

Geotechnical Evaluation Report

Christianson Addition
Intersection of 43rd Avenue Northeast and Ottawa Street
Bismarck, North Dakota

Prepared for

Paces Lodging Corporation

Professional Certification:

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.

Charles W. Dickhut, PE
Principal/Principal Engineer
Registration Number: PE-9213
April 20, 2018



Project B1802725

Braun Intertec Corporation



The Science You Build On.

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April 20, 2018

Project B1802725

Mr. Nate Vollmuth
Paces Lodging Corporation
4265 45th Street South, Suite 200
Fargo, ND 58104

Re: Geotechnical Evaluation
Christianson Addition
Intersection of 43rd Avenue Northeast and Ottawa Street
Bismarck, North Dakota

Dear Mr. Vollmuth:

Braun Intertec Corporation is pleased to present this Geotechnical Evaluation Report for the Christianson Addition to be located to the northwest of the 43rd Avenue Northeast intersection with Ottawa Street in Bismarck, North Dakota. A detailed summary of our recommendations is included in the attached report.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please call Wes Dickhut at 701.355.5430.

Sincerely,

BRAUN INTERTEC CORPORATION

David N. Ackert, EI
Project Engineer

Charles W. (Wes) Dickhut, PE
Principal/Principal Engineer

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Soil Boring Location Sketch

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Descriptive Terminology of Soil

Unconfined Compression Test

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the proposed design and construction of the Christianson Addition located to the northwest of the 43rd Avenue Northeast intersection with Ottawa Street in Bismarck, North Dakota. The Christianson Addition will include the construction of a new bank, bar and restaurant, retail/restaurant building and associated parking. The proposed layout is depicted on Figure 1.

Figure 1. Site Layout

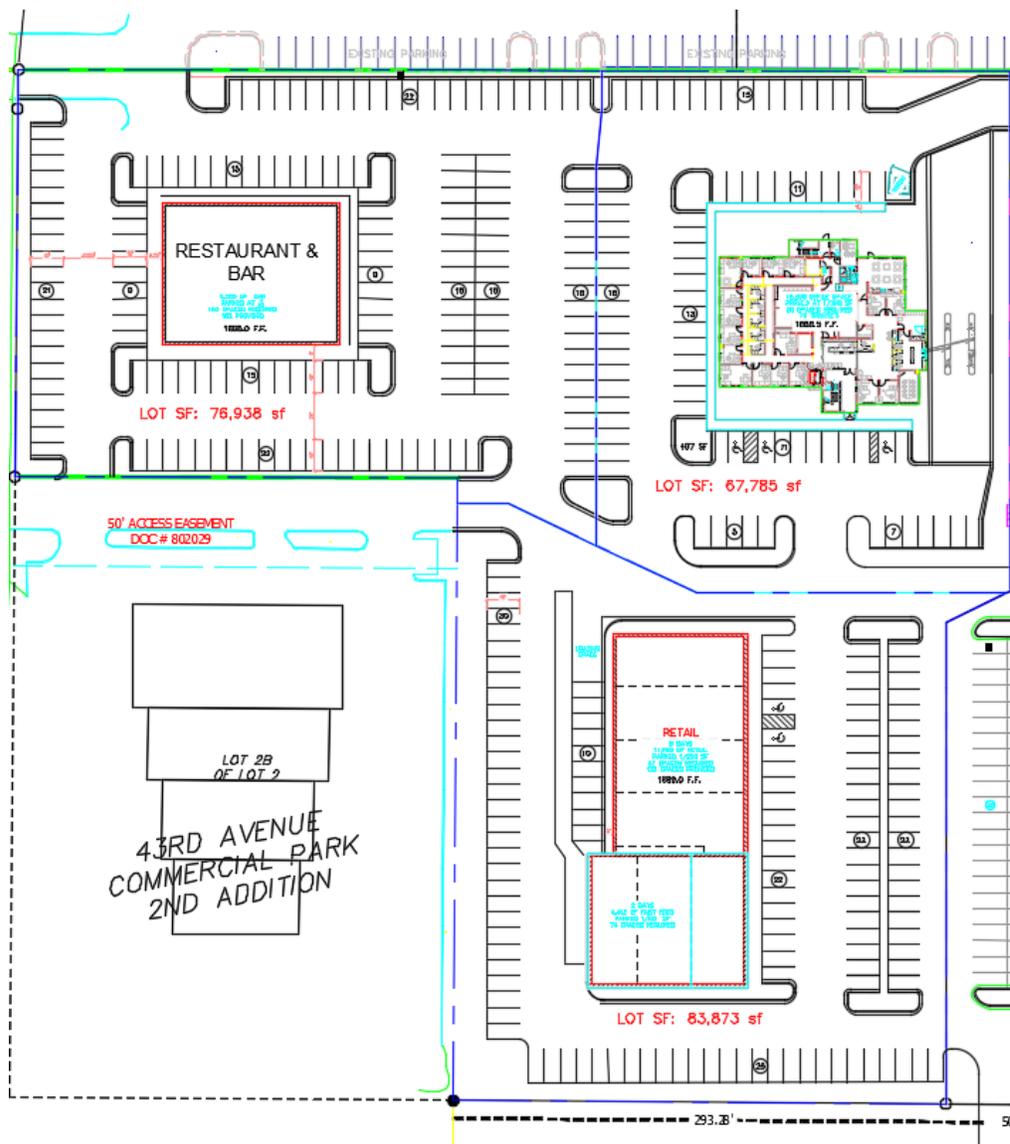


Figure provided by SEH, Inc.

We have assumed maximum column loads of up to 100 kips and maximum wall loads of up to 6 kips per linear foot (klf) for the buildings. We have not been provided loads for the structures at this time.

In the northwest corner of the lot, a new approximately 8,000 square foot bar and restaurant will be constructed, with a finished floor elevation of 1898.0 feet. We anticipate construction will consist of a slab-on-grade structure, supported over frost depth spread footings. Based on the ground surface elevation in this area we anticipate fills of up to 2 to 3 feet will be required.

We understand the bank will be located at the northeast corner of the site, just to the west of the new grocery store and will have a finished floor elevation of 1888.5feet. The bank will be a two-story structure that will be supported using typical frost depth spread footings. Based on the ground surface elevation in this area we anticipate fills of up to 2 feet, and cuts of up to 6 feet will be required.

We understand in the south portion of the site a new retail store and restaurant will be constructed, with a finished floor elevation of 1889.0 feet. The retail store and fast food restaurant will be a single story, slab-on-grade structure supported over frost depth spread footings. Based on the ground surface elevation in the area, we anticipate cuts and fills of up to 1 foot will be required.

We understand that bituminous pavement or a rigid concrete pavement has not been selected at this time for the parking lot and drive lanes located around the proposed structures. Based on the information available to us we understand 162 parking spaces will be provided around the bar and restaurant, 78 provided around the bank, and an additional 206 around the retail store and restaurant. We assumed a 20-year pavement life for bituminous pavement, and a 35-year life for rigid pavement. Our assumed traffic is shown in Table 1 below. These traffic estimates should be reviewed by the design team.

Table 1. Assumed Traffic

Vehicle	Vehicles per Day	Days per Week
Passenger Car	250	7
Pick-up Truck or Van	200	7
Semi-Truck Delivery	2	6
Delivery Trucks	3	5
Garbage Trucks	1	3

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we may have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

A.2. Site Conditions and History

Currently, the site exists as partially developed, grass covered lot with an approximate drop in grade of 16 feet from the northwest corner to the southeast corner. The surrounding areas have been developed with streets and utilities. To the south there an existing retail space and parking lot, and to the north there is an existing business and parking lot. Photograph 1 depicts a recent aerial photograph of the site.

Photograph 1. Aerial Photograph of the Site



Photograph obtained from Google Earth™, imagery date of May 30, 2017.

A.3. Purpose

The purpose of our geotechnical evaluation will be to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of the new structures and parking lots.

A.4. Background Information and Reference Documents

We reviewed the following information:

- Site layout labeled “Christianson Addition”, by SEH, Inc., not dated;
- AutoCad drawing labeled “Bismarck Cash Wise Site Plan”, provided by Paces Lodging Corporation, dated April 12, 2018;
- Aerial images of the site viewed in Google Earth™, imagery dates ranging from July 1991 to May 2017.
- Communications with Mr. Nate Vollmuth with Paces Lodging Corporation regarding project details;
- *The Land Form and Geologic Map of Burleigh County, North Dakota*, Bulletin 42, Plate 1, prepared by the North Dakota Geological Survey (Wilson M. Laird, State Geologist).

A.5. Scope of Services

We performed our scope of services for the project in accordance with our proposal to Mr. Nate Vollmuth, dated March 22, 2018, and authorized with the signed proposal on March 23, 2018. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewing the background information and reference documents previously cited.
- Staking and clearing the exploration location of underground utilities. The boring locations were staked prior to our arrival, and the soil boring elevations were provided to us by SEH, Inc. The Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings.

