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June 15, 2020

Vermillion Area Chamber & Development Company
2 E. Main Street, Suite 101
Vermillion, South Dakota 57069

Attn: Nate Welch

Subj: Geotechnical Exploration
Proposed Site Development
Bliss Pointe – Phase 2
Vermillion, South Dakota
GeoTek #20-668

This correspondence presents our written report of the geotechnical exploration program for the referenced project. Our work was performed in accordance with your authorization. We are transmitting an electronic copy of our report for your use. An additional copy of our report is also being sent as noted below.

We thank you for the opportunity of providing our services on this project and look forward to continued participation during the design and construction phases. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,
GeoTek Engineering & Testing Services, Inc.

Jared Haskins

Jared Haskins, PE
Geotechnical Manager

Cc: Banner Associates, Inc., Attn: Rich Uckert, PE

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GEOTECHNICAL EXPLORATION
PROPOSED SITE DEVELOPMENT
BLISS POINTE – PHASE 2
VERMILLION, SOUTH DAKOTA
GEOTEK #20-668

INTRODUCTION

Project Information

This report presents the results of the recent geotechnical exploration program for the proposed development of Bliss Pointe – Phase 2 in Vermillion, South Dakota.

Scope of Services

Our work was performed in accordance with the authorization of Nate Welch with the Vermillion Area Chamber & Development Company. The scope of work as presented in this report is limited to the following:

1. To perform 5 standard penetration test (SPT) borings to gather data on the subsurface conditions at the site.

2. To perform laboratory tests that include moisture content, dry density and standard Proctor.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our earthwork and foundation recommendations for design and construction.

The scope of our work was intended for geotechnical purposes only. This scope of work did not include determining the presence or extent of environmental contamination at the site or to characterize the site relative to wetlands status.

SITE & SUBSURFACE CONDITIONS

Site Location & Description

The site is located along the west side of Stanford Street (north of Rockwell Trail) in Vermillion, South Dakota. A Project Location Map (Figure 1) is attached showing the location of the site.

The site is currently vacant and covered with vegetation. Two (2) stockpiles of soil are located at the site (1 in the north portion of the site and 1 in the middle portion of the site). Based on our observations, the stockpile of soil in the north portion of the site may consist of topsoil materials and the stockpile of soil in the middle portion of the site may consist of loess soils.

Ground Surface Elevations & Test Boring Locations

The ground surface elevations at the test boring locations were provided by Banner Associates, Inc. and were 1,222.6 feet at test boring 1, 1,224.0 feet at test boring 2, 1,224.1 feet at test boring 3, 1,223.9 feet at test boring 4 and 1,225.0 feet at test boring 5. A Site Map (Figure 2) is attached showing the relative location of the test borings.

Subsurface Conditions

Five (5) test borings were performed at the site on May 29, 2020. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

The subsurface profile at the test boring locations consisted of the following soil types: topsoil materials, loess soils and glacial till soils. The topsoil materials were encountered at all of the test borings and extended to depths varying from 1 foot and 2 feet. The loess soils were encountered beneath the topsoil materials. The loess soils extended to the termination depth of the test borings at test borings 3, 4 and 5. The glacial till soils were encountered beneath the loess soils at test borings 1 and 2 (at a depth of 12 feet). The topsoil materials consisted of lean clay soils. The loess soils consisted of lean clay soils. The glacial tills soils consisted of lean clay with sand soils.

The consistency or relative density of the soils is indicated by the standard penetration resistance ("N") values as shown on the boring logs. A description of the soil consistency or relative density based on the "N" values can be found on the attached Soil Boring Symbols and Descriptive Terminology data sheet.

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, then it is important that you contact us so that our recommendations can be reviewed.

Water Levels

Measurements to record the groundwater levels were made at the test boring locations. The time and level of the groundwater readings are recorded on the boring logs. Also, a summary of the groundwater levels is shown in Table 1.

Table 1. Groundwater Levels

Test Boring	Ground Surface Elevation, ft	Groundwater Level, ft	Elevation of Groundwater, ft
1	1,222.6	8	1,214.6
2	1,224.0	7	1,217.0
3	1,224.1	8	1,216.1
4	1,223.9	9	1,214.9
5	1,225.0	8	1,217.0

ENGINEERING REVIEW & RECOMMENDATIONS

Project Design Data

We understand that the project will consist of developing the site for residential use. The development will likely include the following: new residential lots, several new concrete surfaced streets and new utilities (water main, sanitary sewer and possibly storm sewer). An installation depth of approximately 10 feet is expected for the sanitary sewer (deepest utility). We assume that the structures on the residential lots will likely consist of typical wood-framed residential buildings with light foundation loads. Grade changes within the development will include filling of 1 foot to 2 feet.

The information/assumptions detailed in the project design data section are important factors in our review and recommendations. If there are any corrections or additions to the information detailed in this section, then it is important that you contact us so that we can review our recommendations with regards to the revised plans.

