# Preliminary Geotechnical Engineering Report

**Anderson 400 Site Certification**
**LeClaire, Iowa**
November 16, 2018
Terracon Project No. 07175146

**Prepared for:**
Shive-Hattery, Inc.
Moline, Illinois

**Prepared by:**
Terracon Consultants, Inc.
Bettendorf, Iowa

November 16, 2018

Shive-Hattery, Inc.
1701 River Drive, Suite 200
Moline, Illinois 61265

Attn: Mr. Dan Solchenberger, P.E.

Re: Preliminary Geotechnical Engineering Report
Anderson 400 Site Certification
24500 Great River Road
LeClaire, Iowa
Terracon Project No. 07175146

Dear Mr. Solchenberger:

Terracon Consultants, Inc. (Terracon) has completed the preliminary subsurface exploration for the proposed Anderson 400 development located at 24500 Great River Road in LeClaire, Iowa. These services were performed in general accordance with our Agreement for Services Terracon Proposal No. P07175146 dated June 1, 2017. This report presents the findings of the subsurface exploration and provides preliminary geotechnical engineering recommendations regarding earthwork, site preparation, foundation design, and floor slab and pavement subgrade preparation.

We appreciate the opportunity to be of service to you on this project and look forward to providing further services as the project develops. If you have any questions concerning this report, or if we can be of further service, please contact us.

Sincerely,

**Terracon Consultants, Inc.**

Sara J. Somsky, P.E.
Iowa No. 23543

Kathleen E. Taft
for: W. Ken Beck, P.E.
Iowa No. 10684

Attachments

## REPORT TOPICS



**Note: This report was originally delivered in a web-based format. Orange Bold text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the *GeoReport* logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.**

## ATTACHMENTS

# Preliminary Geotechnical Engineering Report

**Anderson 400 Site Certification**
**24500 Great River Road**
**LeClaire, Iowa**
**Terracon Project No. 07175146**
**November 16, 2018**

## INTRODUCTION

This report presents the results of our preliminary subsurface exploration and geotechnical engineering services performed for the Anderson 400 development planned at 24500 Great River Road in LeClaire, Iowa. The purpose of these services is to describe subsurface conditions encountered at the boring locations, present the test data, and provide preliminary geotechnical engineering recommendations relative to:

- site preparation and earthwork
- foundation design
- floor slab subgrades
- seismic site classification
- pavement subgrade preparation

The geotechnical engineering scope of services for this project included eight borings extending to depths of approximately 12 to 50 feet below existing site grades and two seismic surveys. Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on samples obtained during the field exploration are included on the boring logs in the **Exploration Results** section; results of the seismic surveys are included in **Seismic Survey Results**.

## SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration.

| Item | Description |
|---|---|
| **Parcel Information** | The 400-acre parcel is located at 24500 Great River Road in LeClaire, Iowa. |
| **Existing Improvements** | primarily agricultural land with tree-lined drainage swales; a driveway and house/farm structures are located in the northeastern portion of the property (between Lots 2 and 9) |
| **Current Ground Cover** | crops, trees, weeds, grass |
| **Existing Topography** | A grading plan was not provided. Based on the Cordova, Illinois quadrangle map, approximately 125 feet of elevation change is expected across the site; approximately 86 feet of elevation change occurs between boring locations. |

## PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. Our current understanding of the project conditions is as follows:

| \Item | Description |
|---|---|
| **Project Description** | We understand that the site is being evaluated consistent with the Iowa Site Certification Program (SCP). Future development is expected to consist of an office park or commercial structures. |
| **Proposed Structures** | This project is in the preliminary stage and details regarding future structures were not provided. Future buildings are expected to be one to three stories. Construction may consist of wood and steel buildings and/or load-bearing masonry walls and concrete construction. |
| **Finished Floor Elevations** | not provided, but will vary |
| **Maximum Loads** | not provided; the following values will be used in our analysis:<br>■ Columns: 50 to 300 kips<br>■ Walls: 2 to 6 kips per linear foot (klf)<br>■ Slabs: 50 to 150 pounds per square foot (psf) |
| **Grading/Slopes** | A grading plan has not yet been developed for this site. |
| **Pavements** | Pavements will be required for development of the site; however, information regarding the locations, final grades, and traffic loading was not provided. |

## GEOTECHNICAL CHARACTERIZATION

A general characterization of the subsurface conditions was developed based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed **GeoModel**, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the **GeoModel** can be found in **Attachments**.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the **GeoModel** and/or boring logs.

| Model Layer | Layer Name | General Description |
|---|---|---|
| **1** | **Surface** | Topsoil |
| **2** | **Native Soils** | Lean clay, silty clay, lean to fat clay |
| **3** | **Native Soils** | Sandy lean clay, lean clay, lean to fat clay, fat clay |
| **4** | **Native Soils (residual)** | Clayey sand |
| | | Lean clay, fat clay |

The boreholes were observed during and shortly after drilling for the presence and level of subsurface water. Several boreholes were caved at the time the after drilling levels were recorded. The water levels and caved depths observed in the boreholes are provided on the boring logs in **Exploration Results**.

Subsurface water level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Subsurface water levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of subsurface water level fluctuations should be considered when developing the design and construction plans for the project.

## GEOTECHNICAL OVERVIEW

Topsoil was present at the boring locations to depths of about 4 to 6 inches below current grades. Variations in the thickness of topsoil/organic materials are expected across the site and could extend to greater depths in other areas of the site not explored, including the drainage swales. In general, soils with organic contents above 5% should be removed wherever encountered below shallow footings, floor slabs, and pavements, particularly where they will be exposed to freezing temperatures and/or higher foundation/floor loads. Future explorations should evaluate topsoil thickness. For preliminary purposes, an estimated stripping depth on the order of 6 inches could be considered across the site. Actual stripping depths will vary across each site.

At several boring locations, medium to high plasticity soils (lean to fat and fat clay) were present beneath the topsoil. These soils will shrink and swell with soil moisture content fluctuations. Where these soils are encountered at floor slab subgrade level, we recommend removing them to at least 12 inches below any building floor subgrade elevation and replacing them with low volume change (LVC) engineered fill. LVC clay soils have a liquid limit (LL) and plasticity index (PI) below 45 and 20, respectively, or are granular, as discussed in **Earthwork**. Depending upon the results of future explorations, a greater LVC thickness may be recommended. The LVC engineered fill layer is intended to help reduce the potential for future subgrade and floor slab movement. Please refer to the **Earthwork** section of this report for further information.

At Borings 2, 5, and 7, the water level observed after drilling was about 6 to 15 feet. Future explorations should include delayed water level readings to better evaluate subsurface water levels across the site. In our opinion, the grading plan should consider not lowering the site grades below or near the observed water levels to reduce concerns with subsurface water and subgrade stability. Even without lowering grade, some native soils encountered at the borings are easily disturbed from construction traffic. Repetitive traffic on subgrade soils should be minimized and lightweight equipment may be required in some areas to reduce soil disturbance and the associated repair work needed to improve subgrade soils. The subgrade soils must be properly prepared to provide a suitable bearing surface for floor slab and pavement support and to place and compact engineered fill.