- Performing 10 standard penetration test (SPT) borings, denoted as ST-01 to ST-10, to a nominal depth of 31 feet below grade across the site.
- Performing laboratory testing on select samples to aid in soil classification and engineering analysis.
- Preparing this report containing a boring location sketch, logs of soil borings, a summary of the soils encountered, results of laboratory tests, and recommendations for the structure subgrade preparation and the design of foundations, floor slabs, exterior slabs, concrete and bituminous pavements, and utilities.

Our scope of services did not include environmental services or testing, and we did not train the personnel performing this evaluation to provide environmental services or testing. We can provide these services or testing at your request.

B. Results

B.1. Geologic Overview

Based on our review of the “Land Form and Geologic Map of Burleigh County”, the surficial geological material consists of river sediment of the Coleharbor Formation and glacial till, draped over the underlying bedrock. The underlying bedrock consists of weakly lithified siltstone, sandstone, claystone, and lignite of the Tertiary-aged Cannonball Formation.

We based the geologic origins used in this report on the soil types, laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

B.2. Boring Results

Table 2 provides a summary of the soil boring results, in the general order we encountered the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in Table 2.

Table 2. Subsurface Profile Summary*

Strata	Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
Topsoil	CL	--	<ul style="list-style-type: none"> ▪ Predominantly lean clay with varying amounts of sand. ▪ Predominantly brown in color. ▪ Thicknesses at boring locations approximately 1/2 foot. ▪ Soils were generally frozen and were moist when thawed.
Glacial Deposits	ML, SP-SM	6 to 14 BPF	<ul style="list-style-type: none"> ▪ Intermixed layers of glacial outwash and till but predominately lean clay glacial till. ▪ Thicknesses of glacial outwash and till at boring locations varied from 4 to 18 feet. ▪ Variable amounts of gravel; may contain cobbles and boulders. ▪ Moisture condition generally moist. ▪ Drillers encountered cobbles and boulders at 3 feet and had auger refusal in Boring ST-09.
	CL, CH	6 to 32 BPF	
Bedrock – Cannonball Formation	Claystone, Sandstone, Siltstone,	11 to 44 BPF	<ul style="list-style-type: none"> ▪ Top of bedrock varied from an approximate elevation of 1870 1/2 (ST-05) to 1884 feet (ST-09). ▪ Claystone predominantly consisted of Lean Clay and Fat Clay. ▪ Sandstone predominantly consisted of Silty Sand and Clayey Sand. ▪ Siltstone predominantly consisted of Silt.

*Abbreviations defined in the attached Descriptive Terminology sheets.

B.3. Groundwater

We did not observe groundwater while advancing our borings. Therefore, it appears that groundwater is below the depths explored. Project planning should anticipate seasonal and annual fluctuations of groundwater.

B.4. Laboratory Test Results

We performed 36 moisture content tests (per ASTM D2216), 1 unconfined compressive strength test (per ASTM D2166), 2 Atterberg Limits tests (per ASTM D4318), and 2 percent passing #200 sieve tests (P200, per ASTM D1140A) on selected samples to aid in the soil classification and estimation of engineering properties.

We performed moisture content (MC) tests (per ASTM D2216) on selected samples to aid in our classifications and estimations of the materials' engineering properties. Tables 3 below present the results of our moisture content tests for each pond.

Table 3. Moisture Content Results.

Material Type	Moisture Content Range (%)	Average Moisture Content (%)	Above/Below Estimated Optimum Moisture
Glacial Till - Lean Clay (CL)	9 to 22	17	Near
Glacial Till – Fat Clay (CH)	17 to 19	18	Slightly Below
Glacial Outwash – Silt (ML)	9	9	Below
Claystone – Fat Clay (CH)	12 to 35	25	Slightly Above
Claystone – Lean Clay (CL)	22 to 36	26	Above

Tables 4 presents the results of our Atterberg Limit, Percent Passing the #200 Sieve, and Unconfined Compressive Strength laboratory tests.

Table 4. Laboratory Classification Test Results

Location	Sample Depth (ft)	Classification	Dry Density (γ , pcf)	Unconfined Compressive Strength (psf)	Moisture Content (w, %)	Percent Passing a #200 Sieve	Liquid Limit	Plastic Limit	Plastic Index
ST-01	4	Lean Clay with Sand	113	3420	15	--	--	--	--
ST-04	6	Silt	--	--	9	93	--	--	--
ST-05	7	Fat Clay with Sand	--	--	19	--	55	17	38
ST-06	12	Sandstone – Silty Sand	--	--	14	44	--	--	--
ST-07	7	Claystone – Fat Clay	--	--	16	--	51	16	35

These results indicate that the soils tested were fat clay. We anticipate the fat clay soils to have a high potential for shrinking/swelling with changes in their moisture content. The results of the Atterberg limits, P200s, and unconfined compressive strength tests are listed in the "Tests or Notes" column on the attached Log of Boring sheets.

C. Recommendations

C.1. Design and Construction Discussion

Based on the results of the borings, the site generally appears suitable for support of the proposed structures using typical spread footing foundations after onsite soil is used to raise grades across the site. Prior to raising grades below the structures, the topsoil should be removed from within the footprint of the structures. We found the on-site materials will be suitable for re-use as engineered fill, but will require moisture conditioning prior to placement as fill. However, based on finished floor elevations provided to us, we believe that an imported clay material may be needed to finish raising grade across the site. It would be prudent to provide a rest period of at least 2 weeks after the fill placement prior to floor slab and pavement construction to allow some anticipated settlement to occur.

C.1.a. Reuse of On-Site Soils

On-site soils, excluding the fat clay and topsoil, generally appear to be suitable for re-use as engineered fill, provided they can be moisture conditioned and compacted per the recommendations listed in Section C.2. The topsoil and the fat clay soils should not be used as backfill or fill below the structural footprints. These materials may be used in landscaped areas or hauled off-site. Consideration may be given to using fat clay as structural fill below pavement, especially if it can be buried below at least 5 feet of lean clay fill.

C.1.b. Groundwater

We did not observe groundwater while advancing our borings. Therefore, it appears that groundwater is below the depths explored. However, perched water may be found while excavating and should be controlled if encountered. If water enters an excavation, or perched groundwater conditions are encountered we recommend the water be removed. We anticipate that sumps and pumps would be suitable to dewater excavations at this site.

C.1.c. Construction Disturbance

The contractor should note the on-site clayey soils are susceptible to disturbance due to repeated construction traffic particularly when wet. Disturbance of these soils may cause areas that were previously prepared or suitable for pavement or structure support to become unstable and require additional moisture conditioning compaction, and/or subcutting. Care should be taken to avoid disturbing the soils.