Utility Improvements

Subgrade Soils

The subgrade soils anticipated at the invert depths for the underground utilities will likely consist of clay soils. Where soils having moderate moisture and density values are encountered at the bottom of the trench excavations, it is our opinion that the soils are considered suitable for support of the proposed utilities, provided they are adequately dewatered, and are not disturbed by construction traffic. Localized areas of wet or soft soils may be encountered at the bottom of the trench excavations. These areas will require subexcavation and trench stabilization methods and materials. Appropriate bedding materials should be used for the utility pipes. Due to the depth of the sanitary sewer, groundwater levels and moisture content levels of the lower portions of the loess soils, we expect that some subexcavation and trench stabilization methods and materials will be needed for the sanitary sewer.

Dewatering

Water may enter the trench excavations as a result of subsurface water, precipitation or surface run off. Dewatering procedures may be required in order to control and remove water entering the trench excavations. Where clay soils are encountered, it may be possible to remove and control water entering the trench excavations using normal sump pumping techniques. However, if waterbearing sand soils are encountered, then extensive dewatering techniques will likely be required due to the potentially large volumes of water. The contractor should provide appropriate dewatering methods and equipment. Again, groundwater was measured at depths varying from 7 feet to 9 feet (elevation 1,217.0 feet to 1,214.6 feet) at the test boring locations. Based on the groundwater levels, some dewatering will likely be needed for the sanitary sewer. Any water that accumulates at the bottom of the excavations should be immediately removed and surface drainage away from the excavations should be provided during construction.

OSHA Requirements

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, “Excavations and Trenches”. This document states that the excavation safety is the responsibility

of the contractor. Reference to this OSHA requirement should be included in the project specifications.

Trench Backfill

We performed 2 standard Proctor tests for the project (1 on the loess soils at test boring 5 and 1 on the loess soils within the stockpile of soil in the middle portion of the site). The results of the standard Proctor tests are shown in Table 2.

Table 2. Standard Proctor Test Results

Test Boring	Depth (ft)	Soil Type	Optimum Moisture Content (%)	Maximum Dry Density (pcf)
5	4 to 10	Lean Clay (Loess)	19.2	104.7
Stockpile	N/A	Lean Clay (Loess)	18.6	105.9

Based on the results of the moisture content and standard Proctor tests, it is our opinion that the majority of the on-site loess soils have in-situ moisture content levels that range from 6 percent above to 14 percent above the optimum moisture content. We would like to point out that the upper 2 feet of the loess soils at test borings 2, 4 and 5 have in-situ moisture content levels that are 1 percent above to 3 percent above the optimum moisture content.

In our opinion, the majority of the on-site loess soils should not be used as trench backfill. Our opinion of this is based on our observations of the collected samples, the results of the laboratory tests and the difficulties that the contractor may have trying to dry the wet soils. Therefore, the majority of the on-site loess soils should be replaced with an off-site borrow material.

The off-site borrow material should consist of either a granular or clay material. If a granular material is used, then it should consist of a pit-run or processed sand or gravel having a maximum particle size of 1 inch. The granular material can be placed in lifts of up to 1 foot in thickness. If a clay material is selected, then it should consist of a non-organic clay having a liquid limit less than 45. Scrutiny on the clay material's moisture content should be made prior to the acceptance and use. The clay fill should be placed in lifts of up to 6 inches in thickness. The moisture content of clay backfill soils should be within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698). All trench backfill should be

compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698). If granular materials are used, then the upper 2 feet to 3 feet of the trench backfill should consist of a clay material in order to provide a consistent subgrade condition beneath the pavement section.

Street Improvements

Subgrade Soils

Loess soils are expected to be encountered as subgrade soils for the project. The loess soils have a Unified Soils Classification System symbol of CL and an AASHTO classification of A-6. In our opinion, the majority of the loess soils have low strength characteristics and are prone to instability during freeze-thaw cycles. In addition, the majority of the loess soils are prone to instability from normal construction traffic and additional moisture. Our opinions are based on our observations of the collected samples, the results of the laboratory tests and the generally low "N" values within the loess soils.

We estimate California Bearing Ratio (CBR) values of 1.0 to 2.0 for the loess soils. CBR values of 1.0 to 2.0 are considered low CBR values. The CBR value is a measure of the supporting value of the subgrade soils. The value can be determined from a soaked test or an unsoaked test. The value from a soaked test is used to simulate the worst conditions (wet periods of the year and the spring thaw), while the value from an unsoaked test is used to simulate normal field conditions (summer and fall). Values from soaked tests are much lower than values from unsoaked tests. The values discussed above would represent values from soaked tests.

In order to provide a stable and uniform subgrade condition throughout the project, it is our opinion that subgrade reinforcement (option 1) or cement stabilization (option 2) will be needed. The subgrade reinforcement should consist of a woven geotextile fabric with granular subbase.

Initial Subgrade Preparation

We recommend removing any vegetation and highly organic materials. A removal depth of 6 inches to 12 inches should be expected. Low-ground-pressure construction equipment or excavators with smooth-edged buckets should be used for the stripping and removals. We recommend limiting the amount of heavy wheeled construction traffic on the subgrade.

