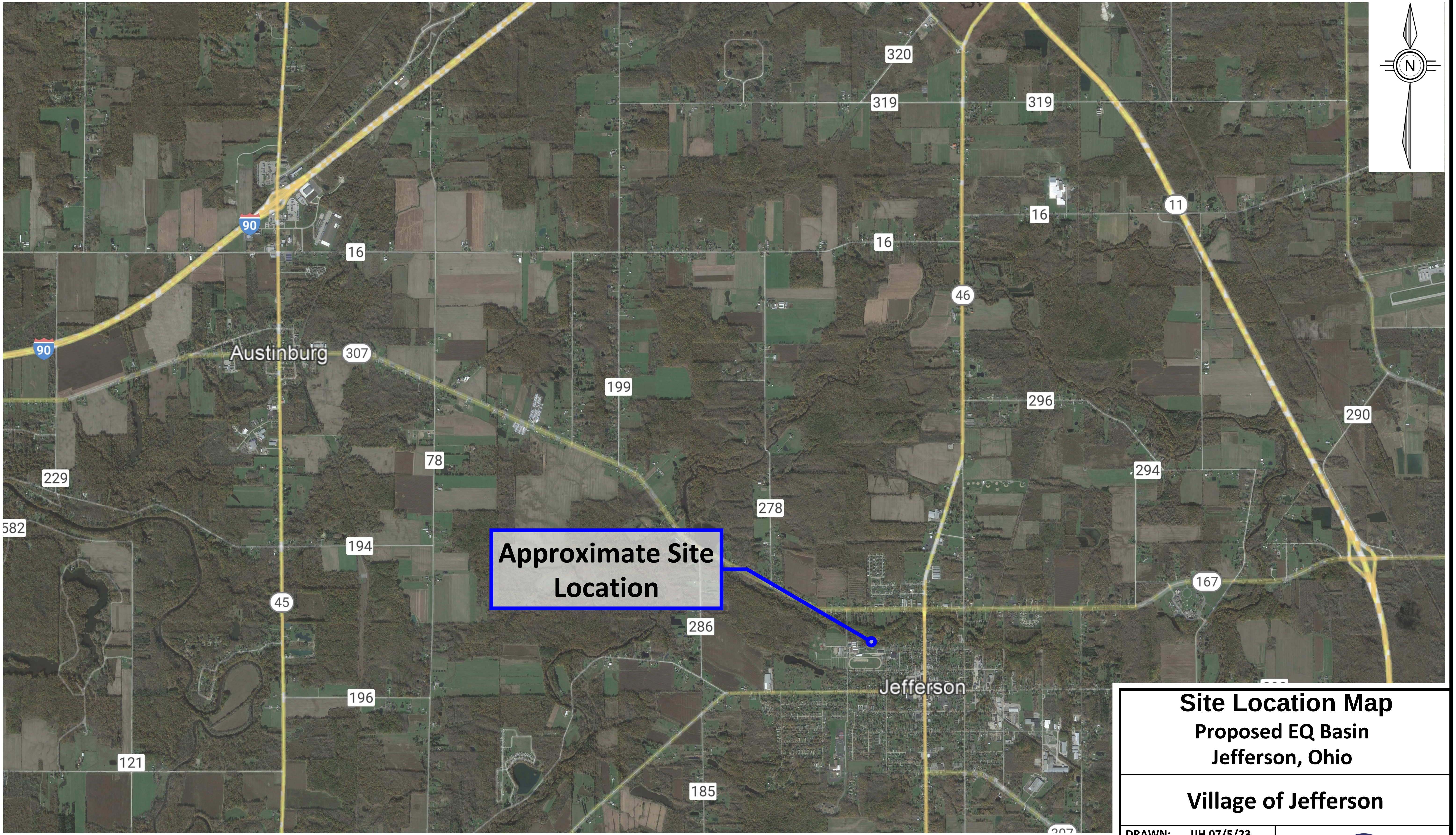
The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, a qualified geotechnical engineer should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. CT is not responsible for the conclusions, opinions, or recommendations of others based on this data.

