Geotechnical Evaluation Report

CHS – Calvin Facility Scales
401 Railroad Avenue
Calvin, North Dakota

Prepared for

CHS Country Operations

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.

REGISTERED PROFESSIONAL ENGINEER
EZRA BALLINGER
PE 7328
DATE 10-29-13
NORTH DAKOTA

Ezra Ballinger, PE
Associate Principal/Project Engineer
Registration Number: PE-7328
October 29, 2013

Project FA-13-06700

Braun Intertec Corporation

BRAUN INTERTEC

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October 29, 2013

Project FA-13-06700

Mr. Jim Gales
CHS Country Operations
3321 70th Avenue
Greeley, CO 80634

Re: Geotechnical Evaluation
CHS – Calvin Facility Scales
401 Railroad Avenue
Calvin, North Dakota

Dear Mr. Gales:

We are pleased to present this Geotechnical Evaluation Report for the proposed scales at the existing facility at the above referenced address in Calvin, North Dakota. The purpose of this geotechnical evaluation was to assist CHS Country Operations (CHS) and their design consultants in designing the foundations. Our results and recommendations are summarized in the attached report. We appreciate the opportunity to be of service to you on this project. If you have questions about the attached report, please contact Ezra Ballinger at 701.232.8701.

Sincerely,

BRAUN INTERTEC CORPORATION

Ezra Ballinger, PE
Associate Principal/Project Engineer

Sean S. Swartz, PE
Principal Engineer

Table of Contents

Table of Contents (continued)

Description **Page**

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the design and construction of two new scales at the CHS facility in Calvin, North Dakota. The site is located in the southwest quadrant of the intersection between 2nd Avenue and Main Street on the west side of Calvin. The two new scales are planned as part of larger site improvements including one or more new grain bins. The scope of the project is illustrated in the Soil Boring Exhibit attached in the Appendix.

A.2. Purpose

The purpose of our geotechnical evaluation was to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of the proposed scales.

A.3. Background Information and Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

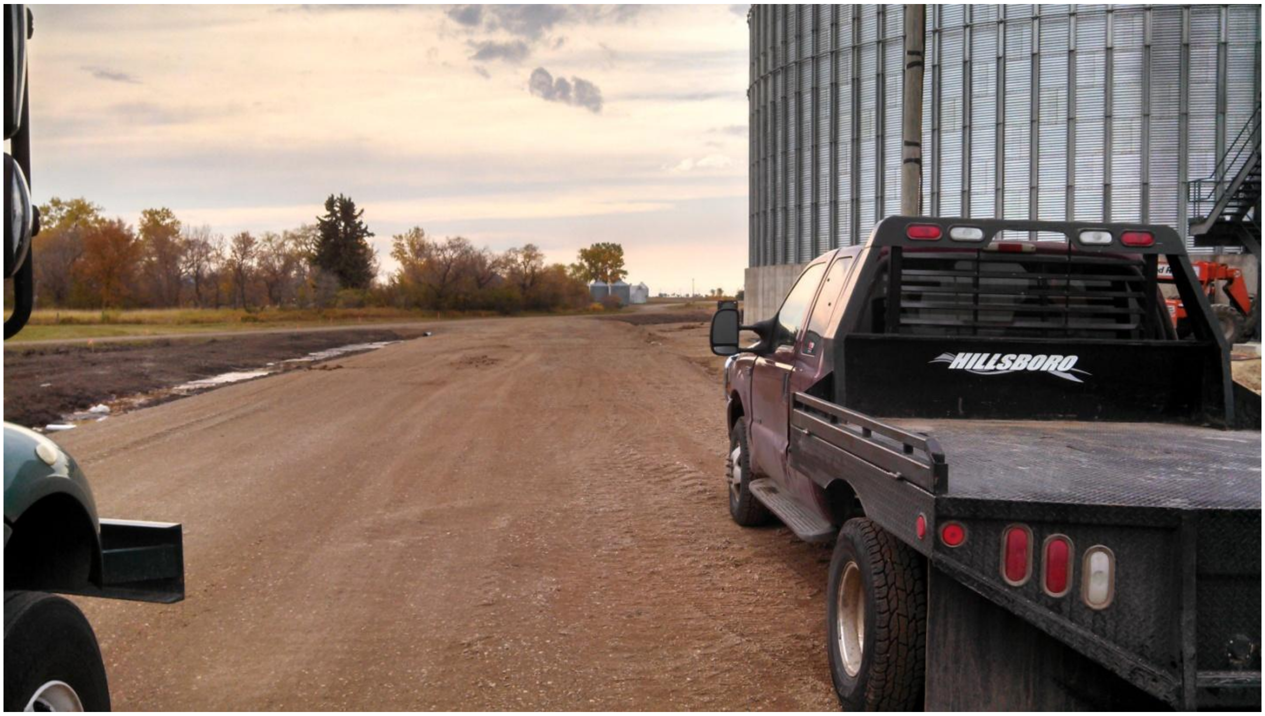
- A copy of drawings prepared by J&D Construction, Inc. showing the scales in relation to new bins and the railroad to the west.
- Aerial photography of the site available from Google Earth™; and
- Map titled *Geology of Cavalier County* (County Groundwater Studies 20, Bulletin 62, Part 1, Plate 1), prepared by the North Dakota State Water Commission and North Dakota Geological Survey, for aid in classification of the site geology.

