SPN Helms
ENGINEERS & SURVEYORS

416 PRODUCTION STREET N.
ABERDEEN, SD 57401

PHONE (605) 225-1212
FAX (605) 225-3189

April 21, 2026

Re: Revenue Producing Hangar
Winner Regional Airport
Winner, South Dakota
AIP #3-46-0061-023/024-2026
Helms #A-9857

Bid Opening: **April 22, 2026**
2:00 pm Local Time

ADDENDUM NUMBER 3

The following modifications are made to the plans and specifications for the Revenue Producing Hangar Project, Winner Regional Airport:

SEE ATTACHED SOILS REPORT

ALL OTHER ITEMS OF THE PLANS AND SPECIFICATIONS REMAIN UNCHANGED

Registered Professional Engineer
REG. No.
11520
MICHAEL A.
SCHMIT
SOUTH DAKOTA

BY: ______________________

PROJECT ENGINEER – HELMS & ASSOCIATES

Acknowledge receipt of the Addendum by inserting its number on the Bid Form. Failure to do so may subject bidder to disqualification. This Addendum forms a part of the Contract Documents. It modifies them as above.

Soil Technologies, Inc.

28822 124th Street – Mobridge, SD 57601 – (605) 762-3406
www.soil-technologies.com

"Building Your Success On A Solid Foundation"

January 5, 2026

Helms and Associates
Attn: Mr. Michael Schmit, P.E.
416 Production St. N.
Aberdeen, SD 57402

Subj: Soil Exploration
Proposed Revenue Producing Hangar
Regional Airport
Winner, SD
STI #25-1952

This report presents the findings of the Soil Exploration performed for the above referenced project. The exploration was performed in accordance with your authorization of our proposal to you dated September 23, 2025. An electronic file copy is being sent to you.

Soil Technologies, Inc. (STI) is dedicated to providing our clients with the most complete Soil Exploration and Geotechnical Engineering services. To accomplish this, a Geotechnical Engineer from Soil Technologies, Inc. should be retained to monitor the earthwork operations during construction. The Geotechnical Engineer will observe the soil conditions at the project site and judge when the excavations are satisfactorily completed. The Geotechnical Engineer's observations will help affirm that the earthwork is performed according to the recommendations of this report.

Thank you for the opportunity to perform these services for you on this project. If you have any questions regarding the contents of this report, or if we can be of further service to you, please feel free to contact us.

SOIL TECHNOLOGIES, INC.

Mr. Kim E. Stoecker, PE
President

REGISTERED PROFESSIONAL ENGINEER REG. NO 6394 KIM E. STOECKER SOUTH DAKOTA

HELMS AND ASSOCIATES
ABERDEEN, SD

SOIL EXPLORATION

PROPOSED REVENUE PRODUCING HANGAR

REGIONAL AIRPORT

WINNER, SD

STI #25-1952

January 5, 2026

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1.0 INTRODUCTION

1.1 Project Information

We understand the proposed project will consist of the construction of a Revenue Producing Hangar building at the regional airport in Winner, SD. The facility will be a single-story, insulated and potentially heated, slab-on-grade structure (no below grade floors or crawl space). It will have overall dimensions of approximately 90 x 100 feet. We assume the finished top of roof height will be between 12 and 18 feet. The structure will be supported on shallow spread footing foundations.

- **Conditions:**

- The finished floor elevation of the proposed building is assumed to be within 1 foot above the existing pavement along the northeast side (about 0.5 to 5.5 feet above the existing grades) and be at an elevation between 1228.0 and 1229 feet.*
- The perimeter frost footings of the proposed building will rest 4.5 to 6 feet below the finished floor and be at an elevation between 1222.0 to 1224.5 feet.*
- The new perimeter finished grades immediately surrounding the proposed building will be below the finished floor elevation.
- Column loads will be a maximum of 200 kips (total dead and live loads) with continuous footing loads less than 4 kips/ft (total dead and live loads).
- Uniform floor slab loadings exerted on the underlying soils will be a maximum 500 pounds per square foot (psf).

**Elevations based on the survey benchmark shown on the attached sketch.*

2.0 ENGINEERING REVIEW

The engineering recommendations provided in this report are based on the soil information obtained under this Soil Exploration along with the information and conditions of the project as described above. The recommendations are valid for the specific information and conditions listed. If there are additions, corrections, or changes to the above information or conditions, it is necessary that we be notified so that we can determine whether the new information or conditions affect our recommendations.

Our design assumptions include a minimum theoretical safety factor of 3 with respect to shearing or base failure of the foundations. We assume an allowable total settlement of 1 inch and a differential settlement of up to ½ inch over a length of 30 feet.

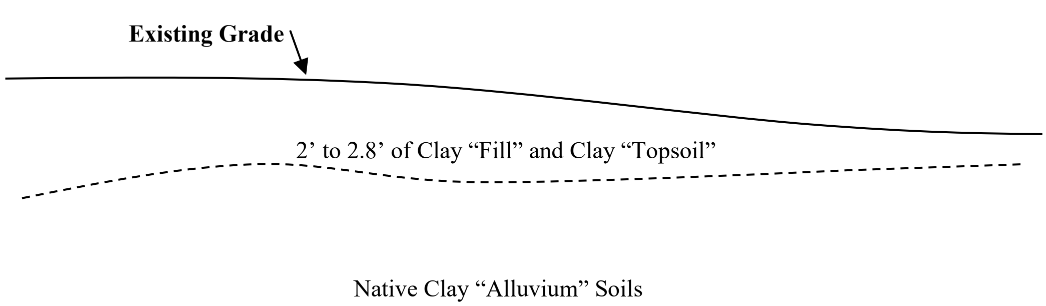
The recommendations in this report assume the location of the proposed building is within 50 feet of the boring locations as shown on the attached sketch. If the location of the proposed building is changed so as not to be within this distance for each of the respective borings, the opinions and recommendation of this report may not be applicable, and we must be contacted for additional review and potentially additional borings.

2.1 Discussion

- **Soil Profile**

The boring logs suggest that the general soil profile in the area of the proposed structure consists of about 2 to 2.8 feet of clay “fill” soils” and clay “topsoil” overlying native clay “alluvium” (water deposited soils) which extend to the termination depths of the borings at 16 feet below the existing grades. Please refer to Figure #1 below and the attached boring logs.

Existing General Soil Profile



1. Fill: Deposited by the action of man.
2. Native: Naturally occurring soils – does not include topsoil.

Figure #1 (not a plan drawing)

Note: The existing “fill” soils are assumed to be “undocumented” and thus, they are considered uncontrolled fill that was not monitored nor tested for quality and compaction during placement.

- **General**

Based on the subsurface conditions encountered at the boring locations, it is our opinion that the native soils at the site will support the proposed structure on shallow spread footing foundations, provided the recommendations in this report are performed and the estimated settlements are acceptable. Listed below are some of the more prominent site conditions.

- **FOOTING AREAS**: Based on the boring logs, "fill" soils and "topsoil" exist at the site and extend from the surface to depths of about 2 to 2.8 feet below the existing grades. In our opinion, these soils are <u>not</u> suitable for support of the footings and should be removed from the footing areas. In addition, fat clay soils were encountered at the site. The fat clay soils pose a significant risk of movement and subsequent distress to the proposed structure and should be mitigated as noted below under "FAT CLAY SOILS."
- **FLOOR AREA:** As mentioned above, "fill" soils and "topsoil" were encountered at the site and extend from the surface to depths of about 2 to 2.8 feet below the existing grades. Similar to the footings, the "fill" soils and "topsoil" and should be removed from the floor areas. Also, similar to the footings, the fat clay soils pose a significant risk of movement and subsequent distress to the proposed structure and should be mitigated as noted below under "FAT CLAY SOILS."
- **FAT CLAY SOILS:** Fat clays soils were encountered in the borings. Fat clay soils typically have a potential for movement (swelling and shrinkage) with a change in the in-situ moisture content. The movement of fat clay soils can cause the footings or floor slab of a structure to be displaced, which can result in structural distress. The potential movement of the fat clay depends on a number of uncontrolled variables such as climate conditions at and after the time of construction, long term fluctuations of the groundwater level, construction backfill methods, utility line leakage, landscaping, sprinkling (watering) of plants and lawns, and other similar aspects.

  Based our experience with similar soils, the laboratory test results, and calculated liquidity index, it is our opinion that the fat clay soils encountered at this site generally have a high potential for movement with a change in the in-situ moisture content. Therefore, they present a high potential risk of moisture related movement and subsequent structural distress to the proposed building.

  A common method to significantly reduce and nearly eliminate the risk of structural distress, (due to moisture related movement of the fat clay) is to support the entire structure (all structural components including the floor slab) on a deep foundation system such as drilled piers or pile. In general, the cost of installing a deep foundation system is typically much higher than the cost of normal spread footing foundations. As an example, drilled piers would extend to a depth of about 20 to 25 feet below the existing grades.

