# **Geotechnical Reports**

- 1. West Rapid Substation GT Exploration and Review
- 2. West Rapid City Substation Investigative Borings
- 3. West Rapid Substation Transmission Line Poles GT Report



**CONSULTANTS** 

- **GEOTECHNICAL**
- **MATERIALS**
- **ENVIRONMENTAL**
- **FORENSICS**



# **REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW**

WEST RAPID SUBSTATION RAPID CITY SERVICE CENTER 409 DEADWOOD AVENUE RAPID CITY, SOUTH DAKOTA

AET No. 17-03356

Date:

May 31, 2018

**Prepared for:** 

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57702



CONSULTANTS · GEOTECHNICAL · MATERIALS · ENVIRONMENTAL

May 31, 2018

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57702

Attn: Mr. Ron Williams, PE

RE: Geotechnical Exploration and Review West Rapid Substation Rapid City Service Center 409 Deadwood Avenue Rapid City, South Dakota Report No.17-03356

Dear Ron,

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed West Rapid Substation to be constructed at 409 Deadwood Avenue, in Rapid City, South Dakota. These services were performed in general accordance with our proposal dated April 10, 2018 and the signed Statement of Services No. 38863, dated April 25, 2018. We are submitting one (1) electronic copy of the report to you and one (1) additional copy to Ms. Maria Garduna (Black Hills Energy).

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in the Appendix entitled "Geotechnical Report Limitations and Guidelines for Use".

Please contact our office if you have any questions about the report. We can also be contacted to arrange the observation and testing services during construction of the project.

Sincerely, American Engineering Testing, Inc.

Walt Feeger, P.É. Senior Geotechnical Engineer Phone: (605) 388-0029 wfeeger@amengtest.com

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#### SIGNATURE PAGE

Prepared for:

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57701

Attn: Mr. Ron Williams, PE

Prepared by:

American Engineering Testing, Inc. 1745 Samco Road Rapid City, South Dakota 57702

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APPENDIX B - Geotechnical Report Limitations and Guidelines for Use

# **1.0 INTRODUCTION**

We understand the construction of a new substation has been proposed at Black Hills Energy's Rapid City Service Center facility at 409 Deadwood Avenue in Rapid City, South Dakota. Please refer to the Site Location Map included in Appendix A of this report. To assist with the planning and design, American Engineering Testing, Inc. (AET) has been authorized to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services, and provides our engineering recommendations based on this data.

## 2.0 SCOPE OF SERVICES

AET's services were performed in general accordance with our proposal dated April 10, 2018. The authorized scope consists of the following:

- Ten (10) standard penetration test (SPT) borings within the proposed substation area to depths of about 30 feet below existing grade.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination.

## **3.0 PROJECT INFORMATION**

Based on the information provided, we understand the proposed 230/69kV substation will be constructed at Black Hills Energy's Rapid City Service Center facility located at 409 Deadwood Avenue in Rapid City. The substation will consist of a control building as well as deadends, bus/switch supports, transformers, and take-off structures. Furthermore, we understand these types of structures are typically placed on pad/mat foundations or reinforced concrete drilled piers (caissons).

The previously stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

# 4.0 SUBSURFACE EXPLORATION AND TESTING

### 4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of ten (10) SPT borings which were drilled on May 8 and 9, 2018. The borings were located in the field by AET personnel at the approximate locations shown on the Boring Location Map within Appendix A. Surface elevations at the boring locations were referenced to a Temporary Benchmark (TBM). The TBM selected for this project was the top of the well cover located northeast of Boring B-3. For purposes of our report, the TBM was given a reference elevation on 100.0 feet.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

### 4.2 Laboratory Testing

The laboratory test program included water content, dry density, Atterberg Limits, percent passing the #200 sieve, and unconfined compression. The laboratory test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed with the exception of the unconfined compression tests, which can be found on separate sheets within Appendix A of this report.

#### **5.0 SITE CONDITIONS**

## **5.1 Surface Observations**

The project site is located within the area of the former Black Hills Power Plant at the Rapid City Service Center, on the west side of Deadwood Avenue in Rapid City. At the time of our field work, the project site consisted of an equipment and vehicle staging area, which was covered with about 9 to 10 inches of crushed limestone aggregate. In general, the site slopes slightly downward to the west, with an elevation difference of about  $2\frac{1}{2}$  feet noted between the borings.

### 5.2 Subsurface Soils/Geology

Underlying approximately 9 to 10 inches of aggregate surfacing, the subsurface soils encountered in the borings consisted of about 1 to 12 feet of fill overlying varying depths of alluvium and/or claystone bedrock and gypsum, associated with the Spearfish Formation. The fill is comprised of residual coal from the former power plant as well as silty/sandy lean clays. The alluvium consists of stiff to hard lean clays. The claystone/gypsum bedrock extended to the total depths explored in each of the borings, with the exception of Boring B-1. Within Boring B-1, the alluvial silty lean clays extended to the total depth explored.

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A of this report.

### 5.3 Groundwater

At the time of our field work, measurable groundwater was encountered within Borings B-1, B-2, B-4, B-7, and B-10 at depth varying from approximately 10½ to 15 feet below existing grades. The presence or lack of groundwater noted at the boring locations should not be taken as an accurate representation of the actual groundwater levels. Groundwater level fluctuations occur due to seasonal variations in the amount of precipitation, surface drainage, local irrigation practices, and other factors not evident at the time the borings were performed. Due to the relatively low permeability of the clay soils encountered in the borings, a relatively long period of time may be needed for a groundwater level to develop and/or stabilize in the borings. The possibility of encountering groundwater and associated fluctuations in groundwater levels should be considered when developing the design and construction plans for the project.

## 5.3 Hydrocarbon Impacted Soils and Groundwater

Potential hydrocarbon impacted soils and groundwater may be encountered during the project excavation activities based on field photoionization detector (PID) screening results of samples obtained from the borings (please refer to the results shown on the Boring Logs). Hydrocarbon impacted soils that are encountered during the excavation activities could be considered solid waste material by the South Dakota Department of Environment and Natural Resources (SD DENR), which would require proper removal and disposal in accordance with SD DENR guidelines.

Regarding hydrocarbon-impacted groundwater that may require dewatering during the project, concentrations of hydrocarbons in groundwater may exceed the surface water quality standards as established by the SD DENR, and therefore, cannot be discharged as surface water. If dewatering of hydrocarbon impacted groundwater is required for the project, the successful bidding contractor for the project would need to coordinate with the City of Rapid City to obtain permission to discharge to the sanitary sewer or discuss other potential disposal options acceptable to the City of Rapid City and/or DENR.

