



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

April 25, 2022

City of Lake Norden
508 Main Ave.
Lake Norden, SD 57248

Attn: Kendra Rikard, Finance Officer

Subj: Geotechnical Exploration
Proposed Wastewater Improvements
Lake Norden, South Dakota
GeoTek #22-433

Cc: Banner Associates, Attn: Deidre Beck

Introduction

This report presents the results of the recent geotechnical exploration program for the referenced project.

Scope of Services

We performed our work in accordance with your authorization. The authorized scope of services included the following:

1. Perform 3 standard penetration test (SPT) boring to gather data on the subsurface conditions at the project site.
2. Perform laboratory tests that assist in the evaluation of the index properties of the collected soil samples.
3. Prepare an engineering report that includes the results of the field and laboratory tests as well as our geotechnical engineering opinions and recommendations.

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 Location and Description

Test boring 1 was performed for the new lift station; located NE of the water treatment plant. The site is currently covered with grass/vegetation and trees. Test borings 2 and 3 were performed in a farm field north of the waste water treatment plant ponds. See the attached test boring location images for more details regarding the site location and the location of the test borings.

The surface elevation (1677.75 feet) for test boring 1 was provided by Banner Associates. For test borings 2 and 3, we determined the relative surface elevations for the test boring locations by using the top-nut of the fire hydrant east of test boring 3 as a benchmark. We established an elevation of 100.0 feet for the top-nut of the fire hydrant. The surface elevations are listed on the geotechnical test boring logs that have been attached to this report.

Subsurface Conditions

At test boring location 1, we encountered lean clay fill soils, natural lean clay (fine alluvium) soils, and natural lean clay with sand (glacial till) soils. The fill soils appeared to be about 2 feet deep. At test boring locations 2 and 3, we encountered organic lean clay topsoil, natural lean clay (fine alluvium) soils, natural clayey sand (mixed alluvium) soils, and natural lean clay with sand (glacial till) soils. The topsoil layer appeared to be about 1 foot thick.

We would like to point out that the subsurface conditions at other locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, it is important that you contact us so that our recommendations can be reviewed.

Water Levels

We performed measurements to record the groundwater level at the test boring location after completion of the test boring. Groundwater entered the holes for test borings 1 and 3 at a depth of 19 feet and 12 ½ feet, respectively. We backfilled the holes prior to leaving the site.

The water levels shown on the boring logs may not be an accurate indication of the current level or lack of subsurface groundwater. A long period of time is generally required for subsurface water to stabilize in the impervious soils encountered at the boring locations. Long term water level monitoring was not included in our scope of work.

Project Design Data

We understand that the project will consist of constructing a new lift station and making improvements to the existing waste water system. The lift station will be 25 feet deep and have an 8-foot diameter.

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

Discussion

The soils encountered at the test boring locations are considered suitable for support of the proposed lift station and utility pipes. The soils may be reused as utility backfill; however, some moisture conditioning (drying) of the soils may be necessary to achieve required compaction specifications.

Based on the proposed depth of the lift station, we anticipate that typical dewatering techniques (sump pump) will be needed during construction to remove standing water from the bottom of the excavation.

Recommendations for Material Types and Compaction Levels

Granular Fill – A granular fill material should have a maximum particle size of 1 ½-inch, less than 40% passing the No. 40 sieve, and less than 15% passing the No. 200 sieve.

Free-Draining Granular Fill – A granular fill material should have a maximum particle size of 1 ½-inch, less than 40% passing the No. 40 sieve, and less than 5% passing the No. 200 sieve.

Clay Fill – A clay backfill material should consist of non-organic clay soils, having a liquid limit less than 45 and a plastic limit between 15 and 35. The on-site lean clay soils may be reused as clay backfill material. However, without lowering the moisture content, the on-site lean clay soils can be difficult to compact after being disturbed.

Recommended Compaction Levels – The recommended compaction levels listed in Table 1 are based on a material’s maximum dry density value, as determined by a standard Proctor (ASTM: D698) test.

Table 1: Recommended Compaction Levels

Placement Location	Compaction Specifications
Utility Backfill – Green Areas	90%
Utility Backfill – Below Roads	95%
Lift Station Wall Backfill	95%

Recommended Lift Sizes – Typically, as backfill is placed, the loose lift thickness should not exceed 8 inches for granular structural backfill or 6 inches for clay backfill material. Lift sizes may be increased if the equipment used for compaction is large enough to fully compact a thicker lift to the recommended compaction levels.