Plates

Plate 1.0 Site Location Map
Plate 2.0 Test Boring Location Plan



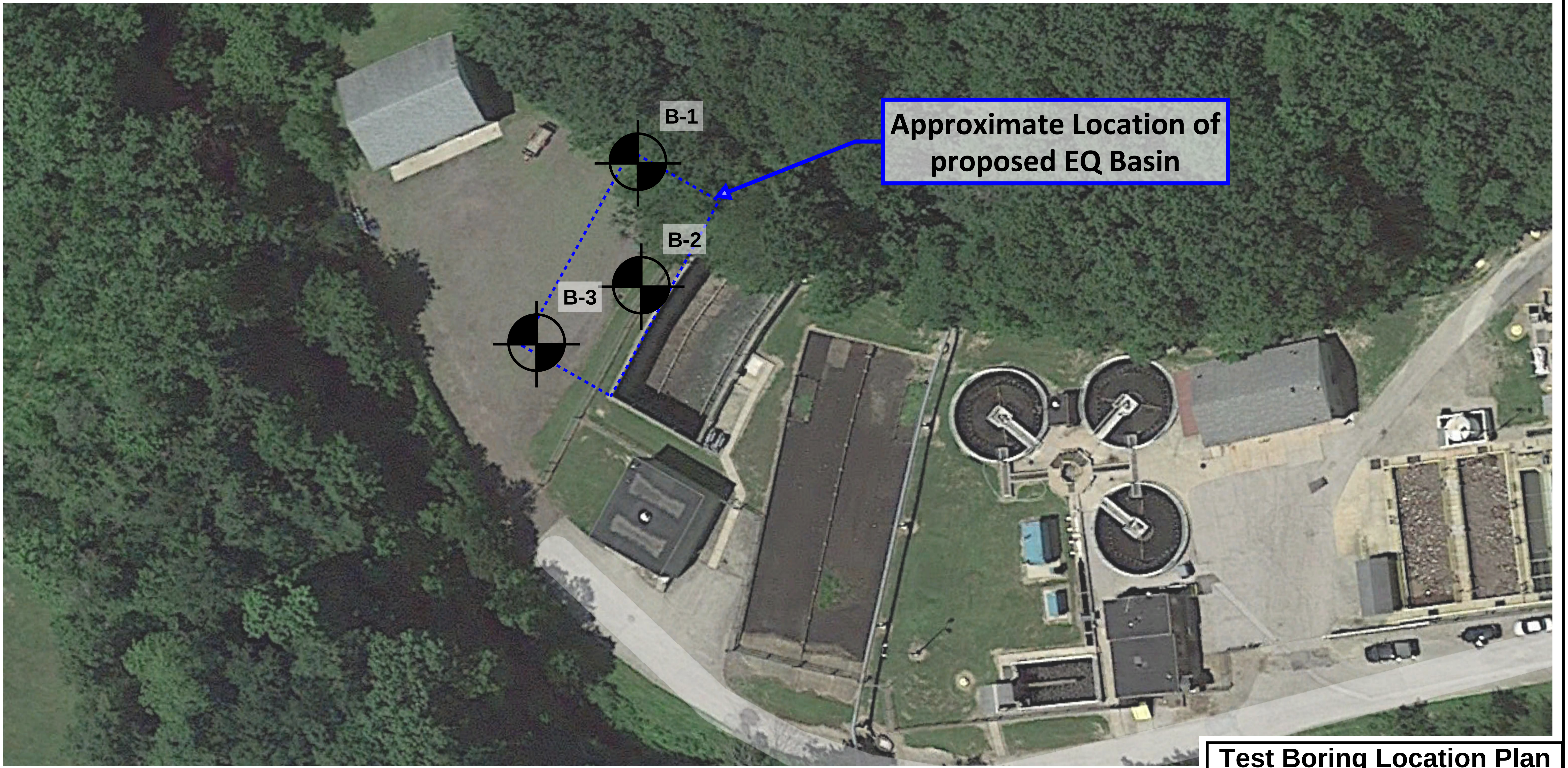
Site Location Map

Proposed EQ Basin
Jefferson, Ohio

Village of Jefferson

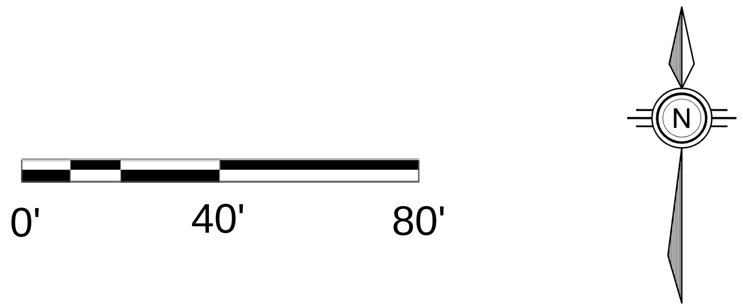
DRAWN: IJH 07/5/23
REVISED: ---
Project No.: 220733
Drawing No.: Plate 1.0

Notes: Aerial Basemap obtained From Google Earth and dated 06/11/2021.