C.2. Site Grading and Subgrade Preparation

C.2.a. Subgrade Excavations

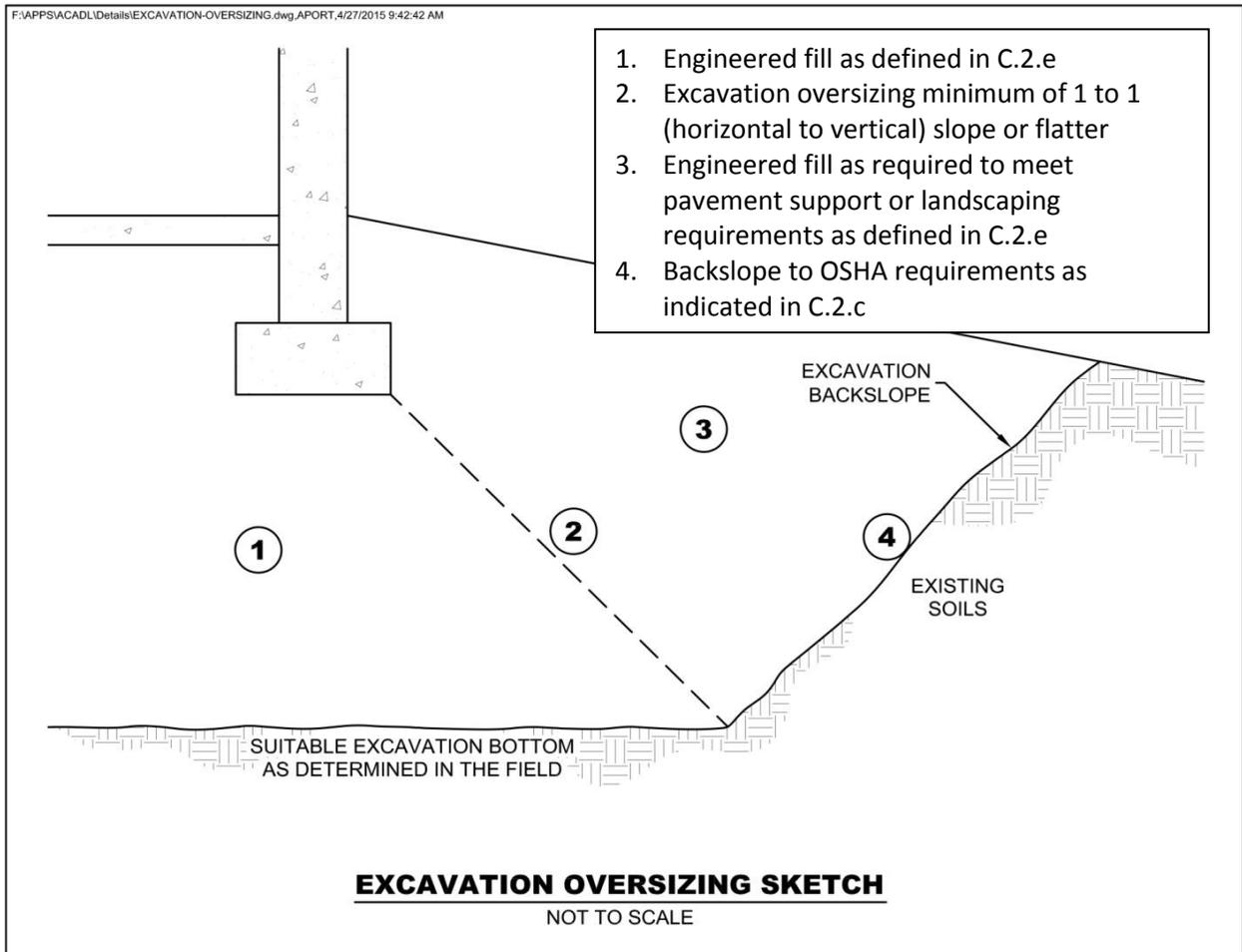
We recommend removing unsuitable materials from below the building foundations. We define unsuitable materials as existing fill, frozen materials, organic soils, existing structures, existing utilities, vegetation, and soft/loose soils. Based on the borings, we anticipate the excavations for removal of the unsuitable materials will be approximately 1/2 foot across the site. Excavation depths will vary between the borings. Portions of the excavations may also extend deeper than indicated by the borings to remove the topsoil. A geotechnical representative should observe the excavations to make the necessary field judgments regarding the suitability of the exposed soils.

The contractor should use equipment and techniques to minimize soil disturbance. If soils become disturbed or are wet, we recommend excavation and replacement with suitable on site or imported materials.

C.2.b. Excavation Oversizing

If unsuitable materials are encountered below the bottom of the foundations, we recommend excavations extend outward and downward at a slope of 1H:1V (horizontal: vertical) or flatter. See Figure 2 for an illustration of excavation oversizing.

Figure 2. Generalized Illustration of Oversizing



C.2.c. Excavated Slopes

Based on the borings, we anticipate on-site soils in excavations will consist of lean clays, fat clays, silts, clayey sands, and silty sands. Cohesive soils may be considered Type B soils, and soils consisting predominately of silt and sand should be considered Type C soils under OSHA (Occupational Safety and Health Administration) guidelines. OSHA guidelines indicate unsupported excavations in Type B soils should have a gradient no steeper than 1H: 1V, and in Type C soils should be no steeper than 1.5H:1V. Slopes constructed in this manner may still exhibit surface sloughing. OSHA requires an engineer to evaluate slopes or excavations over 20 feet in depth.

An OSHA-approved qualified person should review the soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches." This document states excavation safety is the responsibility of the contractor. The project specifications should reference these OSHA requirements.

C.2.d. Excavation Dewatering

Based on the conditions encountered in the borings and the excavation depths for the additions, we do not anticipate that dewatering will be required. If water enters an excavation, or perched groundwater conditions are encountered we recommend the water be removed. We anticipate that sumps and pumps would be suitable to dewater excavations at this site.

It will be important that the earthwork contractor maintain proper site drainage around the excavation areas during construction. Site drainage around the excavations should include grading the site to drain towards low areas or disposal points, and to minimize low points within construction traffic areas.

C.2.e. Engineered Fill Materials and Compaction

Table 5 below contains our recommendations for engineered fill materials.

Table 5. Engineered Fill Materials*

Locations To Be Used	Engineered Fill Classification	Possible Soil Type Descriptions	Gradation	Additional Requirements
Below foundations, interior slabs, and pavement	Structural fill	SP, SP-SM, SM, CL, SC	100% passing 2-inch sieve	< 2% Organic Content (OC)
Below landscaped surfaces, where subsidence is not a concern	Non-structural fill		100% passing 6-inch sieve	< 10% OC

* More select soils comprised of coarse sands with < 5% passing #200 sieve may be needed to accommodate work occurring in periods of wet or freezing weather.

We anticipate that the on-site soils excluding fat clay will be suitable for re-use as structural fill. Fat clay may be used as structural fill at least 5 feet below pavement. We recommend that fill be placed in loose lifts of approximately 4 to 8 inches. We recommend compacting engineered fill in accordance with the criteria presented below in Table 6. The project documents should specify relative compaction of engineered fill, based on the structure located above the engineered fill, and vertical proximity to that structure.

Table 6. Compaction Recommendations Summary

Reference	Relative Compaction, percent (ASTM D698 – Standard Proctor)	Moisture Content Variance from Optimum, percentage points	
		Imported Granular Materials (typically SP, SP-SM, SM, SC)	On-Site Clays (typically CL, CH)
Below foundations and oversizing zones	98	±3	-1 to +3
Below exterior slabs and pavements	95	±3	-1 to +3
Below landscaped surfaces	90	±5	±4

*Increase compaction requirement to meet compaction required for structure supported by this engineered fill.

The project documents should not allow the contractor to use frozen material as engineered fill or to place engineered fill on frozen material. Frost should not penetrate under foundations during construction.

We recommend performing density tests in engineered fill to evaluate if the contractors are effectively compacting the soil and meeting project requirements.

C.2.f. Special Inspections of Soils

We recommend including the site grading and placement of engineered fill within the area the fuel islands will be located under the requirements of Special Inspections, as provided in Chapter 17 of the International Building Code, which is adopted into the state building code. Special Inspection requires observation of soil conditions below engineered fill or footings, evaluations to determine if excavations extend to the anticipated soils, and if engineered fill materials meet requirements for type of engineered fill and compaction condition of engineered fill. A registered geotechnical engineer should direct the Special Inspections of site grading and engineered fill placement. The purpose of these Special Inspections is to evaluate whether the work is in accordance with the approved Geotechnical Report for the project. Special Inspections should include evaluation of the subgrade, observing preparation of the subgrade (surface compaction or dewatering, excavation oversizing, placement procedures and materials used for engineered fill, etc.) and compaction testing of the engineered fill.

C.3. Spread Footings

Table 7 below contains our recommended parameters for foundation design.

Table 7. Recommended Spread Footing Design Parameters

Item	Description
Maximum net allowable bearing pressure (psf)	Bar and Restaurant : 4,000 Bank: 3,000 Retail and Restaurant: 3,000
Minimum factor of safety for bearing capacity failure	3.0
Minimum dimension (inches) for columns	36
Minimum embedment below final exterior grade for heated structures exposed to freezing temperatures	60
Minimum embedment below final exterior grade for unheated structures or for footings not protected from freezing temperatures during construction (inches)	72
Total estimated settlement (inches)	Less than 1 1/2 inches
Differential settlement	Typically about 2/3 of total settlement*

* Actual differential settlement amounts will depend on final loads and foundation layout.

C.4. Interior Slabs

C.4.a. Subgrade Protection

Fat clay soils are not suitable to be left in place below floor levels because it has the potential to shrink and swell excessively with changes in the moisture content, and could cause cracks in the floor slab and vertical separation between slabs. We recommend that a separation distance of at least 4 feet be maintained between the bottom of the floor slabs and top of the fat clay to reduce the potential for unacceptable movements. This will require removing the fat clay if encountered and replacing with suitable low plasticity clay or imported sand and gravel material. Our borings did not encounter fat clay within 4 feet of the proposed floor levels

C.4.b. Subgrade Modulus

We recommend using a modulus of subgrade reaction, k, of 110 pounds per square inch per inch of deflection (pci) to design the slabs.

C.4.c. Moisture Vapor Protection

Excess transmission of water vapor could cause floor dampness, certain types of floor bonding agents to separate, or mold to form under floor coverings. If project planning includes using floor coverings or coatings, we recommend placing a vapor retarder or vapor barrier immediately beneath the slab. We also recommend consulting with floor covering manufacturers regarding the appropriate type, use and installation of the vapor retarder or barrier to preserve warranty assurances.

