LAKE SAKAKAWEA PIPELINE CROSSING REPORT

Appendix 9.3

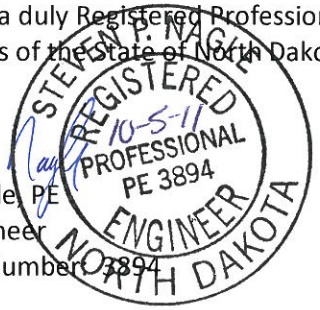
Soil Boring Report and Logs

A Subsurface Evaluation Report for

Bakkenlink Pipeline
Across Lake Sakakawea
South of Tioga, North Dakota

Professional Certification

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 laws of the State of North Dakota.



Steven P. Nagle, PE
Principal Engineer
Registration Number 3894

FA-11-01275
October 5, 2011
Braun Intertec Corporation

BRAUN INTERTEC

Braun Intertec Corporation
526 10th Street NE, Suite 300
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October 5, 2011 Project FA-11-01275

Mr. Jame Todd
Bartlett &West
3456 30th Avenue NE
Bismarck, ND 58503-0737

Dear Mr. Todd:

Re: Subsurface Evaluation for Bakkenlink Pipeline Crossing Lake Sakakawea,
South of Tioga, North Dakota

We have completed the report of the Subsurface Evaluation authorized by you in accordance with the Master Service Agreement between Bartlett & West and Braun Intertec. The purpose of this evaluation was to provide lake-bottom soil data to aid in design of the pipeline which crosses Lake Sakakawea south of Tioga, North Dakota.

Summary of Results

A total of six (6) standard penetration test borings were performed in locations across the proposed alignment. The general soil profile consisted of lake sediment overlying alluvial soils. The lake sediment were encountered in three of the six borings and appeared to consist of 1 foot of "soil" that would classify as fat clay, however, the moisture content of the sediment was higher than the soils liquid limit. Therefore, this sediment was acting more as a fluid. Below the sediment, alluvial soils consisting of lean clay, silty sand, and poorly graded sand with silt and gravel was encountered. These alluvial soils are the native soils that were at this site prior to flooding of the lake. The cohesive portions of these soils generally were very soft to rather soft in consistency and the granular soils had a very loose to medium dense, relatively density.

Summary of Recommendations

The borings indicate that 0 to 1 foot of lake sediment has collected across the lake profile. It does not seem practical to "sink" a weighted pipeline into the sediment. We have provided information to assist in designing a support system, however, the soils below the lake sediment would adequately support the lowered pipeline or any supporting structure.

General

Please refer to the attached report for a more detailed summary of our analyses and recommendations. If we can provide additional assistance, or observation and testing services during construction, please call Steve Nagle at 701.238.3425.

Sincerely,

BRAUN INTERTEC CORPORATION

Debashis Sikdar, PE, PhD
Project Engineer

Steven P. Nagle, PE
Principal Engineer/Vice President

Attachment: Geotechnical Evaluation Report

Table of Contents

Description **Page**

A. Introduction

A.1. Project

Bartlett & West is assisting their client in the design of the Bakkenlink pipeline Lake Sakakawea crossing. To assist in the design, Braun Intertec is performing a subsurface evaluation to determine the type of material in the lake bottom which will support the pipeline.

A.2. Purpose of This Evaluation

The purpose of this geotechnical evaluation is to provide soils data for preparing plans and specifications for the pipeline crossing.

A.3. Scope

The proposed scope has been requested by Mr. Jame Todd of Bartlett & West during several email messages. The final scope of work for this project included the following tasks:

- conducting six (6) penetration test borings approximately 10 feet below the lake bottom,
- collecting samples for ellutriate testing from each boring (ellutriate testing performed by others),
- performing strength testing (unconfined compression tests) at midcore depth in each boring,
- performing grain size distributions if sands are encountered,
- performing electrical resistivity testing in three of the borings,
- classifying the samples and preparing boring logs,
- providing a bearing capacity at the surface and midpoint of the boring,
- submitting a geotechnical evaluation report containing logs of the borings, analyses of the field laboratory tests, and recommendations.

A.4. Documents Provided

We were provided a profile of the proposed pipeline, and the GPS coordinates of the six borings.

B. Results

B.1. Logs

Log of Boring sheets indicating the depths and identifications of the various soil strata, penetration resistances, water level and laboratory test results are included in the Appendix. The strata changes were inferred from the changes in the penetration test samples and auger cuttings. It should be noted that the depths shown as changes between the strata are only approximate. The changes are likely transitions and the depths of the changes vary between the borings.

Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and available common knowledge of the depositional history of the site. Because of the complex glacial and post-glacial depositional environments, geologic origins are frequently difficult to ascertain. A detailed investigation of the geologic history of the site was not performed.

B.2. Site Conditions

The project is located approximately 200 feet west of where the existing Dakota Gasification Company's CO_2 pipeline crosses Lake Sakakawea. The pipeline crosses the lake in a relatively wide location.

B.3. Soils

A total of six (6) penetration test borings were performed across the lake, just east of the existing pipeline. The general soil profile consists of lake sediment overlying both cohesive and granular soil. The individual strata are described in more detail in the following sections**.**

B.3.a. Lake Sediment. Borings ST-2, ST-3 and ST-6 encountered 1 foot of lake sediment. The lake sediment classified as fat clay based on the results of the Atterberg limits. However, the moisture contents of the sediment were significantly higher than the Liquid Limit of the soil. Therefore the sediment was acting more like a liquid then a soil.

B.3.b. Alluvium. Underlying the lake sediment, the borings encountered both cohesive and granular alluvium. This alluvium is the native soil that existed at this location prior to the lake being filled. The cohesive alluvium consisted of fat clay, and lean clay with varying amounts of sand. The cohesive soil had a very soft to medium consistency.

The granular alluvium consisted of silty sand, and poorly graded sand with silt and gravel. The penetration resistance in the granular alluvium indicateed the relative density of the granular alluvium was very loose to medium dense.

B.4. Laboratory Test Results

The result of the laboratory tests performed on the different soil samples are presented on the respective boring logs. Also, a summary of all the test results are presented in the Table "Summary of Laboratory Test Data" in the Appendix of this report.

B.4.a. Moisture Content Tests

Moisture content (MC) tests (per ASTM D2216) were conducted on selected samples to aid in our classifications and estimations of the soils' engineering properties. The moisture contents of the soils tested in the sediment soils ranged from 104 to 105% and for alluvial soils ranged from 25 to 46 percent. All the soils are submerged with approximately 50 feet of standing water. All these moisture contents are saturated moisture contents of soil samples.

The results of the moisture content tests are listed in the "MC" column of the Log of Boring Sheets attached in the Appendix.

B.4.b. Unit Weight Tests

The unit weight tests were conducted on selected samples to aid in developing engineering parameters related to settlement calculations. The tests indicated the sediment soils had uniform wet density (WD) of 90 pounds per cubic foot (pcf). The wet densities of alluvial soils varied from 107 to 123 pcf. The results of the density tests are listed in the "Tests or Notes" column on the attached Log of Boring sheets.

B.4.c. Atterberg Limits Tests

The Atterberg limits tests (per ASTM D4318) were conducted on selected samples for classification, evaluation of the soils' plasticity, and estimation of engineering parameters related to consolidation to aid in settlement calculations. The tests indicated the selected

sediment sample had liquid limit (LL) of 76 percent, plastic limit (PL) of 16 percent, and plasticity index (PI) of 60 percent, indicating the soils are classified as fat clays (CH). The tests on the alluvium soil samples indicated they had liquid limits (LL) of 34 to 50 percent, plastic limits (PL) of 19 percent, and plasticity indices (PI) of 15 to 31 percent, indicating the soils are classified as lean clays (CL) and fat clays (CH). The results of the Atterberg Limits test are listed in the "Tests or Notes" column on the attached Log of Boring sheets.

B.4.d. Percent Passing the #200 Sieve Tests

Percent passing the #200 sieve analyses tests (P200) (per ASTM D1140) were performed to estimate the engineering properties of the granular material. The results of the P200 tests indicated the soils encountered had P200's ranging from 8 to 70 percent, indicating the soils are classified as poorly graded sand with silt and sandy lean clay.

B.4.e. Electrical Resistivity Testing

Electrical resistivity testing was conducted in the three selected alluvial soil samples. The electrical resistivity test results were generally in the range of 580 to 1900 Ohm-cm.

C. Analyses and Recommendations

C.1. Project Background

We understand the Bakkenlink pipeline will either be placed in the bottom of the lake through a direct cut or it will be sunk into place. Based on previous experience with pipelines crossing the lake, we assume the minimum cover depth goal is 5 feet. If sinking is feasible it will involve placing a concrete encased pipeline. At this time it does not appear that simply weighting the pipe will cause it to settle a minimum of 5 feet because we found 1 to 2 feet of sediment in three of the six borings. The direct cut method will likely require either a hydraulic jet or a dragline to create a trench for the pipeline.