An alternative, (but higher risk method) to reduce the risk of structural distress due to fat clay soils, is to perform an "excavate refill program" below the structure. The excavate/refill program typically consists of placing a 3 to 5-foot layer of non-expansive engineered fill soils between the structural components (including slabs) and the fat clay. The purpose of placing the non-expansive engineered fill below the structure is to provide a "buffer zone" between the fat clay and the structural components. CAUTION: This buffer zone will reduce (mitigate) the potential of movement and subsequent distress to the proposed structure, but it will not eliminate it. (Keep in mind that the excavate/refill program requires above normal monitoring and workmanship of all earthwork activities.)

The decision as to which method to use (the deep foundation system or the 3 to 5-foot excavate/refill program) and their corresponding risks, is solely that of the owner/client. This report provides recommendations relative to a minimum 3 foot excavate/refill program along with typical shallow spread footings construction. (Note: The risk of distress can be limited further by using a 5 foot excavated/refill program.) Please contact us if you desire more information about supporting the structure on deep foundations. Also, please be aware that additional laboratory tests, such as "pressure-swell" tests can be performed to further verify the severity of the fat clay's potential to move and cause distress.

2.2 Site Preparations

Assuming the owner desires to support the proposed building on typical shallow spread footings and to reduce (but not eliminate) the risk of structural distress due to potential movement of the fat clay soils, we recommend the following site preparations:

FOOTINGS (Interior, Exterior, & Thickened Edged): In our opinion, the existing "fill" soils and "topsoil" should not be used for support of the footings. In addition, the existing fat clay soils should not be used for direct support of the footings. Therefore, we recommend that the excavations for the footings extend through the existing "fill" soils" and "topsoil." In addition, the footing excavations should extend deep enough to place at least a 3-foot layer of non-expansive clay engineered fill soils between the footings (structural components of the building) and the fat clay. Thus, the footing excavations should extend through the existing "fill" soils and "topsoil" and to a depth of at least 3 feet below the design footing grade. For example, if a footing is designed to rest at an elevation of 95.0 feet, and the existing "fill" soils and "topsoil" extend to an elevation of 94.0 feet, the excavation for the footing should extend through the "fill" soils and "topsoil" and to at least 3 feet below the footing, to an elevation of 92.0 feet. Or, as another example, if a footing is designed to rest at an elevation of 95.0 feet, and the existing "fill" soils and "topsoil" extend to an elevation of 90.0 feet, the excavation for the footing should extend at least 3 feet below the footing and through the "fill" soils and "topsoil" to an elevation of 90.0 feet.

During the footing area excavations, the exposed native clay soils at the bottom of the excavations should be observed by STI's on-site Geotechnical Engineer. The Geotechnical Engineer should perform shallow hand auger borings into the exposed soils. Very soft, sheared, disturbed, loose, or otherwise weak soils should be excavated and replaced with engineered fill as directed by the Geotechnical Engineer. Once adequate excavation depths are reached and the strength of the exposed native soils are judged adequate by the on-site Geotechnical Engineer, the footing excavations should be refilled with at least 3 feet of clay engineered fill (fill soils that have been compacted and tested to the specified density) to meet the design footing grade elevations. The footings should be constructed to rest on at least 3 feet of the clay engineered fill. Please refer to Figure #2 on page 6 showing "Typical Building Site Preparations." Also, refer to the "Engineered Fill" recommendations on page 9.

FLOOR SLAB: Similar to the footing areas, site preparations for the floor slab area should consist of the excavation of the existing fill" soils and "topsoil." In addition, the footing excavations should extend deep enough to place at least a 4-foot layer of non-expansive clay engineered fill soils between the floor and the fat clay soils. For example, if a floor is designed to rest at an elevation of 99.5 feet, and the existing "fill" soils and "topsoil" extend to an elevation of 97 feet, the excavation for the floor area should extend through the "fill" soils and "topsoil" and to at least 4 feet below the floor, to an elevation of 95.5 feet. Or, as another example, if the floor slab is designed to rest at an elevation of 99.5 feet, and the existing "fill" soils and "topsoil" extend to an elevation of 94.0 feet, the excavation for the floor should extend at least 3 feet below the bottom of the floor and through the "fill" soils and "topsoil" to an elevation of 94.0 feet.

During the floor area excavation, the exposed native clay soils at the bottom of the excavation should be observed by STI's on-site Geotechnical Engineer. The Geotechnical Engineer should perform shallow hand auger borings into the exposed soils. Very soft, sheared, disturbed, loose, or otherwise weak soils should be excavated and replaced with engineered fill as directed by the Geotechnical Engineer. Once adequate excavation depths are reached and the strength of the exposed native soils are judged adequate by the on-site Geotechnical Engineer, the floor excavation should be refilled with at least 4 feet of clay engineered fill (fill soils that have been compacted and tested to the specified density) to meet the design floor grade elevation. The floor should be constructed to rest on at least 4 feet of the clay engineered fill. Please refer to Figure #2 below showing "Typical Building Site Preparations." Also, please refer to page 9 for the type of engineered fill.

Typical Building Site Preparations

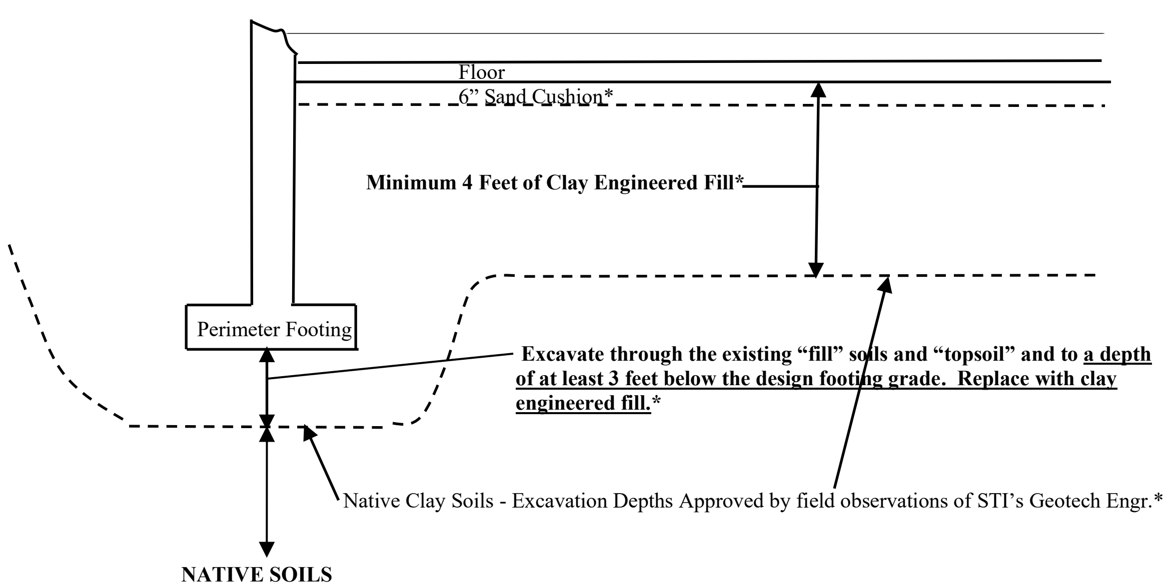


Figure #2 (not a plan drawing)

*Specific specifications listed in this report.

- **Excavation Oversize Requirements**

Engineered fill placed below the footings should be oversized one foot laterally for each foot of engineered fill placed below the footings (extend the excavation outwards from the outer edges of the footings a distance of 1 foot for every 1 foot of engineered fill placed below the footings). The maximum lateral over-excavation required is 1.5 times the width of the footing. Please refer to Figure #3 below illustrating the 1:½ excavation oversize requirement.