C.5. Frost Protection

C.5.a. General

We consider the onsite soils to be moderately frost susceptible. Soils of this type can retain moisture and heave upon freezing. In general, this characteristic is not an issue unless these soils become saturated, due to surface runoff or infiltration, or are excessively wet in situ. Once frozen, unfavorable amounts of general and isolated heaving of the soils and the surface structures supported on them could develop. This type of heaving could affect design drainage patterns and the performance of exterior slabs and pavements, as well as any isolated exterior footings and piers.

Note that general runoff and infiltration from precipitation are not the only sources of water that can saturate subgrade soils and contribute to frost heave. Roof drainage and irrigation of landscaped areas in close proximity to exterior slabs, pavements, and isolated footings and piers, contribute as well.

C.5.b. Frost Heave Mitigation

To address most of the heave related issues, we recommend setting general site grades and grades for exterior surface features to direct surface drainage away from buildings, across large paved areas and away from walkways. Such grading will limit the potential for saturation of the subgrade and subsequent heaving. General grades should also have enough “slope” to tolerate potential larger areas of heave, which may not fully settle after thawing.

Even small amounts of frost-related differential movement at walkway joints or cracks can create tripping hazards. Project planning can explore several subgrade improvement options to address this condition.

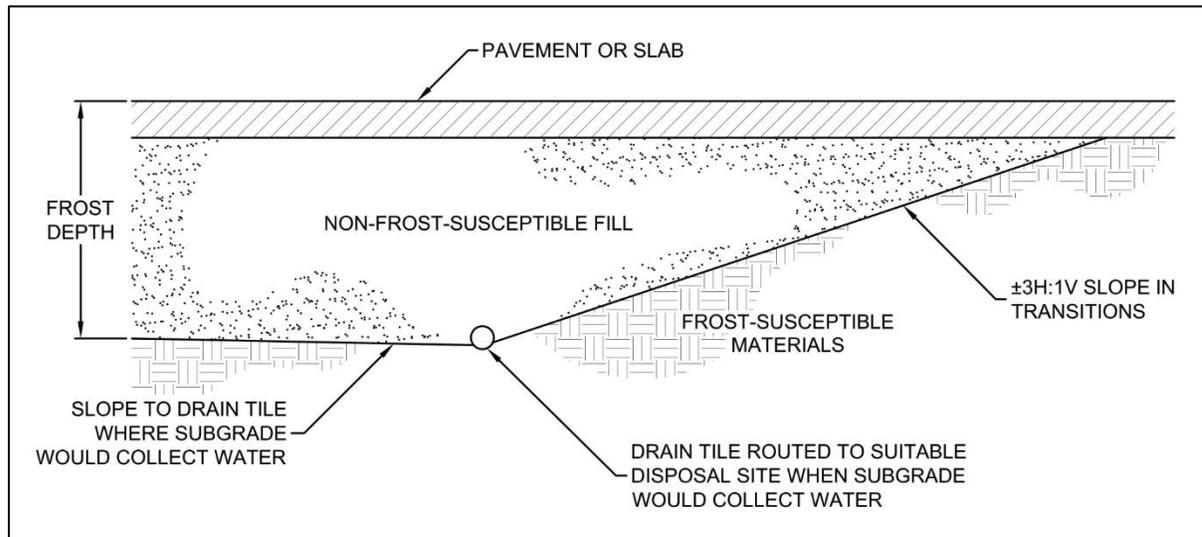
One of the more conservative subgrade improvement options to mitigate potential heave is removing any frost-susceptible soils present below the exterior slab areas down to a minimum depth of 2 feet below subgrade elevations. We recommend filling the resulting excavation with non-frost-susceptible fill. We also recommend sloping the bottom of the excavation toward one or more collection points to remove any water entering the engineered fill. This approach will not be effective in controlling frost heave without removing the water.

An important geometric aspect of the excavation and replacement approach described above is sloping the banks of the excavations to create a more gradual transition between the unexcavated soils considered frost susceptible and the engineered fill in the excavated area, which is not frost susceptible. The slope allows attenuation of differential movement that may occur along the excavation boundary.

We recommend slopes that are 3H:1V, or flatter, along transitions between frost-susceptible and non-frost-susceptible soils.

Figure 3 shows an illustration summarizing some of the recommendations.

Figure 3. Frost Protection Geometry Illustration



Another option is to limit frost heave in critical areas, such as doorways and entrances, via frost-depth footings or localized excavations with sloped transitions between frost-susceptible and non-frost-susceptible soils, as described above.

Over the life of slabs and pavements, cracks will develop and joints will open up, which will expose the subgrade and allow water to enter from the surface and either saturate or perch atop the subgrade soils. This water intrusion increases the potential for frost heave or moisture-related distress near the crack or joint. Therefore, we recommend implementing a detailed maintenance program to seal and/or fill any cracks and joints. The maintenance program should give special attention to areas where dissimilar materials abut one another, where construction joints occur and where shrinkage cracks develop.

C.6. Pavements and Exterior Slabs

C.6.a. Pavement Subgrade Preparation

We recommend removing surface vegetation, roots, and soils with an organic content greater than 5 percent before fill or aggregate base course placement. Areas that are soft or become soft due to excessive moisture or repetitive construction traffic should be excavated and replaced by materials able to be adequately moisture conditioned and compacted per the requirements of Section C.2.e.

If, as a result of weather or seasonal conditions, the subgrade soils are wet and cannot be adequately compacted and stabilized through conventional methods such as discing and drying, we recommend consideration be given to excavating the wet subgrade soils and replacing them with soils which can be more easily compacted. If grading operations and construction are planned to begin during the spring season, wet conditions should be anticipated.

C.6.b. Backfill and Fill Requirements

After removal of the vegetation, topsoil, and organic materials, backfill and fill may be required to achieve design grades. On-site clayey materials may be reused as backfill and fill in the pavement areas, however, silt and fat clay should not be used within 2 feet of pavement subgrade. Backfills and fills placed within the pavement areas should be placed and compacted in loose lifts not to exceed 4 to 8 inches, and moisture conditioned and compacted per the requirements listed in Section C.2.e.

C.6.c. Subgrade Scarification and Proof-Roll

In cut areas, or areas receiving less than 1/2-foot of fill to reach subgrade elevation, we recommend those areas be scarified to a minimum depth of 6 inches and then moisture conditioned and compacted per the requirements listed in Section C.2.e.

After backfill and fill have been placed up to the design subgrade elevations, we recommend performing heavy surface compaction with a smooth-drum vibratory roller weighing at least 10 tons. At least 10 passes in each of 2 perpendicular directions should be performed. Any areas that are unstable or uncompactible should be repaired by overexcavating and replacing with engineered fill, or other methods. After the subgrade is confirmed to be stable, grades may be raised with engineered fill placed and compacted in accordance with Section C.2. A second proof-roll should then be performed after the aggregate base material is in place, and prior to placing bituminous or concrete pavement.

C.6.d. Bituminous Pavements

For the bituminous-surfaced portions of the pavements, we utilized the simplified design chart for calculating pavement thicknesses presented in "Figure 3.1. - Design Chart for Flexible Pavements Based on Using Mean Values for Input", of the AASHTO Guide for Design of Pavement Structures (1993). The parameters used to perform the calculations were assumed/calculated as follows:

- Reliability = 90%;
- Standard Deviation = 0.45;
- Design Life=20 years;
- Light Duty Equivalent Single Axle Loads (ESALs) = 25,000;
- Heavy Duty ESALs = 75,000;

- Effective Roadbed Soil Resilient Modulus (M_R) = 4,500 psi; and
- Design Serviceability Loss = 1.7 (Initial Serviceability = 4.2, Terminal Serviceability = 2.5).

The above design method provides an end result of a Design Structural Number (SN), which is then used to iteratively calculate the required pavement thickness. The Design Structural Number obtained for light duty bituminous surfaced pavements are 2.3, and for heavy duty bituminous pavement was 2.8. The pavement thicknesses are calculated from the equation:

$$SN = (D_1 \times a_1) + (D_2 \times a_2 \times m_2)$$

D_1 = Bituminous Thickness (inches);

a_1 = Structural Layer Coefficient for Bituminous = 0.4;

D_2 = Aggregate Base Thickness (inches);

a_2 = Structural Layer Coefficient for Aggregate Base = 0.1; and

m_2 = Drainage Modifier = 0.9.

Solving the above equation for the required Structural Number, we recommend the bituminous-surfaced pavement sections for the parking area and drive lane areas consist of three layers as follows:

Light Duty Areas

- 4" of Bituminous Surfacing over;
- 8" of aggregate base over.

Heavy Duty Areas

- 5" of Bituminous Surfacing over;
- 12" of aggregate base over.

