Geotechnical Evaluation Report

University Drive and Interstate 94 Interchange Improvements
Fargo, North Dakota
IM-8-094(090)351; PCN 21169 and CPU-8-081(039)924; PCN 21400

Prepared for

Houston Engineering, Inc.

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.

Ezra Ballinger, PE
Associate Principal/Senior Engineer
Registration Number: PE-7328
December 30, 2016

REGISTERED PROFESSIONAL ENGINEER
EZRA BALLINGER
PE 7328
DATE 12-30-16
NORTH DAKOTA

Projects B1609797 and B1609798

Braun Intertec Corporation

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December 30, 2016

Projects B1609797 and B1609798

Ms. Nancy Wills
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, North Dakota 58102

Re: Geotechnical Evaluation Report
University Drive and Interstate 94 Interchange Improvements
IM-8-094(090)351; PCN 21169 and CPU-8-081(039)924; PCN 21400
Fargo, North Dakota

Dear Ms. Wills:

We are pleased to present this Geotechnical Evaluation Report for the proposed interchange improvements in Fargo. We performed the work on this project in accordance with our proposals dated September 1, 2016.

In the Appendix, we present the Linear Soils Report, which summarizes the results of laboratory testing in borings along the existing roadway. The Appendix also contains the Boring Logs, Grain Size Accumulation Curves and Proctors. This information is being provided to Houston Engineering, Inc. (Houston) and the North Dakota Department of Transportation's (NDDOT) Construction Division, Materials and Research Division, and the Fargo District to assist in the roadway design and determination of quantities.

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 contact Ezra Ballinger at 701.232.8701 or by email at eballinger@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Ezra Ballinger, PE
Associate Principal/Senior Engineer

Steven P. Nagle, PE
Principal Engineer/Vice President

AA/EOE

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A. Introduction

A.1. Project Description

The North Dakota Department of Transportation (NDDOT) is planning intersection improvements to the ramps for Interstate 94 (I-94) as well as reconstruction of portions of University Drive near the ramps. The portion of the project along University Drive has been given NDDOT project number CPU-8-081(039)924, PCN 21400 (Braun Intertec project number B1609797). The ramp intersection improvements project has been given NDDOT project number IM-8-094(090)351, PCN 21169 (Braun Intertec project number B1609798).

University Drive will be reconstructed from I-94 to 18th Avenue South. The intersection of the east leg of 21st Avenue South will be modified to improve pedestrian connectivity. For this project Houston Engineering Inc. (Houston) and the NDDOT requested a linear soils survey to evaluate the subgrade conditions beneath University Drive from the north side of the I-94 ramps to 18th Avenue South.

The westbound I-94 on and off ramps will also be improved. The improvements will necessitate replacing one overhead mast sign over the off ramp. A new signal foundation will be needed at University Drive where it intersects the on ramp as the intersection footprint is enlarged. A pedestrian underpass tunnel is being considered for the westbound I-94 on ramp. The finished grade of the on ramp will be about 1 to 2 feet above the existing ramp grade. The exact location of the pedestrian tunnel along the ramp alignment has not been finalized at this time. For this project Houston and the NDDOT requested a linear soils survey to evaluate the subgrade conditions beneath the I-94 off ramp, recommendations for support of the foundations for the signs, and recommendations for support of the pedestrian tunnel.

A.2. Site Conditions

The ramps as well as University Drive are constructed with concrete pavement overlying aggregate base course. The roadways also have a concrete curb and gutter. A sidewalk running on the west side of University Drive carries pedestrian traffic north and south with an at grade crossing at the on ramp to I-94. University Drive is a 3-lane roadway in each direction, the off ramp has two dedicated left turn lanes and a dedicated right turn lane, and the on ramp is a single lane that can only be accessed from southbound University Drive. Photographs 1 and 2 are pictures of the site taken during staking for the boring locations.

Photograph 1. Looking south on the east side of University Drive

University Drive is bordered by greenspace boulevard on the east side and predominantly business access and parking lots on the west side. Either side of the ramps are bordered by greenspace with shallow ditches for carrying water.

Photograph 2. Looking northeast from the I-94 on ramp

A.3. Purpose

The purpose of the geotechnical evaluation is to assist Houston and the NDDOT with evaluating the geotechnical conditions along the portions of University Drive and the off ramp being constructed by performing a linear soils survey and providing recommendations for geotechnical support of the signs and pedestrian tunnel.

A.4. Background Information and Reference Documents

We reviewed the following information:

- Project Location Map provided via email from Ms. Wills on October 11, 2016.
- Communications with Ms. Wills and others at Houston regarding the sign foundation types, preliminary size and bearing depth of the box culvert for the pedestrian crossing, and the grade raises at the site.

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.5. Scope of Services

We submitted two proposals to Mr. Jeff Lansink of Houston on September 1, 2016. Our scope of services in the proposals consisted of the following tasks and subtasks:

- Engineering and Project Management
  - Project kickoff meeting
  - Staking; after we staked the borings Houston surveyed them and provided us the coordinates and elevations for them
  - Prepare drilling instructions/call in utility locates
  - Drilling oversight
  - Traffic control
  - Oversee laboratory testing

    - Prepare boring logs
    - Develop recommendations for roadway and structure design
    - Attend design meetings/conference calls
    - Prepare a draft geotechnical report
    - Prepare a final geotechnical report
    - Overall project management of drilling, laboratory testing, and engineering

- Drilling
    - Drill two (2) linear soils survey borings along University Drive to a depth of 6 feet.
    - Drill two (2) linear soils survey borings along the I-94 off ramp to a depth of 6 feet.
    - Drill two (2) structure borings for the overhead sign on the I-94 off ramp to a depth of 40 feet.
    - Coordinate with utility companies to locate buried lines.

- Laboratory Testing
    - Conduct an average of four moisture contents, one modified Proctor, one Atterberg limits, and one grain size analysis test for each linear soils survey boring.
    - Conduct an average of 10 moisture contents, three Atterberg limits, and two unconfined compressive strength tests per structure boring.

Our scope of work was modified as the project progressed:

- Drilling
    - We were asked to drill two additional structure borings for the pedestrian crossing tunnel under the on ramp
    - We were asked to drill one additional structure boring for the signal foundation on the west side of University Drive just north of the on ramp.

B. Results

B.1. Geologic Overview

Geologically, the area is dominated by glacial lake deposited soils consisting mainly of fat clays that are strength sensitive and compressible. These soils are underlain at an appreciable depth by glacial till, also consisting mainly of clay but of greater strength and limited compressibility.

The glacial lake soils, from the ground surface down, are generally associated with the Sherack, Brenna, and Argusville Formations. These soils are locally overlain with existing fill from historic grading and construction. While consisting mainly of fat clay, the existing fill and lake-deposited soils also consist locally of lean clay and silt. Silt in particular is often prevalent near the lower boundary of the Sherack Formation, and slickensides are often prevalent in the underlying Brenna Formation, helping reveal the boundary between the two formations.

The uppermost glacial lake layers, typically the Sherack and the upper portion of the Brenna Formations, are generally over-consolidated, while the deeper layers, including the lower portion of the Brenna and the Argusville, are normally consolidated. Shear strength typically falls to a minimum below the zone of over-consolidation but rises again with depth. The soils are typically saturated or nearly so, even above the hydrostatic groundwater surface, and possess low to very low hydraulic conductivities.

B.2. Local Subsurface Geologic Profile

Log of Boring Sheets for our 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 (if any) performed within them, laboratory tests performed on samples retrieved from them, and groundwater measurements. Borings with a “LSSU” prefix are linear soils survey borings performed along University Drive. Borings with a “LSS94” prefix are linear soils survey borings performed along the westbound I-94 off ramp. Borings with a “ST94” prefix are structure borings performed where signs or the pedestrian underpass will be constructed.

Our standard penetration test borings encountered topsoil or fill to estimated depths of 1 to 6 1/2 feet. The topsoil and fill generally consisted of fat clay that was shades of brown and black, was moist to wet, and occasionally contained trace amounts of sand, gravel and roots. Penetration resistance testing of the fill yielded N-values that varied between 10 and 14 blows per foot (BPF).

Based on the depths to which traces of silt or silt lenses or layers were observed to extend at the standard penetration test borings, we estimated the Sherack Formation extended down to a depth of approximately 23 feet below exploration grades (elevation 878 to 882 feet). The standard penetration test borings terminated in the underlying Brenna Formation.

Penetration resistance testing of the glacial lake deposited soils indicated the Sherack, with blow counts typically in the range of four to eight BPF, was rather soft to medium (one sample had an N-value of 16 BPF). The Brenna yielded N-values in the range of two to five BPF, indicating they were soft to rather soft.

Groundwater was not observed as our borings were advanced. Given the cohesive nature of the geologic materials encountered, however, it is likely that insufficient time was available for groundwater to seep into the boreholes and rise to its hydrostatic level. Typically in the region groundwater is seasonally located within the upper 5 to 10 feet below grade. Seasonal and annual fluctuations of groundwater should also be anticipated.

B.3. Laboratory Test Results

B.3.a. Structure Borings

The standard penetration test borings used for the development of structure recommendations consisted of Borings ST94-1 to ST94-5. Laboratory testing was performed for these borings to aid in design of the proposed structures.

B.3.a.1. Moisture Content

Moisture content tests (listed on the Log of Boring Sheets under the MC column) were performed on selected penetration test and thin-walled tube samples to aid in our classifications and estimations of the materials' engineering properties. The moisture contents for the fill soils ranged from 19 to 27 percent, those samples within the Sherack had moisture contents ranging from 27 to 46 percent and those samples within the Brenna had moisture contents ranging from 55 to 76 percent.

B.3.a.2. Moisture Contents and Unit Weights

Unit weight tests (listed in the Tests or Notes column on the Log of Boring Sheets) were performed on selected thin-walled tube samples to assist in our estimation of the materials' engineering properties and aid in our settlement calculations. All tests were performed on soils in the Sherack and Brenna Formations. The results of the tests indicate the samples within the Sherack have wet densities (WD)

ranging from 111 to 114 pounds per cubic foot (pcf) and dry densities (DD) ranging from 78 to 81 pcf. The samples within the Brenna have wet densities of 98 and 100 pcf and dry densities of 57 and 59 pcf.

B.3.a.3. Atterberg Limits

Atterberg limits tests (also listed in the Tests or Notes column on the Log of Boring Sheets) were performed on selected samples for classification, evaluation of the soils' plasticity, and estimation of engineering parameters. The results of the Atterberg limits tests indicated the Sherack soils tested had liquid limit (LL) ranging from 64 to 74 percent, plastic limits (PL) ranging from 16 to 24 percent, and plasticity indices (PI) ranging from 41 to 54 percent. The samples of the Brenna soils tested had liquid limits ranging from 99 to 103 percent, plastic limits ranging from 21 to 32 percent, and plastic indices ranging from 67 to 78.

B.3.a.4. Unconfined Compressive Strength Tests

Unconfined compressive strength (Q_u) tests (also listed in the Tests or Notes column on the Log of Boring Sheets and inserted as individual reports in the Appendix) were performed on selected thin-walled tube samples to aid in estimating the soils' undrained shear strength for our calculations. The results of the tests indicated the samples within the Sherack had unconfined compressive strengths ranging from 1010 to 2330 pounds per square foot (psf), indicating undrained shear strengths ranging from 505 to 1165 psf. The samples within the Brenna had unconfined compressive strengths of 990 and 1610 psf, indicating undrained shear strengths of 495 and 805 psf.

Pocket penetrometer tests (q_p), the results of which are shown in the Tests or Notes column on the Log of Boring Sheets were performed on selected penetration test samples to provide an additional estimation of the soils' unconfined compressive strength. Penetrometer tests performed on the Sherack soils ranged from 1/4 to 4 tons per square foot (tsf), indicating estimated undrained shear strengths ranging from about 250 to 4000 psf. Penetrometer tests performed on the Brenna soils ranged from 1/4 to 1/2 tsf, indicating estimated undrained shear strengths ranging from 250 to 500 psf.

B.3.b. Linear Soils Survey

The power auger borings used for the development of a linear soils survey to meet the requirements of NDDOT were LSSU-1, LSSU-2, LSS94-1, and LSS94-2.