A.4. Site Conditions

The proposed scales will be constructed on the east and west sides of a new 91 feet diameter bin that has been constructed during the past summer. The location is bordered by 2nd Avenue to the east and Main Street to the north.

When we arrived on site the site was relatively level and had been graded in the roadways and near the new bin. A view of the site is presented in Figure 1 below.

Figure 1. View of the site taken from the north looking south.



A.5. Scope of Services

Our scope of services for this project was originally submitted via email with a Cost Estimate and a description of the proposed services to Mr. Jim Gales of CHS on October 4, 2013. We received authorization to proceed from Mr. Gales on the same day.

Our scope of services was performed under the terms of our September 1, 2013, General Conditions.

A.5.a. Staking and Surveying

The north and south ends of the scales were staked when we arrived on site. We staked exploration locations by measuring dimensions from each end of each scale with a tape measure. Surface elevations were measured using a surveyor's level. We referenced surface elevations to the top of the foundation wall of the new grain bin, which was assumed to be at elevation 150.0 feet.

A.5.b. Subsurface Exploration

We performed four (4) standard penetration test borings at the locations shown on the Soil Boring Exhibit attached in the Appendix. The borings were extended to 10 to 25 feet below grade.

Prior to commencing with our subsurface exploration activities, we cleared the exploration locations of underground utilities through North Dakota State One Call.

A.5.c. Laboratory Testing

We performed moisture content, organic content, percent passing the #200 sieve, and Atterberg limit tests on selected penetration test samples obtained from the borings.

A.5.d. Geotechnical Evaluation, Analysis and Reporting

Information obtained from the soil borings and laboratory testing was used to identify the geotechnical issues influencing design and construction, qualify the nature of their impact, and outline alternatives for their mitigation. Upon reviewing our results and agreeing on performance expectations for the project, we developed baseline recommendations for:

- Structure subgrade preparation, including excavations and ground improvement.
- Excavation dewatering.
- Selecting, placing and compacting on-site or imported earth materials.
- Designing foundations.
- Providing quality control and evaluating differing site conditions during construction.

B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance tests performed within them, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

B.2.a. Fill

Fill was encountered at the surface of all of our borings and extended to depths of 3 to 6 feet. The fill was variable, consisting of silty sand, clayey sand, and poorly graded sand with a little gravel. All of the soils were fine to medium grained, brown and moist. Penetration resistance values in the fill soils ranged from 5 to 36 blows per foot (BPF).

B.2.b. Buried Topsoil

In three of the borings (ST-1, ST-2 and ST-3) the fills were underlain by buried topsoils that were black in color and contained roots and organic matter. The topsoil ranged from ½- to 1 ½ feet thick and was composed of lean clay soils.

B.2.c. Glacial Till and Outwash

Beneath the fill or buried topsoils we encountered glacial deposits to the termination depth of the borings. The glacial deposits consisted of lean clay with sand (ASTM symbol “CL”), sandy lean clay (CL), clayey sand (SC), or poorly graded sand (SP). In each of the borings the upper 8 to 11 ½ feet of the native soils were considerably softer than the underlying soils.