Legend:

B-1 Approximate Test Boring Location



Notes: Aerial Basemap obtained From Google Earth and dated 06/03/2022

Test Boring Location Plan

Proposed EQ Basin
Jefferson, Ohio

Village of Jefferson

DRAWN: IJH 07/5/23

REVISED: ---

Project No.: 220733

Drawing No.: Plate 2.0

LEADING THROUGH the next 100 years
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APPENDIX A

Logs of Test Borings

CT Consultants, Inc.
1915 N 12th St
43604
Telephone: 419-324-2222

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH

DRILLING CONTRACTOR CT Consultants Inc. TB JP

RIG NO. D70

GROUND ELEVATION 876 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 4/19/23

COMPLETED 4/19/23

▽ **AT TIME OF DRILLING** 9.0 ft / Elev 867.0 ft

LOGGED BY KKC

CHECKED BY IEH

▼ **AT END OF DRILLING** 3.8 ft / Elev 872.2 ft

NOTES Auger refusal encountered at 12.8 feet and 5.0 feet of rock cored.

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL 20 MC 40 60 LL 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL w/Gravel - 5 Inches 0.4'						
875			Moist Medium Stiff Gray/Brown SILTY CLAY w/Sand and Trace Gravel (CL-ML) 3.0'	SS 1	44	3-2-3 (5)	NI		16
	5		▼ Moist Very Stiff Gray/Brown SILTY CLAY w/Sand and Trace Gravel (CL-ML) 6.0'	SS 2	78	5-7-9 (16)	2.13	113	16
870			Moist Very Stiff Brown SANDY SILT w/Trace Gravel (ML) 8.0'	SS 3	100	9-9-9 (18)	4.50		13
865	10		▽ Moist Hard Gray LEAN CLAY w/Trace Sand (CL) (Noted as Highly Weathered Shale) 12.8'	SS 4	100	28-28-25 (53)	NP	115	11
860	15		SHALE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG TO STRONG, JOINTED, HIGHLY FRACTURED TO MODERATELY FRACTURED, NARROW TO TIGHT; RQD 47% REC 100% @16.3': Qu = 7450 PSI 17.8'	RC 1	100 (47)		533	159	
			Bottom of hole at 17.8 feet.						

CT Consultants, Inc.
1915 N 12th St
43604
Telephone: 419-324-2222

BORING NUMBER B-2

PAGE 1 OF 1

CLIENT Village of Jefferson
PROJECT NAME Proposed Equalization Basin
PROJECT NUMBER 220733
PROJECT LOCATION Jefferson, OH
DRILLING CONTRACTOR CT Consultants TB JP
RIG NO. D70
GROUND ELEVATION 874 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 4/19/23
COMPLETED 4/19/23
AT TIME OF DRILLING Induced @10.0'
LOGGED BY KKC
CHECKED BY IEH
▼ **AT END OF DRILLING** 4.8 ft / Elev 869.2 ft
NOTES Auger refusal encountered at 10.0 feet and 5.0 feet of rock cored.
0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL w/Gravel - 5 Inches 0.4'						
			Moist Very Soft Brown LEAN CLAY w/Sand, Trace Gravel, and Organics (CL) 3.0'	SS 1	17	1-1-1 (2)	0.42	104	23
870	5		Moist Medium Stiff Brown/Gray LEAN CLAY w/Sand and Trace Gravel (CL) ▼ 6.0'	SS 2	89	2-2-4 (6)	1.40	108	20
			Moist Hard Gray/Brown SANDY SILT w/Shale Fragments (ML) 8.0'	SS 3	89	6-21-15 (36)	NI		12
865			Moist Hard Gray LEAN CLAY w/Trace Sand (CL) (Noted as Highly Weathered Shale) 9.0'	SS 4	100	50	NP		6
	10		Gray Weathered SHALE 10.0'						
860	15		SHALE, GRAY, MODERATELY TO HIGHLY WEATHERED, SLIGHTLY STRONG TO MODERATELY STRONG, JOINTED, HIGHLY FRACTURED TO MODERATELY FRACTURED, NARROW TO TIGHT; RQD 15% REC 100% @10': Qu = 15310 PSI 15.0'	RC 1	100 (15)		1102	158	

Bottom of hole at 15.0 feet.

CT Consultants, Inc.
1915 N 12th St
43604
Telephone: 419-324-2222

BORING NUMBER B-3

PAGE 1 OF 1

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH

DRILLING CONTRACTOR CT Consultants Inc. TB JP

RIG NO. D70

GROUND ELEVATION 873 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 4/19/23

COMPLETED 4/19/23

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY IEH

AT END OF DRILLING None

NOTES Auger refusal encountered at 2.0 feet due to obstruction.