For the linear soils survey we collected a total of four bulk samples and 24 moisture content samples from the flight auger. All of the borings were extended to a depth of 6 feet, as indicated on the attached Log of Boring Sheets. Because the roadways are concrete, the linear soils survey borings were performed off the edge of the pavement.

The results of our laboratory testing for the linear soils survey are shown in Tables 1 and 2 below and on the boring logs and laboratory results sheets, and Linear Soils Report, which are provided in the Appendix.

Table 1. Summary of Classification, Moisture Content, and Maximum Dry Unit Weight Testing for Linear Soils Survey Borings

AASHTO Classifications	Quantity	In Place Moisture Range (%)		In Place Moisture Average (%)	AASHTO T-180 Optimum Moisture Average (%)	AASHTO T-180 Maximum Dry Unit Weight Average (pcf)
		Min	Max			
A-7-6	4	16	36	26.7	18.8	108.5

Table 2. Summary of Atterberg Limits Testing for Linear Soils Survey Borings

AASHTO Classifications	Quantity	Liquid Limit Range (%)		Liquid Limit Average (%)	Plastic Limit Range (%)		Plastic Limit Average (%)	Plastic Index Range		Plastic Index Average
		Min	Max		Min	Max		Min	Max	
A-7-6	4	62	83	71	16	25	20	43	58	51

As can be seen in Table 1, the soils encountered in the borings were slightly below to 17 percent wet of their optimum moisture contents on the average as determined by AASHTO T-180. The moisture content of the soils will most likely vary over the year as the seasons change and may be different at the time of construction than was encountered in our borings.

The soils encountered in the borings are considered highly frost-susceptible. Soils classified as A-7-6 soils are generally considered poor subgrade materials. The Atterberg limits testing results provided in Table 7 are used to determine the group index of the soils. A group index of 20 or greater indicates very poor subgrade materials. All of the soils tested had a group index of 47 or higher (average of 57).

C. Analysis and Recommendations

In the following sections, we present our recommendations for the roadway reconstruction, sign foundation design, and the design of a box culvert for the pedestrian crossing under the on ramp.

C.1. Roadway Reconstruction

C.1.a. Proposed Construction

The project includes the widening of the off ramp from westbound I-94, the reconstruction of University Drive, and the reconstruction of a portion of the on ramp to westbound I-94. The pavements will be reconstructed or widened, curb and gutter will be reconstructed, and a new sidewalk will be constructed for pedestrian access. The centerline elevation of the reconstructed roadways are not anticipated to change and fill depths in the widening areas will be less than 2 feet.

The pavement section for the new roadway will be developed by the NDDOT. We understand that all work on the site will be performed in accordance with NDDOT Standard Specifications.

C.1.b. Treatment of Organic Soils

Organic topsoils are present in the boulevards and in the ditches where the widening will occur. In these areas, we recommend that all vegetation, root zones and organic topsoils be removed prior to subgrade preparation (and placement of new fill where it is required). After the removal of organics, the subgrade should be prepared as indicated in Section C.1.c. Organic soils that are removed should not be reused as embankment fill; however, they could be stockpiled and may be used in landscaping areas.

C.1.c. Subgrade Preparation

The reconstructed and widening areas are receiving little to no new fill. We recommend 12 inches of subgrade preparation beneath the roadway in cut areas, and in fill areas where less than 18 inches of fill will be placed. If the subgrades that are present after the completion of any removals are stable enough to support construction equipment (loaders, dozers, scrapers, etc.), consideration could be given to placement of a geogrid directly on the subgrades in lieu of the 12 inches of subgrade preparation. Geogrid, if used, should meet the requirements of NDDOT Specification 858.02.

In fill areas where greater than 18 inches of fill will be placed, it is not necessary to perform subgrade preparation beyond topsoil stripping. If unstable soils are present below the topsoil, scarification and drying or overexcavation and replacement of the unsuitable soils could be considered.

Subgrade preparation should comply with NDDOT Specification 230.04 D (Type A). Compaction control for subgrade preparation should be in accordance with AASHTO T-180 and NDDOT Specification 203.04 E.2.a (Type A).

C.1.d. Subgrade Remediation

Based on the conditions encountered in our borings, we do not anticipate that remediation will be necessary for the soils beneath the existing roadway alignment.

The native soils do have high liquid limits, are moist to wet, and have variable silt contents. Based on our experience, these soils are susceptible to strength loss during and after construction and may require subgrade remediation depending on the conditions at the time of construction. If localized soft spots are encountered during the course of construction, we recommend they be remediated at the discretion of the NDDOT Project Engineer.

If it is required, subgrade remediation should be performed with a backhoe using a smooth cutting edge to minimize disturbance of the underlying soils. A 20H:1V transition shall be constructed prior to entering and exiting subcut excavations. Construction equipment traffic should not be allowed to operate on the exposed subgrades. We anticipate that the majority of any subgrade remediation could be performed by removing the existing soft soil and replacing it with embankment fills. If very soft subgrades are encountered and this approach will not work, then subcutting (removal and backfill with imported aggregate) should be performed in accordance with NDDOT Specification 203.02C.

C.1.e. Subgrade Drainage

We recommend that drainage be provided for aggregate base placed over the on-site soils or similar soils used to construct new embankments. We recommend that drainage be provided by sloping the subgrades to the roadway edges and an underdrain be constructed in accordance with NDDOT Specification 714.03B.

C.1.f. Unsuitable Materials

Based on the soils encountered in our borings, we anticipate that the soils encountered in excavations for the project will generally be suitable for construction of the widened roadway embankment. As discussed in Section C.1.b, organic soil deposits should not be used as embankment fill. We recommend that the balance of imported soils used as borrow be similar to the existing subgrade soils in the area. Any soils encountered or imported that cannot be moisture conditioned and compacted according to the recommendations of this report should not be used.

C.1.g. Settlement

As discussed above, the new fills for the project will generally be less than about 2 feet. Based on these conditions and assuming that the construction is in accordance with the recommendations of this report, we anticipate the settlement in these areas due to new soil load will occur during construction.

C.1.h. Inslopes and Backslopes

We recommend that inslopes and backslopes designed for the project be no steeper than 4H:1V (Horizontal:Vertical). Site specific evaluations should be performed at any locations under consideration for steepening beyond a 4H:1V.

C.2. Overhead Signs

A new cantilevered sign will be constructed along southbound University Drive just north of the westbound I-94 on ramp. The existing overhead sign spanning the top of the westbound I-94 off ramp will also be replaced. Based on our conversations with Houston Engineering, all of the signs will be supported on drilled pier foundations, recommendations for which are provided in the following sections.

C.2.a. Frost Heave and Embedment Depth

Frozen soil near the ground surface will adhere to the sides of the pier. As the soil freezes, it will attempt to heave this soil and the pier to which it froze. The freezing soil will attempt to pull the pier upward. To counteract the potential frost heave forces, we recommend the drilled shaft extend to a depth that is equal to at least twice the anticipated frost penetration depth. The extreme frost penetration depth in the Fargo area is estimated to be approximately 6 feet and therefore, we recommend the drilled shafts extend to a minimum depth of 12 feet below final grades.

We also recommend that care be given to forming drilled piers within the anticipated frost penetration depths. The drilled piers should be formed within this zone such that the pier sidewalls are as near vertical as possible. Drilled piers that are “carrot-topped” (wider at the top) will be much more prone to frost heave.

C.2.b. Design Parameters

The drilled piers must be designed to withstand sustained (dead loads) and transient (live load) loading conditions. Axial compressive loads on drilled piers are supported by a combination of skin (side) friction and end-bearing capacity. Uplift loads are resisted by the weight of the concrete and skin friction/adhesion. Lateral resistance is provided by passive pressures against the pier.

The following tables summarize our recommended design parameters for the drilled shafts based upon the relatively consistent soil profile amongst the structure borings. Please note that we have provided parameters for both sustained and transient loading conditions. The values provided were selected

based on laboratory testing for this project with consideration to our overall experience with the soil formation units across the Fargo-Moorhead area and in the Red River Valley.

The strength of soils, particularly clayey soils, depends on the loading intensity, rate, and duration; therefore, the parameters provided for sustained and transient loads are different. In clayey soils, when a load is applied to the soils, the load is taken up in the soil structure and will increase the pore water pressure within the soil, creating an undrained condition. If that load is maintained on the soil, the pore pressure will dissipate over time, and the soil structure will behave in a drained condition. In an undrained condition, the undrained cohesion of a clay soil will control the design and the friction angle of the material is zero due to pore pressure increases. However, in a drained state, the pore pressure dissipates, and the soil strength is based on frictional resistance, described by the friction angle of the soil. We recommend that both sustained and transient conditions be evaluated for drilled pier design. Where load combinations include both sustained and transient loads, the combined loading should be evaluated using the transient load conditions, and the sustained load condition should then be checked using only the sustained loads.

Table 3a. Sustained Loading Design Parameters for Drilled Piers[1]

Depth, feet	Material	Estimated Unit Weight, pcf	Estimated Cohesion, psf	Estimated Friction Angle, degrees	Passive Pressure Coefficient, K_p	At Rest Earth Pressure Coefficient, K_o
0 – 6	Fill or Native Fat Clay (CH)	110	0	22	2.20	0.63
6 – 23	Sherack Fat Clay (CH)	50	0	22	2.20	0.63
> 23	Brenna Fat Clay (CH)	40	0	13	1.58	0.78

Table 3b. Transient Loading Design Parameters for Drilled Piers[1]

Depth, feet	Material	Estimated Unit Weight, pcf	Estimated Cohesion, psf	Estimated Friction Angle, degrees	Allowable Passive Pressure, psf	Allowable Adhesion/Friction, psf	Net Allowable End-Bearing Capacity, psf
0 – 6	Fill or Native Fat Clay (CH)	110	650	0	1300	180	--
6 – 23	Sherack Fat Clay (CH)	50	850	0	1700	230	2600
> 23	Brenna Fat Clay (CH)	40	500	0	1000	140	1500

[1] Please note the following for the parameters in Table 3a and 3b:

- Unit weight, cohesion and friction angle values do not include a factor of safety;
- Allowable passive pressure values include a factor of safety of three (3);
- Adhesion/skin friction values include a factor of safety of two (2); and
- Allowable end-bearing capacities include a factor of safety of three (3).

Table 3c. Summary of p – y Parameters for Drilled Piers[2]

Depth, feet	Material	Sustained Loading		Transient Loading		
		Static & Cyclic Modulus "Dry", pci	Static & Cyclic Modulus, Submerged, pci	Static Modulus, Clay, pci	Cyclic Modulus, Clay, pci	ε_{50}
0 – 6	Fill or Native Fat Clay (CH)	28	24	237	95	0.0122
6 – 23	Sherack Fat Clay (CH)	25	22	318	127	0.0103
> 23	Brenna Fat Clay (CH)	13	13	185	74	0.0141

[2] In Table 3c none of the parameters contain a factor of safety.

For the design parameters in Tables 3a, 3b and 3c, we have assumed the groundwater will be about 6 feet below grade at each location.

C.2.c. Settlement

The net allowable bearing pressures provided in the right column of Table 3b have been calculated with the intent of limiting settlement of the drilled pier foundations to less than about 1 inch.

C.2.d. Pier Diameter

To facilitate shaft evaluation, we recommend a minimum drilled shaft diameter of 30 inches.

C.2.e. Drilled Shaft Support

We anticipate that the pier shafts may need to be cased due to groundwater to prevent caving. Telescoping casings may be required for longer shafts. With telescoping casings, the largest casing is set at the top of the shaft, and subsequent casings becoming progressively smaller with the smallest casing having a diameter equal to the design diameter of the pier. To help accommodate telescoping casings for this project, we recommend assuming a 6-inch increase in diameter per casing. Provided the casing is removed at the time of concrete placement, the design parameters provided in Tables 3a through 3c may be used for design. If there are any locations where casings will remain in the ground after construction, we should be contacted to review the design parameters used for the specific condition.