If filling is required to achieve the design subgrade elevations, then the fill materials should consist of non-organic lean clay or sandy lean clay soils having a liquid limit less than 45 and a plasticity index between 15 and 35. The moisture content of the fill soils should be 1 percent below to 4 percent below the optimum moisture content. The fill soils should be placed in compacted lifts having a maximum thickness of 6 inches. We recommend a minimum compaction specification of 95 percent of standard Proctor (ASTM:D698) for the fill soils.

Once the design subgrade elevations have been achieved, 1 of the subgrade preparation options should be used to prepare the subgrade.

Subgrade Preparation Option 1 – Subgrade Reinforcement

For this option, a layer of granular subbase should be placed on top of a geotextile fabric that is overlying the subgrade. The aggregate base course material should be placed above the granular subbase. Regarding the geotextile fabric, we recommend using Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45, or an approved alternative. The granular subbase should consist of crushed quartzite, recycled concrete or a crushed pit-run material meeting the gradation specifications shown in Table 3. The granular subbase should be compacted to a minimum of 97 percent of standard Proctor density (ASTM:D698). It should be noted that compaction testing may not be practical for the granular subbase due to the large aggregate.

Table 3. Granular Subbase Gradation Specifications

Sieve Size	Percent Passing
4-inch	100
3-inch	70 – 90
2-inch	60 – 80
1-inch	40 – 70
#4	10 – 50
#40	5 – 20
#200	0 – 8

Subgrade Preparation Option 2 – Cement Stabilization

The cement stabilization should consist of blending the subgrade soils with cement to a minimum depth of 12 inches. The percentage of cement used typically ranges from 5 percent to 7 percent and should be based on a site specific mix design. For bidding purposes, the percentage of cement used should be 6 percent (example: if the in-place dry density equals 105 pounds per cubic foot (pcf), then 6.0 pounds of cement should be applied to the subgrade, per square foot). We recommend that the percentage of cement used during the blending process be determined by a mix design that should be performed when the subgrade soils are exposed during construction. The mix design typically takes about 2 weeks to complete.

Once the percentage of cement is determined, the cement should be placed uniformly over the subgrade surface at the specified percentage with a truck-mounted cement spreader. In addition to the cement being placed uniformly, the truck-mounted spreader will help control the spread of cement dust. Then, a self-propelled pulvimixer/reclaimer should be used to reclaim the upper 12 inches of the subgrade along with the cement. Within 30 minutes, the reclaimed mixture of soil and cement should be initially compacted with a large (60-inch to 72-inch diameter) vibratory sheepsfoot roller to a minimum of 95 percent of the maximum dry density as determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). The moisture content of the material should be adjusted to a moisture level that is within 3 percent below to 3 percent above the optimum moisture content determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). After initial compaction, the subgrade should be graded to design elevations, rolled with a pneumatic tire roller and watered with a commercial water truck. Construction traffic should not be allowed on the subgrade for 48 hours to 72 hours after the final watering. This delay allows for the cement to properly hydrate without being disturbed. If at any time during or after the cement stabilization process it is determined that the subgrade is not performing as expected, then the problem should be assessed to determine the best course of action. This may include an additional application of cement.

Pavement Section Thicknesses

We assume that the traffic will consist of mostly automobiles with some trucks. Table 4 summarizes the recommended concrete pavement section thicknesses for the streets. Again,

option 1 consists of granular subbase overlying a geotextile fabric (subgrade reinforcement) and option 2 consists of cement stabilization.

Table 4. Recommended Concrete Pavement Section Thicknesses

Option	Concrete Pavement Thickness, in	Aggregate Base Course Thickness, in	Granular Subbase Thickness, in	Subgrade Reinforcement	Cement Stabilization
1	7	4	10*	Geotextile Fabric	-
2	7	4	-	-	Yes**

Notes: *The thickness of the granular subbase may need to be increased if very poor subgrade conditions are encountered. **The percentage of cement may need to be increased if very poor subgrade conditions are encountered.

It should be noted that routine maintenance such as crack filling and localized patching should be expected with our recommendations.

Concrete & Aggregate Base Course Materials

We recommend that the concrete pavement meet the requirements of Section 380 of the SDDOT Standard Specifications. We recommend that the aggregate base course materials meet the requirements of Sections 260 and 882 of the SDDOT Standard Specifications. The aggregate base course materials should be compacted to a minimum of 97 percent of standard Proctor (ASTM:D698).

General Site Grading

It is our opinion that the on-site loess soils can be used as general fill; however, the on-site topsoil materials should not be used as general fill. Excessive drying should be expected with the majority of the on-site loess soils. An off-site borrow material could also be used as general fill. Also, the stockpile of soil in the middle portion of the site, which may consist of loess soils, could potentially be used as general fill. The topsoil materials could be used as finishing material in green areas. The stockpile of soil in the north portion of the site, which may consist of topsoil materials, could potentially be used as finishing material in green areas.

