PRELIMINARY
GEOTECHNICAL ENGINEERING
SERVICES REPORT

For the:

Proposed “The Highlands” Subdivision
Downing Property
STH 18
Waukesha, Wisconsin

Prepared for:

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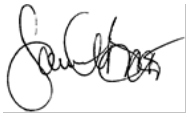

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1 INTRODUCTION

1.1 GENERAL

This report presents the results of the preliminary subsurface exploration, foundation and stormwater management evaluation for the proposed "The Highlands" Subdivision in Waukesha, Wisconsin. The work was performed for Bielinski Homes, Inc., at the request of Mr. John Donovan.

1.2 PURPOSE

The purpose of this preliminary study was to evaluate the subsurface conditions at specific boring locations on the site, and to provide subsurface information for general site feasibility and preliminary design planning. A comprehensive foundation evaluation and recommendations for specific structures were beyond the scope of this preliminary site evaluation but are recommended as part of design planning. In addition, a slope stability study was not requested or performed.

1.3 SCOPE

The scope of services included the subsurface exploration, an evaluation of soil characteristics by field and laboratory testing, and an evaluation and analysis of the data obtained. Subgrade preparation recommendations and construction considerations are also provided. The scope of the field work, including the number, depth, and locations of the borings was determined by the client.

1.4 AUTHORIZATION

The description of services and authorization to perform this subsurface exploration and analysis were in the form of a signed acceptance copy of PSI Proposal No. 267624R2, dated April 22, 2019. The general conditions for the performance of the work were referenced in the proposal. This report has been prepared on behalf of, and exclusively for the use of Bielinski Homes, Inc. The information contained in this report may not be relied upon by any other parties without the express written consent of PSI, and acceptance by such parties of PSI's General Conditions.

2 SITE AND PROJECT DESCRIPTION

2.1 SITE FEATURES

The subject site is the Downing Farm Property located north of State Highway 18, approximately 600 feet west of Century Oaks Drive, in Waukesha, Wisconsin. At the time of the exploration, the project site predominantly consisted of agricultural fields, with an approximately 1,000 by 450 foot wooded section located in the southwest portion of the subject site. A farmstead was present on the south-central portion of the site, adjacent to State

Highway 18. Wetland areas are present on the west portion of the site and adjacent to the north side of the site. Surrounding parcels predominantly consisted of agricultural and residential properties, with the exception of wooded property to the north. A review of historical aerial photographs available from Google Earth indicates that subject site has remained relatively similar in appearance between the photos taken in 2000 and 2018. As an exception, the residential subdivisions to the south and east of the subject site began construction sometime between the photos taken in 2002 and 2006. The subject site is depicted on the enclosed Boring Location Plan (Figure 1).

The topography of the general area and subject site is rolling, with an elevation difference of about 63 feet across the site (approximately EL. 1053 to EL. 990) and a difference in elevation of about 39.5 feet between the boring locations. Existing elevations at the borings ranged between about EL. 1033.7 and EL. 994.2. The site generally slopes down to the west and east; however, locally the site slopes down steeply to north and south. At the time of the exploration, the surface of the site at the boring locations was relatively soft, and an ATV drill rig was required to move around the site.

2.2 PROJECT DESCRIPTION

Based on the information provided, it is understood that the project will consist of the construction of a new residential subdivision, “The Highlands”, on the Downing Farm property. The development will consist of the construction of multiple residential structures, associated residential roadways, and stormwater management areas. The residential structures are planned to consist of one to two-story buildings with basements. It is estimated that the proposed residential roadways will be subjected to relatively light traffic volumes and loading consisting primarily of passenger vehicles. The stormwater management areas are planned to consist of ponds; however, their bottom elevations were unknown at the time of report preparation.

The finished floor elevations for the proposed structures, utility invert, surface grades, or other planned elevations were not known at the time of report preparation. However, based on existing elevations, substantial cuts and fills (possibly in excess of 10 to 20 feet) are estimated to be necessary.

This preliminary exploration has been commissioned to evaluate the subsurface conditions across areas of the subject site and to provide subsurface information for general site feasibility and preliminary design planning for the proposed development. The number and spacing of the borings requested is not considered sufficient to serve as a conventional foundation evaluation for the proposed buildings. Additional borings are necessary and recommended within each of the proposed building footprints to further evaluate more specific soil conditions and provide subsequent recommendations at each building location. In addition, when finished floor, yard, utility invert, and other elevations are determined, PSI must be provided an opportunity to review them and determine if a redirection of the evaluation and recommendations contained herein is warranted, or if additional borings in areas beyond the planned structures are also necessary.

3 EXPLORATION AND LABORATORY PROCEDURES

3.1 SCOPE SUMMARY

The field and laboratory data utilized in the evaluation and analysis of the subsurface materials was obtained by drilling exploratory test borings, securing soil samples by the split-spoon sampling method, and subjecting the samples to laboratory testing.

With respect to the stormwater management area, the field and laboratory work for classification of the subgrade soils was performed to provide information for use by the basin design personnel when considering requirements of Chapter NR151 of the Wisconsin Administrative Code, and of WDNR Technical Standard 1002, “Site Evaluation for Stormwater Infiltration” guidelines. The design of the proposed stormwater management area was beyond the scope of services for this project.

3.2 FIELD EXPLORATION

As requested, a total of twenty (20) soil test borings were planned to be performed to a depth of 20 feet. However, auger refusal on possible cobbles, boulders, and/or bedrock was experienced at B-1 through B-3, B-5 through B-9, B-9A, B-11 through B-16, and B-18 through B-20 at depths ranging from about 1 to 17 feet (EL. 1017.6 to EL. 978.2) below existing grade. In addition, after encountering refusal at B-9 at a depth of about 1 foot (EL. 999.3) on probable cobbles and/or boulders, B-9A was offset approximately 5 feet north of B-9 and performed. Borings B-1, B-4, B-5, B-7, B-8, B-10 through B-13, and B-15 through B-18 were performed within the proposed lots and roadways; whereas, B-2, B-3, B-6, B-9, B-9A, B-14, B-19, and B-20 were performed within the stormwater management areas. The number, depths, and locations of the borings were determined by the client. The borings were staked in the field by the client. The surface elevations shown on the logs were provided by the client.

Borings B-14 and B-15 were offset approximately 35 feet and 30 feet north and northeast, respectively, from their originally planned locations due to trees.

The soil test borings were performed with an ATV-mounted rotary drilling rig utilizing continuous flight hollow stem augers to advance the holes. Representative samples were obtained by the Standard Penetration Test (SPT) method using split-spoon sampling procedures in general accordance with ASTM D-1586 procedures. Samples were collected at 2.5-foot intervals to 10 feet, and then at 5-foot intervals thereafter to the end of the borings. As an exception, samples were obtained at 2-foot intervals at the boring performed within the proposed stormwater management areas. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling thirty (30) inches, required to advance the split-spoon sampler one (1) foot into the soil. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of the three (3) successive increments of six (6) inches penetration. The “N” value is obtained by adding the second and third incremental numbers. The SPT provides a means of estimating the relative density of granular soils and comparative

consistency of cohesive soils, thereby providing a method of evaluating the relative strength and compressibility characteristics of the subsoils.

The SPT soil samples were transferred into clean glass jars immediately after retrieval, and returned to the laboratory upon completion of the field operations. Samples will be discarded unless other instructions are received. All soil samples were visually classified by a soils engineer in general accordance with the Unified Soil Classification System. The samples collected within the stormwater management area were visually classified by a certified soil tester in general accordance with USDA National Resources Conservation Service textural soil classification procedures. A description of the subsurface conditions encountered at each boring location is shown on the enclosed Soil Boring Logs. After completion of the borings, the auger holes were backfilled to the ground surface with bentonite chips.

A copy of the Soil Boring Logs and Boring Location Plan (Figure 1) are enclosed in the Appendix. The soil stratification shown on the logs represents the approximate soil conditions in the actual boring locations at the time of the exploration. The terms and symbols used on the logs are described in the General Notes found in the Appendix.

3.3 LABORATORY PHYSICAL TESTING

Soil samples obtained from the exploration were visually classified in the laboratory, and subjected to testing, which included moisture content determinations. Selected cohesive soil samples were tested in unconfined compression with an uncontrolled strain loading rate and/or with a calibrated hand penetrometer to aid in evaluating the soil strength characteristics. The values of strength tests performed on soil samples obtained by the Standard Penetration Test Method (SPT) are considered approximate, recognizing that the SPT method provides a representative but somewhat disturbed soil sample.

The laboratory testing was performed in general accordance with the respective ASTM methods, as applicable, and the results are shown on the boring logs and data sheets in the Appendix.

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 GENERAL

A description of the subsurface conditions encountered at the test boring locations is shown on the Soil Boring Logs. The lines of demarcation shown on the logs represent approximate boundaries between the various soil classifications. It must be recognized that the soil descriptions are considered representative for the specific test boring location, but that variations may occur between and beyond the sampling intervals and boring locations. Soil depths, topsoil and layer thicknesses, and demarcation lines utilized for preconstruction planning should not be expected to yield exact and final quantities. A summary of the major soil profile components is described in the following paragraphs.

4.2 SUBSURFACE CONDITIONS

The surface at the borings within the proposed lots and roadways (B-1, B-4, B-5, B-7, B-8, B-10 through B-13, and B-15 through B-18) generally consisted of about 4 to 19 inches of topsoil (with 6 to 11 inches being more typical), generally comprised of dark brown clay with intermixed root matter. As an exception, no discernable topsoil layer was present at B-16, and fill comprised of brown clay with gravel and dark brown seams was present to a depth of about 1 foot (EL. 1029.6) below existing grade. Regraded soil (likely attributable to past tilling or other agricultural related activities) consisting of clay with dark brown seams was present below the topsoil at B-10 to a depth of about 3 feet (EL. 1011.3) below existing grade. Beneath the surface topsoil; and beneath the regraded soil and fill at B-10 and B-16, the underlying natural soils predominantly consisted of brown clay to depths ranging from about 2.5 to 8 feet (EL. 1029.5 to EL. 998.5), generally underlain by light brown silt and silty fine sand with variable amounts of gravel, and gravelly fine sand with silt to the maximum depths explored by the borings.

The fill and regraded soils encountered were classified as such based on their varied visual characteristics and composition. However, it must be recognized that in the absence of foreign substances and/or debris within the soil samples obtained, it is often difficult to distinguish between natural soils and clean soil fill.

The natural cohesive soils encountered in the borings within the proposed lots and roadways were generally soft to stiff in comparative consistency, with Standard Penetration resistances (N-values) typically between about 4 and 7 blows per foot (bpf), and unconfined compressive strengths generally ranging from about 0.5 to 1.5 tons per square foot (tsf). The underlying natural granular soils encountered in the borings within the proposed lots and roadways were generally medium dense to dense in relative density, with N-values typically between about 6 and 26 bpf. Very dense granular soils (N-values >45 bpf) were encountered at B-1 through B-3, B-5 through B-9A, B-11 through B-13, B-15, B-16, and B-18 through B-20 generally beginning at depths ranging from about 6 to 13.5 feet (EL.1020.6 to EL. 986.6) below existing grade.

The surface at the borings within the stormwater management areas (B-2, B-3, B-6, B-9, B-9A, B-14, B-19, and B-20) consisted of about 5 to 12 inches of topsoil comprised of dark brown or dark grayish brown clay with intermixed root matter. The underlying natural soils predominately consisted of brown clay to depths ranging from about 2 to 3 feet (EL. 1008.4 to EL. 991.2) below existing grade, generally underlain by light yellowish brown gravelly loam, gravelly fine sandy loam, very gravelly fine sandy loam, gravelly sandy loam, and very gravelly sandy loam to the maximum depth explored by the borings. As an exception, layers of gravelly fine sand, very gravelly loamy fine sand, and gravelly fine sand were encountered at B-19 and B-20 at depths beginning at 10 and 12 feet (EL. 1000.4 and EL. 993.3), respectively, to the refusal depths.