C.2.f. Concrete Placement

It is possible to pull telescoping casing in such a way as to construct the drilled pier at its design diameter for its entire length. This practice, however, risks leaving loose material against the pier and effectively reducing confinement offered to the pier. To avoid problems associated with this situation, we recommend that the concrete be placed to the full diameter of the drilled out hole for its entire depth.

If, prior to placing concrete, more than 2 inches of uncontaminated groundwater is present in the shaft, we recommend installing a sump and pump to remove the excess water. Alternatively, the concrete can be placed with a tremie pipe, although the concrete should then be designed for a slump between approximately 4 and 6 inches.

C.3. Box Culvert Alternative

The pedestrian walking trail access under the on ramp will be through an approximately 14’ x 10’ reinforced concrete box culvert that will be approximately 50 feet long. The bottom of the box culvert will bear approximately 10 to 12 feet below grade at our borings ST94-4 and ST94-5. The ramp grade will be raised about 1 to 2 feet in order to cross over the box culvert. Recommendations for the box culvert design and construction are provided in the following sections.

C.3.a. General Removals

The existing pavement section and all topsoils, vegetation and root zones should be removed from below all areas that will receive new fills. Organic soils should be treated in accordance with Section C.1.b.

C.3.b. Excavation Support

The existing fill and native soils are Type C Soils under OSHA guidelines. Unsupported excavations in Type C soils should be maintained at a gradient no steeper than 1 ½:1 (horizontal:vertical).

C.3.c. Dewatering

We anticipate that dewatering of the excavation may be required. Groundwater seepage into the excavation may occur through silt lenses and seams encountered within the fill and upper native soils. We recommend removing groundwater from the excavations if it is encountered. Sumps and pumps should be suitable for dewatering needs.

C.3.d. Subgrade Preparation

Based on the soils encountered in our borings and the assumed invert elevations, we anticipate the box culvert will bear on soft glacial lake soils that will be susceptible to disturbance. To provide support for construction traffic and limit the amount of down time due to soft and weak soils, we recommend a minimum overexcavation of 1 foot below the base of the box culvert. We also recommend that the overexcavation extend a minimum of 1 foot horizontally beyond the outside edges of the box culvert.

After the overexcavation has been completed, we recommend the excavation be fully enveloped in a Type S1 Geotextile fabric (NDDOT Specification Section 858). We recommend the overexcavation be backfilled with NDDOT Specification 816.02 Class 7. Dewatering of the excavation can be performed by sumps and pumps placed in the Class 7 aggregate.

C.3.e. Excavation Backfilling

After the box culvert has been constructed the excavation will need to be backfilled. The soils placed around the box culvert and above it to the bottom of the pavement section should consist of soils meeting the following requirements:

- Mineral soil with an organic content of less than 3 percent by mass.
- Free of rocks larger than 4 inches in its longest dimension where placed within the top 1 foot of the finished subgrade.
- Classified in accordance with ASTM guidelines with a prefix letter of S, C or G (e.g. SP, SC, CH, GP, etc.), with exception to materials classified as CL-ML (silty clay) and SC-SM (silty clayey sand).
- Liquid limit (LL) ≤ 90 percent.

Compaction control for subgrade preparation should be in accordance with AASHTO T-180 and NDDOT Specification 203.04 E.2.a (Type A).

D. Procedures

D.1. Penetration Test Borings

We drilled the penetration test borings with a flotation tire-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D1586 taking penetration test samples at 2 1/2- or 5-foot intervals. We collected thin-walled tube samples in general accordance with ASTM D1587 at selected depths. The boring logs show the actual sample intervals and corresponding depths.

D.2. Power Auger Borings

We performed the power auger borings with the same equipment as our penetration test borings and in general accordance with ASTM D1452. We inferred the soil classifications and strata depths from the cuttings brought to the surface by dead pulling the auger after screwing it to selected depths in the ground. At desired depths, we placed auger cuttings in bags and jars.

D.3. Exploration Logs

D.3.a. Log of Boring Sheets

The Appendix includes Log of Boring Sheets for our penetration test and power auger borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance tests where they were performed. The logs also present the results of laboratory tests performed on penetration test samples and auger cuttings, and groundwater measurements.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

D.3.b. Geologic Origins

We assigned geologic origins to the materials shown on the logs and referenced within this report, 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.

D.4. Material Classification and Testing

D.4.a. Visual and Manual Classification

We visually and manually classified the geologic materials encountered in accordance with ASTM D2488. The Appendix includes a chart explaining the classification system.

D.4.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with AASHTO procedures.

D.5. Groundwater Measurements

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes or allowed them 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

We developed our evaluation, analyses and recommendations 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. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata 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 performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such

variations could increase construction costs, and we recommend including a contingency to accommodate them.

E.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels 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

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

E.2.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction. This will allow us to correlate the subsurface conditions encountered during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase.

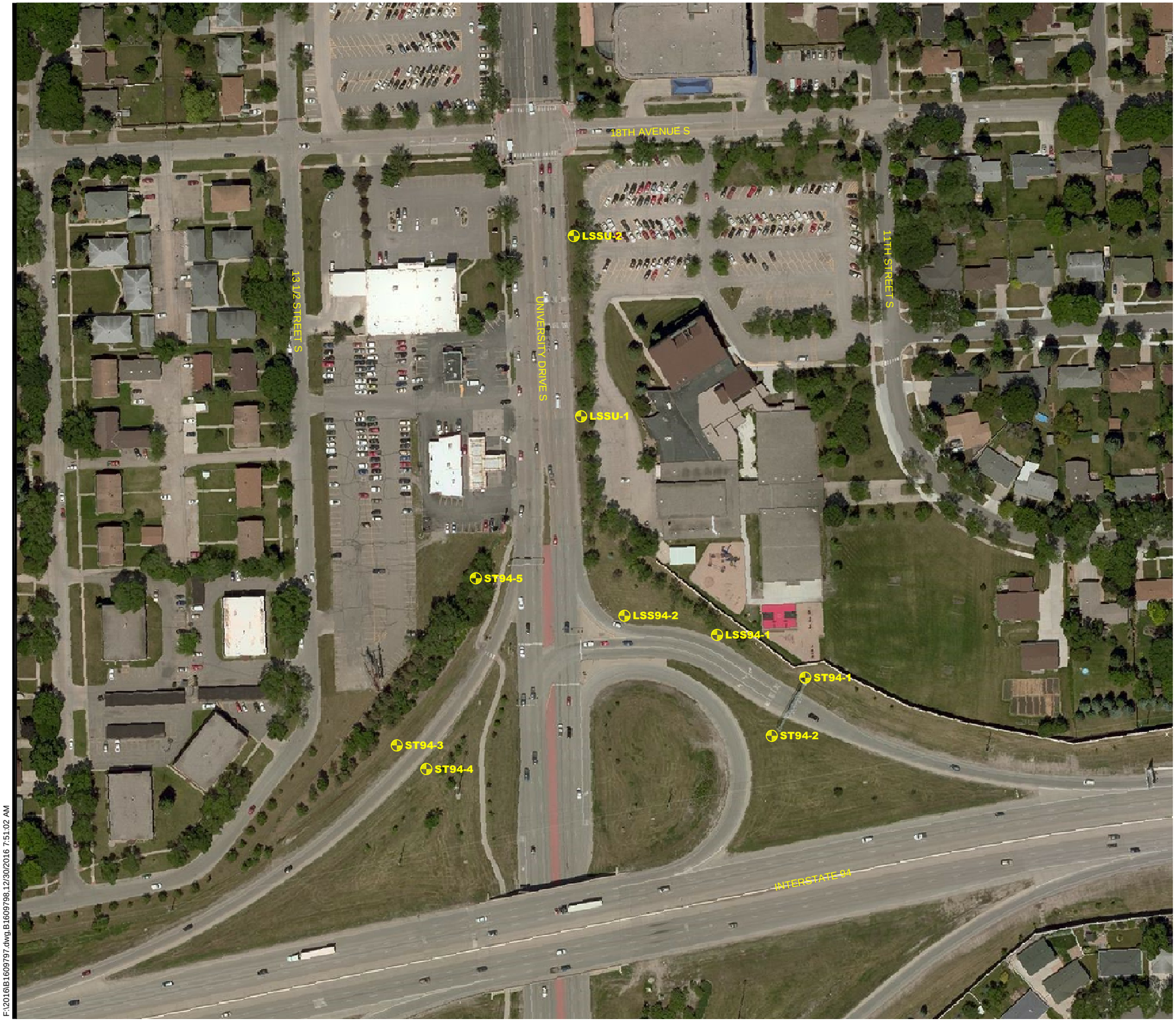
E.3. Use of Report

This report is for the exclusive use of the addressed parties. 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



DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

N

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
PH. (952) 995-2000
FAX (952) 995-2020

SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
I-94 AND UNIVERSITY DRIVE INTERSECTION IMPROVEMENTS
IM-8-094(090)351; PCN 21169 AND CPU-8-081(039)924; PCN 21400
FARGO, NORTH DAKOTA

Project No:	B1609798
Drawing No:	B1609797
Scale:	1" = 150'
Drawn By:	BJB
Date Drawn:	12/9/16
Checked By:	EB
Last Modified:	12/30/16
Sheet: of	Fig:

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Linear Report of Tests on Soil Samples

PROJECT NO.: B1609797 & B1609798
PROJECT: I-94 Ramps and Univ. Improvements
University Drive and I-94
Fargo, North Dakota

Braun Intertec Corporation
PO Box 485, West Fargo, ND
Phone: (701) 232-8701

BRAUN INTERTEC

Boring Number	LSSU-1	LSSU-2	LSS94-1	LSS94-2
Northing	453676.871	453957.518	453335.791	453370.088
Easting	2894659.333	2894643.725	2894881.922	2894722.650
Elevation	905.1	905.1	904.6	903.6
Sample Depth	1' - 6'	1' - 6'	1' - 6'	1' - 6'
% Passing 3/8" Sieve	100	100	100	100
% Passing No. 4 Sieve	100	100	100	100
% Passing No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10, +No. 40)	1	1	0	0
% Fine Sand (-No. 40, +No. 200)	1	1	1	1
% Silt (0.075 - 0.002 mm)	46	37	28	19
% Clay (<0.002 mm)	52	60	71	80
% Finer than 0.02 mm	85	90	96	98
Frost Group	F4	F4	F4	F4
Liquid Limit (-No. 40)	62	64	76	83
Plastic Limit (-No. 40)	19	16	21	25
Plasticity Index (-No. 40)	43	48	55	58
Soil Color	Brown and Gray	Brown and Gray	Brown and Gray	Brown and Gray
USCS Classification	FAT CLAY(CH)	FAT CLAY(CH)	FAT CLAY(CH)	FAT CLAY(CH)
Soil Classification (AASHTO M-15)	A-7-6 (47)	A-7-6 (52)	A-7-6 (62)	A-7-6 (67)
Optimum Moisture (%)	17.0	19.0	19.0	20.0
Maximum Dry Density (pcf)	113.0	109.0	107.0	105.0

Depth (ft)	Moisture (%)							
		1.0	20	1.0	17	1.0	26	1.0	26
		2.0	21	2.0	23	2.0	29	2.0	30
		3.0	23	3.0	16	3.0	31	3.0	32
		4.0	25	4.0	23	4.0	33	4.0	33
		5.0	30	5.0	26	5.0	33	5.0	36
Avg. Moisture of Sample Depth		24		21		30		31	

BRAUN INTERTEC

LOG OF BORING

Braun Project B1609797
Geotechnical Evaluation
CPU-8-081(039)924 - PCN21400 University Drive Improvements
University Drive
Fargo, North Dakota

BORING: **LSSU-1**

LOCATION: N453676.871; E2894659.333 See sketch.

DRILLER: G. Bevre | METHOD: Power Auger | DATE: **10/25/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	Tests or Notes
905.1	0.0						
904.1	1.0	CH	FAT CLAY, trace roots, brown and black, wet.			21	
		CH	FAT CLAY, trace Sand, brown and gray, wet. A-7-6 (47) MDD = 113.0 pcf; OMC = 17.0%.			20	LL=62, PL=19, PI=43; P200=98%
						21	
						23	
						25	
						30	
899.1	6.0						
			END OF BORING. Bag sample collected from 1 to 6 feet. Water not observed with 6 feet of power auger in the ground. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project B1609797
Geotechnical Evaluation
CPU-8-081(039)924 - PCN21400 University Drive Improvements
University Drive
Fargo, North Dakota

BORING: **LSSU-2**

LOCATION: N453957.518; E2894643.725 See sketch.