Penetration resistance values in the till ranged from 4 to 50 blows per foot (BPF) and generally increased with depth. Within the upper 8 to 11 ½ feet the penetration resistances ranged from 4 to 6 BPF, and below these depths they ranged from 12 to 50 BPF. In Boring ST-1 the auger met “refusal” at 9 feet on apparent gravel and cobbles.

B.2.d. Groundwater

Groundwater was not observed in any of the boring as they were advanced. Groundwater was observed in Boring ST-2 at a depth of 14 feet with a cave-in depth of 16 feet immediately after the auger was removed. Given the localized nature of the groundwater, it is likely that we encountered groundwater trapped atop the more cohesive, less permeable strata. The depths/elevations at which perched groundwater accumulates is highly variable both seasonally and annually, and could be shallower/higher at the exploration locations and between the exploration locations. Given the higher moisture contents within the softer glacial deposits, we anticipate that water may be encountered within these deposits during excavation.

B.3. Laboratory Test Results

B.3.a. Moisture Contents

Moisture content (MC) tests (per ASTM D2216) were performed on selected penetration test samples to aid in our classifications and estimations of the materials' engineering properties. The moisture contents for the soils ranged from 8 to 26 percent, with an average moisture content of about 19 percent. The results of the moisture content tests are listed in the "MC" column of the Log of Boring Sheets attached in the Appendix.

B.3.b. Organic Contents

Organic content (OC) tests (per ASTM D2974) were performed on a single sample of the buried topsoil to determine the reusability of the material for structure support. We generally recommend that soils having organic contents greater than 3 percent not be reused below structures, and greater than 5 percent not be reused below pavements. The organic content of the sample tested was 6 percent. The result of the organic content test is listed in the "Tests or Notes" column on the attached Log of Boring sheets.

B.3.c. Percent Passing the #200 Sieve Tests

Two (2) percent passing the #200 sieve analyses tests (P200) (per ASTM D1140) were performed to evaluate the frost susceptibility of the granular fill soils. The results of the P200 tests indicated the soils encountered had P200 values of 14 an 33 percent, indicating the soils tested were classified as silty or clayey sand. The results of the P200 tests are listed in the "Tests or Notes" column on the attached Log of Boring sheets.

B.3.d. Atterberg Limits

Atterberg limits tests (per ASTM D4318) were performed on selected samples for classification, evaluation of the soils' plasticity, and estimation of engineering parameters related to consolidation to aid in settlement calculations. The results of the Atterberg limits tests indicated the soils tested had liquid limits (LL) of 31 and 34 percent, plastic limits (PL) of 13 and 18 percent, and plasticity indices (PI) of 16 and 18 percent, indicating the soils tested were lean clays. The results of the Atterberg limits tests are listed in the "Tests or Notes" column on the attached Log of Boring sheets.

C. Basis for Recommendations

C.1. Design Details

C.1.a. Structure Loads

Based on the structure and loading information provided by CHS, it is our understanding that the scales will be supported on a mat foundation bearing within 2 to 3 feet of the ground surface. The mat foundation will exert a bearing pressure of 1,500 pounds per square foot (psf).

C.1.b. Anticipated Grade Changes

It is our understanding that the new scale is planned to be constructed at the existing roadway grade, thus additional cuts and fills of less than 1 foot are anticipated.

C.1.c. Precautions Regarding Changed Information

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

C.2. Design and Construction Considerations

C.2.a. Site Preparations

"Undocumented" fills and buried topsoils were encountered in each of the borings to depths of 4 to 7 feet. Undocumented fill is material that was placed without documented measurement or observation of (1) the removal of unsuitable materials from below the fills, (2) the suitability of the material that is being placed as fill, (3) the relative compaction and moisture content of the fill materials, and (4) placement and compaction procedures. In three of the borings the fill was underlain by buried topsoil.

Undocumented fills and buried topsoil can generally not be relied up for structural support due to the risk of differential strength and compressibility of the fills. The risks associated with undocumented fill are related to settlement of the fill and topsoil under the structure loads and the presence of unsuitable materials within the fill. The fill and buried topsoils will need to be removed and replaced with properly compacted fill. Because the existing fill materials are frost susceptible they will not be suitable for reuse beneath the scale foundations.

