U.S. Department of Veterans Affairs
Washington, DC

Geotechnical Subsurface Investigation
Proposed
National Veterans Burial Grounds
40th Avenue NW (County Road 20)
Raymond Township (Fargo),
Cass County, North Dakota

December 2015

TTL
associates inc
Environmental, Geotechnical Engineering & Testing

TTL associates inc
Environmental, Geotechnical Engineering & Testing

1915 North 12th Street
Toledo, OH 43604-5305
T 419-324-2222
F 419-241-1808
www.ttlassoc.com

December 22, 2015

TTL Project No. 12369.03

U.S. Department of Veterans Affairs
c/o Ms. Belinda Gamble-DiCupe
Savills Studley
1201 F Street, NW
Washington, DC 20004

Geotechnical Subsurface Investigation
Proposed National Veterans Burial Grounds
40th Avenue NW (County Road 20)
Raymond Township (Fargo), Cass County, North Dakota

Dear Ms. Gamble-DiCupe:

Following is the report of the geotechnical subsurface investigation performed by TTL Associates, Inc. (TTL) for the referenced project conducted for Savills Studley on behalf of U.S. Department of Veterans Affairs (VA). This study was performed in accordance with TTL Proposal No. 12369.03, dated December 12, 2014, and authorized by you via a Subcontract Agreement on May 29, 2015. The geotechnical subsurface investigation was subsequently put on hold by Savills Studley until October 26, 2015.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for installation and support of pre-placed crypts, as well as design and construction of columbarium foundations and pavements, for the proposed national veterans burial grounds.

Soil samples collected during this investigation will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

TTL Associates, Inc.

Christopher P. Iott, P.E. (OH 69734)
Senior Geotechnical Engineer

Chett A. Siefring, P.E.
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
CHETT ANTHONY SIEFRING
PE-0455
DATE 12-22-15
NORTH DAKOTA

GEOTECHNICAL SUBSURFACE INVESTIGATION
PROPOSED NATIONAL VETERANS BURIAL GROUNDS
40TH AVENUE NW (COUNTY ROAD 20)
RAYMOND TOWNSHIP (FARGO), CASS COUNTY, NORTH DAKOTA

FOR

U.S. DEPARTMENT OF VETERANS AFFAIRS
811 VERMONT AVENUE, NW
WASHINGTON, DC

SUBMITTED

DECEMBER 22, 2015
TTL PROJECT NO. 12369.03

TTL ASSOCIATES, INC.
1915 NORTH 12TH STREET
TOLEDO, OHIO 43604
(419) 324-2222
(419) 321-6257 FAX

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for the proposed national veterans burial grounds to be constructed on the north side of 40th Avenue NW (County Road 20), between 81st Street and 93rd Street, in Raymond Township (Fargo), Cass County, North Dakota. The approximate site location is shown on the attached Site Location Map (Plate 1.0).

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, discusses our evaluations and conclusions, and provides our recommendations for installation and support of pre-placed crypts, as well as design and construction of columbarium foundations and pavements.

This study was performed in accordance with TTL Proposal No. 12369.03, dated December 12, 2014, and authorized by Ms. Belinda Gamble-DiCupe of Savills Studley via a Subcontract Agreement on May 29, 2015. The geotechnical subsurface investigation was subsequently put on hold by Savills Studley until October 26, 2015.

The purpose of this investigation was to evaluate the subsurface conditions and laboratory data relative to installation and support of pre-placed crypts, as well as design and construction of columbarium foundations and pavements at the referenced site. This investigation included ten test borings, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, and review of available geologic information.

This report includes:

- A description of the subsurface soil and groundwater conditions encountered in the borings.
- Design recommendations for columbarium foundations and pavements.
- Recommendations concerning soil- and groundwater-related construction procedures such as site preparation, excavation for pre-placed crypts, earthwork, foundation and pavement construction, and related field testing.

A Phase I Environmental Site Assessment (ESA) and a NEPA Environmental Assessment will be performed by TTL at the project site, and the results will be provided in separate reports.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included ten test borings, designated as B-1 through B-10, drilled on November 16 and 30, 2015. The borings were drilled in a grid pattern across the site. The borings were located in the field based on an ALTA/ACSM Land Survey Plat of the site prepared by Clark Surveying, Mapping, Geospatial, which was provided via email from Savills Studley on October 26, 2015. The borings were located in the field and completed by a local drilling contractor, Braun Intertec of West Fargo, North Dakota, under the direction of TTL's geotechnical engineer. Ground surface elevations at the boring locations were interpolated to the nearest half-foot based on the provided Survey Plat of the site, which contained ground surface topographic contours. The approximate locations of the borings, as well as the approximate site boundaries are shown on the Test Boring Location Plan (Plate 2.0). As indicated on Plate 2.0, and the provided ALTA/ACSM Land Survey Plat, the project boundary is approximately 80 feet west of the boundary shown on the plan.

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standards D 1452 and D 5434. The test borings performed during this investigation were performed with a drilling rig utilizing 3¼-inch inside diameter hollow-stem augers. Borings B-4, B-6, and B-8 were extended to a depth of 21 feet below existing grade. The remaining borings were extended to a depth of 10 feet.

During auger advancement, soil samples were collected continuously over 18-inch or 24-inch intervals to a depth of 5 feet, at 2½-foot intervals to 15 feet, and at 5-foot intervals thereafter. Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three or four successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. The soil samples were sealed in jars, and the samples were shipped to our laboratory for further classification and testing. Topsoil samples collected using split-spoon samplers were retained for organic content testing as described below.

Shelby tube samples, designated ST on the Logs of Test Borings, were obtained from Borings B-6 (14½ to 16½ feet) and B-8 (8½ to 10½ feet). The Shelby tube samples were obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into relatively undisturbed soil in accordance with ASTM D 1587. The Shelby tubes were then extracted from the subsoils, and the ends were capped and sealed. The samples were transported to the Braun Intertec laboratory where a selected sample was extruded, classified, and tested.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

All recovered samples of the subsoils were visually or manually classified in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 and D 2488). Approximately 90 percent of the samples were tested in our laboratory for moisture content (ASTM D 2216). A dry density determination and an unconfined compressive strength tests by the constant rate of strain method (ASTM D 2166) were performed on the Shelby tube sample obtained from Boring B-6. Unconfined compressive strength estimates were obtained using a calibrated hand penetrometer for the intact cohesive split-spoon samples. Additionally, organic content determinations by the loss-on-ignition (LOI) method (ASTM D 2974) were performed on the topsoil samples. An Atterberg limits test (ASTM D 4318) and a particle size analysis (ASTM D 422) were performed on a selected sample from Boring B-5 (SS-1b) to determine soil classification and index properties. Additionally, an Atterberg limits test was performed on a selected sample from Boring B-4 (SS-4) to determine soil index properties. A particle size analysis was also performed on a selected sample from Boring B-4 (SS-6) to determine soil classification properties. These test results are presented on the Logs of Test Borings, Tabulation of Test Data sheets, and Grain Size Distribution sheet attached to this report.

Two samples were selected for pH determinations (ASTM D 4972). Two additional samples were selected for sulfate content determinations (EPA 9056). These test results are summarized in Section 5.5 of this report. Additionally, the pH results are presented on the Tabulation of Test Data sheets and analytical lab reports of the sulfate content tests are attached to this report.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.0 PROPOSED CONSTRUCTION

It is our understanding that VA is seeking to acquire approximately 4.8 acres of land near Fargo, North Dakota for the establishment of National Veterans Burial Grounds. The site is located along the northern side of 40th Avenue NW (County Road 20), between 81st Street and 93rd Street, in Raymond Township (Fargo), Cass County, North Dakota. The site is located easterly adjacent to the Maple Sheyenne Lutheran Church and the associated Sheyenne Cemetery.

The development will include pre-placed crypts. Bearing depths for the crypts are assumed to be on the order of 7 to 10 feet below existing grades. Loads associated with the crypts were not identified at the time of preparing this report, but are assumed to be light in magnitude. It is assumed that the bearing pressure associated with the crypts will be equal to or less than the existing overburden soil pressure at the crypt bearing depth.

The development will also include columbarium structures. The structure locations, as well as loads associated with the structures, were not identified at the time of preparing this report. Bearing depths for the columbarium structures are assumed to be deeper than the minimum required depth for protection from frost penetration.

Flexible (asphalt) pavements are also anticipated to be constructed as part of the burial grounds development. Traffic loads and volumes were not provided at the time of preparing this report.

It is assumed that final site grades will approximate existing site grades.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

The site is located along the north side of 40th Avenue NW (County Road 20), between 81st Street and 93rd Street, in Raymond Township (Fargo), Cass County, North Dakota. The site is located easterly adjacent to the Maple Sheyenne Lutheran Church and the associated Sheyenne Cemetery. The site is an approximately 4.8-acre area of unimproved, cultivated agricultural land. Based on the provided ALTA/ACSM Land Survey Plat of the site, which included ground surface topographic contours, site grades were generally level, ranging from Elevs. 897 to 900.

Surface materials encountered at the boring locations consisted of topsoil, generally on the order of 6 to 11 inches in thickness. The topsoil encountered in Boring B-2 was approximately 24 inches in thickness. Moisture contents for the topsoil samples ranged from approximately 27 to 35 percent. Organic contents for the topsoil samples ranged from approximately 6 to 11 percent.