Based on the results of our exploration and analysis, the soils present at the boring locations are generally suitable for supporting lightly loaded structures on shallow foundations using a relatively low bearing pressure; however, depending upon grading, a greater bearing pressure may be possible in some areas. To support moderate to heavily loaded buidlings supported on shallow foundations could require removal of the lower strength soils and replace them with engineered fill. Ground modification methods such as rammed aggregate piers or stone columns could also be considered to improve the shallow soils for support of moderate building loads. Rammed aggregate piers or stone columns are procured on a design-build basis and installed by licensed contractors. The use of footing foundations with ground modification procedures must be evaluated by each specialty contractor's designer.

Deep foundations such as driven steel piles, augered cast-in-place (ACIP) piles or drilled shafts could be considered to support moderate to high building loads. These deep foundation systems can provide an economical means to support moderate to heavy building loads when extended into very stiff clay soils or bedrock; however, layers suitable to develop high capacities were not encountered at all boring locations. The shear wave profiles obtained from the seismic survey included in **Seismic Survey Results**, indicate bedrock may be present at depths on the order of 35 to 60 feet. Where moderate to heavy building loads are possible, future borings should extend to greater depths and into soils/bedrock suitable for support of deep foundations. For the greatest capacity, deep foundations should extend to bedrock, especially if it is present at the anticipated depths discussed.

The **General Comments** section provides an understanding of the report limitations.

## EARTHWORK

Preliminary recommendations for site preparation, excavation, subgrade preparation, and placement of engineered fill for the project are provided in the following sections.

Climatic conditions will affect earthwork. Climatic data published in the USDA Soil Survey for Scott County, Iowa reports that average precipitation is highest from April to October with an average of 2.62 to 4.36 inches per month. The least precipitation occurs between the months of November and February. Freezing temperatures can occur as early as late October and last until mid-April. Snowfall can be expected from November to April. The average daily temperature from May to October ranges from about 62 to 76 degrees (F). If site grading occurs prior to early May or after mid-October, scarification and recompaction of subgrades, and adjustments to the on-site soils' moisture contents could be difficult. The published precipitation data for each month is outlined in the following table.

| Month | Monthly Precipitation Average (inches) | Month | Monthly Precipitation Average (inches) |
|---|---|---|---|
| January | 1.39 | July | 4.36 |

| Month | Monthly Precipitation Average (inches) | Month | Monthly Precipitation Average (inches) |
|---|---|---|---|
| February | 1.07 | August | 3.65 |
| March | 2.31 | September | 3.39 |
| April | 3.47 | October | 2.62 |
| May | 3.68 | November | 2.03 |
| June | 4.13 | December | 1.76 |

## Site Preparation

Site preparation should include removal of vegetation and organic material as previously discussed. Loose, soft or otherwise unsuitable material should be removed during mass grading. We recommend that a Terracon representative assist in evaluating the removal depths prior to and during construction to avoid lowering the site any more than necessary.

Many of the soils observed are susceptible to disturbance and softening under construction traffic loads. Improvements of the subgrade soils should be expected in most areas. The need for subgrade improvement and the most appropriate method to improve subgrade soils will depend upon on a number of factors including the time of year improvements are needed, the final use of the subgrade, soil type, subsurface water levels, weather conditions, the proposed grading plan, the construction schedule and methods of construction that will be used. Typical alternatives for improving subgrades include the following:

- Scarification, moisture conditioning (typically drying) and compaction
- Removal and replacement of unsuitable soils with crushed limestone or LVC engineered fill if appropriate for the application
- The use of high modulus geotextiles with crushed limestone
- Chemical treatment

## Fill Material Types

Engineered fill for the project should meet the following material property requirements:

| Fill Type [1, 2] | USCS Classification | Acceptable Location for Placement |
|---|---|---|
| Cohesive | CL, CL/ML[3], ML[3]<br>(LL ≤ 45 and PI ≤ 20) | all locations, including LVC |
| Granular | GW, GP, GM, GC[4], SW, SP, SM, SC[4] | all locations, including LVC |
| Unsuitable | CL/CH[5], CH[5], MH[5], OL, OH[5], PT | non-structural locations |

1. Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation prior to use on this site.
2. Any organic materials, rock fragments larger than 3 inches, and other unsuitable materials should be removed prior to use as engineered fill.
3. Highly susceptible to frost; unstable when wet; are commonly used for pavement support with the knowledge that additional maintenance and/or shorter pavement life are likely.
4. Any fines must be low plasticity.
5. High plasticity. Not recommended beneath movement sensitive features such as foundations, floor slabs, and pavements.

## Fill Compaction Requirements

New fill should be placed in lifts and compacted in accordance with the material's maximum standard Proctor dry density (ASTM D 698). The degree of compaction will depend upon the type and magnitude of load to be supported by the fill. The water content of cohesive clay fill soils should be maintained within 2% below to 3% above the soil's optimum moisture value as determined by the standard Proctor test. For this reason, some adjustment to the on-site soils' moisture contents will likely be required to achieve adequate compaction. Site specific recommendations will be provided in future reports once specific design information is known.

## Grading and Drainage

During construction, grades should be developed to direct surface water flow away from or around construction areas. Exposed subgrades should be sloped to provide positive drainage so saturation of subgrades is avoided. Surface water should not be permitted to accumulate on the site.

Final grades should slope away from future buildings to promote rapid surface drainage. Accumulation of water adjacent to a building could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement. Roof drains should discharge into a storm sewer or at least 10 feet away from the building. Trees should be planted at least ½ of their mature height away from the building. Final surrounding grades should be sloped away from the building on all sides to prevent accumulation of water.

## Earthwork Construction Considerations

The water contents of the on-site soils are likely outside the recommended range for compaction in accordance with the standard Proctor test method. For this reason, adjustments to the on-site soils' water contents should be expected to obtain the degree of compaction recommended in this report.

Care should be taken to avoid disturbance of prepared subgrades. New engineered fill can become disturbed under construction equipment. Construction traffic should not operate directly on saturated or low strength soils. If the subgrade becomes saturated, desiccated, or disturbed, the affected materials should either be scarified and compacted or be removed and replaced as previously discussed. Subgrades should be observed and tested by Terracon prior to construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, as well as other applicable codes, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, Furniture Mart, the contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

## SHALLOW FOUNDATIONS

Preliminary recommendations are provided for shallow foundations. Alternatively, ground improvement methods such as rammed aggregate piers or stone columns could also be considered for support of building loads. Selecting the most appropriate foundation type will depend upon the final loads and settlement sensitivity of the structure. We are available to provide specific foundation recommendations once specific project designs are further developed.