Compaction of fill in structural areas, such as drives, sidewalks or within the footprint of residential buildings, should be performed to a level of at least 95 percent of standard Proctor

(ASTM:D698). Compaction of fill in non-structural areas, such as lawn or landscaping, should be performed to a level of at least 90 percent of standard Proctor (ASTM:D698).

Shrinkage Factors

Table 5 summarizes the estimated shrinkage factors for the various soils encountered at the test boring locations.

Table 5. Summary of the Shrinkage Factors of the Soils

Soil Type	Estimated Shrinkage Factors (%)
Topsoil Materials	30
Loess Soils (Moisture Content above 25%)	30
Loess Soils (Moisture Content below 25%)	20

Future Residential Buildings

It is our opinion that the topsoil materials are not suitable for support of the residential buildings. Regarding the loess soils, it is our opinion that the loess soils are considered suitable for support of the residential buildings. However, a slight overexcavation (6 inches to 12 inches) may be needed with the loess soils in basement areas. Also, if our recommendations are followed during site grading, then it is our opinion that the newly placed fill would be suitable for support of a typical residential building.

Basements & Groundwater Control

Based on the groundwater levels at the test boring locations, it is our opinion that long term groundwater control will be needed if the residential buildings have basements. Therefore, residential buildings with basements should have a drainage system (drain tile and a sump).

Sump Pump Collection System & Estimated Percolation Rates

In our opinion, a sump pump collection system may be needed with the development. Our opinion on the sump pump collection system is based on the groundwater levels at the test boring locations and the fact that most of the residential structures will have basements. Regarding

percolation rates of the soils, we estimate a percolation rate of 30 to 50 minutes per inch for the loess soils.

Excavation & Earth Moving Activities

Conventional scrapers can typically be utilized for soils having low to moderate moisture contents levels; however, if soils with high moisture content levels are encountered, then low-ground pressure construction equipment should be used.

The clay soils are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. The clay soils should be considered frost-susceptible. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance.

Drainage

Proper drainage should be maintained during and after construction. The general site grading should direct surface run-off waters away from the excavations. Water which accumulates in the excavations should be removed in a timely manner.

Finished grades around the perimeter of the structures should be sloped such that positive drainage away from the structures is provided. Also, a system to collect and channel roof run-off waters away from the structures is suggested.

CONSTRUCTION CONSIDERATIONS

Groundwater & Surface Water

Water may enter the excavations due to subsurface water, precipitation or surface run off. Any water that accumulates in the bottom of the excavation should be immediately removed and surface drainage away from the excavation should be provided during construction.

Disturbance of Soils

The soils encountered at the test boring locations are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance.

Cold Weather Precautions

If site preparation and construction is anticipated during cold weather, then we recommend all foundations, slabs and other improvements that may be affected by frost movements be insulated from frost penetration during freezing temperatures. If filling is performed during freezing temperatures, then all frozen soils, snow and ice should be removed from the areas to be filled prior to placing the new fill. The new fill should not be allowed to freeze during transit, placement and compaction. Concrete should not be placed on frozen subgrades. Frost should not be allowed to penetrate below the footings. If floor slab subgrades freeze, then we recommend the frozen soils be removed and replaced, or completely thawed, prior to placement of the floor slab. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

Excavation Sideslopes

The excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, “Excavations and Trenches”. This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

Observations & Testing

This report was prepared using a limited amount of information for the project and a number of assumptions were necessary to help us develop our conclusions and recommendations. It is recommended that our firm be retained to review the geotechnical aspects of the final design plans and specifications to check that our recommendations have been properly incorporated into the design documents.

The recommendations submitted in this report have been made based on the subsurface conditions encountered at the test boring locations. It is possible that there are subsurface conditions at the site that are different from those represented by the test borings. As a result, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on-site at the following times to observe the site conditions and effectiveness of the construction.

Excavation

We recommend that a geotechnical engineer or geotechnical engineering technician working under the direct supervision of a geotechnical engineer observe all excavations for foundations, slabs and pavements. These observations are recommended to determine if the exposed soils are similar to those encountered at the test boring locations, if unsuitable soils have been adequately removed and if the exposed soils are suitable for support of the proposed construction. These observations should be performed prior to placement of fill or foundations.

Testing

After the subgrade is observed by a geotechnical engineer/technician and approved, we recommend a representative number of compaction tests be taken during the placement of the structural fill and backfill placed below foundations, slabs and pavements, beside foundation walls and behind retaining walls. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least 1 test be taken for every 2,000 square feet of structural fill placed in building and pavement areas, at least 1 test for every 75 feet to 100 feet in trench fill, and for every 2-foot thickness of fill or backfill placed. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed fill and backfill materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

SUBSURFACE EXPLORATION PROCEDURES

Test Borings

We performed 5 SPT borings on May 29, 2020 with a truck rig equipped with hollow-stem auger. Soil sampling was performed in accordance with the procedures described in ASTM:D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-pound 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 the penetration resistance, or "N" value. The "N" value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. In addition, thin walled tube samples were obtained according to ASTM:D1587, where indicated by the appropriate symbol on the boring logs.