The above pavement designs are based upon a 20-year performance life. This is the amount of time before major reconstruction is anticipated. This performance life assumes maintenance, such as seal coating and crack sealing, is routinely performed. The actual pavement life will vary depending on variations in weather, traffic conditions, and maintenance.

C.6.e. Concrete Pavements

For the concrete-surfaced portions of the pavements, we utilized the simplified design chart for calculating pavement thicknesses presented in "Figure 3.7. - Design Chart for Rigid Pavement Based on Using Mean Values for Each Input Variable", of the AASHTO Guide for Design of Pavement Structures (1993). The parameters used to perform the calculations were assumed/calculated as follows:

- Reliability – 90%;
- Standard Deviation – 0.35;
- Design Life = 35 years;
- Light Duty Equivalent Single Axle Loads (ESALs) = 30,000;
- Heavy Duty ESALs = 200,000;
- Effective Modulus of Subgrade Reaction – 140 pci; and
- Design Serviceability Loss = 2.5 (Initial Serviceability = 4.5, Terminal Serviceability = 2.0).

We recommend the pavement sections consist of the below layers for light duty pavements:

Light Duty Pavements

- 5" of non-reinforced concrete, over;
- 6" of aggregate base.

Heavy Duty Pavements

- 6" of non- reinforced concrete, over;
- 6" of aggregate base.

The above estimated concrete pavement design is based on a 35-year performance life. This is the amount of time before major reconstruction is anticipated. This performance life assumes maintenance, such as seal coating and crack sealing, is routinely performed. The actual pavement life will vary depending on variations in weather, traffic conditions, and maintenance. We noted that the concrete thickness is a minimum, and should be increased below dumpster pads or concentrated truck traffic is anticipated.

C.6.f. Subgrade Drainage

We recommend installing perforated drainpipes throughout pavement areas at low points, around catch basins, and behind curb in landscaped areas. We also recommend installing drainpipes along pavement and exterior slab edges where exterior grades promote drainage toward those edge areas. The contractor should place drainpipes in small trenches, extended at least 8 inches below the granular subbase layer, or below the aggregate base material where no subbase is present.

C.6.g. Performance and Maintenance

We based the above pavement designs on a 20-year performance life for bituminous and a 35-year life for concrete. This is the amount of time before we anticipate the pavement will require reconstruction. This performance life assumes routine maintenance, such as seal coating and crack sealing. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

It is common to place the base course of bituminous and then delay placement of wear course. For this situation, we recommend evaluating if the reduced pavement section will have sufficient structure to support construction traffic.

Many conditions affect the overall performance of the exterior slabs and pavements. Some of these conditions include the environment, loading conditions and the level of ongoing maintenance. With regard to bituminous pavements in particular, it is common to have thermal cracking develop within the first few years of placement, and continue throughout the life of the pavement. We recommend developing a regular maintenance plan for filling cracks in exterior slabs and pavements to lessen the potential impacts for cold weather distress due to frost heave or warm weather distress due to wetting and softening of the subgrade.

C.7. Utilities

C.7.a. Excavation and Backfill

We anticipate that utilities can be installed per manufacturer bedding requirements. Earthwork activities associated with utility installations located inside the building area should adhere to the recommendations in Section C.2.

C.7.b. Corrosion Potential

A majority of the soil borings indicated the site predominantly consists of sandy soils. We consider these soils non- to slightly-corrosive to metallic conduits. If utilities extend through clay soils, we recommend bedding the utilities in sandy soil free of any clay lumps or constructing the utilities with non-corrosive materials.

D. Procedures

D.1. Penetration Test Borings

The penetration test borings were drilled with a truck-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken continuously as the borings were advanced. Actual sample intervals and corresponding depths are shown on the boring logs. The borings were backfilled with auger cuttings upon completion.

D.2. Material Classification and Testing

D.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars and returned to our facility for review and storage.

D.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

D.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

E.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

E.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

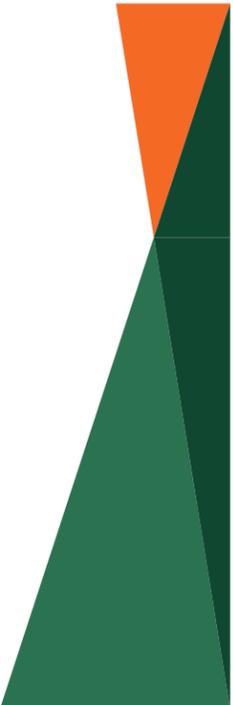
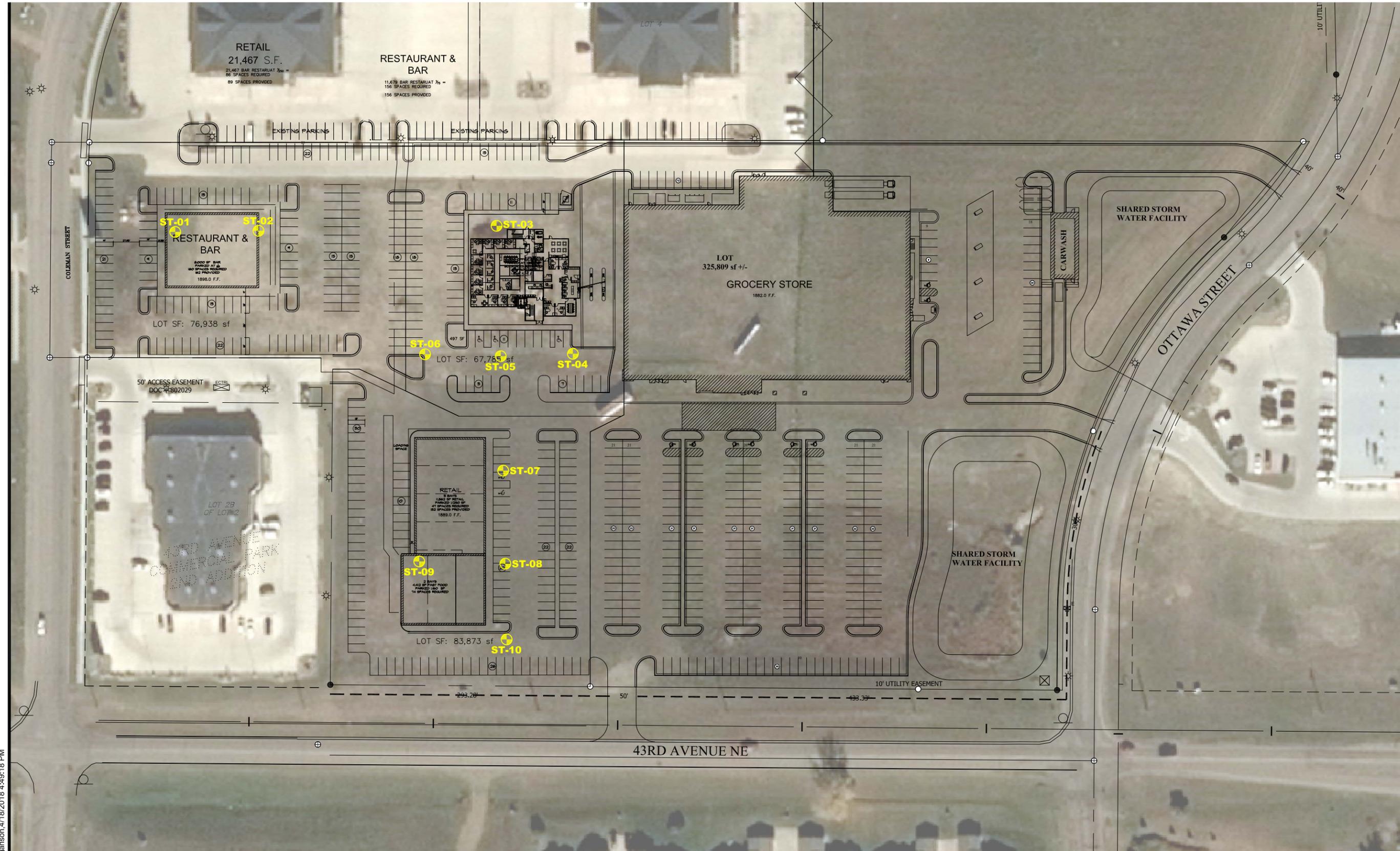
E.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix



Drawing Information

Project No:	B1802725
Drawing No:	B1802656
Drawn By:	BJB
Date Drawn:	4/18/18
Checked By:	DA
Last Modified:	4/18/18