According to the US Department of Agriculture (USDA) Web Soil Survey, the near-surface soils at the site are mapped as Fargo silty clays and Fargo-Nutley silty clays. These soils consist of clayey lacustrine (lake-bed) deposits, generally formed on flats. The middle-southern portion of the site was indicated to be formed in a depression. These soils tend to include silt and clay laminations or varves associated with seasonal deposition. These soils exhibit moderately low permeability, and are considered poorly drained. The lacustrine deposits in this area generally exhibit a “crust” of stiffer material in the upper-soil profile. The lacustrine deposits then transition to soft to medium stiff consistency that extends to depths on the order of 90 feet below existing grades where till is encountered.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the encountered subsoils consisted of predominantly cohesive soils that can be generally described as three strata with varying strength characteristics. The cohesive soils consisted of fat clay (CH) with sand. A zone of clayey sand was encountered in the lower-soil profile in two of the three deeper borings.

Stratum I consisted of predominantly stiff to very stiff cohesive soils underlying the topsoil to depths ranging from 2 to 6 feet below existing grade (Elevs. 895± to 892±). SPT N-values generally ranged from 9 to 19 blows per foot (bpf). Unconfined compressive strengths ranged from 5,500 pounds per square foot (psf) to greater than 9,000 psf (maximum reading obtainable using a hand penetrometer). Moisture contents ranged from approximately 23 to 34 percent. A liquid limit of 59 percent and a plasticity index of 33 percent were determined for a sample from this stratum obtained from Boring B-5 (SS-1b). These values, along with particle size analysis results, are indicative of fat clay (CH) as determined in accordance with the Unified Soil Classification System (USCS).

Stratum II consisted of predominantly medium stiff to stiff cohesive soils underlying Stratum I to termination in Borings B-2, B-3 and B-5 at a depth of 10 feet (Elevs. 890± to 889±), and to a depth of 8½ feet (Elevs. 891± to 888±) in the remaining borings. SPT N-values ranged from 5 to 11 bpf, unconfined compressive strengths generally ranged from 1,500 to 4,000 psf, and moisture contents ranged from approximately 29 to 49 percent. A liquid limit of 51 percent and a plasticity index of 25 percent were determined for a sample from this stratum obtained from Boring B-4 (SS-4). These values, along with particle size analysis results, are indicative of a USCS fat clay (CH) designation.

Stratum III consisted of predominantly **soft** to medium stiff cohesive soils underlying Stratum II in Borings B-1, B-7, B-9 and B-10 to termination at a depth of 10 feet (Elevs. 888± to 887±), as well as in Borings B-4, B-6 and B-8 to termination at a depth of 21 feet (Elevs. 879± to 878±). SPT N-values ranged from 1 to 4 bpf, unconfined compressive strengths generally ranged from 1,000 to 2,500 psf, and moisture contents ranged from approximately 33 to 54 percent.

In Borings B-4 and B-8, a zone of **very loose** clayey sand (SC) was encountered within Stratum III from 12 to 14½ feet (Elevs. 887± to 884±). SPT N-values of 3 bpf and 4 bpf, as well as moisture contents on the order of 32 percent and 33 percent were determined for the recovered samples. Based on gradation results for the sample obtained from Boring B-4, the silt and clay fraction of the tested specimen was approximately 48 percent, slightly below the 50 percent demarcation for cohesive soils.

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

4.3 Groundwater Conditions

Groundwater was not initially encountered during drilling or observed upon completion of drilling operations in any of the borings. It should be noted that each boring was drilled and backfilled within the same day, and stabilized water levels may not have occurred over this limited period. Instrumentation was not installed to observe long-term groundwater levels.

Based on the limited data available, such as the soil characteristics and the moisture conditions encountered in the borings, it is our opinion that the “normal” groundwater level may be encountered at depths on the order of 14 to 19 feet below existing grades. However, this investigation did not include research of possible hydrological influences at the project site. It should be noted that groundwater elevations can fluctuate with seasonal and climatic influences. In particular, “perched” water may be encountered in the upper-soil profile within silt laminations. As mentioned in Section 4.1, according to the USDA Web Soil Survey, the near-surface soils are mapped as Fargo silty clays and Fargo-Nutley silty clays. Seasonal high groundwater levels for these soils are indicated to be on the order of 1½ feet below grade up to the ground surface during the months of March through May, with surface ponding also frequent during this period. There is also potential for perched high water table up to 1½ to 3½ feet below grade during the remainder of the year. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this investigation.

5.0 DESIGN AND CONSTRUCTION RECOMMENDATIONS

The following conclusions and recommendations are based on our understanding of the proposed construction and on the data obtained during the field investigation. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL. These recommendations are subject to the satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in the following sections.

5.1 Pre-Placed Crypts

The development will include pre-placed crypts. Bearing depths for the crypts are assumed to be on the order of 7 to 10 feet below existing grades. Loads associated with the crypts were not identified at the time of preparing this report, but are assumed to be light in magnitude. It is assumed that the bearing pressure associated with the crypts will be equal to or less than the existing overburden soil pressure at the crypt bearing depth, on the order of 850 to 1,000 pounds per square foot (psf).

The soils at the bearing depths for the crypts are anticipated to consist of Stratum II medium stiff to stiff cohesive soils and Stratum III **soft** to medium stiff cohesive soils. These soils are considered generally suitable for support of the lightly-loaded crypts. However, the soft bearing materials may require overexcavation and replacement with granular base to provide a working platform for installation of the crypts.

The soils encountered during this investigation, within the anticipated depths of excavation, consist of the following OSHA Type soils:

- OSHA Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- OSHA Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- OSHA Type C soils (cohesive soils with unconfined compressive strengths of 1,000 psf or less, and granular soils).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

Additional excavation recommendations are presented in Section 5.7.

It should be noted that the “normal” groundwater level is anticipated at depths on the order of 14 to 19 feet below existing grades. However, seasonal high and/or perched water conditions may be encountered as shallow as the ground surface. These seasonal high and perched water conditions are not anticipated to significantly affect crypt installation due to the relatively impermeable on-site cohesive soils. However, for long-term design, a subsurface drainage system may be required to drain the groundwater if buried crypts are to remain dry, as well as to for buoyancy concerns. We recommend that a groundwater drainage system be installed due to the potential for seasonal high and perched groundwater within depths of the installed crypts. Additional recommendations for groundwater management during construction are presented in Section 5.6.

If a groundwater drainage system is not installed for the below-grade crypts, consideration should be given to buoyancy to evaluate whether the crypts will remain stable under high water conditions. If the weights of the crypts and overlying soil fill are not enough to resist uplift pressures associated with high water conditions, it may be necessary to tie the crypts to a ballast slab or provide additional fill over the crypts.

5.2 Shallow Columbarium Foundations

The development will include columbarium structures. The structure locations, as well as loads associated with the structures, were not identified at the time of preparing this report. Bearing depths for the columbarium structures are assumed to be deeper than the minimum required depth of 4½ feet for protection from frost penetration. For unheated structures, we recommend foundations extend to a minimum depth of 6 feet below final grade.

The soils encountered in the borings at the anticipated foundation bearing depth of 6 feet below grade are expected to consist of Stratum II medium stiff to stiff cohesive soils. Based on the borings, the Stratum II bearing material may only extend 2½ feet below the bearing depth prior to the presence of Stratum III **soft** to medium stiff cohesive soils. Therefore, the Stratum III soils will also affect bearing capacity and settlement associated with the columbarium structures. In any case, these “layered” soils are considered generally suitable for support of shallow foundations.

Following the satisfactory completion of the site preparation and footing excavation inspections outlined in this section of the report, the proposed structure may be supported on a conventional shallow spread foundation system consisting of wall (strip) and/or column (square) footings. Shallow foundations may be designed utilizing an allowable bearing pressure of 2,800 pounds per square foot (psf) for spread footings. The bearing materials should be field-verified as being native cohesive soils with a minimum unconfined compressive strength of 2,000 psf, or properly placed and compacted new engineered fill.

We strongly recommend that the bearing surface at the bottom of all footing excavations be inspected during construction by a geotechnical engineer or qualified representative. Inspection should be performed to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings and are suitable for bearing. Additionally, the presence of the geotechnical engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of hand penetrometer or other strength tests indicate the exposed soil conditions are not suitable for the design bearing pressure, it may be necessary to increase the footing size to accommodate the lower bearing strengths or to over-excavate and backfill with engineered fill or flowable fill.

If soft cohesive soils or other unsuitable foundation soils are encountered, over-excavation should extend through these materials to suitable bearing soils, but not exceeding 1 foundation width for columns and 2 foundation widths for walls. Additionally, the base of the over-excavation should be widened one foot for every foot of depth and centered along the footing. The over-excavated areas should be backfilled with dense-graded aggregate, placed in controlled lifts, and compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Alternatively, the over-excavated areas could be backfilled with flowable controlled-density fill having a minimum compressive strength of 300 pounds per square inch (psi).

All exterior footings for unheated structures should be constructed at a minimum depth of 6 feet below finished exterior grades for protection from frost penetration. Wall (strip) footings should be at least 18 inches wide and column (square) footings should be at least 30 inches wide, regardless of sizing based on design loads and the allowable bearing pressure.