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

The soil samples collected from the test boring locations will be retained in our office for a period of 1 month after the date of this report and will then be discarded unless we are notified otherwise.

Soil Classification

As the samples were obtained in the field, they were visually and manually classified by the crew chief according to ASTM:D2488. 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, select samples were then submitted to a program of laboratory tests. Where laboratory classification tests (sieve analysis and Atterberg limits) have been performed, classifications according to ASTM:D2487 are possible. Logs of the test 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 in Appendix A. Charts illustrating the soil classification procedures,

the descriptive terminology and the symbols used on the boring logs are also attached in Appendix A.

Water Level Measurements

The water levels indicated on the boring logs may or may not be an accurate indication of the depth or lack of subsurface groundwater. The limited length of observation restricts the accuracy of the measurements. Long term groundwater monitoring was not included in our scope of work.

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the test boring locations. Fluctuations occur due to varying seasonal and yearly rainfall amounts and snowmelt, as well as other factors. It is possible that the subsurface groundwater levels during or after construction could be significantly different than the time the test borings were performed.

Laboratory Tests

Laboratory tests were performed on select samples to aid in determining the index properties of the soils. The index tests consisted of moisture content, dry density and standard Proctor. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring logs opposite the samples upon which the tests were performed or on the data sheets included in the Appendix.

LIMITATIONS

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the test boring locations. We wish to point out that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between test borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where samples were retrieved or where water was observed. It is not standard engineering practice to continuously retrieve samples for the full depth of the borings. Therefore, strata boundaries and thicknesses must be inferred to some extent.

Additionally, some soils layers present in the ground may not be observed between sampling intervals. If the subsurface conditions encountered at the time of construction differ from those represented by our test borings, it is necessary to contact us so that our recommendations can be reviewed. The variations may result in altering our conclusions or recommendations regarding site preparation or construction procedures, thus, potentially affecting construction costs.

This report is for the exclusive use of the addressee and its representatives for use in design of the proposed project described herein and preparation of construction documents. Without written approval, we assume no responsibility to other parties regarding this report. Our conclusions, opinions and recommendations may not be appropriate for other parties or projects.

STANDARD OF CARE

The recommendations submitted in this report represent our professional opinions. Our services for your project were performed in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing at this time and area.

This report was prepared by:
GeoTek Engineering & Testing Services, Inc.

Jared Haskins, PE
Geotechnical Manager

FIGURE 1
PROJECT LOCATION MAP
PROPOSED SITE DEVELOPMENT
BLISS POINTE - PHASE 2
VERMILLION, SD

ACAD/GEOTEK/JARED/20-668

PROJECT#: 20-668

DRAWN BY: DHP

GEOTEK ENGINEERING & TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, South Dakota 57104
605-335-5512 Fax 605-335-0773

GRID BEARING

50' 25' 0 50' 100'

HORIZONTAL DATUM:
- NAD 83
- PROJECTION: SOUTH DAKOTA STATE PLANE COORDINATES SOUTH ZONE

VERTICAL DATUM:
- NAVD 88
- GEOID 09

BASIS OF BEARING: GEODETIC NORTH

ALL DIMENSIONS SHOWN ARE IN TERMS OF U.S. SURVEY FEET

BANNER
engineering a better community
www.bannerassociates.com - Toll Free: 1.855.323.6342

PROJECT / SHEET TITLE :
BLISS POINTE PHASE 2
OPTION 2A
VERMILLION, SD

REV.	DATE	DESCRIPTION

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

JOB No.:	21374-00-07
DATE:	NOVEMBER 2019
DESIGNED BY:	JDB
CHECKED BY:	RSU
DRAWN BY:	JDB

0 1/2" 1"
SCALE REDUCTION BAR

SHEET No. :
2

F:\21374-00-07\Design Phase\CADD\Design File\Bliss Pointe Option 2A.dwg,4/13/2020 10:47 AM

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-668** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Site Development, Bliss Pointe - Phase 2, Vermillion, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1222.6 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	LEAN CLAY: very dark brown, moist, (CL)	TOPSOIL			1	HSA	25				
1½											
	LEAN CLAY: dark brown, moist to wet, firm, (CL)	LOESS	5		2	SPT	27	91			
4½											
	LEAN CLAY: mottled brown and gray, wet, soft to firm, (CL)	LOESS	5		3	SPT	28				
			3	▼	4	SPT	30				
			4		5	SPT	28				
12											
	LEAN CLAY WITH SAND: a little gravel, mottled brown and gray, moist, firm, (CL)	GLACIAL TILL	7		6	SPT					
13½											
	Bottom of borehole at 13½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
5-29-20	--	13.5	--	11	▼ 8
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 5-29-20 COMPLETE 5-29-20

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-668.GPJ GEOTEKENG.GDT 6/12/20