Project Information

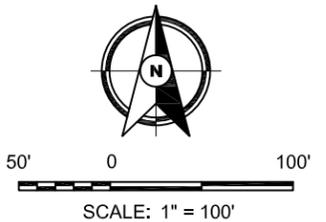
Christianson Addition

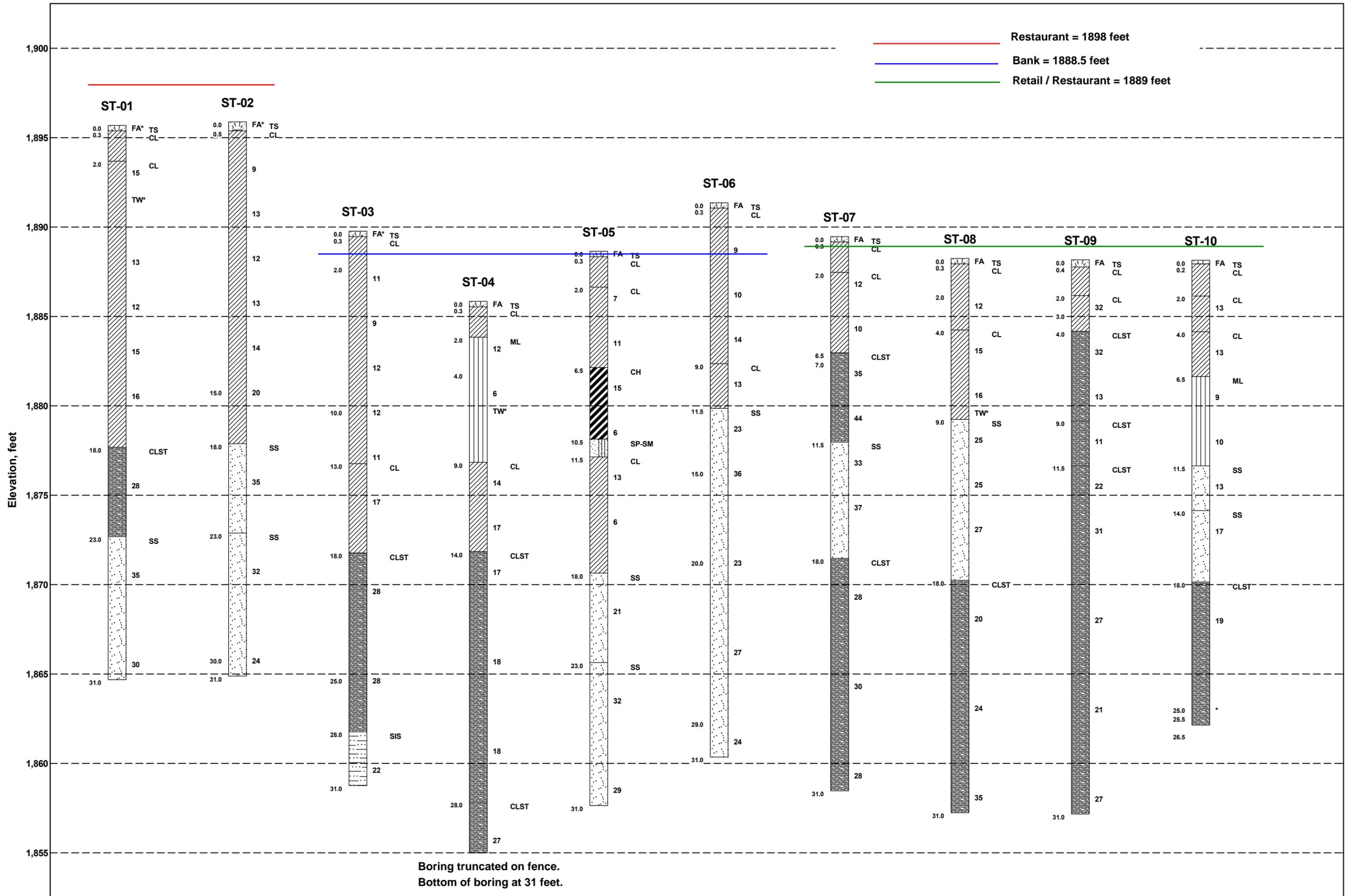
Intersection of 43rd Avenue Northeast and Ottawa Street

Bismarck, North Dakota

Soil Boring Location Sketch

☉ DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING





11X17 ELEVATION-TITLE BLOCK 02725.GPJ BRAUN_V8_CURRENT.GDT 4/19/18 10:02

FENCE DIAGRAM
GEOTECHNICAL EVALUATION
CHRISTIANSON ADDITION
INTERSECTION OF 43RD AVENUE NORTHEAST AND OTTAWA STREET
BISMARCK, NORTH DAKOTA

Project No:
B1802725
Scale:
Vert=5 ft
Hor NTS
Date: 4-19-18
Figure:

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2018\02725.GPJ BRAUN_V8_CURRENT.GDT 4/20/18 09:24

Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-01				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
SCALE: 1" = 4'		LOCATION: See sketch						
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1895.7	0.0							
1895.4	0.3	TS	LEAN CLAY with SAND, trace roots and Gravel, brown, frozen (moist when thawed). (Topsoil)	FA*				*Influenced by frost to 8 inches.
1893.7	2.0	CL	LEAN CLAY with SAND, trace Gravel, brown, frozen (moist when thawed) to moist. (Glacial Till)	15		4.5+	13	
		CL	LEAN CLAY with SAND, trace Gravel, calcification, and Lignite fragments, brown, moist, stiff to very stiff. (Glacial Till)	TW*			15	*24 inches of recovery. Qu=3420 psf, WD=113 pcf, DD=98 pcf
				13		4.5+	17	
				12		4.5+		Elevations provided to us by SEH, Inc.
				15		4.5+	18	
				16		4.5+	21	
1877.7	18.0	CLST	CANNONBALL FORMATION, CLAYSTONE, trace iron staining, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".	28		4.5+	22	
1872.7	23.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	35				*Water not observed to cave-in depth of 28 feet immediately after withdrawal of auger.
1864.7	31.0			30				Boring then backfilled.
			END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-02				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
SCALE: 1" = 4'		LOCATION: See sketch						
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1895.9	0.0							
1895.4	0.5	TS CL	LEAN CLAY, trace roots, black, frozen (moist when thawed). (Topsoil)	FA*				*Influenced by frost to 8 inches.
			LEAN CLAY with SAND, trace Gravel, little Lignite, calcification, and iron staining, brown, frozen (moist when thawed) to moist, stiff to very stiff. (Glacial Till)	9		4.5+	15	
				13		4.5+	14	
				12		4.5+	14	
				13		4.5+		
				14		4.5+	19	
			-brownish gray below 15 feet.	20				
1877.9	18.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, little iron staining and calcification, gray, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	35				
1872.9	23.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining, grayish brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	32				
			-brownish gray below 30 feet.	24				
1864.9	31.0		END OF BORING.*					

*Water not observed to cave-in depth of 25 feet immediately after withdrawal of auger.
Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-03				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
Elev. feet 1889.8		Depth feet 0.0		SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1889.5	0.3	TS CL	LEAN CLAY, trace roots, black, frozen (moist when thawed). (Topsoil)	FA*				*Influenced by frost to 8 inches.
			LEAN CLAY with SAND, trace Gravel, brown, frozen (moist when thawed) to moist, stiff. (Glacial Till)	11		4	22	
			-little Lignite and calcification below 2 1/2 feet.	9		4 1/4	19	
				12		4 1/2	21	
			-trace iron staining below 10 feet.	12		4		
1876.8	13.0	CL	SANDY LEAN CLAY, trace Gravel, little Lignite and iron staining, grayish brown, moist, very stiff. (Glacial Till)	11		3 3/4		
				17		4.5+		
1871.8	18.0	CLST	CANNONBALL FORMATION, CLAYSTONE, trace Siltstone lenses, little Gypsum crystals, gray, moist, decomposed, very soft, hand deformed sample classified as "Fat Clay (CH)".	28		4.5+		
			-trace iron staining below 25 feet.	28		4.5+		*Water not observed to cave-in depth of 24 feet immediately after withdrawal of auger.
1861.8	28.0	SIS	CANNONBALL FORMATION, SILTSTONE, interbedded with Claystone, little iron staining, calcification, and Gypsum crystals, dark gray and brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silt (ML)".	22				Boring then backfilled.
1858.8	31.0		END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-04				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
Elev. feet		Depth feet		SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1885.8	0.0							
1885.5	0.3	TS CL	LEAN CLAY with SAND, trace Gravel and roots, black, moist. (Topsoil)	FA				
1883.8	2.0	ML	LEAN CLAY with SAND, black, moist. (Glacial Till)	12				
			SILT, brown, moist, medium dense to loose. (Glacial Outwash) -driller noted Cobbles and Boulders from 4 feet to 8 feet.	6			9	P200=93%
				TW*			9	*12 inches of recovery.
1876.8	9.0	CL	SANDY LEAN CLAY with GRAVEL, brown, moist, stiff to very stiff. (Glacial Till)	14		4.5+		
				17		4 1/2		
1871.8	14.0	CLST	CANNONBALL FORMATION, CLAYSTONE, trace crystallization, iron staining, and Lignite, brown to gray, moist, decomposed, very soft, hand deformed sample classified as "Fat Clay (CH)".	17		4 1/2		
				18		4 1/2	33	
				18		4.5+	35	*Water not observed immediately after withdrawal of auger.
1857.8	28.0	CLST	CANNONBALL FORMATION, CLAYSTONE, iron staining, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".					Boring then backfilled.
1854.8	31.0		END OF BORING.*	27		4.5+		