DRILLER: G. Bevre | METHOD: Power Auger | DATE: **10/25/16** | SCALE: **1" = 4'**

Elev. feet 905.1	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	Tests or Notes
904.1	1.0	CH	FAT CLAY, trace roots, black, wet.			22	
		CH	FAT CLAY, trace Sand, occasional Silt lenses, brown and gray, moist to wet. A-7-6 (52) MDD = 109.0 pcf; OMC = 19.0%.			17	LL=64, PL=16, PI=48; P200=98%
						23	
						16	
						23	
899.1	6.0					26	
			END OF BORING. Bag sample collected from 1 to 6 feet. Water not observed with 6 feet of power auger in the ground. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

NDDOT LOG 09797.GPJ BRAUN.GDT 12/30/16 08:01

BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
I-94 Interchange
Fargo, North Dakota

BORING: **LSS94-1**

LOCATION: N453335.791; E2894881.922 See sketch.

DRILLER: G. Bevre | METHOD: Power Auger | DATE: **10/25/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	Tests or Notes
904.6	0.0						
903.6	1.0	CH	FAT CLAY, trace roots, black, wet.			24	
		CH	FAT CLAY, trace Sand, occasional Silt lenses, brown and gray, moist to wet. A-7-6 (62) MDD = 107.0 pcf; OMC = 19.0%.			26	LL=76, PL=21, PI=55; P200=99%
						29	
						31	
						33	
898.6	6.0					33	
			END OF BORING. Bag sample collected from 1 to 6 feet. Water not observed with 6 feet of power auger in the ground. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
I-94 Interchange
Fargo, North Dakota

BORING: **LSS94-2**

LOCATION: N453370.088; E2894722.650 See sketch.

DRILLER: G. Bevre | METHOD: Power Auger | DATE: **10/25/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	MC %	Tests or Notes
903.6	0.0						
902.6	1.0	CH	FAT CLAY, trace roots, black, wet.			24	
		CH	FAT CLAY, trace Sand, occasional Silt lenses, brown and gray, moist to wet. A-7-6 (67) MDD = 105.0 pcf; OMC = 20.0%.			26 30 32 33 36	LL=83, PL=25, PI=58; P200=99%
897.6	6.0		END OF BORING. Bag sample collected from 1 to 6 feet. Water not observed with 6 feet of power auger in the ground. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-1**

LOCATION: N453284.773; E2895013.827 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
902.0	0.0							
901.0	1.0	CH	FAT CLAY, trace roots, dark brown, moist. (Topsoil)	9		27		
		CH	FAT CLAY, with Silt lenses, brown with iron-staining, wet, rather soft to medium. (Glacial Lake Deposit)	6		35	1 1/2	
				6		38	1	
			-with Silt seams, brown and gray below 7 1/2 feet.	4		41	1/2	
				4		36	1/2	LL=65, PL=24, PI=41
				4		41	1/2	
				4		37	1/2	
			-gray at 20 feet.	6		46	1	
879.0	23.0							
		CH	FAT CLAY, gray, wet, rather soft. (Glacial Lake Deposit)					
				4		76	1/4	LL=103, PL=28, PI=75
				3		70	1/4	

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-1 (cont.)**

LOCATION: N453284.773; E2895013.827 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
870.0	32.0		FAT CLAY, gray, wet, rather soft. (Glacial Lake Deposit) *(continued)*					
				TW*		71	1/4	*Full recovery. Qu=990 psf, WD=100 pcf, DD=59 pcf
861.0	41.0			4		57	1/4	
			END OF BORING.					
			Water not observed with 39 1/2 feet of hollow stem auger in the ground.					
			Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-2**

LOCATION: N453195.043; E2894961.879 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/25/16** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
905.2	0.0	FILL	FILL: Fat Clay, trace roots and Sand, black, moist.	10		23		
			-black and brown below 2 1/2 feet.	14		22		
				10		26		
898.7	6.5	CH	FAT CLAY, with Silt lenses, brown with iron-staining, wet, rather soft to medium. (Glacial Lake Deposit)	7		36	1 3/4	LL=70, PL=16, PI=54
				6		35	2	
			-Silt seams at 12 1/2 feet.	5		39	1	
			-gray below 15 feet.	5		43	1 1/2	LL=72, PL=19, PI=53
				6		34	1 1/2	
882.2	23.0	CH	FAT CLAY, gray, wet, rather soft. (Glacial Lake Deposit)					
				5		58	1/2	
				TW*		73	1/4	*Full recovery. Qu=1610 psf, WD=98 pcf, DD=57 pcf

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-2 (cont.)**

LOCATION: N453195.043; E2894961.879 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/25/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
873.2	32.0		FAT CLAY, gray, wet, rather soft. (Glacial Lake Deposit) *(continued)*					
				3		66	1/4	
864.2	41.0			2		65	1/4	
			END OF BORING.					
			Water not observed with 39 1/2 feet of hollow stem auger in the ground.					
			Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-3**

LOCATION: N453120.624; E2894328.297 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
901.7	0.0							
900.7	1.0	CH	FAT CLAY, trace roots, black, moist. (Topsoil)	5		25		
		CH	FAT CLAY, with Silt lenses, brown and gray with iron-staining, wet, rather soft to medium. (Glacial Lake Deposit)	7		38	1 1/2	
				7		40	1 1/2	
				TW*		43		*Full recovery. Qu=2330 psf, WD=111 pcf, DD=78 pcf
				4		41	3/4	
			-with Silt layers from 12 1/2 to 16 feet.	4		39	3/4	
				4		32		
				7		39	2	
878.7	23.0							
		CH	FAT CLAY, gray, wet, soft to rather soft. (Glacial Lake Deposit)					
				4		64	1/4	
				3		65	1/4	LL=99, PL=21, PI=78

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-3 (cont.)**

LOCATION: N453120.624; E2894328.297 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
869.7	32.0		FAT CLAY, gray, wet, soft to rather soft. (Glacial Lake Deposit) *(continued)*					
				2		65	1/4	
860.7	41.0			2		65	1/4	
			END OF BORING.					
			Water not observed with 39 1/2 feet of hollow stem auger in the ground.					
			Water not observed to cave-in depth of 18 feet immediately after withdrawal of auger.					
			Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\AX PROJECTS\2016\09798.GPJ BRAUN_V8_CURRENT.GDT 12/14/16 07:59

BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-4**

LOCATION: N453073.499; E2894376.371 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
902.6	0.0							
901.6	1.0	CH	FAT CLAY with roots, black, wet. (Topsoil)	11		27		
		CH	FAT CLAY, with Silt lenses, brown with iron-staining, wet, rather soft to medium. (Glacial Lake Deposit)	8		31	1 1/2	
				7		37	1 3/4	
				5		39	1 1/2	LL=65, PL=22, PI=43
			-brown and gray from 10 to 14 feet.	6		44	1 1/2	
				5		43	1/4	
			-gray below 15 feet.	TW*		41	1	*Full recovery. Qu=1010 psf, WD=114 pcf, DD=81 pcf
				6		41	1 1/2	LL=99, PL=32, PI=67
879.6	23.0							
		CH	FAT CLAY, gray, wet, soft to rather soft. (Glacial Lake Deposit)					
				3		68	1/4	
				3		69	1/4	

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-4 (cont.)**

LOCATION: N453073.499; E2894376.371 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
870.6	32.0		FAT CLAY, gray, wet, soft to rather soft. (Glacial Lake Deposit) *(continued)*					
				4		73	1/4	
				3		62	1/4	
861.6	41.0		END OF BORING.					
			Water not observed with 39 1/2 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\AX PROJECTS\2016\09798.GPJ BRAUN_V8_CURRENT.GDT 12/14/16 07:59

BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-5**

LOCATION: N453413.421; E2894501.362 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
903.7	0.0							
901.7	2.0	FILL	FILL: Fat Clay, with roots, trace Gravel, dark brown, moist.	12		19		
899.7	4.0	FILL	FILL: Fat Clay, brown, moist.	13		21		
		CH	FAT CLAY, with Silt lenses, brown with iron-staining, wet, rather soft to medium. (Glacial Lake Deposit)	16		27	4	
				8		36	1 1/2	
				TW*		40		*Full recovery. Qu=1980 psf, WD=112 pcf, DD=80 pcf
				4		37	1	LL=74, PL=24, PI=50
				4		38	1	
				5		42	1 1/2	
880.7	23.0	CH	FAT CLAY, gray, wet, soft. (Glacial Lake Deposit)	3		73	1/4	
				3		66	1/4	LL=101, PL=31, PI=70

BRAUN INTERTEC

LOG OF BORING

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: **ST94-5 (cont.)**

LOCATION: N453413.421; E2894501.362 See sketch.

DRILLER: G. Bevre | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/24/16** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
871.7	32.0		FAT CLAY, gray, wet, soft. (Glacial Lake Deposit) *(continued)*					
				3		60	1/4	
				3		55	1/4	
862.7	41.0		END OF BORING.					
			Water not observed with 39 1/2 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\AX PROJECTS\2016\09798.GPJ BRAUN_V8_CURRENT.GDT 12/14/16 07:59

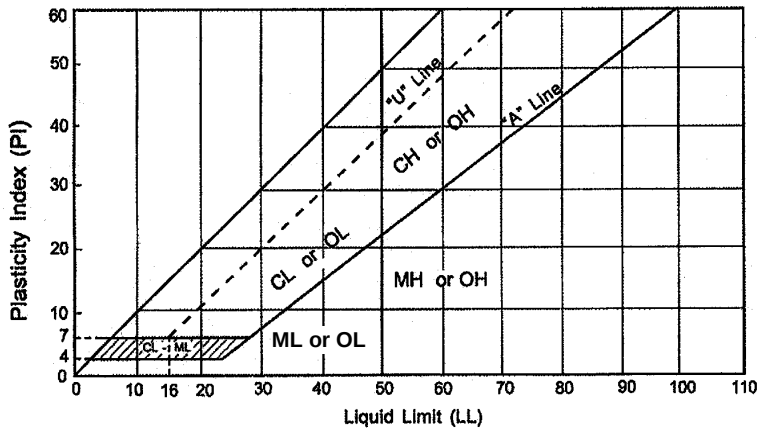
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487
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	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 [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 Less than 5% 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-inch (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60}/D_{10}$ $C_c = \frac{(D30)^2}{D_{10} \times D_{60}}$
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. Sand 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" lines.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcg	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liquid limit, %	**C**	Cohesion, psf
PL	Plastic limits, %	**Ø**	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 about "A" line

Relative Density of Cohesionless Soils

Very Loose..... 0 to 4 BPF
Loose..... 5 to 10 BPF
Medium dense ..... 11 to 30 PPF
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. All samples were taken with the standard 2" OD split-tube samples, except where noted.

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

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.

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.

