Report of Geotechnical Exploration Program

Proposed Dunn County Safety Center
Manning, North Dakota
MTS G25-046

For

Dunn County

September 9, 2025

MATERIAL TESTING SERVICES, LLC

MTS
MATERIAL TESTING SERVICES, LLC

September 9, 2025

Attn: Dave Olson, Commissioner
Dunn County
205 Owens Street
Manning, ND 58642

ref: **Geotechnical Exploration Program**
Proposed Dunn County Safety Center
Manning, North Dakota
MTS G25-046

Dear Mr. Olson:

Enclosed is the geotechnical report for the referenced project. We are transmitting this report as an electronic file in pdf format. If you require a hard copy, please contact us. The work was conducted in general accordance with our proposal dated June 24, 2025.

Approximately 50 percent of the soil samples will be stored at the laboratory for a period of approximately 30 days from the date of this report. The samples will then be discarded unless we are requested to store them for a longer period.

We appreciate the opportunity to be of service to you on this project. If there are questions about the data or our recommendations, please contact us at 701-852-5553.

Sincerely,
MATERIAL TESTING SERVICES, LLC

Steven Wald, PE
President

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Manning, North Dakota
MTS G25-046

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Report of Geotechnical Exploration

Proposed Dunn County Safety Center
Manning, North Dakota
MTS #G25-046

1. INTRODUCTION

1.1. Authorization

This work was conducted in accordance with our proposal dated June 24, 2025.

1.2. Scope of Services

The authorized scope of services included soil borings, laboratory testing and an engineering report.

Authorized drilling included four soil borings to nominal depths of 25 feet and two borings to a nominal depth of 8 feet. Three percolation tests were also requested in the proposed drain field area. The boring locations were selected by JLG. Soil sampling was to be performed using standard penetration test (SPT) procedures. Laboratory tests in the proposal included moisture content, dry density, gradation through a #200 sieve, Atterberg limits (liquid & plastic limits) and unconfined compression testing. If soft cohesive soils were encountered undisturbed 3-inch diameter thin-walled Shelby tubes were to be taken.

The authorized engineering report includes the results of the field and laboratory testing as well as engineering recommendations regarding:

a. Site preparation
b. Foundation types and depths
c. Allowable bearing capacity and estimated potential foundation settlement
d. Potential construction difficulties
e. Potential expansive or compressible soils
f. Site drainage
g. Exterior backfill
h. Floor slabs
i. Frost considerations
j. Lateral Earth Pressures
k. Pavements
l. Excavation slopes

m. Construction monitoring

Determining if there is potential on-site contamination is not included in the scope of services.

2. ENGINEERING REVIEW

2.1. Project Data

If the project information presented below is not correct or has been changed, it is necessary that the correct project data be presented to us for further review.

The proposed project will include a new 5,720 square foot office building with an attached 10,880 square foot garage located at the southwest corner of 13th Street SW and ND Highway 22 in Manning, ND.

The proposed office building will be a two-story, steel framed structure with a basement. The garage will be a precast concrete structure with a slab-on-grade. It is anticipated that the structure will be found on shallow frost footings. The ground floor of the office and garage buildings will be 2228 feet. It is our understanding that office building pad footing loads are 110 kips. The precast strip footing loads will be 6 kips per foot. We assume the maximum settlement under working load is 1 inch and a maximum differential settlement of ½ inch.

2.2. Special Concerns and Constructability

The proposed finished floor elevation of 2228 feet will require a grade raise of approximately 4 to 6 feet on the east side of the building. The west side of the building is near finished floor grade. To limit differential and total settlement, we recommend that the engineered fill below the proposed building floors and foundations consist of sand or sand and gravel.

The fat clay soils at this site are potentially expansive. Index tests were performed on the fat clay soil samples to determine the potential for expansion. The index tests indicated the on-site fay clays have liquidity indexes of approximately 0. George B. Sowers and George F. Sowers in “Introductory to Soil Mechanics and Foundations” indicate that liquidity index values of less than 0.25 suggests that varying amounts of swell potential exists. For the site soils, the potential for volume change is probably high. Care must be taken to keep the moisture content as close to the in-situ as possible to limit the potential for volume change. It is standard practice to assume that clay within 5 feet of the bottom of the footings could eventually become saturated. Typically, the swelling is in the form of differential movement since the intrusion of water usually takes place in some areas, but not uniformly everywhere.

Based on the results of the laboratory tests, the potential swelling of the fat clays is a concern. Precautions should be taken to minimize the potential for an increase or decrease of the soil moisture content both during and after construction and to minimize the potential post-construction floor and footing movements due to expansive soil.

Our recommendations are intended to minimize, to varying degrees, swell-related problems with the proposed building. Even if our recommendations are followed, we cannot guarantee that some movement will not occur. The present state of the art is such that the risk of movement cannot be accurately assessed. It depends on several uncontrolled variables such as climatic conditions at and after construction, long term fluctuations of the groundwater level, utility line leakage, landscaping and other similar aspects. The owner should be made aware that there is still some risk of post-construction movement due to expansive soil and be willing to assume this risk if the project proceeds.

2.3. Excavation and Site Preparation

2.3.1. Building

We recommend that any uncontrolled fill and topsoil (if encountered) in the building area be removed and replaced with controlled, compacted fill. Up to four feet of fill was encountered in borings 1 and 2. We also recommend an excavate-refill plan to remove the potentially expansive clays from within 5 feet of any floor slab and footing.

The intent of the subcut is to make sure there are no expansive clays within five feet of the bottom of footings and/or floors. No subcut will be required in areas where site fill will provide that separation. The subcut excavation for the expansive soils only needs to over-sized nominally larger than the structure footprint.

We recommend that the excavated areas be observed by the geotechnical engineer of record or their representative prior to the placement of concrete or controlled, compacted fill. The purpose of the observations would be to make sure that no existing fill or soft natural soil is left in place and that the exposed natural soils can support the proposed fill and structural loads. It also would be to verify that the potentially expansive soils have been adequately removed. We wish to point out that there could be deeper excavations required away from the boring locations.

We recommend that a hydraulic excavator be used for foundation excavation. It should have a smooth cutting edge on the bucket. The clay soil at the bottom of the excavation should not be compacted prior to placement of controlled, compacted fill. However, any loose materials should be removed as much as possible.

After the excavations are complete, backfill should be placed as soon as possible. Also, care should be taken so that the grades slope away from the excavations in case it rains. Although it is impossible to completely keep rainwater from the site, provisions must be made to protect the excavations as much as possible from the influx of rainwater or surface runoff both during and after construction. Water and any soft/saturated soil should be removed as soon as possible.

The over-excavation refill should consist of a pit-run sand or sand with gravel. Any gravel in the fill should have 100 percent passing the 1-1/2-inch sieve and have no more than 10% passing a #200 sieve. Loose lift thicknesses of new fill should be no more than 8 inches. Any fill that is to support footings or floor slabs should be compacted to at least 98 percent of maximum dry density as determined according to ASTM D 698 (standard Proctor).

If earthwork is done during periods of freezing temperatures, we recommend protecting the fill from freezing once it has been placed. No frozen soils should be used as fill and fill should not be placed on frozen ground. Earthwork could be difficult in the spring or late fall when conditions are often cool and wet.

2.3.2. Parking and Driveways

Any vegetation and topsoil should be stripped and removed for the new parking areas and drive lanes. The existing non-organic soils on the site are considered poor to fair as subgrade soils for pavements. In addition, the subgrade soils are potentially expansive and may be frost susceptible; therefore, some damage from movement can be expected during the life of the pavement.

Once the topsoil is removed, the pavement areas should be cut, as necessary to the proposed subgrade elevation. The exposed subgrade soils should be scarified a minimum of twelve inches, moisture conditioned to within at to plus 4 percent of optimum, and re-compacted to a minimum of 95 to 100 percent of the standard Proctor density. In addition, the subgrade should be proof rolled with a heavy wheeled vehicle (such as a loaded dump truck) to detect soft spots. Soft spots should be stabilized prior to placing base course.

If off site material will be used for controlled, compacted fill below the aggregate base, it can consist of non-expansive, non-organic lean clay with a liquid limit less than 40, or pit-run sand or sand with gravel with a maximum size of 1-½”. Lean clays should be placed at a moisture content of minus 3 to plus 3 percent of optimum moisture content. Sand should be moisture conditioned as necessary to facilitate compaction. Again, the on-site fat clays should be moisture conditioned within at to plus 4% of optimum.

2.4. Frost Considerations

Footings should be carried to frost depth as indicated in the following sections. Also, no frozen soil should be used as fill and no fill should be placed on frozen ground. Furthermore, the soil should be protected from freezing once they have been placed and compacted and until the building can be heated. Please note the attached information sheet "***Precautions for Excavating and Refilling During Cold Weather***" in Appendix C.

2.5. Foundation Recommendations

2.5.1. Footing Depths

Perimeter footings for heated buildings should be carried to a frost depth of 5 feet. The frost depth should be considered from final grade to the bottom of the footing. Interior footings can be placed at a convenient depth below the floor slab.

For footings which will be in an unheated environment, we recommend using a frost depth of 7 feet.

2.5.2. Bearing Capacity and Settlement

With the recommended site preparation, on-site observations by the geotechnical engineer and adequate compaction testing of the new fill, it is our opinion that continuous strip and column footings can be proportioned for a net allowable soil bearing capacity of up to 4000 psf. This loading should provide a theoretical safety factor of 3 or more with respect to punching shear failure.

Our calculations suggest that total settlements should be 1 inch or less and that the differential settlement should be ½ inch or less.

2.5.3. Lateral Earth Pressures

Walls that must retain earth should be designed for the at-rest lateral earth pressure. For the fat clays at this site, we recommend that the at-rest pressure be considered equivalent to that generated by a fluid with a total unit weight of 85 pcf above groundwater levels. For imported lean clay and sand we recommend using 65 pcf and 45 pcf, respectively.

To resist lateral loads, we recommend assuming that the natural undisturbed clays have an ultimate passive pressure equivalent to that generated by a fluid having a total unit weight of

285 pcf. For compacted sand, we recommend using an ultimate passive pressure of 425 pcf. If compacted fill is placed on the passive side next to the foundation resisting lateral loads, it should be compacted to at least 95 percent of maximum density as determined by ASTM D 698. In addition, those portions of the foundations within five feet of final grade in unheated areas should be ignored when calculating passive resistance due to frost softening. An ultimate friction factor of 0.30 can be used between the bottom of the footing and the foundation soils. We wish to point out that these values will give the ultimate resistance to lateral loads. We recommend that a theoretical safety factor of 2.0 be applied for a safe design.

2.5.4. Methods of Analysis

The allowable foundation loading recommended was arrived at using the Terzaghi-Meyerhof bearing capacity equation with estimates using empirical correlations with the “N” values, as well as our experience with similar site and soil conditions.

Settlements were estimated using empirical correlations between the “N” values and the pressuremeter modulus, with consideration given to soil type. The pressuremeter modulus is determined with in-situ pressuremeter testing. The pressuremeter method of analysis was then used.

The equivalent passive, at-rest and active earth pressures were calculated using estimated unit weights and estimated angles of internal friction based on our experience, the laboratory testing and correlations with the Atterberg limits and soil type.