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		CRUSHED STONE - 6 Inches 0.5'						
		▨	FILL - Moist Very Hard Brown SILTY CLAY w/Crushed Stone and Sand 2.0'	SS 1	67	0-4-50/0"	2.00		14 ● >>▲
			Bottom of hole at 2.0 feet.						
				SS 2	56	3-17-17 (34)	NP		▲
				SS 3	100	5-6-8 (14)	1.50		▲
				SS 4	100	12-24-29 (53)	4.50		▲
				SS 5	89	8-18-26 (44)	NP		▲
				SS 6	89	41-50/3"			>>▲

CT Consultants, Inc.
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43604
Telephone: 419-324-2222

BORING NUMBER B-3a

CLIENT Village of Jefferson
PROJECT NAME Proposed Equalization Basin
PROJECT NUMBER 220733
PROJECT LOCATION Jefferson, OH
DRILLING CONTRACTOR CT Consultants Inc. TB JP
RIG NO. D70
GROUND ELEVATION 873 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 4/19/23
COMPLETED 4/19/23
▽ **AT TIME OF DRILLING** 17.5 ft / Elev 855.5 ft
LOGGED BY KKC
CHECKED BY IEH
▼ **AT END OF DRILLING** 11.3 ft / Elev 861.7 ft
NOTES Boring moved 4 feet East. from B-3. Auger refusal encountered at 19.5 feet.
0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL (20 40 60 80) / ▲ SPT N VALUE ▲ (20 40 60 80)
	0	See B-3 2.0'						
870		FILL - Moist Dense Gray/Brown WOOD and PEA GRAVEL 4.5'	SS 1	56	3-17-17 (34)	NP		13
	5	FILL - Moist Dense Brown CLAYEY SAND w/Crushed Stone and Wood 5.0'						
		Moist Stiff Gray SILTY CLAY w/Sand and Shale Fragments (CL-ML) 8.0'	SS 2	100	5-6-8 (14)	1.50		18
865	10	Moist Very Hard Brown SANDY SILT w/Shale Fragments (ML) ▼ 12.0'	SS 3	100	12-24-29 (53)	4.50		11
860	15	Moist Hard Gray LEAN CLAY w/Trace Sand and Shale Fragments (CL) (Noted as Highly Weathered Shale) ▽ 17.5'	SS 4	89	8-18-26 (44)	1.84	127	8
855		Gray Weathered SHALE 19.5'	SS 5	89	41-50/3"		127	10 >>
		Bottom of hole at 19.5 feet.						

APPENDIX B

Legend Key

LEGEND KEY

Unified Soil Classification System Soil Symbols

▦ GW - WELL GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

○ GP - POORLY GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

◫ GM - SILTY GRAVEL Includes Gravel-Sand-Silt mixtures.

▨ GC - CLAYEY GRAVEL Includes Gravel-Sand-Clay mixtures.

░ SW - WELL GRADED SAND Includes Gravelly Sands, little or no fines.

░ SP - POORLY GRADED SAND Includes Gravelly Sands, little or no fines.

░ SM - SILTY SAND Includes Sand-Silt mixtures.

▨ SC - CLAYEY SAND Includes Sand-Clay mixtures.

▥ ML - SILT Includes Silt with Sand and Sandy Silt.

▨ CL - LEAN CLAY Includes Sandy Lean Clay and Lean Clay with Sand and Gravel.

▥ MH - ELASTIC SILT Includes Sandy Elastic Silt and Elastic Silt with Sand.

▨ CH - FAT CLAY Includes Sandy Fat Clay and Fat Clay with Sand.

▥ CL-ML - SILTY CLAY Includes Clayey Silt of low plasticity.

▤ OL - ORGANIC SILT and ORGANIC CLAY of low plasticity.

▤ OH - ORGANIC SILT and ORGANIC CLAY of medium to high plasticity.

☐ Pt - PEAT Includes humus, swamp and other soils with high organic content.

▩ FILL MATERIAL - Includes controlled and non-controlled soil and non-soil materials.

░ TOPSOIL

■ ASPHALT - Bituminous Asphalt

░ CONCRETE - Includes broken concrete rubble.

Sample Symbols

☒ SS - Split Spoon

■ ST - Shelby Tube

◨ RC - Rock Core

⧗ GS - Geoprobe Sleeve

◧ AU - Auger Cuttings

✋ GB - Grab

Notes:

1. Exploratory borings were drilled during on April 19, 2023, using 3¼-inch diameter hollow-stem augers. Upon encountering auger refusal in Boring B-1 and B-2, a rock core run was performed using an NQ2 diamond-bit core barrel.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. The borings were located in the field by CT in accordance with the Proposed Boring Location Plan, attached to the proposal.

