Soils & Engineering Services, Inc.

EXHIBIT "D"

December 4, 2019

Project 13300.31 R01

Ms. Sarah Lerner, LEED AP, RLA
City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342

Subject: Geotechnical Exploration and Analyses Report
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison
Dane County, Wisconsin

Dear Ms. Lerner:

We have completed the requested exploration consisting of the performance of two soil borings and associated laboratory testing and geotechnical engineering analyses. The purpose of these borings was to obtain information about the soil, bedrock, and water conditions at the boring locations. We present our findings, comments, recommendations, and analyses results in the enclosed *Geotechnical Exploration and Analyses Report* for the subject project.

Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

Craig M. Bower

Craig M. Bower, P.E.

CMB:DER:cmb

Enclosure

Delivered by email: SLerner@cityofmadison.com

1102 Stewart Street
Madison, WI 53713-4648
Phone: 608-274-7600
888-866-7645
Fax: 608-274-7511
www.soils.ws
soils@soils.ws
Geotechnical Engineers since 1966

Geotechnical Exploration and Analyses Report

Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison
Dane County, Wisconsin
SES Project Number 13300.31

Prepared By

Soils & Engineering Services, Inc.
1102 Stewart Street
Madison, Wisconsin 53713-4648
phone: (608) 274-7600
e-mail: soils@soils.ws

Craig M. Bower, P.E.

WISCONSIN
CRAIG M.
BOWER
E-26676
COTTAGE GROVE,
WIS.
12/4/19
PROFESSIONAL ENGINEER

Submitted To

City of Madison Parks Division
City-County Building, Room 104
210 Martin Luther King, Jr. Boulevard
Madison, Wisconsin 53703-3342
Phone: (608) 261-4281

Ms. Sarah Lerner, LEED AP, RLA

December 4, 2019

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I. INTRODUCTION

This *Geotechnical Exploration and Analyses Report* summarizes the findings of the geotechnical exploration, laboratory tests, and geotechnical engineering analyses performed for the design of a park shelter, parking lot, and storm sewer for the Warner Park Beach located at 1101 Woodward Drive in the City of Madison in Dane County, Wisconsin. We completed this work under the general direction of City of Madison Parks Division who established the general scope of the work.

The intent of this report is to: (1) convey the geotechnical information obtained from two soil borings; (2) present the results of laboratory and field tests; (3) provide the results of our geotechnical engineering analyses; and (4) present our comments and recommendations for the design and construction of the proposed facility modifications. We recommend City of Madison Parks Division employ Soils & Engineering Services, Inc. to make observations and perform tests at the time of excavation and construction of the proposed improvements to verify the subsurface conditions encountered by the exploration performed, and to validate our comments, analyses, and recommendations presented in this report for the subject improvements.

II. PROJECT DESCRIPTION

The project consists of the construction of a park shelter, parking lot, and storm sewer for the Warner Park Beach located on Woodward Drive in the City of Madison in Dane County, Wisconsin. We were not provided with specifics regarding any of the proposed improvements. We anticipate the following regarding these three improvements:

- The finished floor elevation for the park shelter will be similar to the existing structure.
- The park shelter will have a cast-in-place concrete foundation wall resting on spread footings placed at frost depth. The floor for this structure will consist of cast-in-place concrete.
- The existing ground surface elevation for the terrain surrounding the area will remain basically unchanged.
- The existing parking lot will be reconstructed with similar horizontal limits and finished grade elevations and that it will consist of a hot-mix asphalt (HMA) pavement over crushed stone base course.

- A storm sewer will be installed to collect the surface drainage from the reconstructed parking lot.

III. GEOTECHNICAL EXPLORATION

The geotechnical field exploration consisted of the performance of two soil borings (designated Borings 1 and 2).

A. Boring Locations

We located Borings 1 and 2 as close to the requested locations as possible. We show the boring locations on the Location Sketch, Drawing 13300.31-1, enclosed in Appendix A.

B. Boring Elevations

We did not determine the ground surface elevation at the boring locations after completion of the drilling and sampling. We set ground surface at 0 feet of depth for each soil boring on the Boring Log Records enclosed in Appendix A. We plotted the Boring Log Records with depth scales for reference.

C. Drilling and Sampling Procedures

The exploration plan was to complete Borings 1 and 2 to a depth of 15 feet below existing grade. We drilled and sampled the borings to the planned depth.

We used 2¼-inch-inside-diameter hollow-stem augers (HSA) for the borings to maintain open boreholes as we advanced the borings to the termination depth. As we advanced the boreholes of these borings, we obtained soil samples at 2½-foot intervals starting at a depth of 1-foot below the ground surface and continued to the boring termination depth. We performed this sampling using a 2-inch-outside-diameter split-barrel sampler according to ASTM Designation D1586. We visually identified the recovered soils in general compliance with the Unified Soil Classification System (USCS) identification procedures as defined in ASTM Designation D2488.

Please refer to the Boring Log Records enclosed in Appendix A for additional information regarding the drilling and sampling of these borings. We provide information pertinent to the Boring Log Records on the Notes and Legend Record enclosed in Appendix A.

D. Subsurface Stratigraphy

In general terms, we characterize the soil stratigraphy encountered at Borings 1 and 2 as fill material and/or topsoil overlying native soil strata. Neither of these borings encountered bedrock within the depth drilled.

The borings encountered fill material and/or topsoil of variable thickness and type. We describe these materials as follows:

- Boring 1 encountered 8 inches of very dark brown LEAN CLAY FILL TOPSOIL over 28 inches of brown fine to medium POORLY-GRADED SAND WITH GRAVEL (SP) FILL with dark brown LEAN CLAY (CL) layers.

- Boring 2 encountered 15 inches of very dark brown LEAN CLAY FILL TOPSOIL.

Below the fill material and/or topsoil, Borings 1 and 2 encountered a native soil strata that was variable. We describe the native soil strata encountered at these borings as follows:

- Boring 1 encountered black fine to medium POORLY-GRADED SAND WITH SILT (SP-SM) with trace organics over brown and dark brown fine POORLY-GRADED SAND WITH SILT (SP-SM) with trace gravel and trace shells over light gray fine to medium POORLY-GRADED SAND (SP) over gray fine POORLY-GRADED SAND (SP).

- Boring 2 encountered dark brown LEAN CLAY (CL) over brown fine POORLY-GRADED SAND (SP) with trace shells over brown fine to medium POORLY-GRADED SAND (SP).

We noted that the light gray and brown fine to medium POORLY-GRADED SAND (SP) contained few gravel particles and little to some shells.

Please refer to the Boring Log Records enclosed in Appendix A for a further description of the fill material, topsoil, and native soil strata encountered at the locations of Borings 1 and 2.

E. Subsurface Water

Our drilling crew found the boreholes of the borings performed to have a water level and were caved at the completion of the drilling and sampling at each of these borings. We summarize these water and caved level depths for Borings 1 and 2 as follows:

Boring	Subsurface Water Level Depth (feet-inch)	Caved Level Depth (feet-inch)
1	5'-9"	6'-1"
2	5'-6"	5'-7"

We expect the subsurface (groundwater) levels to fluctuate as influenced by precipitation, snowmelt, surface water runoff, the stage of Lake Mendota, and other hydrological and hydrogeological factors. The groundwater levels at the time of construction of the subject project may be higher or lower than the groundwater levels encountered on the day that we performed the borings.

IV. LABORATORY AND FIELD TESTS

A. Laboratory Tests

We performed laboratory tests on a portion of selected split-barrel soil samples to determine the physical properties of the fill material and underlying native soil strata encountered at the boring locations. The laboratory tests on the selected material from the split-barrel soil samples consisted of determining the moisture content (MC), Atterberg limits (liquid limit [LL] and plastic limit [PL]), wet and dry densities (γ_w and γ_d), unconfined compressive strength (q_u), the percentage of soil particles passing the No. 200-mesh sieve (P_{200}), and particle size distribution analysis. In addition to the above tests, we tested some of the cohesive soils for approximate unconfined compressive strength (q_p) using a spring penetrometer.

We include the laboratory test results obtained for this report on the Boring Log Records and Laboratory Test Result Records (Figures 1 through 3) enclosed in Appendix A. We used the results from the Atterberg limits, q_u, P_{200}, and particle size distribution analysis tests to confirm or modify the USCS soil identifications in general compliance with USCS classification procedures as defined in ASTM Designation D2487.