Auger refusal on probable cobbles and/or boulders was encountered at B-9 at a depth of about 1 foot (EL. 1029.6) below existing grade. Auger refusal on possible cobbles, boulders, and/or bedrock was encountered at B-1 through B-3, B-5 through B-8, B-9A, B-11 through B-16, and B-18 through B-20 at depths ranging from about 12 to 17 feet (EL. 1017.6 to EL. 978.2) below existing grade. Refusal depths are outlined below:

Boring No.	Approximate Refusal Depth (Feet)	Approximate Refusal Elevation (Feet)
B-1	17	986.5
B-2	15.5	989.9
B-3	15.5	983
B-5	16	991.9
B-6	16	981.2
B-7	12	995.2
B-8	17	1000
B-9	1	999.3
B-9A	12	988.3
B-11	17	1016.7
B-12	17	1007.7
B-13	17	990.8
B-14	16	978.2
B-15	17	1015.5
B-16	13	1017.6
B-18	17	1000.4
B-19	15	995.4
B-20	16	989.3

The foregoing discussion of soil conditions on this site represents a generalized soil profile as determined at the test boring locations. A more detailed description and supporting data for each test location can be found on the individual Soil Boring Logs.

4.3 GROUNDWATER OBSERVATIONS

Groundwater observations were made during the drilling operations, and in the open boreholes upon completion. Groundwater was encountered in the boreholes during auger advancement at B-1 through B-8, B-10, B-12, and B-14 through B-20 at depths ranging from about 2 to 14 feet (EL. 1027.5 to EL. 991.2) below existing grade. Upon completion and removal of the augers, groundwater was encountered at B-6, B-7, and B-10 at depths ranging from about 6 to 8 feet (EL. 1006.3 to EL. 991.2). The borings caved at depths ranging from about 6 to 12 feet below existing grade; therefore, observations could not be made below the caved depths.

The groundwater observations reported herein are considered approximate and may consist of both perched zones and/or the long-term groundwater level. It must be recognized that groundwater levels fluctuate with time due to variations in seasonal precipitation, lateral

drainage conditions, and soil permeability characteristics. Longer term monitoring would be required and is recommended to better evaluate groundwater levels on this site, especially with regard to utility and basement floor elevations.

5 CONSIDERATIONS AND RECOMMENDATIONS

5.1 GENERAL DEVELOPMENT CONSIDERATIONS

In view of the subsurface conditions encountered in the test borings, together with the structural loading criteria and development grades anticipated, conventional spread footings, along with conventional basement construction, can generally be used for support of the proposed structures. Fill soils were present at B-16 to a depth of about 1 foot (EL. 1029.6). Regraded soil and fill are not suitable for foundation support due to potential excessive total and differential settlement. All foundations must be extended through the fill and any buried topsoil to bear on suitable natural soils.

Extreme difficulty with groundwater and softening of subgrade soils may occur where excavations encroach upon or extend below the groundwater level or perched zones, especially within basement and utility excavation work. An adequate dewatering effort, possibly in conjunction with the overexcavation of unstable zones, and the use of a crushed stone working mat (or “mud mat”), may be required. Additionally, it is recommended that basement slabs be placed at least 2 feet above the groundwater level. It is recommended that grades be raised or that basements be eliminated for buildings where the basement slab is not at least 2 feet above the groundwater level. Careful design planning will be essential when establishing surface grades, and corresponding basement floor elevations across the site, especially where substantial grade changes are required.

Auger refusal on probable cobbles and/or boulders was encountered at B-9 at a depth of about 1 foot (EL. 1029.6) below existing grade, and auger refusal on possible cobbles, boulders, and/or bedrock was encountered at B-1 through B-3, B-5 through B-8, B-9A, B-11 through B-16, and B-18 through B-20 at depths ranging from about 12 to 17 feet (EL. 1017.6 to EL. 978.2) below existing grade. Very dense granular soils were encountered at B-1 through B-3, B-5 through B-9A, B-11 through B-13, B-15, B-16, and B-18 through B-20 generally beginning at depths ranging from about 6 to 13.5 feet (EL.1020.6 to EL. 986.6) below existing grade. Substantial difficulty digging, and longer excavation times will likely be experienced with increasing depths. Dependent on final grades, specialized excavation techniques and/or blasting may be required, especially for basements and utilities and substantial difficulty with cutting some areas of the site with scrapers may be experienced due to the very dense nature of the soils (the use of ripping devices and dozers, in lieu of scrapers may be necessary). It is recommended that test pits be performed as part of design planning to better evaluate the depth, character and excavatability of the refusal materials; and to better evaluate groundwater levels.

The existing soils (with the exception of topsoil) can generally be utilized for support of the floor slabs and residential roadways. However, some overexcavation of unsuitable soils may be

necessary on at least an isolated basis. A discussion of the building foundation and pavement design parameters, as well as the support conditions for the floor slabs and pavements are included in later sections.

The number, depth, and spacing of the borings performed for this preliminary study is not considered sufficient to serve as a conventional foundation evaluation for specific structures, especially considering the substantial elevation differences across the site and large cuts/fills estimated to be required, along with the presence of relatively shallow refusal conditions and varying groundwater depths. Therefore, additional borings within the footprints of the proposed structures, and in utility areas are recommended and considered essential to further evaluate the subsurface conditions and groundwater levels in order to provide subsequent recommendations. It must be recognized that the conditions encountered by the additional explorations may warrant an alteration of the preliminary foundation and soil bearing design recommendations presented in this report. A discussion of preliminary guidelines and recommendations is included in the following sections.

5.2 SITE PREPARATION

The presence of organic topsoil and vegetation within the subgrade can adversely affect the serviceability of structural fills, foundations, floor slabs, pavements, and other structures placed upon them. Approximately 4 to 19 inches of topsoil (with 6 to 11 inches being more typical) were typically present on the surface of the site at the boring locations. However, some variation should be anticipated, especially within agricultural fields. All topsoil, vegetation, trees, roots and other organic matter must be stripped from the areas of footings, floor slabs, pavements, sidewalks, and other structures. Exposed subgrades must not be allowed to undergo significant moisture changes, or to desiccate, since subsequent swelling, possibly resulting in slab or pavement deformation, may occur with the addition of moisture. To reduce the potential for detrimental settlements, site preparation must include the removal of all topsoil, buried topsoil, vegetation, trees, roots, and other unsuitable materials from within, and extending a minimum of 10 feet beyond the areas of floor slabs, footings, sidewalks, and other structural areas.

A majority of the project site has previously been utilized as an agricultural field. If any drain tiles are encountered during construction, it is generally recommended that they be tied into new drainage structures or otherwise properly drained to suitable areas of the site (in accordance with state, local or other municipal requirements), since they may still actively drain areas of the subject site or adjacent properties.

Site preparation will include the removal of the existing farmstead including any remnants of the former buildings, foundations, and underground utilities. Extensive areas of loose backfill material may be encountered within utility trenches, adjacent to the existing structures, and in former building and basement areas. These will also require removal. The areas, including basements, must then be properly backfilled with compacted structural fill. Prior to the backfilling, the areas must be observed by a PSI representative to evaluate the suitability of the subgrade for subsequent support of new additions, utilities, or other structures.

Based on a site map provided by the client, wetland areas are present on the west portion of the site (near the west end of the wooded section of the site) and adjacent to the north side of the site. Topsoil depths and the presence/thickness of organic soil layers may increase substantially within and encroaching upon wetland areas, or other wet areas. It is generally recommended that development within wetland areas not be performed due to the typical presence of highly organic soils and shallow groundwater. If such development is contemplated, special permits will likely be required from the Army Corps of Engineers, the WDNR, or other government agencies.

After stripping the topsoil and cutting high areas of the site to the planned finished grade, and prior to the placement of new fill which may be placed to raise grades, the subgrade must be thoroughly proofrolled to detect unstable, yielding soils, which must be removed or improved by appropriate preparation and compaction techniques. Proofrolling should consist of overlapping passes in a perpendicular grid pattern of a fully-loaded tandem-axle dump truck, or other equipment of similar size and weight. However, care must be used on this site to avoid disturbing the near surface fine-grained soils during the proofrolling, especially during periods of precipitation or spring thaw. Proofrolling with rubber tired equipment may be preferable, but should be performed in consultation with the geotechnical engineer at the time of construction. Loose, soft, unstable, or otherwise unsuitable soils should be expected, especially within existing wet materials. When encountered, they must be removed and replaced with compacted structural fill. Scarification, drying and recompaction of wet soils or removal and replacement with suitable fill, are two methods, which can be considered, but this must be determined by the soils engineer at the time of construction. Low areas may then be raised to the planned grades with suitable properly compacted fill.

Equipment and worker traffic must be kept to a minimum on subgrade bearing surfaces, especially during times of precipitation or following spring thaw. Substantial difficulty with subgrade preparation can be expected in wet or cold weather conditions. Removal of unsuitable portions of the near surface soils and replacement with structural fill will likely be required, on at least an isolated basis (but may become extensive dependent upon weather conditions, time of year, and other factors), especially if earthwork is not carried out during periods of relatively warm, dry weather, which provide more favorable conditions for drying of these soils. Any soft zones, which cannot be improved by scarification and aeration, must be removed and replaced with compacted structural fill, such as clean crushed stone, possibly in conjunction with the use of a geotextile fabric. Lime, lime kiln dust, portland cement, and fly ash modification are additional remedial measures which can be considered for fine-grained soils. However, this must only be performed at the direction and under the supervision of the geotechnical engineer. A proper mix design must be performed prior to the performance of any modification. Substantial construction delays and difficulty with subgrade stabilization should be expected during periods of wet and/or cool weather. Consideration should be given to installing construction roads to reduce disturbance to the sensitive subgrade soils.

Every effort must be made to keep excavations dry. If construction proceeds during wet weather, some additional overexcavation may be necessary. If weather permits, the soil could be dried and recompacted. A crushed stone working mat, possibly in conjunction with a

geotextile fabric may also be feasible to help stabilize subgrades. Site grading runoff should be directed to appropriate areas of the site, so that the potential for the softening of the foundation and pavement subgrade soils is reduced.

Where the removal of unsuitable bearing material is performed beneath proposed footings, the excavation must extend laterally beyond the perimeter of the foundation for a distance at least equal to the thickness of the fill below the footing bottom. This general guideline also applies to instances where a raised structural fill pad is constructed to achieve a bearing elevation greater than existing grades. The influence zone of footing stresses can be represented as an imaginary 45° line extending downward and outward from the footing bottom. All fill placed within this zone after cutting to firm soil must be properly engineered, from the bottom of the cut, up to the floor slab subgrade elevation.

If site grades are raised in excess of 2 feet, the first lift of new fill must be placed so as to extend a minimum lateral distance of 5 feet beyond the planned top building pad dimension (for fills less than 5 feet in thickness), or for a distance equal to at least 1 foot laterally beyond the top pad dimension for every foot of fill thickness (for fills greater than 5 feet in depth). Subsequent lifts can then be placed on an approximate 1H:1V slope back up to the planned top perimeter dimension of the pad. Proper moisture control is essential to reduce the amount of compactive effort necessary to achieve the desired densities.

When a firm and stable subgrade is established, low areas may be raised to planned grades with properly compacted structural fill. Any new fill should be a clean granular soil, such as those materials meeting the gradations outlined in Section 209 or 305 of the State of Wisconsin Standard Specification for Highway and Structure Construction. If fine-grained soils, such as those with high silt or clay content are used, they should generally be placed over large open areas, where conditions are more favorable for the proper placement and compaction of such materials. It must be recognized that high silt or clay content materials are difficult to compact when placed at moisture contents beyond a few percent of the optimum moisture content. In addition, the near surface soils across the site are considered to be highly moisture sensitive; therefore, some difficulty with subgrade preparation should be expected, especially if they become wet during construction. If so, severe difficulty may be experienced, resulting in the need for extensive undercutting or stabilization. Fill must be placed in layers of not more than nine (9) inches in thickness, at moisture contents at or near optimum, and be compacted to a minimum density of 95 percent of the maximum dry density as determined by ASTM designation D-1557 (Modified Proctor). However, where fill depths exceed 10 feet, the compaction percentage must be increased to 97 percent of the Modified Proctor. The on-site natural soils beneath the topsoil can generally be used as new fill to raise grades, generally over large, open areas. However, some sorting or moisture conditioning may be required. Silt, clay, and wet granular soils are not suitable for reuse as fill in trenches, or adjacent to foundation stem walls or retaining walls. Substantial importing of granular fill may be necessary.