### Shallow Foundation Design Considerations

Based on the limited subsurface information obtained, in our opinion, it should be possible to support light to moderate building loads using shallow footing foundations. Depending upon the size of the footing and design bearing elevation, footings bearing on suitable native soils or on engineered fill extending to approved native soils could likely be designed using a maximum net allowable soil bearing pressure in the range of 1,500 to 2,000 psf. The net pressure is the pressure in excess of the minimum surrounding overburden pressure at the design footing base elevation.

At some locations, lower strength native soils will likely be encountered at or near the design bearing depth, requiring removal of lower strength soil and placement of engineered fill. Further details will be provided in future reports when specific loading information is available for each building.

Perimeter foundations beneath heated structures should extend at least 3½ feet below final grade for frost protection; however, the extreme frost depth in this region for unheated areas can be on the order of 4½ feet. If it is desired to reduce the potential for frost heave, footings below unheated areas and those that will be exposed to freezing conditions during construction should extend to at least this depth.

## SEISMIC CONSIDERATIONS

November 6, 2018, a seismic refraction system (SRS) was used to perform a site-specific seismic class survey. The SRS test procedure is outlined in **Exploration and Test Procedures**, the survey results are provided in **Seismic Survey Results**, and the approximate locations of the survey lines are shown on the **Exploration Plan**.

The International Building Code (IBC) requires structural design to be in accordance with the appropriate site class definition for soil profile type. Based upon the Site Class Definitions in IBC 2015, Section 1613.3.2, which refers to ASCE 7, Chapter 20, Table 9.4.1.2, and the average shear wave velocity at Boring 1 of 950 feet/second derived from our seismic survey data, a Class "D" seismic site classification could be used for design for a majority of the site. Portions of the site may be suitable for a Site Class C (an average shear wave velocity of 1,300 feet/second was derived near Boring 4), however additional testing may be required once grading plans have been developed for the site. The average shear-wave velocity analyses presented in this report are based upon the data obtained from the SRS performed at the site on the referenced date. This analysis does not reflect variations that may occur across the site or variations that may occur throughout the year. Please refer to **Seismic Survey Results** for specific shear wave velocity profiles.

## FLOOR SLABS

Terracon recommends supporting floor slabs on LVC engineered fill extending to approved native soils. Parties who will design, own, and/or lease future buildings developed on the site should understand that where high plasticity soils (fat clays) are present, using a limited thickness of LVC engineered fill beneath the floor slab will not eliminate the possibility of subgrade movement resulting from volume change of the soils. Where necessary, high plasticity native clays should be removed and replaced with at least 12 inches of LVC engineered fill as discussed in the **Geotechnical Overview** section of this report. To further reduce the potential for subgrade movement, the use of a greater thickness of engineered fill beneath the slabs should be considered.

The need for a vapor retarder, and where to place it, should be determined by architect based on the proposed floor treatment, building function, concrete properties, placement techniques, and the construction schedule. In our opinion, the use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions regarding the use and placement of a vapor retarder.

## PAVEMENTS

The soils encountered at the borings locations are primarily clay soils, which are considered poor subgrade materials due to their potential for frost heave, particularly in the presence of free moisture. To reduce construction costs, clay soils are commonly used for pavement support. In our opinion, the high plasticity clays should be maintained in a moist condition during construction or be partially removed to a depth of about 12 inches below the final subgrade elevations and replaced with LVC engineered fill as discussed in the **Earthwork** section of this report. Although the initial construction costs will be reduced, pavements supported directly on high plasticity soils (native and engineered fill) will have greater maintenance risks and reduced useable life.

Subdrains should be considered wherever subsurface water is present within 4 feet of the final subgrade elevation and when free draining base is included in the pavement design. Subsurface drains should be installed in accordance with Iowa DOT requirements. A drainable base should also be constructed beneath the pavement. The drainable base should daylight to an adequate source to allow for proper gravity drainage. We are available to further evaluate the need for subdrains once the grading plan is further developed.

As previously discussed in the **Earthwork** section, it may not be possible to improve in-place subgrade soils for support of construction equipment necessary to construct the pavements and/or the equipment required to place and compact new engineered fill. Improvement to the pavement subgrades may be necessary as discussed in the **Geotechnical Overview** and **Earthwork** sections of this report.

## GENERAL COMMENTS

Additional borings are recommended once the plans for the site are finalized. In addition, Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our preliminary and future supplemental geotechnical recommendations in the design and specifications. Terracon also should be retained to provide testing and observation during excavation, grading, foundation, construction and other earth related construction phases of the project.

The recommendations presented in this report are based on our knowledge of the site soil conditions, our experience with similar sites and structures, and our understanding that the owner is willing to accept the potential risk of post construction movements and related damage in order to reduce construction costs. The recommendations provided in this report will not eliminate the risk of movement and cosmetic distress for slab-on-ground construction, but this risk could be further reduced if significantly more expensive measures are used during construction.

The analysis and recommendations presented in this preliminary report are based upon limited data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather and/or construction. The nature and extent of such variations may not become evident until during or after additional exploration and construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If Shive-Hattery, Inc. (Shive) and/or the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of Shive for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes only. Reliance upon the services and any work product is limited to Shive, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/ design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

| | |
|---|---|
| LICENSED PROFESSIONAL ENGINEER<br>SARA J.<br>SOMSKY<br>23543<br>IOWA | I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.<br><br>11-16-18<br>Sara J. Somsky, P.E. Date<br><br>My license renewal date is December 31, 2019. |

# ATTACHMENTS

# SITE LOCATION AND EXPLORATION PLAN

## SITE LOCATION

Anderson 400 Site Certification ■ LeClaire, Iowa
November 16, 2018 ■ Terracon Project No. 07175146