4. Ground Surface Elevations were depicted from Google Earth and reported to the nearest foot.

5. Unconfined Compressive Strength (tsf):
NI = Not Intact.
NP = Non Plastic

APPENDIX C

Tabulation of Laboratory Test Data

CT Consultants, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

SUMMARY OF LABORATORY RESULTS

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	1.0							15.6			
B-1	3.5							16.5	113.2		
B-1	6.0							13.2			
B-1	8.5	31	18	13	2	92	CL	11.1	115.0		
B-1	16.3							0.0	159.5		
B-2	10.0							0.0	157.9		
B-3	1.0							14.3			
B-3a	3.5							12.6			
B-3a	6.0							18.4			
B-3a	8.5							10.6			
B-3a	13.5	33	20	13	12.5	95	CL	8.1	127.4		
B-3a	18.5							9.5	127.4		

APPENDIX D

Laboratory Test Results

CT Consultants, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

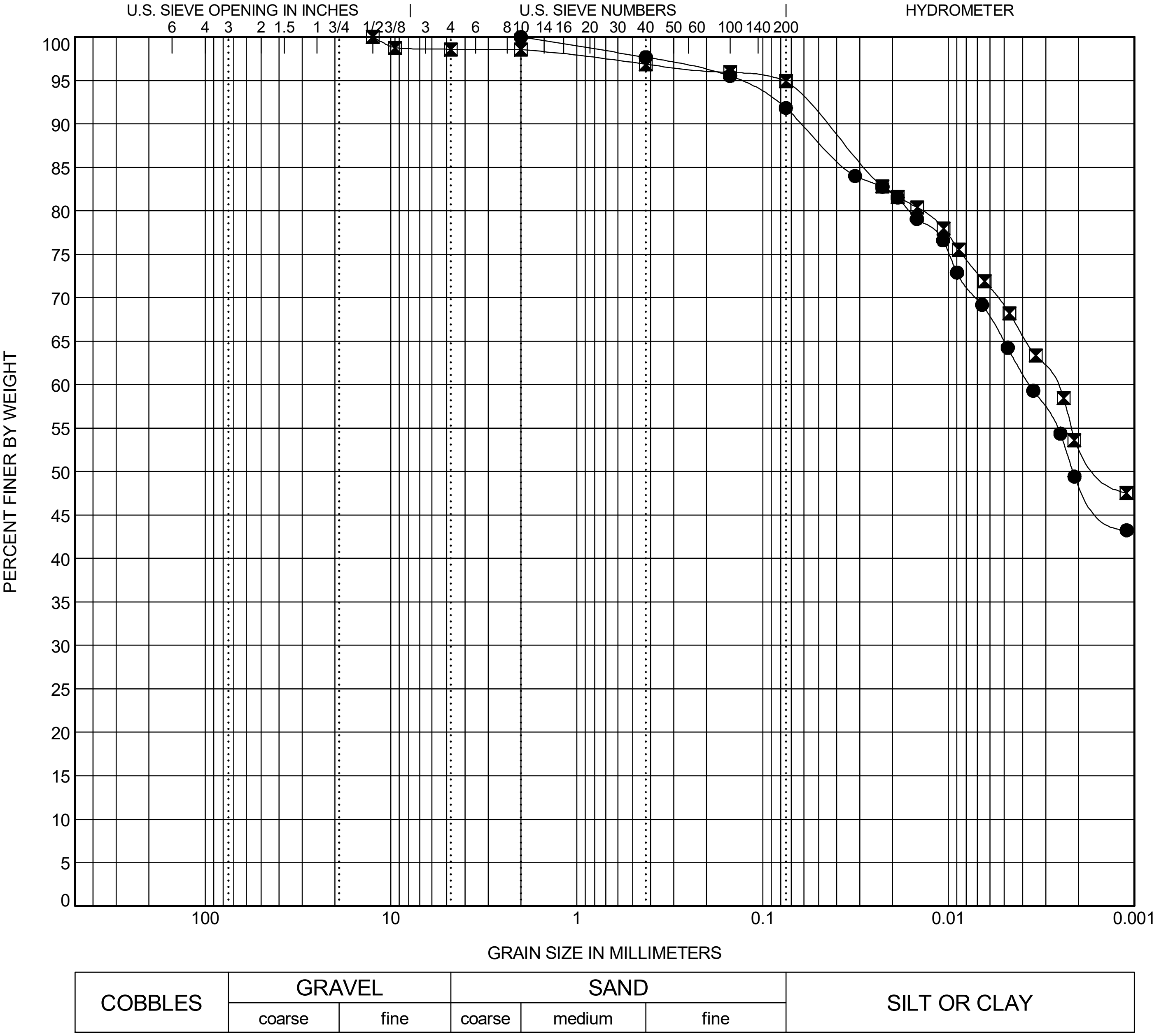