Proper moisture control is essential to reduce the amount of compactive effort necessary to achieve the desired densities. This is especially true of clayey soils, where scarification and aeration may be required to achieve near - optimum moisture levels prior to compaction. A

sheepsfoot roller is generally required for compaction of clayey soils, whereas a vibratory smooth drum roller is preferred for granular material. Small hand-operated compactors should be used in confined areas; granular fills are generally more readily compacted to the required densities in such applications.

It is recommended that well-graded granular soils be utilized as backfill in new utility trenches and alongside below grade walls to reduce the potential for consolidation and settlement of the fill. All fill soils must be placed and compacted under engineering controlled conditions, to provide suitable support for overlaying structures and roadways. Additional guidance can be provided at the time of construction in the selection process for grade-raising fill and trench backfill.

When excavations encroach upon or extend below the groundwater or perched zones, subgrade instability and sloughing/caving of sidewalls can occur. Some overexcavation of softened or loosened soils, in conjunction with the use of a crushed stone working mat, may be necessary. Additionally, significantly widened excavations may result, or be required for stability.

The selection of fill materials for various applications should be done in consultation with the soils engineer. Similarly, the evaluation of the subgrade and placement and compaction of fill for structural applications should be monitored and tested by a qualified representative of the soils engineer.

5.3 PRELIMINARY FOUNDATION EVALUATION

The following is a general overview of the subsurface conditions for the site, as it relates to foundation analysis, and can be used in preliminary site planning.

Based on the data obtained at the borings for this preliminary study, the natural inorganic soils below the topsoil can generally be used for support of the structures. Fill was present at B-16 to a depth of about and 1 foot (EL. 1029.6). Fill soils are not suitable for foundation support and all foundations must be extended through existing fill and any buried topsoil. The proposed buildings, with basements, may be supported by conventional spread foundations when founded on natural inorganic soils or structural compacted fill used to raise grades. For preliminary planning the on-site soils encountered within the borings, or new structural fill used to raise grades can be used for support of conventional spread footings designed to exert net allowable soil bearing pressures of 2,000 to 4,000 psf, dependent upon location and bearing elevation. However, some undercutting of soft, loose, or otherwise unsuitable natural soils may be required and may become extensive in some areas, especially where shallow groundwater or perched zones are encountered and/or encroaching upon wetland areas. All foundations must bear upon suitable and stable soils of sufficient strength. A more comprehensive exploration, consisting of additional borings is recommended to better evaluate bearing pressures within each structure.

It must be recognized that the subsurface conditions may vary between the relatively widespread boring locations, therefore some nominal overexcavation below planned grade or

subgrade improvement may be necessary in isolated areas of the site to utilize the recommended bearing capacity. Some undercutting and replacement with compacted structural fill or lean concrete mix may be necessary. Due to the possible variation in subsoil conditions, it is recommended that the actual foundation bearing capacity be verified by a representative of the soils engineer, so that the foundations are founded within suitable bearing soils or appropriate subgrade improvement is provided.

It must be recognized that shallow groundwater or perched water, and wet soils were encountered in most of the borings. Such conditions are not conducive to the use of "bank" poured footings due to the potential for caving. All footings must be cast without soil or water intrusion into the foundation concrete. Where such conditions occur, the areas must be removed and recast. If soil and/or groundwater intrusion becomes severe, conventional formed footings must be used. Additionally, it is recommended that applicable building codes and local building inspector be consulted regarding the use of "bank" poured footings as part of design planning.

Wet soils may be encountered within footing excavations and may be widespread. These soils are susceptible to a substantial loss in strength when the confining effect of the overburden is removed. A significantly softened subgrade may develop, requiring undercutting and the use of a crushed stone working mat (or "mud mat") to establish a stable bearing grade. Substantial sloughing and caving may also occur, and dewatering may be required.

The suitability of the existing soils for support of proposed foundations is recommended to be determined by testing by a qualified geotechnical engineer during construction, utilizing static cone penetrometer tests or dynamic cone penetrometer tests for cohesive and granular soils, respectively. Soft, loose, or otherwise unsuitable materials not disclosed by the borings, may be encountered in the foundation excavations at the bearing elevation. If unsuitable existing soil is present, it must be removed throughout a zone extending one foot laterally for each foot removed below the foundation, on either side of the planned footing. The over-excavated area must be backfilled with structural compacted fill. As an alternate, the excavation could extend 4 inches beyond the plan footing width to suitable bearing soil and then backfilled with lean (500 to 1000 psi) concrete mix to planned footing grade to reduce lateral over-excavation.

All perimeter footings must be placed at a depth of at least 4 feet (or deeper if required by local code or customary practice) below the finish grade for frost protection. Due to periodic severity of winters in this area, it is recommended that footings in poorly heated or unheated areas of the building also be placed at least 4 feet below the adjacent exterior grade. Interior footings not subject to frost action may be placed at a shallow depth of 18 inches below the floor slab, provided they bear on suitable natural soils or engineered fills. All footings must be protected from the effects of frost if construction is carried out during winter months.

It is recommended that the footings supporting individual columns have a minimum dimension of 30 inches, and continuous footings have a minimum width of 24 inches, even if the maximum recommended allowable bearing pressure is not fully utilized. In order to minimize the effects of any slight differential movement that may occur due to variations in the character of the

supporting soils and any variations in seasonal moisture contents, it is recommended that all continuous footings be suitably reinforced to make them as rigid as needed.

Since cutting and filling is anticipated to be necessary, the subgrade must be properly prepared prior to filling activities. All fill must be placed in a controlled manner, which must be monitored and tested by a representative of the soils engineer. Recommendations for subgrade preparation and compaction were presented in the Site Preparation section of this report.

In general, the performance of the foundation system on this site is dependent on the various factors discussed herein. The excavation, preparation, and concreting of foundations should be monitored and tested by a representative of the soils engineer.

5.4 PRELIMINARY FLOOR SLAB AND PAVEMENT SUBGRADES

Prior to constructing the floor slabs or pavements, and prior to the placement of any fill used to raise grades, the exposed subgrade must be prepared utilizing the proofrolling procedures described previously. In areas that exhibit soft, yielding or unstable soil conditions, the following remedial measures are recommended to provide a stable subgrade. It must be recognized that the high silt and clay content soils are highly sensitive to increases in moisture and construction disturbance. It will therefore be necessary to maintain these materials in a relatively dry condition to allow for proper subgrade preparation. It is recommended that the proofrolling operations be monitored by a representative of the geotechnical engineer so that a firm, suitable subgrade is present prior to placement of new fills, or to construction of floor slabs and pavements.

Localized wet, soft or unstable areas should be undercut to such depths determined necessary in the field to reach stable material. The overexcavations should then be backfilled with imported crushed stone, such as a 1¼-inch dense graded base specified in Section 305 of the WisDOT Standard Specifications, placed and compacted as recommended in the Site Preparation section of this report. If relatively thick zones or areas of extensive yielding (such as may occur within fill zones, or encroaching upon and within wetlands) are observed that cannot be stabilized by normal discing, aeration and recompaction procedures, undercutting and replacement with crushed stone and geotextile fabric (if needed) may also be required in these areas.

The floor slabs may be designed utilizing an estimated modulus of subgrade reaction of 150 pci based on the presence of naturally occurring clay and fill soils. The final design and detailing should be performed by a qualified structural engineer based on the intended slab use, loading conditions and anticipated subgrade conditions.

A granular mat, which can be designed as a drainage layer, should be provided below floor slabs. This must be a minimum of six (6) inches in thickness and properly compacted. In moisture sensitive areas, a vapor barrier may be placed beneath the floor slab or base course; however, it is recommended that the architect be consulted in this regard. The proper use of a vapor barrier may not completely prevent moisture beneath or on top of slabs. If the base

course contains sharp particles, a cushion layer of sand approximately 2 inches in thickness may be required to provide protection from puncture.

The floor slabs must be suitably reinforced to make them as rigid as necessary and proper joints provided at the junction of slabs and the foundation system so that a small amount of independent movement can occur without causing damage. Large floor areas must be provided with joints at frequent intervals (maximum spacing of 30 times the slab thickness, per ACI) to compensate for concrete volume changes (shrinkage). Where the slab will be supporting live loads, such as moving vehicles, joints must be keyed or dowelled to permit proper load transfer. It is recommended that appropriate construction methods and curing procedures be used to minimize shrinkage and curling of the floor slabs.

5.5 EXTERIOR/UNHEATED AREA SLABS

Entry slabs, sidewalks, aprons, and other slabs in exterior or unheated areas may bear upon silty or clayey soils, which are anticipated to be highly frost susceptible and poorly drained. Slabs placed directly upon such soils are subject to heaving and subsequent settlement due to freeze/thaw cycles. This can result in heaving, cracking, misalignment, and other related effects (especially at joints). It is recommended that consideration be given to limited undercutting of the frost susceptible materials to a depth of 1 to 2 feet below the slab, and replacement with well graded, properly placed and compacted granular soils. A properly designed under drain system connected to the municipal sewer (if permissible) or directed to on-site stormwater management areas should also be incorporated to reduce the potential effects of freeze/thaw cycles.

5.6 UTILITY CONSTRUCTION

In general, the on-site soils (with the exception of topsoil) can be used for support of utility lines. However, some undercutting of soft, loose, or otherwise unsuitable soils, in conjunction with the placement of crushed stone or other suitable granular backfill may be necessary to establish a stable working mat and/or bearing subgrade, and may become extensive in some areas, especially within existing fill and encroaching upon wetlands. Substantial difficulty with the stability of utility trenches may be experienced, especially in the presence of water. The use of shoring, bracing, or trench boxes will be required for excavations. Additionally, excavations encroaching upon or extending below the groundwater or perched zones can become substantially unstable when the confining effect of the overburden is removed. If groundwater is encountered during excavation work, an adequate dewatering effort and bracing of sidewalls will be required. Utility construction should be performed in accordance with “The Standard Specifications for Sewer and Water Line Construction” for the State of Wisconsin.

It is recommended that well graded granular soils such as those specified in Tables 37 and 39 of the Standard Specification for Sewer and Water Construction be utilized as backfill in utility trenches to reduce the potential for consolidation and settlement of the backfill. All fill soils must be properly placed and compacted under engineering controlled conditions to provide suitable support for overlaying structures and roadways. Silty and clayey soils, organic soils, and wet granular materials are not recommended for use as backfill within utility trenches due

to the substantial difficulty of obtaining proper compaction in confined areas. Substantial importing of suitable fill will likely be required.

As with all excavation work, all open cut trenches must be properly shored and braced as required by applicable federal and state OSHA codes, and as necessary to protect life and property.

5.7 BASEMENT WALLS

It is recommended that basement slab elevations be placed at least 2 feet above the groundwater level to prevent moisture problems and constantly running sump pumps. This may require filling of several feet or more in some areas to raise surface grades sufficiently to accommodate placing basement slabs at higher elevations. This may also necessitate significant filling to raise first floor grades for the other structures, in order to establish or maintain sufficient drainage pathways, to allow for similar entrance elevations, to meet utility slope requirements, and to achieve aesthetic requirements. Detailed and careful design and construction planning will be required. If proper grading cannot be accomplished or if it is elected to not raise existing surface elevations, it is recommended that the basement be eliminated or that "watertight" construction be utilized (in applicable areas), with walls designed to resist both lateral earth and water pressure, and the floor designed to resist uplift. Considering the substantial grade changes that will likely be required across the site, in conjunction with the presence of relatively shallow refusal and groundwater conditions, additional exploration with backhoe test pits is recommended as part of design planning to assist with establishing basement slab elevations.

It is recommended that an underdrain system and drainage course be placed beneath the floor slab and alongside the basement walls (if conventional construction is used) to alleviate hydrostatic uplift pressure beneath the slab and excessive lateral pressure on the walls. The drain system should be connected to adequate sumps for drainage and be properly discharged in accordance with all state and local discharge requirements. Drain tile should have a minimum diameter of four (4) inches and should be wrapped with an appropriate filter fabric. Drainage pipes should be surrounded by clean gravel and extend up to the near ground surface in window well areas. At least six (6) inches of clean ¾ inch stone should be utilized for the free draining layer beneath the floor areas.