2.6. Floor Slabs

We recommend that the site be prepared as stated in ***Section 2.3***. We recommend that slabs-on-grade be constructed structurally independent of foundation walls and columns. We also recommend a minimum 6-inch layer of free draining sand be placed directly below the slabs. The sand should have less than seven percent passing the #200 sieve by weight. If it contains gravel, the gravel should have a maximum size of one inch. The sandy layer will be used to provide a working surface for concrete placement and serve as a capillary break.

With the site prepared as recommended, it is our opinion that the subgrade modulus of 200 pci can be used if a minimum of 18 inches of granular fill is used below the slab. A subgrade modulus of 150 pci can be used if clay fill is used to within 6 inches of the bottom of the slab.

2.7. Exterior/Basement Foundation Backfill

2.7.1. Garage Foundation Walls

The exterior foundation backfill above the footings could consist of imported lean clay for the garage portion. Sand or fat clay should not be used as exterior foundation backfill. Sand could allow the infiltration of surface water into the soils below the footing and fat clay could exert excess lateral pressures on the foundation walls. Any joints between concrete paving and building walls should be sealed and maintained. Foundation walls should be properly braced during construction.

The exterior backfill should be placed in loose lift thicknesses not to exceed 8 inches. Compaction should be to a minimum of 92 percent of the standard Proctor density in lawn areas. For sidewalks, pavements, or lightly loaded structures such as air conditioning units, the compaction should be increased to 95 percent. Lean clay backfill should be placed at a moisture content of -2 to +3 percent of the optimum moisture content.

2.7.2. Basement Walls

The exterior backfill for the basement walls should consist of a sand with no more than seven (7) percent passing a #200 sieve and a maximum size of one inch. The sand fill should be placed at a 45-degree angle out from the wall starting at the bottom of the footing. A lean clay cap at least 18 inches thick should be placed at the surface to divert water away from the structure. The sand should be compacted to a minimum of 92 percent in landscaped areas and 95 where structures or pavements are to be supported. The sand should be placed at a moisture content that facilitates compaction.

2.8. Drain Tile System

Because no groundwater was encountered, the main purpose of the drain tile system is to remove any surface water infiltration beneath the building.

We recommend that a properly designed permanent drain tile system that includes exterior and interior perimeter and interior runs be installed for the basement. The drain tile system should be installed in the sand and gravel layer beneath the building so any infiltration of water is removed to the extent possible beneath the structure.

2.9. Surface Drainage

We advise that adequate drainage be maintained during and after construction. Unless roof drainage is internal, we also recommend that downspouts and gutters or an appropriate closed conduit system be used to control roof drainage. Downspouts should have extensions that carry roof water well past the backfill line. Splash pads should also be provided at the end of the extensions, if applicable.

The exterior clay backfill should slope away from the buildings at a rate of 1 inch per foot or greater for a distance of at least 10 feet from the building in lawn areas. In parking areas much positive surface drainage should be provided as practical. Sprinklers should not be placed to prevent watering the backfill zone. Flower beds or other surface landscaping should be placed on the sloped backfill. Plastic edging or other similar means to provide separation between grass and rock areas should not be used unless a dependable means of allowing water out of the edging area is provided. Otherwise, water that is trapped within the edging is likely to percolate into the backfill. The water could then contact the foundation or under slab soil. We recommend that the foundation and under slab soil, especially the clay, be maintained at their existing moisture content both during and after construction.

2.10. Exterior Slabs

Due to the potential for frost movement for exterior slabs, precautions should be taken to minimize future post construction movement of sensitive slabs due to frost action. Options available include excavating frost susceptible soils to a depth of 5 feet below the slabs and replacing them with non-frost susceptible sand containing less than 5 percent passing the #200 sieve by weight. Another option would be to place at least 4 inches of extruded polystyrene foam insulation below the slabs and extend it at least 8 feet laterally past the edge of the slabs. Typically, 6 to 12 inches of sand is placed above the insulation for protection. A third option is to support the slabs or steps on foundations taken to frost depth. At least a 4-inch void should be provided below the slabs if this option is used.

Sensitive slabs are slabs that cannot tolerate much movement without causing some difficulties. An example would be the sidewalk or steps in front of a doorway. It is ***not*** intended to include all exterior sidewalks and driveways, etc.

2.11. Flexible Pavement Design

Flexible pavement design was based on our experience and in accordance with the "AASHTO Guide of Design of Pavement Structures 1993". No traffic volumes for the parking lot or driveway were given. For our analysis, we assumed a traffic loading of 50,000 equivalent 18-kip axle loads (ESAL's) over a 20-year design life for the pavements. The subgrade should be prepared as described in previous sections. Parameters used in design are as follows:

Table 2 – Pavement Design Parameters

Parameter	Value
Reliability	85%
Standard Deviation	0.45
Initial Serviceability	4.2
Terminal Serviceability	2.2
Estimated Subgrade CBR	2.9
Resilient Modulus	4350
HBP Layer Coefficient	0.36
Aggregate Base Layer Coefficient	0.1
Drainage Factor of Base and Subbase	1.0

The granular base course should meet the specifications as outlined in Section 816 of the 2020 North Dakota Department of Transportation's (NDDOT) "Standard Specifications for Road and

Bridge Construction" for Class 5 aggregate, or equivalent. The base material should be compacted to at least 100 percent of the standard Proctor density at a moisture content that facilitates compaction.

For a light duty traffic load of 50,000 ESALs, we recommend that the minimum section consist of 4.0 inches of hot bituminous pavement (HBP) over 10 inches of granular base course. For heavy duty pavements, we recommend that the minimum section consist of 6 inches of hot mix bituminous pavement over 12 inches of granular base. We also recommend a separation fabric be placed between the subgrade soils and the aggregate base section.

Adequate drainage should be considered imperative to prolong the life of the pavement. The pavement should be properly sloped to catch basins or appropriate inlets, as necessary. We recommend a minimum slope of 1 percent and preferably 2 percent.

The bituminous pavement should be composed of a quality mix such as FAA 42 as outlined in Section 430 of the NDDOT's "Standard Specifications for Road and Bridge Construction".

2.12. Rigid Pavement Design

We recommend that rigid pavement consist of a minimum 5 inches of unreinforced concrete pavement on a minimum of 6 inches of NDDOT Class 5 base course. For heavy duty pavement, we recommend a minimum 7 inches of unreinforced concrete pavement on a minimum of 8 inches of NDDOT Class 5 base course. Depending on the actual traffic loads, a thicker concrete section may be necessary.

The concrete mix should have proven success, or a mix design should be established for proper proportions of aggregate, cement, water and any admixtures. The concrete should be handled, placed and cured according to current ACI guidelines and specifications for exterior concrete. The concrete should have a minimum compressive strength of 4000 psi. The concrete should be placed with a maximum water/cement ratio of 0.45 and should have air entrainment between 5 and 7 percent.

Maintenance should be performed on all pavements on a regular basis. Cracks should be properly sealed as soon as they are observed. Again, adequate drainage should be considered imperative to prolong the life of the pavement.

2.13. Percolation Test

Three percolation tests and one shallow flight auger boring was drilled at the proposed drain field on the east side of the site. The percolation test locations are as shown on the attached aerial photograph in appendix A.

The soils were classified in accordance with ASTM D2488 by visual methods. The soils encountered were consistent with the other borings at the site. Approximately 2 inches of topsoil was encountered at the surface underlain by brown fat clay (CH) to the termination of the auger boring at 10 feet. The soil in the test holes was consistent with the auger boring.

The percolation tests were performed according to the North Dakota Department of Health (NDDH) guidelines at depths of approximately 3 feet below existing grade.

Test Hole	Depth (ft)	Soil Classification	Percolation Rate (min/in)	NDDH Relative Absorption Rate
P-1	0-3	Fat Clay	None	Impervious
P-2	0-3	Fat Clay	60+	Impervious
P-3	0-3	Fat Clay	60+	Impervious

No measurable groundwater was observed at the test locations. Water levels can fluctuate yearly and seasonally and may differ significantly at the time of construction. Long-term monitoring of groundwater levels was not included as part of our scope of work.

2.14. Excavation Slopes

Safe excavations must be always maintained. The excavation contractor is responsible for the safety of the excavations. Current OSHA requirements should be carefully followed when excavating for the back slope of the excavation. The OSHA soil type and excavation requirements must be verified by a competent person for the contractor at the time of construction. MTS does not assume responsibility for site safety or the contractors' activities.

3. CONSTRUCTION OBSERVATION AND TESTING

The recommendations contained in this report have been made based on the subsurface conditions found at the boring locations. It is possible that there are soil conditions on site that were not represented by the borings. Also, we presumed that close construction monitoring during excavation and backfilling would be authorized. Consequently, on-site observation during construction is considered integral to the successful implementation of the recommendations.

It is imperative that the geotechnical engineer be on site at the following times to observe the site conditions and effectiveness of the construction. We recommend that the testing be performed by the geotechnical engineer as the **Owner's** representative during construction.

3.1. Excavation Observations

The geotechnical engineer should observe the entire excavation bottom of the excavation prior to the placement of engineered fill and/or concrete. He would also be available for additional consultation and recommendations if necessary.

3.2. Placement of Fill

It will also be necessary to perform a representative number of compaction tests during placement of engineered fill. The tests should be performed to determine if the required compaction was achieved. As a general guideline, tests should be taken for each 2,500 square feet embankment fill, every 75 to 100 feet in trench fill, and for each 2-foot thickness of fill. The actual number of tests should be left to the discretion of the geotechnical engineer.

4. EXPLORATION LIMITATIONS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at according to currently accepted engineering practices at this time and location. Other than this, no warranty is intended or implied.

This report is written by:

Steve Wald, P.E
President

REGISTERED PROFESSIONAL ENGINEER
STEVEN A. WALD
PE-3841
DATE
NORTH DAKOTA

Steven Wald, P.E.
Date: 09/09/25

APPENDIX A – FIELD EXPLORATION PROGRAM

Attachments to Appendix A

Location Maps
Soil Profile Drawing
Boring Logs
Symbols & Descriptive Terminology on Test Boring Logs
Soil Classification Sheet

A. FIELD EXPLORATION PROGRAM

A.1 Exploration Scope

Four SPT borings were drilled to a nominal depth of 25 feet and two SPT borings were drilled to a nominal depth of 8 feet for the project. In addition, an auger boring was drilled to 10 feet deep in the proposed drainfield area and three percolation tests were conducted at approximately three feet deep. The field work was conducted on August 5 and 6, 2025. The boring locations are illustrated on the attached drawing and aerial photo at the back of this Appendix.

The borings were backfilled with on-site soil and some settlement can be expected to occur. The final closure of the holes is the responsibility of the client or property owner.

A.2 Surface Observations

The surface elevations at the test boring locations were estimated using Google Earth. Therefore, the elevations are only as accurate as the information provided by Google Earth.

The site was located at the southwest corner of the intersection of 13th Street SW and ND Highway 66 in Manning, ND. The area for the proposed addition is currently a vacant lot. The west portion of the site is surfaced with scoria. The east portion is barren or covered with grass/vegetation. Grade elevation ranged from 2223 feet at boring 1 to 2238 feet at boring 6. The site appeared to slope from west to east.

A.3 Subsurface Conditions

The subsurface conditions encountered at the test locations are illustrated by means of the attached boring logs and profile drawing. We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, it is necessary that you contact us so that our recommendations can be reviewed. The test boring log also shows the possible geologic origin of the materials encountered.