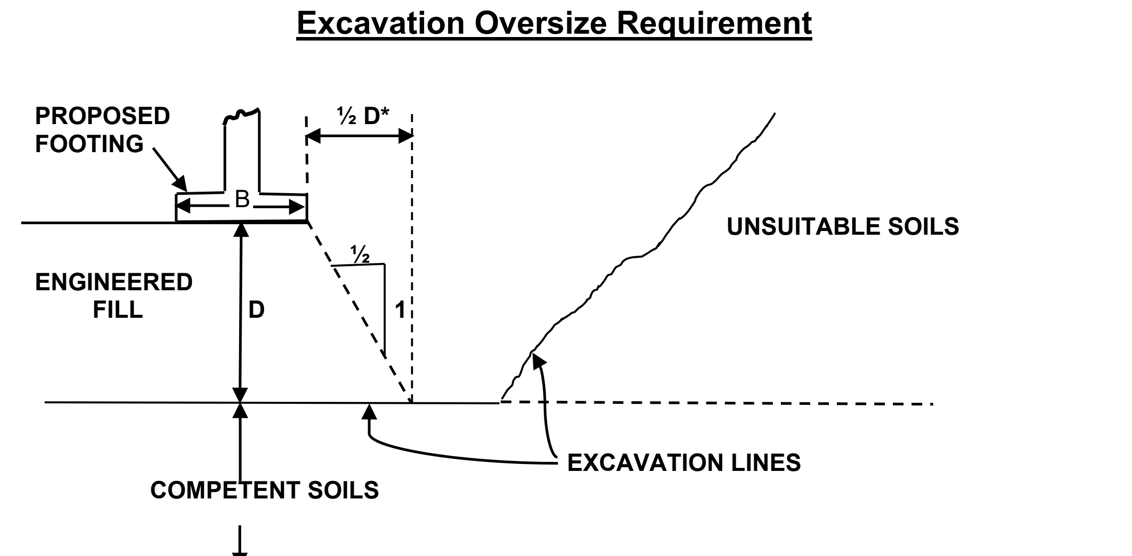


Figure #3 (not a plan drawing) ***D:** The maximum lateral over-excavation required = 1.5 x B

- **Utility Trenches**

Utility trenches within the building footprint (and in structural areas outside the building footprint) should be refilled with engineered fill. The engineered fill should be compacted and tested to the specified density listed on page 9. In addition, utility trenches should not be placed within the influence zone of the footings, including the influence zone of thickened edge footings. Please refer to Figure #4 below. If it is necessary to install a utility by crossing beneath an existing footing (new or old), that portion of the utility trench below the existing footing should be refilled with a lean concrete mix (flowable fill).

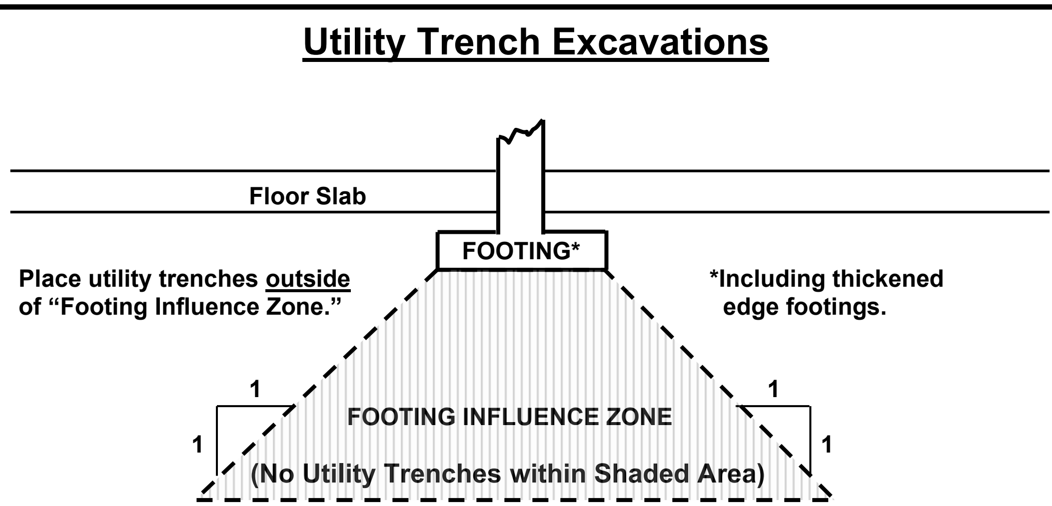


Figure #4 (not a plan drawing)

- **Geotechnical Engineer's Observations**

Soil types and strengths can sometimes vary around and in-between the borings. Some soils may not be as competent for support of the proposed building as those encountered in the borings. Therefore, we recommend that the soils exposed in the final footing and floor area excavations of the proposed structure(s) be observed in the field by a Geotechnical Engineer from Soil Technologies, Inc (STI). The Geotechnical Engineer will compare the exposed soils with the soils listed on the boring logs of this report to determine if they are the correct soil types and strengths. Once the type and strength of the soils exposed in the excavations are judged competent by STI's Geotechnical Engineer, the engineered fill, concrete footings, and floors can be placed as needed. STI's Geotechnical Engineer will provide a written report detailing the observations of the exposed soils in the footing and floor slab areas. **The general contractor or owner's representative should contact STI's Geotechnical Engineer to perform these field observations prior to the earthwork phase of the project.**

Note: This report and its recommendations are a <u>two-step process</u>. The first step is the implementation of the recommendations of this report <u>during the design</u> of the project. The second step is the implementation of these recommendations <u>during construction</u>. **The second step is critical to the success of the project, and it must include the field observations of the soils by STI's Geotechnical Engineer during the earthwork phase of the project.** It has been our experience that the lack of field observations by the Geotechnical Engineer during the earthwork phase of the project can result in oversight, in part or in whole, of the recommendations of the soils report. <u>Therefore, the absence of our field observations of the soils during the earthwork phase, especially during the footing and floor area excavations, shall relieve us of the liability of the work performed during that phase of the project and its effect on related components. Also, refer to IBC Chapter 17 - "Special Inspections" Table 1705.6.</u>

BUFFER ZONE: The above listed site preparations will result in leaving fat clay soils in-place below the footings and floor slab. Thus, as noted above, although the placement of 3 and 4 feet of engineered fill will reduce the risk by acting as a "buffer zone," there will still be some risk of structural distress due to the potential movement of the fat clay soils that is left in-place. We wish to emphasize that the depth (thickness) of the clay engineered fill placed below both the footings and floor slab can be increased to 5 feet or more. An increase in the depth of clay engineered fill placed below the footings and floor slab generally lessons the risk of structural distress due to moisture changes of the fat clay. The decision as to the depth of clay engineered fill placed below the footings and basement floor slab is that of the owner/client.

- **Engineered Fill - Foundation and Floor Areas**

We recommend the following types of engineered fill and compaction of engineered fill.

NOTE: Soils are classified as sand if more than 50% (by weight) is retained above the #200 sieve.

6-to 12 inches of sand cushion below floor slab (capillary break):	The final 6" to 12" of engineered fill placed directly beneath the floor slab) should consist of free draining sand (SP or SW) having a maximum gravel size of 1" and with less than 10% passing the #200 sieve by weight. The purpose of the sand cushion is to provide a working surface for the placement of concrete and also to serve as a capillary barrier.	
Below the footings:	**Use Only Lean Clay Soil:** In moist to dry excavations, use a lean clay (CL) engineered fill. The lean clay should have a liquid limit of less than 43 and a plasticity index of at least 16.	
Above footings and below the floor slab, up to within 6 inches or more below the bottom of the floor slab (including utility trenches):	**Primary Recommendation - Use Only Lean Clay Soil:** In moist to dry excavations, use a lean clay (CL) engineered fill. The lean clay should have a liquid limit of less than 43 and a plasticity index of at least 16. **Higher Risk Alternative:** In moist to dry excavations, a dirty granular soil such as a silty sand (SM) or clayey sand (SC) could be used. The sand should have at least 20% passing the #200 sieve, a maximum gravel size of 3 inches, and a liquid limit less than 43%. **Note**: In our opinion, the use of a granular soil for engineered fill increases the risk of moisture reaching the fat clay soil and thus, increases the risk of structural distress to the proposed building. **NOTE the following:** - The on-site, fat clay soils (CH) are NOT suitable as CL engineered fill. - Organic soils (topsoil) should not be used for engineered fill.	
Compaction of engineered fill: (Less than 10 feet total thickness):	- Below Footings and in the footing influence zone (pg. 7): - Below Floor Slabs: - Utility Trenches (inside & within 10' outside of the building):	**Minimum % Compaction** ➢ 97% of the ASTM: D698* ➢ 97% of the ASTM: D698* ➢ Same as "Below Floor Slabs" *Standard Proctor Density

- **Compaction Equipment and Placement of Engineered Fill**

Engineered fill should be compacted in maximum 12-inch loose lifts using heavy, self-propelled compaction equipment, or maximum 6-inch loose lifts using hand-operated compaction equipment. Smooth-faced, vibratory compaction equipment should be used for compaction of granular engineered fill (sand). Clay engineered fill should be placed at a moisture content ranging from -4% to +2% of the optimum moisture content as determined by the Standard Proctor (ASTM: D698). The moisture content of granular engineered fill should be such to achieve the specified compaction. The moisture content of the clay soils should be maintained until the placement of the footings and floor slabs. The engineered fill should be free of frost and should not be placed on frozen soils. Please refer to the attached "Precautions…During Cold Weather."