GRAIN SIZE DISTRIBUTION

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH



Specimen Identification			USCS Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**8.5**	**LEAN CLAY (CL)**	**31**	**18**	**13**		
⧗	**B-3a**	**13.5**	**LEAN CLAY (CL)**	**33**	**20**	**13**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**8.5**	**2**	**0.004**			**0.0**	**8.2**	**27.0**	**64.9**
⧗	**B-3a**	**13.5**	**12.5**	**0.003**			**1.4**	**3.7**	**26.0**	**69.0**

CT Consultants, Inc.
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Telephone: 419-324-2222
Fax: 419-241-1808

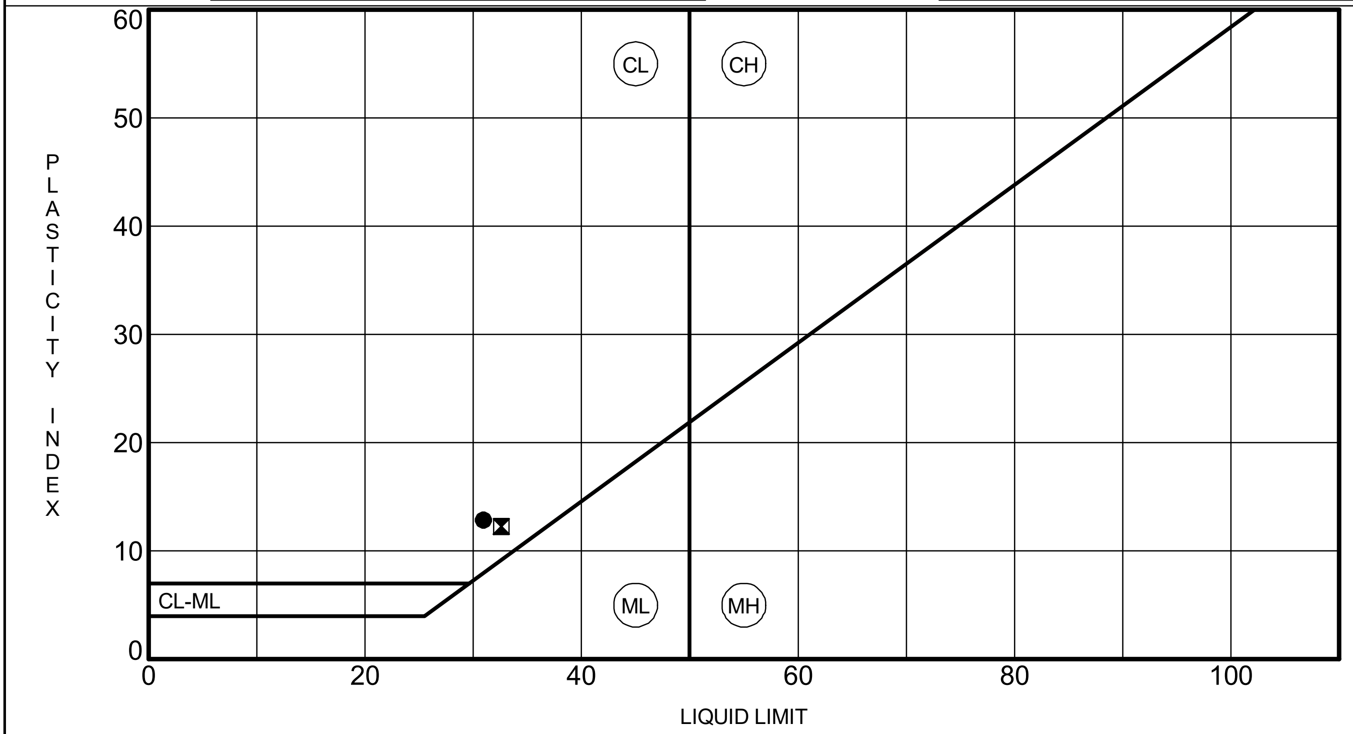
ATTERBERG LIMITS' RESULTS

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-1**	**8.5**	**31**	**18**	**13**	**92**	**LEAN CLAY (CL)**
☒	**B-3a**	**13.5**	**33**	**20**	**13**	**95**	**LEAN CLAY (CL)**