Scoria surfacing was present at borings 1 to 6. Beneath the scoria, fill was encountered up to four feet deep in borings 1 and 2. Below the fill, predominately naturally deposited fat clay was encountered. Lignite was encountered at the bottom of the 25-foot borings.

Based on the standard penetration resistance (“N” values), the fat clay soil was typically firm to hard in consistency.

A.4 Water Levels

Groundwater measurements were made in the test bore holes during drilling and at completion of drilling. This information is shown at bottom of the attached boring logs.

Groundwater was not observed in any of the bore holes during or at completion of the drilling.

Water levels should be expected to fluctuate seasonally and annually. The water levels at the time of construction could be significantly different than what was recorded on the boring logs. The time of year the borings were drilled and the history of precipitation prior to drilling should be known when using the groundwater readings on the boring logs to extrapolate water levels at other points in time.

A.5 Soil Sampling

Soil sampling was done according to the procedures described by ASTM D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-lb weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as penetration resistance or "N" value. The "N" value is an index of the relative density of cohesionless soils and the consistency of cohesive soils.

We are retaining representative samples of the soil obtained during our field operations for approximately one month. We will then discard them unless we are notified further as to their disposition.

A.6 Soil Classification Procedure

As the samples were obtained in the field they were visually and manually classified by the crew chief according to ASTM D 2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, selected samples were then submitted to a program of laboratory tests. Logs of the borings indicating the depth and identification of the various strata, the "N" value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached. Charts illustrating the soil classification procedures, the descriptive terminology and symbols used on the boring logs are also attached.

APPENDIX B – LABORATORY TEST PROGRAM

Attachments to Appendix B

Mechanical Sieve Analysis
Unconine Compression
Moisture-Density Relationship
CBR

B. LABORATORY TEST RESULTS

B.1 Testing Scope

Laboratory testing was conducted to characterize soil index properties including Atterberg limits (liquid and plastic limits), mechanical sieve analysis, moisture content, unconfined compression, moisture-density relationship, and CBR.

B.2 Test Methods

2. Testing and classification of soil was performed in accordance with the following standards as applicable:

Description	ASTM Method
Unified soil classification system	D 2487
Atterberg limits	D 4318
In-situ moisture content	D 2216
Sieve analysis	D 422, C 117, C 136
Moisture-density relationship	D 698 or D 1557
In-situ dry density	Direct measurement
Unconfined compression, Qu	D 2166
CBR	D 1883

APPENDIX C

Precautions for Excavating & Refilling During Cold Weather

PRECAUTIONS FOR EXCAVATING AND REFILLING DURING COLD WEATHER

The winter North Dakota presents specific problems for foundation construction. Soils which are allowed to freeze undergo a moisture volume expansion, resulting in a loss of density. These frost-expanded soils will consolidate upon thawing, causing settlement of any structure supported on them. To prevent this settlement, frost should not be allowed to penetrate the soils below any proposed structure.

Ideally, winter excavation should be limited to areas small enough to be refilled to a grade higher than footing grade on the same day. Typically, these areas should be filled to floor grade. Trenching back down to unfrozen soils for foundation construction can then be performed just prior to footing placement. The excavated trenches should be protected from freezing by means of insulation or heating during foundation construction. Backfilling of the foundation trenches should be performed immediately after the below-grade foundation construction is finished. In addition, any interior footings, or footings designed without frost protection should be extended below frost depth, unless adequate precautions are taken to prevent frost intrusion until the building can be enclosed and heated.

In many cases, final grades cannot be attained in one day's time, even though small areas are worked. In the event final grade cannot be attained in one day's time, frost can be expected to develop overnight. The depth of frost penetration can be minimized by leaving a layer of loose soil on top of the compacted material overnight. However, any frost which forms in this loose layer, or snow, should never be used as fill material.

After the structure has been enclosed, all floor slab areas should be subjected to ample periods of heating to allow thawing of the soil system. Alternatively, the frozen soil can be completely removed and be replaced with an engineered fill. The floor slab areas should be checked at random and representative locations for remnant areas of frost, and density tests should be performed to document fill compaction prior to slab placement.

Due to the potential problems associated with fill placement during cold weather, any filling operations should be monitored by a full-time, on-site soils technician. Full-time monitoring aids in detecting areas of frozen material, or potential problems with frozen material within the fill, so that appropriate measures can be taken. The choice of fill material is particularly important during cold weather, since clean granular fill materials can be placed and compacted more efficiently than silty or clayey soils. In addition, greater magnitudes of heaving can be expected with freezing of the more frost susceptible silts and clays.

If more specific frost information or cold weather data concerning other construction materials is required, please contact us.

MTS
MATERIAL TESTING SERVICES, LLC

September 9, 2025

Attn: Dave Olson, Commissioner
Dunn County
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1.2. Scope of Services

The authorized scope of services included soil borings, laboratory testing and an engineering report.

Authorized drilling included four soil borings to nominal depths of 25 feet and two borings to a nominal depth of 8 feet. Three percolation tests were also requested in the proposed drain field area. The boring locations were selected by JLG. Soil sampling was to be performed using standard penetration test (SPT) procedures. Laboratory tests in the proposal included moisture content, dry density, gradation through a #200 sieve, Atterberg limits (liquid & plastic limits) and unconfined compression testing. If soft cohesive soils were encountered undisturbed 3-inch diameter thin-walled Shelby tubes were to be taken.

The authorized engineering report includes the results of the field and laboratory testing as well as engineering recommendations regarding:

a. Site preparation
b. Foundation types and depths
c. Allowable bearing capacity and estimated potential foundation settlement
d. Potential construction difficulties
e. Potential expansive or compressible soils
f. Site drainage
g. Exterior backfill
h. Floor slabs
i. Frost considerations
j. Lateral Earth Pressures
k. Pavements
l. Excavation slopes

m. Construction monitoring

Determining if there is potential on-site contamination is not included in the scope of services.

2. ENGINEERING REVIEW

2.1. Project Data

If the project information presented below is not correct or has been changed, it is necessary that the correct project data be presented to us for further review.

The proposed project will include a new 5,720 square foot office building with an attached 10,880 square foot garage located at the southwest corner of 13th Street SW and ND Highway 22 in Manning, ND.

The proposed office building will be a two-story, steel framed structure with a basement. The garage will be a precast concrete structure with a slab-on-grade. It is anticipated that the structure will be found on shallow frost footings. The ground floor of the office and garage buildings will be 2228 feet. It is our understanding that office building pad footing loads are 110 kips. The precast strip footing loads will be 6 kips per foot. We assume the maximum settlement under working load is 1 inch and a maximum differential settlement of ½ inch.

2.2. Special Concerns and Constructability

The proposed finished floor elevation of 2228 feet will require a grade raise of approximately 4 to 6 feet on the east side of the building. The west side of the building is near finished floor grade. To limit differential and total settlement, we recommend that the engineered fill below the proposed building floors and foundations consist of sand or sand and gravel.

The fat clay soils at this site are potentially expansive. Index tests were performed on the fat clay soil samples to determine the potential for expansion. The index tests indicated the on-site fay clays have liquidity indexes of approximately 0. George B. Sowers and George F. Sowers in “Introductory to Soil Mechanics and Foundations” indicate that liquidity index values of less than 0.25 suggests that varying amounts of swell potential exists. For the site soils, the potential for volume change is probably high. Care must be taken to keep the moisture content as close to the in-situ as possible to limit the potential for volume change. It is standard practice to assume that clay within 5 feet of the bottom of the footings could eventually become saturated. Typically, the swelling is in the form of differential movement since the intrusion of water usually takes place in some areas, but not uniformly everywhere.

Based on the results of the laboratory tests, the potential swelling of the fat clays is a concern. Precautions should be taken to minimize the potential for an increase or decrease of the soil moisture content both during and after construction and to minimize the potential post-construction floor and footing movements due to expansive soil.

Our recommendations are intended to minimize, to varying degrees, swell-related problems with the proposed building. Even if our recommendations are followed, we cannot guarantee that some movement will not occur. The present state of the art is such that the risk of movement cannot be accurately assessed. It depends on several uncontrolled variables such as climatic conditions at and after construction, long term fluctuations of the groundwater level, utility line leakage, landscaping and other similar aspects. The owner should be made aware that there is still some risk of post-construction movement due to expansive soil and be willing to assume this risk if the project proceeds.

2.3. Excavation and Site Preparation

2.3.1. Building

We recommend that any uncontrolled fill and topsoil (if encountered) in the building area be removed and replaced with controlled, compacted fill. Up to four feet of fill was encountered in borings 1 and 2. We also recommend an excavate-refill plan to remove the potentially expansive clays from within 5 feet of any floor slab and footing.

The intent of the subcut is to make sure there are no expansive clays within five feet of the bottom of footings and/or floors. No subcut will be required in areas where site fill will provide that separation. The subcut excavation for the expansive soils only needs to over-sized nominally larger than the structure footprint.

We recommend that the excavated areas be observed by the geotechnical engineer of record or their representative prior to the placement of concrete or controlled, compacted fill. The purpose of the observations would be to make sure that no existing fill or soft natural soil is left in place and that the exposed natural soils can support the proposed fill and structural loads. It also would be to verify that the potentially expansive soils have been adequately removed. We wish to point out that there could be deeper excavations required away from the boring locations.

We recommend that a hydraulic excavator be used for foundation excavation. It should have a smooth cutting edge on the bucket. The clay soil at the bottom of the excavation should not be compacted prior to placement of controlled, compacted fill. However, any loose materials should be removed as much as possible.

After the excavations are complete, backfill should be placed as soon as possible. Also, care should be taken so that the grades slope away from the excavations in case it rains. Although it is impossible to completely keep rainwater from the site, provisions must be made to protect the excavations as much as possible from the influx of rainwater or surface runoff both during and after construction. Water and any soft/saturated soil should be removed as soon as possible.

The over-excavation refill should consist of a pit-run sand or sand with gravel. Any gravel in the fill should have 100 percent passing the 1-1/2-inch sieve and have no more than 10% passing a #200 sieve. Loose lift thicknesses of new fill should be no more than 8 inches. Any fill that is to support footings or floor slabs should be compacted to at least 98 percent of maximum dry density as determined according to ASTM D 698 (standard Proctor).

If earthwork is done during periods of freezing temperatures, we recommend protecting the fill from freezing once it has been placed. No frozen soils should be used as fill and fill should not be placed on frozen ground. Earthwork could be difficult in the spring or late fall when conditions are often cool and wet.

2.3.2. Parking and Driveways

Any vegetation and topsoil should be stripped and removed for the new parking areas and drive lanes. The existing non-organic soils on the site are considered poor to fair as subgrade soils for pavements. In addition, the subgrade soils are potentially expansive and may be frost susceptible; therefore, some damage from movement can be expected during the life of the pavement.

Once the topsoil is removed, the pavement areas should be cut, as necessary to the proposed subgrade elevation. The exposed subgrade soils should be scarified a minimum of twelve inches, moisture conditioned to within at to plus 4 percent of optimum, and re-compacted to a minimum of 95 to 100 percent of the standard Proctor density. In addition, the subgrade should be proof rolled with a heavy wheeled vehicle (such as a loaded dump truck) to detect soft spots. Soft spots should be stabilized prior to placing base course.

If off site material will be used for controlled, compacted fill below the aggregate base, it can consist of non-expansive, non-organic lean clay with a liquid limit less than 40, or pit-run sand or sand with gravel with a maximum size of 1-½”. Lean clays should be placed at a moisture content of minus 3 to plus 3 percent of optimum moisture content. Sand should be moisture conditioned as necessary to facilitate compaction. Again, the on-site fat clays should be moisture conditioned within at to plus 4% of optimum.