B. Field Tests

The field tests consisted of the performance of the standard penetration resistance test (SPT) for Borings 1 and 2. We performed the SPT during the sampling procedure at these borings. It consists of driving the split-barrel sampler up to 18 inches with a 140-pound hammer weight falling 30 inches. From the SPT, we obtain the N-value which is the sum of the number of blows required to drive the split-barrel sampler the last 12 inches or portion thereof as noted on the Soil Boring Records.

We include the N-value results obtained for this report on the Boring Log Records enclosed in Appendix A.

C. Test Results Discussion

The laboratory and field tests indicated the following:

- The granular fill material is in a moist relative moisture condition and in a medium dense state of relative density.
- The dark brown LEAN CLAY (CL) is in a moist relative moisture condition and of very stiff to hard consistency.
- The black fine to medium POORLY-GRADED SAND WITH SILT (SP-SM) with trace organics is in a wet relative moisture condition and in a loose state of relative density.
- The brown and dark brown fine POORLY-GRADED SAND WITH SILT (SP-SM) with trace gravel and trace shells is in a wet relative moisture condition and in a loose state of relative density.
- The light gray or brown fine to medium POORLY-GRADED SAND (SP) with few gravel and little to some shells is in a wet relative moisture condition. This soil is in a loose state of relative density at Boring 1 and in a medium dense state of relative density at Boring 2.
- The gray fine POORLY-GRADED SAND (SP) is in a wet relative moisture condition and in a medium dense state of relative density.
- The brown fine POORLY-GRADED SAND (SP) with trace shells is in a wet relative moisture condition and in a loose state of relative density.

We utilized the laboratory and field test results in our evaluation of the soils for the determination of soil design parameters, and to provide comments and recommendations for the design and construction of the subject project.

V. CONCLUSIONS

We offer the following general comments regarding the soils encountered by the borings:

- The borings encountered 8 to 15 inches of topsoil.
- Below the topsoil, Boring 1 encountered 15 inches of low to moderate strength fill soil over native granular soil. The native granular soil is of low strength to approximately 12 feet of depth where it grades to a moderate strength material.
- Below the topsoil, Boring 2 encountered moderate to high strength native cohesive soil over native granular soil. The native granular soil is of low strength to approximately 8 feet of depth where it grades to a moderate strength material.
- None of the borings encountered bedrock within the depth drilled.

Based on the soil information obtained, construction of the proposed improvements is feasible. Dependant upon the depth of the storm sewer, the depth of the park shelter foundation and the depth to groundwater, dewatering may be necessary.

VI. COMMENTS AND RECOMMENDATIONS

Based on the soil boring information and laboratory tests performed, we offer the following comments and recommendations regarding the design and construction of the Proposed Warner Park Beach Improvements located on Woodward Drive in the City of Madison, Dane County, Wisconsin.

A. Dewatering Recommendations

At the time that we performed the borings, groundwater was measured between 5½ and 5¾ feet below existing grade. Therefore, we recommend the contractor be prepared to dewater the excavations for the proposed improvements to lower the groundwater level to 12 to 24 inches below the lowest anticipated excavation bottom. To avoid soil disturbance due to groundwater inflow into the excavation, we recommend to not excavate until the groundwater level is at the recommended level as indicated by the monitoring wells and/or test pits. This is of extreme importance for a successful excavation. The contractor should be at liberty to select the dewatering system to install at the project site. The dewatering equipment should remove water only. **<u>Removal of soil must be prevented</u>**. The dewatering equipment should be installed outside the construction limits. Starting and stopping of pumps should only be permitted for maintaining a depressed groundwater table and should be controlled by electronic floats or other control devices. The dewatering system should operate until the level of backfill material, either compacted granular fill or concrete, is at least 3 feet above the groundwater level that is present at the time of construction. Dewatering and disposal of water should comply with local, county, and state requirements.

We anticipate the granular soil strata may yield moderate to high amounts of water depending upon the amount of soil "fines" and grain size of the granular particles in the strata, and the state of relative density of the strata. Due to the type and state of relative density of the granular soils encountered by the borings, we anticipate that sand "boiling" will occur if the groundwater is not lowered sufficiently in the building area prior to starting the site excavation work. If sand "boiling" occurs, the strength of the granular soils will be compromised and additional site excavation, or other ground improvement construction method, would need to be performed to provide the proper support of the building and the fill to be placed to raise the grade.

Extensive and deep dewatering will cause consolidation of the soil being dewatered. Since the horizontal extent of the dewatering is not directly controlled, there is the risk of causing consolidation of the soil supporting the adjacent structures. Consolidation of soils results in settlement.

B. Building Excavation

After completion of the site preparation of the building area, excavation of the existing soils can then take place. We recommend that site excavation be performed using a backhoe equipped with a cleaning bucket instead of a bucket with cutting teeth. A cleaning bucket is a standard bucket equipped with a continuous cutting edge which can be fabricated by bolting or welding a flat steel plate in front of the cutting teeth of a toothed bucket. A cleaning bucket is intended to reduce potential disturbance to the subgrade soil which may occur if a bucket with cutting teeth is used for site excavation purposes. Bedrock excavation to reach the proposed foundation subgrade elevations is not anticipated.

1. Foundation Excavation

We recommend the foundation excavations be extended to a minimum depth of 5 feet below the proposed finished ground surface elevation to provide frost protection. Excavations that extend below the design bottom of shallow spread footings should extend out from the lower outer edges of the footing 1-foot for every foot of excavation below the bottom of the foundation element.

If groundwater is present at frost depth, then we recommend the excavation be extended to allow placement of 12 inches of geotextile-wrapped coarse crushed stone to be placed below the proposed footings. The coarse crushed stone should be placed as specified in Section VII.C below.

2. Slab Excavation

We recommend the excavations for the slab-on-grade floor be extended to provide a minimum of 24 inches of compacted granular fill material below the proposed floor subgrade elevation.

Before placing the compacted granular fill material, we recommend thorough compaction of exposed granular soil as indicated to be present based on Boring 1. Thorough compaction of granular excavation surfaces should be performed using vibratory compactors. The granular soil should be compacted to a density of at least 95 percent of the maximum dry density determined for the soil according to ASTM Designation D1557 for a minimum depth of 18 inches below the excavation bottom. We recommend Soils & Engineering Services, Inc. personnel observe the thorough compaction procedure. Soils & Engineering Services, Inc. personnel should test the compacted granular soil to verify that the minimum density has been achieved. If the soils exposed by the excavation cannot be throughly compacted to raise the density of the exposed soils to the specified density, then we recommend at least 18 inches of the exposed granular soils be undercut and then placed back into the excavation in 6- to 12-inch-thick lifts and compacted as specified in Sections VII.D through VII.F.

C. Foundation Recommendations

After complying with the recommendations of Sections VI.A and VI.B above, spread footing foundations may be constructed to provide foundation support of the proposed structure. The bottom of the spread footings should rest at least 5 feet below the proposed finished grade.

The spread footings should rest upon (1) native granular soil or (2) 12 inches of geotextile-wrapped coarse crushed stone over native granular soil. If the above recommendations are implemented, then we recommend an allowable soil bearing capacity of 2,000 pounds per square foot (psf) be used for spread footing foundation design.

We estimate that total strip and column footing settlement should be less than 1-inch and differential settlement should be less than 0.03 inches per foot of horizontal distance between two points of reference, if the above recommendations are followed.

To prevent excessively narrow footings, we recommend that wall and isolated spread footings be designed and constructed with minimum dimensions of 18 and 24 inches, respectively, even if the applied footing bearing pressure is less than the allowable soil bearing resistance.

We recommend that footings and foundation walls include a sufficient quantity of reinforcing steel to reduce the shrinkage effect of the concrete. The steel will also reduce the potential for differential settlement throughout each proposed structure. We recommend all reinforcing steel be installed with at least the minimum ACI-specified concrete cover thickness.

D. Foundation Backfill

We recommend the interior and exterior of the foundations for the building be backfilled using granular fill material. The granular fill material should consist of granular soils meeting the specifications presented in Section VII.D and be placed and compacted as specified in Section VII.D. Below landscaped areas, the granular fill material could be terminated at a depth of 18 inches, or higher, below the proposed finished exterior grade to allow placement of topsoil. Below sidewalks and other paved structures, the granular fill material should be placed to the proposed subgrade elevation for the surface improvement.

E. Paved Areas

We anticipate that the parking lot will be utilized mostly by cars or pickup trucks. The proposed parking and drive areas will include curb and gutter sections. We recommend the comments and recommendations provided herein also be used for any new or reconstructed sidewalks for the subject project.