C.2.b. Frost Susceptibility

The extreme frost penetration depth for the Calvin area is listed to be approximately 7 ½ feet. However, it should be noted that the freezing depth of a soil depends mainly upon the air temperature, the soil type and moisture content, and the presence/absence of cover materials (vegetation, snow, structures, etc.). Thus, the depth of frost penetration can be variable on a project site.

The fill and native soils encountered across the project site are considered to be moderately to highly frost-susceptible. It has been our experience that grade supported foundations that are not protected from frost-related movements may experience as much as 1 to 4 inches of seasonal heave during the winter and early spring months. For mat foundations that have little side frictional support, the foundations will typically settle in the spring/summer after the spring thaw is completed.

The typical method to reduce the potential for frost heave of structures consists of removing frost-susceptible soils from below the foundation to the anticipated depth of frost penetration and replacing them with nonfrost susceptible soils and providing drainage for the nonfrost susceptible materials as necessary. Alternative methods include deepening the foundations to bear below the anticipated frost penetration depth or support the slab on drilled piers that are extended to at least 2x the extreme frost penetration depth. Based on conversations with Mr. Gales, it’s our understanding that the overexcavation and backfill approach will be used at this site.

C.2.c. Grading and Drainage Considerations

Site grading around the scales is important to reducing the potential for swelling or frost related movement. We recommend that site grades within 20 feet horizontal of the perimeter of the scales be sloped down and away from the structure at a minimum gradient of 2 to 5 percent (0.4 to 1.0 foot drop within 20 feet). Additionally, grading should be performed to prevent ponding of run-off from occurring within 10 feet of the scales.

D. Recommendations

D.1. Subgrade Preparation

D.1.a. Excavations

We recommend removing any "unsuitable materials" from below the mat foundations and their 1H:1V oversize areas. "Unsuitable materials" consist of undocumented fill, buried topsoils, and any other organic or foreign materials. To reduce the potential for frost related movements, we recommend excavating fill and native soils from below the bottom of the mat foundation to a minimum depth of 7 ½ feet (7 ½ feet measured from the planned finished grade surrounding the scale). Fills and buried topsoils that extend more than 7 ½ feet below planned finished grades must also be removed.

To provide lateral support to replacement backfill, additional required fill and the structural loads they will support, we recommend oversizing (widening) the excavations 1 foot horizontally beyond the outer edges of the mat foundations for each foot the excavations extend below bottom-of-footing elevations (1H:1V oversizing).

If the bottom of the excavations are wet or soft at the time of placement, we recommend the bottom 2 to 3 feet of backfill be placed in 8 to 12 inch lifts and be static compacted to minimize disturbance of the underlying native clays.

D.1.b. Excavation Support

The fill and native glacial clays are Type B Soils under OSHA guidelines; unless they also meet the requirements for Type C soils, in which case they will be Type C soils. Any soils from which groundwater is observed to be freely seeping from the excavation sidewalls, and soils having a pocket penetrometer resistance less than 1,000 psf should be considered Type C Soils under OSHA guidelines. Unsupported excavations in Type C soils should be maintained at a gradient no steeper than 1.5H:1V; and Type B soils maintained at a gradient no steeper than 1H:1V.

D.1.c. Excavation Dewatering

If groundwater is encountered within the excavations, we recommend it be removed from the excavations prior to fill placement. We anticipate that sumps and pumps will be suitable for excavations in the low-permeability clay-rich soils.

D.1.d. Backfill Requirements

Imported nonfrost susceptible soils should be used below the mat foundations and in their oversize areas. We recommend these materials consist of sand having less than 5 percent of the particles by weight passing a #200 sieve and are able to be placed and compacted by standard equipment per the requirements of this report. Please note that the existing fill materials do not meet these requirements.

D.1.e. Placement and Compaction of Backfill

We recommend spreading granular materials in 6 to 10 inch thick loose lifts, depending on the type of compactor used. We recommend that the backfill below the mat foundations be compacted to the requirements of Table 1 below.