## 6.0 RECOMMENDATIONS

### 6.1 Discussion

Our recommendations in the following sections are based on our understanding of the project details at this time. The geotechnical engineer should be allowed to review the final project plans to verify the following recommendations remain applicable for construction.

Based on the field and laboratory data, it is our opinion drilled pier foundations can be used to support the proposed dead-end structures, transmission line poles, and other miscellaneous substation structures. Conventional spread footing or mat foundations can be used for support of the new control building, transformers, capacitor banks, or other miscellaneous support equipment provided the recommendations provided herein are followed.

As designed, spread footing/mat loadings should provide a theoretical safety factor of 3 or more with respect to a general shear or base failure of the footings/mats. For drilled piers, loadings should provide a theoretical safety factor of 2 or more. Total and differential movement should not exceed 1-inch and 1/2-inch, respectively.

Additionally, it should be noted that gypsum is a common geologic feature found in the Spearfish Formation derived soils at this site. Once exposed, gypsum material can degrade which could cause future movement related distress to the structures, especially if water is introduced to the gypsum matrix.

If gypsum is encountered at the base of the excavations for foundations, retaining walls, and concrete slabs-on-grade, the geotechnical engineer should be allowed to observe the excavations and provide additional recommendations. Such recommendations typically involve over-excavation of the gypsum material to a specified depth and replacement with approved engineered fill material or lean concrete flowable fill. Gypsum fragments greater than 2-inches in nominal size should be screened out of all fill material prior to placement. Drilled pier foundations <u>should</u> not terminate (end bear) on gypsum.

# **6.2 General Site Preparation Recommendations**

At this time, a grading plan or design finished structure elevations has not been provided. Based on the elevations obtained at the boring locations, fills on the order of about 3 feet (or less) will be required along the western portion of the proposed substation in order to provide a level building pad. All proposed imported fill material required to reach the design substation grade elevations should consist of lean clay or sand/gravel material. We do not recommend fat clay or shale material be used as fill within the proposed substation. All proposed imported material should be submitted to the geotechnical engineer for approval prior to being hauled and stockpiled on-site.

The existing aggregate surfacing, coal layers associated with the former power plant, and other unsuitable materials should be removed from within the construction limits of the proposed new substation. Any former infrastructure or structural elements associated with the former power plant should also be removed in their entirely if encountered during require site excavations. The existing lean clay material may be left in-place provided it is properly reconditioned as recommended herein prior to placement of structures and/or additional fill material required

Once the required stripping and foundation excavations are complete, we recommend the exposed subgrade soils be moisture conditioned to within  $\pm 3\%$  of the optimum moisture content and compacted to at least 92% of maximum modified Proctor dry density (ASTM D 1557). Once completed and approved, applicable engineered fill zones and/or structural elements may be placed.

### **6.3 Drilled Pier Foundation Recommendations**

Based on the results of the borings, laboratory testing, and our analysis, we have developed the following design parameters. We recommend all drilled piers bear at least 5 feet into the very stiff/hard lean clay alluvium or claystone bedrock and have a minimum length of 15 feet.

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $0-5$ '	Ignore	Ignore
Lean Clay Fill	300	na
Lean Clay Alluvium	600	6,000
Gypsum	na	na
Claystone Bedrock	1,000	10,000

In designing to resist uplift, <sup>2</sup>/<sub>3</sub> of the allowable side friction values provided for compressive loading could be used along with the effective weight of the drilled shafts. Straight shaft piers with a minimum diameter of 18-inches are recommended. Proper reinforcing steel should be included in the drilled shaft designs.

Lateral deflections of drilled shafts should be evaluated using an appropriate design procedure, and would be dependent on shaft diameter, length, configuration, stiffness and "fixed head" or "free head" conditions.

Single pier lateral load capacity can be estimated using the following design parameters for the soil profile in a p-y analysis such as conducted using the computer program LPILE:

Design Parameter	Lean Clay Fill	Lean Clay Alluvium	Gypsum	Claystone
Moist Unit Weight (pcf)	115	120	na	125
Undrained Shear Strength (psf)	1,000	2,000	na	4,000
Friction Angle (degrees)	18	18	na	15
Static Soil Modulus Parameter, k (pci)	500	500	na	2,000
Strain, <b>ɛ</b> 50 (in/in)	0.005	0.005	na	0.004

Drilling to design depths should be possible with conventional large drilled pier equipment. Difficult drilling should be anticipated where gypsum masses are encountered which may require rock cutting teeth and/or coring in order to advance the drilled pier hole. We highly recommend a separate bid item be provided in the bid documents that addresses drilling through the gypsum.

Care should be taken so that the sides and bottom of the shaft excavations are not disturbed during drilling. The bottom of the shaft excavations should be free of loose material and water when concrete is placed. Concrete should be placed as soon as possible after the foundation excavation is completed to reduce the potential for disturbance of the bearing surface.

Groundwater was encountered at the time of our field work; therefore, the use of temporary casing will likely be required. The need for casing will depend on the conditions encountered at the time the pier excavations are made. A sufficient head of plastic concrete having a minimum slump on the order of 6-8 inches should be maintained inside the casing as it is withdrawn to prevent concrete arching and the influx of soil and water (if encountered) and creation of voids in the pier shaft.

Drilled shaft construction should be constructed in accordance with applicable portions of ACI 336.3R-93 or other similar, approved specification. Concrete mix should be designed utilizing cement to have a minimum 28-day compressive strength of 4,000 psi and a maximum water cement ratio of 0.45. A super plasticizer may be necessary to increase concrete slump/flow temporarily for drilled shaft placement.

Concrete should be on-site and ready for placement as soon as practical after each pier excavation is completed. Concrete placement in pier excavations should occur on the same day as pier excavation is completed.

We do not recommend free-fall concrete placement in piers. The use of a bottom-dump hopper, tremie, or pump, discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

A representative from AET should observe all drilled shaft excavations to evaluate the suitability of the bearing materials and to verify that conditions in the drilled shaft excavations are consistent with those encountered in the test borings. If unsuitable materials are encountered at planned depths, it may be necessary to deepen the shaft.

### 6.4 Spread Footing or Mat Foundation Recommendations

As noted, clay soils are present at the site. In order to limit potentially damaging differential and total movements through moisture variations in the clay soils, we recommend the site clays be removed within the proposed structure footprints to allow for the placement of at least two (2) feet of imported granular low/non-frost susceptible engineered fill below the foundations and/or mats.