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-668** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Site Development, Bliss Pointe - Phase 2, Vermillion, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1224.0 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	LEAN CLAY: very dark brown, moist, (CL)	TOPSOIL			1	HSA	22				
2	**LEAN CLAY**: brown, moist, soft, (CL)	LOESS									
3			4		2	SPT	21	101			
	LEAN CLAY: mottled brown and gray, wet, soft, (CL)	LOESS									
			3	▼	3	SPT	28				
			4		4	SPT	32				
			4		5	SPT	27				
12	**LEAN CLAY WITH SAND**: a little gravel, mottled brown and gray, moist, firm, (CL)	GLACIAL TILL	6		6	SPT					
13½	Bottom of borehole at 13½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
5-29-20	--	13.5	--	8	▼ 7
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 5-29-20 COMPLETE 5-29-20

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-668.GPJ GEOTEKENG.GDT 6/12/20

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-668** BORING NO. **3 (1 of 1)**

PROJECT **Proposed Site Development, Bliss Pointe - Phase 2, Vermillion, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1224.1 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	LEAN CLAY: very dark brown, moist, (CL)	TOPSOIL			1	HSA	27				
1½	**LEAN CLAY**: dark brown, moist, firm, (CL)	LOESS	7		2	SPT	25	95			
4½	**LEAN CLAY**: brown, moist, firm, (CL)	LOESS	5		3	SPT	24				
6	**LEAN CLAY**: mottled brown and gray, wet, soft, (CL)	LOESS	3	▼	4	SPT	31				
			2		5	SPT	33				
			4		6	SPT					
13½	Bottom of borehole at 13½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
5-29-20	--	13.5	--	11.5	▼ 8
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 5-29-20 COMPLETE 5-29-20

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-668.GPJ GEOTEKENG.GDT 6/12/20

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-668** BORING NO. **4 (1 of 1)**

PROJECT **Proposed Site Development, Bliss Pointe - Phase 2, Vermillion, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1223.9 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
1	**LEAN CLAY**: very dark brown, moist, (CL)	TOPSOIL			1	HSA	24				
	LEAN CLAY: dark brown, moist, soft, (CL)	LOESS	4		2	SPT	20	100			
3½	**LEAN CLAY**: mottled brown and gray, moist to wet, soft to firm, (CL)	LOESS	6		3	SPT	26				
			5	▼	4	SPT	27				
			3		5	SPT	32				
			3		6	SPT					
13½	Bottom of borehole at 13½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
5-29-20	--	13.5	--	11	▼ 9
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

START 5-29-20 COMPLETE 5-29-20

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-668.GPJ GEOTEKENG.GDT 6/12/20

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GEOTECHNICAL TEST BORING LOG

GEOTEK # **20-668** BORING NO. **5 (1 of 1)**

PROJECT **Proposed Site Development, Bliss Pointe - Phase 2, Vermillion, SD**

DEPTH in FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1225.0 ft)	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	LAB WC	LAB D	LAB LL	LAB PL	LAB QU
	LEAN CLAY: very dark brown, moist, (CL)	TOPSOIL			1	HSA	24				
1½	**LEAN CLAY**: dark brown, moist, firm, (CL)	LOESS	5		2	SPT	19	103			
3½	**LEAN CLAY**: mottled brown and gray, moist to wet, soft, (CL)	LOESS			7	BAG					
			4		3	SPT	26				
			4	▼	4	SPT	30				
			4		5	SPT	31				
			4		6	SPT					
13½	Bottom of borehole at 13½ feet.										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL
5-29-20	--	13.5	--	10.5	▼ 8
--	--	--	--	--	--
--	--	--	--	--	--
--	--	--	--	--	--

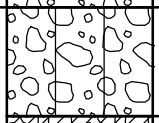
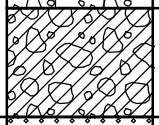
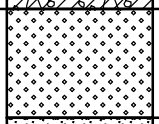
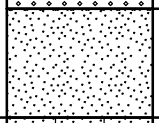
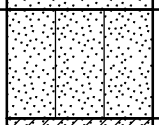
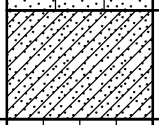
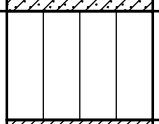
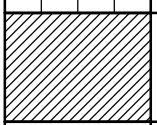
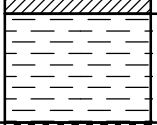
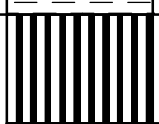
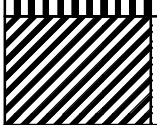
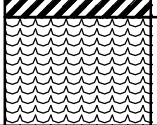
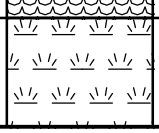
START 5-29-20 COMPLETE 5-29-20

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTECHNICAL TEST BORING 20-668.GPJ GEOTEKENG.GDT 6/12/20

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				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