Table 1. Compaction Recommendations Summary

Location	Relative Compaction, % (ASTM D 698 – std. Proctor)	Moisture Content Variance from Optimum, percentage points
Granular materials below foundations	≥ 95	-3 to +3

D.1.f. Backfill Drainage

The scale foundations will be underlain by imported granular backfill extending to a depth of about 7 ½ feet below the lowest exterior grade, which will be underlain by native clay soils. Where granular backfills are underlain by low permeability clays, there is a likelihood for groundwater or surface water to collect within the permeable granular soils following spring thaw, snow melt, and extended periods of precipitation, creating a “bathtub” condition.

The main concern with a “bathtub” condition at this site is the development of conditions prone to frost heaving. Although the use of nonfrost-susceptible soils below the foundations is intended to reduce the potential for heaving, freezing of any saturated soils below structures can still result in frost heaving.

In addition to the placement of nonfrost-susceptible soils below structures, just as important is proper drainage of those nonfrost-susceptible materials. The most effective method to reduce the potential for the development of a bathtub condition (and subsequent frost heave) is to establish and maintain surficial drainage by sloping perimeter grades down and away from the structure at a minimum slope of 2 to 5 percent. If it is not possible or practical to achieve this grading, we recommend that one or more of the following measures be considered:

- Sealing the surface with pavements, slabs, or low permeability clays: or
- Installing a permanent drainage system at the bottom of the granular backfill.

It is our understanding that the finished grades around the perimeters of the scales will be surfaced with well compacted aggregate base that is sloped down and away from the foundations. The placement of a well-compacted and sloping aggregate base around the structures will aid in limiting the potential for frost heave from occurring. We recommend adhering to the recommendations stated in Section C.2.c. Additionally, we recommend the facility maintenance plans include the periodic evaluation and maintenance of grading around the scale foundations to ensure that surficial drainage away from the structures is continually maintained.

We wish to note that, by itself, grading the site to direct drainage away from near surface foundations will not *prevent* the possibility of frost heave of those foundations, but it is the most cost effective and efficient means of *reducing* the potential. The only way to *prevent* frost heave from occurring is to construct the foundation on non-frost susceptible soils, control surface drainage so that water cannot collect near the foundation, and install and permanent drainage system at the bottom of the non-frost susceptible soils.

D.2. Mat Foundations

D.2.a. Subgrade Preparations

As recommended in Section D.1 above, we recommend that the mat foundation bear over imported nonfrost susceptible soils that extend to a depth of at least 7 ½ feet below finished grades.

D.2.b. Net Allowable Bearing Pressure

We recommend sizing the mat foundations to exert a net allowable bearing pressure of 1,500 pounds per square foot (psf). This value includes a safety factor of at least 3.0 with regard to bearing capacity failure.

D.2.c. Settlement

We estimate that total and differential settlements among the foundations will amount to less than about 1 inch and ½- inch, respectively, under the reported loads.

D.3. Construction Quality Control

D.3.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation and spread footing, slab-on-grade and pavement construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

D.3.b. Materials Testing

We recommend density tests be taken in excavation backfill placed below foundations.

We also recommend slump, air content and strength tests of Portland cement concrete.

D.3.c. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings.

E. Procedures

E.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 at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

E.2. Material Classification and Testing

E.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 or bags and returned to our facility for review and storage.

E.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 or AASHTO procedures.

E.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.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.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.

F.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.

F.2. Continuity of Professional Responsibility

F.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.

F.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.