2.4. Frost Considerations

Footings should be carried to frost depth as indicated in the following sections. Also, no frozen soil should be used as fill and no fill should be placed on frozen ground. Furthermore, the soil should be protected from freezing once they have been placed and compacted and until the building can be heated. Please note the attached information sheet "***Precautions for Excavating and Refilling During Cold Weather***" in Appendix C.

2.5. Foundation Recommendations

2.5.1. Footing Depths

Perimeter footings for heated buildings should be carried to a frost depth of 5 feet. The frost depth should be considered from final grade to the bottom of the footing. Interior footings can be placed at a convenient depth below the floor slab.

For footings which will be in an unheated environment, we recommend using a frost depth of 7 feet.

2.5.2. Bearing Capacity and Settlement

With the recommended site preparation, on-site observations by the geotechnical engineer and adequate compaction testing of the new fill, it is our opinion that continuous strip and column footings can be proportioned for a net allowable soil bearing capacity of up to 4000 psf. This loading should provide a theoretical safety factor of 3 or more with respect to punching shear failure.

Our calculations suggest that total settlements should be 1 inch or less and that the differential settlement should be ½ inch or less.

2.5.3. Lateral Earth Pressures

Walls that must retain earth should be designed for the at-rest lateral earth pressure. For the fat clays at this site, we recommend that the at-rest pressure be considered equivalent to that generated by a fluid with a total unit weight of 85 pcf above groundwater levels. For imported lean clay and sand we recommend using 65 pcf and 45 pcf, respectively.

To resist lateral loads, we recommend assuming that the natural undisturbed clays have an ultimate passive pressure equivalent to that generated by a fluid having a total unit weight of

285 pcf. For compacted sand, we recommend using an ultimate passive pressure of 425 pcf. If compacted fill is placed on the passive side next to the foundation resisting lateral loads, it should be compacted to at least 95 percent of maximum density as determined by ASTM D 698. In addition, those portions of the foundations within five feet of final grade in unheated areas should be ignored when calculating passive resistance due to frost softening. An ultimate friction factor of 0.30 can be used between the bottom of the footing and the foundation soils. We wish to point out that these values will give the ultimate resistance to lateral loads. We recommend that a theoretical safety factor of 2.0 be applied for a safe design.

2.5.4. Methods of Analysis

The allowable foundation loading recommended was arrived at using the Terzaghi-Meyerhof bearing capacity equation with estimates using empirical correlations with the "N" values, as well as our experience with similar site and soil conditions.

Settlements were estimated using empirical correlations between the "N" values and the pressuremeter modulus, with consideration given to soil type. The pressuremeter modulus is determined with in-situ pressuremeter testing. The pressuremeter method of analysis was then used.

The equivalent passive, at-rest and active earth pressures were calculated using estimated unit weights and estimated angles of internal friction based on our experience, the laboratory testing and correlations with the Atterberg limits and soil type.

2.6. Floor Slabs

We recommend that the site be prepared as stated in ***Section 2.3***. We recommend that slabs-on-grade be constructed structurally independent of foundation walls and columns. We also recommend a minimum 6-inch layer of free draining sand be placed directly below the slabs. The sand should have less than seven percent passing the #200 sieve by weight. If it contains gravel, the gravel should have a maximum size of one inch. The sandy layer will be used to provide a working surface for concrete placement and serve as a capillary break.

With the site prepared as recommended, it is our opinion that the subgrade modulus of 200 pci can be used if a minimum of 18 inches of granular fill is used below the slab. A subgrade modulus of 150 pci can be used if clay fill is used to within 6 inches of the bottom of the slab.

2.7. Exterior/Basement Foundation Backfill

2.7.1. Garage Foundation Walls

The exterior foundation backfill above the footings could consist of imported lean clay for the garage portion. Sand or fat clay should not be used as exterior foundation backfill. Sand could allow the infiltration of surface water into the soils below the footing and fat clay could exert excess lateral pressures on the foundation walls. Any joints between concrete paving and building walls should be sealed and maintained. Foundation walls should be properly braced during construction.

The exterior backfill should be placed in loose lift thicknesses not to exceed 8 inches. Compaction should be to a minimum of 92 percent of the standard Proctor density in lawn areas. For sidewalks, pavements, or lightly loaded structures such as air conditioning units, the compaction should be increased to 95 percent. Lean clay backfill should be placed at a moisture content of -2 to +3 percent of the optimum moisture content.

2.7.2. Basement Walls

The exterior backfill for the basement walls should consist of a sand with no more than seven (7) percent passing a #200 sieve and a maximum size of one inch. The sand fill should be placed at a 45-degree angle out from the wall starting at the bottom of the footing. A lean clay cap at least 18 inches thick should be placed at the surface to divert water away from the structure. The sand should be compacted to a minimum of 92 percent in landscaped areas and 95 where structures or pavements are to be supported. The sand should be placed at a moisture content that facilitates compaction.

2.8. Drain Tile System

Because no groundwater was encountered, the main purpose of the drain tile system is to remove any surface water infiltration beneath the building.

We recommend that a properly designed permanent drain tile system that includes exterior and interior perimeter and interior runs be installed for the basement. The drain tile system should be installed in the sand and gravel layer beneath the building so any infiltration of water is removed to the extent possible beneath the structure.

2.9. Surface Drainage

We advise that adequate drainage be maintained during and after construction. Unless roof drainage is internal, we also recommend that downspouts and gutters or an appropriate closed conduit system be used to control roof drainage. Downspouts should have extensions that carry roof water well past the backfill line. Splash pads should also be provided at the end of the extensions, if applicable.

The exterior clay backfill should slope away from the buildings at a rate of 1 inch per foot or greater for a distance of at least 10 feet from the building in lawn areas. In parking areas much positive surface drainage should be provided as practical. Sprinklers should not be placed to prevent watering the backfill zone. Flower beds or other surface landscaping should be placed on the sloped backfill. Plastic edging or other similar means to provide separation between grass and rock areas should not be used unless a dependable means of allowing water out of the edging area is provided. Otherwise, water that is trapped within the edging is likely to percolate into the backfill. The water could then contact the foundation or under slab soil. We recommend that the foundation and under slab soil, especially the clay, be maintained at their existing moisture content both during and after construction.

2.10. Exterior Slabs

Due to the potential for frost movement for exterior slabs, precautions should be taken to minimize future post construction movement of sensitive slabs due to frost action. Options available include excavating frost susceptible soils to a depth of 5 feet below the slabs and replacing them with non-frost susceptible sand containing less than 5 percent passing the #200 sieve by weight. Another option would be to place at least 4 inches of extruded polystyrene foam insulation below the slabs and extend it at least 8 feet laterally past the edge of the slabs. Typically, 6 to 12 inches of sand is placed above the insulation for protection. A third option is to support the slabs or steps on foundations taken to frost depth. At least a 4-inch void should be provided below the slabs if this option is used.

Sensitive slabs are slabs that cannot tolerate much movement without causing some difficulties. An example would be the sidewalk or steps in front of a doorway. It is ***not*** intended to include all exterior sidewalks and driveways, etc.

2.11. Flexible Pavement Design

Flexible pavement design was based on our experience and in accordance with the "AASHTO Guide of Design of Pavement Structures 1993". No traffic volumes for the parking lot or driveway were given. For our analysis, we assumed a traffic loading of 50,000 equivalent 18-kip axle loads (ESAL's) over a 20-year design life for the pavements. The subgrade should be prepared as described in previous sections. Parameters used in design are as follows:

Table 2 – Pavement Design Parameters

Parameter	Value
Reliability	85%
Standard Deviation	0.45
Initial Serviceability	4.2
Terminal Serviceability	2.2
Estimated Subgrade CBR	2.9
Resilient Modulus	4350
HBP Layer Coefficient	0.36
Aggregate Base Layer Coefficient	0.1
Drainage Factor of Base and Subbase	1.0

The granular base course should meet the specifications as outlined in Section 816 of the 2020 North Dakota Department of Transportation's (NDDOT) "Standard Specifications for Road and

Bridge Construction" for Class 5 aggregate, or equivalent. The base material should be compacted to at least 100 percent of the standard Proctor density at a moisture content that facilitates compaction.

For a light duty traffic load of 50,000 ESALs, we recommend that the minimum section consist of 4.0 inches of hot bituminous pavement (HBP) over 10 inches of granular base course. For heavy duty pavements, we recommend that the minimum section consist of 6 inches of hot mix bituminous pavement over 12 inches of granular base. We also recommend a separation fabric be placed between the subgrade soils and the aggregate base section.

Adequate drainage should be considered imperative to prolong the life of the pavement. The pavement should be properly sloped to catch basins or appropriate inlets, as necessary. We recommend a minimum slope of 1 percent and preferably 2 percent.

The bituminous pavement should be composed of a quality mix such as FAA 42 as outlined in Section 430 of the NDDOT's "Standard Specifications for Road and Bridge Construction".

2.12. Rigid Pavement Design

We recommend that rigid pavement consist of a minimum 5 inches of unreinforced concrete pavement on a minimum of 6 inches of NDDOT Class 5 base course. For heavy duty pavement, we recommend a minimum 7 inches of unreinforced concrete pavement on a minimum of 8 inches of NDDOT Class 5 base course. Depending on the actual traffic loads, a thicker concrete section may be necessary.

The concrete mix should have proven success, or a mix design should be established for proper proportions of aggregate, cement, water and any admixtures. The concrete should be handled, placed and cured according to current ACI guidelines and specifications for exterior concrete. The concrete should have a minimum compressive strength of 4000 psi. The concrete should be placed with a maximum water/cement ratio of 0.45 and should have air entrainment between 5 and 7 percent.

Maintenance should be performed on all pavements on a regular basis. Cracks should be properly sealed as soon as they are observed. Again, adequate drainage should be considered imperative to prolong the life of the pavement.

2.13. Percolation Test

Three percolation tests and one shallow flight auger boring was drilled at the proposed drain field on the east side of the site. The percolation test locations are as shown on the attached aerial photograph in appendix A.

The soils were classified in accordance with ASTM D2488 by visual methods. The soils encountered were consistent with the other borings at the site. Approximately 2 inches of topsoil was encountered at the surface underlain by brown fat clay (CH) to the termination of the auger boring at 10 feet. The soil in the test holes was consistent with the auger boring.

The percolation tests were performed according to the North Dakota Department of Health (NDDH) guidelines at depths of approximately 3 feet below existing grade.

Test Hole	Depth (ft)	Soil Classification	Percolation Rate (min/in)	NDDH Relative Absorption Rate
P-1	0-3	Fat Clay	None	Impervious
P-2	0-3	Fat Clay	60+	Impervious
P-3	0-3	Fat Clay	60+	Impervious

No measurable groundwater was observed at the test locations. Water levels can fluctuate yearly and seasonally and may differ significantly at the time of construction. Long-term monitoring of groundwater levels was not included as part of our scope of work.

2.14. Excavation Slopes

Safe excavations must be always maintained. The excavation contractor is responsible for the safety of the excavations. Current OSHA requirements should be carefully followed when excavating for the back slope of the excavation. The OSHA soil type and excavation requirements must be verified by a competent person for the contractor at the time of construction. MTS does not assume responsibility for site safety or the contractors' activities.