For the purposes of this report, the term "paved areas" refers to parking, drive, waste receptacle, sidewalk, and any other area that will have an asphalt or concrete surface layer, hereafter referred to as pavement.

We offer the following comments and recommendations regarding the paved areas for the subject project. Additional comments and recommendations are provided in the various sub-sections of Section VII starting on page 16 that would apply to the paved areas construction.

1. Site Excavation and Filling

We recommend initial site preparation of the paved areas be performed as specified in Section VII.A. All site preparation excavations that extend below the design elevation of the bottom of the proposed pavement should extend out from the lower outer edges of the pavement for every foot of excavation below the bottom of the pavement. If curb and gutter is installed, then the site preparation excavations should extend outward from the lower outer edge of the curb and gutter 1-foot for every foot of excavation below the bottom of the pavement.

We anticipate that cut and fill areas will be located within the paved area limits for this project. Based on the borings and the anticipated finished paved area elevations, we do not anticipate the need for dewatering or bedrock excavation for the paved areas.

We recommend that all paved areas have a minimum of 3 feet of "good to excellent sand and gravel soils" as defined by the Wisconsin Asphalt Pavement Association (WAPA) "Asphalt Pavement Design Guide" below the recommended HMA and crushed stone base course provided in Section VI.E.2 below.[1] We recommend imported material used to raise the grade in pavement areas consist of sand and gravel meeting the requirements presented below in Section VII.D. These sand and gravel requirements are considered to meet the WAPA "good to excellent sand and gravel soils" criteria. Hereafter, we will refer to WAPA "good to excellent sand and gravel soils" as WAPA Soil. The on-site SILTY SAND WITH GRAVEL (SM) meets the criteria for WAPA Soil. Cohesive soils (clays and silts) exposed at the proposed paved areas subgrade elevation should be removed to a depth of 3 feet below the subgrade elevation. We recommend the WAPA Soil within the paved areas be placed and compacted as specified in Section VII.D below.

Based on the borings, the soils present below the topsoil consist of cohesive soil over granular soil. We recommend cohesive soil exposed by the paved area site excavation at the proposed base course subgrade elevation be undercut a minimum of 3 feet. If the recommended cohesive soil undercut exposes granular soil prior to reaching the 3-foot depth, then the undercut excavation could be terminated. Exposed cohesive soil present at the 3-foot undercut subgrade surface should be proof-rolled prior to placement of the WAPA Soil to raise the grade to the proposed base course subgrade elevation.

[1]Asphalt Pavement Design Guide. Version 2016.1. Madison, WI: Wisconsin Asphalt Pavement Association, 2016. Print.

Excavations that extend below the design elevation of the bottom of the proposed pavement should extend out from the lower outer edges of the pavement 1-foot for every foot of excavation below the bottom of the pavement. If curb and gutter is installed, then the site preparation excavations should extend outward from the lower outer edge of the curb and gutter 1-foot for every foot of excavation below the bottom of the pavement.

We recommend granular soil exposed by the paved area site excavation be thoroughly-compacted and cohesive soil exposed by the paved area site excavation be proof-rolled prior to placement of WAPA Soil in undercut excavations or the recommended crushed stone base course where the granular soils are present at the proposed base course subgrade elevation.

Proof-rolling of cohesive excavation surfaces should be performed using a heavily-loaded, triaxle dump truck or similar heavy rubber-tire equipment. The equipment used should traverse the exposed cohesive soil twice each in two directions that are perpendicular to each other. Soils & Engineering Services, Inc. personnel should observe the proof-rolling procedure. If the excavation surface soil exhibits rutting, pumping, or yielding during the initial proof-rolling, the proof-rolling should be stopped and the need for excavation surface stabilization should be considered. Excavation surface stabilization may consist of excavation of poor-quality soil, placement of a separation-type geotextile and coarse crushed stone, or other possible methods.

Thorough compaction of granular excavation surfaces should be performed using a self-propelled or tow-behind vibratory, steel-drum compactor. Soils & Engineering Services, Inc. personnel should observe the thorough compaction procedure. The granular soil should be compacted to a density of at least 95 percent of the maximum dry density determined for the soil according to ASTM Designation D 1557 for a minimum depth of 18 inches below the excavation bottom. Soils & Engineering Services, Inc. personnel should test the compacted granular soil to verify that the minimum density has been achieved before placing compacted granular fill material. If the soils exposed by the excavation cannot be compacted, additional undercut may be necessary.

We recommend all paved area excavation surfaces be graded similar to the proposed pavement grade to provide drainage of any water entering the subgrade soils. A means of removing this water, such as discharge piping to a ditch or storm sewer structure, should be included in the design of the paved areas.

2. Parking and Drive Pavement Sections

We recommend the hot-mix asphalt (HMA) pavement for the subject paved areas meet the requirements of Type LT or Type MT HMA material as specified in Section 460 of the WisDOT *Standard Specifications for Highway and Structure Construction*. Type LT HMA material is used for automobile areas and Type MT HMA material is used for truck areas.

If needed, we recommend paved areas requiring a Portland cement concrete (PCC) pavement contain steel reinforcement and consist of a concrete mix with a minimum compressive strength of 4,000 pounds per square inch at 28 days. The size and spacing of the steel reinforcement should be determined by a civil engineer licensed in the State of Wisconsin specializing in concrete pavement design.

We recommend all aggregate base course material for the subject paved areas consist of material meeting the requirements for 1¼-inch Dense Graded Base per Section 305 of the WisDOT *Standard Specifications for Highway and Structure Construction*. We recommend compacting the entire depth of aggregate base course material to a density of at least 95 percent of the maximum dry density determined for the material in accordance with ASTM Designation D1557.

Based on the 2016 WAPA "Asphalt Pavement Design Guide," we recommend the use of 3 inches of Type LT HMA pavement over 8 inches of aggregate base course for the parking lot and drive areas limited to cars or pickup trucks. We recommend the aggregate base course material be placed on top of the approved subgrade surface following completion of the site excavation and filling as recommended in Section VI.E.1 above. We recommend the aggregate base course material be placed and compacted in two 4-inch-thick lifts.

Based on the 2016 WAPA "Asphalt Pavement Design Guide," we recommend the use of 4 inches of Type MT HMA over 12 inches of aggregate base course for any areas where large trucks will travel. We recommend the aggregate base course material be placed on top of the approved subgrade surface following completion of the site excavation and filling as recommended in Section VI.E.1 above. We recommend the aggregate base course material be placed and compacted in two 6-inch-thick lifts. Thinner loose lifts could be used if the recommended percent compaction cannot be achieved with the 6-inch-thick lifts.

The above HMA pavement and crushed stone base course section thicknesses are based on the provision that 3 feet of WAPA Soil is provided below these materials.

For a waste receptacle (dumpster) area, we recommend the use of 10-inches of reinforced PCC pavement over 6 inches of aggregate base course.

F. Underground Utilities

We offer the following comments and recommendations regarding the underground utilities for the subject project. Additional comments and recommendations are provided in the various sub-sections of Section VII starting on page 16 that would apply to the underground utility construction.

1. Dewatering Recommendations

We recommend dewatering of underground utility excavations be performed as specified above in Section VI.A.

2. Excavation Recommendations

We recommend the "open cut and cover" excavations be accomplished using a hydraulic backhoe. We recommend the backhoe be equipped with a cleaning bucket to minimize the amount of soil disturbance at the bottom of the excavation. A cleaning bucket is a conventional bucket equipped with a continuous cutting edge. This could be fabricated by welding a steel plate in front of the cutting teeth.

Bedrock excavation and removal is not expected for underground utilities for this project.

We recommend the bottom of the "open cut and cover" excavations be extended to at least 24 inches below the design bottom of the utility lines to accommodate a layer of bedding material over a layer of geotextile-wrapped coarse crushed stone. The type of bedding material should be chosen based upon the type of pipe used and the loadings anticipated. The geotextile-wrapped coarse crushed stone should be placed as specified in Section VII.C below.

Although not anticipated, if low-strength organic/cohesive/granular soils are present at or below the bottom of the trench excavations, the excavation should be extended to a sufficient depth to completely remove all of the low-strength organic/cohesive/granular soils from beneath the proposed improvements.

Excavations that extend below the bottom of the proposed improvements should extend horizontally outward 1-foot for every vertical foot of distance between the excavation surface and the lowest exterior dimensions of the proposed pipes. For pipes, the lowest exterior dimensions should be defined as the outside walls of the pipe at the spring line of the pipe.