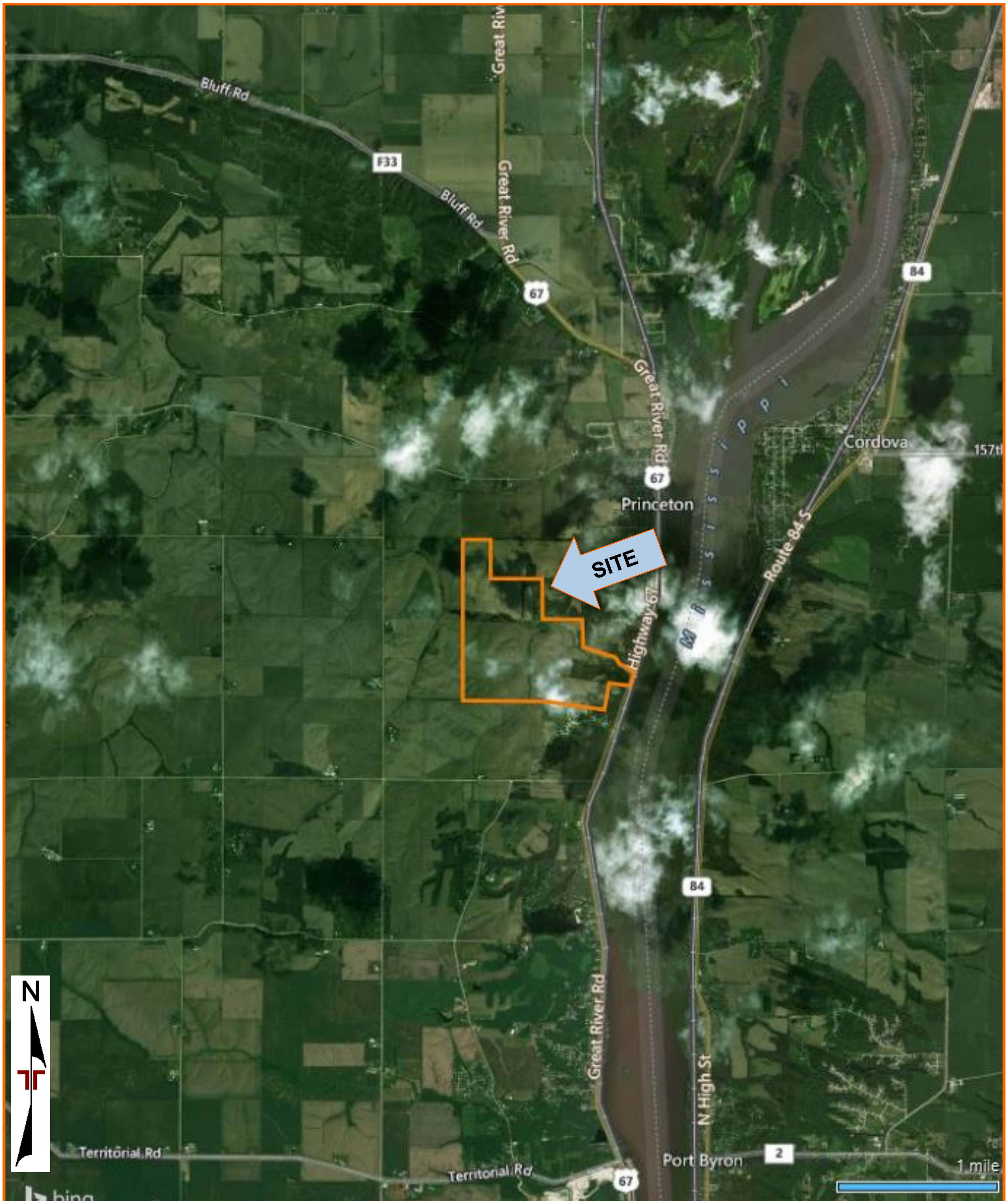



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

**EXPLORATION PLAN**

Anderson 400 Site Certification ■ LeClaire, Iowa

November 16, 2018 ■ Terracon Project No. 07175146

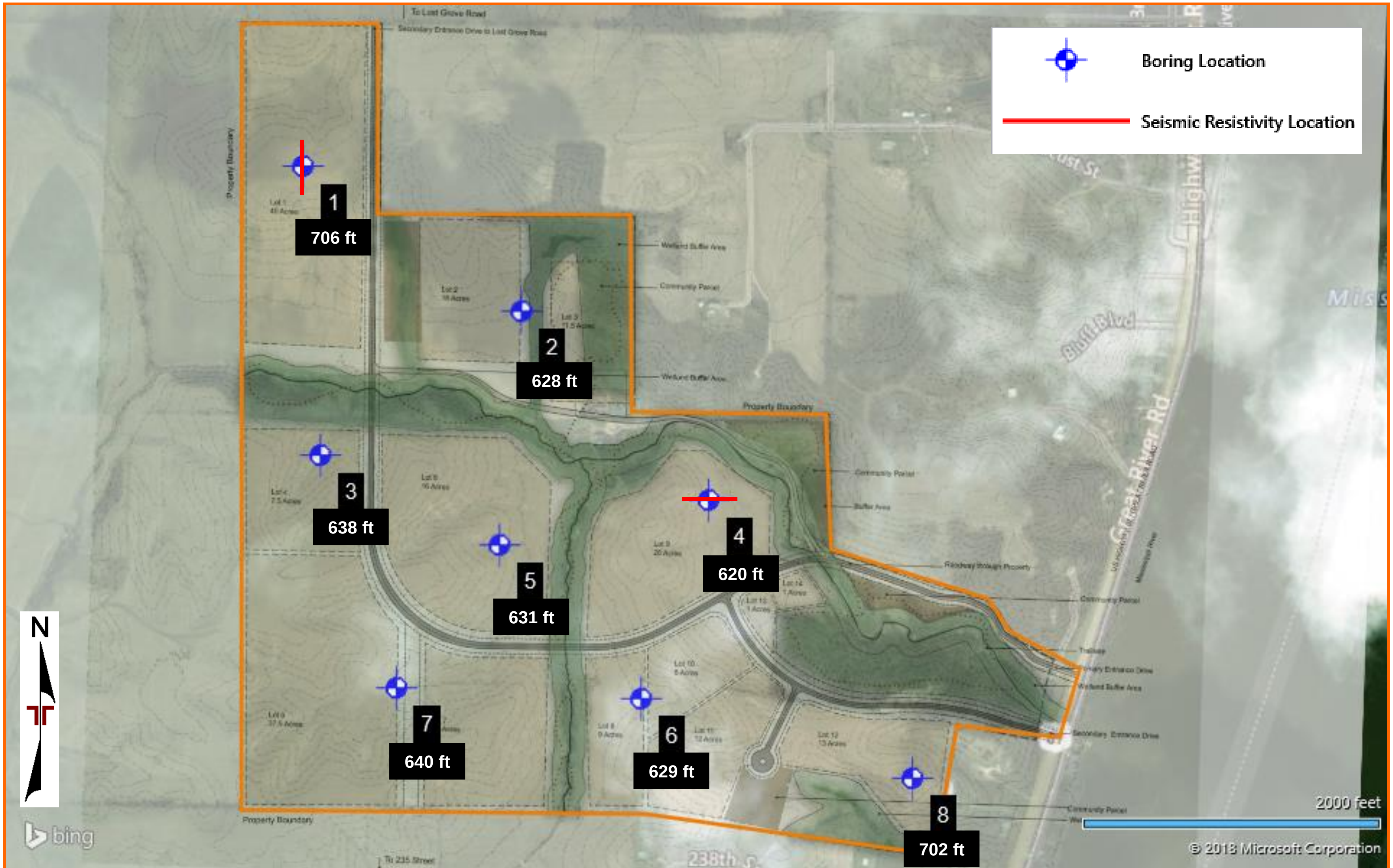


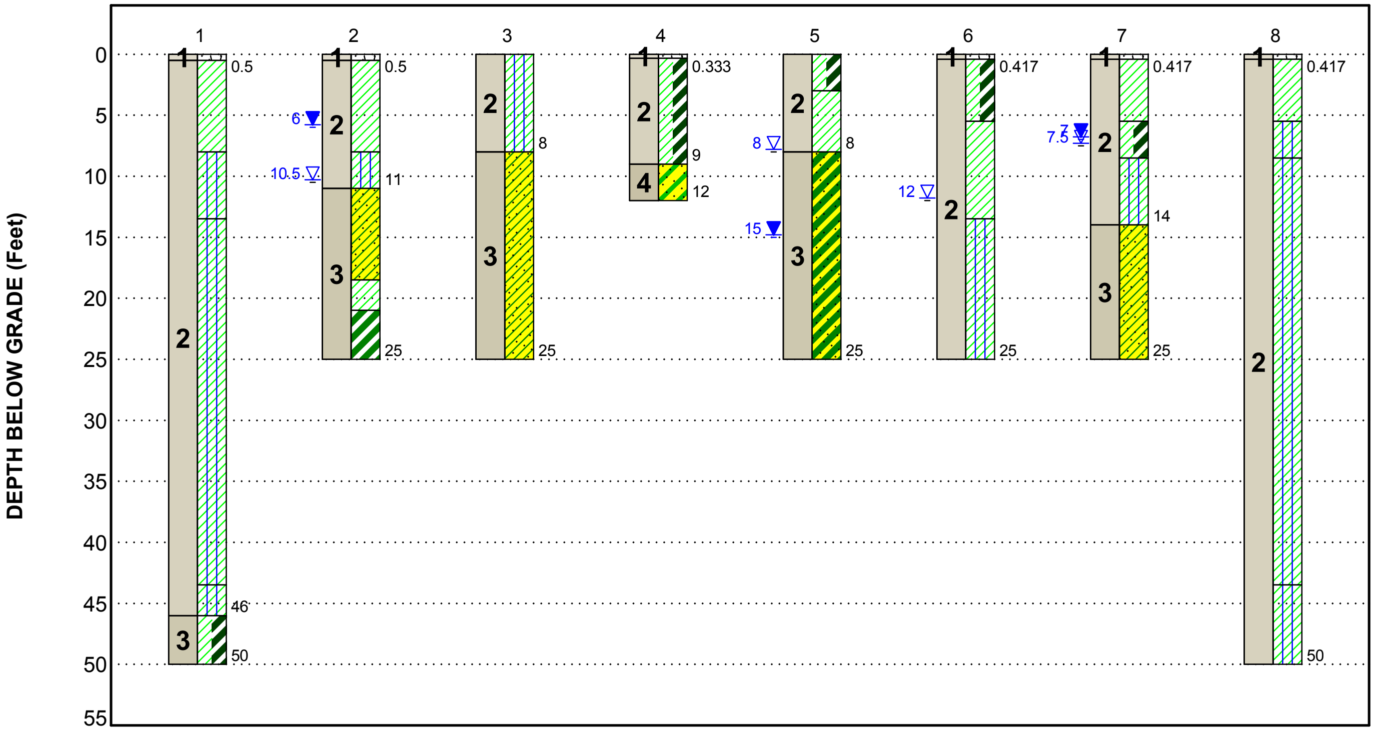

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

**GEOMODEL**

**GEOMODEL**

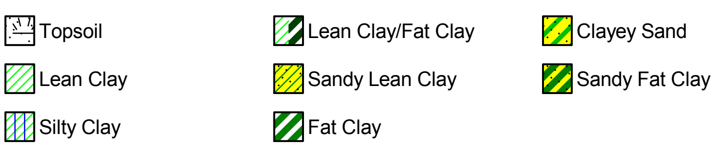
**Anderson 400 Site Certification ■ LeClaire, Iowa**
**11/16/2018 ■ Terracon Project No. 07175146**




This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

| Model Layer | Layer Name | General Description |
|---|---|---|
| 1 | **Surface** | Topsoil |
| 2 | **Native Soils 1** | Lean clay, silty clay, lean to fat clay |
| 3 | **Native Soils 2** | Sandy lean clay, lean clay, lean to fat clay, fat clay |
| 4 | **Native Soils (residual)** | Clayey sand, lean clay, fat clay |

## LEGEND




▽ First Water Observation
▼ Second Water Observation

Subsurface water levels are representative of the date and times the borings were performed. Significant changes are possible over time. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the project engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

# EXPLORATION RESULTS

# BORING LOG NO. 1



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6675° Longitude: -90.363°

Approximate Surface Elev: 706 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.5 | **TOPSOIL**, approx. 6" | 705.5+/- | | | | | | | | | |
| 2 | | **LEAN CLAY (CL)**, brown and dark brown, medium stiff | | | | X | 8 | 1-2-3 N=5 | 1 | | 24 | |