Where applicable, excavations should be laterally oversized at a 1H:1V ratio as necessary to accommodate the two (2) feet of granular engineered fill material. Once the over excavation is complete, we recommend the exposed subgrade be scarified to a depth of at least 8-inches, the moisture content of the scarified soils adjusted to  $\pm 3\%$  of the optimum moisture content and the scarified soils compacted to at least 92% of maximum modified Proctor dry density (ASTM D 1557). The excavated site clays may be stockpiled on-site and used as overlot fill outside of the building limits, where required.

<u>Conventional Spread Footing Foundations</u> – Imported granular engineered fill can then be placed within the over-excavations below the foundations. The granular engineered fill should be preapproved by the geotechnical engineer prior to use. The granular engineered fill should be a pit run or crushed/screened material with a maximum aggregate size of 3-inches, no more than 15% passing the #200 sieve with a Liquid Limit less than 25. Engineered fill should be placed in 8inch thick maximum loose lifts; the moisture content conditioned to within  $\pm$ 3% of optimum moisture content and compacted to at least 95% of maximum modified Proctor (ASTM D 1557) dry density.

We recommend exterior footings, interior footings in unheated portions of the building, or footings placed during freezing conditions be placed at least four (4) feet below final grades for frost protection. Interior footings in heated areas may be placed directly below the floor slab (where applicable).

The spread footing foundation system may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf) bearing on the properly placed imported granular engineered fill. As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. Total and differential settlement should not exceed 1 inch and 1/2-inch, respectively.

<u>Mat Foundations</u> – In our opinion, the proposed substation structures can also be supported by a slab-on-grade (mat) foundation system bearing on a zone of compacted select (low frost susceptible) granular engineered fill extending to a depth of at least two (2) feet below the base of the mat. The mat foundation system may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf). As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. Total and differential settlement should not exceed 1 inch and 1/2-inch, respectively.

Lateral loads transmitted to the mat foundation can be resisted by the soil-concrete friction on the base of the foundation. The friction on the base of the concrete and underlying granular engineered fill may be computed using a friction coefficient of 0.45.

# 6.5 Backfill Considerations

It is our opinion exterior backfill around the structures, utility trench backfill and overlot fill may consist of the site soils and should be placed as follows. All recommendations are based on the modified Proctor method (ASTM: D 1557).

- 1. All backfill should be free of deleterious/frozen material and have a maximum aggregate size of 3-inches. Gypsum material, if encountered, should be removed to the extent possible and in no case should fill material contain gypsum fragments greater than 2-inches in nominal size.
- 2. Fill should be moisture conditioned to within  $\pm 3\%$  of optimum moisture content prior to being placed.
- 3. All fill should be placed in loose lift thicknesses of 8-inches or less. If hand-operated compaction equipment is used, the loose lift thickness should be reduced to 4-inches or less.

- 4. Each lift of backfill should be compacted to at least 92% of maximum proctor density. Compaction should be increased to 95% for the final lift of utility trench backfill placed within areas to receive pavement.
- 5. Compaction density tests should be performed on alternating lifts to ensure the minimum density is maintained.

# 7.0 CONSTRUCTION CONSIDERATIONS

### 7.1 Potential Difficulties

Depending on the time of year in which construction takes place, unstable subgrade soils could be encountered during the site and building grading operations. If encountered, additional conditioning of the soils may be required to obtain moisture contents which allow for firm and unyielding subgrade and/or compaction.

Localized areas of soft wet subgrades can be remedied with additional excavation to expose firmer soils, placement of coarse rock to provide a solid base on which to place additional fill and/or the use of geotextiles between the soft soils and the overlying fill and/or pavement sections. The appropriate means of subgrade stabilization should be evaluated by the geotechnical engineer at the time of construction.

## 7.2 Runoff Water in Excavation

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, reduce the potential for soil disturbance, and facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the groundwater can be handled with conventional sump pumping.

## 7.3 Disturbance of Soils

The on-site soils can become disturbed under construction traffic, especially if the soils are wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompacted back into place, or they should be removed and replaced with drier imported fill.

# 7.4 Excavation Backsloping

If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on <u>www.osha.gov)</u>. Even with the required OSHA sloping, water seepage or surface runoff can potentially induce sideslope erosion or running which could require slope maintenance.

# 7.5 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a geotechnical engineer/technician during construction to evaluate these potential changes. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been satisfied.

# **8.0 LIMITATIONS**

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use".



AET Project No. 17-03356

Boring Log Notes Unified Soil Classification System Site Location Map Boring Location Map Subsurface Boring Logs Unconfined Compression Test Results

#### A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling standard penetration test borings. The locations of the borings appear on the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

#### A.2 SAMPLING METHODS

#### A.2.1 Ring-lined barrel Samples - Calibrated to N<sub>60</sub> Values

Standard penetration (ring-lined barrel) samples were collected in general accordance with ASTM: D3550. The ASTM test method consists of driving a 2.5-inch O.D. thick-walled, split-barrel sampler lined with brass rings into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

#### A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

#### A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

#### A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

Visual-manual judgment of the AASHTO Soil Group is also noted as a part of the soil description. A chart presenting details of the AASHTO Soil Classification System is also attached.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