3. Excavation Sidewall Stability

We recommend the sidewalls of any "open cut and cover" excavations be adequately sloped or properly shored in accordance with the OSHA and Wisconsin Department of Safety and Professional Services regulations regarding construction excavations.

Due to the type of existing fill material and native soil strata encountered by the soil borings, the sidewalls of the excavations may experience instability if the sidewalls are not "laid back" to a stable slope or supported by an earth retention system. We recommend the existing fill material, and native soil strata along the project route be designated as "Type C" soil in accordance with the OSHA regulations. The OSHA regulations indicate that Type C soils should be excavated at a slope not steeper than 1½H:1V. In areas affected by nearby facilities such as roadways, flatter slopes may be necessary to maintain the stability of the excavated trench sidewalls.

If saturated fill material or native soil strata is encountered, it may be unstable. Effective and efficient dewatering will be important to aid in maintaining sidewall stability.

4. Pipeline and Access Structures Subgrade Support

Based on the expected depth to install underground utilities for the subject project, we anticipate the bottom of the "open cut and cover" excavations will terminate within native soil strata. Soils & Engineering Services, Inc. should observe and test the exposed material at the bottom of all of the "open cut and cover" excavations.

Based on the information obtained, the native soil strata encountered by the borings are generally suitable for stable, long-term support of the proposed improvements. As previously stated, all fill material and topsoil should be removed from below proposed pipes and access structures.

5. Pipeline and Access Structures Backfill Material

We recommend all "open cut and cover" excavations be properly backfilled as presented below. The materials and density requirements for the backfill soils specified herein surrounding the pipe should be modified if the pipe manufacturer so indicates.

The effort used to compact the backfill materials should be monitored by Soils & Engineering Services, Inc. at regular depths and intervals to determine if the minimum density has been achieved, especially during initial placement of the fill material. Any compacted lift that does not meet the specified density should receive additional compactive effort and then be retested until the required density has been achieved. Subsequent lifts should not be placed until the specified minimum density has been achieved on the preceding lift.

During cold weather conditions, granular fill material should not be deposited over frozen native soil or frozen fill material. Also, granular fill material to be placed and compacted should not be frozen or contain snow or ice.

The trenches should be hand backfilled to an elevation at least one (1) foot above the top of the pipe as specified in Madison SSPWC Section 502.1(e). Above this elevation, we recommend the trenches be backfilled as follows dependant upon whether the trench is located in a paved area or a landscaped area.

a. Below Paved Surfaces

For project areas where the backfill material will be supporting roadways, driveways, sidewalks, or other paved surfaces, we recommend to utilize granular fill material as specified in Section VII.D below.

For the uppermost 3 feet of backfill material below the pavement subgrade elevation or other structural features, we recommend the granular backfill material be placed and compacted as specified in Section VII.D below. For granular backfill material placed below a depth of 3 feet below the design subgrade elevation, the material should be placed with the same loose lift thickness and with each lift being compacted to a density of at least 90 percent of the maximum dry density determined for the backfill material in accordance with ASTM Designation D1557.

The above compaction requirements should be used for all backfill material in any "open cut and cover" excavation that is located within a line extending down and away from the exterior limits of the paved surface at a slope of ½-foot horizontal to 1-foot vertical.

b. Below Landscaped Areas

For project areas where the backfill material will be supporting landscaping areas such as grass or shrubbery, we recommend the material be placed and compacted as specified in Section VII.B below.

G. Protection of Existing Structures

"Open cut and cover" excavations performed to accommodate the proposed improvements may affect the stability of existing structures including existing utility lines.

We recommend the project engineer review the foundation grades corresponding to nearby existing structures with respect to the proposed excavation depths for the proposed improvements to determine if the existing structures or utility lines may be affected by the site excavations.

If required, it may be necessary to underpin the existing structures and perhaps provide lateral restraint to the soils below the existing structures or utility lines in the form of steel sheetpiling, soil nailing, or other forms of lateral support. This work should be completed prior to "open cut and cover" excavations and trenchless installations.

VII. SUPPLEMENTARY COMMENTS AND RECOMMENDATIONS

A. Initial Site Preparation

Initial site preparations should include removing existing topsoil, vegetation (including trees and tree roots) in existing landscape areas and the existing pavement, curb and gutter sections, and base course material in paved areas.

The borings found the surficial native topsoil to be 8 to 15 inches in thickness. The thickness of the topsoil encountered elsewhere on the project site could be more or less than what was encountered by our soil borings. The topsoil could be stockpiled for reuse in landscaped areas.

The thickness of the pavement in the existing parking lot is unknown. The excavated base course material could be stockpiled for reuse as granular fill material.

We expect the selected earthwork contractor can accomplish removal of the above surficial materials with normal earth-moving equipment.

B. Landscaped Area Filling

We recommend the material used to raise the grade below landscaped areas be placed in maximum 12-inch-thick loose layers and compacted to at least 88 percent of the maximum dry density determined for the material according to ASTM Designation D1557. Improper or poor densification of the fill material placed in landscaped areas could result in settlement of the soils and subsequent depressions in the landscaped area surface.

C. Coarse Crushed Stone

If needed due to the presence of groundwater and to reduce potential disturbance and loss of strength in the soil at the bottom of the excavation, a minimum 12-inch-thick geotextile-wrapped coarse crushed stone mat may be needed to be placed in the foundation and/or storm sewer excavations. We recommend the coarse crushed stone consist of Number 2 stone as defined in ASTM Designation C33 for backfilling of any excavation for the subject project as specified above. Number 2 stone consists of particles primarily in the 1½- to 2½-inch range without fines as follows:

Sieve Size	Percent Passing
3-inch	100
2½-inch	90 to 100
2-inch	35 to 70
1½-inch	0 to 15
¾-inch	0 to 5

After approval of the native or fill soil at the bottom of the excavation, we recommend a woven geotextile, such as Mirafi 600X, Contech C300, or equivalent, be placed on the entire excavation area and extend up the sidewalls of the excavation. The geotextile should be pulled taut to remove wrinkles and slack. The coarse crushed stone should then be placed in maximum 1-foot-thick loose layers.

Each layer of coarse crushed stone should be thoroughly-compacted with a large, vibratory smooth-drum compactor, or a backhoe-mounted plate compactor, to densify the placed stone. Following placement of the minimum 12 inches of coarse crushed stone, either additional coarse crushed stone or granular fill material could be placed to raise the grade to the design subgrade elevation. The geotextile should be wrapped onto and cover the entire top of the coarse crushed stone.

The geotextile-wrapped coarse crushed stone is intended to form a working mat upon which construction of the proposed spread footings can take place and to aid in dewatering the foundation excavation.

D. Granular Fill Material

We recommend the granular fill material consist of imported well-graded sand, or sand and gravel, with a maximum aggregate size of 2½ inches in the greatest dimension, not more than 30 percent of the material retained on the ¾-inch sieve, and not more than 25 percent passing the No. 200-mesh sieve. The on-site fill and native granular strata are acceptable for use as granular fill material.

We recommend the granular fill material be placed in maximum 12-inch-thick loose lifts. We recommend each lift be compacted to at least 95 percent of the maximum dry density determined for the material according to ASTM Designation D1557. Depending upon the selected granular fill material's particle-size composition, thinner loose lift thicknesses, drying out of the material, or the addition of water to the material may be necessary to achieve the recommended percent compaction.

E. Fill Material Monitoring

We recommend the compactive effort of the Coarse Crushed Stone, Granular Fill Material, and Cohesive Fill Material be monitored during construction by Soils & Engineering Services, Inc. personnel at regular depths and intervals to verify that the minimum density has been achieved, especially during initial placement of the fill material. Any compacted lift that does not meet the specified density should receive additional compactive effort and then be retested until the required density has been achieved. Subsequent lifts should not be placed until the specified minimum density has been achieved on the preceding lift.

F. Cold Weather Fill Material Placement

During cold weather conditions, Coarse Crushed Stone, Granular Fill Material, and Cohesive Fill Material used to backfill any excavation or to raise the grade should not be deposited over frozen soil, either frozen native soil or frozen fill material.

Also, any of the fill materials to be placed and compacted should not be frozen or contain snow or ice.

G. Suitability of On-Site Soils

The existing fill/native topsoil and native cohesive soil are not suitable to use as fill material beneath the proposed structures or as material to be placed to backfill the below-grade section of the foundation elements. Excavated fill/native topsoil could be stockpiled for use in landscaped areas only.

Existing granular native soil could be used as backfill material as long as the moisture content of the soil is in the proper range to obtain the required density at the time of compaction.