We recommend that the foundation excavations be concreted as soon as practical after they are excavated and that water not be allowed to pond in any excavation. If it is necessary to leave the bearing surface open for any extended period of time, we recommend that a thin mat of lean concrete be placed over the bottom of the excavation to reduce damage to the surface from weather or construction. Foundation concrete should not be placed on frozen or saturated subgrade.

Based on the above bearing pressure and proper foundation inspection techniques, the total settlement associated with each structure bearing on wall and/or column foundations should not exceed 1 inch and differential settlement should not exceed ¾ inch.

Although not anticipated, “mat” spread foundations may be utilized for support of the columbarium structures. It should be noted that settlement on the order of 2 to 2½ inches was calculated considering a 20-foot square mat with an average bearing pressure of 2,800 psf. If a “mat” spread foundation will be utilized, TTL should be consulted regarding settlement evaluation, and potential need for a reduced bearing pressure depending on project design constraints.

5.3 Subgrades

5.3.1 Existing Subgrade

The subgrades that would result upon the satisfactory completion of the site preparation as described in Section 5.8 of this report are considered generally acceptable for support of the proposed pavements. Based on field and laboratory data developed during this investigation, the subgrade soils consist of native cohesive soils. Laboratory analyses for representative samples, as well as visual descriptions of the upper profile, indicate that the cohesive subgrade soils may be generally classified as Group A-7-6 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) system of soil classification. These soils are considered fair to poor as subgrade materials because they have relatively low permeabilities and a high percentage of silt and clay particles, which makes them susceptible to moisture.

At the time of this investigation, the moisture contents in the upper 3 feet of the subgrade soils ranged from approximately 23 to 32 percent. These moisture contents are estimated to vary from near to significantly above the expected optimum moisture contents for these soils. Therefore, some remedial action should be expected to be required to adjust the moisture contents of the existing materials and achieve proper compaction of the subgrade, especially during wet seasonal periods.

It should be noted that fat clay (CH) subgrade soils tend to be moisture sensitive. Care and diligence will be required to ensure that these clay soils do not undergo a significant increase in moisture content during construction. Otherwise, additional undercut and replacement with new engineered fill may be required due to unstable subgrade conditions.

5.3.2 Modified Subgrade

Although not anticipated to be prevalent, if soils are dry of optimum, water should be uniformly mixed into the subgrade. More likely to be encountered at this site are soils that are wet of optimum. Where soils wet of optimum are encountered, lowering the moisture content by scarification and aeration (discing and exposure to sun and wind) may be required. However, this may not be feasible if construction occurs during wet seasonal conditions. Very moist to wet soils will “pump” under the operation of heavy equipment, resulting in deep rutting and perhaps rendering the operation of grading and paving equipment difficult or impossible.

Therefore, other methods of subgrade modification may be required in areas of high moisture content. Modification may be achieved by undercutting and replacement with granular subbase (possibly in combination with a geotextile separation layer or geogrid reinforcement), mixing stone into the subgrade, or treating the subgrade with lime or cement. The method of subgrade modification should be determined at the time of construction (See Section 5.8, “Site and Subgrade Preparation”).

5.4 Pavements

5.4.1 Flexible (Asphalt) Pavement

Based on the results of the gradation analyses, as well as visual classification of the recovered samples, we recommend a subgrade CBR value of 3 percent for the Group A-7-6 or better subgrade soils. This CBR value is based on subgrade compacted to at least 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof rolling.

It should be noted that we are not privy to the design traffic loads or intended design life. The subgrade support recommendations indicated herein should be reviewed by the site engineer in conjunction with the design traffic criteria to determine the required pavement sections. In any case, we recommend the light-duty pavement cross-section consist of at least 4 inches of asphalt underlain by 8 inches of aggregate base for even the lightest-duty pavements based on our experience regarding environmental exposure and reasonable serviceability. For the same reason, we recommend the heavy-duty pavement cross-section (at a minimum, for any heavy equipment or large trucks) consist of at least 5 inches of asphalt underlain by 12 inches of aggregate base. All paving operations should conform to North Dakota Department of Transportation specifications. The pavement and subgrade preparation procedures outlined in this report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all flexible pavements need repairs or overlays from time to time as a result of progressive yielding under repeated traffic loads for a prolonged period of time, as well as exposure to weather conditions.

5.4.2 Rigid (Concrete) Pavement

For properly prepared subgrade materials, a modulus of subgrade reaction (k) of 100 pounds per cubic inch (pci) may be used for rigid pavement design. A concrete pavement section is recommended in the loading-unloading areas, areas of repetitive turning, site exit and entrance aprons, and trash enclosure areas (including where the truck parks while servicing the container). This section should consist of a minimum of 6 inches of reinforced, air-entrained concrete with a minimum compressive strength of 3,500 pounds per square inch (psi) underlain by a minimum of 6 inches of a dense-graded granular base. The pavement section should be supported on a subgrade compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof rolling. All paving operations should conform to North Dakota Department of Transportation specifications.

5.4.3 Pavement Drainage

Based on the poorly-drained nature of the cohesive subgrade soils, it is anticipated that surface water infiltration may collect in the aggregate base course. Without adequate drainage, water will remain in the base for extended periods of time, creating localized wet, soft pockets. The presence of these pockets will increase the likelihood that pavement distress (cracking, potholes, etc.) will develop. Drainage features may include grading the subgrade surface to slope downward to the outside edge of pavements and/or providing longitudinal edge drains connected to storm sewers or other outlets. A system of “finger drains” could also be installed near catch basins within the pavement areas to collect surface water.

5.5 Corrosion Considerations

Corrosion characteristics were evaluated for selected soil samples. The samples were tested for pH or sulfate content. The results of the corrosivity tests are summarized as follows:

Table 5.5. Corrosivity Test Results

Boring Number/ Sample	Approximate Sample Depth (feet)	pH	Sulfate Content (mg/kg)
B-3 (SS-3)	3½ – 5	8.4	–
B-3 (SS-4)	6 – 7½	–	42
B-5 (SS-4)	6 – 7½	8.2	–
B-8 (SS-4)	6 – 7½	–	88

This range of pH is characterized as moderately alkaline soil reaction by the USDA Soil Conservation Service. Typically, soils with a pH range between 5 and 9 are not considered to represent a significant corrosion risk to buried structural concrete or underground utilities.

The sulfate content for the tested samples ranged from 42 to 88 mg/kg (equivalent to parts per million, ppm). The American Concrete Institute (ACI) in "Building Code Requirements for Structural Concrete (ACI 318) and Commentary" indicates that, for concrete in sulfate exposures, concentrations up to 1,000 ppm are considered "low" sulfate exposure, for which there is no type restriction for Portland cement.

We recommend that the structural engineer and/or civil engineer review the above data with respect to design of buried structural concrete and underground utilities for this project. If potential corrosion is considered problematic for "normal" design of these structures, options to address potential corrosion could include the use of Type II Portland cement. For underground utilities, plastic pipes (e.g. PVC) for storm sewers, sanitary sewers and water lines could be used in lieu of ductile iron, CMP or concrete. In any case, state and local building codes must be followed.

5.6 Groundwater Control and Drainage

Groundwater conditions for the borings performed for this investigation are summarized in Section 4.3. Based on the limited data available, such as the soil characteristics and the moisture conditions encountered in the borings, it is our opinion that the "normal" groundwater level may be encountered at depths on the order of 14 to 19 feet below existing grades. However, "perched" water may be encountered in the upper-soil profile within silt laminations. As mentioned in

Section 4.3, seasonal high groundwater levels for the on-site upper-profile cohesive soils are indicated to be on the order of 1½ feet below grade up to the ground surface during the months of March through May, with surface ponding also frequent during this period. There is also potential for perched high water table up to 1½ to 3½ feet below grade during the remainder of the year.

It is our experience that adequate control of groundwater seepage, perched water, or surface water run-off into shallow excavations extending even a few feet below the groundwater table in cohesive soils should be achievable by minor dewatering systems, such as pumping from prepared sumps. In the event excessive seepage is encountered during construction, TTL may be notified to evaluate whether other dewatering methods are required.

5.7 Excavations and Slopes

The sides of temporary excavations for pre-placed crypts, columbarium foundations, utility installations, and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Un-braced excavations should meet the side-slope criteria presented in Section 5.1. For permanent excavation slopes, we recommend that grades be no steeper than 3 horizontal to 1 vertical (3H:1V) without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

5.8 Site and Subgrade Preparation

Prior to proceeding with construction operations, all topsoil, root mat, vegetation, and other deleterious non-soil materials should be removed from the proposed construction areas. Suitable topsoil may be stockpiled for later use in landscape areas. **Topsoil encountered at the boring locations was generally on the order of 6 to 11 inches in thickness, although topsoil thicknesses may vary across the site, particularly with the previous agricultural use.** Organic contents for the topsoil samples ranged from approximately 6 to 11 percent. Dark soils having the appearance of topsoil but exhibiting only **root "hairs"** or trace organics less than approximately two or three percent may not require stripping for the full depth of the darkly colored zone. Additionally, there may be areas where stripping of soils with organics in excess of the thicknesses referenced in the borings is required. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.

It should be noted that the USDA Web Soil Survey indicates that the mapped soils at the site exhibit very limited suitability for lawns and landscaping, due to the clayey soils that are susceptible to saturated conditions and ponding. In any case, the tested "topsoil" samples contained generally suitable organic contents.