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-05	
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18	
Elev. feet		Depth feet		SCALE: 1" = 4'	
		Symbol		Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	
				BPF	WL
				q _p tsf	MC %
				Tests or Notes	
1888.6	0.0	TS	LEAN CLAY with SAND, trace roots, brown, moist. (Topsoil)	FA	
1888.3	0.3	CL	LEAN CLAY with SAND, brown, moist. (Glacial Till)		
1886.6	2.0	CL	SANDY LEAN CLAY, trace Gravel and calcification, brown, moist, medium to stiff. (Glacial Till)	7	4 1/2 16
				11	4.5+ 15
1882.1	6.5	CH	FAT CLAY with SAND, trace Gravel, calcification, and Lignite fragments, brown, moist, stiff to medium. (Glacial Till)	15	4.5+ 19
					LL=55, PL=17, PI=38
1878.1	10.5	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, brown, moist, loose. (Glacial Outwash)	6	4 1/2 17
1877.1	11.5	CL	LEAN CLAY with SAND and GRAVEL, trace iron staining, brown, moist, stiff to medium. (Glacial Till)	13	4 1/2
				6	21
1870.6	18.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	21	
1865.6	23.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Clayey Sand (SC)".	32	
					*Water not observed immediately after withdrawal of auger.
					Boring then backfilled.
1857.6	31.0		END OF BORING.*	29	

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-06				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
Elev. feet 1891.4		Depth feet 0.0		LOCATION: See sketch				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/5/18				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1891.1	0.3	TS CL	LEAN CLAY with SAND, trace roots, brown, moist. (Topsoil)	FA				
			LEAN CLAY with SAND, trace Gravel, little Lignite, brown, moist, stiff. (Glacial Till)	9		4.5+		
				10		4.5+	18	
				14		4.5+	20	
1882.4	9.0	CL	SANDY LEAN CLAY, trace Gravel, little Lignite and iron staining, brown, moist, stiff. (Glacial Till)	13		4.5+	17	
1879.9	11.5	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining, gray, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	23			14	P200=44%
			-little Lignite from 15 feet to 24 feet.	36				
			-grayish brown below 20 feet.	23				
				27				
			-little Gypsum crystals below 29 1/2 feet.	24				
1860.4	31.0		END OF BORING.*					

*Water not observed to cave-in depth of 25 feet immediately after withdrawal of auger.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-07				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/4/18				
Elev. feet		Depth feet		SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1889.5	0.0							
1889.2	0.3	TS CL	LEAN CLAY with SAND, trace Gravel, black, moist. (Topsoil)	FA				
1887.5	2.0	CL	LEAN CLAY with SAND, trace Gravel, brown, moist. (Glacial Till)					
		CL	SANDY LEAN CLAY with GRAVEL, trace calcification, brown, moist, stiff. (Glacial Till)	12		4.5+		
				10		4.5+	14	
1883.0	6.5	CLST	CANNONBALL FORMATION, CLAYSTONE, trace iron staining, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Fat Clay (CH)". -trace calcification from 7 feet to 8 feet.	35		4.5+	16	LL=51, PL=16, PI=35
				44			12	
1878.0	11.5	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace calcification, iron staining, and Lignite, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Clayey Sand (SC)".	33				
				37				
1871.5	18.0	CLST	CANNONBALL FORMATION, CLAYSTONE, iron staining and Lignite, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".	28		4.5+	23	
				30		4 1/2	25	*Water not observed immediately after withdrawal of auger.
				28		4.5+		Boring then backfilled.
1858.5	31.0		END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-08				
				LOCATION: See sketch				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/4/18				
				SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1888.2	0.0							
1887.9	0.3	TS CL	LEAN CLAY with SAND, trace Gravel and roots, black, moist. (Topsoil)	FA				
			LEAN CLAY with SAND, trace Gravel, brown, moist, stiff. (Glacial Till)	12				
1884.2	4.0	CL	-drillers noted Boulders from 2 1/2 feet to 4 1/2 feet. SANDY LEAN CLAY with GRAVEL, trace calcification and iron staining, brown, very stiff. (Glacial Till)	15		4.5+	12	
				16			22	
1879.2	9.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining and calcification, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Clayey Sand (SC)".	25				*12 inches of recovery.
				25				
				27				
1870.2	18.0	CLST	CANNONBALL FORMATION, CLAYSTONE, trace iron staining, brown to gray, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".	20				
				24				*Water not observed to cave-in depth of 25 feet immediately after withdrawal of auger.
				35				Boring then backfilled.
1857.2	31.0		END OF BORING.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-09				
DRILLER: A.Horner		METHOD: 3 1/4" HSA, Autohammer		DATE: 4/4/18				
Elev. feet		Depth feet		SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1888.2	0.0							
1887.8	0.4	TS CL	LEAN CLAY, trace roots and Sand, black, moist. (Topsoil)	FA				Drillers encountered auger refusal at 3 feet, offset boring 10 feet to the south and resumed drilling. *Water not observed to cave-in depth of 22 feet immediately after withdrawal of auger. Boring then backfilled.
1886.2	2.0	CL	LEAN CLAY with SAND, black, moist. (Glacial Till)					
1884.2	4.0	CL	LEAN CLAY, trace Sand and Gravel, brown, dry, hard. (Glacial Till)	32				
		CLST	-driller encountered Cobbles and Boulderes from 2 1/2 feet to 3 1/2 feet.					
		CLST	CANNONBALL FORMATION, CLAYSTONE, iron staining and mineralization, brown, moist, decomposed, very soft, hand deformed sample classified as "Lean Clay (CL)".	32	4.5+	26		
				13		36		
1879.2	9.0	CLST	CANNONBALL FORMATION, CLAYSTONE, trace Siltstone, iron staining, and crystallization, brown, moist, decomposed, very soft, hand deformed sample classified as "Fat Clay (CH)".	11	4.5+	28		
1876.7	11.5	CLST	CANNONBALL FORMATION, CLAYSTONE, iron staining and Lignite, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".	22	4.5+			
				31				
				27				
				21				
1857.2	31.0			27				
			END OF BORING.*					

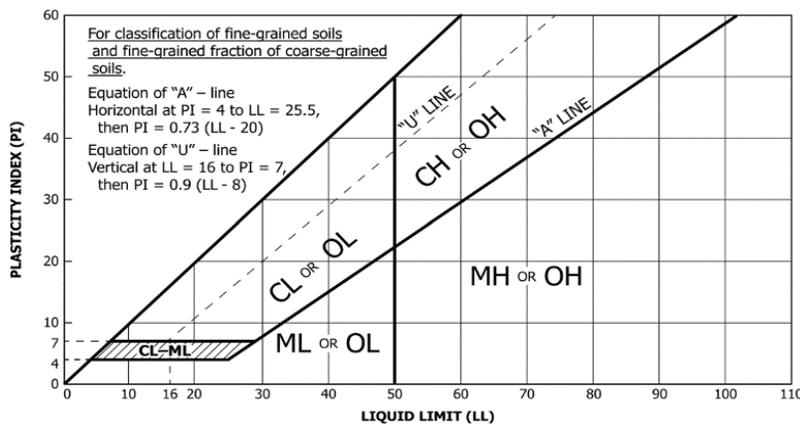
LOG OF BORING (See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2018\02725.GPJ BRAUN_V8_CURRENT.GDT 4/20/18 10:22

Braun Project B1802725 Geotechnical Evaluation Christianson Addition Intersection of 43rd Avenue Northeast and Ottawa Street Bismarck, North Dakota				BORING: ST-10				
DRILLER: A.Horner				METHOD: 3 1/4" HSA, Autohammer				
DATE: 4/4/18				SCALE: 1" = 4'				
Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	q _p tsf	MC %	Tests or Notes
1888.1	0.0	TS	LEAN CLAY with SAND, trace Gravel, brown, moist. (Topsoil)	FA				
1887.9	0.2	CL	LEAN CLAY with SAND, trace Gravel, brown, moist, stiff. (Glacial Till)					
1886.1	2.0	CL	LEAN CLAY with SAND, with Lignite fragments and Gravel, brown, moist, stiff. (Glacial Till)	13		4 1/2	9	
1884.1	4.0	CL	LEAN CLAY with SAND, trace Gravel and calcification, brown, moist, stiff. (Glacial Till)	13		4.5+	17	
1881.6	6.5	ML	SANDY SILT, trace calcification, brown, moist, loose. (Glacial Outwash)	9				
				10				
1876.6	11.5	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Silty Sand (SM)".	13				
1874.1	14.0	SS	CANNONBALL FORMATION, SANDSTONE, fine-grained, trace iron staining, brown, moist, decomposed, very soft, sample retrieved as non-cemented "Clayey Sand (SC)".	17				
1870.1	18.0	CLST	CANNONBALL FORMATION, CLAYSTONE, brown, moist, decomposed, very soft, hand deformed sample classified as "Sandy Lean Clay (CL)".	19				
				*				
1861.6	26.5		-layer of soft cemented Sandstone at 25 feet. -driller noted hard cemented Sandstone at 26 1/2 feet.					*50/4" (set). Auger refusal at 26 1/2 feet.
			END OF BORING.					
			Water not observed immediately after withdrawal of auger.					
			Boring then backfilled.					