SYMBOLS FOR DRILLING AND SAMPLING

Symbol	Definition
Bag	Bag sample
CS	Continuous split-spoon sampling
DM	Drilling mud
FA	Flight auger; number indicates outside diameter in inches
HA	Hand auger; number indicates outside diameter in inches
HSA	Hollow stem auger; number indicates inside diameter in inches
LS	Liner sample; number indicates outside diameter of liner sample
N	Standard penetration resistance (N-value) in blows per foot
NMR	No water level measurement recorded, primarily due to presence of drilling fluid
NSR	No sample retrieved; classification is based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit
SH	Shelby tube sample; 3-inch outside diameter
SPT	Standard penetration test (N-value) using standard split-spoon sampler
SS	Split-spoon sample; 2-inch outside diameter unless otherwise noted
WL	Water level directly measured in boring
▼	Water level symbol

SYMBOLS FOR LABORATORY TESTS

Symbol	Definition
WC	Water content, percent of dry weight; ASTM:D2216
D	Dry density, pounds per cubic foot
LL	Liquid limit; ASTM:D4318
PL	Plastic limit; ASTM:D4318
QU	Unconfined compressive strength, pounds per square foot; ASTM:D2166

DENSITY/CONSISTENCY TERMINOLOGY

Density		Consistency
Term	N-Value	Term
Very Loose	0-4	Soft
Loose	5-8	Firm
Medium Dense	9-15	Stiff
Dense	16-30	Very Stiff
Very Dense	Over 30	Hard

PARTICLE SIZES

Term	Particle Size
Boulder	Over 12”
Cobble	3” – 12”
Gravel	#4 – 3”
Coarse Sand	#10 – #4
Medium Sand	#40 – #10
Fine Sand	#200 – #40
Silt and Clay	passes #200 sieve

DESCRIPTIVE TERMINOLOGY

Term	Definition
Dry	Absence of moisture, powdery
Frozen	Frozen soil
Moist	Damp, below saturation
Waterbearing	Pervious soil below water
Wet	Saturated, above liquid limit
Lamination	Up to ½” thick stratum
Layer	½” to 6” thick stratum
Lens	½” to 6” discontinuous stratum

GRAVEL PERCENTAGES

Term	Range
A trace of gravel	2-4%
A little gravel	5-15%
With gravel	16-50%

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MOISTURE - DENSITY TEST REPORT

REPORTED TO:

Vermillion Area Chamber & Development Company
Nate Welch
116 Market Street, Suite 103
Vermillion, SD 57069

PROJECT: 20-668

Proposed Site Development
Bliss Pointe Phase 2
Vermillion, SD

COPIES TO:

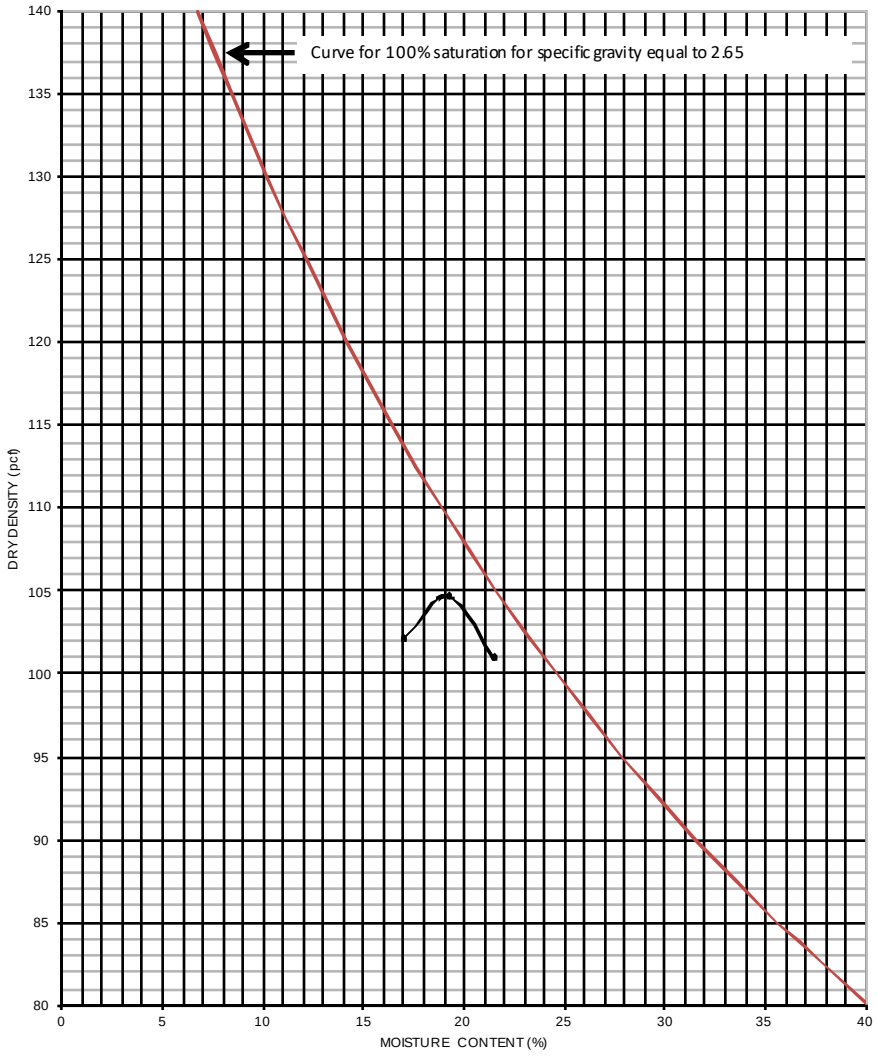
DATE REPORTED: 6/8/2020

SAMPLE DATA

Sample No.: 1
ASTM Test Method: D698B Manual
Soil Classification: Lean Clay, Dark Brown (CL)
Remarks: SB 5 (4' to 10')