3. CONSTRUCTION OBSERVATION AND TESTING

The recommendations contained in this report have been made based on the subsurface conditions found at the boring locations. It is possible that there are soil conditions on site that were not represented by the borings. Also, we presumed that close construction monitoring during excavation and backfilling would be authorized. Consequently, on-site observation during construction is considered integral to the successful implementation of the recommendations.

It is imperative that the geotechnical engineer be on site at the following times to observe the site conditions and effectiveness of the construction. We recommend that the testing be performed by the geotechnical engineer as the **Owner's** representative during construction.

3.1. Excavation Observations

The geotechnical engineer should observe the entire excavation bottom of the excavation prior to the placement of engineered fill and/or concrete. He would also be available for additional consultation and recommendations if necessary.

3.2. Placement of Fill

It will also be necessary to perform a representative number of compaction tests during placement of engineered fill. The tests should be performed to determine if the required compaction was achieved. As a general guideline, tests should be taken for each 2,500 square feet embankment fill, every 75 to 100 feet in trench fill, and for each 2-foot thickness of fill. The actual number of tests should be left to the discretion of the geotechnical engineer.

4. EXPLORATION LIMITATIONS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at according to currently accepted engineering practices at this time and location. Other than this, no warranty is intended or implied.

This report is written by:

Steve Wald, P.E
President

REGISTERED PROFESSIONAL ENGINEER
STEVEN A. WALD
PE-3841
DATE
NORTH DAKOTA

Steven Wald, P.E.
Date: 09/09/25

APPENDIX A – FIELD EXPLORATION PROGRAM

Attachments to Appendix A

Location Maps
Soil Profile Drawing
Boring Logs
Symbols & Descriptive Terminology on Test Boring Logs
Soil Classification Sheet

A. FIELD EXPLORATION PROGRAM

A.1 Exploration Scope

Four SPT borings were drilled to a nominal depth of 25 feet and two SPT borings were drilled to a nominal depth of 8 feet for the project. In addition, an auger boring was drilled to 10 feet deep in the proposed drainfield area and three percolation tests were conducted at approximately three feet deep. The field work was conducted on August 5 and 6, 2025. The boring locations are illustrated on the attached drawing and aerial photo at the back of this Appendix.

The borings were backfilled with on-site soil and some settlement can be expected to occur. The final closure of the holes is the responsibility of the client or property owner.

A.2 Surface Observations

The surface elevations at the test boring locations were estimated using Google Earth. Therefore, the elevations are only as accurate as the information provided by Google Earth.

The site was located at the southwest corner of the intersection of 13th Street SW and ND Highway 66 in Manning, ND. The area for the proposed addition is currently a vacant lot. The west portion of the site is surfaced with scoria. The east portion is barren or covered with grass/vegetation. Grade elevation ranged from 2223 feet at boring 1 to 2238 feet at boring 6. The site appeared to slope from west to east.

A.3 Subsurface Conditions

The subsurface conditions encountered at the test locations are illustrated by means of the attached boring logs and profile drawing. We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, it is necessary that you contact us so that our recommendations can be reviewed. The test boring log also shows the possible geologic origin of the materials encountered.

Scoria surfacing was present at borings 1 to 6. Beneath the scoria, fill was encountered up to four feet deep in borings 1 and 2. Below the fill, predominately naturally deposited fat clay was encountered. Lignite was encountered at the bottom of the 25-foot borings.

Based on the standard penetration resistance (“N” values), the fat clay soil was typically firm to hard in consistency.

A.4 Water Levels

Groundwater measurements were made in the test bore holes during drilling and at completion of drilling. This information is shown at bottom of the attached boring logs.

Groundwater was not observed in any of the bore holes during or at completion of the drilling.

Water levels should be expected to fluctuate seasonally and annually. The water levels at the time of construction could be significantly different than what was recorded on the boring logs. The time of year the borings were drilled and the history of precipitation prior to drilling should be known when using the groundwater readings on the boring logs to extrapolate water levels at other points in time.

A.5 Soil Sampling

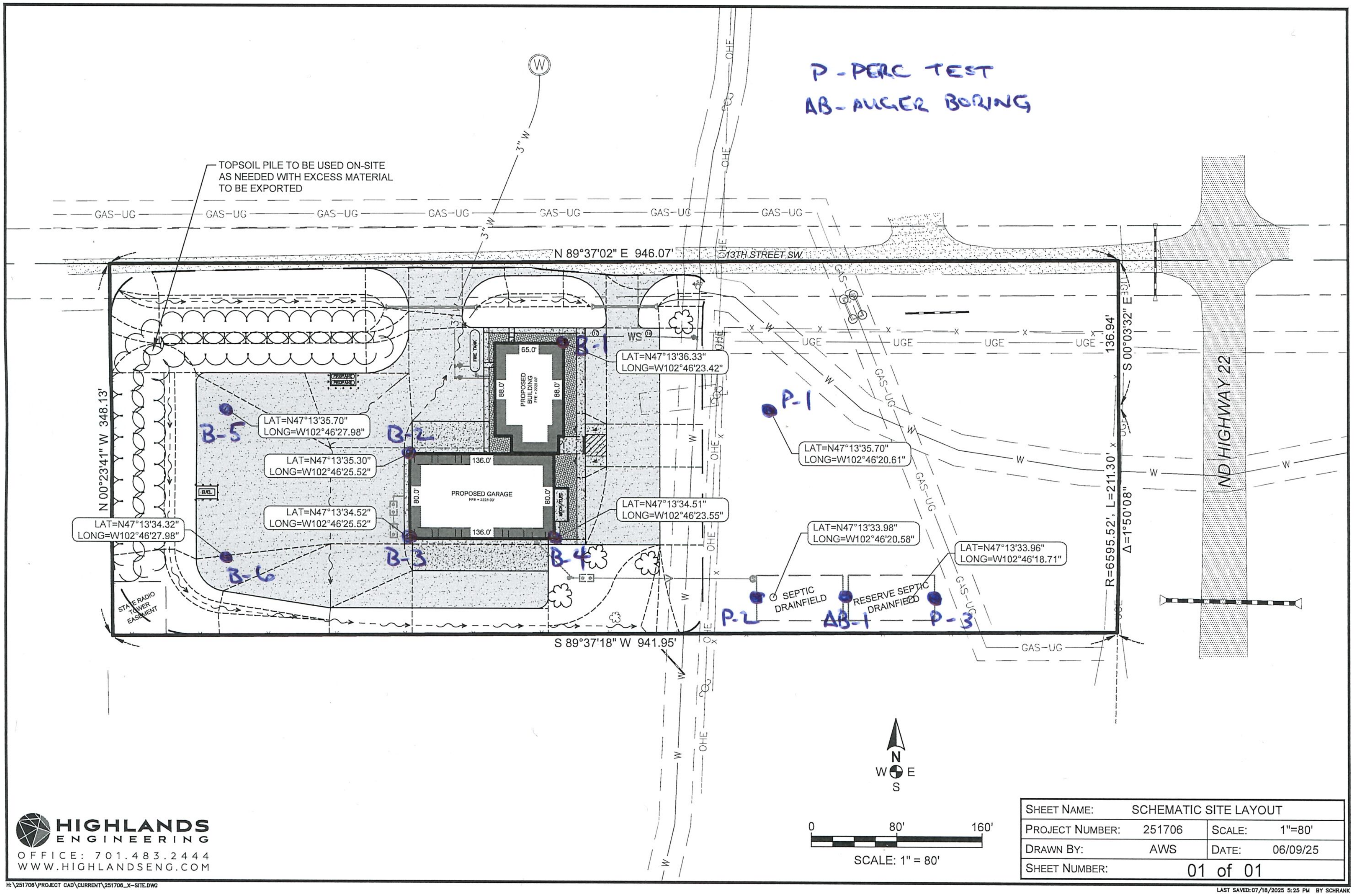
Soil sampling was done according to the procedures described by ASTM D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-lb weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as penetration resistance or "N" value. The "N" value is an index of the relative density of cohesionless soils and the consistency of cohesive soils.

We are retaining representative samples of the soil obtained during our field operations for approximately one month. We will then discard them unless we are notified further as to their disposition.

A.6 Soil Classification Procedure

As the samples were obtained in the field they were visually and manually classified by the crew chief according to ASTM D 2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, selected samples were then submitted to a program of laboratory tests. Logs of the borings indicating the depth and identification of the various strata, the "N" value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached. Charts illustrating the soil classification procedures, the descriptive terminology and symbols used on the boring logs are also attached.

Dunn County Safety Center Boring Locations

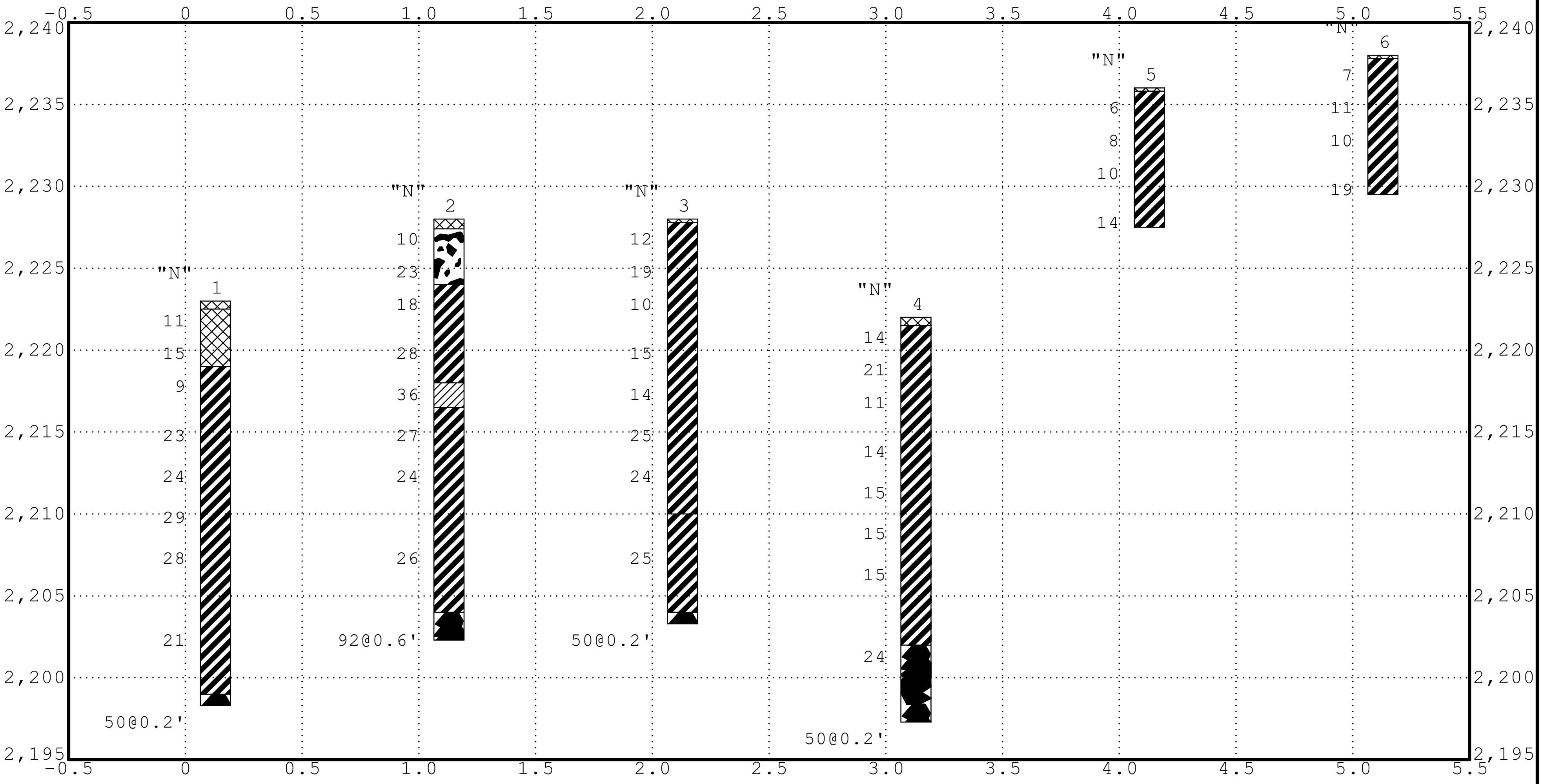


HIGHLANDS ENGINEERING
OFFICE: 701.483.2444
WWW.HIGHLANDSENG.COM

SHEET NAME:	SCHEMATIC SITE LAYOUT		
PROJECT NUMBER:	251706	SCALE:	1"=80'
DRAWN BY:	AWS	DATE:	06/09/25
SHEET NUMBER:	01 of 01		