Upon completion of the stripping and clearing, the areas intended to support new fill and pavements should be carefully inspected by a geotechnical engineer. At that time, the engineer may require proof rolling of the cohesive subgrades utilizing a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The truck should make several passes throughout proposed fill and pavement areas, with additional passes as necessary to achieve required compaction and/or subgrade stabilization. Installation of site stormwater utilities early in the site grading activities will also help to alleviate any "perched" or ponded water conditions and achieve a more stable subgrade.

The purpose of proof rolling the cohesive subgrades is to locate any weak, soft, or excessively wet soils that may be present at the time of construction. Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. Once the site has been proof rolled, inspected, and stabilized, the proof-rolled or inspected subgrades should not be exposed to wet conditions. It should be recognized that, during periods of wet weather, the clayey soils that will be exposed at design subgrades will tend to pond water for short periods of time, with the potential to deteriorate the prepared subgrade. **It should be noted that fat clay (CH) subgrade soils tend to be moisture sensitive. Care and diligence will be required to ensure that these clay soils do not undergo a significant increase in moisture content during construction. Otherwise, additional undercut and replacement with new engineered fill may be required due to unstable subgrade conditions.**

The results of the inspection and proof-rolling operations will be partially dependent on construction operations, the moisture content of the soil, and the weather conditions prevalent at the time. If pumping or rutting is encountered and difficulty is experienced in the operation of construction equipment, TTL should be notified in order to determine which method of subgrade modification may be best suited for the conditions encountered. Should such conditions be experienced, we may recommend that a small test area be used to determine the necessary depth of undercutting and stone replacement or other remedial action necessary to achieve a stable subgrade condition.

5.9 Fill

Material for engineered fill or backfill required to achieve design grades may consist of any non-organic soils having a maximum dry density as determined by the Standard Proctor (ASTM D 698) of 90 pounds per cubic foot (pcf) or greater. If fat clay (CH) borrow materials are brought on-site, they should be no worse than the on-site soils, with respect to liquid limit and plasticity index.

On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. **It should be noted that fat clay (CH) site soils tend to be moisture sensitive. Care and diligence will be required to ensure that these clay soils do not undergo a significant increase in moisture content during construction.** Depending on seasonal conditions, the on-site soils may be wet of optimum and may require scarification and aeration to achieve satisfactory compaction. Diligent scarification and aeration activities will likely be required for moisture conditioning of the cohesive soils. If the construction schedule does not allow for scarification and aeration activities, it may be more practical or economical to utilize imported granular fill.

Fill should be placed in uniform layers no more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill within structure areas and pavement subgrades should be compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor).

The subgrade soils the site consist of native cohesive soils. The contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive subgrade soils. For engineered fill consisting of granular materials, a vibratory smooth-drum roller would provide effective compaction of these materials. In narrow utility or footing excavations, the on-site cohesive soils may be difficult to compact; therefore, a clean granular material may be required in these areas.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

5.10 Seismic Considerations

We have reviewed seismic design parameters in accordance with International Building Code (IBC) criteria. It should be noted that the IBC seismic site characterization is based on the upper 100 feet of the geologic profile and the borings performed for this investigation extended only to a maximum depth of 21 feet below existing grade. Without site data regarding the strength and depth of the till underlying the Stratum III soft to medium stiff lacustrine deposits, the Stratum III deposits were modeled to a depth of 100 feet.

The OBC criteria for the s_u-method (for cohesive soil layers with a plasticity index $PI > 20$) are based on site characterization using undrained shear strengths determined by ASTM D 2166 or D 2850. Based on the limited scope of this investigation, evaluation was based predominantly on unconfined compressive strengths determined using a hand penetrometer, supplemented with a strength determined from ASTM D 2166 methods for a Stratum III Shelby tube sample. Although not encountered, the lower-profile till may be considered a "cohesionless" soil layer (if exhibiting $PI < 20$) for which the N_{ch} or N-method is also considered.

Based on the unconfined compressive strengths determined for the overburden soils at the site, and projection of Stratum III to a depth of 100 feet, the average undrained shear strength (s_u) was calculated to be approximately 935 pounds per square foot (psf). Using the s_u-method, based on IBC Table 1613.5.5 criteria, the average undrained shear strength narrowly falls below 1,000 psf, indicative of a Site Class E "soft soil" designation. Using the N-method, the average SPT N-value (N_{ch}) was calculated to be approximately 3 blows per foot (bpf), much less than 15 bpf which is also indicative of a Site Class E "soft soil" designation in accordance with IBC Table 1613.5.5 criteria.

If a Site Class E designation will be restrictive to structural design, it may be prudent to perform deeper SPT borings for seismic site class evaluations, to determine if a better site class designation is appropriate. However, there is no guarantee that such testing would yield a more favorable site class designation.

An alternate method to evaluate seismic site class incorporates shear wave velocity. Development of a shear wave velocity profile is typically performed in conjunction with down-hole or cross-hole seismic testing, which would require additional boreholes and specialized testing equipment. It should be noted that shear wave velocity testing is comparatively costly and, like the deeper SPT borings, there is no guarantee that such testing would yield a more favorable site class designation.

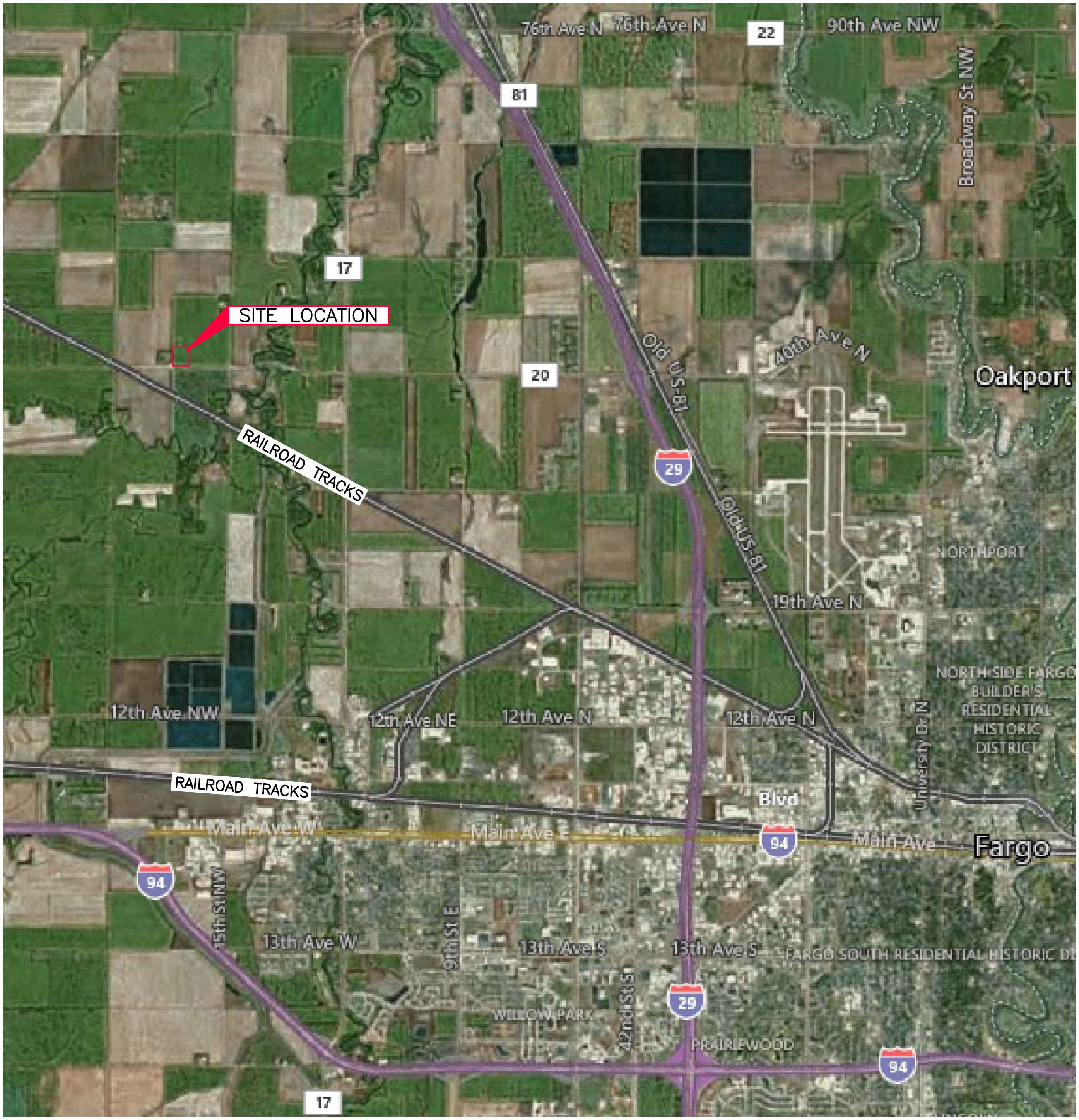
6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of pre-placed crypt, columbarium, and pavement soils-related design and construction conditions has been based on our understanding of the site and project information, as well as the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data obtained at the boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, a qualified geotechnical engineer should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.