2.3 Foundations

- **Allowable Soil Bearing Pressure**

In our opinion, the proposed structure can be supported on a shallow spread footing foundation system (column pads and/or strip footings). We recommend that the spread footings be designed using **an allowable soil bearing pressure of up to 3500 psf.**

The allowable soil bearing pressure listed above assumes that the site is prepared as recommended in section 2.2 Site Preparations and that the project is constructed as per the information and conditions listed in section 1.1 Project Information. **If the project information or conditions are changed, STI must be notified in writing for additional review and possibly revised recommendations.**

The allowable soil bearing pressure is based on our judgment of the soil conditions at the boring locations along with recommended compaction levels and our experience with similar soil conditions. The allowable soil bearing pressure is a net pressure and can be increased 30% for short-term loadings such as wind loads.

- **Foundation Settlement**

The recommendations in this report should provide a theoretical safety factor of at least 3.0 against localized shear failure of the footings. Long term total settlements of the building footings are estimated to be less than 1 inch with estimated differential settlements less than ½ inch over a 30-foot length.

The above estimated settlements are based on the above recommended soil bearing pressure, the site being prepared as recommended in section 2.2 Site Preparations, and the project being constructed as per the information and conditions listed in section 1.1 Project Information: **… the**

finished floor elevations will range from1228.0 to 1229.0 feet, column loads will be a maximum of 200 kips (total dead and live loads) with continuous footing loads less than 4 kips/ft (total dead and live loads), etc.

Please note that the total and differential settlement of the footings (and floor slab) could be significantly greater than the above estimates if improper construction practices are used. These practices may include but are not limited to: allowing snow or ice to be incorporated into the engineered fill soils, allowing the soils below the footings or floor to be saturated or freeze prior to or after their placement, inadequate compaction of engineered fill soils, supporting the footings or floor slab on expansive soils such as fat clay (CH) or on soils that were inadvertently loosened during construction, etc.

- **Soil/Concrete Sliding Friction**

For horizontal loads, we recommend a soil-concrete friction factor of 0.35. The frictional factor should be applied only to the base (bottom) of the concrete foundation units and only the net downward vertical load should be used to determine the friction. An appropriate safety factor should be applied to the calculated lateral values.

- **Frost Depth**

To avoid frost related movement of the footings of heated structures during their entire life, the exterior footings should be placed at or below a frost depth as per city/county code, or a minimum 5 feet below finished grade. Interior footings of heated buildings can be placed at shallower depths provided they are protected from frost during and after construction. To avoid frost related movement of the footings of unheated enclosed structures, exterior canopies, etc., both the exterior and interior footings should be placed at least 6 feet below the finished exterior grade or the floor slab, as appropriate.

For unheated floor slabs, some frost related movement of floor slabs should be expected unless measures are taken to limit frost related movement below the slab, such as rigid insulation sheeting or placement of significant depths of free-draining granular fill.

2.4 Exterior Backfill

- **Soil Type**

Assuming the absence of retaining or below grade lower level walls, it is our opinion that imported non-organic and non-expansive lean clay (CL), soils should be used for exterior backfill soils (fill soils placed outside the exterior foundation walls and adjacent areas). The on-site non-organic fat clay soils (CH) can also be used but are not desired; and the Geotechnical Engineer should approve their use and placement. Utility trenches or other excavations leading to the building foundations or floor areas can be backfilled with the on-site or imported non-organic lean clay or fat clay soils. (Please refer to Figure #5 on page 13.)

Organic soils (usually black colored) should not be used for exterior backfill, except for cover material. Also, soils that can expand, such as fat clay (CH), should not be used for backfill against retaining type structures or below slabs, sidewalks, approach slabs, driveways, etc.

- **Compaction and Placement of Exterior Backfill**

Exterior backfill soils placed along foundation walls and in adjacent areas such as beneath lawns, sidewalks, traffic areas, or in utility line trenches, should be compacted to the following minimum percent densities as listed in Table 1 below. Note: Exterior backfill soils placed within the "influence zone" below the footings (page7) should be compacted to the minimum densities listed for footings on page 9.

TABLE 1

Compaction of Exterior Backfill	Light Traffic Areas (autos, driveways, sidewalks, etc. - below granular base):	95% of the ASTM: D698*
	Heavy Truck Traffic Areas (below granular base):	97% of the ASTM: D698*
	Utility lines and other backfill within 10 feet of the proposed structure(s) except in traffic areas use above %..	95% of the ASTM: D698*
	Non- Traffic Areas (lawns, landscaping areas, etc.) greater than 10 feet of the proposed structure(s)	92% of the ASTM: D698*

*Standard Proctor Density

Exterior backfill soils should be compacted in maximum 12-inch loose lifts using heavy, self-propelled compaction equipment, or maximum 6-inch loose lifts using hand-operated compaction equipment. Clay exterior backfill soils should be placed at a moisture content ranging from -4% to +2% of the optimum moisture content as determined by the Standard Proctor. The moisture content of granular exterior backfill soils (sand) should be such to achieve the specified compaction. Smooth-faced, vibratory compaction equipment should be used for compaction of granular backfill soils. The backfill material should be free of frost and should not be placed on frozen soils. Please refer to the "Precautions…During Cold Weather" attached to this report.

2. 5 Site Drainage

- **Site Grading**

Proper drainage should be maintained during and after construction. General site grading should not allow water to pond in the building area or in the excavations. Any ponded water should be removed immediately. Finished grades around the perimeter of the structure should be sloped away from the structure with a minimum slope of 1 inch per foot for at least 15 feet beyond the excavation lines. (Please refer to Figure #5 below.) The slope can be reduced to ¼ inch per foot in areas that are completely surfaced and properly sealed with asphalt or concrete. The slope and proper drainage should be maintained throughout the life of the structure.

Exterior Backfill and Site Drainage

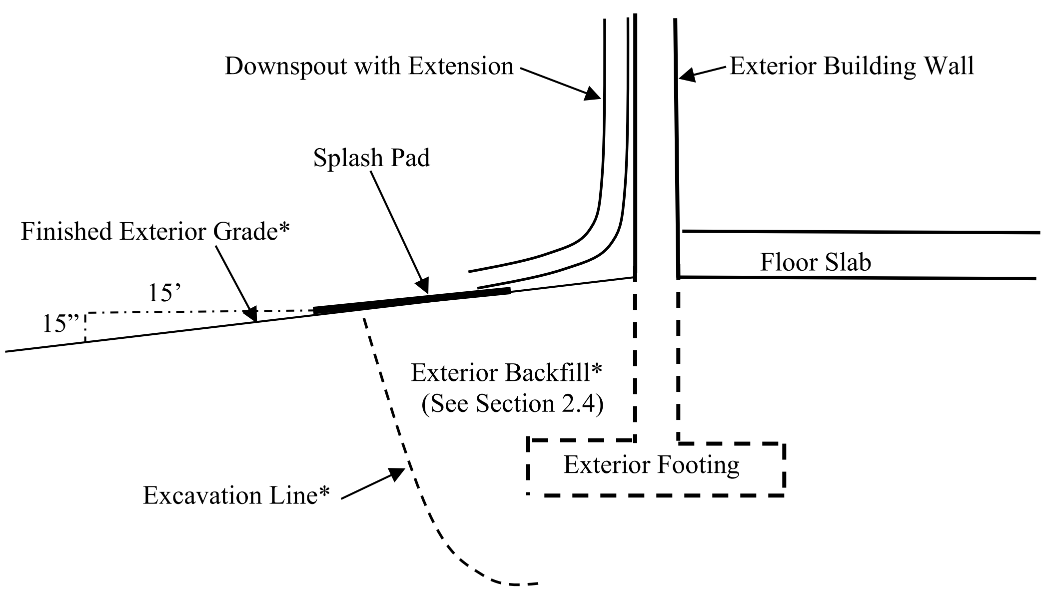


Figure #5 (not a plan drawing) *Specific specifications listed in this report.

- **Roof Runoff**

Roof runoff water should be controlled by a system of downspouts and gutters with proper extensions to remove the runoff water away from the structure. The gutters and downspouts, as well as splash pads and extensions, should be maintained so that leakage does not occur adjacent to the structure. (Please refer to Figure #5 above.)

- **Exterior Plantings & Watering**

Due to the presence of the fat clay at the site and its potential to cause structural distress, we recommend that trees and shrubs which have a high water demand not be placed adjacent to the proposed structure. Trees should be planted no closer to the structure than the anticipated mature height. Also, excessive watering to the exterior plants should be prohibited. If foundation plantings are desired, self-contained planters should be utilized. If the lawn within 15 feet of the building is watered, sprinkling should be done sparingly, and the water should not be allowed to spray directly on the structure.