If our understanding of the proposed project is not correct, or if the proposed grades differ significantly from the above grades, we should be informed. Additional analyses and revised recommendations may be necessary.

C.2. Sediment Parameters

As indicated, the sediment has moisture contents over the liquid limit of the soil and will act more like a liquid then a soil. In order to determine the weight needed in the pipeline to sink into the sediment, an estimate of the sediment unit weight is needed. The following table contains the information collected within the sediment in the various borings.

Table No. 1. Parameter of Lake Sediment.

Boring	Thickness (feet)	Moisture Content %	Wet * Density (pcf)**
ST-1	NA	-	-
ST-2	1	105	90
ST-3	1	105	90
ST-4	NA	-	-
ST-5	NA	-	-
ST-6	1	105	90

Note: * Wet Weight equals the total weight of the soil. To determine the effective weight, subtract the weight of water (62.4 pcf).
** pcf = Pounds Per Cubic Foot.

Because of the very soft and fluid nature of the sediment, we have no way to test the soil strength, however, there is likely some type of soil strength that has developed in the sediment. The strength of the sediment may be estimated as cohesion that has developed from the preconsolidation of the sediment.

On page 7.1-141 of the Department of Navy Design Manual 7.2, there is a relation to calculate the cohesion of a soil based on the preconsolidation of the soil (weight of material above the soil). The relation is: Cohesion = (Unit Weight of soil – Weight of Water) * Depth into the sediment *(0.11+0.0037 * Plastic Index of the Soil)

For this project, the PI of the sediment should be assumed to be at 60. This relationship shows that the strength of the sediment will increase with depth. The increase in the soil strength should be linear.

C.3. Bearing Capacity

As requested, we collected undisturbed samples from near the midpoint of the borings. We had planned to perform an unconfined compression test on the samples, however the samples were soft and became disturbed during the extraction process.

As an alternative, we recommend that the cohesion of the soil can be estimated by taking the blow count time 125 pounds per square foot. The ultimate bearing capacity of the soil can be roughly estimated by multipling the cohesion of a soil by 9. The net allowable bearing capacity of the alluvium soil at five feet depth below the existing lake bed for a spread footing foundation is estimated up to nine hundred (900) psf. This value includes a safety factor of at least 3.0 with regard to bearing capacity failure.

Although these soils have strength, their moisture content will cause these soils to deform and settle. Design of the pipeline will need to be designed to resist the movement of the soil.

C.3. Soil Corrosivity

The results of our electrical resistivity testing indicate that the soils are severely corrosive to steel structures. We recommend that corrosion protection be provided for below-grade ductile iron pipe.

Per current engineering practice, the corrosivity of concrete is evaluated based on the sulphate or chloride concentration tests of the on site soils. These tests were beyond the scope of work for the current project. However, based on our experience with the project site, we anticipate the soils on this site provide a mild to moderate degree of exposure to sulfate attack. Per the ACI requirements we recommend the cementitious material consist of *either* ASTM C 150 Type II cement (designed for moderate sulfate resistance) *or* a combination of any type of ASTM C 150 cement with sufficient quantities of fly ash and/or slag to produce an expansion not exceeding 0.05% at six months or 0.10% at one year when the combination is tested according to ASTM C 1012, “Standard Test Method for Length Change of Hydraulic-

Cement Mortars Exposed to a Sulfate Solution.” We also recommend that all below-grade and below-water concrete be designed with a water-cement ratio of 0.50 or less, and with a minimum 28-day compressive strength of 4000 psi.

D. Procedures

D.1. Drilling and Sampling

We performed the standard penetration test borings from July 25 to 27, 20011, with a trailer-mounted core and auger drill equipped with 3 1/4-inch, inside diameter hollow-stem auger to the bottom of the boring. Sampling for the borings was conducted in general accordance with ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils." We advanced the boreholes with the hollow-stem auger to the desired test depths. A 140-pound hammer falling 30 inches was then used to drive the standard 2-inch split-barrel sampler a total penetration of 2 feet below the tip of the hollow-stem auger. The blows for the middle foot of penetration were recorded and are an index of soil strength characteristics. Samples were taken at 2 foot vertical intervals for the termination depths of the borings. A representative portion of each sample was then sealed in a glass jar.

D.2. Soil Classifications

A geologist visually and manually classified soils encountered in the test borings in the field in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)." A summary of the ASTM classification system is included in the Appendix. All samples were then returned to our laboratory for review of the field classifications by a geotechnical engineer. Representative samples will remain in our office for a period of 60 days to be available for your examination.