H. Lateral and Vertical Support of Existing Improvements

To maintain the stability of existing improvements (e.g. structures, pavement, sidewalks, utilities, etc.), the soil supporting these existing improvements should be properly retained at all times. If any excavation accomplished for the proposed improvements will intersect a 1½H:1V line extending down and away from the exterior limits of the existing improvements (such as building foundations or paved areas), then a suitable earth retaining method should be implemented to support the existing improvements.

I. Site Grading Recommendations

As groundwater can cause problems with construction, so can surface water from precipitation runoff if allowed to accumulate within the construction area. The contractor should grade the site to drain surface water away from the construction areas. Water accumulations in the construction area should be promptly removed. Any soil softened, loosened or disturbed by water should be excavated, removed and replaced with compacted granular fill material or coarse crushed stone. Temporary surface water diversion structures, such as ditches and berms, could be constructed in areas where surface water drainage into the work area is encountered.

J. Seismic Site Classification

The Wisconsin Commercial Building Code specifies the Seismic Site Class for a building site be determined using the procedures defined in Chapter 20 of ASCE Standard 7. The latest version of this ASCE standard is dated 2016. In ASCE 7-16 Chapter 20, the upper 100 feet of subsurface profile is used to determine the

Seismic Site Class. Where site-specific subsurface profile data are not available to a depth of 100 feet, appropriate soil properties are permitted to be estimated by the registered design professional preparing the soil exploration report based on known geologic conditions.

Using the SPT and unconfined compressive strength information obtained from the soil borings, we computed the seismic site class for each of Borings 1 and 2 using the procedures described in Chapter 20 of ASCE Standard 7-16. As defined in Chapter 20, the softest soil profile classification controls the seismic site class for a site. Based on our computations, we determined the subsurface stratification for the park shelter site (Boring 1) and the parking lot site (Boring 2) meet the criteria for Site Class D, "stiff soil." We include our seismic site class calculation results obtained for this report on the Seismic Site Class Record (Table 1) enclosed in Appendix B. Borings 1 and 2 were extended to depths of 15 feet and encountered predominantly low to moderate strength soils. Higher site classifications may be possible, but would require the performance of shear wave analyses or the performance of a soil boring to a depth of 100 feet or sound bedrock.

Assuming the subject structure meets the definitions for seismic Risk Category II, we provide additional site-specific seismic parameters in the Applied Technology Council (ATC) "Hazards by Location" Information Printout enclosed in Appendix B.[2]

K. Cold Weather Construction

Construction during cold weather (late fall, winter and early spring) requires special considerations. The soil which will be supporting foundation elements should not be frozen at the time of construction. We recommend that a means of preventing the soil from freezing be implemented at the time of excavation, during backfilling operations, or after fill material is placed to the design elevation. To prevent the soil from freezing, various materials are available, such as a thick layer of straw or insulation blankets which should be placed on the soil after excavation to the design grade and prior to the placement of concrete for foundation elements. An alternative method is to provide a heated enclosure for the area under construction.

We recommend that concrete for foundation elements not be placed on frozen soil. If the soil becomes frozen prior to the placement of concrete, either the frozen soil should be excavated and replaced with compacted granular fill material or crushed stone, or a means of thawing the frozen soil should be implemented followed by re-

[2] "Hazards by Location." *ATC Hazards by Location*, Applied Technology Council (ATC), 25 November 2019, https://hazards.atcouncil.org/#/seismic?lat=43.1281521&lng=-89.3793875&address=1101%20Woodward%20Dr%2C%20Madison%2C%20WI%2053704%2C%20USA.

compaction of the bearing soil. The bearing soils should then be observed and tested by Soils & Engineering Services, Inc. to verify the suitability of the soil for support of the concrete. Any forms or reinforcing steel should be warmed prior to the placement of the concrete.

At the time of placement of fresh concrete for foundation elements, the concrete should be protected against freezing for a minimum of 7 days, and possibly longer depending on the design strength of the concrete. Insulation blankets or heated enclosures should be used to protect the fresh concrete against freezing. The use of concrete forms as the method of protecting fresh concrete is <u>not</u> acceptable. We recommend the procedures presented in American Concrete Institute's (ACI) document titled "Recommended Practices for Cold Weather Concreting" (ACI 306) be used for placing and protecting concrete during the cold weather.

L. Project Safety

Safety precautions, such as those required by OSHA and the Wisconsin Department of Safety and Professional Services, should be followed throughout the entire construction of the proposed project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls and adjacent embankments, roadways, access ramps, sidewalks, utility lines, towers, and/or buildings.

VIII. CLOSING COMMENTS

Soils & Engineering Services, Inc. prepared this report for the exclusive use of the City of Madison Parks Division to aid in the design of the proposed construction of a park shelter, parking lot, and storm sewer for the Warner Park Beach located at 1101 Woodward Drive in the City of Madison in Dane County, Wisconsin. The recommendations in this report are based on the project information provided to our office. Soils & Engineering Services, Inc. should review any changes in the nature, design, or location of the proposed improvements after submittal of this *Geotechnical Exploration and Analyses Report* to revise the recommendations in the report, if necessary. The nature and extent of soil or groundwater variations between the boring locations may not become evident until the time of excavation or construction of the subject project. If soil or groundwater variations are evident at the time of excavation or construction, it will be necessary for Soils & Engineering Services, Inc. to re-evaluate the soil and groundwater, and other site conditions, which may result in the revision of our recommendations in this report.

Please read the *Important Information about This Geotechnical-Engineering Report* advisory sheet enclosed in Appendix C which provides comments about how to interpret and use this *Geotechnical Exploration and Analyses Report* for the Proposed Improvements project.

Soils & Engineering Services, Inc. should review the final design and specification documents for this project to verify that our recommendations regarding the proposed improvements are interpreted correctly and implemented in the design of the subject project as they are intended. We recommend that Soils & Engineering Services, Inc. be present at the time of construction to observe compliance with the design concept and specifications, and to provide recommendations to modify the design if subsurface conditions differ from those anticipated prior to construction. It is important that the exposed soil strength, degree of compaction, and other soil properties required be confirmed and/or determined at the time of excavation and construction activities for the subject project.

The recommendations provided in this report are based on our identification/classification and interpretation of the soils and information given on the Boring Log Records, and may not be based solely on the contents of the driller's field logs.

Soils & Engineering Services, Inc. prepared this report for the subject project in accordance with generally accepted geotechnical engineering practices at this time. Soils & Engineering Services, Inc. offers no other expressed or implied warranty.

Soils & Engineering Services, Inc. will store the soil samples obtained from the soil borings performed for this project for a period of 60 calendar days after the date of this report. Please advise us if we should extend this period.

We recommend that this *Geotechnical Exploration and Analyses Report*, in its entirety, be made available to bidding contractors or subcontractors for information purposes. The Appendices, Boring Log Records, and/or other attachments referenced in this report should not be separated from the text of this report. This report should be considered invalid if used for purposes other than those described herein.

Soils & Engineering Services, Inc. respectfully submits this *Geotechnical Exploration and Analyses Report*, dated December 4, 2019, to the **City of Madison Parks Division**.

APPENDIX A

Appendix A Contents

- Location Sketch, Drawing 13300.31-1
- Notes and Legend Record for Boring Log Records
- Boring Log Records for Borings 1 and 2
- Laboratory Test Result Records, Figures 1 through 3

NOT-TO-SCALE

Map Source: "Woodward Drive, Madison, WI." Google Earth. October 2018 Aerial. Accessed November 14, 2019.

LOCATION SKETCH
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison, Dane Count, Wisconsin

DRAWING
13300.31-1

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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Created on 11/21/2019 Revised on

NOTES

1. The boundary lines between different soil strata, as shown on the Boring Log Records, are approximate and may be gradual.

2. The boring field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Boring Log Records contains the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the boring field logs and soil samples and/or laboratory test results.

3. We define "Caved Level" as the depth below the existing ground surface at a boring location where the soils have collapsed into the borehole following removal of the drilling tools.

4. We define "Water Level" as the depth below the existing ground surface at a boring location to the level of water in the open borehole at the time indicated unless otherwise defined on the Boring Log Records.

5. We define "at completion" for a boring as being the time when our drilling crew has completed the removal of all drilling tools from the borehole.

6. The Notes and Legend Record and the Boring Log Records are a part of the geotechnical report. The geotechnical report should be included in the bidding or reference documents.