3.0 CONSTRUCTION AND DESIGN CONSIDERATIONS

3.1 Construction Considerations

- **Soil Disturbance & Moisture Changes**

The soils encountered at the site are sensitive to disturbance and may experience strength loss under the influence of construction traffic and/or additional moisture. Construction traffic in areas where these soils are used for structural or floor support should be limited. <u>If self-propelled compaction equipment is used, extra care should be taken so as not to disturb (weaken) the native soils due to excess weight and/or vibration of the equipment.</u> If the soil used for structural, floor, or wheel traffic support becomes frozen, desiccated, or is disturbed, the affected soil should be removed; or if the disturbance is shallow, it can be recompated in-place prior to placement of additional fill or structural units.

Also, the site preparations should include complete removal of all remnants of previously existing structures, structural units, utilities, tree roots, etc. Excavations to remove these items, or intrusions (accidental, deliberate, or otherwise) should be backfilled with engineered fill and compacted to the specified density listed on page 9.

The excavations should be left open a minimal amount of time to prevent strength loss of these soils by sluffing of soils, ponding of water, or changes in their in-situ moisture content. In addition, surface drainage away from the excavations should be provided during construction. Also, the excavations should be done with an excavation bucket having a <u>smooth cutting edge</u>.

- **Moisture of Fat Clay Soils**

To limit the potential of movement (expansion or shrinkage) of the fat clay soils, it is important that their moisture content at the bottom or along the sidewalls of the footing and floor excavations be maintained. Significant drying or wetting of the fat clay soils will increase their potential for movement and subsequent structural distress. To prevent moisture changes, especially drying, the time period that the excavation is left open (exposed) should be minimized. Alternatively, the fat clay soils may need to be covered with engineered fill or with other protective methods as soon as practical. If drying or wetting of the fat clay soils occurs during construction, we recommend you contact us prior to placement of engineered fill, structural components, pavement sections, etc.

- **Dewatering**

We do not anticipate that the footing or floor excavations will extend below the groundwater level, and thus, dewatering techniques for proper placement of engineered fill and/or the footings/floor slab systems are not anticipated, but they should not be ruled out. Generally, we anticipate that, if required, the de-watering will be able to be accomplished using typical sump-pump methods. Please refer to the groundwater measurements listed at the bottom of the attached boring logs.

If groundwater is encountered, the excavations and dewatering must be such as to provide for physical access and observations of the soils at the bottom of the excavations, and for proper compaction of the engineered fill soils at the bottom of excavations. Also, the excavations should remain dewatered until placement of the engineered fill, foundations, and lower portions of the exterior backfill are completed.

3.2 Design Considerations

- **Subgrade Modulus**

Placement of engineered fill soils from the bottom of the recommended floor excavation depths to the design slab elevation will generally increase the overall modulus. The amount of increase is dependent on the type and depth of engineered fill placed. A granular engineered fill would generally provide a higher modulus than clay engineered fill. For design purposes, we have provided estimated subgrade modulus (“K”) values as listed below in Table 2. The subgrade modulus values are assumed to be at the surface of the described soil type compacted to at least 97% of the Standard Proctor density (ASTM: D698). Please note that these values are only estimates based on soil types and densities. “Plate Load Tests” should be performed to provide specific “K” values.

TABLE 2

Soil Type (Minimum 97% Compaction) and/or approved by the on-site Geotechnical Engineer)	**Depth of Engineered Sand Soils**	**Estimated Subgrade Modulus (pci)***
Engineered Sand Soils over Clay Soils	6" to 9"	160
Engineered Sand Soils over Clay Soils	9" to 12"	200

*Values should be reduced (up to 40%) for exterior pavements or slabs exposed to freeze thaw cycles.

- **Polyethylene Vapor Membrane (Slab-on-grade)**

We recommend that consideration be given to placing a polyethylene vapor membrane (retarder) beneath the floor slab, especially if there are areas where moisture sensitive flooring materials, or impermeable floor coatings, or moisture sensitive equipment or product are planned. If used, consideration should be given to the potential of curling of the concrete floor due to the presence of the membrane. Placing the membrane at least 2 inches beneath the surface of the sand cushion can help to minimize the potential for curling of the concrete floor. The architect or structural engineer of record should decide on the use and placement of the membrane. The slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. Also refer to IBC section 1907.

- **Seismic Category**

Based on IBC 2021, the subsurface conditions encountered at the site, and our experience with other general geologic conditions for this area, it is our opinion that Site Class D should be used to determine site coefficients and seismic design category.

- **Existing Structure**

Although not anticipated, if the foundations for the proposed building are placed next to an existing structure, care should be taken not to undermine the foundations of the existing structure. Also, to prevent additional loading on the existing foundations, the new foundations should rest at or below the depth of the existing foundations. If the new foundations rest within a 45^0 envelope below the existing foundations, the new foundations may need to be designed for increased loading caused by the overlying pressures of the existing footings. Please contact us if this situation develops in the design.

- **Moisture or Frost Related Movement**

Exterior architectural features, slabs, and utilities can experience moisture or frost related movement which can result in distress. The existing clay soils likely have a high susceptibility of frost related movement. The risk of this potential movement and subsequent distress can be reduced (but not necessarily eliminated) by:

1. The use of control joints.
2. The use of self-adjusting utility connections.
3. Allowing for movement of exterior features attached to structural elements.
4. The use of significant depths of clean granular fill beneath slabs-on-grade (floors), driveways, sidewalk, etc.
5. Proper drainage away from exterior slabs-on-grade.
6. Placement of rigid insulation sheeting under at least 10 inches of free draining granular fill.

Also, if limited differential frost movement between the driveway approach slab and the building floor slab is desired, high density extruded polystyrene insulation can be placed below the driveway approach slabs. Please refer to Figure #6 below.

FROST PROTECTED APPROACH/GARAGE SLABS

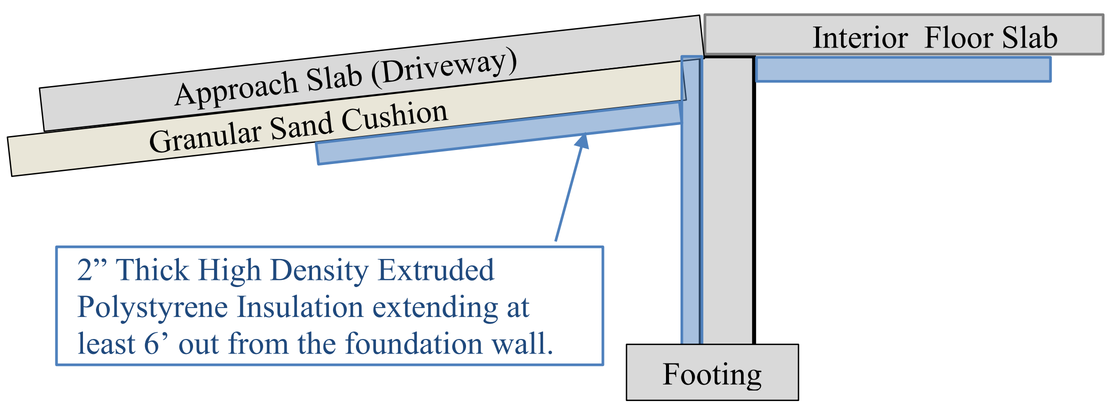


Figure 6 (not a plan drawing)

- **OSHA**

Excavations must comply with the requirements of local, state, federal and other prescribed safety regulations, e.g., OSHA Part 1926, Subpart P, "Excavations." Reference to these requirements should be included in the project specifications.

- **Concrete**

The concrete used for the project should be composed of a quality mix that has 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 the recommendations in the current **ACI** manual. Improper mix designs, placement methods, saw joints, curing methods, temperatures, etc. could result in the concrete experiencing excessive shrinkage, cracking, curling, pop-outs, and other distress. These items should be monitored by a qualified engineer during construction. Also, floor covering should not be placed on the slab until it is nearly fully cured. Typically, flooring manufactures require 3 to 4 weeks or more of curing time at room temperature (60° F or more) prior to placement of flooring.

4.0 EXCAVATION OBSERVATION AND TESTING

The recommendations contained in this report are based on the subsurface conditions found at the boring locations. It is possible that there are soil conditions on the site that were not represented by the borings. Consequently, on-site observation by a qualified Geotechnical Engineer during construction is considered integral to the successful implementation of the recommendations.

We recommend that a Geotechnical Engineer from Soil Technologies, Inc. be on-site during the excavation operations. The engineer will judge if the soils exposed at the bottom and along the sidewalls of the excavations are adequate for support of the floor slab and for the foundations designed with the allowable soil bearing pressure recommended in this report. The Geotechnical Engineer should also be on-site immediately prior to placement of the sand cushion and reinforcing steel of the floor slab to verify that the floor area soils are not frozen, rutted, desiccated, saturated and/or otherwise disturbed. In addition, we recommend that density testing be performed within the sequence of the engineered fill.