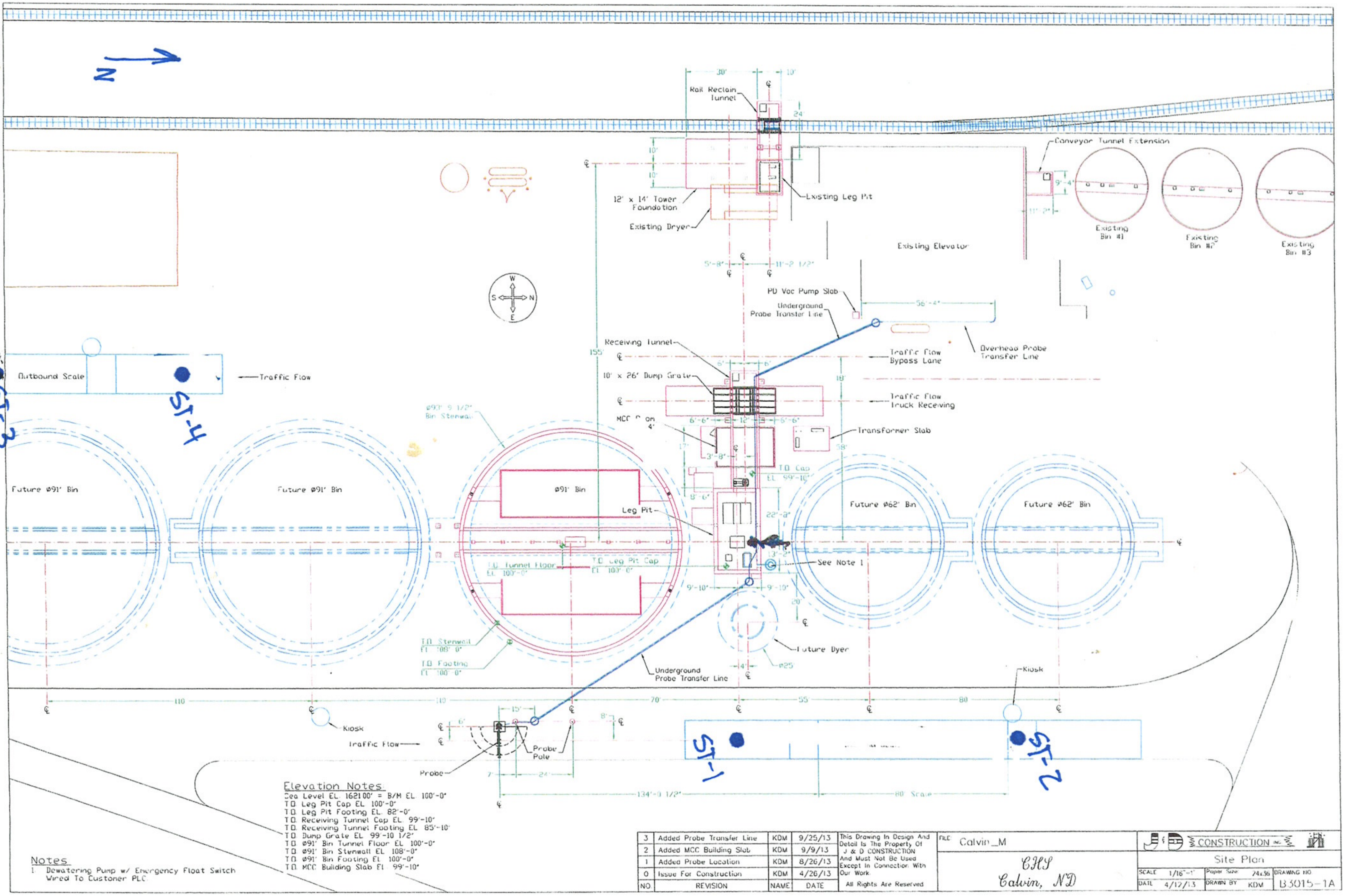
F.3. Use of Report

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.