RELATIVE PERCENTAGE TERMS

no	0%
trace	<5%
few	5 to <10%
little	10 to <30%
some	30 to < 50%

TEST RESULTS LEGEND

q_p = Penetrometer reading, $^{ton}/_{ft^2}$
MC = Moisture Content, % moisture by weight
LL = Liquid Limit, % moisture by weight
PL = Plastic Limit, % moisture by weight
PI = Plasticity Index, % moisture by weight
q_u = Unconfined Compressive Strength, $^{ton}/_{ft^2}$
γ_w = Wet Density, $^{lb}/_{ft^3}$
γ_d = Dry Density, $^{lb}/_{ft^3}$
LI = Organic Matter Content, % organic content by weight
P_{200} = % Passing the No. 200-mesh Sieve

RELATIVE MOISTURE TERMS AT TIME OF SAMPLING

Frozen or F = Frozen material
Dry = Dusty, dry to touch, absence of moisture
Moist or M = Damp to touch, no visible water
Wet or W = Visible free water

DRILLING METHODS LEGEND

HSA = Continuous flight hollow-stem augers

SAMPLER TYPE LEGEND

Grab sample

2-inch-outside-diameter, split-barrel sampler

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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NOTES AND LEGEND RECORD
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison, Dane County, Wisconsin

13300.31

General Location:

Boring 1

LATITUDE:	LONGITUDE:	COUNTY:	SECTION:	CREW CHIEF:	DRILL RIG:	PAGE:
—	—	Dane	36	RRR	CME 550X	1 of 1
NORTHING:	**EASTING:**	**TOWNSHIP:**	**¼:**	**LOG REVIEW:**	**HAMMER TYPE:**	**TOTAL DEPTH:**
—	—	(Westport) 8 N	NW	CMB	Automatic	15'-0"
STATION:	**OFFSET:**	**RANGE:**	**¼ ¼:**	**LOG QC:**	**DATE STARTED:**	**DATE COMPLETED:**
—	—	9 E	SW	CMB	11/13/2019	11/13/2019

DEPTH (feet)	Material Description	N-Value	Test Results	Sampler Type / Recovery / Remarks
0 – 0.67	***LEAN CLAY (CL)*** *— medium plasticity, very dark brown, moist,* ***FILL TOPSOIL****-[8" thick]*			M
0.67 – 3	***POORLY-GRADED SAND WITH GRAVEL (SP)*** *— fine to medium grained, brown, moist, medium dense relative density,* ***FILL****, with dark brown LEAN CLAY (CL) layers-[28" thick]*	11	q_p=1.6	M; M
3 – 5.5	***POORLY-GRADED SAND WITH SILT (SP-SM)*** *— fine to medium grained, non-plastic to low plasticity fines, black, moist, loose relative density, trace organics*	5	MC=14.6; LI=2.6; P_{200}=7.3	M
5.5 – 8	***POORLY-GRADED SAND WITH SILT (SP-SM)*** *— fine grained, non-plastic to low plasticity fines, brown and dark brown, wet, loose relative density, trace gravel, trace shells*	7		W
8 – 12	***POORLY-GRADED SAND (SP)*** *— fine to medium grained, light gray, wet, loose relative density, few gravel, little to some shells*	7		W
12 – 15	***POORLY-GRADED SAND (SP)*** *— fine grained, gray, wet, medium dense relative density*	15		W

WATER LEVEL LEGEND	OTHER LEVEL LEGEND
▼ 5'-9" at completion	6'-1" Caved at completion

DRILL METHOD	TOOL SIZE	CASING SIZE	DRILL FLUID	DEPTH FROM	DEPTH TO	HOLE DIA
HSA	2 1/4"	—	None	0'-0"	15'-0"	6.3"

SAMPLING METHOD(S): ASTM D1586

SURFACE PATCH: —

BACKFILL: Auger Cuttings, Bentonite Chips, Caved Soil

The Notes and Legend Record is considered a part of this Boring Log Record.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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BORING LOG RECORD
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison, Dane County, Wisconsin

13300.31

General Location:

Boring 2

LATITUDE:	LONGITUDE:	COUNTY:	SECTION:	CREW CHIEF:	DRILL RIG:	PAGE:
—	—	Dane	36	RRR	CME 550X	1 of 1
NORTHING: —	EASTING: —	TOWNSHIP: (Westport) 8 N	¼: NW	LOG REVIEW: CMB	HAMMER TYPE: Automatic	TOTAL DEPTH: 15'-0"
STATION: —	OFFSET: —	RANGE: 9 E	¼ ¼: SW	LOG QC: CMB	DATE STARTED: 11/13/2019	DATE COMPLETED: 11/13/2019

Depth (feet)	Material Description	N-Value	Test Results	Sampler Type / Recovery / Remarks
0 – 1.25	***LEAN CLAY (CL)*** — *medium plasticity, very dark brown, moist,* ***FILL TOPSOIL***- [15" thick]			M
1.25 – 3	***LEAN CLAY (CL)*** — *medium plasticity, dark brown, moist, very stiff to hard consistency, occasional gravel*	9	q_p=4.5; q_p=3.7; MC=17.6 LL=38; PL=18 q_u=2.59; γ_w=132.1 γ_d=112.4	M; M
3 – 5.5	***POORLY-GRADED SAND (SP)*** — *fine grained, brown, wet, loose relative density, trace shells*	5		W
5.5 – 15	***POORLY-GRADED SAND (SP)*** — *fine to medium grained, brown, wet, loose to medium dense relative density, few gravel, little to some shells*	5; 12; 20		W; W; W

DEPTH (feet): 0, 3, 6, 9, 12, 15, 18

WATER LEVEL LEGEND	OTHER LEVEL LEGEND
▼ 5'-6" at completion	5'-7" Caved at completion

DRILL METHOD	TOOL SIZE	CASING SIZE	DRILL FLUID	DEPTH FROM	DEPTH TO	HOLE DIA
HSA	2 1/4"	—	None	0'-0"	15'-0"	6.3"

SAMPLING METHOD(S): ASTM D1586

SURFACE PATCH: —

BACKFILL: Bentonite Chips, Caved Soil

The Notes and Legend Record is considered a part of this Boring Log Record.

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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BORING LOG RECORD
Proposed Improvements
Warner Park Beach
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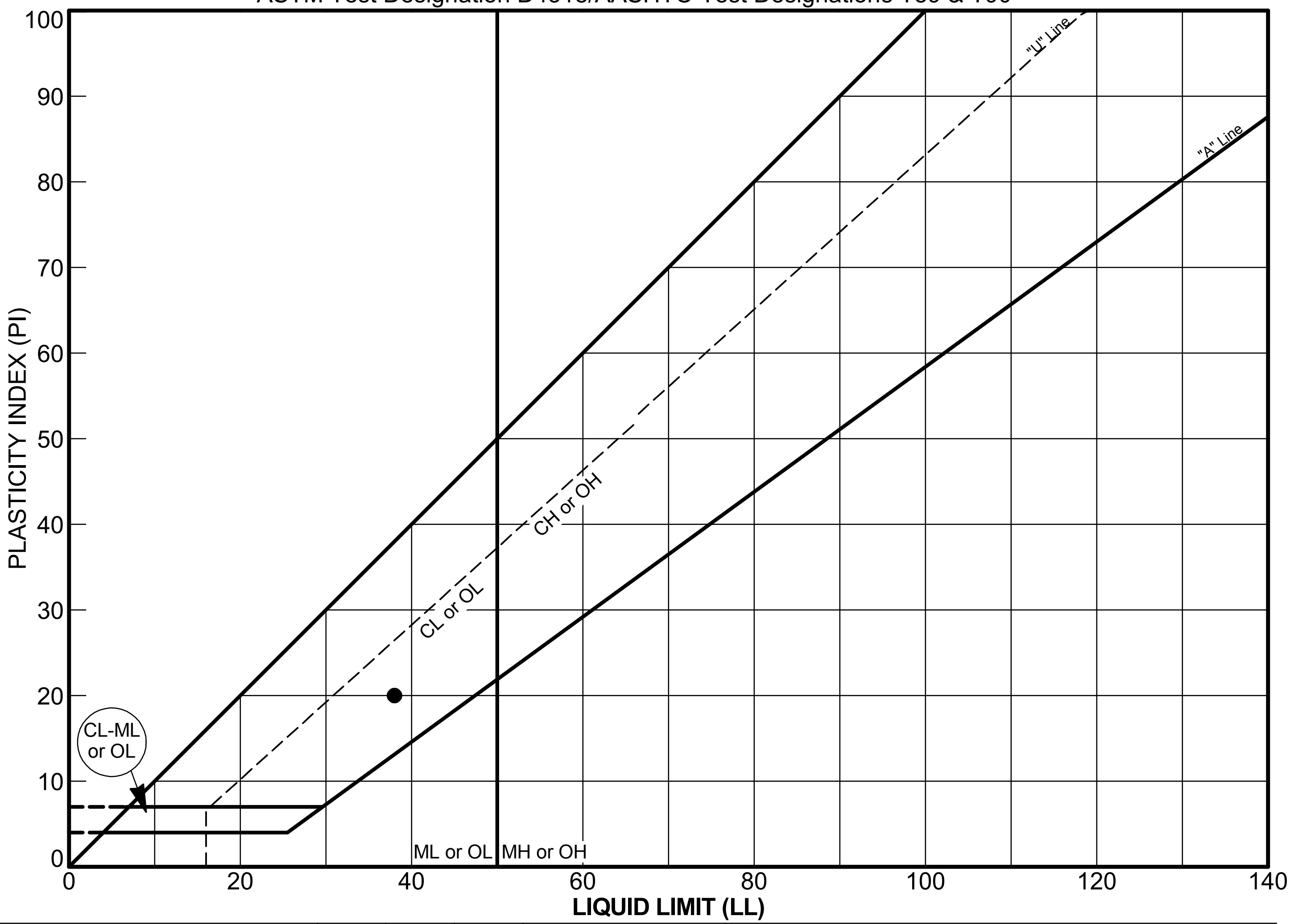
ATTERBERG LIMITS TEST REPORT