LEGEND

🟥 APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – FEET

0 7,000 14,000

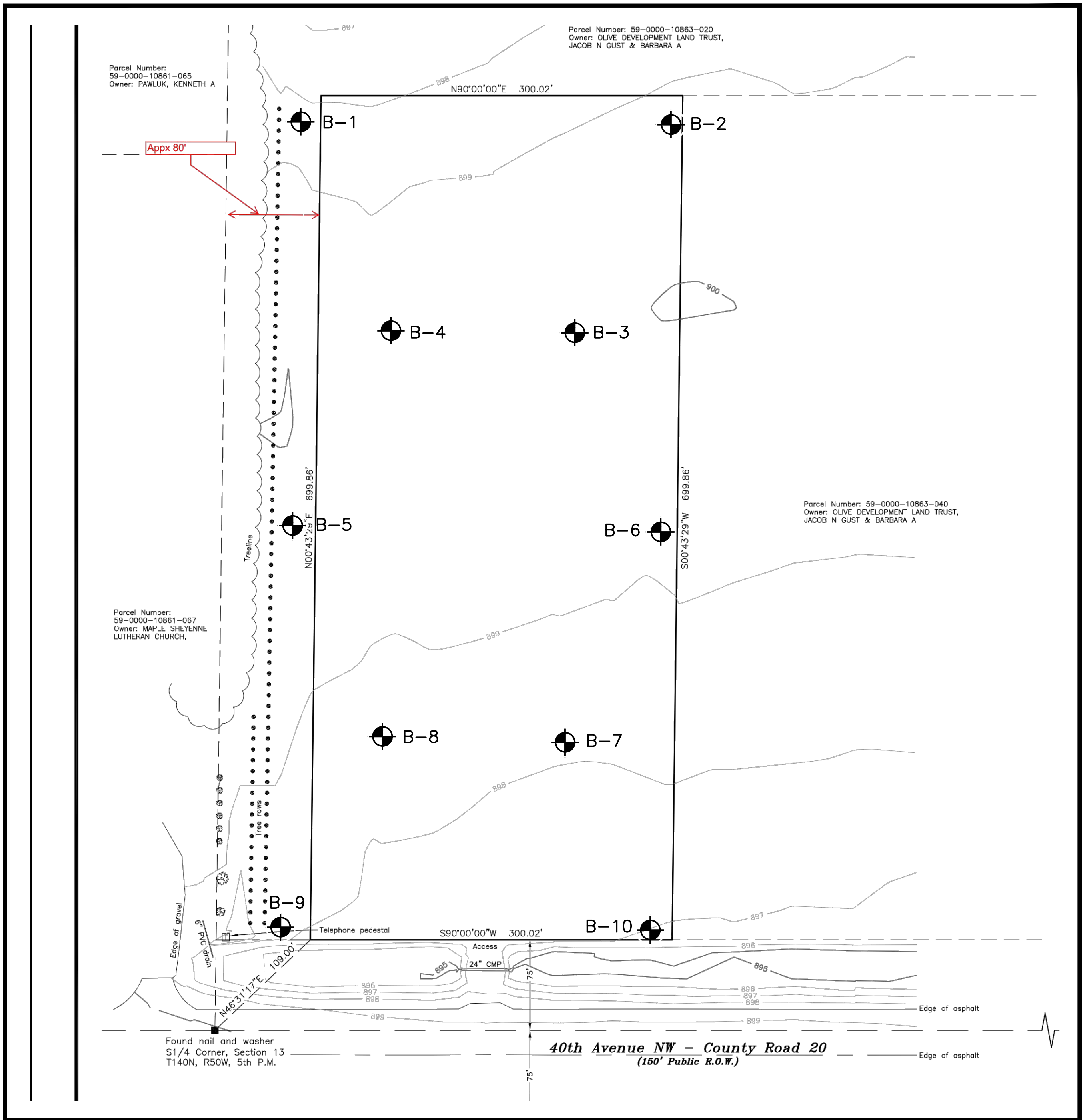
PLATE 1.0
SITE LOCATION MAP

PROPOSED NATIONAL VETERANS BURIAL GROUNDS
40TH AVENUE NW (COUNTY ROAD 20)
RAYMOND TOWNSHIP (FARGO),CASS COUNTY,NORTH DAKOTA

PREPARED FOR
U.S. DEPARTMENT OF VETERANS AFFAIRS
WASHINGTON, DC

DRAWN	TRR/12–7–15	CHECKED	CPI/12–7–15
REVISED		APPROVED	
JOB NO.	12369.03		
DRAWING NUMBER	**1236903–01G**		

TTL associates inc
Environmental, Geotechnical Engineering & Testing



LEGEND

B–1 ⊕ APPROXIMATE BORING LOCATION

APPROXIMATE SCALE – FEET

0 125 250

PLATE 2.0
TEST BORING LOCATION PLAN

PROPOSED NATIONAL VETERANS BURIAL GROUNDS
40TH AVENUE NW (COUNTY ROAD 20)
RAYMOND TOWNSHIP (FARGO), CASS COUNTY, NORTH DAKOTA

PREPARED FOR
U.S. DEPARTMENT OF VETERANS AFFAIRS
WASHINGTON, DC

DRAWN	TRR/12–7–15	CHECKED	CPI/12–7–15
REVISED		APPROVED	
JOB NO.	12369.03		
DRAWING NUMBER	**1236903–02G**		

TTL associates inc
Environmental, Geotechnical Engineering & Testing

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND

DRILLING CONTRACTOR Braun Intertec KM DC

RIG NO. 7512

GROUND ELEVATION 898 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 11/16/15

COMPLETED 11/16/15

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY CPI

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 / ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 8 Inches 0.7'	SS 1A	100	1	2.50		33
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Organics (CH) @2': Brown/Gray, w/Trace Calcite Stain	SS 1B	100	4-7-8 (11)	>4.5		24
895				SS 2	100	3-7-8 (15)	>4.5		23
	5		@3.5': Very Stiff, Gray 6.0'	SS 3	100	3-7-9 (16)	>4.5		27
890			Moist Medium Stiff to Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH) 8.5'	SS 4	100	2-3-4 (7)	1.50		42
	10		Wet Soft Brown/Gray FAT CLAY w/Sand and Trace Iron Oxide Stain Seam (CH) (Free Water Noted in Jar) 10.0'	SS 5	100	2-2-2 (4)	0.50		33
			Bottom of hole at 10.0 feet.						

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-2

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND

DRILLING CONTRACTOR Braun Intertec KM DC

RIG NO. 7512

GROUND ELEVATION 899 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 11/30/15

COMPLETED 11/30/15

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY CPI

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 24 Inches [Moist Medium Stiff Black FAT CLAY w/Sand and Trace Organics (CH)] 2.0'	SS 1	100	1-2-5-8 (7)	>4.5		27
			Moist Stiff to Very Stiff Brown/Gray FAT CLAY w/Sand and Trace Organics (CH)	SS 2	100	3-6-8 (14)	>4.5		26
895	5		@3.5': w/Trace Calcite Stain Seam	SS 3	100	2-5-7 (12)	3.00		32
			6.0'						
			Moist Medium Stiff to Stiff Brown/Gray FAT CLAY w/Sand and Trace Calcite Stain Seam (CH)	SS 4	100	2-3-3 (6)	1.25		44
890	10		10.0'	SS 5	100	1-3-3 (6)	1.50		49
			Bottom of hole at 10.0 feet.						

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-3

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12369.03
PROJECT LOCATION Fargo, ND
DRILLING CONTRACTOR Braun Intertec KM DC
RIG NO. 7512
GROUND ELEVATION 900 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 11/30/15
COMPLETED 11/30/15
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
900	0		TOPSOIL - 11 Inches 0.9'						
			Moist Stiff to Very Stiff Brown/Gray FAT CLAY w/Sand and Trace Calcite Stain Seam (CH)	SS 1	100	2-2-4-9 (6)	>4.5		26
				SS 2	100	3-6-8 (14)	>4.5		23
895	5			SS 3	100	3-5-7 (12)	3.00		32
			6.0'						
			Moist Medium Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH)	SS 4	100	2-3-4 (7)	0.75		44
			@8.5': Medium Stiff to Stiff	SS 5	100	1-3-3 (6)	1.50		40
890	10		10.0'						
			Bottom of hole at 10.0 feet.						