#### A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

#### A.5 LABORATORY TEST METHODS

#### A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

#### A.5.2 Atterberg Limits Tests

Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

#### A.5.3 Sieve Analysis of Soils (thru #200 Sieve)

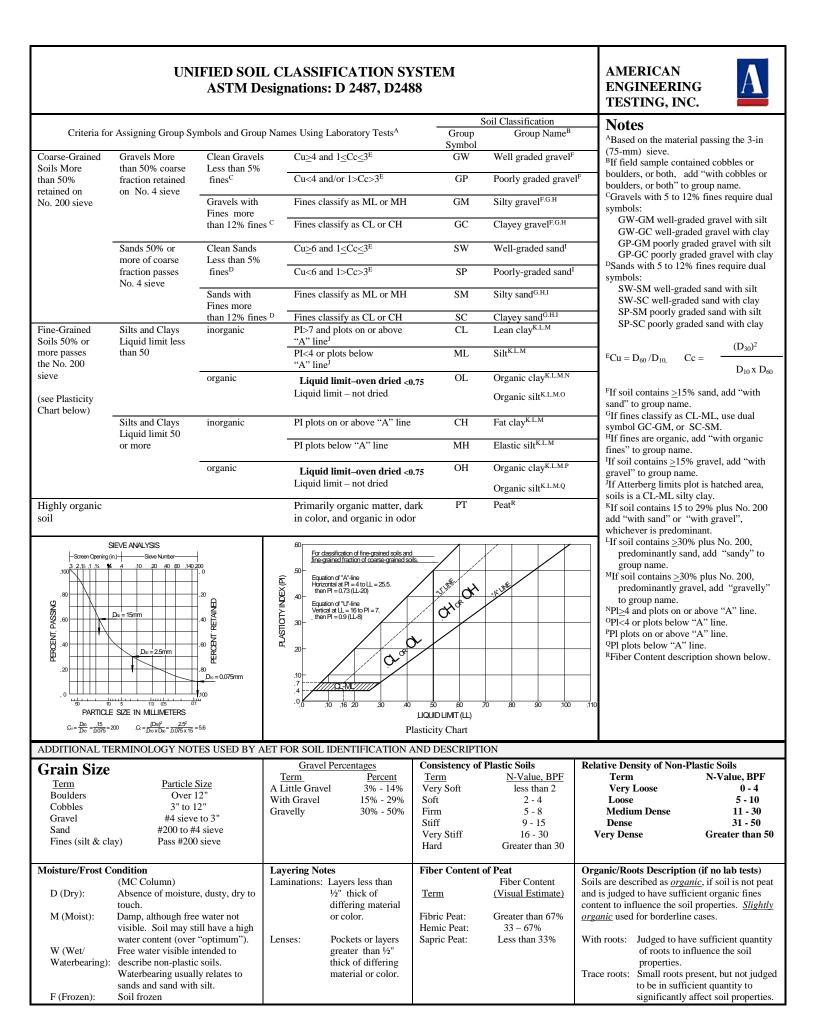
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

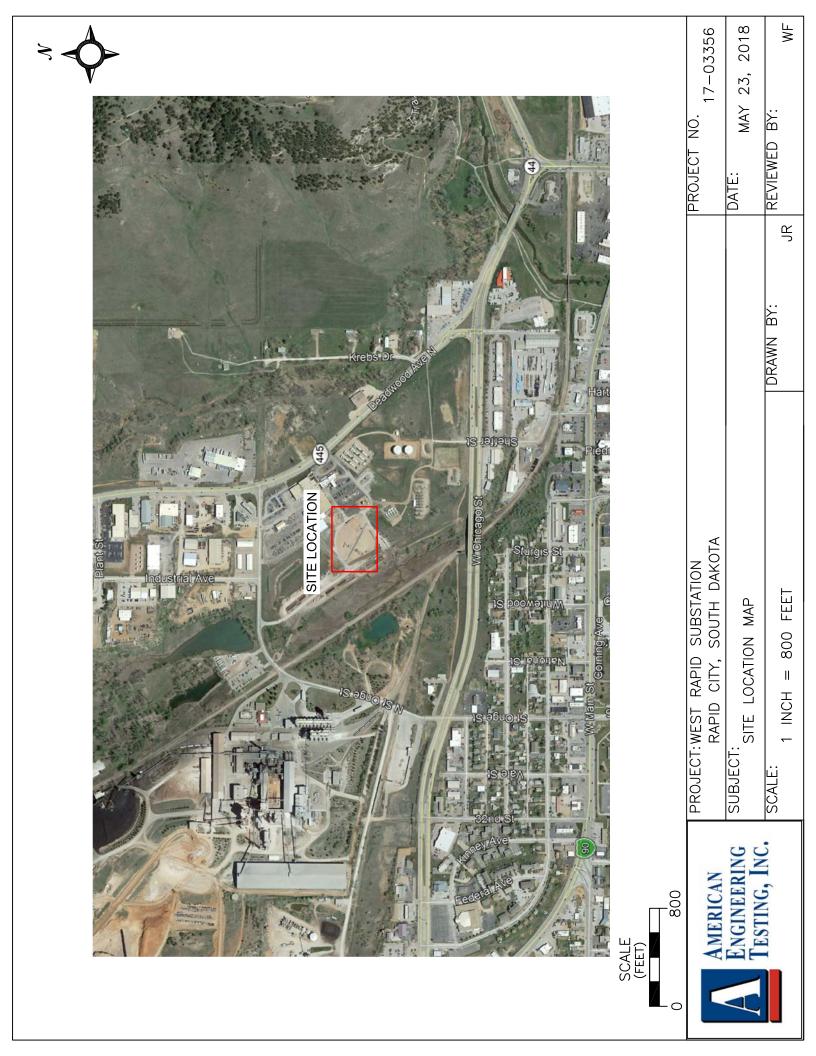
#### A.6 TEST STANDARD LIMITATIONS

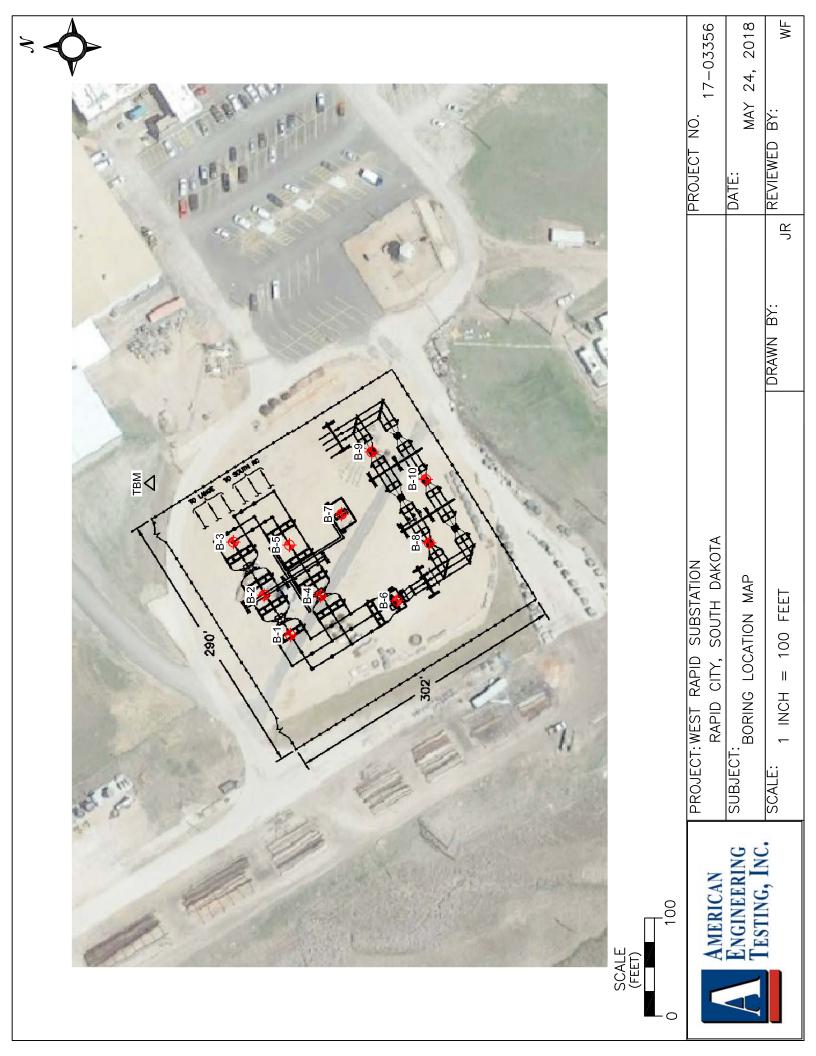
Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