| | | soft to medium stiff at Sample 2 | | 5 | | X | 11 | 2-2-2 N=4 | 2 | | 26 | 38-23-15 |
| | | soft at Sample 3 | | | | X | 7 | 2-1-2 N=3 | 3 | 500 | 28 | |
| | 8.0 | **SILTY CLAY (CL/ML)**, brown, medium stiff | 698+/- | 10 | | X | 14 | 2-3-3 N=6 | 4 | | 16 | |
| | 13.5 | **SILTY CLAY (CL-ML)**, brown, stiff | 692.5+/- | 15 | | X | 18 | 3-4-6 N=10 | 5 | | 14 | |
| | | | | 20 | | X | 18 | 3-5-8 N=13 | 6 | | 14 | |
| | | | | 25 | | X | 18 | 3-5-5 N=10 | 7 | | 15 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-25-2018 | Boring Completed: 10-25-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 1

**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6675° Longitude: -90.363°

Approximate Surface Elev: 706 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | **SILTY CLAY (CL-ML)**, brown, stiff *(continued)* | | | | | | | | | | |
| | | | | 30 | | X | 18 | 3-4-7 N=11 | 8 | | 14 | |
| | | trace sand at Samples 9 and 10 | | 35 | | X | 18 | 3-5-6 N=11 | 9 | 3500 | 17 | |
| | | | | 40 | | X | 16 | 3-4-5 N=9 | 10 | | 24 | |
| | 43.5 | **SILTY CLAY (CL/ML)**, dark brown, medium stiff | 662.5+/- | 45 | | X | 18 | 2-2-4 N=6 | 11 | 2000 | 26 | |
| 3 | 46.0 | **LEAN TO FAT CLAY (CL/CH)**, brown to reddish-brown, stiff | 660+/- | | | | | | | | | |
| | 50.0 | | 656+/- | 50 | | X | 18 | 3-5-7 N=12 | 12 | | 29 | |
| | | ***Boring Terminated at 50 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-25-2018 | Boring Completed: 10-25-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 2