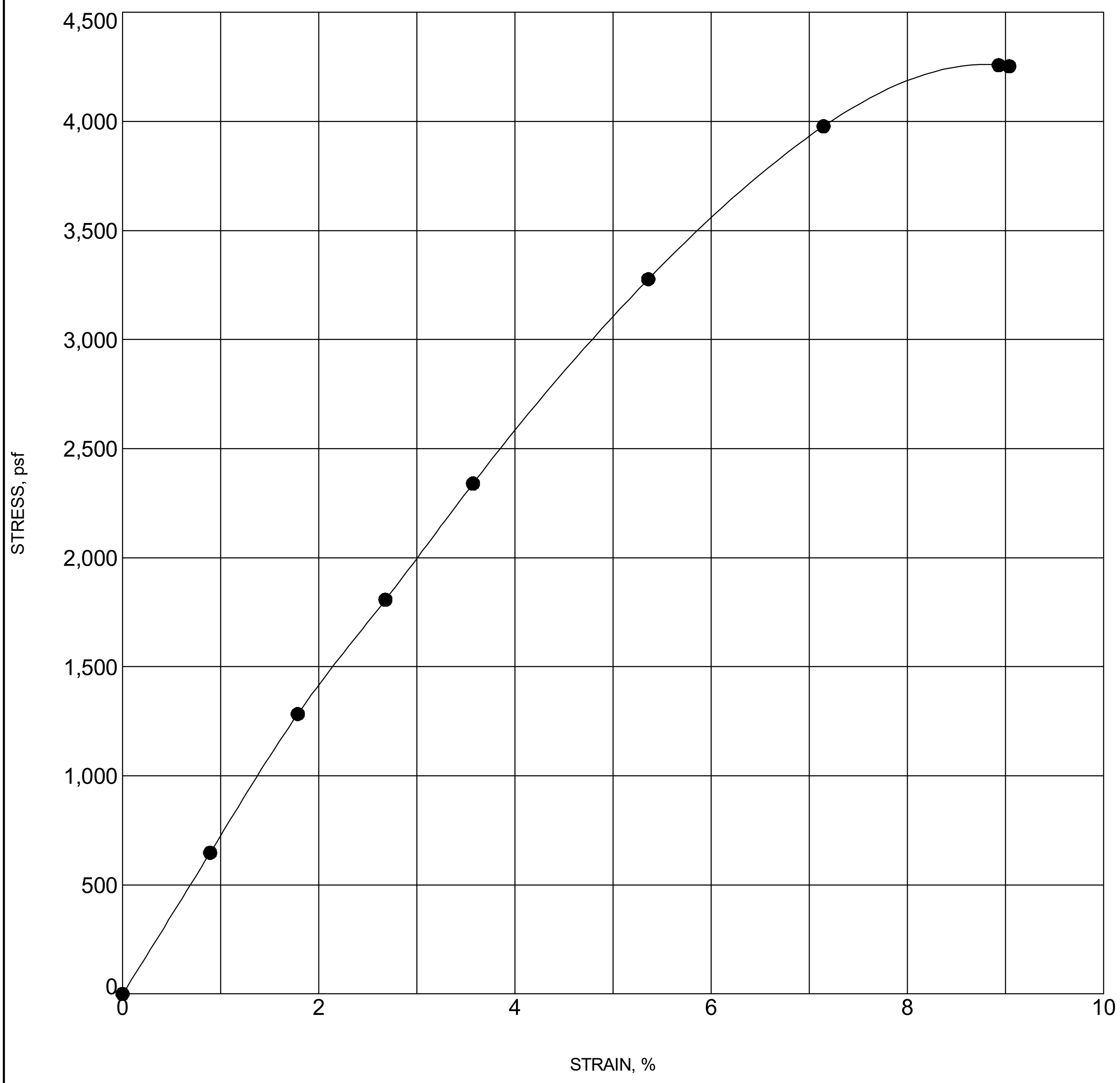
UNCONFINED COMPRESSION TEST

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH



	Specimen Identification		Classification	γ_d	MC%
●	**B-1**	**3.5**		**113**	**17**

CT Consultants, Inc.
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Telephone: 419-324-2222
Fax: 419-241-1808