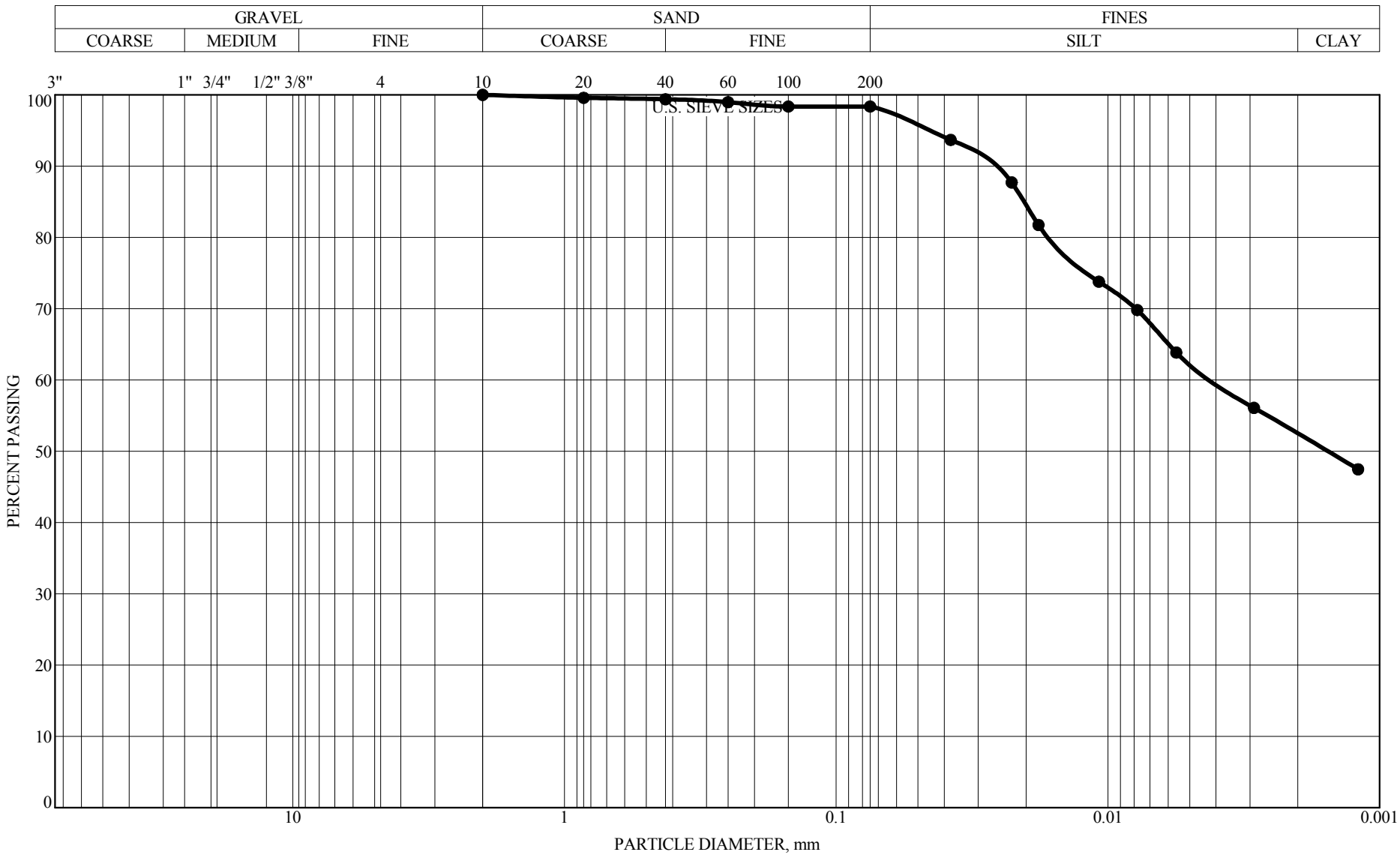
WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

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

TW: TW indicates thin-walled (undisturbed) tube sample.

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

GRAIN SIZE ACCUMULATION CURVE (AASHTO)



Braun Project B1609797
Geotechnical Evaluation
CPU-8-081(039)924 - PCN21400 University Drive Improvements
Fargo, North Dakota

BORING: LSSU-1 DEPTH: 1.0'-6.0'

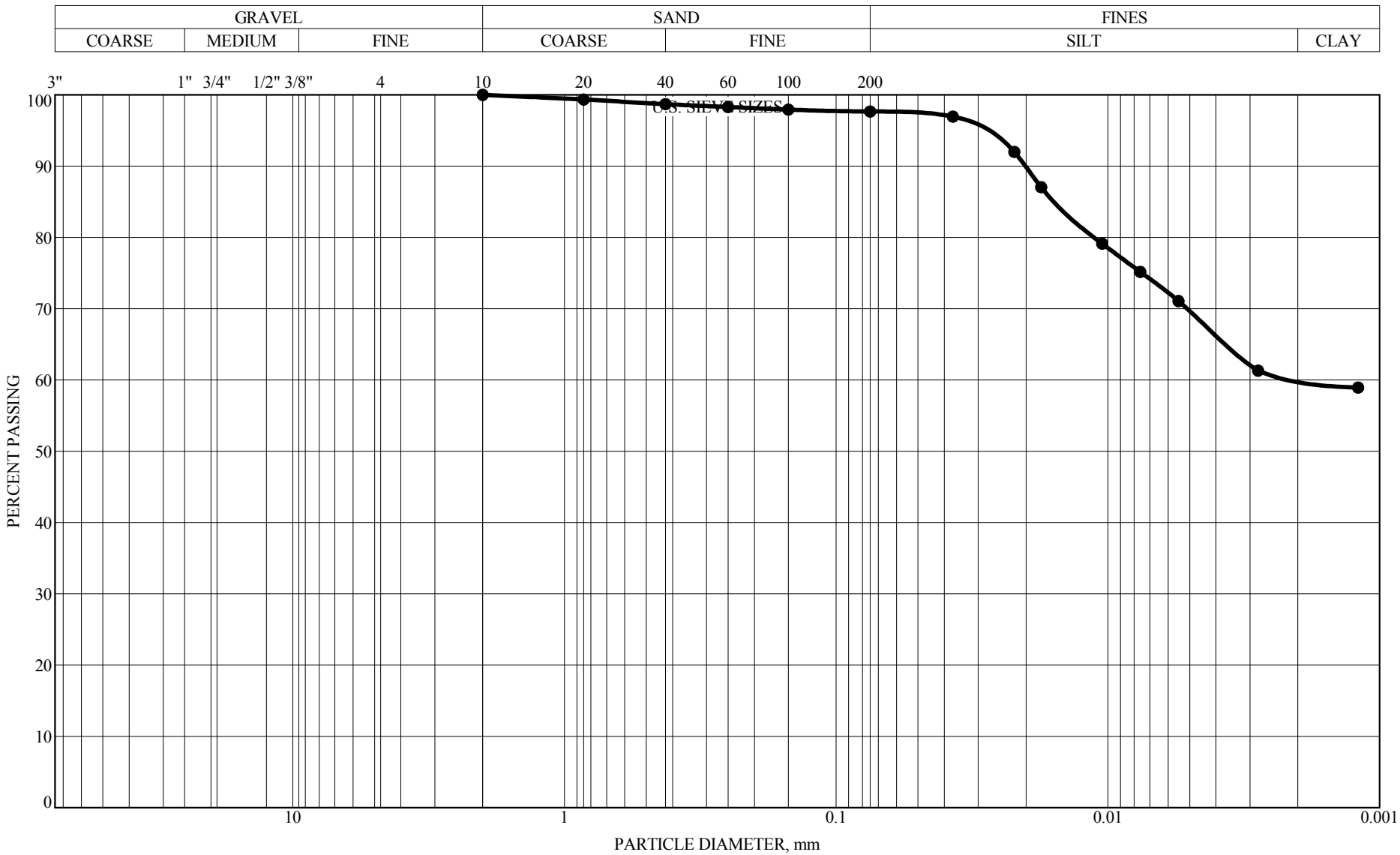
GRAVEL	0.0%
SAND	1.6%
SILT	45.9%
CLAY	52.5%

CLASSIFICATION:
A-7-6 (47), Brown and Gray
FAT CLAY(CH)

LL=62, PL=19, PI=43; P200=98%

GS AASHTO 09797.GPJ BRAUN.GDT 12/30/16 08:07

GRAIN SIZE ACCUMULATION CURVE (AASHTO)



BRAUN INTERTEC

Braun Project B1609797
Geotechnical Evaluation
CPU-8-081(039)924 - PCN21400 University Drive Improvements
Fargo, North Dakota

BORING: LSSU-2 DEPTH: 1.0'-6.0'

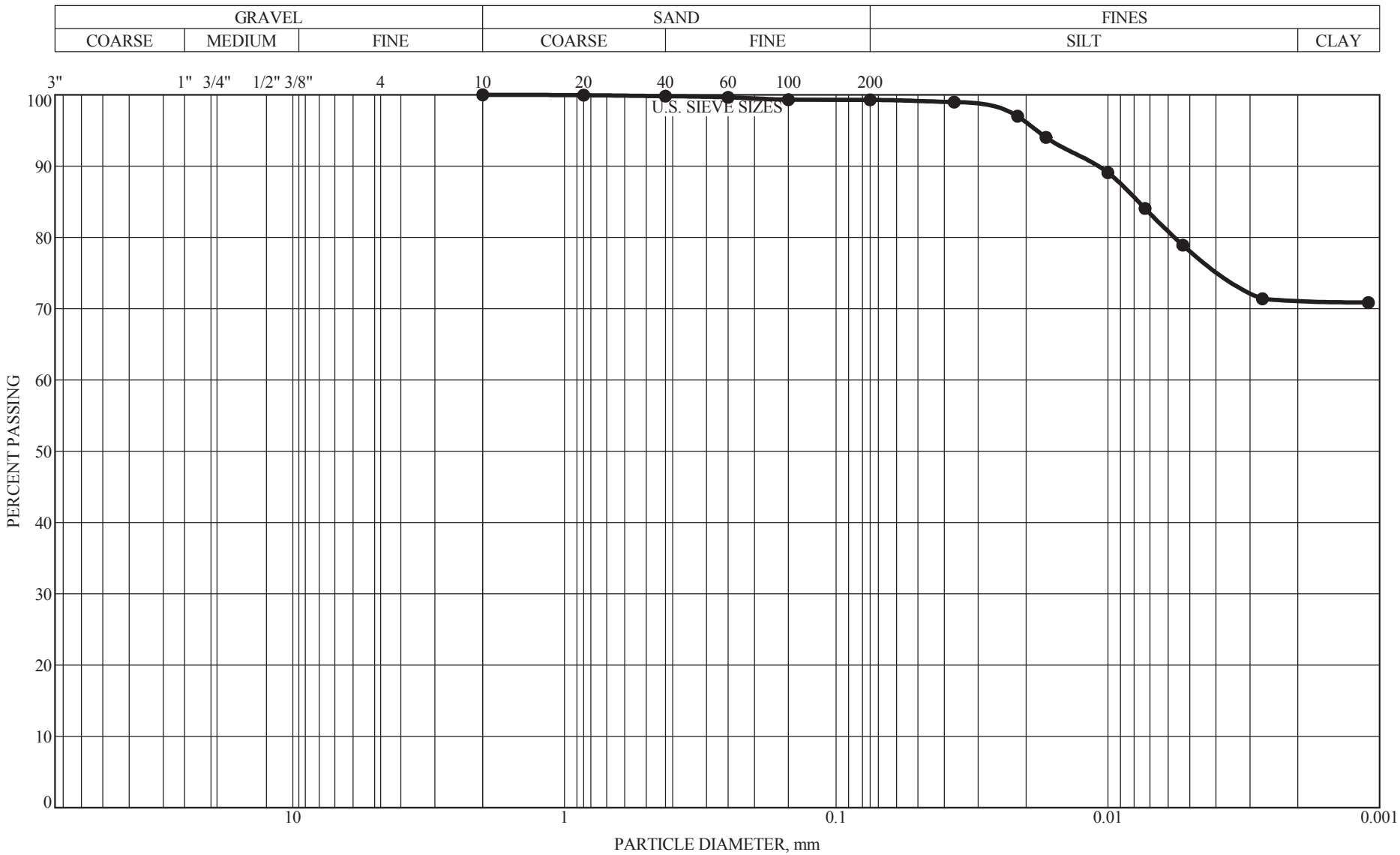
GRAVEL	0.0%
SAND	2.3%
SILT	37.3%
CLAY	60.4%

CLASSIFICATION:
A-7-6 (52), Brown and Gray
FAT CLAY(CH)

LL=64, PL=16, PI=48; P200=98%

GS AASHTO 09797.GPJ BRAUN.GDT 12/30/16 08:07

GRAIN SIZE ACCUMULATION CURVE (AASHTO)



BRAUN INTERTEC

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: LSS94-1 DEPTH: 1.0'-6.0'