The below grade walls must be backfilled for a lateral distance of 3 to 4 feet with a well-graded, free draining granular material. This should be placed in lifts not exceeding 12 inches in thickness and be compacted to at least 95 percent of the Standard Proctor density. Based upon the use of a clean, crushed stone fill, and a constantly maintained fully drained condition (and exclusive of any surcharge loads), an equivalent fluid pressure of 65 psf may be used as the horizontal component of earth pressure at rest. If the basement walls are designed for watertight construction, an equivalent fluid pressure of 95 psf may be used as the coefficient of at rest pressure. However, when a proposed fill material has been selected, a representative sample must be submitted to PSI for testing to verify the above values and associated recommendations. Silt and clay soils, organic soils, and wet granular materials are not suitable for use as backfill alongside basement walls.

Based on the observed groundwater levels at the time of this exploration, constantly running sump pumps and damp basement conditions may occur in some of the basements if grades are not established so that floor slabs remain at least 2 feet above the groundwater. Placement of the basement slab (with conventional construction) below the groundwater is not recommended.

Stormwater management basins are not recommended to be placed in close proximity to basements or other below grade structures. Proper and careful consideration of soils and subsurface conditions must be given during site and design planning, and extreme care must be exercised during construction. Lateral migration of water may result in substantially increased sump pump activity and can quickly overcome the ability of such pumps to maintain a desirable water level, resulting in significant flooding. The potential for such conditions to occur can greatly increase when basement floors are below the elevation of basin bottoms and/or when basins are placed in close proximity to structures (strongly not recommended). In addition, the presence of granular or other generally permeable soils, which is typically necessary in the areas of structures, especially within utility backfill, alongside basement walls, or within other development excavations, can act as extensive migration channels to rapidly carry large volumes of water from basins and into nearby basements. Building codes or municipal regulations may require that basement floor elevations be a specified distance above the water level of nearby basins. It is therefore recommended that the design engineer (or other appropriate representative) review applicable municipal requirements, and if necessary, verify the design normal and design high water elevations of stormwater basins with respect to planned basement slab elevations.

6 CONSTRUCTION CONSIDERATIONS

6.1 GROUNDWATER CONTROL

Groundwater was encountered in the boreholes during auger advancement at B-1 through B-8, B-10, B-12, and B-14 through B-20 at depths ranging from about 2 to 14 feet (EL. 1027.5 to EL. 991.2) below existing grade. Upon completion and removal of the augers, groundwater was encountered at B-6, B-7, and B-10 at depths ranging from about 6 to 8 feet (EL. 1006.3 to EL. 991.2). These observations were somewhat erratic and may be indicative of a perched condition and/or the long-term groundwater level.

On the basis of the observations, substantial difficulty with groundwater may be experienced during excavation work, especially encroaching upon wetlands. If excavations extend only a few inches or so below the groundwater or perched zones, filtered sump pumps or other conventional means may suffice to control the groundwater. However, for deeper excavations, or for substantial perched zones, prolonged dewatering with a series of sumps or well points and high capacity sump pumps, or other more comprehensive means may be necessary to facilitate construction.

Since the foundation materials are subject to softening when exposed to free moisture, every effort should be made to keep excavations dry. Discharge water from roof drains should be directed away from buildings, and the site grading direct runoff to catch basins or other appropriate areas of the site, so that the potential for the softening of the foundation and pavement subgrade soils is reduced.

The groundwater observations reported herein are considered approximate, and preliminary. As noted previously, additional evaluation of the groundwater levels is recommended. It must be recognized that groundwater levels fluctuate with time due to variations in seasonal precipitation, lateral drainage conditions, and soil permeability characteristics.

6.2 EXCAVATIONS AND SITE DRAINAGE

Sloping, shoring or bracing of the excavation sidewalls will be necessary. Excavating may be difficult due to the instability of vertical slopes, and will therefore require a flattening of trench sides, or some other means of protection, to facilitate construction and to protect life and property. Substantial sloughing and caving should be expected within unprotected excavations. The degree of excavation instability problems is dependent upon the depth and length of time that excavations remain open, excavation bank slopes, water levels and the effectiveness of any dewatering systems. However, severe instability can be expected within granular or soft cohesive soils, especially encroaching upon and extending below the groundwater or perched zones. All excavation work must be performed in accordance with OSHA and local building code requirements.

Where excavations encroach upon or extend below the groundwater or perched zones and into fine sand, silt, or soft clay, they may become substantially unstable when the confining effect of the overburden is removed. Significant sloughing or caving of sidewalls may also occur. Some overexcavation of softened or loosened soils, in conjunction with the use of a crushed stone working mat, may be necessary to establish a stable bearing subgrade. Additionally, significantly widened excavations may result, or be required to maintain or achieve sidewall stability.

Auger refusal on probable cobbles and/or boulders was encountered at B-9 at a depth of about 1 foot (EL. 1029.6) below existing grade. Auger refusal on possible cobbles, boulders, and/or bedrock was encountered at B-1 through B-3, B-5 through B-8, B-9A, B-11 through B-16, and B-18 through B-20 at depths ranging from about 12 to 17 feet (EL. 1017.6 to EL. 978.2) below existing grade. Additionally, very dense granular soils were encountered in several of the borings beginning at depths ranging from about 6 to 13.5 feet (EL.1020.6 to EL. 986.6) below existing grade. Substantial difficulty digging and longer excavation times may be experienced with increasing depth, in at least some areas. In addition, excavations in some areas may encroach upon and extend below the refusal depths. Specialized removal techniques, such as ripping and/or blasting, may be required to establish the planned elevations for the proposed structures or to establish the invert elevations for utilities. If blasting is performed, it is recommended that a specialty contractor be utilized to perform the blasting operations. Blasting can cause noise and vibration disturbance to neighboring structures, and must be performed using extreme caution. Consideration should be given to the performance of video and/or

photographic documentation of the condition of nearby buildings, utilities, and other structures prior to any blasting. Following the blasting, the exposed subgrade should be observed by the geotechnical engineer so that disturbance of the overburden is not excessive, and that the blasted rock is sufficiently stable for piping or foundation support. It is likely that at least some compaction of the blasted rock will be required. In addition, some overexcavation of larger stone may be required. Additional subsurface exploration with backhoe test pits is recommended as part of design planning (especially with regard to establishing utility invert, basement, and finished surface grade elevations) to further evaluate refusal depths, and the type and excavatability of the refusal materials. The test pits should also be used to further evaluate groundwater conditions.

All excavations must be performed with caution and utilize methods which will prevent undermining or destabilization of buildings, utilities, pavements, sidewalks or other structures. The use of a properly designed shoring and bracing, sheet piling, or underpinning system must be utilized as necessary to adequately protect buildings, utilities, pavements, and other structures. This must be performed by an experienced specialty contractor. Additionally, extreme care must be used during the installation of any bracing system, especially those using driven or vibratory methods, in order to avoid damaging existing buildings, utilities, and other structures. Consideration should be given to the performance of video and/or photographic documentation of the condition of nearby buildings, utilities, and other structures prior to installation.

Since the subgrade soils are generally sensitive to moisture, every effort should be made to provide adequate drainage across the site during construction, and to prevent ponding of runoff on the subgrade. These soils are also subject to erosion caused by runoff, and erosion control measures should be implemented where needed or required by local ordinances.

It is mandated that excavations, whether they be for utility trenches, basement excavations or footing excavations, be constructed in accordance with current Occupational Safety and Health Administration (OSHA) guidelines to protect workers and others during construction. PSI recommends that these regulations be strictly enforced; otherwise, workers could be in danger and the owner(s) and the contractor(s) could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

6.3 SEISMIC DESIGN CONSIDERATIONS

On-site natural soils generally consist of medium dense to very dense granular soils and soft to stiff cohesive soils. The on-site natural soils are considered to meet the criteria for Site Class C in accordance with Table 1613.5.2 of the International Building Code-2015.

7 STORMWATER MANAGEMENT CONSIDERATIONS

As requested by the client, borings B-2, B-3, B-6, B-9, B-9A, B-14, B-19, and B-20 were visually classified in general accordance with USDA National Resources Conservation Service textural soil classification procedures. The stormwater management areas are planned to consist of ponds; however, their bottom elevations were unknown at the time of report preparation.

The subgrade soils encountered consisted of about 5 to 12 inches of topsoil comprised of dark brown or dark grayish brown clay with intermixed root matter. The underlying natural soils predominately consisted of brown clay to depths ranging from about 2 to 3 feet (EL. 1008.4 to EL. 991.2) below existing grade, generally underlain by light yellowish brown gravelly loam, gravelly fine sandy loam, very gravelly fine sandy loam, gravelly sandy loam, and very gravelly sandy loam to the maximum depth explored by the borings. As an exception, layers of gravelly fine sand, very gravelly loamy fine sand, and gravelly fine sand were encountered at B-19 and B-20 at depths beginning at 10 and 12 feet (EL. 1000.4 and EL. 993.3), respectively, to the refusal depths. Groundwater was encountered during auger advancement in the stormwater borings B-2, B-3, B-6, B-14, B-19, and B-20 at depths ranging from about 2 to 14 feet (EL. 1017.6 to EL. 978.2) below existing grade. Upon completion and removal of the augers, groundwater was encountered at B-6 at a depth of about 6 feet (EL. 991.2). Auger refusal on possible cobbles, boulders, and/or bedrock was experienced at all of the stormwater borings to depths ranging from about 1 to 16 feet (EL. 999.3 to EL. 978.2), with depths of 12 to 16 feet (EL. 995.4 to EL. 978.2) being more typical.

With regard to the above soil and groundwater conditions encountered at the borings, NR 151.124(4)(c)1 and 2 – *Infiltration rate exemptions* indicates that infiltration practices located in an area where the infiltration rate of the soil measured at the proposed bottom of the infiltration system is less than 0.6 inches per hour using a scientifically credible field test method; or where the least permeable soil horizon to 5 feet below the proposed bottom of the infiltration system using the USDA method of soils analysis consists of sandy clay loam, clay loam, sandy clay, silty clay or clay may be credited toward meeting the requirements, but the decision to infiltrate under these conditions is optional. In addition, NR 151.124(4)(b)1 – *Separation distances* indicates that infiltration practices shall be located so that the characteristics of the soil and the separation distance between the bottom of the infiltration system and the elevation of seasonal high groundwater or the top of bedrock are in accordance with the following Table (reproduced from NR 151.124):

Table 3. Separation Distances and Soil Characteristics		
Source Area	**Separation Distance**	**Soil Characteristics**
Industrial, Commercial, Institutional Parking Lots and Roads	5 feet or more	Filtering Layer*
Residential Arterial Roads	5 feet or more	Filtering Layer*
Roofs Draining to Surface Infiltration Practices	1 foot or more	Native or Engineered Soil with Particles Finer than Coarse Sand
Roofs Draining to Surface Infiltration Practices	Not Applicable	
All Other Impervious Source Areas	3 feet or more	Filtering Layer*

*Defined in NR 151.002(14r) as a "soil that has at least a 3-foot deep layer with at least 20 percent fines; or at least a 5-foot deep layer with at least 10 percent fines; or an engineered soil with an equivalent level of protection as determined by the regulatory authority for the site."

The information shown above is a selected excerpt from NR151 that is intended only as general guidance for considering stormwater management in conjunction with the encountered subsurface conditions at the borings. Basin design must be performed by a qualified and experienced firm. In addition, the entirety of Chapter NR151 of the Wisconsin Administrative Code, the Site Evaluation for Stormwater Infiltration (1002) document, and other applicable references; along with appropriate state, local or other municipal requirements must be consulted as part of site specific stormwater design.

Stormwater management basins are not recommended to be placed in close proximity to basements or other below grade structures. Proper and careful consideration of soils and subsurface conditions must be given during site and design planning, and extreme care must be exercised during construction. Lateral migration of water may result in substantially increased sump pump activity and can quickly overcome the ability of such pumps to maintain a desirable water level, resulting in significant flooding. The potential for such conditions to occur can greatly increase when basement floors are below the elevation of basin bottoms and/or when basins are placed in close proximity to structures (strongly not recommended). In addition, the presence of granular or other generally permeable soils, which is typically necessary in the areas of structures, especially within utility backfill, alongside basement walls, or within other development excavations, can act as extensive migration channels to rapidly carry large volumes of water from basins and into nearby basements. Building codes or municipal regulations may require that basement floor elevations be a specified distance above the water level of nearby basins. It is therefore recommended that the design engineer (or other appropriate representative) review applicable municipal requirements, and verify the design normal and design high water elevations of stormwater basins with respect to planned basement slab elevations.