Recommended Moisture Levels – The moisture content of a clay backfill material, when used as backfill around either the exterior of a foundation or for utility trench backfill should be maintained within a range of - 3% to + 3% of the material’s optimum moisture content. When clay backfill materials are used below a pavement area, or as site grading, the material’s moisture content should be maintained within a range - 3% to - 1% of the material’s optimum moisture content. The optimum moisture content should be determined using a standard Proctor (ASTM: D698) test.

The moisture content of granular backfill materials and aggregate base course should be maintained at a level that will be conducive for vibratory compaction.

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.

Limitations

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the boring locations. We wish to point out

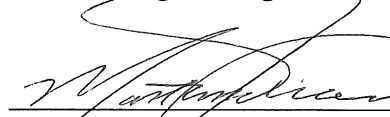
that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where 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 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.


Matthew Thompson, P.E.
Project Manager





Test Boring Location Image 1
Wastewater Improvements
Lake Norden, SD

Project No.: 22-433
Prepared By: MJT
Date Prepared: 4/21/2022





Test Boring Location Image 2
Wastewater Improvements
Lake Norden, SD

Project No.: 22-433
Prepared By: MJT
Date Prepared: 4/21/2022





GEOTEK ENGINEERING & TESTING SERVICES, INC.
 909 E. 50th Street N.
 Sioux Falls, SD 57104
 605-335-5512 Fax 605-335-0773
 info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # 22-433

BORING NO. 1 (1 of 1)

PROJECT Wastewater Improvements, Lake Norden, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS								
					NO.	TYPE	WC	D	LL	PL	QU				
	↓ SURFACE ELEVATION <u>1677.75 ft</u>														
2	FILL, MOSTLY LEAN CLAY: brown and black, moist	FILL			1	HSA									
	LEAN CLAY: brown, moist, firm, (CL)	FINE ALLUVIUM	7		2	SPT	24								
4½	LEAN CLAY WITH SAND: a little gravel, brown, moist, firm to stiff, a lens of sand above 21' (CL)	GLACIAL TILL	8		3	SPT	17	112							
			9		4	SPT									
			8		5	SPT	20								
			8		6	SPT									
			7		7	SPT	24								
24	LEAN CLAY WITH SAND: a little gravel, brown and dark brown, moist, stiff to very stiff, (CL)	GLACIAL TILL	15		9	SPT	19		38	15					
31	Bottom of borehole at 31 feet.		17		10	SPT									

GEOTECHNICAL TEST BORING 22-433.GPJ - GEOTEKENG.GDT 4/21/22

WATER LEVEL MEASUREMENTS

START 4-11-22 COMPLETE 4-11-22 2:15 pm

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD
4-11-22	2:15 pm	31	--	29	▼ 19.0	3.25" ID Hollow Stem Auger
--	--	--	--	--	--	
--	--	--	--	--	--	
--	--	--	--	--	--	CREW CHIEF Roy Hanson



GEOTEK ENGINEERING & TESTING SERVICES, INC.
 909 E. 50th Street N.
 Sioux Falls, SD 57104
 605-335-5512 Fax 605-335-0773
 info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # <u>22-433</u>						BORING NO. <u>2 (1 of 1)</u>											
PROJECT <u>Wastewater Improvements, Lake Norden, SD</u>																	
DEPTH in FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION <u>94.7 ft</u>					GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS						
									NO.	TYPE	WC	D	LL	PL	QU		
1	ORGANIC LEAN CLAY: black, moist, (OL)					TOPSOIL			1	HSA							
	LEAN CLAY: brown and gray, moist, firm, (CL)					FINE ALLUVIUM	5		2	SPT	25						
4½	SANDY LEAN CLAY: brown, moist, firm, (SC)					MIXED ALLUVIUM	8		3	SPT							
6	LEAN CLAY WITH SAND: a little gravel, brown, moist, firm, (CL)					GLACIAL TILL	5		4	SPT	21						
							7		5	SPT							
							8		6	SPT	22						
14½	LEAN CLAY WITH SAND: a little gravel, dark gray, moist, stiff, (CL)					GLACIAL TILL	9		7	SPT							
							9		8	SPT	19						
21	Bottom of borehole at 21 feet.																
WATER LEVEL MEASUREMENTS						START <u>4-11-22</u> COMPLETE <u>4-11-22 12:50 pm</u>											
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD											
4-11-22	12:50 pm	21	--	19	None	3.25" ID Hollow Stem Auger											
--	--	--	--	--	--												
--	--	--	--	--	--												
--	--	--	--	--	--	CREW CHIEF Roy Hanson											