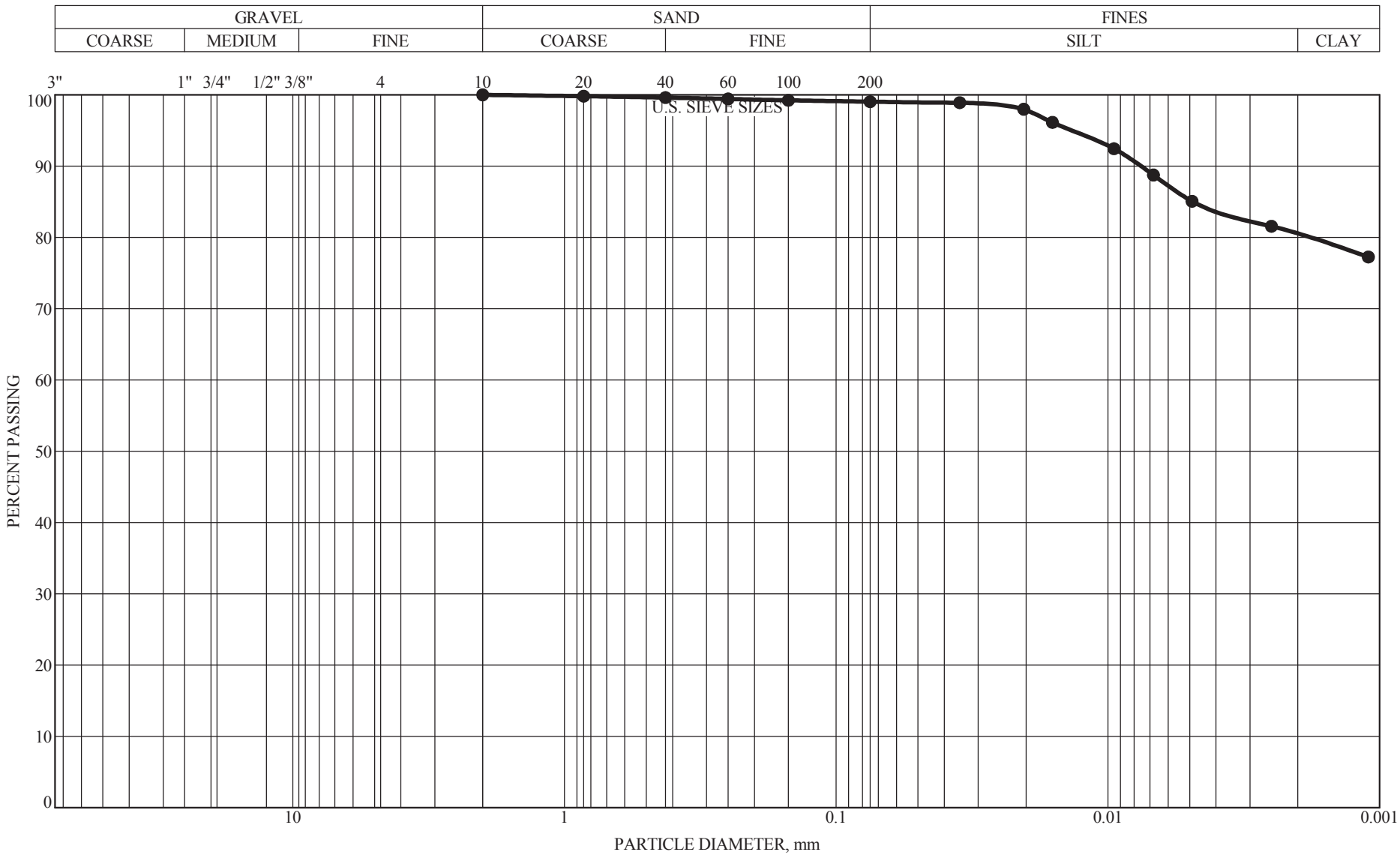
GRAVEL	0.0%
SAND	0.7%
SILT	28.1%
CLAY	71.2%

CLASSIFICATION:
A-7-6 (62), Brown and Gray
FAT CLAY(CH)

LL=76, PL=21, PI=55; P200=99%

GS AASHTO 09798.GPJ BRAUN.GDT 12/8/16 07:53

GRAIN SIZE ACCUMULATION CURVE (AASHTO)



BRAUN INTERTEC

Braun Project B1609798
Geotechnical Evaluation
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
Fargo, North Dakota

BORING: LSS94-2 DEPTH: 1.0'-6.0'

GRAVEL	0.0%
SAND	1.0%
SILT	18.7%
CLAY	80.4%

CLASSIFICATION:
A-7-6 (67), Brown and Gray
FAT CLAY(CH)

LL=83, PL=25, PI=58; P200=99%

GS AASHTO 09798.GPJ BRAUN.GDT 12/8/16 07:53

Braun Intertec Corporation
526 10th Street NE, Suite 300
West Fargo, ND 58078
Phone: 701.232.8701

Proctor Report

Report No: PTR:W16-010283-S1
Issue No: 2

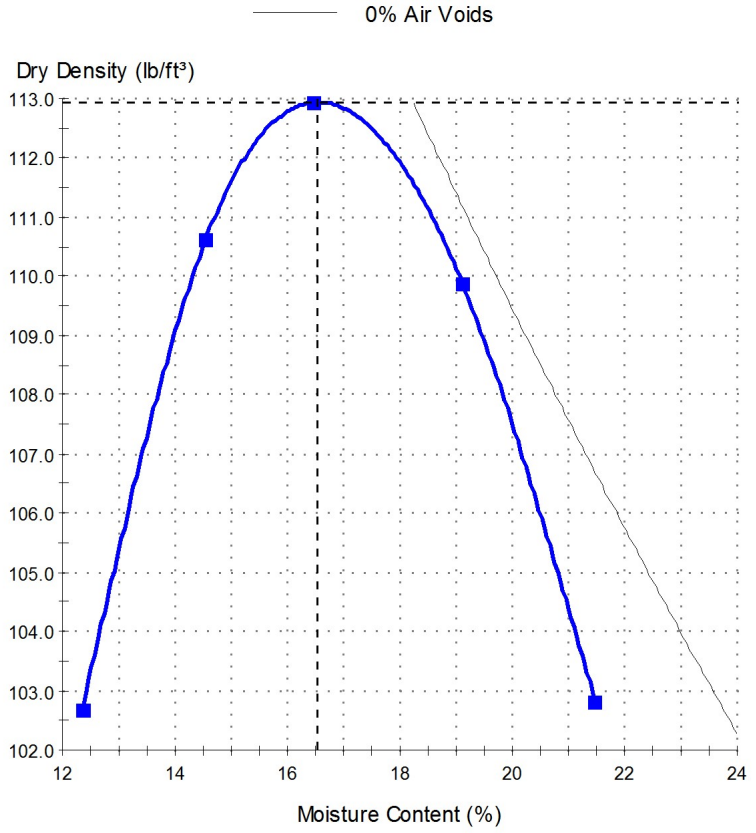
Client: Jeff Lansink
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, ND, 58102
Project: B1609797
CPU-8-081(039)924 - PCN21400 University Drive Improvements
University Drive
Fargo, ND,
TR: Ezra Ballinger, eballinger@braunintertec.com

Brianne Nauman
EIT
Date of Issue: 12/30/2016

Sample Details

Sample ID:	W16-010283-S1	**Alternate Sample ID:**	LSSU-1; 1' to 6'
Date Sampled:	10/25/2016	**Date Submitted:**	10/31/2016
Sampled By:	Gabriel Bevre	**Sampling Method:**	Auger Cuttings
Source:	University Drive Subgrade		
Material:	Fat Clay (CH); A-7-6 (47)		
Specification:	For Informational Purpose Only		
Location:	LSSU-1; 1' to 6'		
Date Tested:	11/4/2016		

Dry Density - Moisture Content Relationship



Test Results

AASHTO T 180 - 01

Maximum Dry Density (lb/ft³):	**113**
Corrected Maximum Dry Density (lb/ft³):	**113**
Optimum Moisture Content (%):	**17**
Corrected Optimum Moisture Content (%):	**17**
Method:	A
Visual Description:	Brown and Gray

Comments

Percent retained on #4 Sieve = 0.0%; Percent passing the #200 sieve = 98.4%
Assumed Specific Gravity = 2.70
LL = 62; PI = 43

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Braun Intertec Corporation
526 10th Street NE, Suite 300
West Fargo, ND 58078
Phone: 701.232.8701

Proctor Report

Report No: PTR:W16-010489-S1
Issue No: 2

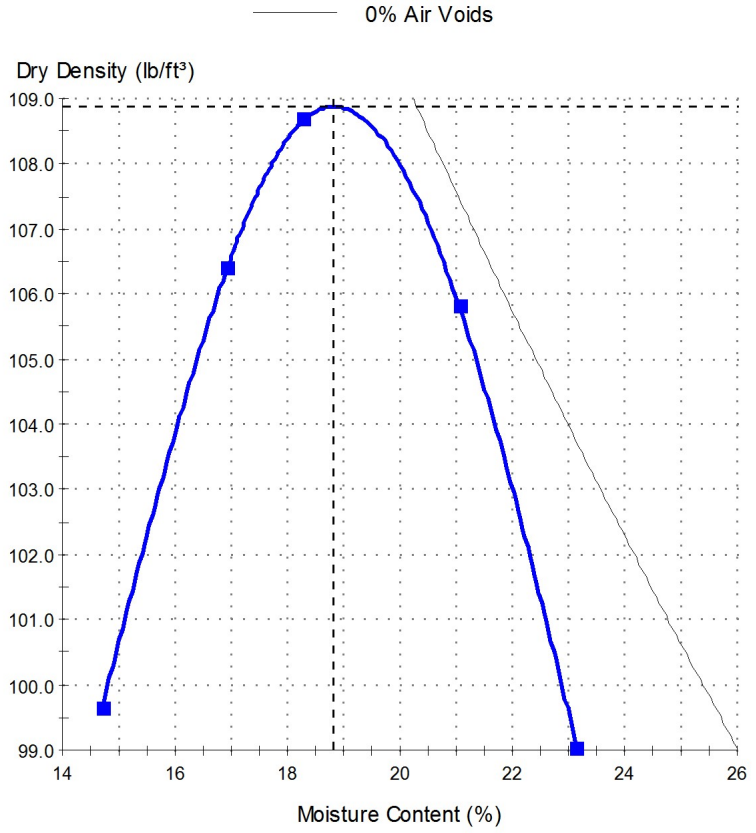
Client: Jeff Lansink
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, ND, 58102
Project: B1609797
CPU-8-081(039)924 - PCN21400 University Drive Improvements
University Drive
Fargo, ND,
TR: Ezra Ballinger, eballinger@braunintertec.com

Brianne Nauman
EIT
Date of Issue: 12/30/2016

Sample Details

Sample ID:	W16-010489-S1	**Alternate Sample ID:**	LSSU-2; 1' to 6'
Date Sampled:	10/25/2016	**Date Submitted:**	10/31/2016
Sampled By:	Gabriel Bevre	**Sampling Method:**	Auger Cuttings
Source:	University Drive Subgrade		
Material:	Fat Clay (CH); A-7-6(52)		
Specification:	For Informational Purpose Only		
Location:	LSSU-2; 1' to 6'		
Date Tested:	11/7/2016		

Dry Density - Moisture Content Relationship



Test Results

AASHTO T 180 - 01

Maximum Dry Density (lb/ft³):	**109**
Corrected Maximum Dry Density (lb/ft³):	**109**
Optimum Moisture Content (%):	**19**
Corrected Optimum Moisture Content (%):	**19**
Method:	A
Visual Description:	Brown and Gray

Comments

Percent retained on #4 Sieve = 0.0%; Percent passing the #200 sieve = 97.7%
Assumed Specific Gravity = 2.70
LL = 64; PI = 48

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Braun Intertec Corporation
526 10th Street NE, Suite 300
West Fargo, ND 58078
Phone: 701.232.8701