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6648° Longitude: -90.3576°

Approximate Surface Elev: 628 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.5 | **TOPSOIL**, approx. 6" | 627.5+/- | | | | | | | | | |
| 2 | | **LEAN CLAY (CL)**, dark gray-brown, soft to medium stiff | | | | X | 18 | 2-2-2 N=4 | 1 | 1000 | 26 | |
| | | gray and brown, medium stiff at Sample 2 | | | | X | 18 | 2-2-3 N=5 | 2 | 1500 | 26 | |
| | | gray, soft at Sample 3 | | 5 | ▽ | X | 16 | 1-2-1 N=3 | 3 | 1000 | 29 | |
| | 8.0 | | 620+/- | | | | | | | | | |
| | | **SILTY CLAY (CL/ML)**, gray-brown to reddish-brown, soft to medium stiff | | | | X | 18 | 2-2-2 N=4 | 4 | | 27 | |
| | 11.0 | | 617+/- | 10 | ▽ | | | | | | | |
| 3 | | **SANDY LEAN CLAY (CL)**, trace gravel, brown, medium stiff | | | | X | 18 | 2-3-4 N=7 | 5 | | 18 | |
| | 18.5 | | 609.5+/- | 15 | | | | | | | | |
| | | **LEAN CLAY (CL)**, dark gray, stiff | | | | X | 18 | 3-4-7 N=11 | 6 | 3000 | 20 | |
| | 21.0 | | 607+/- | 20 | | | | | | | | |
| | | **FAT CLAY (CH)**, dark gray, stiff | | | | X | 18 | 2-4-5 N=9 | 7 | 3000 | 31 | 77-26-51 |
| | 25.0 | | 603+/- | 25 | | | | | | | | |
| | | ***Boring Terminated at 25 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Solid-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *10½' while drilling*

▽ *6' after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-25-2018 | Boring Completed: 10-25-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 3



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road, LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6621° Longitude: -90.3626°

Approximate Surface Elev: 638 (Ft.) +/-

| MODEL LAYER | DEPTH / DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | **SILTY CLAY (CL/ML)**, gray-brown, medium stiff | | | | X | 15 | 2-2-3 N=5 | 1 | 1500 | 21 | |
| | soft at Sample 2 | | | | X | 14 | 2-1-2 N=3 | 2 | | 28 | |
| | | | 5 | | X | 18 | 2-2-3 N=5 | 3 | | 24 | |
| | 8.0 | 630+/- | | | | | | | | | |
| 3 | **SANDY LEAN CLAY (CL)**, trace gravel, gray, stiff | | | | X | 18 | 2-4-6 N=10 | 4 | | 18 | |
| | | | 10 | | | | | | | | |
| | | | | | X | 18 | 3-5-8 N=13 | 5 | | 18 | |
| | | | 15 | | | | | | | | |
| | very stiff at Samples 6 and 7 | | | | X | 18 | 7-10-14 N=24 | 6 | 6500 | 20 | |
| | | | 20 | | | | | | | | |
| | | | | | X | 18 | 6-9-13 N=22 | 7 | | 18 | |
| | 25.0 | 613+/- | 25 | | | | | | | | |
| | ***Boring Terminated at 25 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Solid-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-25-2018 | Boring Completed: 10-25-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 4



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road**
**LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6613° Longitude: -90.353°

Approximate Surface Elev: 620 (Ft.) +/-

| MODEL LAYER | DEPTH | MATERIAL DESCRIPTION | ELEVATION (Ft.) |
|---|---|---|---|
| 1 | 0.3 | **TOPSOIL**, approx. 4" | 619.5+/- |
| 2 | | **LEAN TO FAT CLAY (CL/CH)**, reddish-brown, medium stiff<br>brown, soft to medium stiff at Sample 2<br>reddish-brown to medium stiff at Sample 3 | |
| | 9.0 | | 611+/- |
| 4 | | **CLAYEY SAND (SC)**, brown, medium dense | |
| | 12.0 | | 608+/- |
| | | ***Auger Refusal on Possible Boulder at 12 Feet*** | |

| SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|
| X | 17 | 2-3-3 N=6 | 1 | | 24 | 45-21-24 |
| X | 18 | 2-2-2 N=4 | 2 | | 25 | |
| X | 18 | 2-2-2 N=4 | 3 | | 29 | |
| X | 16 | 8-10-17 N=27 | 4 | | 27 9 | |

DEPTH (Ft.): 5, 10

WATER LEVEL OBSERVATIONS

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 5



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6605° Longitude: -90.3582°

Approximate Surface Elev: 631 (Ft.) +/-

| MODEL LAYER | GRAPHIC LOG | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **LEAN TO FAT CLAY (CL/CH)**, dark brown, soft to medium stiff | | | | | | | | | | |
| | | | | | | | X | 18 | 2-2-2 N=4 | 1 | 1000 | 28 | |
| | | 3.0 | | 628+/- | | | | | | | | | |
| 2 | | | **LEAN CLAY (CL)**, gray to brown, soft | | | | | | | | | | |
| | | | | | | | X | 18 | 1-1-1 N=2 | 2 | 500 | 29 | |
| | | | | | 5 | | | | | | | | |
| | | | soft to medium stiff at Sample 3 | | | | X | 13 | 1-2-2 N=4 | 3 | | 28 | |
| | | 8.0 | | 623+/- | | ▽ | | | | | | | |
| | | | **SANDY FAT CLAY (CH)**, gray and brown, medium stiff | | | | | | | | | | |
| | | | | | | | X | 18 | 2-3-4 N=7 | 4 | 1500 | 22 | |
| | | | | | 10 | | | | | | | | |
| | | | trace gravel, stiff at Sample 5 | | | | X | 18 | 2-4-6 N=10 | 5 | 3000 | 21 | |
| | | | | | 15 | ▽ | | | | | | | |
| 3 | | | | | | | | | | | | | |
| | | | very stiff at Sample 6 | | | | X | 16 | 5-9-14 N=23 | 6 | 6500 | 15 | |
| | | | | | 20 | | | | | | | | |
| | | | hard at Sample 7 | | | | X | 18 | 7-13-20 N=33 | 7 | 9000 | 13 | |
| | | 25.0 | | 606+/- | 25 | | | | | | | | |
| | | | ***Boring Terminated at 25 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *8' while drilling*

▽ *15' after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 6



**PROJECT: Anderson 400 Site Certification** | **CLIENT: Shive-Hattery Inc**

**SITE:** **24500 Great River Road**
**LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6576° Longitude: -90.3547°

Approximate Surface Elev: 629 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | **TOPSOIL**, approx. 5" | 628.5+/- | | | | | | | | | |
| 2 | | **LEAN TO FAT CLAY (CL/CH)**, dark brown, medium stiff | | | | | 15 | 2-3-4 N=7 | 1 | | 27 | |
| | | brown at Sample 2 | | | | | 16 | 2-3-4 N=7 | 2 | 2000 | 27 | |
| | 5.5 | | 623.5+/- | 5 | | | | | | | | |
| | | **LEAN CLAY (CL)**, gray-brown, soft to medium stiff | | | | | 18 | 2-2-2 N=4 | 3 | 1000 | 30 | |
| | | soft at Sample 4 | | | | | 18 | 1-1-2 N=3 | 4 | 1000 | 27 | |
| | | | | 10 | 10' cave in | | | | | | | |
| | | | | | 12' while drilling | | | | | | | |
| | 13.5 | | 615.5+/- | | | | | | | | | |
| | | **SILTY CLAY (CL-ML)**, gray-brown, medium stiff | | | | | 13 | 2-2-2 N=4 | 5 | | 28 | |
| | | | | 15 | | | | | | | | |
| | | dark gray at Sample 6 | | | | | 16 | 1-2-3 N=5 | 6 | | 28 | 26-20-6 |
| | | | | 20 | | | | | | | | |
| | | stiff at Sample 7 | | | | | 17 | 3-6-6 N=12 | 7 | 3500 | 26 | |
| | 25.0 | | 604+/- | 25 | | | | | | | | |
| | | ***Boring Terminated at 25 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*12' while drilling*