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 (Less than 5% fines ^C)	$C_u \geq 4$ and $1 \leq C_c \leq 3^D$	GW	Well-graded gravel ^E	
			$C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$) ^D	GP	Poorly graded gravel ^E	
		Gravels with Fines (More than 12% fines ^C)	Fines classify as ML or MH	GM	Silty gravel ^{EFG}	
			Fines Classify as CL or CH	GC	Clayey gravel ^{EFG}	
	Sands (50% or more coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines ^H)	$C_u \geq 6$ and $1 \leq C_c \leq 3^D$	SW	Well-graded sand ^I	
			$C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$) ^D	SP	Poorly graded sand ^I	
		Sands with Fines (More than 12% fines ^H)	Fines classify as ML or MH	SM	Silty sand ^{FGI}	
			Fines classify as CL or CH	SC	Clayey sand ^{FGI}	
Fine-grained Soils (50% or more passes the No. 200 sieve)	Silt and Clays (Liquid limit less than 50)	Inorganic	PI > 7 and plots on or above "A" line ^J	CL	Lean clay ^{KLM}	
			PI < 4 or plots below "A" line ^J	ML	Silt ^{KLM}	
		Organic	Liquid Limit - oven dried	<0.75	OL	Organic clay ^{KLMN} Organic silt ^{KLMO}
			Liquid Limit - not dried			
	Silt and Clays (Liquid limit 50 or more)	Inorganic	PI plots on or above "A" line	CH	Fat clay ^{KLM}	
			PI plots below "A" line	MH	Elastic silt ^{KLM}	
		Organic	Liquid Limit - oven dried	<0.75	OH	Organic clay ^{KLM P} Organic silt ^{KLM Q}
			Liquid Limit - not dried			
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. $C_u = D_{60} / D_{10}$ $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
- E. If soil contains $\geq 15\%$ sand, add "with sand" to group name.
- 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. 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
- I. If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
- J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
- K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
- L. If soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
- M. If soil contains $\geq 30\%$ plus No. 200 predominantly gravel, add "gravelly" to group name.
- N. $PI \geq 4$ 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



Laboratory Tests			
DD	Dry Density, pcf	OC	Organic content, %
WD	Wet Density, pcf	q_p	Pocket penetrometer strength
P200	% Passing #200 sieve	MC	Moisture content, %

Particle Size Identification

Boulders.....	over 12"
Cobbles.....	3" to 12"
Gravel	
Coarse.....	3/4" to 3" (19.00 mm to 75.00 mm)
Fine.....	No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand	
Coarse.....	No. 10 to No. 4 (2.00 mm to 4.75 mm)
Medium.....	No. 40 to No. 10 (0.425 mm to 2.00 mm)
Fine.....	No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt.....	No. 200 (0.075 mm) to .005 mm
Clay.....	< .005 mm

Relative Proportions^{L, M}

trace.....	0 to 5%
little.....	6 to 14%
with.....	$\geq 15\%$

Inclusion Thicknesses

lens.....	0 to 1/8"
seam.....	1/8" to 1"
layer.....	over 1"

Apparent Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense.....	11 to 30 BPF
Dense.....	31 to 50 BPF
Very dense.....	over 50 BPF

Consistency of Cohesive Soils	Blows Per Foot	Approximate Unconfined Compressive Strength
Very soft.....	0 to 1 BPF.....	< 1/4 tsf
Soft.....	2 to 4 BPF.....	1/4 to 1/2 tsf
Medium.....	5 to 8 BPF	1/2 to 1 tsf
Stiff.....	9 to 15 BPF.....	1 to 2 tsf
Very Stiff.....	16 to 30 BPF.....	2 to 4 tsf
Hard.....	over 30 BPF.....	> 4 tsf

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

Drilling Notes:
BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6 inches into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6-inch increments, and added to get BPF.

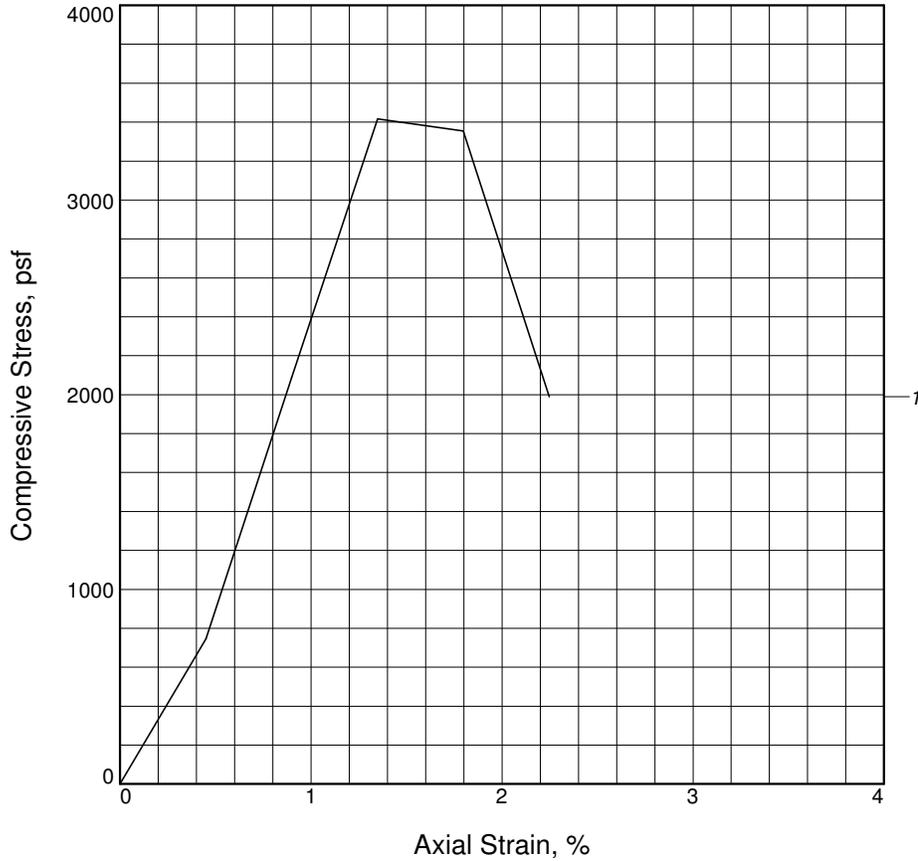
Partial Penetration: If the sampler cannot be driven the full 12 inches beyond the initial 6-inch set, the number of blows for that partial penetration is shown as "No./X" (i.e., 50/2"). If the sampler cannot be advanced beyond the initial 6-inch set, the depth of penetration will be recorded in the Notes column as "No. to set X" (i.e., 50 to set 4").

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

WL: WL indicates the water level measured by the drillers either while drilling or following drilling.

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	3417		
Undrained shear strength, psf	1708		
Failure strain, %	1.3		
Strain rate, in./min.	0.10		
Water content, %	15.3		
Wet density, pcf	112.6		
Dry density, pcf	97.6		
Saturation, %	57.0		
Void ratio	0.7266		
Specimen diameter, in.	2.80		
Specimen height, in.	5.56		
Height/diameter ratio	1.99		

Description: Lean Clay w/ Sand (CL), Brown

LL =	PL =	PI =	GS= 2.70	Type: Thinwall
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<p>Project No.: B1802725</p> <p>Date Sampled: 4/5/2018</p> <p>Remarks: ASTM D 2166</p> <p>Figure _____</p>	<p>Client: Paces Lodging Corporation</p> <p>Project: Christianson Addition Bismarck, ND</p> <p>Location: Boring ST-01</p> <p>Sample Number: TW-1 Depth: 4'-6'</p> <div style="text-align: center;"> </div>
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