GEOTECHNICAL TEST BORING 22-433.GPJ GEOTEKENG.GDT 4/21/22



GEOTEK ENGINEERING & TESTING SERVICES, INC.
 909 E. 50th Street N.
 Sioux Falls, SD 57104
 605-335-5512 Fax 605-335-0773
 info@geotekeng.com

GEOTECHNICAL TEST BORING LOG

GEOTEK # 22-433 BORING NO. 3 (1 of 1)
 PROJECT Wastewater Improvements, Lake Norden, SD

DEPTH in FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION <u>97.1 ft</u>	GEOLOGIC ORIGIN	N	WL	SAMPLE		LABORATORY TESTS						
					NO.	TYPE	WC	D	LL	PL	QU		
1	ORGANIC LEAN CLAY: black, moist, (OL)	TOPSOIL			1	HSA							
	LEAN CLAY: brown, moist, firm, (CL)	FINE ALLUVIUM	7		2	SPT	26						
4½	LEAN CLAY: brown and gray, moist, firm, a lens of sand above 11' (CL)	FINE ALLUVIUM	5		3	SPT							
			7		4	SPT	26						
			9		5	SPT							
12	CLAYEY SAND: a little gravel, fine to medium grained, brown, wet, dense, (SC)	MIXED ALLUVIUM	18	▼	6	SPT							
14½	LEAN CLAY WITH SAND: a little gravel, brown, moist, stiff, (CL)	GLACIAL TILL	13		7	SPT	20						
19	LEAN CLAY WITH SAND: a little gravel, brown and dark brown, moist, very stiff, (CL)	GLACIAL TILL	17		8	SPT	18		34	16			
21	Bottom of borehole at 21 feet.												

WATER LEVEL MEASUREMENTS						START	COMPLETE
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	WATER LEVEL	METHOD	
4-11-22	12:15 pm	21	--	19	▼ 12.5	3.25" ID Hollow Stem Auger	
--	--	--	--	--	--		
--	--	--	--	--	--		
--	--	--	--	--	--	CREW CHIEF Roy Hanson	

GEOTECHNICAL TEST BORING 22-433.GPJ - GEOTEKENG.GDT 4/21/22

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS	
			GRAPH	LETTER		
<p>COARSE GRAINED SOILS</p> <p>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE</p>	<p>GRAVEL AND GRAVELLY SOILS</p>	<p>CLEAN GRAVELS</p> <p>(LITTLE OR NO FINES)</p>		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
		<p>GRAVELS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
		<p>GRAVELS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES	
		<p>GRAVELS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES	
	<p>SAND AND SANDY SOILS</p>	<p>CLEAN SANDS</p> <p>(LITTLE OR NO FINES)</p>		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES	
		<p>SANDS WITH FINES</p> <p>(APPRECIABLE AMOUNT OF FINES)</p>		SM	SILTY SANDS, SAND - SILT MIXTURES	
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES	
			<p>SILTS AND CLAYS</p> <p>LIQUID LIMIT LESS THAN 50</p>		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
<p>SILTS AND CLAYS</p> <p>LIQUID LIMIT GREATER THAN 50</p>		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY			
		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS			
		CH	INORGANIC CLAYS OF HIGH PLASTICITY			
<p>HIGHLY ORGANIC SOILS</p>		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS			
		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

<u>Symbol</u>	<u>Definition</u>
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

<u>Symbol</u>	<u>Definition</u>
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

<u>Density</u>	<u>N-Value</u>	<u>Consistency</u>
<u>Term</u>		<u>Term</u>
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

<u>Term</u>	<u>Particle Size</u>
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

<u>Term</u>	<u>Definition</u>
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

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