Proctor Report

Report No: PTR:W16-010488-S2
Issue No: 1

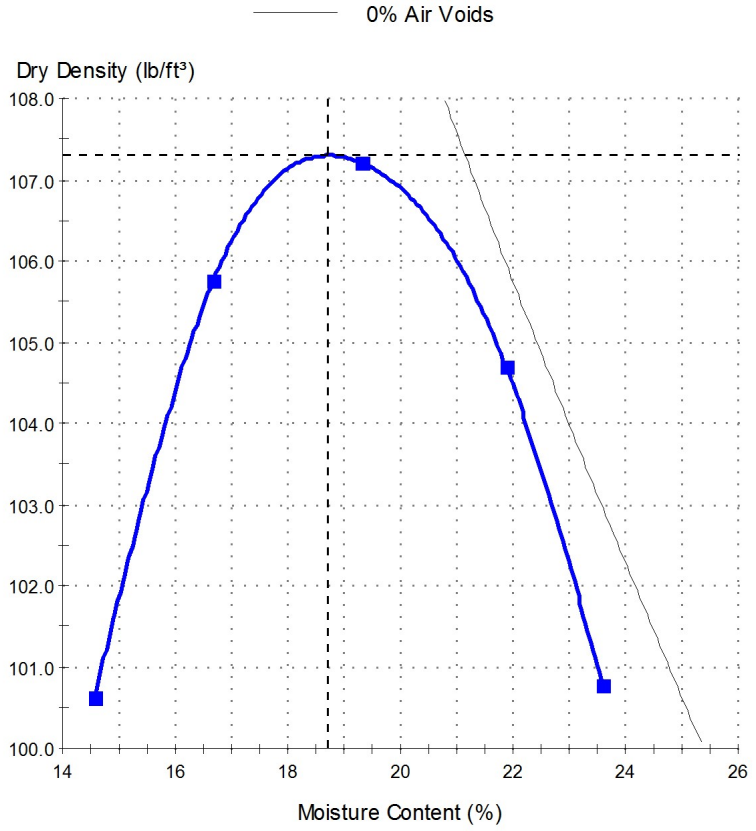
Client: Jeff Lansink
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, ND, 58102
Project: B1609798
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
I-94 Interchange
Fargo, ND,
TR: Ezra Ballinger, eballinger@braunintertec.com

Andrew Lage
Laboratory Coordinator
Date of Issue: 12/9/2016

Sample Details

Sample ID:	W16-010488-S2	**Alternate Sample ID:**	LSS94-1; 1' to 6 '
Date Sampled:	10/25/2016	**Date Submitted:**	10/31/2016
Sampled By:	Gabriel Bevre	**Sampling Method:**	Auger Cuttings
Source:	I-94 WB off ramp subgrade		
Material:	Fat Clay (CH); A-7-6(62)		
Specification:	For Informational Purpose Only		
Location:	LSS94-1; 1' to 6 '		
Date Tested:	11/7/2016		

Dry Density - Moisture Content Relationship



Test Results

AASHTO T 180 - 01

Maximum Dry Density (lb/ft³):	**107**
Corrected Maximum Dry Density (lb/ft³):	**107**
Optimum Moisture Content (%):	**19**
Corrected Optimum Moisture Content (%):	**19**
Method:	A
Visual Description:	Brown and Gray

Comments

Percent retained on #4 Sieve = 0.0%; Percent passing the #200 sieve = 99.3%
Assumed Specific Gravity = 2.70
LL = 76; PI = 55

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Braun Intertec Corporation
526 10th Street NE, Suite 300
West Fargo, ND 58078
Phone: 701.232.8701

Proctor Report

Report No: PTR:W16-010488-S1
Issue No: 1

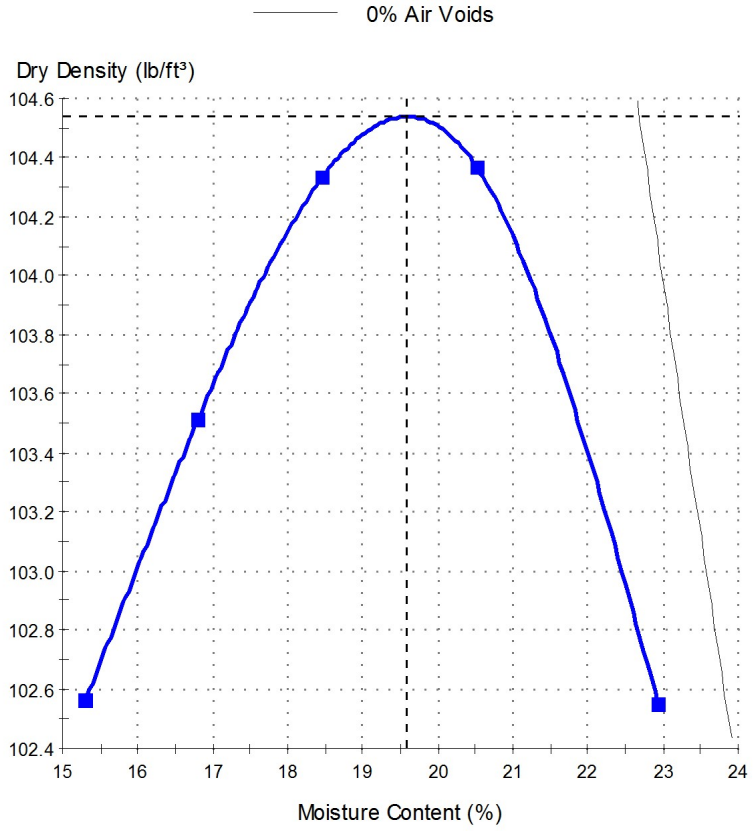
Client: Jeff Lansink
Houston Engineering, Inc.
1401 21st Avenue North
Fargo, ND, 58102
Project: B1609798
IM-8-094(090)351- PCN 21169 I-94 Interchange Improvements
I-94 Interchange
Fargo, ND,
TR: Ezra Ballinger, eballinger@braunintertec.com

Andrew Lage
Laboratory Coordinator
Date of Issue: 12/9/2016

Sample Details

Sample ID:	W16-010488-S1	**Alternate Sample ID:**	LSS94-2; 1' to 6'
Date Sampled:	10/25/2016	**Date Submitted:**	10/31/2016
Sampled By:	Gabriel Bevre	**Sampling Method:**	Auger Cuttings
Source:	I-94 WB off ramp subgrade		
Material:	Fat Clay (CH); A-7-6(62)		
Specification:	For Informational Purpose Only		
Location:	LSS94-2; 1' to 6'		
Date Tested:	11/4/2016		

Dry Density - Moisture Content Relationship



Test Results

AASHTO T 180 - 01

Maximum Dry Density (lb/ft³):	**105**
Corrected Maximum Dry Density (lb/ft³):	**105**
Optimum Moisture Content (%):	**20**
Corrected Optimum Moisture Content (%):	**20**
Method:	A
Visual Description:	Brown and Gray

Comments

Percent retained on #4 Sieve = 0.0%; Percent passing the #200 sieve = 99.0%
Assumed Specific Gravity = 2.70
LL = 83; PI = 58

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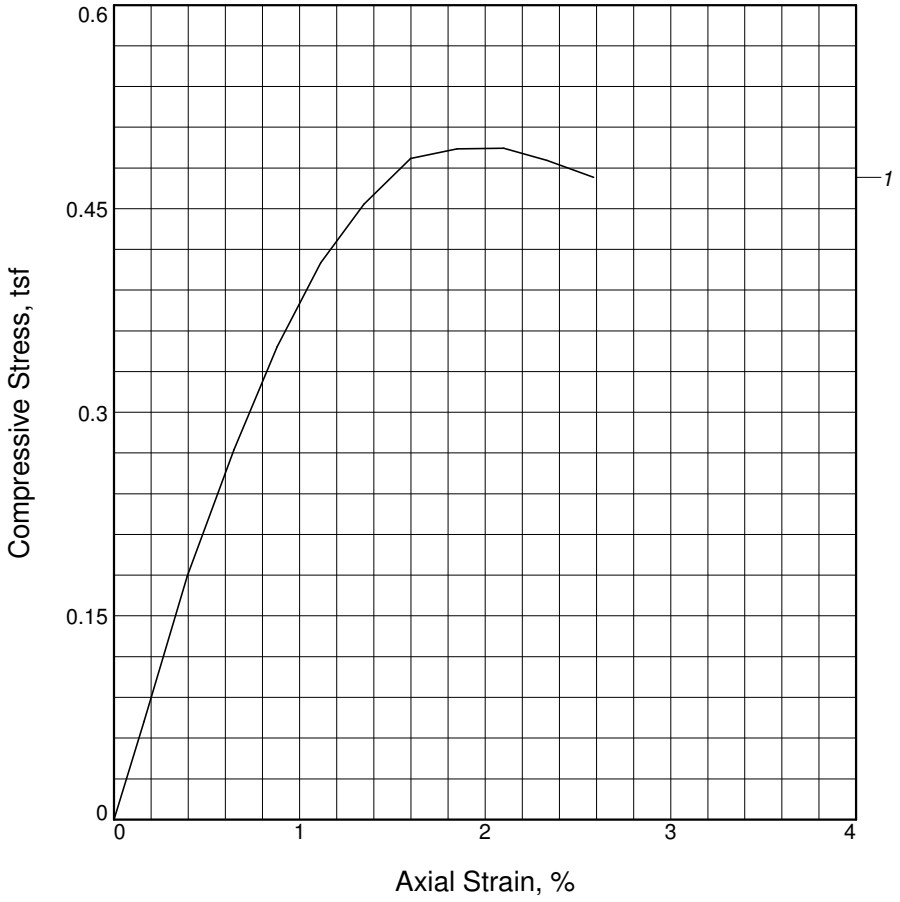
UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.494			
Undrained shear strength, tsf	0.247			
Failure strain, %	2.1			
Strain rate, %/min.	1.00			
Water content, %	70.6			
Wet density, pcf	100.2			
Dry density, pcf	58.7			
Saturation, %	100.0			
Void ratio	1.9755			
Specimen diameter, in.	2.830			
Specimen height, in.	5.570			
Height/diameter ratio	1.97			

Description: FAT CLAY, gray (CH)

LL =	**PL =**	**PI =**	**Assumed GS=** 2.8	**Type:** Thinwall

Project No.: B1609798

Date Sampled: 10/24/2016

Remarks:
ASTM D 2166

Client: Houston Engineering, Inc.

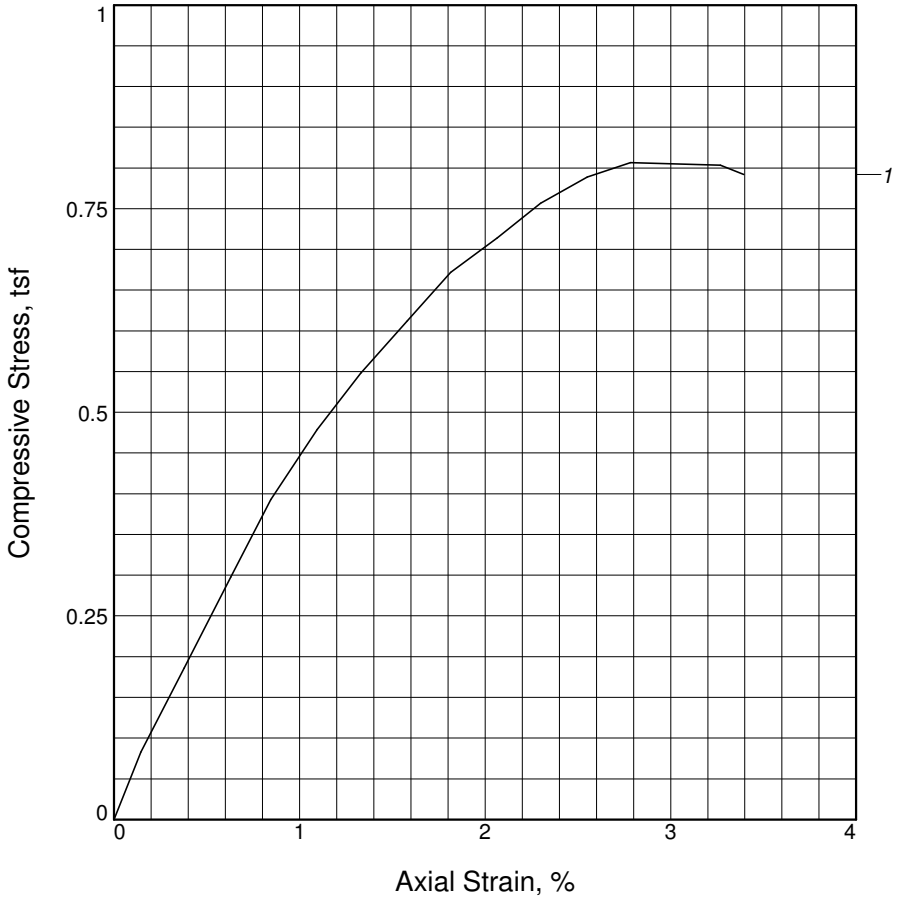
Project: IM-8-094(090)351-PCN 21169 I-94 Interchange Improvements

Sample Number: ST94-1 **Depth:** 34.5-36.5'

Figure _____

BRAUN INTERTEC

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.806			
Undrained shear strength, tsf	0.403			
Failure strain, %	2.8			
Strain rate, %/min.	1.00			
Water content, %	72.7			
Wet density, pcf	98.3			
Dry density, pcf	56.9			
Saturation, %	99.1			
Void ratio	2.0161			
Specimen diameter, in.	2.843			
Specimen height, in.	5.568			
Height/diameter ratio	1.96			

Description: FAT CLAY, gray (CH)

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Thinwall

Project No.: B1609798

Date Sampled: 10/25/2016

Remarks:
ASTM D 2166

Client: Houston Engineering, Inc.