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-4

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND

DRILLING CONTRACTOR Braun Intertec KM DC

RIG NO. 7512

GROUND ELEVATION 899.5 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 11/16/15

COMPLETED 11/16/15

AT TIME OF DRILLING None

LOGGED BY KKC

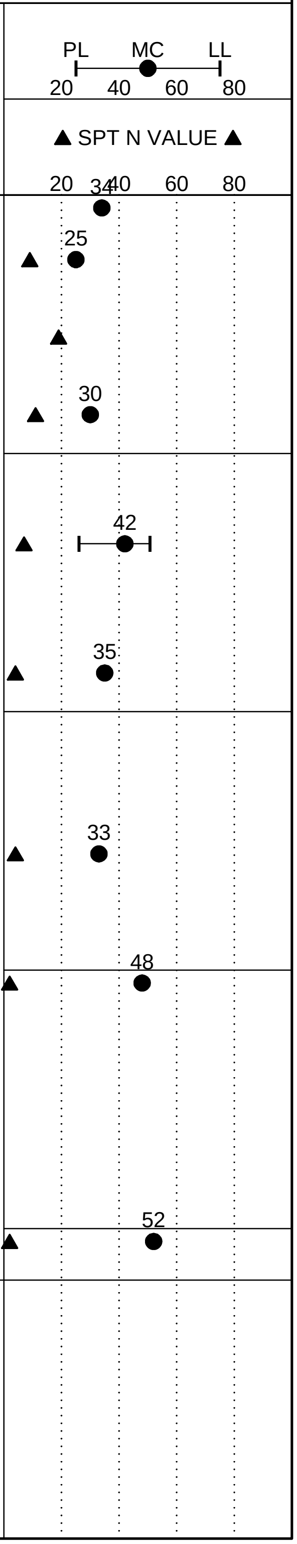
CHECKED BY CPI

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	MC (PL, LL; ▲ SPT N VALUE ▲)
	0		TOPSOIL - 6 Inches 0.5'	SS 1A	100	1	2.50		34
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand (CH)	SS 1B	100	3-6-8 (9)	>4.5		25
			@2': Very Stiff, Brown/Gray, w/Trace Calcite Stain Seam 3.5'	SS 2	100	5-9-10 (19)	>4.5		
895	5		Moist Stiff Brown/Gray FAT CLAY w/Sand (CH)	SS 3	100	3-5-6 (11)	1.50		30
			@6': Medium Stiff to Stiff 8.5'	SS 4	100	2-3-4 (7)	1.50		42
890	10		Moist Soft Brown FAT CLAY w/Sand and Trace Iron Oxide Stain Seam (CH) 12.0'	SS 5	100	1-2-2 (4)	0.50		35
			Moist Very Loose Brown CLAYEY SAND (SC) 14.5'	SS 6	100	1-2-2 (4)	NP		33
885	15		Moist Very Soft to Soft Brown/Dark Gray FAT CLAY w/Sand and Trace Organics (CH)	SS 7	100	0-1-1 (2)	NI		48
880	20		@19.5': Gray 21.0'	SS 8	100	0-1-1 (2)	0.50		52
			Bottom of hole at 21.0 feet.						



TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-5

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12369.03
PROJECT LOCATION Fargo, ND
DRILLING CONTRACTOR Braun Intertec KM DC
RIG NO. 7512
GROUND ELEVATION 899.5 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 11/16/15
COMPLETED 11/16/15
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL (20 40 60 80) / ▲ SPT N VALUE ▲ (20 40 60 80)
	0		TOPSIL - 6 Inches	SS 1A	100	1	2.50		34
			0.5'						
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand (CH) (w/Trace Organics in SS-1B and SS-2 Sample)	SS 1B	100	3-8-9 (11)	>4.5		27
			@2': Brown/Gray, w/Trace Calcite Stain Seam	SS 2	100	5-7-7 (14)	>4.5		24
895	5		@3.5': w/Trace Iron Oxide Stain Seam	SS 3	100	4-6-7 (13)	>4.5		34
			6.0'						
			Moist Stiff Brown/Gray FAT CLAY w/Sand (CH)	SS 4	100	2-4-5 (9)	1.50		
890	10		@8.5': Medium Stiff Gray/Brown	SS 5	100	2-3-4 (7)	NI		35
			10.0'						
			Bottom of hole at 10.0 feet.						

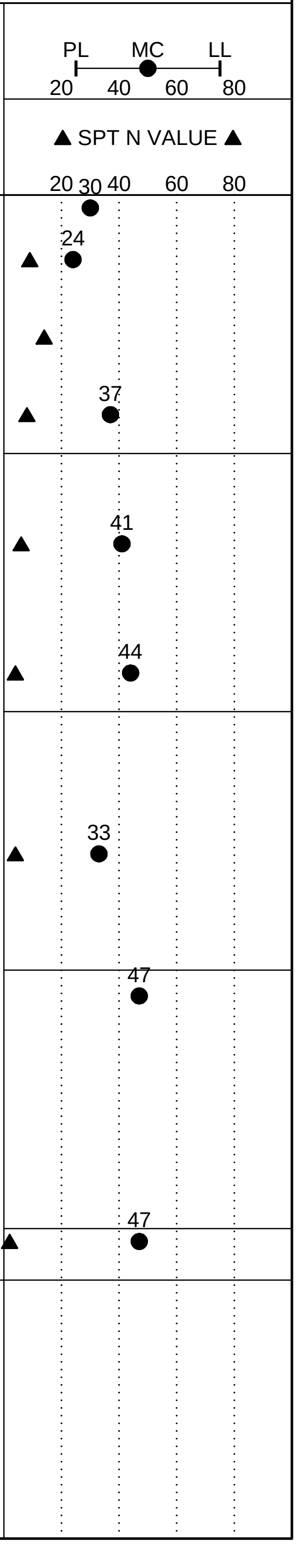
TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-6

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12369.03
PROJECT LOCATION Fargo, ND
DRILLING CONTRACTOR Braun Intertec KM DC
RIG NO. 7512
GROUND ELEVATION 899 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 11/16/15
COMPLETED 11/16/15
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)
	0	TOPSOIL - 6 Inches	SS 1A	100	1	3.00	
		0.5'					
		Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Organics (CH)	SS 1B	100	3-6-8 (9)	>4.5	
		@2': Brown/Gray. w/Trace Calcite Stain Seam	SS 2	100	6-7-7 (14)	4.00	
		3.5'					
895		Moist Medium Stiff to Stiff Brown/Gray FAT CLAY w/Sand and Trace Calcite Stain Seam (CH)	SS 3	100	3-4-4 (8)	2.00	
	5						
		@6': w/Trace Iron Oxide Stain Seam	SS 4	100	2-3-3 (6)	1.00	
		8.5'					
890		Moist Soft to Medium Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH)	SS 5	100	1-2-2 (4)	1.50	
	10						
		@12': Gray/Brown	SS 6	100	1-2-2 (4)	0.50	
885							
	15		ST 1	100		1.04	73
880							
	20	@19.5': Very Soft to Medium Stiff, Gray	SS 7	100	0-0-2 (2)	1.25	
		21.0'					
		Bottom of hole at 21.0 feet.					



TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-7

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12369.03
PROJECT LOCATION Fargo, ND
DRILLING CONTRACTOR Braun Intertec KM DC
RIG NO. 7512
GROUND ELEVATION 898 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 11/16/15
COMPLETED 11/16/15
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 6 Inches 0.5'	SS 1A	100	2	2.50		32
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Calcite Stain Seam (CH) (w/Trace Organics in SS-1B Sample)	SS 1B	100	4-6-9 (10)	>4.5		23
895			@2': Very Stiff, Brown/Gray, w/Trace Iron Oxide Stain Seam 3.5'	SS 2	100	4-7-9 (16)	>4.5		26
	5		Moist Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH)	SS 3	100	3-4-6 (10)	2.00		33
			@6': Medium Stiff to Stiff	SS 4	100	2-3-3 (6)	1.50		46
890			8.5'						
	10		Moist Soft to Medium Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH) 10.0'	SS 5	100	1-2-2 (4)	0.50		49

Bottom of hole at 10.0 feet.

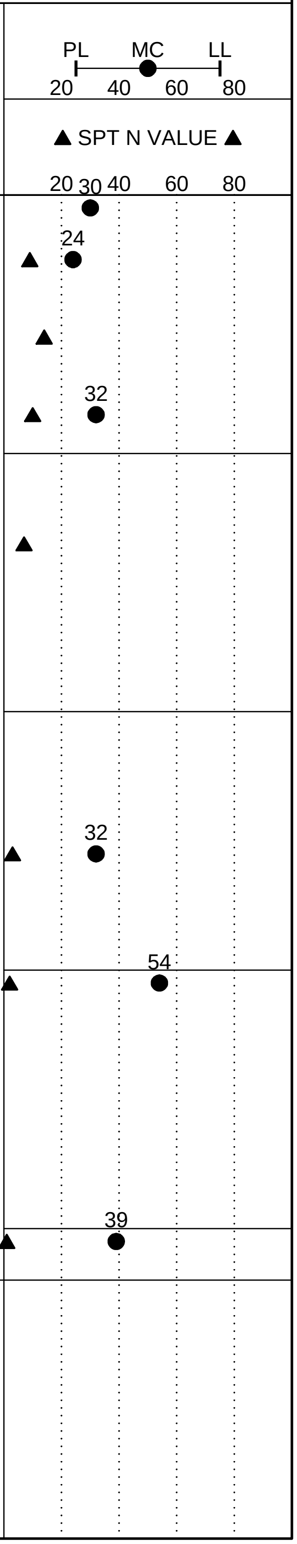
TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-8

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12369.03
PROJECT LOCATION Fargo, ND
DRILLING CONTRACTOR Braun Intertec KM DC
RIG NO. 7512
GROUND ELEVATION 898.5 ft
DRILLING METHOD 3-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 11/16/15
COMPLETED 11/16/15
AT TIME OF DRILLING None
LOGGED BY KKC
CHECKED BY CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL
	0		TOPSOIL - 6 Inches 0.5'	SS 1A	100	1	3.50		
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Organics (CH)	SS 1B	100	3-6-7 (9)	>4.5		24
895			@2': w/Trace Calcite Stain Seam	SS 2	100	4-7-7 (14)	>4.5		
	5		@3.5': Brown/Gray, w/Trace Iron Oxide Stain Seam 6.0'	SS 3	100	3-5-5 (10)	2.75		32
			Moist Medium Stiff to Stiff Brown/Gray FAT CLAY w/Sand and Trace Calcite Stain Seam (CH)	SS 4	100	2-3-4 (7)	1.50		
890	10		12.0'	ST 1	100				
885			Moist Very Loose Brown CLAYEY SAND w/Trace Iron Oxide Stain Seam (SC) 14.5'	SS 5	100	1-1-2 (3)	NP		32
	15		Moist Very Soft to Medium Stiff Gray FAT CLAY w/Sand (CH)	SS 6	100	1-1-1 (2)	1.00		54
880	20		@19.5': Very Stiff to Stiff 21.0'	SS 7	100	0-0-1 (1)	0.50		39
			Bottom of hole at 21.0 feet.						



TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-9

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND

DRILLING CONTRACTOR Braun Intertec KM DC

RIG NO. 7512

GROUND ELEVATION 898 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 11/30/15

COMPLETED 11/30/15

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY CPI

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 11 Inches 0.9'						
			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Organics (CH)	SS 1	100	2-3-6-10 (9)	3.50		32
895				SS 2	100	3-5-7 (12)	>4.5		25
	5		@3.5': Gray/Brown, w/Trace Calcite, and Iron Oxide Stain Seam	SS 3	100	2-4-6 (10)	3.50		32
			6.0'						
			Moist Medium Stiff to Stiff Gray/Brown FAT CLAY w/Sand and Trace Calcite Stain Seam (CH)	SS 4	100	1-3-3 (6)	1.50		42
890			8.5'						
	10		Moist Soft to Medium Stiff Brown/Gray FAT CLAY w/Sand, Trace Calcite, and Iron Oxide Stain Seam (CH) 10.0'	SS 5	100	1-2-2 (4)	1.00		47

Bottom of hole at 10.0 feet.

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-10

PAGE 1 OF 1

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND

DRILLING CONTRACTOR Braun Intertec KM DC

RIG NO. 7512

GROUND ELEVATION 897 ft

DRILLING METHOD 3-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 11/17/15

COMPLETED 11/17/15

AT TIME OF DRILLING None

LOGGED BY KKC

CHECKED BY CPI

AT END OF DRILLING None

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL 20 40 60 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 10 Inches 0.5'	SS 1A	100	0	2.50		35
895			Moist Stiff to Very Stiff Gray FAT CLAY w/Sand and Trace Organics (CH) 2.0'	SS 1B	100	3-6-7 (9)	>4.5		26
			Moist Medium Stiff to Very Stiff Gray FAT CLAY w/Sand (CH) @3.5': w/Trace Calcite Stain Seam	SS 2	100	3-4-4 (8)	3.25		29
	5			SS 3	100	2-2-4 (6)	2.50		32
			6.0'						
890			Moist Medium Stiff to Stiff Gray/Brown FAT CLAY, w/Sand and Trace Iron Oxide Stain Seam (CH)	SS 4	100	1-2-3 (5)	1.25		44
			8.5'						
	10		Moist Soft to Medium Stiff Gray/Brown FAT CLAY w/Sand and Trace Calcite Stain Seam (CH) 10.0'	SS 5	100	1-2-2 (4)	1.50		42
			Bottom of hole at 10.0 feet.						

LEGEND KEY

Unified Soil Classification System Soil Symbols

GW - WELL GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

GP - POORLY GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.

GM - SILTY GRAVEL Includes Gravel-Sand-Silt mixtures.

GC - CLAYEY GRAVEL Includes Gravel-Sand-Clay mixtures.

SW - WELL GRADED SAND Includes Gravelly Sands, little or no fines.

SP - POORLY GRADED SAND Includes Gravelly Sands, little or no fines.

SM - SILTY SAND Includes Sand-Silt mixtures.

SC - CLAYEY SAND Includes Sand-Clay mixtures.

ML - SILT Includes Silt with Sand and Sandy Silt.

CL - LEAN CLAY Includes Sandy Lean Clay and Lean Clay with Sand and Gravel.

MH - ELASTIC SILT Includes Sandy Elastic Silt and Elastic Silt with Sand.

CH - FAT CLAY Includes Sandy Fat Clay and Fat Clay with Sand.

CL-ML - SILTY CLAY Includes Clayey Silt of low plasticity.

OL - ORGANIC SILT and ORGANIC CLAY of low plasticity.

OH - ORGANIC SILT and ORGANIC CLAY of medium to high plasticity.

Pt - PEAT Includes humus, swamp and other soils with high organic content.

FILL MATERIAL - Includes controlled and non-controlled soil and non-soil materials.

TOPSOIL

ASPHALT - Bituminous Asphalt

CONCRETE - Includes broken concrete rubble.

Sample Symbols

SS - Split Spoon

ST - Shelby Tube

RC - Rock Core

GS - Geoprobe Sleeve

AU - Auger Cuttings

GB - Grab

Notes:

1. Exploratory borings were drilled on November 16 and 30, 2015, using 3¼-inch inside diameter hollow-stem augers.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. Boring locations were established in the field by Braun Intertec based on an ALTA/SCSM Land Survey Plat of the site prepared by Clark Surveying, Mapping, Geospatial, which was provided via email to TTL from Savills Studley on October 26, 2015. Ground surface elevations at the boring locations were interpolated to the nearest half-foot based on the provided ALTA survey, which included ground surface topographic contours.

4. Unconfined Compressive Strength (tsf):
   NP = Non Plastic
   NI = Not Intact

PROJECT: Proposed National Veterans Burial Grounds, Fargo, ND	TTL Associates, Inc.	PROJECT NO: 12369.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (Percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-1	SS-1A	0.0-0.7		11	33.3		*5,000	9.2										
	SS-1b	0.7-2.0			23.7		*9,000+											
	SS-2	2.0-3.5		15	23.4		*9,000+											
	SS-3	3.5-5.0		16	26.7		*9,000+											
	SS-4	6.0-7.5		7	42.2		*3,000											
	SS-5	8.5-10.0		4	33.1		*1,000											
B-2	SS-1	0.0-2.0		7	27.3		*9,000+	8.0										
	SS-2	2.0-3.5		14	25.8		*9,000+											
	SS-3	3.5-5.0		12	32.1		*6,000											
	SS-4	6.0-7.5		6	43.6		*2,500											
	SS-5	8.5-10.0		6	48.8		*3,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Fargo, ND | **TTL Associates, Inc.** | PROJECT NO: 12369.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (Percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-3	SS-1	0.0-2.0		6	25.6		*9,000+	5.8										
	SS-2	2.0-3.5		14	22.9		*9,000+											
	SS-3	3.5-5.0		12	31.6		*6,000	pH = 8.4										
	SS-4	6.0-7.5		7	44.0		*1,500											
	SS-5	8.5-10.0		6	39.8		*3,000											
B-4	SS-1A	0.0-0.5		9	34.3		*5,000	7.9										
	SS-1B	0.5-2.0			25.4		*9,000+											
	SS-2	2.0-3.5		19			*9,000+											
	SS-3	3.5-5.0		11	30.5		*3,000											
	SS-4	6.0-7.5		7	41.6		*3,000								51	26	25	
	SS-5	8.5-10.0		4	35.4		*1,000											
	SS-6	12.0-13.5		4	33.1				0	1	1	50	29	19				
	SS-7	14.5-16.0		2	47.9													
	SS-8	19.5-21.0		2	52.2		*1,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Fargo, ND

TTL Associates, Inc.

PROJECT NO: 12369.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (Percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-5	SS-1A	0.0-0.5		11	33.7		5,000	8.0										
	SS-1B	0.5-2.0			26.7		*9,000+		0	0	9	10	17	64	59	26	33	CH
	SS-2	2.0-3.5		14	24.1		*9,000+											
	SS-3	3.5-5.0		13	34.2		*9,000+											
	SS-4	6.0-7.5		9			*3,000	pH = 8.2										
	SS-5	8.5-10.0		7	35.3													
B-6	SS-1A	0.0-0.5		9	29.8		*6,000	8.3										
	SS-1B	0.5-2.0			24.3		*9,000+											
	SS-2	2.0-3.5		14			*8,000											
	SS-3	3.5-5.0		8	36.8		*4,000											
	SS-4	6.0-7.5		6	41.4		*2,000											
	SS-5	8.5-10.0		4	43.9		*3,000											
	SS-6	12.0-13.5		4	33.0		*1,000											
	ST-1	14.5-16.5			46.9	73.1	2,080											
	SS-7	19.5-21.0		2	47.0		*2,500											

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Fargo, ND

TTL Associates, Inc.