5.0 GENERAL EXPLORATION INFORMATION

5.1 Scope of Exploration

We have conducted a soil exploration for the proposed project. The scope of our services under this exploration is limited to the following:

1. To perform soil borings to explore the subsurface soil and groundwater conditions.
2. To perform nominal laboratory tests to aid in judging the soil properties.
3. To provide a geotechnical engineering report including the results of the field and laboratory tests as well as geotechnical engineering opinions and recommendations that are relative to the project.

Five standard penetration test borings were performed at the site on December 1 & 2, 2025. The borings were performed at the locations shown on the attached sketch. Some settlement of the soils used to fill the open bore holes should be anticipated and closure of the holes is the responsibility of the client or property owner.

5.2 Site Surface Conditions

The site of the proposed construction is located at the regional airport at Winner, SD. The site is bordered on the northeast by a paved apron and northwest by an existing buildings. The site surface at the time of our soil borings consisted of grass. The overall general topography of the site slopes downward to the south. The ground elevations at the boring locations were referenced to the survey benchmark (BM) shown on the attached sketch. The elevations are listed at the top of the attached boring logs.

5.3 Site Subsurface Conditions

The subsurface conditions encountered at each boring location are illustrated on the boring logs attached to this report. The logs also indicate the possible geologic origin of the materials encountered (alluvium, till, lacustrine etc.). A description of the general soil profile is also provided in section **2.1 Discussion.** We wish to point out that the subsurface conditions at other times and locations at this site may differ from those found at our boring locations. If different subsurface conditions are encountered during construction, it is necessary that you contact us so that our recommendations can be reviewed.

5.4 Water Levels

Observations for subsurface groundwater were made at the boring locations during our field operations. Groundwater was not encountered at the boring locations during our sampling operations. Specific information relative to the groundwater observations is shown at the bottom of the attached boring logs.

The absence or present level of groundwater in the borings may not represent the actual static groundwater levels. In order to accurately determine the static groundwater level, observations over an extended period are usually required. Such periods of observation are normally not available in a typical soil exploration program. Seasonal and annual fluctuations of the groundwater levels should be expected to occur. It is possible that the subsurface groundwater levels during or after construction could be significantly different than at the time the borings were performed.

5.5 Laboratory Test Program

Soil samples were selected for laboratory tests to determine the engineering and index properties. Where applicable, the tests were performed in accordance with the American Society for Testing and Materials (ASTM) procedures. The test results are shown on the boring logs opposite the samples upon which the tests were made, or they are attached.

6.0 LIMITATIONS, REVIEW, USE, AND PURPOSE OF REPORT

- **Limitations**

The data obtained from the sampling and testing of the soils encountered at the boring locations are the basis of the opinions and recommendations submitted in this report. However, variations can occur between these borings and between the samples. Thus, no exploration program can totally reveal the exact subsurface conditions for the entire site. If the subsurface conditions encountered at the time of construction differ from those represented by our borings, it is necessary to contact us so that our opinions and recommendations can be reviewed. Differing subsurface conditions may result in altering our recommendations, which may affect construction costs. It is suggested that a contingency be provided for this purpose.

- **Review of Report**

This report is founded on the information and conditions listed in this report for design of the proposed structure(s). We recommend that we be retained to briefly review the geotechnical aspects of the final design and specifications to determine whether any changes in design may have had an effect on the validity of the recommendations contained in this report, and whether our recommendations have been correctly communicated so that their intent has been implemented in the design and specifications. Divergence from our recommendations by the design, specifications, or field applications shall relieve us of the responsibility of that portion of the project and its effect on related components unless our written agreement with such divergence has been obtained. Also, we recommend that this report is provided to the owner(s) along with the architect(s), engineer(s,) contractor(s), etc. chosen for design and construction of the project.

- **Use of Report**

This report is intended for the Client's sole use and benefit and solely for the Client's use in the design and construction of the proposed project described herein and in preparation of construction documents. The data, analysis, opinions, and recommendations contained in this report may not be appropriate for extensions of the proposed project or for other projects or purposes. Thus, this report shall not be used or relied on by persons or entities for extensions of the proposed project or for other projects or purposes. Parties contemplating extensions of the proposed project or for other projects or purposes must contact us for additional review. In the absence of our written review and approval, we make no representation and assume no responsibility for extensions of the proposed project or for other projects or purposes. Also, this report is not a bidding document and is only an aid in the design and construction of the proposed project. Contractors and others involved in the project must draw their own conclusions regarding the site conditions and construction methods.

- **Purpose of Report**

The purpose of this report is to present the results of our field and laboratory tests as well as our geotechnical engineering review and recommendations for the project. Our work is intended for geotechnical purposes only and not to verify the presence or extent of any contamination at the site. If environmental information is desired, an environmental assessment should be conducted.

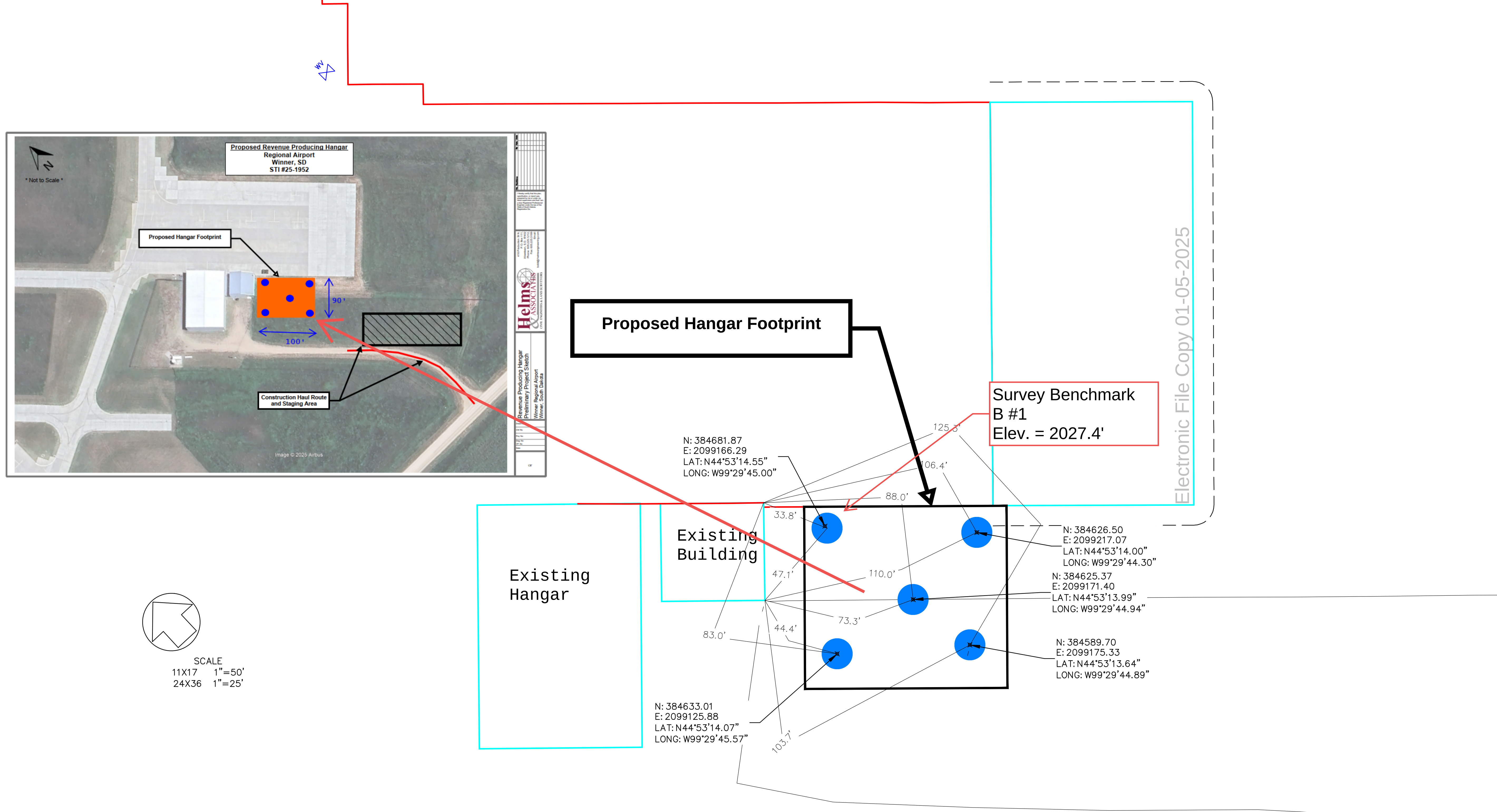
7.0 STANDARD OF CARE

The opinions contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering procedures at this time and location. Other than this, no other representation, guarantee, or warranty, either expressed or implied, is made.