H:\251706\PROJECT CAD\CURRENT\251706_X-SITE.DWG

LAST SAVED: 07/18/2025 5:25 PM BY SCHRANK



SOIL PROFILE DIAGRAM

Dunn County Safety Center

Manning, ND

PROJECT #	DATE	PLATE
G25-046	Sep 25	1

MATERIAL TESTING SERVICES, LLC
Box 634
Minot, North Dakota 58702
(701) 852-5553

SOIL BORING RECORD

BORING NUMBER **1** SHEET **1** OF **1**
PROJECT **Dunn County Safety Center**
PROJECT LOCATION **Manning, ND**
PROJECT NUMBER **G25-046**
START DATE **8/5/25** FINISH DATE **8/5/25**

LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	SYMBOLIC LOG	ELEVATION/ DEPTH (FT)	GEOLOGY	SAMPLE TYPE	SAMPLE LEGEND	SAMPLE D (pcf)	SAMPLE N VALUES BLOWS/FT	SAMPLE WATER LEVEL	TEST RESULTS MOISTURE CONTENT(%)	TEST RESULTS LIQUID LIMIT (%)	TEST RESULTS PLASTIC LIMIT (%)	TEST RESULTS Qu (psf)
0.5 2222.5	**Fill, scoria surfacing,**, red **Fill, mostly lean/fat Clay,**, brown to gray		0 2223.0	Fill	SB			11					
					SB			15					
4.0 2219.0										17	43	15	
	Fat Clay, brown to gray, mottled, trace lignite, hard, (CH)			Fine Alluvium	SB			9					
			5 2218.0										
					SB			23					
					SB			24					
			10 2213.0										
					SB			29					
					SB			28					
			15 2208.0										
					SB			21					
			20 2203.0										
24.0 2199.0	**Lignite,**, black												
24.7 2198.3	End of Boring NM = None Measured				SB			50@0.2'					

DRILLER **RB**
METHOD **4" FA from 0-24.5'**
LOGGER **JF**
REVIEWER **SW**
DRILL RIG **CME 45**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/5/25	945	24.7	none	23.9		NM
8/6/25	1040			23.8		NM

MATERIAL TESTING SERVICES, LLC
Box 634
Minot, North Dakota 58702
(701) 852-5553

SOIL BORING RECORD

BORING NUMBER	**2**
SHEET	**1** OF **1**
PROJECT	**Dunn County Safety Center**
PROJECT LOCATION	**Manning, ND**
PROJECT NUMBER	**G25-046**
START DATE	**8/5/25**
FINISH DATE	**8/5/25**

LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	SYMBOLIC LOG	ELEVATION/ DEPTH (FT)	GEOLOGY	SAMPLE TYPE	SAMPLE LEGEND	SAMPLE D (pcf)	SAMPLE N VALUES BLOWS/FT	SAMPLE WATER LEVEL	TEST RESULTS MOISTURE CONTENT(%)	TEST RESULTS LIQUID LIMIT (%)	TEST RESULTS PLASTIC LIMIT (%)	TEST RESULTS Qu (psf)
0.6	**Fill, scoria surfacing,**, red		0 2228.0	Fill	SB			10					
2227.4	**Possible Fill, mostly fat clay,**, brown												
					SB			23		19			
4.0 2224.0	**Fat Clay,** brown to gray, mottled, trace lignite, hard, (CH)			Fine Alluvium	SB			18					
			5 2223.0							24	71	20	
					SB			28					
10.0 2218.0	**Lean Clay with Sand,** gray, very hard, (CL)		10 2218.0		SB			36		15			
11.5 2216.5	**Fat Clay,** brown, hard, (CH)				SB			27					
			15 2213.0		SB			24					
			20 2208.0		SB			26					
24.0 2204.0	**Lignite,**, black		25 2203.0		SB			92@0.6'					
25.7 2202.3	End of Boring NM = None Measured												

DRILLER	**RB**
METHOD	**4" FA from 0-24.5'**
LOGGER	**JF**
REVIEWER	**SW**
DRILL RIG	**CME 45**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/5/25	1300	25.7	none	24.3		NM
8/6/25	1030			24.3		NM

MATERIAL TESTING SERVICES, LLC
Box 634
Minot, North Dakota 58702
(701) 852-5553

SOIL BORING RECORD

BORING NUMBER **3** SHEET **1** OF **1**
PROJECT **Dunn County Safety Center**
PROJECT LOCATION **Manning, ND**
PROJECT NUMBER **G25-046**
START DATE **8/6/25** FINISH DATE **8/5/25**

LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	ELEVATION/ DEPTH (FT)	GEOLOGY	SAMPLE TYPE	D (pcf)	N VALUES BLOWS/FT	WATER LEVEL	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	Qu (psf)
0.2 2227.8	**Fill, scoria surfacing,**, red	0 2228.0	Fill	SB		12					
	Fat Clay, brown, firm to hard, (CH)		Fine Alluvium					19			
				SB		19					
				SB		10					
		5 2223.0			90			31	55	21	4209
				SB		15					
				SB		14					
		10 2218.0									
				SB		25					
				SB		24					
		15 2213.0									
18.0 2210.0	**Fat Clay,** dark gray, hard, (CH)										
		20 2208.0		SB		25					
24.0 2204.0	**Lignite,**, black										
24.7 2203.3	End of Boring NM = None Measured			SB		50@0.2'					

DRILLER **RB**
METHOD **4" FA from 0-24.5'**
LOGGER **JF**
REVIEWER **SW**
DRILL RIG **CME 45**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/6/25	815	24.7	none	22.8		NM

MATERIAL TESTING SERVICES, LLC
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Minot, North Dakota 58702
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SOIL BORING RECORD

BORING NUMBER **4** SHEET **1** OF **1**
PROJECT **Dunn County Safety Center**
PROJECT LOCATION **Manning, ND**
PROJECT NUMBER **G25-046**
START DATE **8/6/25** FINISH DATE **8/5/25**

LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	SYMBOLIC LOG	ELEVATION/ DEPTH (FT)	GEOLOGY	SAMPLE						TEST RESULTS			
					TYPE	LEGEND	D (pcf)	N VALUES	BLOWS/FT	WATER LEVEL	MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	Qu (psf)
0.5 2221.5	**Fill, scoria surfacing,**, red		0 2222.0	Fill	SB			14						
	Fat Clay, brown to gray, mottled, trace lignite, firm to hard, (CH)			Fine Alluvium	SB			21			16			
					SB			11						
			5 2217.0											
					SB			14						
					SB			15						
			10 2212.0											
					SB			15						
					SB			15						
			15 2207.0											
					SB			24						
20.0 2202.0	**Lignite,**, black		20 2202.0											
					SB			50@0.2'						
24.7 2197.3	End of Boring NM = None Measured													

DRILLER	**RB**
METHOD	**4" FA from 0-24.5'**
LOGGER	**JF**
REVIEWER	**SW**
DRILL RIG	**CME 45**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/6/25	850	20.7	none	24.7		NM

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SOIL BORING RECORD

BORING NUMBER **5** SHEET **1** OF **1**
PROJECT **Dunn County Safety Center**
PROJECT LOCATION **Manning, ND**
PROJECT NUMBER **G25-046**
START DATE **8/6/25** FINISH DATE **8/5/25**

LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	SYMBOLIC LOG	ELEVATION/ DEPTH (FT)	GEOLOGY	SAMPLE					TEST RESULTS			
					TYPE	LEGEND	D (pcf)	N VALUES BLOWS/FT	WATER LEVEL	MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	Qu (psf)
0.2 2235.8	**Fill, scoria surfacing,**, red	☒	0 2236.0	Fill	SB	☒		6					
	Fat Clay, brown, soft to firm, (CH)	▨		Fine Alluvium						26			
		▨			SB	☒		8					
		▨			SB	☒		10					
		▨	5 2231.0										
		▨			SB	☒		14					
8.5 2227.5	End of Boring NM = None Measured												

DRILLER RB
METHOD 4" FA from 0-7'
LOGGER JF
REVIEWER SW
DRILL RIG CME 45

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/6/25	915	7.0	none	8.5		NM

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SOIL BORING RECORD

BORING NUMBER **6** SHEET **1** OF **1**
PROJECT **Dunn County Safety Center**
PROJECT LOCATION **Manning, ND**
PROJECT NUMBER **G25-046**
START DATE **8/6/25** FINISH DATE **8/5/25**

					SAMPLE					TEST RESULTS			
LAYER DEPTH/ ELEVATION (FT)	SOIL DESCRIPTION	SYMBOLIC LOG	ELEVATION/ DEPTH (FT)	GEOLOGY	TYPE	LEGEND	D (pcf)	N VALUES BLOWS/FT	WATER LEVEL	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	Qu (psf)
0.2 2237.8	**Fill, scoria surfacing,**, red	☒	0 2238.0	Fill	SB	☒		7					
	Fat Clay, brown, mottled, firm, (CH)	▨		Fine Alluvium	SB	☒		11					
		▨								23			
		▨			SB	☒		10					
		▨	5 2233.0										
		▨			SB	☒		19					
8.5 2229.5	End of Boring NM = None Measured												

DRILLER RB
METHOD 4" FA from 0-7'
LOGGER JF
REVIEWER SW
DRILL RIG CME 45

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL
8/6/25	940	6.7	none	8.5		NM

SYMBOLS AND DESCRIPTIVE TERMINOLOGY
ON TEST BORING LOG

SYMBOLS FOR DRILLING AND SAMPLING

Symbol	Description
HSA	3 1/4" I.D. hollow stem auger
_FA	4", 6" or 10" diameter flight auger
_HA	2", 4" or 6" hand auger
_DC	2 1/2", 4", 5" or 6" steel drive casing
_RC	Size A, B or N rotary casing
PD	Pipe drill or cleanout tube
CS	Continuous split barrel sampling
DM	Drilling mud
JW	Jetting water
SB	2" O.D. split barrel sampling
_L	2 1/2" or 3 1/2" O.D. SB liner sample
_T	2" or 3" thin walled tube sample
3TP	3" thin walled tube using pitcher sampler
_TO	2" or 3" thin walled tube using Osterberg sampler
W	Wash sample
B	Bag sample
P	Test pit sample
_Q	BQ, NQ, or PQ wireline system
_X	AX, BX, or NX double tube barrel
N	Standard penetration test, blows per foot
CR	Core recovery, percent
WL	Water level
?	Water level
NMR	No measurement recorded, primarily due to presence of drilling or coring fluid