#### A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.









PROJECT: West Rapid Substation; Rapid City, South Dakota         DEPTH IN FEET       SURFACE ELEVATION: 92.6 MATERIAL DESCRIPTION       GEOLOGY       N       MC       SAMPLE REC TYPE       FIELD & LABORATOR         UMESTONE AGGREGATE SURFACING 9 inches       SURFACING FILL, Silty Lean Clay with Sand, reddish brown (CL)       SURFACING FILL       A         4       4       20       M       MC       18       4       4       4         5       6       14       M       MC       18       19       10         8       18       M       MC       18       19       110	PII (ppi
INT       SURFACE ELEVATION:       JAD       GEOLOGY       N       MC       SAMPLE       REC         FEET       MATERIAL DESCRIPTION       ESURFACING       SURFACING       SURFACING       Image: Surface of the second secon	PII (pp) NI
1       9 inches       SURFACING       SURFACING         2       FILL, Silty Lean Clay with Sand, reddish       FILL         3       SURFACING       M         4       20       M         5       M       MC         6       14       M         7       M       MC	- (ppi NI ) NI
1       9 inches         2       FILL, Silty Lean Clay with Sand, reddish         3       -         4       -         5       -         6       -         7       -         14       M         M       MC         18       -         14       M	NI P NI
2 -       FILL, Silty Lean Clay with Sand, reddish         3 -         4 -         5 -         6 -         7 -         14         M<	) NI
$\begin{bmatrix} 3 - & brown (CL) \\ 4 - & & \\ 5 - & & \\ 6 - & & \\ 7 - & & \\ & &$	) NI
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	) NI
$\begin{bmatrix} 5 \\ 6 \\ 7 \\ 7 \\ - \\ 0 \end{bmatrix}$ $\begin{bmatrix} 14 \\ M \\ MC \\ 18 \\ 26 \\ 96 \\ 43 \\ 1 \end{bmatrix}$	
	NI
	NI
11 - 13 M MC 18 20 114	NI
13     SILTY LEAN CLAY with SAND reddish     ALLUVIUM     18     W     MC     18	NI
14 – brown, very stiff to hard, sandstone fragments present (CL)	
$\begin{bmatrix} 15 - \\ 16 - \end{bmatrix}$ present (CL) $\begin{bmatrix} 25 \\ M \end{bmatrix}$ MC 18 $\begin{bmatrix} 18 \\ 18 \end{bmatrix}$	NI
21 – 31 M MC 18	NI
26 – 45 M MC 18	NI
30 - 25 M MC 18	NS
29 -       30 -         31 -       25 M MC 18         Bottom of Boring       25 M MC 18         DEPTH:       DRILLING METHOD         WATER LEVEL MEASUREMENTS       NOTE: RE         30.0       3.25" HSA         DATE       TIME         SAMPLED       CASING         CAVE-IN       DRILLING         WATER       LEVEL         BORING       5/8/18         COMPLETED:       5/8/18	
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS NOTE: RE	FER TC
<b>30.0 3.25" HSA</b> DATE TIME SAMPLED CASING CAVE-IN DRILLING WATER LEVEL THE ATTA	CHED
5/8/18 10:20 31.5 30.0 NA NA 12.5 SHEETS F	OR AN
EXPLANA	ION O
BORING COMPLETED: 5/8/18	OGY O
DR: ES LG: JH Rig: RC-1 THIS I	OG



AET JC	DB NO: <b>17-03356</b>					LC	G OF	BO	RING N	NO	B	- 2	( <b>p.</b> 1	<b>of 1</b> )	)
PROJE	CT: West Rapid Sub	ostation;	Rapid C	City, So	outh Dakot	a									
DEPTH IN	SURFACE ELEVATION:	94.0			GEOLOGY			SA	MPI F	REC	FIELI	<b>) &amp;</b> LA	ABORA	TORY	TES
IN FEET	MATERIAL	DESCRIPTI	ON		GLOLOGI	N	MC		MPLE YPE	IN.	WC	DEN	LL	PL	P (pp
	LIMESTONE AGGREC	GATE SUI	RFACING	;	SURFACING			Ł							
	√10 inches FILL, Silty Lean Clay Sa:	nd raddish	brown	_/ 🞆	FILL	1		ł							
2 -	(CL)	ilu, reduisi	l blown					Ł							
3 -						38	М		MC	18					N
4 -								Ł							
5 —	GYPSUM, white, hard				SPEARFISH	50/.3	М		MC	10					N
6 -	GTT SOWI, white, hard			$\rightarrow -$	FORMATION			И	me	10					11
7 -								Ъ							
8 -		<u></u>		<u>- 0 -</u>		34	М		MC	18	8				N
9 — 10 —	CLAYSTONE, Silty Lear to hard, gypsum lenses pro	n Clay, red esent (CL)	i, very stiff					3							
10	, C) 1 - F-	( -)				20	М		MC	18					N
11 - 12 -								Я							
12 - 13 -							$\square$	¥							
13 – 14 –						50/.4	Ŵ		MC	17	13				N
14 -								$\{$							
15 16 —						NSR	М		MC	0					N
17 -								R							
17 - 18 -								ł							
10 19 —								ł							
20 -								Į							
20						50/.4	М		MC	11					N
21 22 -								R							
22 - 23 -								ł							
24 -								ł							
25 -								Į							
26 –						50/.4	М		MC	11					N
27 —								Ł							
28 -								Į							
29 -								ł							
30 -								ł							
-	Bottom of	Boring				50/.4	M		MC	11					NS
	Bottom of	Doring													
DEP	TH: DRILLING METHOD				ER LEVEL ME								NOTE:	REFE	R T
3	0.0 3.25" HSA	DATE	TIME	SAMPI DEPT	ED CASING H DEPTH	CAV DE	'E-IN PTH	FL	DRILLII UID LE	NG VEL	WATE LEVE	ER EL	THE A	TTAC	HEL
		5/8/18	17:00	30.9	30.0	N	A		NA		13.0	)	SHEET	FS FOI	R AN
						1						H	EXPLA	NATIO	ON C
BORIN COMPI	G Leted: <b>5/8/18</b>											T	ERMIN	IOLOG	GY C
DR: ES								$\square$		+			TH	IS LO	3
03/2011		1	1	1	1	1		1						01-D	JD