PROJECT NO: 12369.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (Percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-7	SS-1A	0.0-0.5		10	31.7		*5,000	10.6										
	SS-1B	0.5-2.0			23.3		*9,000+											
	SS-2	2.0-3.5		16	26.2		*9,000+											
	SS-3	3.5-5.0		10	32.6		*4,000											
	SS-4	6.0-7.5		6	45.9		*3,000											
	SS-5	8.5-10.0		4	49.0		*1,000											
B-8	SS-1A	0.0-0.5		9	29.5		*7,000	9.2										
	SS-1B	0.5-2.0			23.8		*9,000+											
	SS-2	2.0-3.5		14			*9,000+											
	SS-3	3.5-5.0		10	31.6		*5,500											
	SS-4	6.0-7.5		7			*3,000											
	ST-1	8.5-10.5																
	SS-5	12.0-13.5		3	32.2													
	SS-6	14.5-16.0		2	53.8		*2,000											
	SS-7	19.5-21.0		1	39.0		*1,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Fargo, ND	**TTL Associates, Inc.**	PROJECT NO: 12369.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (Percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-9	SS-1	0.0-2.0		9	32.4		*7,000	9.8										
	SS-2	2.0-3.5		12	25.2		*9,000+											
	SS-3	3.5-5.0		10	32.2		*7,000											
	SS-4	6.0-7.5		6	42.0		*3,000											
	SS-5	8.5-10.0		4	47.4		*2,000											
B-10	SS-1A	0.0-0.5		9	35.3		*5,000	9.2										
	SS-1B	0.5-2.0			25.8		*9,000+											
	SS-2	2.0-3.5		8	28.5		*6,500											
	SS-3	3.5-5.0		6	32.3		*5,000											
	SS-4	6.0-7.5		5	43.7		*2,500											
	SS-5	8.5-10.0		4	41.9		*3,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

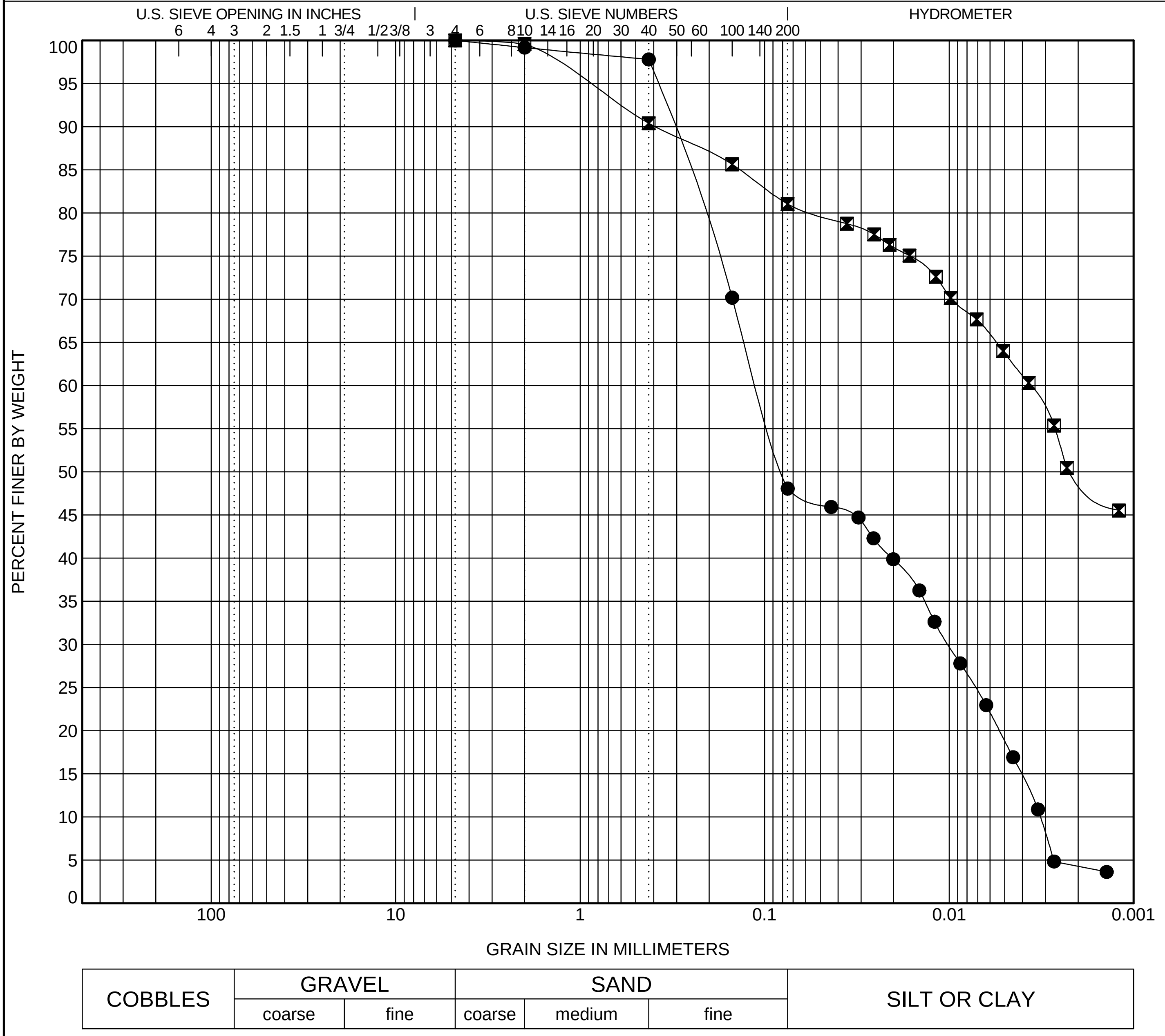
GRAIN SIZE DISTRIBUTION

CLIENT U.S. Department of Veterans Affairs

PROJECT NAME Proposed National Veterans Burial Grounds

PROJECT NUMBER 12369.03

PROJECT LOCATION Fargo, ND



Specimen Identification			USCS Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**12.0**					**0.3**	**34.0**
☒	**B-5**	**0.5**	**FAT CLAY with SAND (CH)**	**59**	**26**	**33**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**12.0**	**4.75**	**0.109**	**0.01**	**0.003**	**0.0**	**51.9**	**29.3**	**18.8**
☒	**B-5**	**0.5**	**4.75**	**0.004**			**0.0**	**19.0**	**17.3**	**63.8**

Fibertec
environmental
services

Analytical Laboratory Report
Laboratory Project Number: 71004
Laboratory Sample Number: 71004-001

Client Identification:	**TTL Associates, Inc.**	Sample Description:	**B-3 (SS-4)**	Chain of Custody:	**131633**
Client Project Name:	**Proposed National Veterans Burial Grounds(12369.03**	Sample No:	**1**	Collect Date:	**12/07/15**
Client Project No:	**12369.03**	Sample Matrix:	**Soil/Solid**	Collect Time:	**NA**

Sample Comments: **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

Definitions: Q: Qualifier (see definitions at end of report) NA: Not Applicable ‡ : Parameter not included in NELAC Scope of Analysis.

Dry Weight Determination (ASTM D 2974-87) **Aliquot ID:** **71004-001** **Matrix: Soil/Solid**
Description: **B-3 (SS-4)**

						Preparation		Analysis		
Parameter(s)	Result	Q	Units	Reporting Limit	Dilution	P. Date	P. Batch	A. Date	A. Batch	Init.
‡ 1. Percent Moisture (Water Content)	**31**		%	0.1	1.0	12/10/15	MC151210	12/11/15	MC151210	BMG

Inorganic Anions by IC (EPA 0300.0 (Solids Prep)/EPA 9056A) **Aliquot ID:** **71004-001** **Matrix: Soil/Solid**
Description: **B-3 (SS-4)**

						Preparation		Analysis		
Parameter(s)	Result	Q	Units	Reporting Limit	Dilution	P. Date	P. Batch	A. Date	A. Batch	Init.
1. Sulfate	**42000**		µg/kg	10000	1.0	12/14/15 09:24	PW15L14B	12/14/15	WT15L14A	JEB

Analytical Laboratory Report
Laboratory Project Number: 71004
Laboratory Sample Number: 71004-002

Client Identification:	**TTL Associates, Inc.**	Sample Description:	**B-8 (SS-4)**	Chain of Custody:	**131633**
Client Project Name:	**Proposed National Veterans Burial Grounds(12369.03**	Sample No:	**2**	Collect Date:	**12/07/15**
Client Project No:	**12369.03**	Sample Matrix:	**Soil/Solid**	Collect Time:	**NA**

Sample Comments: **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

Definitions: Q: Qualifier (see definitions at end of report) NA: Not Applicable ‡: Parameter not included in NELAC Scope of Analysis.

Dry Weight Determination (ASTM D 2974-87) **Aliquot ID:** **71004-002** **Matrix: Soil/Solid**
Description: **B-8 (SS-4)**

						Preparation		Analysis		
Parameter(s)	Result	Q	Units	Reporting Limit	Dilution	P. Date	P. Batch	A. Date	A. Batch	Init.
‡ 1. Percent Moisture (Water Content)	**32**		%	0.1	1.0	12/10/15	MC151210	12/11/15	MC151210	BMG

Inorganic Anions by IC (EPA 0300.0 (Solids Prep)/EPA 9056A) **Aliquot ID:** **71004-002** **Matrix: Soil/Solid**
Description: **B-8 (SS-4)**

						Preparation		Analysis		
Parameter(s)	Result	Q	Units	Reporting Limit	Dilution	P. Date	P. Batch	A. Date	A. Batch	Init.
1. Sulfate	**88000**		µg/kg	10000	1.0	12/14/15 09:24	PW15L14B	12/14/15	WT15L14A	JEB

Definitions/ Qualifiers:

A: Spike recovery or precision unusable due to dilution.
B: The analyte was detected in the associated method blank.
E: The analyte was detected at a concentration greater than the calibration range, therefore the result is estimated.
J: The concentration is an estimated value.
M: Modified Method
U: The analyte was not detected at or above the reporting limit.
X: Matrix Interference has resulted in a raised reporting limit or distorted result.
W: Results reported on a wet-weight basis.
***:** Value reported is outside QC limits

Exception Summary:

Accreditation Number(s):

T104704518-15-3 (TX)