ASTM Test Designation D4318/AASHTO Test Designations T89 & T90



	Specimen Identification	LL	PL	PI	Sample Classification
●	Boring 2, 2'-1" Depth	38	18	20	***LEAN CLAY (CL)*** *— medium plasticity, dark brown, moist, very stiff consistency*

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1102 STEWART STREET ● MADISON, WISCONSIN 53713
Phone: 608-274-7600 ● 888-866-SOIL (7645)
Fax: 608-274-7511 ● Email: soils@soils.ws
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LABORATORY TEST RESULT RECORD
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison, Dane County, Wisconsin

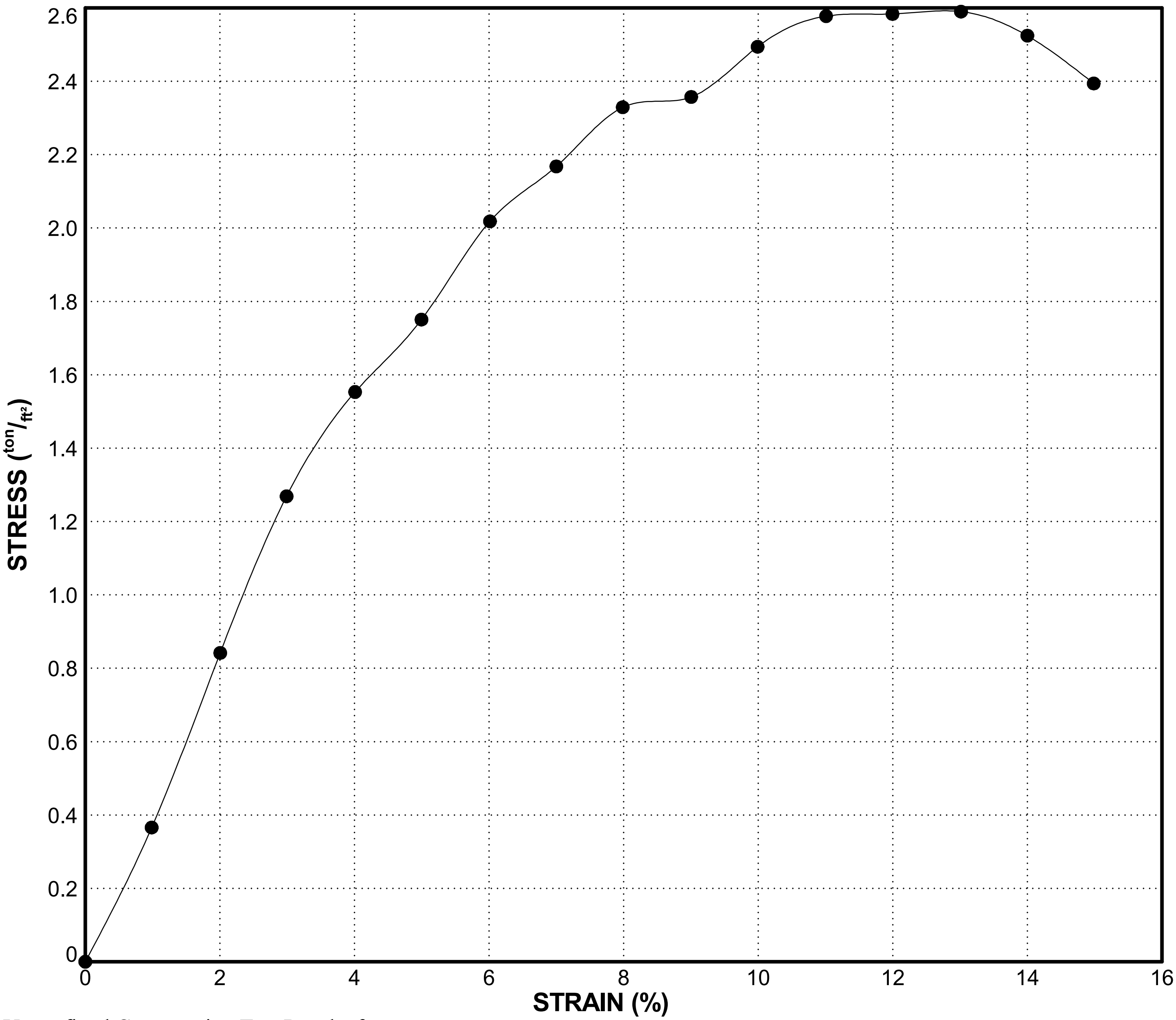
13300.31

FIGURE 1

Printed on 11/22/2019

UNCONFINED COMPRESSION TEST REPORT

ASTM Test Designation D2166



Unconfined Compression Test Results for **Boring 2**

Sample				Diameter (inches)	Height (inches)	H:D Ratio	Wet Density (lb/ft³)	Dry Density (lb/ft³)	MC (%)	Failure	
	Identification	Classification	Type							Stress (ton/ft²)	Strain (%)
●	**2'-1" Depth**	***LEAN CLAY (CL)***	**SS2**	**1.355**	**3.143**	**2.3**	**132.1**	**112.4**	**17.6**	**2.59**	**13.0**