F.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



N
ST-1
ST-2
ST-3
ST-4
Rail Reclaim Tunnel
30'
10'
24'
12' x 14' Tower Foundation
Existing Dryer
Existing Leg Pit
Existing Elevator
Conveyor Tunnel Extension
9'-4"
11'-2"
Existing Bin #1
Existing Bin #2
Existing Bin #3
5'-8"
11'-2 1/2"
PD Vac Pump Slab
Underground Probe Transfer Line
56'-4"
Overhead Probe Transfer Line
Receiving Tunnel
155'
Traffic Flow Bypass Lane
10' x 26' Dump Grate
18'
Traffic Flow Truck Receiving
Outbound Scale
Traffic Flow
MCC Room
6'-6"
12'
Transformer Slab
Ø93' 5 1/2" Bin Stemwall
T.O. Cap EL 99'-10"
Future Ø91' Bin
Future Ø91' Bin
Ø91' Bin
Leg Pit
Future Ø62' Bin
Future Ø62' Bin
22'-8"
T.O. Tunnel Floor EL 100'-0"
T.O. Leg Pit Cap EL 100'-0"
See Note 1
9'-10"
20'
T.O. Stemwall EL 108'-0"
T.O. Footing EL 100'-0"
Future Dyer
Ø25'
Underground Probe Transfer Line
Kiosk
110'
110'
70'
55'
80'
15'
6'
8'
Kiosk
Traffic Flow
Probe Pole
Probe
24'
134'-9 1/2"
80' Scale
Elevation Notes
Sea Level EL 1621.00' = B/M EL 100'-0"
T.O. Leg Pit Cap EL 100'-0"
T.O. Leg Pit Footing EL 82'-0"
T.O. Receiving Tunnel Cap EL 99'-10"
T.O. Receiving Tunnel Footing EL 85'-10"
T.O. Dump Grate EL 99'-10 1/2"
T.O. Ø91' Bin Tunnel Floor EL 100'-0"
T.O. Ø91' Bin Stemwall EL 108'-0"
T.O. Ø91' Bin Footing EL 100'-0"
T.O. MCC Building Slab EL 99'-10"
Notes
1. Dewatering Pump w/ Emergency Float Switch Wired To Customer PLC
3 Added Probe Transfer Line KDM 9/25/13
2 Added MCC Building Slab KDM 9/9/13
1 Added Probe Location KDM 8/26/13
0 Issue For Construction KDM 4/26/13
NO. REVISION NAME DATE
This Drawing In Design And Detail Is The Property Of J & D CONSTRUCTION And Must Not Be Used Except In Connection With Our Work.
All Rights Are Reserved
FILE: Calvin_M
CHS
Calvin, ND
J & D CONSTRUCTION INC.
Site Plan
SCALE 1/16"=1'
Paper Size: 24x36
DRAWING NO. B3015-1A
DATE 4/12/13
DRAWN BY KDM

BRAUN INTERTEC

LOG OF BORING

Braun Project FA-13-06700
Geotechnical Evaluation
CHS - Calvin Facility Scales
401 Railroad Avenue
Calvin, North Dakota

BORING: **ST-1**

LOCATION: See Sketch.

DRILLER: J. Brooks	METHOD: 3 1/4" HSA, Autohammer	DATE: **10/11/13**	SCALE: **1" = 4'**

Elev. feet 149.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		FILL	FILL: Silty Sand, medium-grained, a little Gravel, brown, moist. -Clayey and trace shale fragments at 1 foot.	15				
				5		8		P200=14%
144.3	5.0							
143.8	5.5	CL	LEAN CLAY, with Roots and Organics, trace construction debris, black, moist. (Buried Topsoil)	5			1 3/4	
		CL	LEAN CLAY with SAND, brown with ironstaining, wet, rather soft. (Glacial Till)	4		19		
140.3	9.0		-Gravel and Cobbles at 8 1/2 feet.					
			END OF BORING Auger met refusal at the 9 foot depth. A sister boring was advance at about 5 feet away from ST-1 and also encountered refusal at the same depth. Water not observed with 9 feet of hollow stem auger in the ground. Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\FARGO\2013\06700.GPJ BRAUN_V8_CURRENT.GDT 10/24/13 16:28

BRAUN INTERTEC

LOG OF BORING

Braun Project FA-13-06700
Geotechnical Evaluation
CHS - Calvin Facility Scales
401 Railroad Avenue
Calvin, North Dakota

BORING: **ST-2**

LOCATION: See Sketch.

DRILLER: J. Brooks | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/11/13** | SCALE: **1" = 4'**

Elev. feet 149.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
146.3	3.0	FILL	FILL: Poorly Graded Sand, medium-grained, a little Gravel, brown, moist.	4				
145.3	4.0	CL	LEAN CLAY, with Roots and Organics, black, moist. (Buried Topsoil)					
141.3	8.0	CL	LEAN CLAY with SAND, light brown, wet, rather soft. (Glacial Till)	4		26		LL=31, PL=13, PI=18
				24				
140.8	8.5	SP	POORLY GRADED SAND, coarse grained, trace Gravel, brown, moist, medium dense. (Glacial Outwash)					
123.3	26.0	CL	SANDY LEAN CLAY, a little Gravel, brown with ironstaining, moist, stiff to hard. (Glacial Till)	14		16	3 1/2	
				21	∇		4 1/2	
				24		20	4.5+	
			-gray below 20 feet.	50			4 1/2	
				24		20	4 1/2	

END OF BORING

Water not observed with 24 1/2 feet of hollow stem auger in the ground.