This report was prepared by:

Kim E. Stoecker, PE
President

Proposed Revenue Producing Hangar
Regional Airport
Winner, SD
STI #25-1952



Boring Locations and Benchmark Provided by Helms and Assoc.

No. Revisions Date

I Hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the law of the State of South Dakota.
Registration No.

SPN Helms
CIVIL ENGINEERS & LAND SURVEYORS
416 Production St N.
P.O. Box 111,
Aberdeen, S.D. 57402
Phone: 605.225.1212,
Fax: 605.225.3189
Email: bobb@helmsengineering.com

SOIL BORINGS

REVENUE PRODUCING HANGAR
WINNER MUNICIPAL AIRPORT
WINNER SOUTH DAKOTA

Drawn By:	CDH
Chk' By:	MAS
Proj. No:	?
Dwg. No:	7142 PNT
VP. No:	####
Date:	11/2025

1 OF 1

BORING LOG

STI JOB #: 25-1952	**Project:** Revenue Producing Hangar
BORING #: 1	**Location:** Regional Airport - Winner, SD
Sheet 1 of 1	
Latitude (North)=	Longitude (West)=
SURFACE ELEVATION = 2027.4	

Depth (ft.)	Elev. (ft.)	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	Water Level	N. Value	SAMPLE: Sample No.	SAMPLE: Sample Type	LABORATORY TESTS: Moisture (%)	Dry Density (pcf)	Pocket Pen (tsf)	Qu (psf)	Liquid Limit	Plastic Limit	200 Sieve (%)
		Fill, Organic Fat Clay, dark brown, moist	FILL		12	1	SPT	18	102	4.5+				
2	2025.4													
		Fat Clay, brown and light brown, moist, stiff to very stiff to stiff to very stiff (CH)	FINE ALLUVIUM		13	2	SPT							
					17	3	SPT	19	112	4.5+		66	24	
					14	4	SPT							
					12	5	SPT							
					14	6	SPT							
					16	7	SPT							
					16	8	SPT							
21	2006.4													
		END OF BORING												

WATER LEVEL MEASUREMENTS ▼

DATE:	TIME:	SAMPLED TO:	CAVE IN:	CASING:	DEPTH:
12/01/2025	17:07	21'	21'	19.5'	NONE

Boring Started:	12/01/2025	at	16:35	
Boring Completed:	12/01/2025	at	17:13	
Drilling Method:			to	
Drilling Method:	3 1/4" HSA	0	to	19.5'
Jet with Drilling Mud:			to	
Hammer Type:	Auto Hammer (140 lb.)			
Crew Chief:	M.H.	**Logged By:**	R.H.	
Backfill Method:				

SOIL TECHNOLOGIES, INC
28822 124TH ST., MOBRIDGE, SD
TELEPHONE: (605) 762-3406

BORING LOG

STI JOB #: 25-1952	**Project:** Revenue Producing Hangar	**BORING #:** 2
	Location: Regional Airport - Winner, SD	Sheet 1 of 1
Latitude (North)=	Longitude (West)=	**SURFACE ELEVATION =** 2027.0

Depth (ft.)	Elev. (ft.)	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	Water Level	N. Value	Sample No.	Sample Type	Moisture (%)	Dry Density (pcf)	Pocket Pen (tsf)	Qu (psf)	Liquid Limit	Plastic Limit	200 Sieve (%)
		Fill, Organic Fat Clay, brown and dark brown, moist	FILL		12	1	SPT							
2.8	2024.2				15	2	SPT							
		Fat Clay, brown and light brown, moist, stiff to very stiff (CH)	FINE ALLUVIUM					18	106	4.5+				
					15	3	SPT							
					15	4	SPT							
					13	5	SPT							
					15	6	SPT							
					23	7	SPT							
					23	8	SPT							
21	2006.0													
		END OF BORING												

WATER LEVEL MEASUREMENTS ▼

DATE:	TIME:	SAMPLED TO:	CAVE IN:	CASING:	DEPTH:
12/01/2025	16.25	21'	21'	19.5'	NONE
12/02/2025	7:50		18'		NONE

Boring Started: 12/01/2025 *at* 15:51
Boring Completed: 12/02/2025 *at* 7:55
Drilling Method: *to*
Drilling Method: 3 1/4" HSA 0 *to* 19.5'
Jet with Drilling Mud: *to*
Hammer Type: Auto Hammer (140 lb.)
Crew Chief: M.H. **Logged By:** R.H.
Backfill Method:

SOIL TECHNOLOGIES, INC
28822 124TH ST., MOBRIDGE, SD
TELEPHONE: (605) 762-3406

BORING LOG

STI JOB #: 25-1952	**Project:** Revenue Producing Hangar		**BORING #:** 3
	Location: Regional Airport - Winner, SD		Sheet 1 of 1
Latitude (North)=	Longitude (West)=		**SURFACE ELEVATION =** 2024.2

Depth (ft.)	Elev. (ft.)	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	Water Level	N. Value	SAMPLE: Sample No.	SAMPLE: Sample Type	LABORATORY TESTS: Moisture (%)	Dry Density (pcf)	Pocket Pen (tsf)	Qu (psf)	Liquid Limit	Plastic Limit	200 Sieve (%)
		Organic Fat Clay, dark brown, moist (CH-OH)	TOPSOIL		11	1	SPT							
2	2022.2													
		Fat Clay, brown and light brown, moist, stiff to very stiff to stiff to very stiff (CH)	FINE ALLUVIUM		12	2	SPT							
					21	3	SPT							
					11	4	SPT							
					12	5	SPT							
					17	6	SPT							
					19	7	SPT							
					22	8	SPT							
21	2003.2													
		END OF BORING												

WATER LEVEL MEASUREMENTS ▼

DATE:	TIME:	SAMPLED TO:	CAVE IN:	CASING:	DEPTH:
12/02/2025	8:30	21'	21'	19.5'	NONE

Boring Started:	12/02/2025 *at* 8:57
Boring Completed:	12/02/2025 *at* 8:36
Drilling Method:	*to*
Drilling Method:	3 1/4" HSA 0 *to* 19.5'
Jet with Drilling Mud:	*to*
Hammer Type:	Auto Hammer (140 lb.)
Crew Chief: M.H.	**Logged By:** R.H.
Backfill Method:	

SOIL TECHNOLOGIES, INC
28822 124TH ST., MOBRIDGE, SD
TELEPHONE: (605) 762-3406

BORING LOG

STI JOB #: 25-1952	Project: Revenue Producing Hangar	BORING #: 4
	Location: Regional Airport - Winner, SD	Sheet 1 of 1
Latitude (North)=	Longitude (West)=	SURFACE ELEVATION = 2023.1

Depth (ft.)	Elev. (ft.)	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	Water Level	N. Value	SAMPLE: Sample No.	SAMPLE: Sample Type	LABORATORY TESTS: Moisture (%)	Dry Density (pcf)	Pocket Pen (tsf)	Qu (psf)	Liquid Limit	Plastic Limit	200 Sieve (%)
		Organic Fat Clay, dark brown, moist (CH-OH)	TOPSOIL		9	1	SPT							
2	2021.1													
		Fat Clay, brown and light brown, dry, stiff to very stiff to stiff to very stiff (CH)	FINE ALLUVIUM		14	2	SPT							
					20	3	SPT	17		4.5+				
					13	4	SPT							
					15	5	SPT							
					13	6	SPT							
					15	7	SPT							
					19	8	SPT							
21	2002.1													
		END OF BORING												

WATER LEVEL MEASUREMENTS ▼

DATE:	TIME:	SAMPLED TO:	CAVE IN:	CASING:	DEPTH:
12/02/2025	8:44	21'	21'	19.5'	NONE

Boring Started:	12/02/2025	at	8:04		
Boring Completed:	12/02/2025	at	8:50		
Drilling Method:				to	
Drilling Method:	3 1/4" HSA		0	to	19.5'
Jet with Drilling Mud:				to	
Hammer Type:	Auto Hammer (140 lb.)				
Crew Chief:	M.H.	Logged By:	R.H.		
Backfill Method:					

SOIL TECHNOLOGIES, INC

28822 124TH ST., MOBRIDGE, SD
TELEPHONE: (605) 762-3406

BORING LOG

STI JOB #: 25-1952	**Project:** Revenue Producing Hangar		**BORING #:** 5
	Location: Regional Airport - Winner, SD		Sheet 1 of 1
Latitude (North)=	Longitude (West)=		**SURFACE ELEVATION =** 2025.4