SS2=2-inch-outside-diameter, split-barrel sampler

Soils & Engineering Services, Inc.
1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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LABORATORY TEST RESULT RECORD
Proposed Improvements
Warner Park Beach
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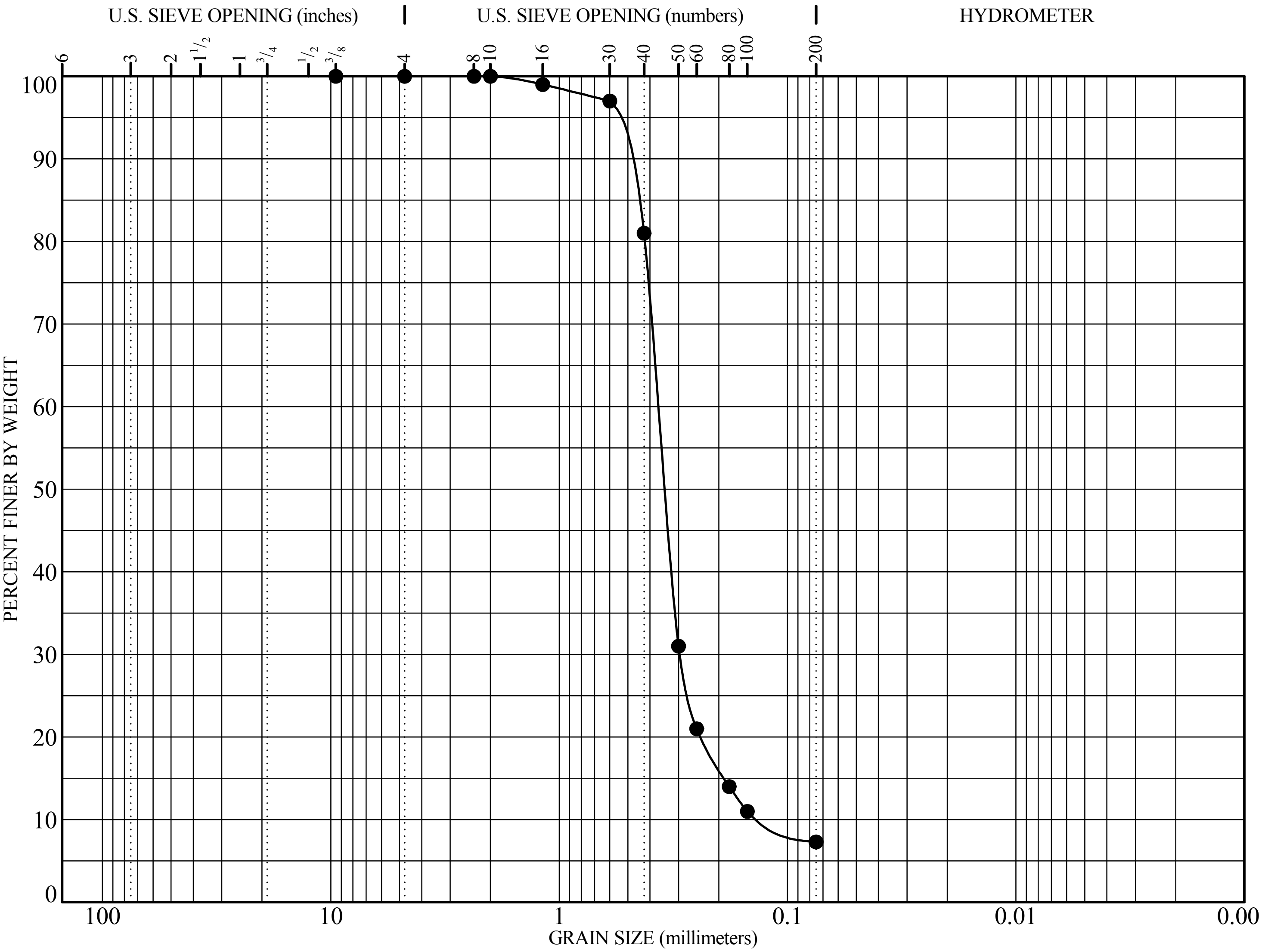
FIGURE 2

PARTICLE SIZE DISTRIBUTION ANALYSIS REPORT



	COBBLES (%)	GRAVEL (%)		SAND (%)			FINES (%)	
		coarse	fine	coarse	medium	fine	SILT (%)	CLAY (%)
●	0	0	0	0	19	74	7.3	

Sieve Size	Percent Finer ●		
3/8-inch	100		
#4	100		
#8	100		
#10	100		
#16	99		
#30	97		
#40	81		
#50	31		
#60	21		
#80	14		
#100	11		
#200	7.3		

Sieve Size	Percent Finer ●		

	Grain Size (mm) D_{60}	D_{30}	D_{10}	Coefficients C_c	C_u
●	0.37	0.30	0.12	2.0	3.1

	Sample Information
●	Boring 1, 4'-7" Depth: ***POORLY-GRADED SAND WITH SILT (SP-SM)*** *— fine to medium grained, non-plastic to low plasticity fines, black, moist, loose relative density, trace organics*

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1102 STEWART STREET • MADISON, WISCONSIN 53713
Phone: 608-274-7600 • 888-866-SOIL (7645)
Fax: 608-274-7511 • Email: soils@soils.ws
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LABORATORY TEST RESULT RECORD
Proposed Improvements
Warner Park Beach
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13300.31
FIGURE 3

APPENDIX B

Appendix B Contents
- Seismic Site Class Record, Table 1
- ATC "Hazards by Location" Information Printout

Boring	Method 2		Method 3				Site Class For Boring
	Avg N-value	Site Class	Avg N-value	Site Class	Avg s_u (tsf)	Site Class	
1	15	D	15	D	—	—	D
Recommend Site Class D (stiff soil) for proposed structure in the vicinity of Boring 1.							
2	17	D	17	D	1.8	C	D
Recommend Site Class D (stiff soil) for proposed structure in the vicinity of Boring 2.							

ASCE Standard 7-16 Site Class Definitions		
Site Class	**Method 2 All Soil Criteria Method 3 Granular Soil Criteria**	**Method 3 Cohesive Soil Criteria**
A: Hard Rock	Shear Wave Analyses Required	Shear Wave Analyses Required
B: Rock	Shear Wave Analyses Required	Shear Wave Analyses Required
C: very dense soil and soft rock	Avg N > 50	Avg s_u > 1.0 tsf
D: stiff soil	15 ≤ Avg N ≤ 50	0.5 tsf ≤ Avg s_u ≤ 1.0 tsf
E: soft clay soil	Avg N < 15	Avg s_u < 0.5 tsf
F: Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, and collapsible weakly cemented soils. See ASCE 7-16 Chapter 20 for additional criteria and exceptions.		

Note: Per ASCE 7-16 Chapter 20, the softest seismic site class from Methods 2 and 3 is applied to a boring subsurface profile. Additionally, the softest seismic site class is applied to a group of borings for a specific improvement.

Soils & Engineering Services, Inc.
1102 STEWART STREET ● MADISON, WISCONSIN 53713
Phone: 608-274-7600 ● 888-866-SOIL (7645)
Fax: 608-274-7511 ● Email: soils@soils.ws
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SEISMIC SITE CLASS RECORD
Proposed Improvements
Warner Park Beach
1101 Woodward Drive
City of Madison, Dane County, Wisconsin

13300.31
Table 1

Printed on 11/22/2019

Hazards by Location

Search Information

Address: 1101 Woodward Dr, Madison, WI 53704, USA

Coordinates: 43.1281521, -89.3793875

Elevation: ft

Timestamp: 2019-11-25T17:09:46.741Z

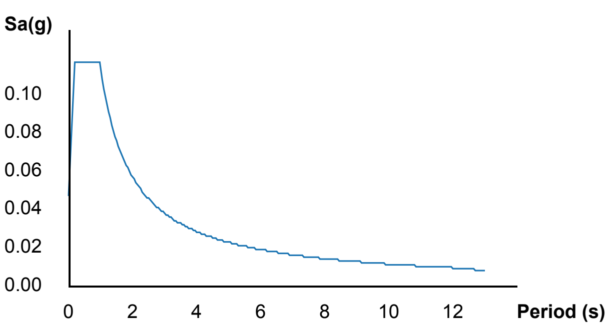
Hazard Type: Seismic

Reference Document: ASCE7-16

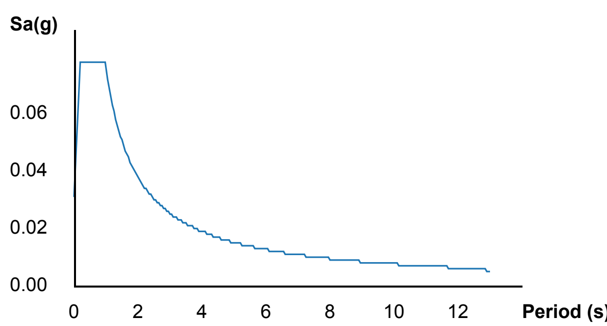
Risk Category: II

Site Class: D

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.073	MCE_R ground motion (period=0.2s)
S_1	0.047	MCE_R ground motion (period=1.0s)
S_{MS}	0.117	Site-modified spectral acceleration value
S_{M1}	0.114	Site-modified spectral acceleration value
S_{DS}	0.078	Numeric seismic design value at 0.2s SA
S_{D1}	0.076	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
CR_S	0.947	Coefficient of risk (0.2s)
CR_1	0.875	Coefficient of risk (1.0s)

PGA	0.035	MCE_G peak ground acceleration
F_{PGA}	1.6	Site amplification factor at PGA
PGA_M	0.057	Site modified peak ground acceleration
T_L	12	Long-period transition period (s)
SsRT	0.073	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.077	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.047	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.054	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

While the information presented on this website is believed to be correct, ATC and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in the report should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. ATC does not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the report provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the report.

Seismic site information obtained from Applied Technology Council (ATC) web site on 25 November 2019. Web address is https://hazards.atcouncil.org/#/seismic?lat=43.1281521&lng=-89.3793875&address=1101%20Woodward%20Dr%2C%20Madison%2C%20WI%2053704%2C%20USA.

APPENDIX C

Appendix C Contents

- *Important Information about This Geotechnical-Engineering Report* advisory

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org