AET JC							OG OF	F BO	RING N	IO	B	-3 (	( <b>p.</b> 1	<b>of 1</b> )	)
PROJE	CT: West Rapid Sul	bstation;	Rapid C	'ity, So	uth Dakot	a									
DEPTH IN FEET	SURFACE ELEVATION:	95.2			GEOLOGY	N	MC	SA	MPLE	REC	FIELI	) & LA	BORA	TORY	
FEET	MATERIAL	DESCRIPTI	ON				wie	]	TYPE	IN.	WC	DEN	LL	PL	PI (pp
1 -	LIMESTONE AGGRE	GATE SUI	RFACING	·	SURFACING	_		ß							
$\frac{1}{2}$	√9 inches FILL, Coal, black				FILL			ł							
$\frac{2}{3}$ -				լերեր 1				1							
4 -	GYPSUM, white, hard, si	Itstone len	ses present	t - ♦ -	SPEARFISH	50/.5	Μ		MC	12					N
4 - 5 -			-		FORMATION	ſ		ł							
6 -						50/.5	М		MC	12					N
7 -								R							
8 -				-0-				¥		-					
9 -						50/.5	M		MC	6					N
10 -								1							
11 -						50/.5	Μ		MC	6					N
12 -								Ł							
13 -				- \		50/.3	м	И	MC	4					N
14 —						50/.5	IVI		MC	4					
15 —								5							
16 -						NSR	Μ		MC	0					N
17 —								Ł							
18 -				- \				ł							
19 -				$-\diamond$				Į							
20 -								R							
21 -	CLAYSTONE, Silty Leas	n Clay, red	l, hard,			78/.8	M		MC	16					N
22 —	gypsum lenses present (C	L)						ß							
23 —								ł							
24 —								ł							
25 -						50/2	м	Ł	MC	0					
26 -						50/.2	М		MC	9					N
27 —								ł							
28 -								Į							
29 -								ß							
30 -						50/.3	Μ		MC	10					NS
	Bottom of	Boring													
DEP	TH: DRILLING METHOD			WATE	R LEVEL ME	 ASURI	EMEI	NTS				1	NOTE:	REFE	ER T
2		DATE	TIME	SAMPL DEPTI	ED CASING H DEPTH	CAV	'E-IN PTH	FI	ORILLII UID LE	NG VEI	WATI LEVE	ER	THE A	TTAC	HEI
3	0.0 3.25" HSA	5/9/18	8:30	<b>30.8</b>	30.0		[A		NA	·	Non		SHEET		
		5/7/10	0.00	50.0	50.0		11		11/1		1101	C	XPLA		
BORIN	G LETED: <b>5/9/18</b>												ERMIN		
														IS LO	
DR: ES 3/2011	S LG: JH Rig: RC-1													01-D	



AET JO	DB NO: 17-03356					LC	OG OF	F BO	RING 1	NO	B	- 4	(p. 1	<b>of 1</b> )	)
PROJE	CT: West Rapid Sul	bstation;	Rapid (	City, So	uth Dakot	a									
DEPTH	SURFACE ELEVATION:	93.5			GEOLOGY			SA	MPI F	REC	FIEL	D & L.	ABORA	TORY	TES
DEPTH IN FEET	MATERIAL	DESCRIPTI	ON		GLOLOGI	N	MC		MPLE FYPE	IN.	WC	DEN	LL	PL	P (pp
	LIMESTONE AGGREC	GATE SUI	RFACINO	· _	SURFACING			Ł							
1 -	√10 inches FILL, Silty Lean Clay wi	th Sand re	ddish	_/ 🞆 '	FILL			Ŧ							
2 -	brown (CL)	tii Sand, ite	duisii					1							
3 -						45	М		MC	18					N
4 -	CLAYSTONE, Silty Lear	n Clay red	hard		SPEARFISH	-		Ł							
5 -	(CL)	li Clay, ieu	, naru		FORMATION	55	М		MC	18	8				N
6 -								И		10					
7 -								Y							
8 -						50/.5	Μ		MC	12	7				N
9 -								Ł							
10 -						85/.8	M		MC	16					1
11 -							$\bigtriangledown$	И							
12 -								¥							
13 -						90	W		MC	18	9	119			5
14 -								Ł							
15 -						75/.9	М		MC	17					<
16 -								И		- /					
17 — 18 —								ł							
18 -								ł							
20 -								Į							
20 - 21 -						50	М		MC	18	11				N
21 - 22 - 22 - 22 - 22 - 22 - 22 - 22 -								R							
22 - 23 -								ł							
23								ł							
25 -								1							
26 -	with gypsum lenses					NSR	Μ		MC	0					<
27 -								R							
28 -								H							
29 -								ł							
30 -						50/.3	м	ł	MC	4					NS
Γ	Sampler Refu	sal at 30.3'					1*1								144
		1													
DEP	TH: DRILLING METHOD			1	R LEVEL MEA	-		-					NOTE:	REFE	RT
3	0.0 3.25" HSA	DATE	TIME	SAMPLI DEPTH	ED CASING H DEPTH	CAV DE	/E-IN PTH	FL	DRILLI UID LE	NG VEL	WAT LEVE	ER EL	THE A	TTAC	HEI
		5/9/18	9:50	30.3	30.0		A		NA		12.0		SHEE	FS FOI	R AN
													EXPLA	NATIO	ON C
BORIN	g Leted: <b>5/9/18</b>												ERMI	IOLOG	GY (
DR: ES													TH	IS LO	G
)3/2011	5 10. <b>911</b> Mg. <b>NO-1</b>	1	1	1		1		1						01-D	