*Not observed after drilling*

*10' cave in after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 7



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6578° Longitude: -90.3607°

Approximate Surface Elev: 640 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | **TOPSOIL**, approx. 5" | 639.5+/- | | | | | | | | | |
| 2 | | **LEAN CLAY (CL)**, dark brown, soft to medium stiff | | | | X | 16 | 2-2-2 N=4 | 1 | | 28 | |
| | | dark gray to very dark gray, soft at Sample 2 | | | | X | 12 | 1-1-2 N=3 | 2 | 1000 | 34 | |
| | 5.5 | | 634.5+/- | 5 | | | | | | | | |
| | | **LEAN TO FAT CLAY (CL/CH)**, trace organics, very dark gray to dark brown, soft | | | ∇ ∇ | X | 10 | 1-1-2 N=3 | 3 | 1000 | 32 | |
| | 8.5 | | 631.5+/- | | | | | | | | | |
| | | **SILTY CLAY (CL/ML)**, very dark gray, very soft | | | | X | 15 | 0-0-0 N=0 | 4 | 500 | 38 | |
| | 14.0 | | 626+/- | 10 | | | | | | | | |
| 3 | | **SANDY LEAN CLAY (CL)**, trace gravel, gray-brown, soft | | | | X | 16 | 1-1-1 N=2 | 5 | 500 | 26 | |
| | | | | 15 | | X | 18 | 3-5-7 N=12 | 6 | 3500 | 17 | |
| | | stiff at Samples 6 and 7 | | 20 | | X | 18 | 4-6-9 N=15 | 7 | 4000 | 17 | |
| | 25.0 | | 615+/- | 25 | | | | | | | | |
| | | ***Boring Terminated at 25 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

∇ *7½' while drilling*

∇ *7' after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 8



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road
LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6562° Longitude: -90.348°

Approximate Surface Elev: 702 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | **TOPSOIL**, approx. 5" | 701.5+/- | | | | | | | | | |
| 2 | | **LEAN CLAY (CL)**, reddish-brown, stiff | | | | X | 16 | 2-4-6 N=10 | 1 | 3000 | 23 | |
| | | medium stiff at Sample 2 | | | | X | 11 | 2-3-3 N=6 | 2 | | 24 | |
| | 5.5 | | 696.5+/- | 5 | | | | | | | | |
| | | **SILTY CLAY (CL/ML)**, brown, soft | | | | X | 12 | 2-1-2 N=3 | 3 | 1000 | 16 | |
| | 8.5 | | 693.5+/- | | | | | | | | | |
| | | **SILTY CLAY (CL-ML)**, brown, medium stiff to stiff | | | | X | 18 | 3-3-5 N=8 | 4 | 2000 | 11 | |
| | | | | 10 | | | | | | | | |
| | | soft to medium siff at Sample 5 | | | | X | 16 | 2-2-2 N=4 | 5 | | 11 | |
| | | | | 15 | | | | | | | | |
| | | | | | | X | 18 | 3-4-4 N=8 | 6 | 2000 | 10 | |
| | | | | 20 | | | | | | | | |
| | | medium stiff at Sample 7 | | | | X | 17 | 2-2-4 N=6 | 7 | 1500 | 12 | |
| | | | | 25 | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# BORING LOG NO. 8



**PROJECT: Anderson 400 Site Certification**

**CLIENT: Shive-Hattery Inc**

**SITE: 24500 Great River Road**
**LeClaire, Iowa**

LOCATION See Exploration Plan

Latitude: 41.6562° Longitude: -90.348°

Approximate Surface Elev: 702 (Ft.) +/-

| MODEL LAYER | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | SAMPLE NUMBER | HAND PENETROMETER (psf) | WATER CONTENT (%) | ATTERBERG LIMITS LL-PL-PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | **SILTY CLAY (CL-ML)**, brown, medium stiff to stiff *(continued)* | | | | | | | | | | |
| | | soft to medium stiff at Sample 8 | | 30 | | X | 16 | 2-2-2 N=4 | 8 | | 12 | |
| | | medium stiff at Sample 9 | | 35 | | X | 18 | 3-3-4 N=7 | 9 | 1500 | 14 | |
| | | stiff at Sample 10 | | 40 | | X | 18 | 3-4-5 N=9 | 10 | 2000 | 13 | |
| | 43.5 | **SILTY CLAY (CL/ML)**, trace sand, brown, medium stiff | 658.5+/- | 45 | | X | 18 | 3-3-4 N=7 | 11 | | 23 | |
| | 50.0 | | 652+/- | 50 | | X | 14 | 2-2-3 N=5 | 12 | | 31 | |
| | | ***Boring Terminated at 50 Feet*** | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous-Flight Hollow-Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were estimated from Iowa LiDAR.

Notes:

**WATER LEVEL OBSERVATIONS**

*Not observed while drilling*

*Not observed after drilling*

Terracon
870 40th Ave
Bettendorf, IA

| | |
|---|---|
| Boring Started: 10-26-2018 | Boring Completed: 10-26-2018 |
| Drill Rig: 748 | Driller: RPP |
| Project No.: 07175146 | |

# SEISMIC SURVEY RESULTS

# ReMi – B1


Average Shear Wave Velocity to 100 ft (rounded) = 950 ft/s

# ReMi – B4


Average Shear Wave Velocity to 100 ft (rounded) = 1,300 ft/s

# EXPLORATION AND TESTING PROCEDURES

# EXPLORATION AND TESTING PROCEDURES

## Field Exploration

| Boring Number | Boring Depth (feet) | Location |
|---|---|---|
| 1 | 50 | Lot 1 |
| 2 | 25 | Lot 2 |
| 3 | 25 | Lot 4 |
| 4 | 12 | Lot 9 |
| 5 | 25 | Lot 6 |
| 6 | 25 | Lots 8, 10 |
| 7 | 25 | Lots 5, 7 |
| 8 | 50 | Lot 12 |

1. Below ground surface
2. Boring 4 terminated at auger refusal above a planned depth of 25 feet.

**Boring Layout and Elevations:** Terracon's drill crew laid out the borings using latitude and longitude values and a handheld GPS unit. Approximate surface elevations were obtained using the Iowa Department of Natural Resources (IDNR) LiDAR Data Elevation Tool. The boring locations and elevations should be considered accurate only to the degree implied by the means and methods used for these measurements.