E. General

E.1. Basis of Recommendations

The analyses and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the attached boring logs. Often, variations occur between these borings, the nature and extent of which do not become evident until additional exploration or construction is conducted. A reevaluation of the recommendations of this report should be made after performing on-site observations during construction to note the characteristics of any variations. The variations may result in additional foundation costs, and it is suggested that a contingency be provided for this purpose.

It is recommended that a qualified firm be retained to perform the observation and testing program for the site preparation phase of this project. This will allow correlation of the soil conditions encountered during construction to the soil borings.

E.2. Soil Evaluation Basis

This report was prepared based on the requested scope of services. It is recommended that a qualified firm be retained to review the geotechnical aspects of any projects and specifications developed based on this report. This review should determine whether any designs have affected the validity of the recommendations, and whether our recommendations have been correctly interpreted and implemented in the design and specifications.

E.3. Use of Report

This report is for the exclusive use of Bartlett & West and their client to use to design the proposed structures and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

E.4. Level of Care

Services performed by Braun Intertec Corporation personnel for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

Appendix

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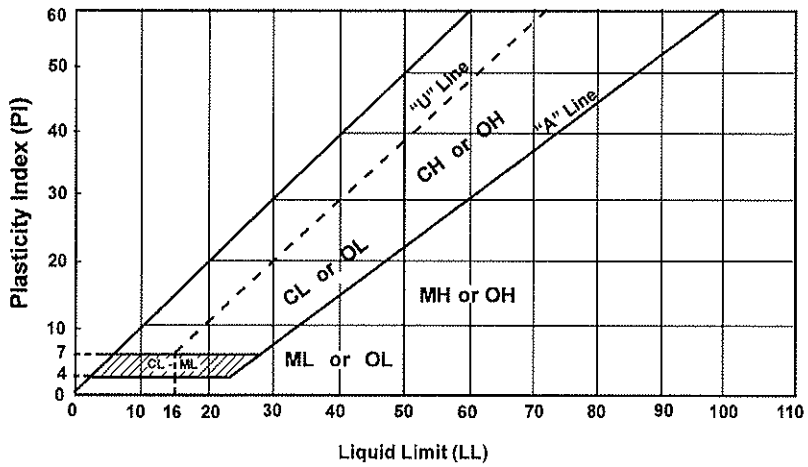
Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

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LOG OF BORING - ST-01

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-01**

LOCATION: 48 08' 56.538" N 102 53' 38.717" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/25/11** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1810.0	0.0							
		CL	SANDY LEAN CLAY, dark brown, wet, very soft. (Alluvium)	WH		27	123	P200=69.8%
1808.0	2.0							
		CH	FAT CLAY, dark brown and dark gray, wet, very soft. (Alluvium)	2		41	112	
				2		51	107	LL=50, PL=19, PI=31
1803.0	7.0					46		
		CL	LEAN CLAY with SAND, brown, wet, medium. (Alluvium)	6		45	110	
1800.0	10.0		Wood encountered at a depth of 9 feet.					
			END OF BORING.					
			Water depth 42 feet.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING -

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-02**

LOCATION: 48 08' 45.218" N 102 53' 37.628" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/25/11** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1806.0	0.0							
1805.0	1.0	CH	FAT CLAY, dark brown, wet, very soft. (Sediment)	WH		104	90	Sediment
		CL	LEAN CLAY, bown, wet, soft to rather soft. (Alluvium)	4		39	114	
1801.0	5.0					38		Electrical Resistivity =1800 ohm-cm
		SM	SILTY SAND, olive, waterbearing, medium dense to loose. (Alluvium)	14		34		P200=19.1%
				7		25		
1796.0	10.0		END OF BORING. Water depth 46 feet.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING - ST-03

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-03**

LOCATION: 48 08' 15.141" N 102 53' 34.395" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/26/11** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1803.0	0.0							
1802.0	1.0	CH	FAT CLAY, olive, wet, very soft. (Sediment)	WH		105	90	
		SM	SILTY SAND, brown, waterbearing, very loose to medium dense to dense. (Alluvium)	2		31		
			Encountered wood and organics at 3 feet.			35		
				11		29		P200=13.8
				29				
1793.0	10.0		END OF BORING. Water depth 49 feet.					