Depth (ft.)	Elev. (ft.)	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	Water Level	N. Value	SAMPLE: Sample No.	SAMPLE: Sample Type	LABORATORY TESTS: Moisture (%)	Dry Density (pcf)	Pocket Pen (tsf)	Qu (psf)	Liquid Limit	Plastic Limit	200 Sieve (%)
		Fill, Organic Fat Clay, dark brown, moist	FILL											
1	2024.4				8	1	SPT							
		Fill and mixture of Organic Fat Clay and Fat Clay, moist												
2	2023.4													
		Fat Clay, brown and light brown, moist, stiff to very stiff to stiff (CH)	FINE ALLUVIUM					15		4.5+				
					11	2	SPT							
					20	3	SPT							
					13	4	SPT	18		4.5+				
					13	5	SPT							
					13	6	SPT							
						7	SPT							
16	2009.4													
		END OF BORING												

WATER LEVEL MEASUREMENTS ▼

DATE:	TIME:	SAMPLED TO:	CAVE IN:	CASING:	DEPTH:
12/02/2025	10:45	16'	16'	14.5'	NONE

Boring Started:	12/02/2025	at	10:20		
Boring Completed:	12/02/2025	at	10:53		
Drilling Method:				to	
Drilling Method:	3 1/4" HSA		0	to	14.5'
Jet with Drilling Mud:				to	
Hammer Type:	Auto Hammer (140 lb.)				
Crew Chief: M.H.	**Logged By:** R.H.				
Backfill Method:					

SOIL TECHNOLOGIES, INC
28822 124TH ST., MOBRIDGE, SD
TELEPHONE: (605) 762-3406

FIELD EXPLORATION PROCEDURES

Soil Sampling

Soil sampling was performed in accordance with ASTM: D1586. Using this procedure, a 2" O.D. split barrel sampler is driven into the soil by a 140-lb. weight (hammer) falling 30". After an initial set of 6", the number of blows required to drive the sampler an additional 12" is known as the penetration resistance or N value. The N value is an index of the relative density of the cohesionless (sandy) soils and the consistency of cohesive (clayey) soils. Thin walled tube samples, if taken, were obtained according the ASTM: D1587 where indicated by the appropriate symbol on the boring logs. Rock core samples, if taken, were obtained by rotary drilling in accordance with ASTM: D2113. Power auger borings, if performed, were done in general accordance with ASTM: D1452.

Soil Classification

As the samples were obtained in the field, they were visually and manually classified by the crew chief in general accordance with ASTM: D2487. Representative portions of the samples were then returned to the laboratory for further examination and for verification of the field classification. Logs of the borings (test holes) indicating the depth and identification of the various strata, the N value, water level information and pertinent information regarding the method of maintaining and advancing the bore holes are attached. Charts illustrating the descriptive terminology and the symbols used on the boring logs are also attached.

LOG OF BORING– "DESCRIPTIONS"

Depth - Depth below the existing grade at the location and time the sampling was performed.
Description of Material – Soil type based on visual and manual methods and/or laboratory tests (see "Soil Classification" above).
Surface Elevation – Elevation of the existing grade at the boring location and at the time the boring was performed.
Geologic Origin - A description of the most likely source of the soil deposit.
WL - The highest groundwater measurement at the time and location the sampling was performed marked by the symbol ▼. (Also see "Water Level Measurements" on boring log).
N VALUE - The number of hammer blows required to drive the sampler 12" (see "Soil Sampling" above).
SAMPLE NO. – The sample number, i.e. 1, 2, 3….
SAMPLE TYPE – The type of equipment used to sample the soil (SPT = Standard Penetration Test, SB = Split Barrel Sampler, FA = Flight Auger, HSA = Hollow Stem Auger).
QU – Laboratory test. (See the attached "Symbols and Terminology.")
Drilling Method – The type of equipment used in to advance (drill) the boring.

SYMBOLS AND TERMINOLOGY

DRILLLING AND SAMPLING SYMBOLS

SYMBOL	DEFINITION
N	Standard Penetration – blows per foot
WOH	Weight of Hammer
B	Bag Sample
DM	Drilling Mud
FA	Flight Auger
HA	Hand Auger
HSA	Hollow Stem Auger
JW	Jetting Water
NSR	No Sample Recovered
_Q	BQ, NQ or PQ Wireline System
SB	Split Barrel Sampler
SPT	Standard Penetration Test
3TW	3” Thin Walled Tube Sample
CS	California Sampler
▼	Water Level Symbol

TEST SYBMOLS

SYMBOL	DEFINITION
W	Water Content by weight (ASTM:D2216)
D	Dry Density - pounds per cubic foot
LL	Liquid Limit (ASTM: D4318)
PL	Plastic Limit (ASTM: D438)
Qu	Unconfined Compressive Strength – pounds per square foot (ASTM: D2166)
Pq	Penetrometer Reading – tons/square ft.
Su	Undrained Shear Strength
R	Laboratory Resistivity
G	Specific Gravity – ASTM: D854
OC	Organic Content
K	Coefficient of Permeability
VS	Field Vane Shear (ASTM: D2573)
RQD	Rock Quality Designation - percent
CR	Core Recovery (percent)

WATER LEVELS

Water levels shown on the test hole (boring) logs are the water levels measured in the test holes at the time and under the conditions indicated. In sand soil, the indicated levels may be considered fairly reliable ground water levels. In clay soil, it may not be possible to determine the ground water level within the normal time required for the test hole, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the water levels shown on the test hole logs for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

RELATIVE DENSITY	"N" VALUE
very loose	0-4
loose	5-10
medium dense	11-24
dense	25-50
very dense	>50

CONSISTENCY	"N" VALUE
very soft	0-1
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	31-60
very hard	>60

"N" is the Standard Penetration, in blows per foot, of a 140 pound hammer falling 30 inches onto a 2 inch OD split barrel sampler.

Lamination	Up to ½” thick stratum
Layer	½” to 6”
Lens	½” to 6” discontinuous stratum, pocket
Varved	Alternating laminations of clay, silt and /or fine grained sand, or colors thereof
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Waterbearing	Pervious - soil is below water

RELATIVE GRAVEL PROPORTIONS

TERM	RANGE
A trace of gravel	Less than 4%
A little gravel	5 – 15%
With gravel	16 – 50%

RELATIVE SIZES

Boulder	Over 12”
Cobble	3” - 12”
Gravel - Coarse	¾” - 3”
Gravel – Fine	#4 - ¾”
Sand – Coarse	#4 - #10
Sand - Medium	#10 - #40
Sand - Fine	#40 - #200
Silt & Clay	-#200, Based on Plasticity

Soil Technologies, Inc.

PRECAUTIONS FOR EXCAVATING AND REFILLING DURING COLD WEATHER

The winter season in this area 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 into 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 insulating 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 grade 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 which accumulates, should be completely removed from the fill area prior to compaction and additional soil placement. Frozen soils, or soils containing frozen material 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 soils 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.

CONSTRUCTION OBSERVATIONS AND TESTING

- **Geotechnical Engineer's Observation**

The recommendations made in this report have been made based on the subsurface conditions found in the borings. It is possible that there are soil and water conditions on-site that were not represented by those borings. Therefore, we recommend that the completed excavation and prepared subgrade be observed and tested by a Geotechnical Engineer prior to fill placement or construction of any foundation elements. These observations are necessary to judge if all unsuitable materials have been removed from within the planned construction area and that an appropriate degree of lateral oversize has been provided for in those areas where fill will be placed below the bottom of foundation grade.

- **Field Density Tests**

We recommend a representative number of field density tests be taken in the engineered fill to aid in judging its suitability. We suggest the following guidelines relative to the number and spacing of the density tests:

- Footing Trench Areas: At least one density test should be performed for each 1½ foot depth of engineered fill placed below the footings and for each 1½ foot depth of engineered fill placed above the footings. The lateral spacing between each 1½ foot test below the footings should not exceed 30 lineal feet. Also, the lateral spacing between each 1½ foot test above the footings should not exceed 30 lineal feet.*
- Floor Slab Areas: At least one density test should be performed for each 1½ foot of engineered fill depth. The density tests should be laterally spaced so that there is a minimum of one test performed for every 2000 square feet of engineered fill placed below the floor slab.*
- Exterior Backfill Areas: At least one density test should be performed for each 2 feet of engineered fill depth and at least one test for every 30 lineal feet of engineered fill placed.*
- Utility Trench Areas: At least one density test should be performed for each 2 feet of engineered fill depth and at least one test for every 50 lineal feet of engineered fill placed.*
- Large Open Areas Such As Small Dams or Athletic Fields: The number of density tests will depend on the size and purpose of the area being filled, and thus should be left to the discretion of a qualified engineer or his representative.*

*Additional tests should be taken in confined areas, such as building corners. The actual number of tests should be left to the discretion of a qualified engineer or his representative. All proposed engineered fill material should be submitted to the laboratory for tests to check compliance with our recommendations and project specifications.

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences:'
The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration, the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage. or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory

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8811 Colesville Road/Suite G106/Slver Spring, Maryland 20910/(301) 565 2733

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