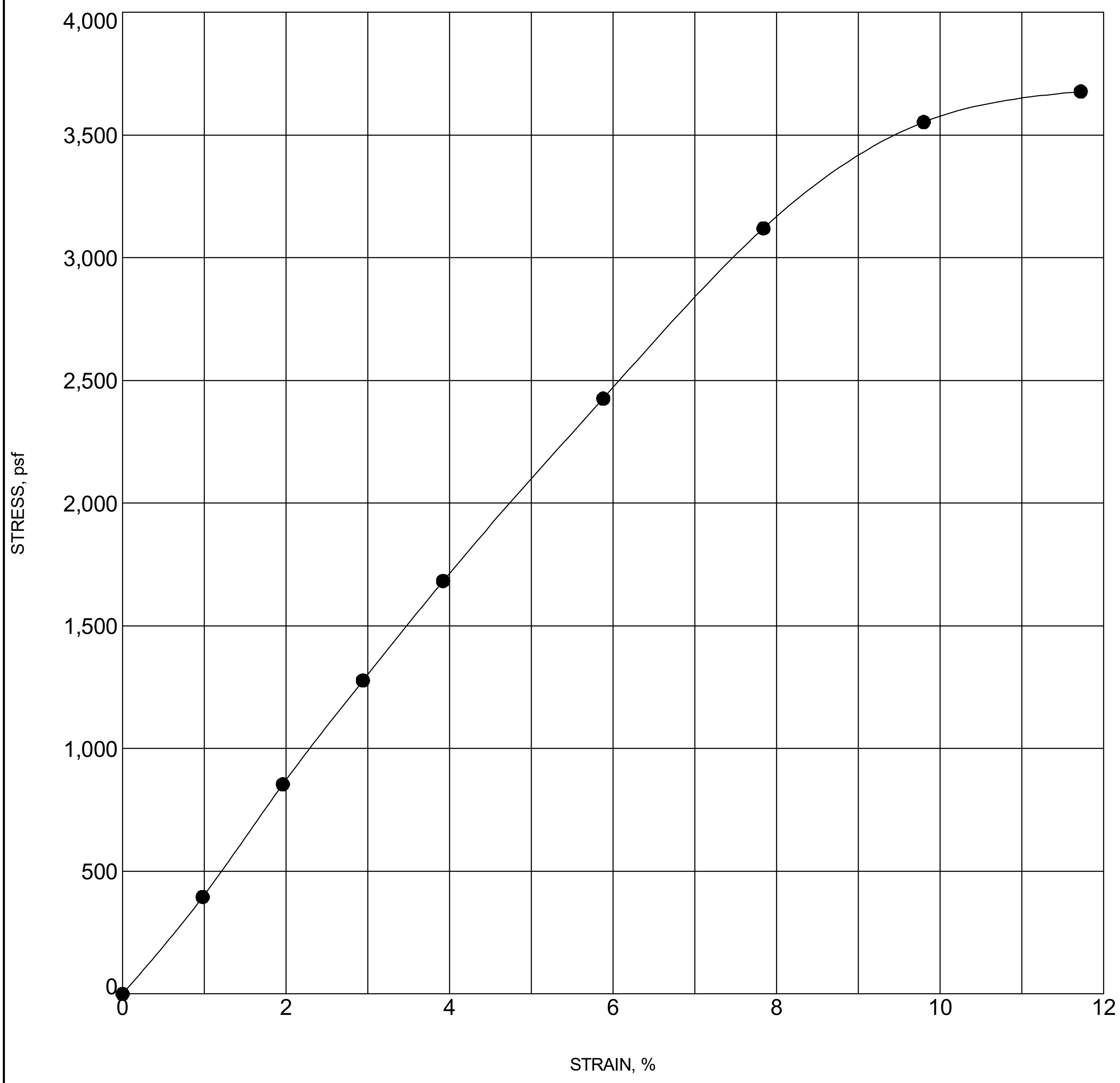
UNCONFINED COMPRESSION TEST

CLIENT Village of Jefferson

PROJECT NAME Proposed Equalization Basin

PROJECT NUMBER 220733

PROJECT LOCATION Jefferson, OH



	Specimen Identification		Classification	γ_d	MC%
●	**B-3a**	**13.5**	**LEAN CLAY (CL)**	**127**	**10**

APPENDIX E

Rock Core Photographic Logs

CORE PHOTO LOG – B-1

Project: Proposed Jefferson Equalization Basin
Project Location: Jefferson, Ohio
CT Project No.: 220733
Core Date: April 19, 2023

re Run	th (feet)	ation (feet)
RC-1	12.8 to 17.8	863.2 - 858.2

Begin RC-1

End RC-1

CORE PHOTO LOG – B-2

Project: Proposed Jefferson Equalization Basin
Project Location: Jefferson, Ohio
CT Project No.: 220733
Core Date: April 19, 2023

re Run	th (feet)	ation (feet)
RC-1	10 to 15	864 - 861

Begin RC-1

End RC-1