LOG OF BORING N:\GINT\PROJECTS\FARGO\2011\01275.GPJ BRAUN_V8_CURRENT.GDT 8/12/11 15:07

BRAUN INTERTEC

LOG OF BORING - ST-04

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-04**

LOCATION: 48 07' 16.571" N 102 53' 28.653" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/26/11** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1804.0	0.0	CL	LEAN CLAY, brown, wet, rather soft to soft. (Alluvium)	4		36	114	
				2		37	115	LL=34, PL=19, PI=15
1801.0	3.0	SM	SILTY SAND, dark brown, waterbearing, loose. (Alluvium)			34		Electrical Resistivity = 580 ohm-cm
				6		27		P200=46.1%
				9		29		
1794.0	10.0		END OF BORING. Water depth 48 feet.					

LOG OF BORING N:\GINT\PROJECTS\FARGO\2011\01275.GPJ BRAUN_V8_CURRENT.GDT 8/12/11 15:07

BRAUN INTERTEC

LOG OF BORING -

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-05**

LOCATION: 48 07' 11.247" N 102 53' 28.391" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/27/11** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1808.0	0.0	CL	SANDY LEAN CLAY, olive, wet, very soft to rather soft. (Alluvium)	1		30	120	
				WH		38	114	
						40		
				2		42		P200=83.6%
				5		38		P200=84.4%
1798.0	10.0		END OF BORING.					
			Water depth of 44 feet.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING - ST-06

Braun Project FA-11-01275
Geotechnical Evaluation
Bakkenlink Pipeline Crossing
Lake Sakakawea
Tioga, North Dakota

BORING: **ST-06**

LOCATION: 48 07' 50.495" N 102 53' 31.978" W

DRILLER: K. Miller | METHOD: 3 1/4" HSA, Safety Hammer | DATE: **7/27/11** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	WD pcf	Tests or Notes
1804.0	0.0							
1803.0	1.0	CH	FAT CLAY, dark brown, wet, very soft. (Sediment)	2		105	90	LL=76, PL=16, PI=60
		CL	LEAN CLAY, dark gray, wet, soft to rather soft. (Alluvium)	6		30	120	
1800.5	3.5	SP	POORLY GRADED SAND with SILT and GRAVEL, fine to medium grained, brown, waterbearing, loose. (Alluvium)			40		Electrical Resistivity = 1900 ohm-cm
				4		27		LL=NP
				11		25		Gravel=34.8%, P200=8.19%
1794.0	10.0		END OF BORING. Water 48 feet deep.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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SUMMARY OF LABORATORY TEST DATA

Project No.: FA-11-01275		**Bakkenlink Pipeline Crossing**
		Lake Sakakawea
		Tioga, North Dakota

Boring No.	Sample Type	Depth	Moisture Content	Moisture Density	Atterberg Limits + MC	P200	Electrical Resistivity (Ohm-cm)	Remarks
ST-01	Composite	0' - 2'	27	123		69.8%		
ST-01	Composite	2' - 4'	41	112				
ST-01	Composite	4' - 6'	51	107	LL=50, PL=19, PI=31			
ST-01	Composite	6' - 8'	46					
ST-01	Composite	8' - 10'	45	110				
ST-02	Composite	0' - 2'	104	90				
ST-02	Composite	2' - 4'	39	114				
ST-02	Composite	4' - 6'	38				1800	
ST-02	Composite	6' - 8'	34			19.1%		
ST-02	Composite	8' - 10'	25					
ST-03	Composite	0' - 2'	105	90				
ST-03	Composite	2' - 4'	31					
ST-03	Composite	4' - 6'	35					
ST-03	Composite	6' - 8'	29			13.8%		
ST-03	Composite	8' - 10'						
ST-04	Composite	0' - 2'	36	114				
ST-04	Composite	2' - 4'	37	115	LL=34, PL=19, PI=15			
ST-04	Composite	4' - 6'	34				580	
ST-04	Composite	6' - 8'	27			46.1%		
ST-04	Composite	8' - 10'	29					
ST-05	Composite	0' - 2'	30	120				
ST-05	Composite	2' - 4'	38	114				
ST-05	Composite	4' - 6'	40					
ST-05	Composite	6' - 8'	42			83.6%		
ST-05	Composite	8' - 10'	38			84.4%		
ST-06	Composite	0' - 2'	105	90	LL=76, PL=16, PI=60			
ST-06	Composite	2' - 4'	30	120				
ST-06	Composite	4' - 6'	40				1900	
ST-06	Composite	6' - 8'	27		LL= NP			
ST-06	Composite	8' - 10'	25			8.19%		Gravel= 34.8%