Water observed at a depth of 14 feet to a cave-in depth of 16 feet immediately after withdrawal of the auger.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\FARGO\2013\06700.GPJ BRAUN_V8_CURRENT.GDT 10/24/13 16:28

BRAUN INTERTEC

LOG OF BORING

Braun Project FA-13-06700 Geotechnical Evaluation CHS - Calvin Facility Scales 401 Railroad Avenue Calvin, North Dakota	BORING: ST-3 LOCATION: See Sketch.

DRILLER: J. Brooks	METHOD: 3 1/4" HSA, Autohammer	DATE: 10/11/13	SCALE: 1" = 4'

Elev. feet 150.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
148.9	2.0	FILL	FILL: Poorly Graded Sand, medium-grained, a little Gravel, brown, moist.					
144.9	6.0	FILL	FILL: Clayey Sand, fine-grained, brown, moist.	36		14		P200=33%
				9				
139.4	11.5	CL	LEAN CLAY with SAND, brown, wet, rather soft to medium. (Glacial Till)	4		20	1 1/2	
				6		22	1 1/2	LL=34, PL=18, PI=16
124.9	26.0	CL	SANDY LEAN CLAY, a little Gravel, brown with ironstaining, moist, stiff to very stiff. (Glacial Till)	23			4 1/2	
				24		20	4.5+	
			-gray below 20 feet.	16			4 1/2	
				18		20	4 1/2	

END OF BORING

Water not observed with 24 1/2 feet of hollow stem auger in the ground.

Water not observed to a cave-in depth of 21 feet when rechecked 1 hour after withdrawal of the auger.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project FA-13-06700
Geotechnical Evaluation
CHS - Calvin Facility Scales
401 Railroad Avenue
Calvin, North Dakota

BORING: **ST-4**

LOCATION: See Sketch.

DRILLER: J. Brooks | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/11/13** | SCALE: **1" = 4'**

Elev. feet 150.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
148.9	2.0	FILL	FILL: Poorly Graded Sand, medium-grained, a little Gravel, brown, moist.					
145.4	5.5	FILL	FILL: Clayey Sand, fine- to medium-grained, brown, moist.	9		13		
				6		22		Organic Content = 6%
143.9	7.0	CL	LEAN CLAY, with Roots and Organics, black, moist. (Buried Topsoil)					
141.9	9.0	SC	CLAYEY SAND, fine- to medium-grained, a little Gravel, brown, moist, loose. (Glacial Till)	6		19		
130.6	20.3	CL	SANDY LEAN CLAY, a little Gravel, brown, moist, rather stiff to hard. (Glacial Till)	47			1 3/4	
				12		24	2 1/2	
				22		21	3	
				*				*100/4" (No Recovery)
			END OF BORING Water not observed with 19 1/2 feet of hollow stem auger in the ground. Water not observed immediately after withdrawal of the auger. Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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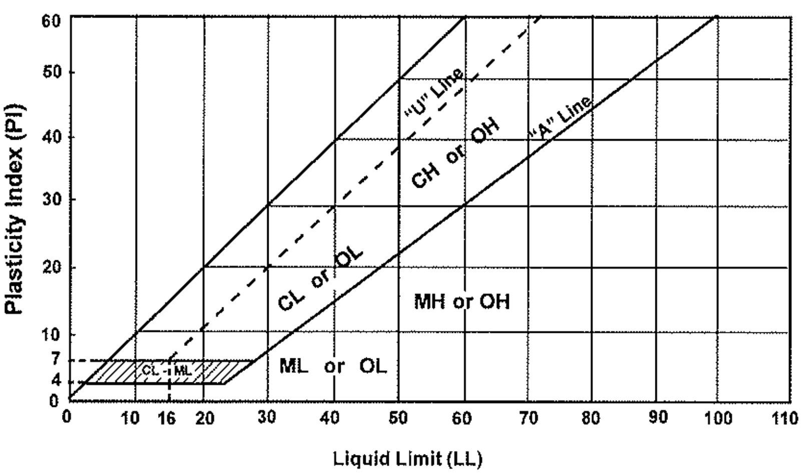
INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils 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 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	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 / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 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
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 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.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

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

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

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.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.