Date Received: 6/1/2020
Date Tested: 6/2/2020

TEST DATA



Maximum Density, pcf: 104.7
Optimum Moisture, %: 19.2

Percent Passing, %:
3/4": 100
3/8": 100
#4: 100
#200: 91

Atterberg Limits (ASTM: D4318):
Liquid Limit:
Plastic Limit:
Plasticity Index:

Nick Bierle, Staff Engineer

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MOISTURE - DENSITY TEST REPORT

REPORTED TO:

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Nate Welch
116 Market Street, Suite 103
Vermillion, SD 57069

PROJECT: 20-668

Proposed Site Development
Bliss Pointe Phase 2
Vermillion, SD

COPIES TO:

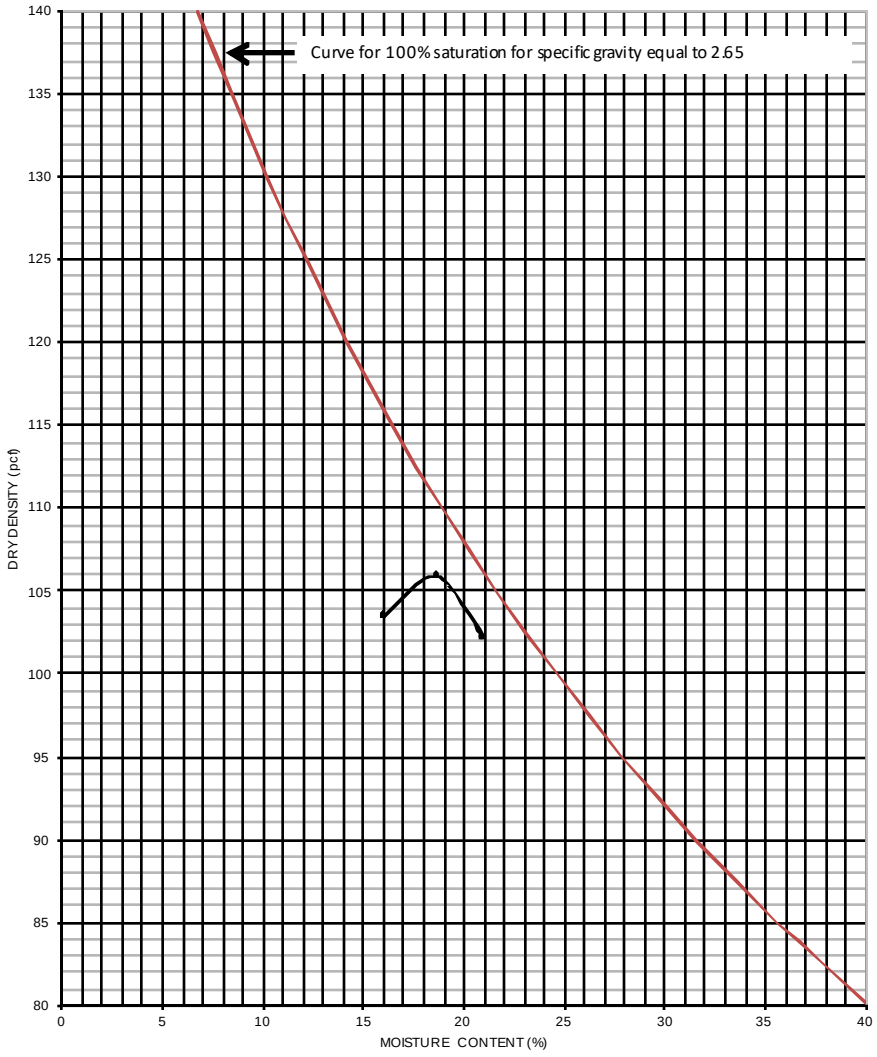
DATE REPORTED: 6/8/2020

SAMPLE DATA

Sample No.: 2
ASTM Test Method: D698B Manual
Soil Classification: Lean Clay, Brown (CL)
Remarks: South Pile

Date Received: 6/1/2020
Date Tested: 6/2/2020

TEST DATA



Maximum Density, pcf: 105.9
Optimum Moisture, %: 18.6

Percent Passing, %:
3/4": 100
3/8": 100
#4: 100
#200: 97

Atterberg Limits (ASTM: D4318):
Liquid Limit:
Plastic Limit:
Plasticity Index:

Nick Bierle, Staff Engineer