**Subsurface Exploration Procedures:** The borings were advanced with an ATV-mounted rotary drill rig using continuous-flight hollow-stem augers. Samples were obtained on a 2½-foot depth interval in the upper 10 feet of each boring and at 5-foot intervals thereafter. Sampling was performed using a split-barrel sampling procedure, in which a standard 2-inch outer diameter split-barrel sampling spoon is driven into the bottom of the borehole using a 140-pound automatic hammer falling a distance of 30 inches. Greater energy efficiency is typically obtained using an automatic hammer as compared to a safety hammer operated with a cathead and rope. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at their test depths. The samples were containerized and taken to our laboratory for testing and classification by the project engineer. Subsurface water levels were observed during and after drilling. The borings were backfilled with auger cuttings after drilling.

Our exploration team prepared field logs as part of the drilling operations. The sampling depths, penetration distances, other sampling information, visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples were recorded on the field logs. The boring logs included in this report represent the project engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

**Seismic Refraction Survey:** Terracon performed two seismic refraction surveys (survey) on November 6, 2018 using the refraction microtremor (ReMi) method. One survey was performed near Boring 1 and the second survey was performed adjacent to Boring 4. Each survey consisted of a seismograph and a linear array of 24 geophones. A computer was used to record refraction microtremors produced by ambient seismic noise. The data was then processed using a wavefield transformation data-processing technique and an interactive Rayleigh-wave dispersion-modeling tool. The refraction microtremor method employs aspects of spectral analysis of surface waves (SASW) and multi-channel analysis of surface waves (MASW) to derive a shear wave profile and an average shear wave velocity for the underlying soil profile. The results of the surveys are in **Seismic Survey Results**.

## Laboratory Testing

The samples were tested in the laboratory to measure their natural water contents. Pocket penetrometer tests were performed on some cohesive samples. Atterberg limits tests were performed on selected samples to evaluate the plasticity of the clays and their shrinkage and swell potential. These test results are provided on the boring logs included in **Exploration Results**.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the **General Notes** and **Unified Soil Classification System** (USCS) included in **Supporting Information**. The estimated USCS group symbols are shown on the boring logs, and a brief description of the USCS is included in **Supporting Information**.

# SUPPORTING INFORMATION

## GENERAL NOTES

Terracon GeoReport

| SAMPLING | | WATER LEVEL | FIELD TESTS | |
|---|---|---|---|---|
| Auger | Split Spoon | Water Initially Encountered | (HP) | **Hand Penetrometer** |
| Shelby Tube | Macro Core | Water Level After a Specified Period of Time | (T) | **Torvane** |
| Ring Sampler | Rock Core | Water Level After a Specified Period of Time | (b/f) | **Standard Penetration Test (blows per foot)** |
| Grab Sample | No Recovery | Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Subsurface water level variations will occur over time. In low permeability soils, accurate determination of subsurface water levels is not possible with short term water level observations. | (PID) | **Photo-Ionization Detector** |
| | | | (OVA) | **Organic Vapor Analyzer** |
| | | | (DCP) | **Dynamic Cone Penetrometer** |

### DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

### STRENGTH TERMS

| **RELATIVE DENSITY OF COARSE-GRAINED SOILS** (More than 50% retained on No. 200 sieve) Density determined by Standard Penetration Resistance | | **CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve) Consistency determined by laboratory shear strength testing, field visual-manual procedures, or standard penetration resistance | | |
|---|---|---|---|---|
| **Descriptive Term (Density)** | **Standard Penetration or N-Value Blows/Ft.** | **Descriptive Term (Consistency)** | **Unconfined Compressive Strength, Qu, psf** | **Standard Penetration or N-Value Blows/Ft.** |
| Very Loose | 0 – 3 | Very Soft | Less than 500 | 0 – 1 |
| Loose | 4 – 9 | Soft | 500 to 1000 | 2 – 4 |
| Medium Dense | 10 – 29 | Medium Stiff | 1000 to 2000 | 4 – 8 |
| Dense | 30 – 50 | Stiff | 2000 to 4000 | 8 – 15 |
| Very Dense | > 50 | Very Stiff | 4000 to 8000 | 15 – 30 |
| | | Hard | > 8000 | > 30 |

**RELATIVE PROPORTIONS OF SAND AND GRAVEL**

| Descriptive term(s) of other constituents | Percent (%) of dry weight |
|---|---|
| Trace | < 15 |
| With | 15 – 29 |
| Modifier | > 30 |

**GRAIN SIZE TERMINOLOGY**

| Major component of sample | Particle size |
|---|---|
| Boulders | Over 12 in. (300mm) |
| Cobbles | 12 in. to 3 in. (300mm to 75mm) |
| Gravel | 3 in. to #4 sieve (75mm to 4.75mm) |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm) |
| Silt or Clay | Passing #200 sieve (0.075mm) |

**RELATIVE PROPORTIONS OF FINES**

| Descriptive term(s) of other constituents | Percent (%) of dry weight |
|---|---|
| Trace | < 5 |
| With | 5 – 12 |
| Modifier | > 12 |

**PLASTICITY DESCRIPTION**

| Term | Plasticity Index |
|---|---|
| Non plastic | 0 |
| Low | 1 – 10 |
| Medium | 11 – 30 |
| High | > 30 |

# UNIFIED SOIL CLASSIFICATION SYSTEM

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A] | | | | | Soil Classification: Group Symbol | Soil Classification: 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:** Less than 5% fines [C] | Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E] | | GW | Well-graded gravel [F] |
| | | | Cu < 4 and/or [Cc<1 or Cc>3.0] [E] | | GP | Poorly graded gravel [F] |
| | | **Gravels with Fines:** More than 12% fines [C] | Fines classify as ML or MH | | GM | Silty gravel [F, G, H] |
| | | | Fines classify as CL or CH | | GC | Clayey gravel [F, G, H] |
| | **Sands:** 50% or more of coarse fraction passes No. 4 sieve | **Clean Sands:** Less than 5% fines [D] | Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E] | | SW | Well-graded sand [I] |
| | | | Cu < 6 and/or [Cc<1 or Cc>3.0] [E] | | SP | Poorly graded sand [I] |
| | | **Sands with Fines:** More than 12% fines [D] | Fines classify as ML or MH | | SM | Silty sand [G, H, I] |
| | | | Fines classify as CL or CH | | SC | Clayey sand [G, H, I] |
| **Fine-Grained Soils:** 50% or more passes the No. 200 sieve | **Silts and Clays:** Liquid limit less than 50 | **Inorganic:** | PI > 7 and plots on or above “A” line | | CL | Lean clay [K, L, M] |
| | | | PI < 4 or plots below “A” line [J] | | ML | Silt [K, L, M] |
| | | **Organic:** | Liquid limit - oven dried | < 0.75 | OL | Organic clay [K, L, M, N] |
| | | | Liquid limit - not dried | | | Organic silt [K, L, M, O] |
| | **Silts and Clays:** Liquid limit 50 or more | **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:** | Liquid limit - oven dried | < 0.75 | OH | Organic clay [K, L, M, P] |
| | | | Liquid limit - not dried | | | 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] 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.

[D] Sands with 5 to 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.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[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 plots below “A” line.