8 PRELIMINARY PAVEMENT DESIGN RECOMMENDATIONS

Pavements for this project are understood to consist of residential roadways and driveways, which are estimated to be primarily subjected to light passenger vehicle traffic.

The near surface subgrade soils encountered within the borings predominantly consisted of clay, generally underlain by fine-grained granular soils. The poorer clay subgrade soils have been assigned a visual classification of A-6 by the AASHTO classification method. They are generally rated as poor for pavement subgrade support due to their moderate to high frost susceptibility, poor drainage characteristics, and moderate to high susceptibility to strength loss when exposed to free water. Provided that the subgrade soils are prepared as outlined in the Site Preparation and Grading section of this report, the in-place subgrade soils and any new structural fill can be used for standard flexible or rigid pavement construction.

Analysis of the visual soil classifications has been made in estimating pertinent subgrade design coefficients as described in the Wisconsin Soils Manual for Pavement Design. Based on the soils encountered, and with proper subgrade preparation and drainage, the following pavement subgrade design parameters are recommended for the pavement section design. However, if soils with support characteristics different from the estimated clay materials are encountered or are used to raise grades in new pavement areas, revised coefficients will need to be provided.

PAVEMENT SUBGRADE DESIGN COEFFICIENTS

AASHTO Soil Classification	A-6
Design Frost Index	F-3
Design Group Index	15
Soil Support Value	3.8
Estimated Subgrade Modulus (k)	150 pci

These values are representative of the cohesive soils, which are the poorer soils present across this site. Some variations may be encountered and should be expected due to the widely spaced borings. In order to use the above values, all new fill used to raise low areas or replace unsuitable material must have pavement support characteristics that are equal to or better than the existing soils. The final design should be performed by a qualified engineer based on the intended pavement use, anticipated loading and subgrade conditions, and desired service life.

The subject site is located in an area that experiences annual freezing cycles and portions of the subgrade soils encountered have been classified as moderately to highly susceptible to frost action when free water is present. In order to reduce the potential for frost action, it will be necessary to control surface runoff and water seepage, as complete removal and replacement of the frost susceptible subgrade soils is not considered economically feasible. It is recommended that underdrains be placed within the subgrade, just below the granular base, to help reduce the potential for trapping water within the aggregate base layer. At a minimum, this should consist of installing 3 to 4 drain tiles extending radially outward, 20 feet from each

catch basin. In addition, drain tiles should extend along curb lines, 20 feet up the slope from curb inlets. The drain tile should be directly connected to the storm sewer manholes or catch basins. The drain tile should consist of 4-inch diameter perforated PVC pipe placed beneath the base layer, extending at least 8 inches into the subgrade. The pipe should be surrounded by 1-inch size clean stone, with the pipe and stone being wrapped with a geotextile filter fabric to reduce the potential of fines (silts and clays) migrating into and obstructing the pipe. It is also recommended that roof drains be connected to the stormwater collection system to minimize the potential for this water to enter the base and subgrade.

9 GENERAL COMMENTS

This preliminary subsurface exploration and site feasibility evaluation has been prepared to aid in the evaluation of the subject site for general site development. The recommendations presented herein are based on the available soil information and the design information provided. Any changes in the design information or building locations should be brought to the attention of PSI to determine if modifications in the recommendations are required. The final design plans and specifications should also be reviewed by PSI to determine that the recommendations presented herein have been interpreted and implemented as intended.

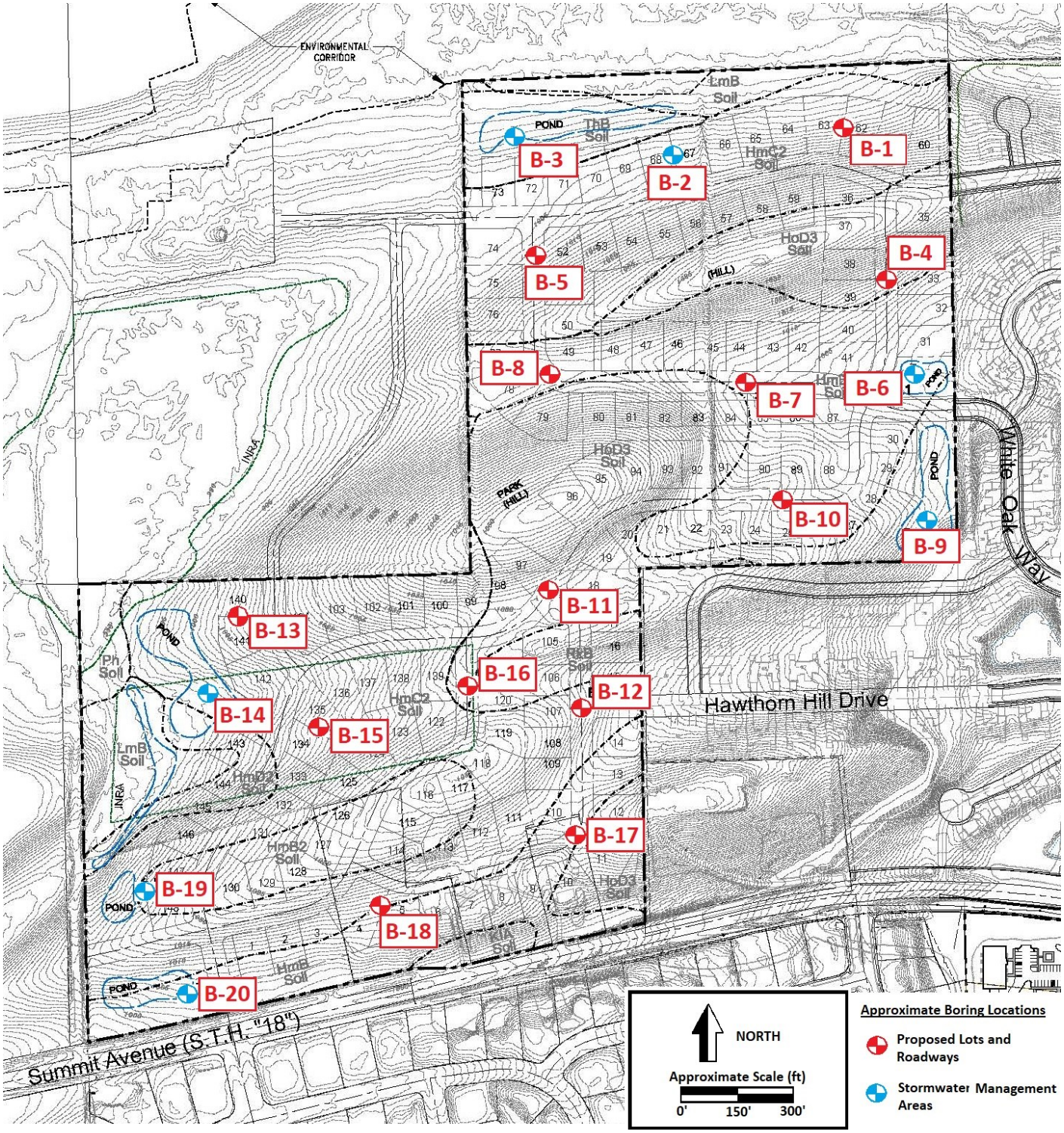
The widely spaced soil borings performed for this preliminary exploration and site evaluation are considered suitable for preliminary planning and design purposes. Additional exploration and evaluation should be performed within the proposed building footprints. The conditions encountered by the additional explorations may warrant an alteration of the preliminary foundation and soil bearing design recommendations presented in this report. Specific foundation and floor slab recommendations can then be provided.

This geotechnical study has been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. The findings, recommendations and opinions contained herein have been promulgated in accordance with generally accepted practice in the fields of foundation engineering, soils mechanics, and engineering geology. No other representations, expressed or implied, and no warranty or guarantee is included or intended in this report.

It is recommended that the earthwork and foundation operations be monitored by the soils engineer, to test and evaluate the bearing capacities, and the selection, placement and compaction of controlled fills.

APPENDIX

Figure 1 - Boring Location Plan
Soil Boring Logs
General Notes



intertek psi	Proposed Subdivision - Downing Property Summit Avenue Waukesha, Wisconsin	**SCALE:** SHOWN ABOVE
		PROJECT NO: 0094875
	FIGURE 1: BORING LOCATION PLAN	**PAGE 1 OF 1**

SOIL BORING LOG: B - 1

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1003.5	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1002.5	0-9": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	24	
	Brown CLAY, with silt and trace root matter, moist	1-SS	7	1.5	-	20	
2 1001.5							▽
3 1000.5	Light brown Sandy CLAY, with silt and trace gravel, very moist to wet	2-SS	6	-	-	10	
4 999.5							
5 998.5	Light brown Silty Fine SAND, with trace clay and gravel, very moist to wet	3-SS	9	-	-	9	
6 997.5							
7 996.5							⊥
8 995.5		4-SS	11	-	-	10	
9 994.5							
10 993.5		5-SS*	21	-	-	7	
11 992.5							
12 991.5							
13 990.5							
14 989.5	Light brown Gravelly SAND, with trace silt, wet	6-SS	70	-	-	7	
15 988.5							
16 987.5							
17 986.5							
18 985.5	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 984.5							
20 983.5							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 2.5± feet below ground surface (EL. 1001.0±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 7± feet below ground surface (EL. 996.5±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery - pushed rock.**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 2

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1005.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1004.4	0-12": 10YR 4/2 Dark grayish brown CLAY, with roots (2,vf), 0,m, mvfr-moist (TOPSOIL)	1-SS	5	-	-	29	
2 1003.4	10YR 4/3 Brown CLAY, with roots (1,vf), 0,m, mvfr-moist			2.5	2.6	25	
3 1002.4		2-SS	5	-	-	10	▽
4 1001.4	2.5Y 6/4 Light yellowish brown GRAVELLY LOAM, 0,m, mvfr-very moist to wet						
5 1000.4		3-SS	8	-	-	10	
6 999.4							
7 998.4		4-SS*	76	-	-	7	
8 997.4							
9 996.4	2.5Y 6/4 Light yellowish brown GRAVELLY FINE SANDY LOAM, 0,m, mefi-moist	5-SS	50/3"	-	-	7	
10 995.4							⊥
11 994.4	2.5Y 6/4 Light yellowish brown VERY GRAVELLY FINE SANDY LOAM, 0,m, mefi-moist	6-SS*	50/S2"	-	-	9	
12 993.4							
13 992.4		7-SS*	50/2"	-	-	4	
14 991.4							
15 990.4		8-SS**	50/S5"				
16 989.4	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 15.5± FEET** **END OF BORING @ 15.5± FEET**						
17 988.4							
18 987.4							
19 986.4							
20 985.4							

FIELD OBSERVATIONS

Water Level $_{during\ drilling}$: 3± feet below existing grade (EL. 1002.4±) ▽
Water Level $_{upon\ completion}$: Not Present ▼
Caved at $_{upon\ completion}$: 10± feet below existing grade (EL. 995.4±) ⊥
Delay Time: N/A
Water Level $_{delayed}$: N/A ¥
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery - pushed rock.**
****No Sample Recovery.**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 3

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 9, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 998.6	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 997.6	0-10": 10YR 3/3 Dark brown CLAY, with roots (1,f), 0,m, mvfr-moist (TOPSOIL)	1-SS	5	-	-	31	
2 996.6	10YR 4/3 Brown CLAY, with roots (1,vf), 0,m, mvfr-moist			1.8	1.9	28	
3 995.6		2-SS	8	-	-	10	▽
4 994.6	2.5Y 6/4 Light yellowish brown SANDY LOAM, 0,m, mvfr-wet						
5 993.6	2.5Y 6/4 Light yellowish brown GRAVELLY LOAM, 0,m, mfr-moist	3-SS	9	-	-	10	
6 992.6							
7 991.6		4-SS	81	-	-	12	
8 990.6							
9 989.6	2.5Y 6/4 Light yellowish brown GRAVELLY SANDY LOAM, 0,m, mvfr-wet	5-SS	10	-	-	9	⊥
10 988.6							
11 987.6		6-SS	14	-	-	11	
12 986.6							
13 985.6		7-SS	80/10"	-	-	7	
14 984.6							
15 983.6	2.5Y 6/4 Light yellowish brown GRAVELLY LOAMY FINE SAND, 0,m, mefi-wet	8-SS	50/3"	-	-	6	
16 982.6	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 15.5± FEET** **END OF BORING @ 15.5± FEET**						
17 981.6							
18 980.6							
19 979.6							
20 978.6							