# SUBSURFACE BORING LOG

AET JO	DB NO: 17-03356					LC	OG OF	BOI	RING 1	NO	B	- 5	(p. 1	<b>of 1</b> )	)
PROJE	CT: West Rapid Sul	bstation;	Rapid C	City, So	outh Dakot	a									
DEPTH IN	SURFACE ELEVATION:	95.0			GEOLOGY			SA	MPLE	REC	FIEL	D & L.	ABORA	TORY	TEST
FEET	MATERIAL	DESCRIPTI	ON		GLOLOGI	N	MC	Ť	MPLE YPE	IN.	WC	DEN	LL	PL	PI (pp
1	LIMESTONE AGGREC	GATE SUI	RFACINO	´ 💻	SURFACIING	ĩ		Ł							
1 — 2 —	<u>\10 inches</u> FILL, Coal, black			_/ _	FILL			ł							
2 — 3 —	SILTY LEAN CLAY wi	ith SAND 1	reddish		ALLUVIUM	-		1							
	brown, very stiff to hard,	claystone f	fragments			42	Μ		MC	18	26	99			N
4 — 5 —	present (CL)							Ł							
5 – 6 –						35	M		MC	18	19				N
0 – 7 –								Я							
8								Ŀ							
8 9 —						35	M		MC	18					17
9 – 10 –								Ĭ							
10	with gypsum fragments					46	М		MC	18					14
11								R							
12									1.16	10	10				
14 -						17	M		MC	18	18	112			8
15 -								1							
16 -						78	М		MC	18	9	126			N
17 -								R							
18 -								Ħ							
19 —								Ł							
20 -								¥							
21 -	CLAYSTONE, Silty Lear	n Clay, red	l, hard,		SPEARFISH	50/.2	M		MC	9					N
22 —	gypsum lenses present (C	L)			FORMATION			Ł							
23 —								Ħ							
24 —								H							
25 —								ł							
26 —						NSR	M		MC	0					N
27 —								Ł							
28 —								H							
29 —								Ħ							
30 -	Sampler Refu	sal at 30 0'				NSR	M	R	MC	0					NS
	Sampin Itera														
29	TH: DRILLING METHOD			WATE	ER LEVEL ME	ASUR	EMEN						Norr		
			TDAT						RILLI	NG	WAT		NOTE:		
3	30.0 3.25" HSA	DATE	TIME	SAMPL DEPT			/E-IN PTH	FĽ	RILLI JID LE	VEL	WAT] LEVE		THE A		
		5/9/18	12:00	30.0	30.0	N	A		NA		Non		SHEE		
	IC												EXPLA		
COMP	IG LETED: <b>5/9/18</b>											1	TERMIN		
DR: <b>E</b> 03/2011	S LG: JH Rig: RC-1												TH	IS LO	



AET JC							OG OF	BC	ORING N	NO	B	- 6	(p. 1	of 1	)
PROJE	CT: West Rapid Sub	ostation;	Rapid C	City, So	outh Dakot	a									
DEPTH	SURFACE ELEVATION:	92.5			GEOLOGY			SA	AMPI F	REC	FIELI	D & L	ABORA	TORY	TEST
DEPTH IN FEET	MATERIAL	DESCRIPTI	ON		GLOLOGI	N	MC		AMPLE TYPE	IN.	WC	DEN	I LL	PL	PI (ppi
	LIMESTONE AGGREC	GATE SUI	RFACINO	j <u> </u>	SURFACING			R							(ppi
	<u>∖10 inches</u> FILL, Coal, black				FILL			Į							
2 -								Ł							
3 –	SILTY LEAN CLAY wi	th SAND, 1	reddish		ALLUVIUM	55	Μ		MC	18					103
4 -	brown, hard, claystone and present (CL)	u gypsum	fragments					Ł							
5 -						50/.5	M		MC	12	12				17
6 -						507.5	141	Þ	wie	12	12				17
7 -								¥							
8 — 9 —						40	Μ		MC	18	12	119			16
9 – 10 –								3							
10						66	М		MC	18					33
11 - 12 -								R		-					
12								Ľ							
14 -						50/.5	M		MC	6	11				13
15 -								Ĭ							
16 -	CLAYSTONE, Silty Lean	n Clav witl	h Sand.		SPEARFISH	50/.4	M		MC	11					<
17 -	red, hard, gypsum lenses p	present (CI	L)		FORMATION	1		Ł							
18 -								H							
19 -								ł							
20 -								ł							
21 -						50/.4	Μ		MC	11					NI
22 -								Ł							
23 —								Į							
24 -								H							
25 -								Į							
26 -						NSR	Μ		MC	0	9	115			<
27 —								ł							
28 —								ł							
29 —								ł							
30 -						50/.3	M	Н	MC	10					NS
-	Bottom of	Boring													
DEP	TH: DRILLING METHOD			WATF	R LEVEL ME	ASUR	L EME	۱ NTS			1		NOTE:	рггг	
		DATE	TIME					-		NG	WATI				
3	0.0 3.25" HSA	DATE		SAMPL DEPT			/E-IN PTH	FĹ	DRILLI UID LE	VEL	WATI LEVE		THE A		
		5/9/18	13:15	30.8	30.0	N	A		NA		Non		SHEE		
BODIN	G					-							EXPLA		
	G Leted: <b>5/9/18</b>					-						1^1	TERMIN		
DR: ES	S LG: JH Rig: RC-1												TH	1IS LO $0$	G



# SUBSURFACE BORING LOG

AET JC	DB NO: <b>17-03356</b>					LC	OG OF	F BC	RING N	NO	B	- 7	(p. 1	of 1)	)
PROJE	CT: West Rapid Sub	ostation;	Rapid C	ity, So	outh Dakot	a									
DEPTH IN FEET	SURFACE ELEVATION:	94.1			GEOLOGY	N	MC	SA	AMPLE FYPE	REC	FIELI	D & LA	ABORA	TORY	
FEET							MC		ГҮРЕ	IN.	WC	DEN	LL	PL	PII (ppn
1 -	LIMESTONE AGGREC	GATE SUI	RFACING	_	SURFACING	-		Į							
2 -	FILL, Coal, black				FILL			Ľ							
3 -				11111		69	М		MC	18					NE
4 -	FILL, Silty Lean Clay with brown, gypsum fragments	th Sand, re	ddish			09	101	R	WIC	10					INL
5 —	brown, gypsum nagments	s present (C	-L)					ŀ							
6 -		~				17	Μ		MC	18					74
7 —	GYPSUM, white, hard to	firm			SPEARFISH FORMATION	J		ł							
8 -						50/.3	М		MC	10					115
9 —				$\left[-\diamond\right]$				ł							
10 -							$  \bigvee_{\mathbf{W}}$		MG	10					100
11 -	CLAYSTONE, Silty Lean	n Clay, red	l, very stiff			6	W		MC	18					120
12 -	to hard, gypsum lenses pro	esent (CL)	, <b>,</b>					1							
13 -						22	М		MC	18					195
14 -								Ł							
15 —						48	М	И	MC	18					147
16 -							111	R	WIC	10					17/
17 -								ł							
18 -								Į							
19 -								Į							
20 -						50/.4	M		MC	11					58
21 -								И							
22 - 23 -								ł							
23 - 24 -								ł							
25 -								Į							
26 -						50/.4	M		MC	5					NSI
20								ł							
28 -								Į.							
20								ł							
30 -						50/3	М	ł	MC	4					NSI
	Sampler Refus	sal at 30.3'													
DEP	TH: DRILLING METHOD			WATE	R LEVEL ME	ASUR	L EMEN					   .		DEFE	
		DATE	TIME	SAMPL		CAV	Æ-IN	I	ORILLI	NG	WATI	ER	NOTE: THE A		
29 – 30 – DEP 30	0.0 3.25" HSA					DE	РТН	FL	UID LE	EVEL	LEVE	EL	SHEE		
		5/9/18	14:25	30.3	30.0		A	-	NA		10.5		EXPLA		
BORIN	G												ERMI		
	LETED: <b>5/9/18</b>											1		IS LOC	
DR: E	S LG: JH Rig: RC-1														