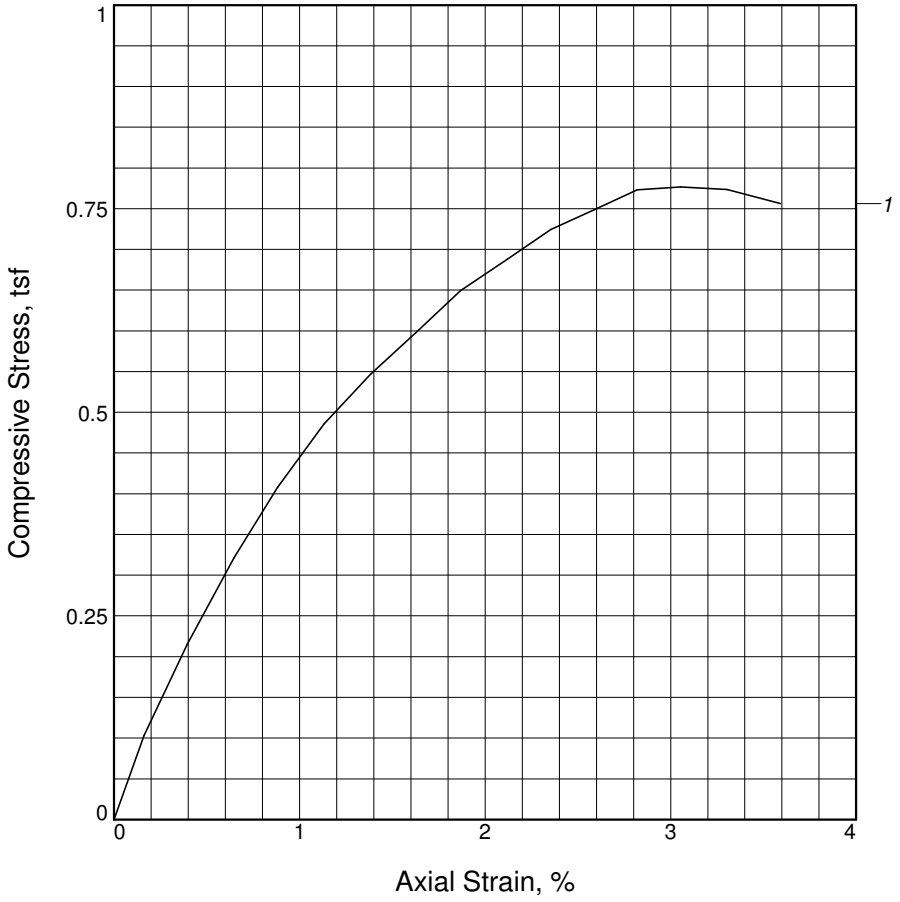
Project: IM-8-094(090)351-PCN 21169 I-94 Interchange Improvements

Sample Number: ST94-2 **Depth:** 29.5-31.5'

Figure _____

BRAUN INTERTEC

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.777			
Undrained shear strength, tsf	0.388			
Failure strain, %	3.1			
Strain rate, %/min.	1.00			
Water content, %	42.9			
Wet density, pcf	110.9			
Dry density, pcf	77.6			
Saturation, %	97.4			
Void ratio	1.2115			
Specimen diameter, in.	2.850			
Specimen height, in.	5.567			
Height/diameter ratio	1.95			

Description: FAT CLAY, brown (CH)

LL =	**PL =**	**PI =**	**Assumed GS=** 2.75	**Type:** Thinwall

Project No.: B1609798

Date Sampled: 10/24/2016

Remarks:
ASTM D 2166

Client: Houston Engineering, Inc.

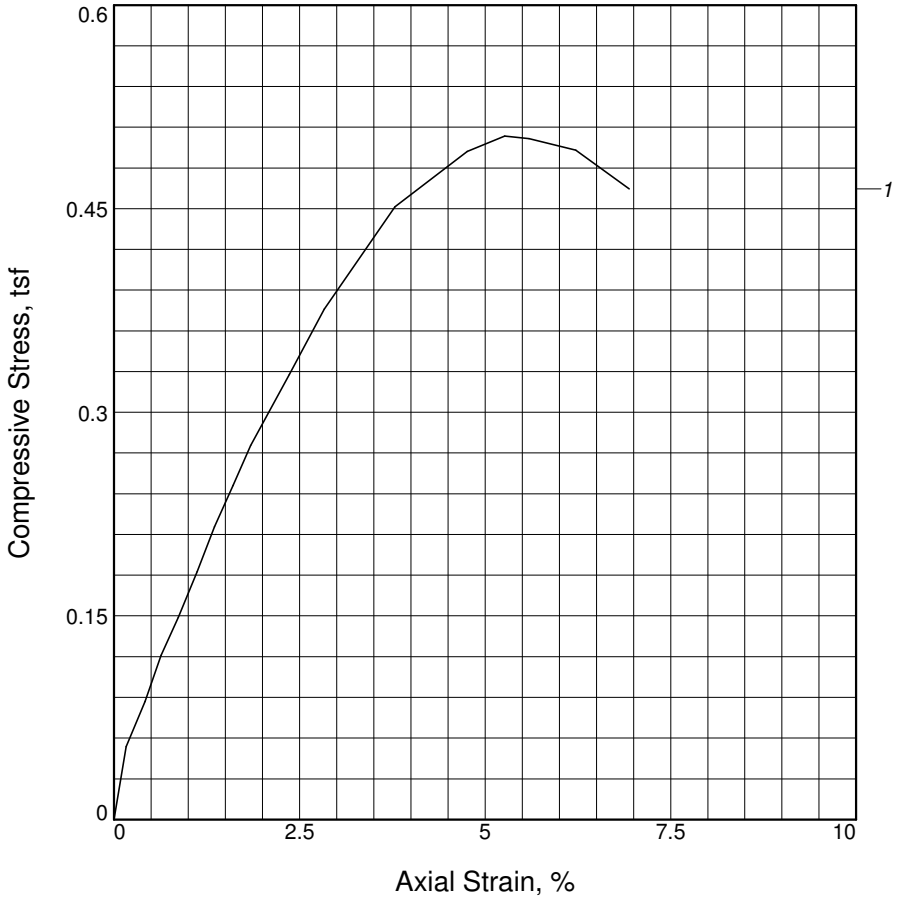
Project: IM-8-094(090)351-PCN 21169 I-94 Interchange Improvements

Sample Number: ST94-3 **Depth:** 7-9'

Figure _____

BRAUN INTERTEC

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.503			
Undrained shear strength, tsf	0.252			
Failure strain, %	5.3			
Strain rate, %/min.	1.00			
Water content, %	41.1			
Wet density, pcf	114.0			
Dry density, pcf	80.8			
Saturation, %	99.8			
Void ratio	1.1413			
Specimen diameter, in.	2.801			
Specimen height, in.	5.546			
Height/diameter ratio	1.98			

Description: FAT CLAY, brown (CH)

LL =	**PL =**	**PI =**	**Assumed GS=** 2.77	**Type:** Thinwall

Project No.: B1609798

Date Sampled: 10/24/2016

Remarks:
ASTM D 2166

Client: Houston Engineering, Inc.

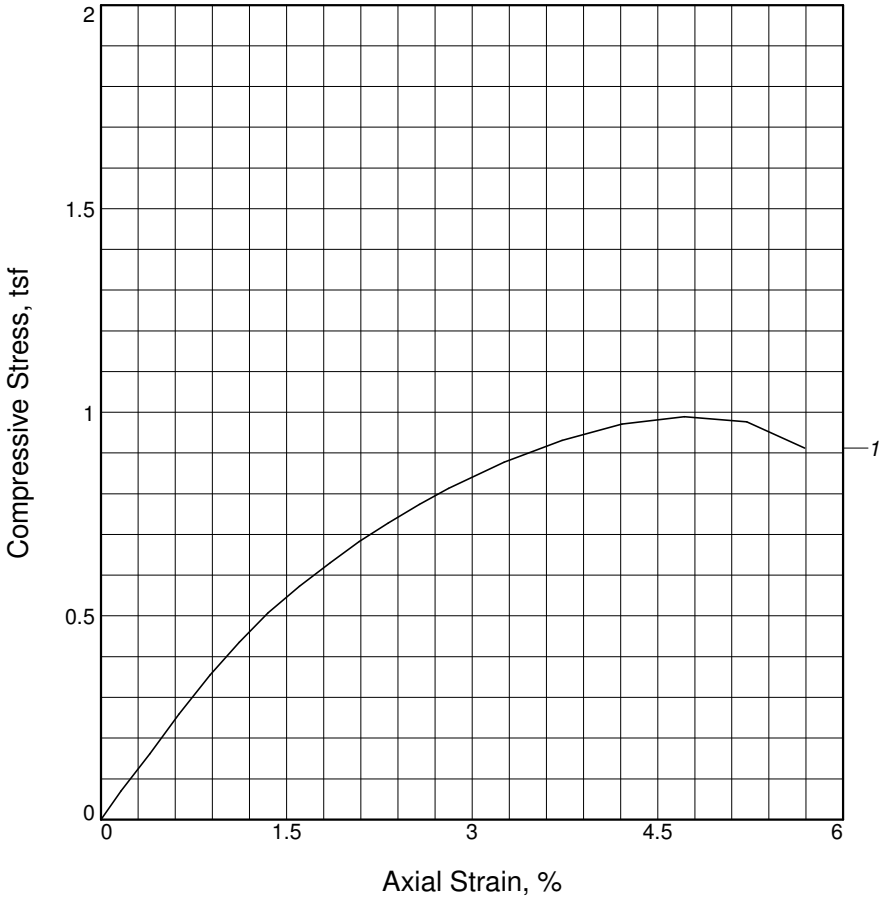
Project: IM-8-094(090)351-PCN 21169 I-94 Interchange Improvements

Sample Number: ST94-4 **Depth:** 14.5-16.5'

Figure _____

BRAUN INTERTEC

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.989			
Undrained shear strength, tsf	0.495			
Failure strain, %	4.7			
Strain rate, %/min.	1.00			
Water content, %	38.9			
Wet density, pcf	111.7			
Dry density, pcf	80.4			
Saturation, %	95.8			
Void ratio	1.0957			
Specimen diameter, in.	2.841			
Specimen height, in.	5.555			
Height/diameter ratio	1.96			

Description: FAT CLAY, brown (CH)

LL =	**PL =**	**PI =**	**Assumed GS=** 2.70	**Type:** Thinwall

Project No.: B1609798

Date Sampled: 10/24/2016

Remarks:
ASTM D 2166

Client: Houston Engineering, Inc.

Project: IM-8-094(090)351-PCN 21169 I-94 Interchange Improvements

Sample Number: ST94-5 **Depth:** 9.5-11.5'

Figure _____

BRAUN INTERTEC