FIELD OBSERVATIONS

Water Level $_{\text{during drilling}}$: 3± feet below existing grade (EL. 995.6±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 9± feet below existing grade (EL. 989.6±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 4

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1011.8	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
	0-7": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	30	
1 / 1010.8	Brown CLAY, with trace root matter, moist	1-SS	4	1.5	-	23	
2 / 1009.8							
3 / 1008.8	Light brown Silty Fine SAND, with gravel and trace clay, moist	2-SS	17	-	-	9	
4 / 1007.8							
5 / 1006.8	Light brown Gravelly Fine SAND, with silt and trace clay, moist	3-SS	19	-	-	8	
6 / 1005.8							
7 / 1004.8							
8 / 1003.8		4-SS*	11	-	-	10	
9 / 1002.8							⊥
10 / 1001.8	Light brown Gravelly Fine SAND, with silt and trace clay, moist to wet						v
11 / 1000.8		5-SS*	6	-	-	10	
12 / 999.8							
13 / 998.8							
14 / 997.8		6-SS	13	-	-	10	
15 / 996.8							
16 / 995.8							
17 / 994.8							
18 / 993.8							
19 / 992.8	Light brown Silty Fine SAND, with gravel and trace clay, wet	7-SS	14	-	-	9	
20 / 991.8	**END OF BORING @ 20± FEET**						

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 10± feet below ground surface (EL. 1001.8±) v
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 9± feet below ground surface (EL. 1002.8±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery - pushed rock.**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 5

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1007.9	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1006.9	0-9": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	32	
1	Brown CLAY, with silt and trace root matter, moist	1-SS	5	1.3	-	22	
1005.9 (2)							▽
1004.9 (3)	Light brown Gravelly CLAY, with fine sand and silt, moist to wet	2-SS	8	-	-	13	
1003.9 (4)							
1002.9 (5)							
1001.9 (6)		3-SS*	19	-	-	14	
1000.9 (7)							
999.9 (8)	Light brown Gravelly Fine SAND, with silt, wet	4-SS*	19	-	-	13	
998.9 (9)							⊥
997.9 (10)							
996.9 (11)	Light brown Gravelly Fine SAND, with silt, moist	5-SS	26	-	-	8	
995.9 (12)							
994.9 (13)							
993.9 (14)		6-SS	53	-	-	8	
992.9 (15)							
991.9 (16)							
990.9 (17)	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 16± FEET** **END OF BORING @ 16± FEET**						
989.9 (18)							
988.9 (19)							
987.9 (20)							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 2.5± feet below ground surface (EL. 1004.4±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 9± feet below ground surface (EL. 998.9±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery - pushed rock.**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 6

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 997.2	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 / 996.2	0-11": 10YR 2/2 Very dark brown CLAY, with roots (2,vf), 0,m, mvfr-moist (TOPSOIL)	1-SS	4	-	-	55	
2 / 995.2	2.5Y 4/3 Olive brown CLAY, with roots (1,vf), 0,m, mvfr-moist			1.5	-	29	
3 / 994.2		2-SS	10	-	-	8	▽
4 / 993.2	2.5Y 6/4 Light yellowish brown VERY GRAVELLY SANDY LOAM, 0,m, mvfr-wet						
5 / **992.2**		3-SS	8	-	-	8	
6 / 991.2							▼ ⊥
7 / 990.2		4-SS	9	-	-	9	
8 / 989.2							
9 / 988.2		5-SS	15	-	-	12	
10 / **987.2**							
11 / 986.2	2.5Y 6/4 Light yellowish brown GRAVELLY SANDY LOAM, 0,m, mefi- very moist to wet	6-SS	47	-	-	7	
12 / 985.2							
13 / 984.2		7-SS	56	-	-	9	
14 / 983.2							
15 / **982.2**		8-SS	7	-	-	12	
16 / 981.2		9-SS**	50/51"	-	-	-	
17 / 980.2	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 16± FEET** **END OF BORING @ 16± FEET**						
18 / 979.2							
19 / 978.2							
20 / **977.2**							

FIELD OBSERVATIONS

Water Level $_{during\ drilling}$: 3± feet below existing grade (EL. 994.2±) ▽
Water Level $_{upon\ completion}$: 6± feet below existing grade (EL. 991.2±) ▼
Caved at $_{upon\ completion}$: 6± feet below existing grade (EL. 991.2±) ⊥
Delay Time: N/A
Water Level $_{delayed}$: N/A ¥
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

****No Sample Recovery.**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 7

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 7, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1007.2	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 / 1006.2	0-19": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)	1-SS	4	-	-	52	
2 / 1005.2	Brown CLAY, with silt and gray blotches, moist					28	
3 / 1004.2		2-SS	4	0.8	0.8	28	
4 / 1003.2							
5 / 1002.2							
6 / 1001.2		3-SS	6	0.5	0.4	23	
7 / 1000.2							▼ ⊥
8 / 999.2		4-SS	30	-	-	10	v
9 / 998.2	Brown GRAVEL, with trace sand, wet						
10 / 997.2							
11 / 996.2	Brown SAND, with gravel, wet	5-SS	50/2"	-	-	9	
12 / 995.2							
13 / 994.2	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 12± FEET** **END OF BORING @ 12± FEET**						
14 / 993.2							
15 / 992.2							
16 / 991.2							
17 / 990.2							
18 / 989.2							
19 / 988.2							
20 / 987.2							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 8± feet below ground surface (EL. 999.2±) v
Water Level $_{\text{upon completion}}$: 7± feet below ground surface (EL. 1000.2±) ▼
Caved at $_{\text{upon completion}}$: 7± feet below ground surface (EL. 1000.2±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 8

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1017.0	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1016.0	0-9": Dark brown SILT, with clay and trace root matter moist (TOPSOIL)			-	-	33	
2 1015.0	Brown CLAY, with sand, silt and trace root matter, moist	1-SS	7	1.8	-	19	
3 1014.0	Light brown CLAY, with silt, moist	2-SS	7	0.5	1.2	26	
4 1013.0							
5 1012.0							
6 1011.0		3-SS	4	0.8	-	23	
7 1010.0							
8 1009.0							▽ ⊥
9 1008.0	Light brown SILT, with clay and trace gravel, moist to wet	4-SS	8	-	-	17	
10 1007.0							
11 1006.0	Light brown Gravelly Fine SAND, with silt, moist to wet	5-SS	12	-	-	9	
12 1005.0							
13 1004.0							
14 1003.0		6-SS	63	-	-	6	
15 1002.0							
16 1001.0							
17 1000.0							
18 999.0	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 998.0							
20 997.0							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 8± feet below ground surface (EL. 1009.0±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 8± feet below ground surface (EL. 1009.0±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 9

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1000.3	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 / 999.3	DRILLED WITHOUT SAMPLING	1-AU	-	-	-	-	
2 / 998.3	AUGER REFUSAL ON PROBABLE COBBLES AND/OR BOULDERS @ 1± FOOT END OF BORING @ 1± FOOT						
3 / 997.3							
4 / 996.3							
5 / 995.3							
6 / 994.3							
7 / 993.3							
8 / 992.3							
9 / 991.3							
10 / 990.3							
11 / 989.3							
12 / 988.3							
13 / 987.3							
14 / 986.3							
15 / 985.3							
16 / 984.3							
17 / 983.3							
18 / 982.3							
19 / 981.3							
20 / 980.3							

FIELD OBSERVATIONS

Water Level during drilling: Not Encountered
Water Level upon completion: Not Present
Caved at upon completion: N/A
Delay Time: N/A
Water Level delayed: N/A
Caved at delayed: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 9A

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 7, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1000.3	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
	0-7": 10YR 4/2 Dark grayish brown SILTY CLAY LOAM, with roots (2,f), mvfr-moist (TOPSOIL)			-	-	21	
1 / 999.3	10YR 4/3 Brown CLAY, with roots (2,f), 0,m, mvfr-moist	1-SS	5	1.0	-	15	
2 / 998.3							
3 / 997.3	2.5Y 6/4 Light yellowish brown GRAVELLY FINE SANDY LOAM, 0,m, mfr-moist	2-SS	10	-	-	8	
4 / 996.3							
5 / 995.3		3-SS	12	-	-	7	
6 / 994.3							
7 / 993.3		4-SS	14	-	-	8	
8 / 992.3							
9 / 991.3	2.5Y 6/4 Light yellowish brown VERY GRAVELLY FINE SANDY LOAM, 0,m, mfi-moist	5-SS	16	-	-	5	
10 / 990.3							
11 / 989.3		6-SS**	77/10"	-	-	-	
12 / 988.3							
13 / 987.3	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 12± FEET** **END OF BORING @ 12± FEET**						
14 / 986.3							
15 / 985.3							
16 / 984.3							
17 / 983.3							
18 / 982.3							
19 / 981.3							
20 / 980.3							

FIELD OBSERVATIONS

Water Level during drilling: Not Encountered
Water Level upon completion: Not Present
Caved at upon completion: 7± feet below existing grade (EL. 993.3±)
Delay Time: N/A
Water Level delayed: N/A
Caved at delayed: N/A

ADDITIONAL COMMENTS:

****No Sample Recovery.**

NOTE: Boring offset approximately 5-feet north of B-9 due to shallow refusal.

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 10

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1014.3	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1013.3	0-11": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)	1-SS	4	-	-	24	
2 1012.3	Brown CLAY, with dark brown seams, moist (REGRADED SOIL)			1.0	-	19	
3 1011.3		2-SS	4	-	-	8	▽
4 1010.3	Light brown Silty Fine SAND, with gravel and trace clay, very moist to wet						
5 1009.3		3-SS	9	-	-	10	
6 1008.3							
7 1007.3		4-SS	6	-	-	9	▼ ⊥
8 1006.3	Light brown Gravelly Fine SAND, with silt, and trace clay, very moist to wet						
9 1005.3		5-SS	7	-	-	11	
10 1004.3							
11 1003.3		6-SS	6	-	-	10	
12 1002.3							
13 1001.3		7-SS	12	-	-	9	
14 1000.3							
15 999.3							
16 998.3							
17 997.3							
18 996.3							
19 995.3							
20 994.3	**END OF BORING @ 20± FEET**						

FIELD OBSERVATIONS:

Water Level $_{during\ drilling}$: 3± feet below ground surface (EL. 1011.3±) ▽
Water Level $_{upon\ completion}$: 8± feet below ground surface (EL. 1006.3±) ▼
Caved at $_{upon\ completion}$: 8± feet below ground surface (EL. 1006.3±) ⊥
Delay Time: N/A
Water Level $_{delayed}$: N/A ¥
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 11

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1033.7	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
	0-7": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	40	
1 / 1032.7	Brown CLAY, with silt, moist	1-SS	6	2.0	2.5	22	
2 / 1031.7							
3 / 1030.7		2-SS	6	0.5	0.7	25	
4 / 1029.7							
5 / 1028.7	Brown SILT, with trace fine sand and gravel, moist	3-SS	10	-	-	16	
6 / 1027.7							
7 / 1026.7		4-SS	23	-	-	11	
8 / 1025.7							
9 / 1024.7							
10 / 1023.7	Light brown Silty Fine SAND, with gravel, moist	5-SS	14	-	-	8	
11 / 1022.7							
12 / 1021.7							
13 / 1020.7		6-SS	79/10"	-	-	9	
14 / 1019.7							
15 / 1018.7							
16 / 1017.7							
17 / 1016.7							
18 / 1015.7	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 / 1014.7							
20 / 1013.7							

FIELD OBSERVATIONS:

Water Level $_{during\ drilling}$: Not Encountered
Water Level $_{upon\ completion}$: Not Present
Caved at $_{upon\ completion}$: 6± feet below ground surface (EL. 1027.7±)
Delay Time: N/A
Water Level $_{delayed}$: N/A
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 12