SYMBOLS FOR LABORATORY TESTS

Symbol	Description
W	Water content
D	Dry density - pounds per cubic foot
LL	Liquid limit - ASTM** D 4318
PL	Plastic limit - ASTM D 4318

--- Inserts in Last Column (Qu or RQD) ---

Qu	Unconfined compressive strength, psf - ASTM D 2166
Pq	Penetrometer reading, tsf
Ts	Torvane reading, tsf
G	Specific gravity
SL	Shrinkage limits - ASTM D 427
OC	Organic content - Combustion method
SP	Swell pressure, tsf
PS	Percent swell under pressure
FS	Free swell, percent
SS	Shrink swell, percent
pH	Hydrogen ion content - Meter Method
SC	Sulfate content, parts/million or mg/l
CC	Chloride content, parts/million or mg/l
C*	One dimensional consolidation - ASTM D 2435
Qc*	Triaxial compression
D.S.*	Direct shear - ASTM D 3080
K*	Coefficient of permeability, cm/sec
DH*	Double hydrometer - ASTM D 4221
MA*	Particle size analysis - ASTM D 422
R	Laboratory electrical resistivity, ohm-cm - ASTM G 57
E*	Pressuremeter deformation modulus, tsf
PM*	Pressuremeter test
VS*	Field vane shear - ASTM D 2573
IR*	Infiltrometer test - ASTM D 3385
RQD	Rock quality designation, percent

*	Results shown on attached data sheet or graph
**	ASTM designates American Society for Testing and Materials

DESCRIPTIONS OF N-VALUES VS. SOIL PROPERTIES

N Value	Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
Over 50	Very dense

N Value	Consistency
0 - 4	Very soft
5 - 8	Soft
9 - 15	Firm
16 - 30	Hard
Over 30	Very hard

DESCRIPTIONS OF SOIL CONDITIONS

Condition	Description
Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Waterbearing	Pervious soil below water
Varved	Alternating laminations of any combinations of clay, silt and fine grained sand

DESCRIPTIONS OF GRAVEL PROPORTIONS IN SOILS

Soil Type	Description	Range, %
Coarse grained soils	A little gravel	2 - 14
Coarse grained soils	With gravel	15 - 49
Fine grained soils:		
71-85% passing #200 sieve	A little gravel	2 - 7
71-85% passing #200 sieve	With gravel	8 - 29
70% passing #200 sieve	A little gravel	2 - 14
70% passing #200 sieve	With gravel	15 - 24
70% passing #200 sieve	Gravelly	16 - 49

DESCRIPTIONS OF PARTICLE SIZES

Material Type	Size
Boulders	Over 12"
Cobbles	3" - 12"
Coarse gravel	3/4" - 3"
Fine gravel	#4 sieve - 3/4"
Coarse sand	#4 - #10 sieve
Medium sand	#10 - #40 sieve
Fine sand	#40 - #200 sieve
Silt	100% passing #200 sieve and > 0.002mm
Clay	100% passing #200 sieve and < 0.002mm

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	●	GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
			○	GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	◫	GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
			▨	GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	⁙	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			░	SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▥	SM	SILTY SANDS, SAND - SILT MIXTURES
			▨	SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	▥	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			▨	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			☰	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	▥	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY
			≋	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			ѱ	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

APPENDIX B – LABORATORY TEST PROGRAM

Attachments to Appendix B

B. LABORATORY TEST RESULTS

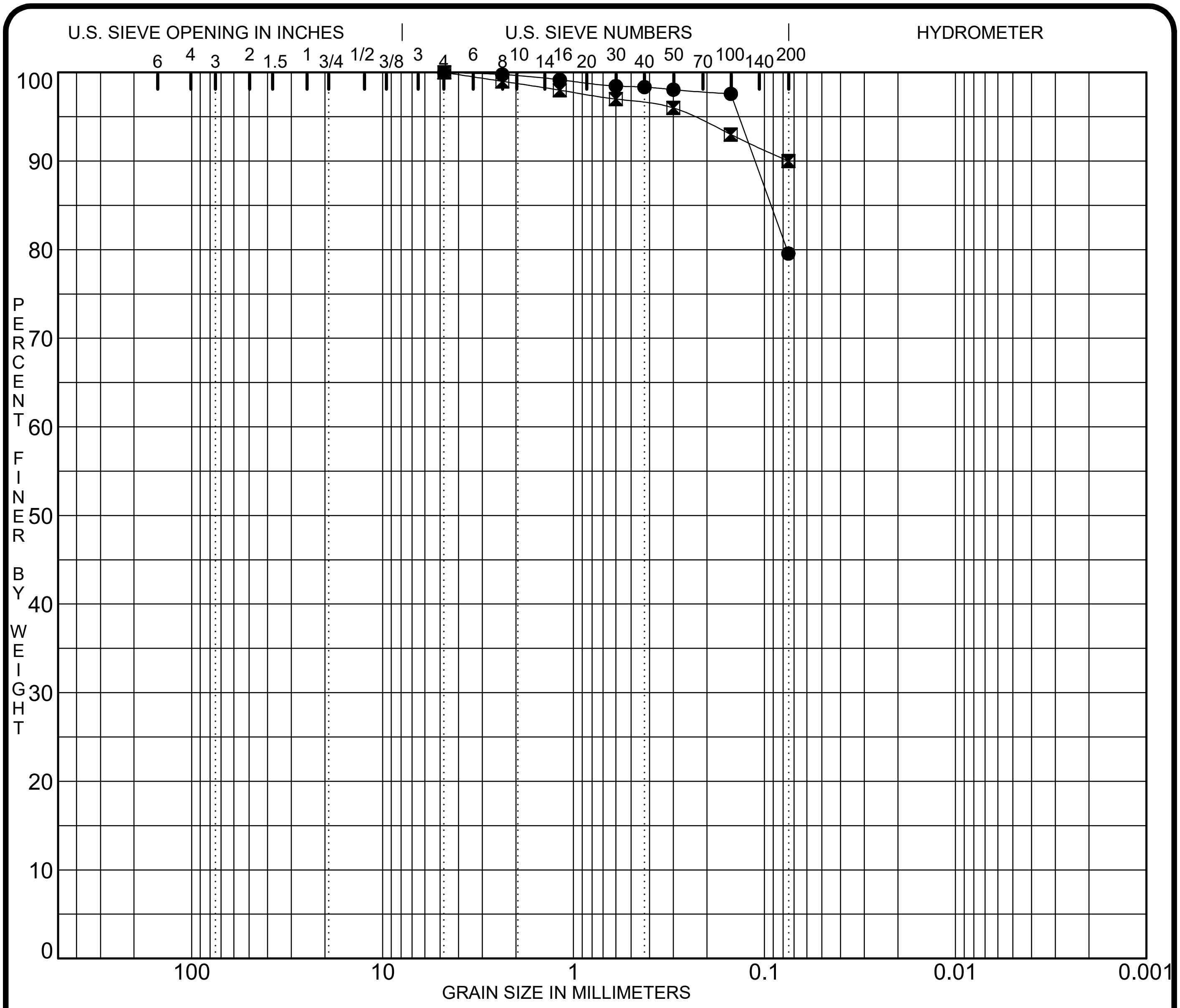
B.1 Testing Scope

Laboratory testing was conducted to characterize soil index properties including Atterberg limits (liquid and plastic limits), mechanical sieve analysis, moisture content, unconfined compression, moisture-density relationship, and CBR.

B.2 Test Methods

2. Testing and classification of soil was performed in accordance with the following standards as applicable:

Description	ASTM Method
Unified soil classification system	D 2487
Atterberg limits	D 4318
In-situ moisture content	D 2216
Sieve analysis	D 422, C 117, C 136
Moisture-density relationship	D 698 or D 1557
In-situ dry density	Direct measurement
Unconfined compression, Qu	D 2166
CBR	D 1883



<table>
<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT OR CLAY</td></tr>
<tr><td>coarse</td><td>fine</td><td>coarse</td><td>medium</td><td>fine</td></tr>
</table>

	Boring No.	Depth (ft)	Classification	MC%	LL	PL	PI	Cc	Cu
●	**2**	**10.0**	**Lean Clay with Sand (CL)**	**15**					
⧗	**Bulk 1**	**0.0**	**FAT CLAY CH**		**59**	**18**	**41**		

	Boring No.	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**2**	**10.0**	**4.75**				**0.0**	**20.4**	**79.6**	
⧗	**Bulk 1**	**0.0**	**4.75**				**0.0**	**10.0**	**90.0**	

PROJECT **Dunn County Safety Center, Manning, ND**

JOB NO. **G25-046**
DATE **9/8/25**

PARTICLE SIZE ANALYSIS

MATERIAL TESTING SERVICES, LLC

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Minot, ND 58702
(701) 852-5553

UNCONFINED COMPRESSIVE STRENGTH
ASTM D 2166

7101 W 2nd Ave
Williston, ND 58801
(701) 572-4226

PROJECT: DUNN COUNTY PUBLIC SAFETY CENTER
MANNING, ND

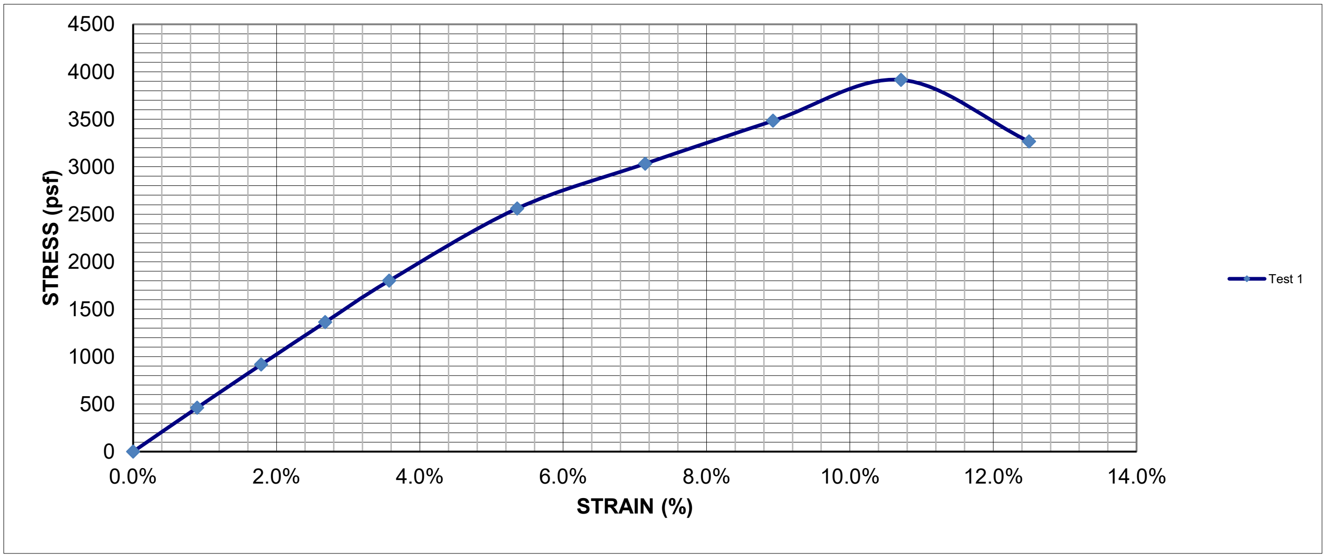
DATE: 8-Sep-25

COPIES TO:

REPORTED TO: Dunn County
205 Owens Street
Manning, ND 58642

MTS No. G25-046

Specimen ID:	**Test 1** B-3 SS, 5-6 feet
Soil Class:	Fat Clay, Brown (CH)
Dry Density (pcf):	91.0
Water Content:	31.0%
Sample Dia. (mm):	34.3
Sample Ht (mm):	71.1
Height/Diameter:	2.07
Unc. Strength (psf):	**4209**
Strain at Failure (%):	10.7



Material Testing Services, LLC

by ______________________

MATERIAL TESTING SERVICES, LLC

P.O. Box 634
Minot, ND 58702
(701) 852-5553

7101 W 2nd Avenue
Williston, ND 58801
(701) 572-4226

MOISTURE-DENSITY RELATIONSHIP

PROJECT: PROPOSED DUNN COUNTY SAFETY CENTER
MANNING, ND

DATE: 9-Sep-25

COPIES TO:

REPORTED TO: Dunn County

MTS No. G25-046

Sample Number: 1

Sample ID: subgrade, auger cuttings, borings 5 and 6

Sampled 8/6/25
Tested 8/8/25

Soil Description: Brown FAT CLAY

Unified Soil Classification: CH

Results:

Method	**ASTM D698, Method B (manual)**	
Maximum Dry Density	**105.8**	pcf
Optimum Moisture Content	**20.5**	%

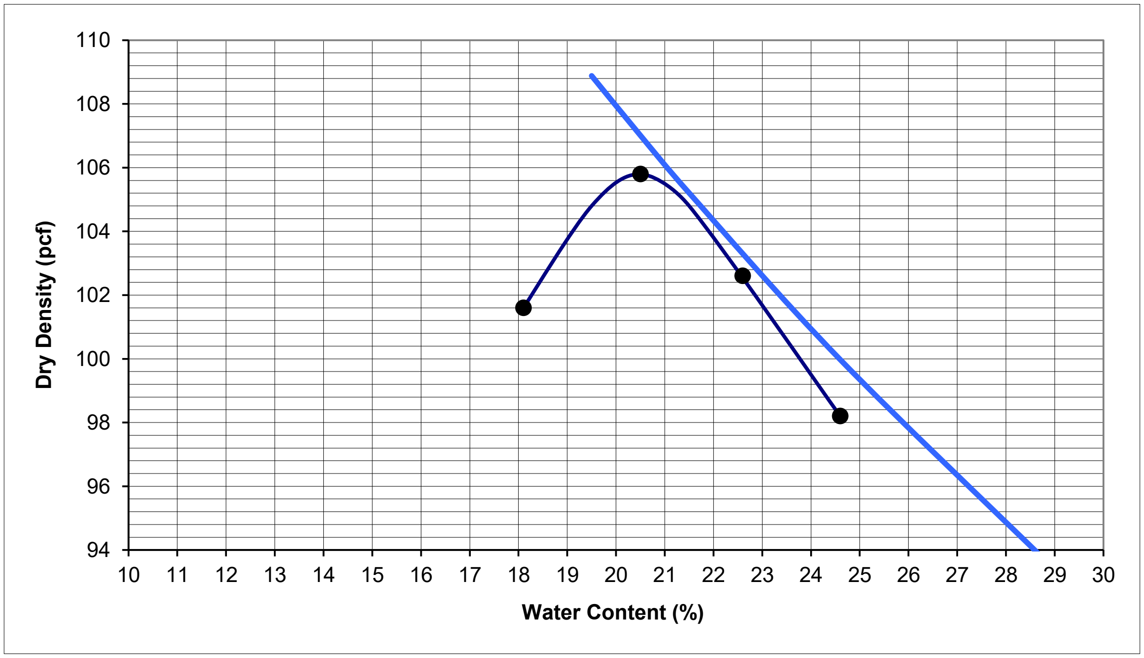
ZAV Specific Gravity (est.): 2.65

Sieve Analysis
ASTM D422, D1140

% Passing	
3/4"	100
3/8"	100
#4	100
#8	99
#16	98
#30	97
#50	96
#100	93
#200	90

Atterberg limits
ASTM D4318, dry prep

LL	59
PL	18
PI	41



Material Testing Services, LLC

by

MATERIAL TESTING SERVICES, LLC

PO Box 634
Minot, ND 58702
(701) 852-5553

CALIFORNIA BEARING RATIO - ASTM 1883

7101 2nd Ave W
Williston, ND 58802
(701) 572-4226

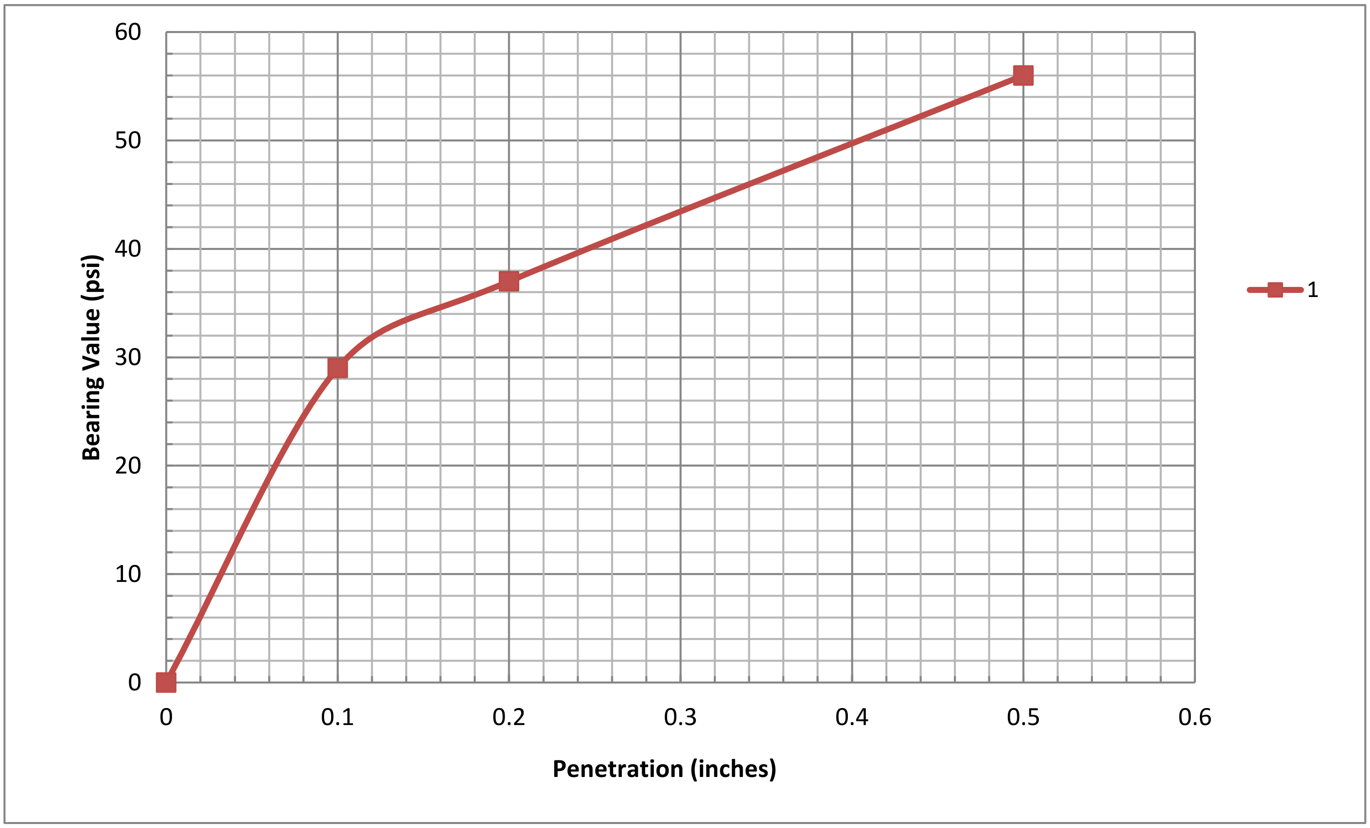
PROJECT: PROPOSED DUNN COUNTY SAFETY CENTER
MANNING, ND

DATE: 9-Sep-25

REPORTED TO: Dunn Conty

Laboratory Number G25-046

SAMPLE IDENTIFICATION:		Bulk 1
SOIL DESCRIPTION:		CH
MOISTURE-DENSITY RELATION:	Max Dry Density (pcf)	105.8
(ASTM D 698)	Optimum Moisture %	20.5
TEST TRIAL:		**1**
Dry Density, at molding		100.9
Moisture Content, at molding		20.5
% of Maximum Dry Density		95.4
Moisture Content after soaking		28.2
CORRECTED BEARING RATIO:		
at 0.1" penetration		2.9
at 0.2" penetration		2.5
SWELL, % of initial heights		2.51
SURCHARGE WEIGHT (pounds):		10.00



APPENDIX C

Precautions for Excavating & Refilling During Cold Weather

PRECAUTIONS FOR EXCAVATING AND REFILLING DURING COLD WEATHER

The winter North Dakota presents specific problems for foundation construction. Soils which are allowed to freeze undergo a moisture volume expansion, resulting in a loss of density. These frost-expanded soils will consolidate upon thawing, causing settlement of any structure supported on them. To prevent this settlement, frost should not be allowed to penetrate the soils below any proposed structure.

Ideally, winter excavation should be limited to areas small enough to be refilled to a grade higher than footing grade on the same day. Typically, these areas should be filled to floor grade. Trenching back down to unfrozen soils for foundation construction can then be performed just prior to footing placement. The excavated trenches should be protected from freezing by means of insulation or heating during foundation construction. Backfilling of the foundation trenches should be performed immediately after the below-grade foundation construction is finished. In addition, any interior footings, or footings designed without frost protection should be extended below frost depth, unless adequate precautions are taken to prevent frost intrusion until the building can be enclosed and heated.

In many cases, final grades cannot be attained in one day's time, even though small areas are worked. In the event final grade cannot be attained in one day's time, frost can be expected to develop overnight. The depth of frost penetration can be minimized by leaving a layer of loose soil on top of the compacted material overnight. However, any frost which forms in this loose layer, or snow, should never be used as fill material.

After the structure has been enclosed, all floor slab areas should be subjected to ample periods of heating to allow thawing of the soil system. Alternatively, the frozen soil can be completely removed and be replaced with an engineered fill. The floor slab areas should be checked at random and representative locations for remnant areas of frost, and density tests should be performed to document fill compaction prior to slab placement.

Due to the potential problems associated with fill placement during cold weather, any filling operations should be monitored by a full-time, on-site soils technician. Full-time monitoring aids in detecting areas of frozen material, or potential problems with frozen material within the fill, so that appropriate measures can be taken. The choice of fill material is particularly important during cold weather, since clean granular fill materials can be placed and compacted more efficiently than silty or clayey soils. In addition, greater magnitudes of heaving can be expected with freezing of the more frost susceptible silts and clays.

If more specific frost information or cold weather data concerning other construction materials is required, please contact us.