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1024.7	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1023.7	0-8": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	26	
2 1022.7	Brown CLAY, with trace root matter, moist	1-SS	4	0.8	-	23	
3 1021.7	Light brown Silty Fine SAND, with gravel and trace clay, moist	2-SS	12	-	-	8	
4 1020.7							
5 1019.7	Light brown Gravelly Fine SAND, with silt, moist	3-SS	10	-	-	8	
6 1018.7							
7 1017.7							⊥
8 1016.7		4-SS	14	-	-	9	
9 1015.7							
10 1014.7	(WET @ 10')						v
11 1013.7		5-SS	52	-	-	11	
12 1012.7							
13 1011.7							
14 1010.7		6-SS	50/2"	-	-	8	
15 1009.7							
16 1008.7							
17 1007.7							
18 1006.7	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 1005.7							
20 1004.7							

FIELD OBSERVATIONS:

Water Level $_{during\ drilling}$: 10± feet below ground surface (EL. 1014.7±) v
Water Level $_{upon\ completion}$: Not Present ▼
Caved at $_{upon\ completion}$: 7± feet below ground surface (EL. 1017.7±) ⊥
Delay Time: N/A
Water Level $_{delayed}$: N/A ¥
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 13

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1007.8	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
	0-4": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	39	
1 / 1006.8	Brown CLAY, moist	1-SS	5	1.3	-	23	
2 / 1005.8							
3 / 1004.8	Light brown Gravelly Fine SAND, with silt, and trace clay, moist	2-SS	25	-	-	8	
4 / 1003.8							
5 / 1002.8							
6 / 1001.8		3-SS*	10	-	-	11	
7 / 1000.8							
8 / 999.8		4-SS	13	-	-	9	
9 / 998.8							
10 / 997.8							
11 / 996.8		5-SS	23	-	-	9	
12 / 995.8							
13 / 994.8							
14 / 993.8		6-SS*	45	-	-	5	
15 / 992.8							
16 / 991.8							
17 / 990.8							
18 / 989.8	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 / 988.8							
20 / 987.8							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: Not Encountered
Water Level $_{\text{upon completion}}$: Not Present
Caved at $_{\text{upon completion}}$: 7± feet below ground surface (EL. 1000.8±)
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery- Pushed rock**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 14

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 994.2	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 993.2	0-5": 10YR 4/2 Dark grayish brown CLAY, with roots (1,f), 0,m, mvfr-moist (TOPSOIL) 10YR 3/3 Dark brown CLAY, 0,m, mvfr-moist	1-SS	5	1.8	2.1	23	
2 992.2							
3 991.2		2-SS	4	-	-	10	▼
4 990.2	2.5Y 6/4 Light yellowish brown SANDY LOAM, 0,m, mvfr-moist						
5 989.2	2.5Y 6/4 Light yellowish brown GRAVELLY SANDY LOAM, 0,m, mfr-very moist to wet	3-SS	11	-	-	10	
6 988.2							
7 987.2		4-SS	4	-	-	11	⊥
8 986.2							
9 985.2		5-SS*	14	-	-	14	
10 984.2							
11 983.2		6-SS*	14	-	-	10	
12 982.2							
13 981.2		7-SS	30	-	-	9	
14 980.2							
15 979.2		8-SS	33	-	-	8	
16 978.2							
17 977.2	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, OR BEDROCK @ 16± FEET** **END OF BORING @ 16± FEET**						
18 976.2							
19 975.2							
20 974.2							

FIELD OBSERVATIONS

Water Level $_{\text{during drilling}}$: 3± feet below existing grade (EL. 991.2±) ▼
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 7± feet below existing grade (EL. 987.2±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Boring offset approximately 35 feet north from its originally planned location due to trees

***Poor Sample Recovery- Pushed rock**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 15

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1032.5	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
	0-6": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)			-	-	29	
1 / 1031.5	Brown CLAY, moist	1-SS	4	0.8	-	25	
2 / 1030.5							
3 / 1029.5	Light brown Silty Fine SAND, with gravel and trace clay, moist	2-SS	6	-	-	11	
4 / 1028.5							
5 / 1027.5	(WET @ 5')						▽
6 / 1026.5		3-SS	7	-	-	8	
7 / 1025.5							
8 / 1024.5		4-SS**	50/51"	-	-	-	⊥
9 / 1023.5							
10 / 1022.5							
11 / 1021.5		5-SS	11	-	-	10	
12 / 1020.5							
13 / 1019.5							
14 / 1018.5		6-SS	57	-	-	11	
15 / 1017.5							
16 / 1016.5							
17 / 1015.5							
18 / 1014.5	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 / 1013.5							
20 / 1012.5							

FIELD OBSERVATIONS:

Water Level $_{during\ drilling}$: 5± feet below ground surface (EL. 1027.5±) ▽
Water Level $_{upon\ completion}$: Not Present ▼
Caved at $_{upon\ completion}$: 8± feet below ground surface (EL. 1024.5±) ⊥
Delay Time: N/A
Water Level $_{delayed}$: N/A ¥
Caved at $_{delayed}$: N/A

ADDITIONAL COMMENTS:

Boring offset approximately 30 feet northeast from its originally planned location due to trees

***Poor Sample Recovery- Pushed rock**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 16

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1030.6	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1029.6	Brown CLAY, with gravel and dark brown seams, (FILL)	1-SS	7	-	-	16	
2 1028.6	Brown CLAY, moist			1.3	-	24	
3 1027.6	Brown Clayey SAND, with silt and trace gravel, wet	2-SS	4	-	-	16	▽
4 1026.6							
5 1025.6							⊥
6 1024.6	Light brown Silty Fine SAND, with trace gravel, wet	3-SS	9	-	-	11	
7 1023.6							
8 1022.6		4-SS	11	-	-	9	
9 1021.6							
10 1020.6							
11 1019.6		5-SS*	50/4"	-	-	1	
12 1018.6							
13 1017.6							
14 1016.6	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 13± FEET** **END OF BORING @ 13± FEET**						
15 1015.6							
16 1014.6							
17 1013.6							
18 1012.6							
19 1011.6							
20 1010.6							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 2.5± feet below ground surface (EL. 1028.1±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 5± feet below ground surface (EL. 1025.6±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery- Pushed rock**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 17

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1021.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1020.4	0-9": Dark brown CLAY, with silt, and trace root matter, moist (TOPSOIL)	1-SS	4	-	-	29	
2 1019.4	Brown Gravelly Fine SAND, with silt and trace clay, moist					15	
3 1018.4	Light brown SILT, with fine sand and trace gravel, and clay, moist	2-SS	9	-	-	8	
4 1017.4							
5 1016.4							▽
6 1015.4	Light brown Silty Fine SAND, with gravel, and trace clay, moist to wet	3-SS	16	-	-	9	
7 1014.4							⊥
8 1013.4		4-SS	11	-	-	10	
9 1012.4							
10 1011.4							
11 1010.4	Light brown Silty Fine SAND, with gravel and trace clay, moist	5-SS	12	-	-	9	
12 1009.4							
13 1008.4							
14 1007.4		6-SS	14	-	-	9	
15 1006.4							
16 1005.4							
17 1004.4							
18 1003.4							
19 1002.4		7-SS	9	-	-	-	
20 1001.4							
	END OF BORING @ 20± FEET						

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 5± feet below ground surface (EL. 1016.4±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 7± feet below ground surface (EL. 1014.4±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 18

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18
Waukesha, Wisconsin

Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1017.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
0 1016.4	0-7": Dark brown CLAY, with silt and trace root matter, moist (TOPSOIL)					28	
1 1016.4	Brown CLAY, with silt, moist	1-SS	6	-	-	23	
2 1015.4							
3 1014.4	Light brown SILT, with fine sand, and gravel, moist	2-SS	19	-	-	4	
4 1013.4							
5 1012.4	Light brown Fine SAND, with trace silt and gravel, moist	3-SS	35	-	-	6	
6 1011.4							
7 1010.4							⊥
8 1009.4	Light brown Silty Fine SAND, with trace gravel and clay, very moist to wet	4-SS	14	-	-	10	v
9 1008.4							
10 1007.4							
11 1006.4		5-SS	6	-	-	12	
12 1005.4							
13 1004.4							
14 1003.4		6-SS	50/4"	-	-	9	
15 1002.4							
16 1001.4							
17 1000.4							
18 999.4	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 17± FEET** **END OF BORING @ 17± FEET**						
19 998.4							
20 997.4							

FIELD OBSERVATIONS:

Water Level $_{\text{during drilling}}$: 7.5± feet below ground surface (EL. 1009.9±) v
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 7± feet below ground surface (EL. 1010.4±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual.

SOIL BORING LOG: B - 19

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1010.4	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
0 – 1009.4	0-6": 10YR 3/2 Very dark grayish brown, CLAY, with roots (2,vf), 0,m, mvfr-moist (TOPSOIL) 10YR 4/3 Brown CLAY, with roots (1,vf), 0,m, mvfr-moist	1-SS	4	-	-	31 23	
2 – 1008.4	2.5Y 6/4 Light yellowish brown GRAVELLY FINE SANDY LOAM, 0,m, mfr-very moist to wet	2-SS	12	-	-	9	▽
4 – 1006.4		3-SS	11	-	-	8	
5 – 1005.4		4-SS*	69/9"	-	-	19	
8 – 1002.4	2.5Y 6/4 Light yellowish brown VERY GRAVELLY FINE SANDY LOAM, 0,m, mefi-moist	5-SS	52	-	-	5	⊥
10 – 1000.4	2.5Y 6/4 Light yellowish brown GRAVELLY FINE SAND, 0,sg, mefi-moist	6-SS	67/9"	-	-	8	
12 – 998.4		7-SS	50/4"	-	-	4	
14 – 996.4		8-SS*	50/2"	-	-	6	
15 – 995.4	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, AND/OR BEDROCK @ 15± FEET** **END OF BORING @ 15± FEET**						
20 – 990.4							

FIELD OBSERVATIONS

Water Level $_{\text{during drilling}}$: 2± feet below existing grade (EL. 1008.4±) ▽
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 9± feet below existing grade (EL. 1001.4±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

***Poor Sample Recovery- Pushed rock**

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

SOIL BORING LOG: B - 20

Project: Proposed Preliminary Exploration - Downing Farm Subdivision
Project No.: 0094875

Location: North Side of State Highway 18, Waukesha, Wisconsin
Drill Date: May 8, 2019
Drilled By: GW/KH

DEPTH/EL. (feet)	VISUAL SOIL CLASSIFICATION GROUND SURFACE ELEVATION: 1005.3	SAMPLE NO.	N (bpf)	Qp (tsf)	Qu (tsf)	MC (%)	REMARKS
1 1004.3	0-11": 10YR 4/2 Dark grayish brown CLAY, with roots (3,f), mvfr-moist (TOPSOIL)	1-SS	4	-	-	31	
2 1003.3	10YR 4/3 Brown CLAY, with roots (2,vf), 0,m, mvfr-moist			0.8	-	18	
3 1002.3	2.5Y 6/4 Light yellowish brown GRAVELLY FINE SANDY LOAM, 0,m, mefi-moist	2-SS	7	-	-	9	
4 1001.3							
5 1000.3		3-SS	25	-	-	5	
6 999.3							
7 998.3	2.5Y 6/4 Light Yellowish brown VERY GRAVELLY FINE SANDY LOAM, 0,m, mefi-moist	4-SS	84/9"	-	-	5	
8 997.3							
9 996.3		5-SS*	50/2"	-	-	6	
10 995.3							
11 994.3		6-SS*	50/54"	-	-	5	
12 993.3							⊥
13 992.3	2.5Y 6/4 Light Yellowish brown VERY GRAVELLY LOAMY FINE SAND, 0,sg, mefi-moist	7-SS	50/3"	-	-	6	
14 991.3							▼
15 990.3	2.5Y 6/4 Light Yellowish brown GRAVELLY FINE SAND, 0,sg, mefi-moist	8-SS	69/11"	-	-	13	
16 989.3							
17 988.3	**AUGER REFUSAL ON POSSIBLE COBBLES, BOULDERS, OR BEDROCK @ 16± FEET** **END OF BORING @ 16± FEET**						
18 987.3							
19 986.3							
20 985.3							

FIELD OBSERVATIONS

Water Level $_{\text{during drilling}}$: 14± feet below existing grade (EL. 991.3±) ▼
Water Level $_{\text{upon completion}}$: Not Present ▼
Caved at $_{\text{upon completion}}$: 12± feet below existing grade (EL. 993.3±) ⊥
Delay Time: N/A
Water Level $_{\text{delayed}}$: N/A ¥
Caved at $_{\text{delayed}}$: N/A

ADDITIONAL COMMENTS:

Note: Lines of stratification represent an approximate boundary between soil types. Variations may occur between sampling intervals and/or boring locations. Transitions may also be gradual. Dashed lines are indicative of potentially erratic or unknown transitions, such as fill-to-natural soil zone transitions.

GENERAL NOTES

SAMPLE IDENTIFICATION

1. Information on each log is a compilation of subsurface conditions, based on visual soil classifications of soil samples obtained from the field as assigned by a soils engineer, as well as from laboratory testing of samples, if performed. The strata lines on the logs may be approximate or the transition between the strata may be gradual rather than distinct. Water level measurements refer only to those observed at the times and locations indicated, and may vary with time, geologic condition and construction activity.
2. Unified Soil Classification System (USCS) designations are based on visual soil classification estimates on the basis of textural and particle size categorization and various soil behavior characteristics. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.

USCS SOIL PARTICLE SIZE CLASSES

U.S. Std. Sieve			#200	#40	#10	#4	¾"	3"	12"	
Soil Type	Clay	Silt	Sand			Gravel		Cobbles	Boulders	
			Fine	Medium	Coarse	Fine	Coarse			
Millimeters	0.002	0.074	0.42	2	4.8	19	76	300		

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487-00)

Criteria for assigning group symbols and group names using laboratory tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve)	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean gravels w/ < 5% fines [E]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [C]	GW	Well-graded gravel [D]
			Cu < 4 and/or1 > Cc > 3 [C]	GP	Poorly graded gravel [D]
		Gravels w/ > 12% fines [E]	Fines classify as ML or MH	GM	Silty gravel [D,F,G]
			Fines classify as CL or CH	GC	Clayey gravel [D,F,G]
	Sands (More than 50% of coarse fraction passes the No. 4 sieve)	Clean sands w/ < 5% fines [I]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [C]	SW	Well-graded sand [H]
			Cu < 6 and/or 1 > Cc > 3 [C]	SP	Poorly graded sand [H]
		Sands w/ > 12% fines [I]	Fines classify as ML or MH	SM	Silty sand [F,G,H]
			Fines classify as CL or CH	SC	Clayey sand [F,G,H]
FINE-GRAINED SOILS (More than 50% passes the No. 200 sieve)	Silts and clays w/ liquid limit (LL) < 50	Inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 and plots below "A" line [J]	ML	Silt [K,L,M]
		Organic	LL (Oven dried) / LL (Not dried) < 0.75	OL	Organic clay [K,L,M,N]
				OL	Organic silt [K,L,M,O]
	Silts and clays w/ liquid limit (LL) ≥ 50	Inorganic	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic silt [K,L,M]
		Organic	LL (Oven dried) / LL (Not dried) < 0.75	OH	Organic clay [K,L,M,P]
				OH	Organic silt [K,L,M,Q]
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-inch (75 mm) sieve
[B] If field sample contained cobbles or boulders, or both, add " with cobbles or boulders, or both" to group name
[C] $Cu = D_{60}/D_{10}$; $Cc = (D_{30})^2 / D_{10} \times D_{60}$
[D] If soil contains ≥ 15% sand, add "with sand" to group name
[E] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G] If fines are organic, add "with organic fines" to group name
[H] If soil contains ≥ 15% gravel, add "with gravel" to group name
[I] Sands with 5 - 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
[K] If soil contains 15 - 29% plus No. 200, add "with sand" or "with gravel"
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name
[N] PI ≥ 4 and plots on or above "A" line
[O] PI < 4 or plots below "A" line
[P] PI plots on or above "A" line
[Q] PI below "A" line

RELATIVE SOIL COMPOSITION

Trace - 0 - 15% of sample
With - 15 - 35% of sample
Soil modifier - > 35% of sample (i.e. sandy, silty, clayey, gravelly)

DRILLING & SAMPLING SYMBOLS

AU - Auger sample from cuttings
BS - Bag sample
HA - Hand auger sample
SS - Split spoon sample (2" O.D. by 1⅜" I.D.)
ST - Shelby Tube sample (2" or 3" O.D.)
WS - Wash sample from wash water return

SOIL PROPERTY SYMBOLS

N - N-value (blow count) is the standard penetration resistance based on the total number of blows required to advance a split spoon sampler one (1) foot, using a 140 lb. hammer with a 30 inch free fall. To avoid damage to sampling tools, driving is typically limited to 50 blows during any 6 inch interval. Additional description is provided below:

N-value (bpf)	Description
HW	Sampler penetrated soil under weight of hammer and rods; no driving required
25	25 blows to advance sampler 12 inches after initial 6 inches of seating
75/10"	75 blows to advance sampler 10 inches after initial 6 inches of seating
50/S3"	50 blows to advance sampler 3 inches during initial 6 inch seating interval

MC - Moisture content, %
Qu - Unconfined compressive strength, tons per square foot (tsf)
Qp - Calibrated hand penetrometer resistance, tsf
γd - Dry density, pounds per cubic foot (pcf)
LL - Liquid limit, % (ASTM D4318)
PL - Plastic limit, % (ASTM D4318)
PI - Plasticity index, % (ASTM D4318)
%P200 - Percent of sample passing the No. 200 sieve
RQD - Rock quality designation of NX-size core sample
RMR - Rock mass rating, as developed by Z.T. Bieniawski
PID - Photoionization detector (Hnu meter) volatile vapor level, ppm

SOIL RELATIVE DENSITY & CONSISTENCY CLASSIFICATION

NON-COHESIVE SOILS		COHESIVE SOILS		
Density	N-Value Range	Consistency	Qu Range (tsf)	Approximate N-value Range
Very loose	0 - 3	Very soft	0 - 0.25	0 - 2
Loose	3 - 7	Soft	0.25 - 0.5	2 - 5
Medium dense	7 - 15	Medium stiff	0.5 - 1.0	5 - 10
Dense	15 - 38	Stiff	1.0 - 2.0	10 - 14
Very dense	38+	Very Stiff	2.0 - 4.0	14 - 32
		Hard	4.0+	32+

SOIL STRUCTURE TERMINOLOGY

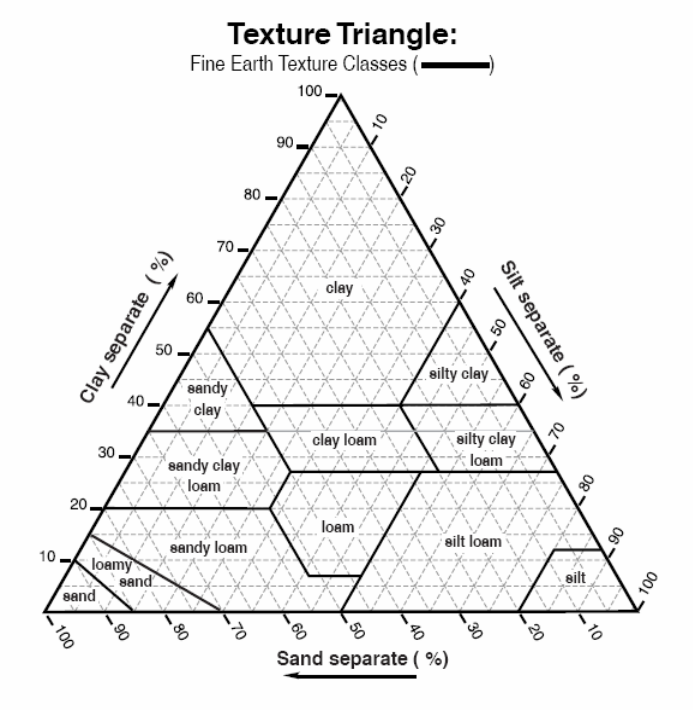
Interlayered - Alternating layers of different soil types
Layer - Inclusion greater than 3 inches thick
Seam - Inclusion ⅛ to 3 inches thick
Laminated - Alternating seams of different soil type
Intermixed - Pockets of different soil types, no layering
Pocket - Inclusion of material of different texture
Varved - Alternating layers or seams of sand, silt, and/or clay

GROUNDWATER & MOISTURE CONDITIONS

v - Approximate groundwater level as noted during drilling and sampling
▼ - Groundwater level as noted within the open borehole upon removal of the augers
¥ - Delayed groundwater level within open borehole
Dry - Absence of moisture, dry to the touch
Moist - Damp, but no visible water
Wet - Visible free water, saturated, usually below water table

NOTE: General Notes have been adapted from and incorporate portions of ASTM D2487 "Classification of Soils for Engineering Purposes (Unified Soil Classification System)" and ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)."

USDA SOIL CLASSIFICATION SYSTEM*



NOTE: **Soil Texture** encompasses only the fine earth fraction (≤ 2 mm). **Particle Size Distribution** (PSD) encompasses the whole soil, including both the fine earth fraction (≤ 2 mm; weight %) and rock fragments (> 2 mm; volume %).

TEXTURE CLASS

Texture Class or Subclass	Code	
	Conv.	NASIS
Coarse Sand	cos	COS
Sand	s	S
Fine Sand	fs	FS
Very Fine Sand	vfs	VFS
Loamy Coarse Sand	lcos	LCOS
Loamy Sand	ls	LS
Loamy Fine Sand	lfs	LFS
Loamy Very Fine Sand	lvfs	LVFS
Coarse Sandy Loam	cosl	COSL
Sandy Loam	sl	SL
Fine Sandy Loam	fsl	FSL
Very Fine Sandy Loam	vfsl	VFSL
Loam	l	L
Silt Loam	sil	SIL
Silt	si	SI
Sandy Clay Loam	scl	SCL
Clay Loam	cl	CL
Silty Clay Loam	sicl	SICL
Sandy Clay	sc	SC
Silty Clay	sic	SIC
Clay	c	C

TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for **Rock Fragments - Size and Quantity**.

Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., *loam*).
15 to < 35	Use adjective for appropriate size; e.g., *gravelly*.
35 to < 60	Use "very" with the appropriate size adjective; e.g., *very gravelly*.
60 to < 90	Use "extremely" with the appropriate size adjective; e.g., *extremely gravelly*.
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., *gravel*. Use **Terms in Lieu of Texture**.

TEXTURE MODIFIERS - *(adjectives)*

ROCK FRAGMENTS: Size & Quantity [1]	Code		Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (*name size*): [1]
	Conv.	PDP/ NASIS	
ROCK FRAGMENTS (> 2 mm; ≥ Strongly Cemented)			
Gravelly	GR	GR	≥ 15% but < 35% gravel
Fine Gravelly	FGR	GRF	≥15% but < 35% fine gravel
Medium Gravelly	MGR	GRM	≥15% but < 35% med. gravel
Coarse Gravelly	CGR	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	VGR	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	XGR	GRX	≥ 60% but < 90% gravel
Cobbly	CB	CB	≥ 15% but < 35% cobbles
Very Cobbly	VCB	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	XCB	CBX	≥ 60% but < 90% cobbles
Stony	ST	ST	≥ 15% but < 35% stones
Very Stony	VST	STV	≥ 35% but < 60% stones
Extremely Stony	XST	STX	≥ 60% but < 90% stones
Bouldery	BY	BY	≥ 15% but < 35% boulders
Very Bouldery	VBY	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	XBY	BYX	≥ 60% but < 90% boulders
Channery	CN	CN	≥ 15% but < 35% channers
Very Channery	VCN	CNV	≥ 35% but < 60% channers
Extremely Channery	XCN	CNX	≥ 60% but < 90% channers
Flaggy	FL	FL	≥ 15% but < 35% flagstones
Very Flaggy	VFL	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	XFL	FLX	≥ 60% but < 90% flagstones

* As outlined in the NRCS Field Book for Describing and Sampling Soils, Version 2.0 (2002).