01-DHR-060



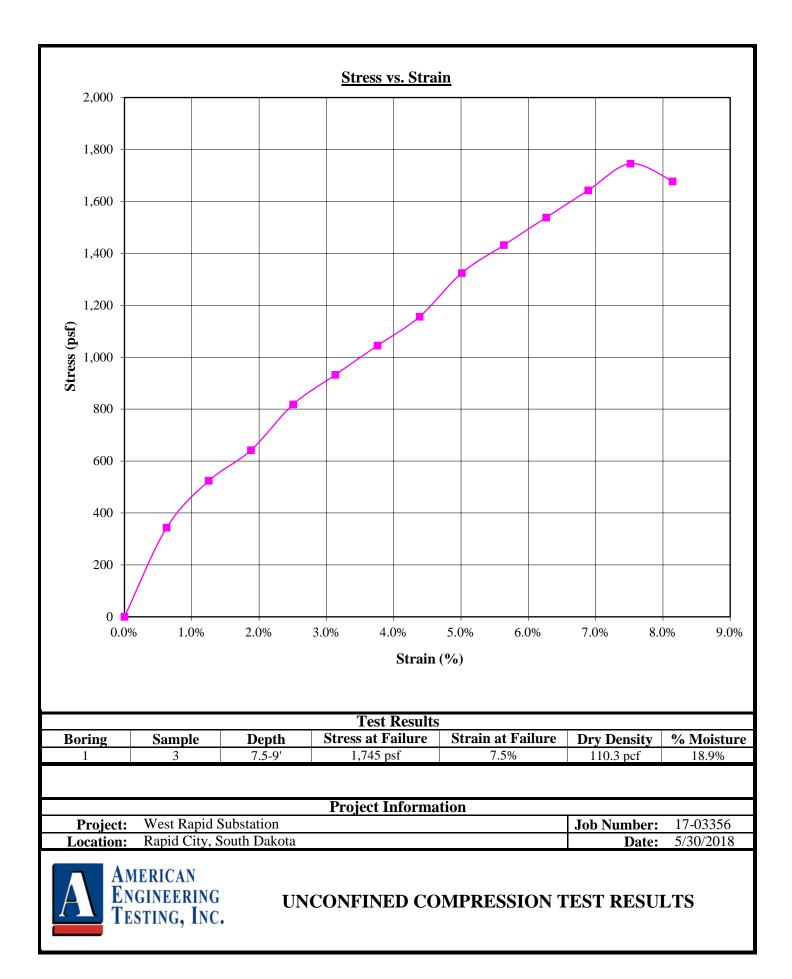
PROJE										NO			<b>U</b> <sup>2</sup>	<b>of 1</b>	/
	West Rapid Su	bstation;	Rapid C	City, So	uth Dakot	a									
DEPTH IN	SURFACE ELEVATION:	92.5			GEOLOGY			SA	MDI E	REC	FIELI	D & LA	ABORA	TORY	TEST
IN FEET	MATERIAL	DESCRIPTI	ON		GEOLOGI	N	MC	T	MPLE YPE	IN.	WC	DEN	LL	PL	PI (pp
	LIMESTONE AGGREO	GATE SU	RFACINO	·	URFACING			रि							
	√9 inches FILL, Coal, black			_/ 🛓 F	TILL	]		Ħ							
2 -								Ł							
3 -	<b>FILL</b> , Silty Lean Clay wi brown to dark brown, gyp					50/.5	М		MC	6					NS
4 -	coal fragmnets present (C	L)	sione, and					Ł							
5 —						10	М	И	MC	18	16	100			N
6 -						10	IVI		WIC	10	10	100			111
7 -	-							1							
8 -	CLAYSTONE, Silty Lea	n Clay wit	h Sand,		PEARFISH	61	М		MC	18	8	131			N
9 -	red, hard, gypsum lenses	present (CI	L)		ORMATION	1		Ł							
10 -						50/.5	М		MC	12					5
11 -								И							
12 -								1							
13 -						50/.4	М		MC	11	14				1
14 -								Ł							
15 — 16 —						50/.3	М		MC	10	11				NS
10 -								R							
17 - 18 -								ł							
19 -								ł							
20 -								Į							
20						50/.2	М		MC	3					NS
22 -								R							
23 -								H							
24 -								ł							
25 -								Į							
26 -						NSR	М		MC	0					N
27 —	-							R							
28 —	-							Ħ							
29 —								¥.							
30 -						50/.2	M	¥	MC_	_3_					NS
	Sampler Refu	sal at 30.2'													
DEI															
29	PTH: DRILLING METHOD				R LEVEL ME			-			WAT		NOTE:		
3	30.0 3.25" HSA	DATE	TIME	SAMPLE DEPTH	D CASING DEPTH	CAV DEI	E-IN PTH	FLU	ORILLII UID LE	VEL	WATI LEVE	ER EL	THE A	TTAC	HEL
		5/9/18	15:50	30.2	30.0	N	A		NA		Non	e	SHEE	FS FOI	R AN
												I	EXPLA	NATIO	ON C
BORIN COMP	NG LETED: <b>5/9/18</b>											T	ERMI	NOLO	GY C
	S LG: JH Rig: RC-1												TH	IS LO	G

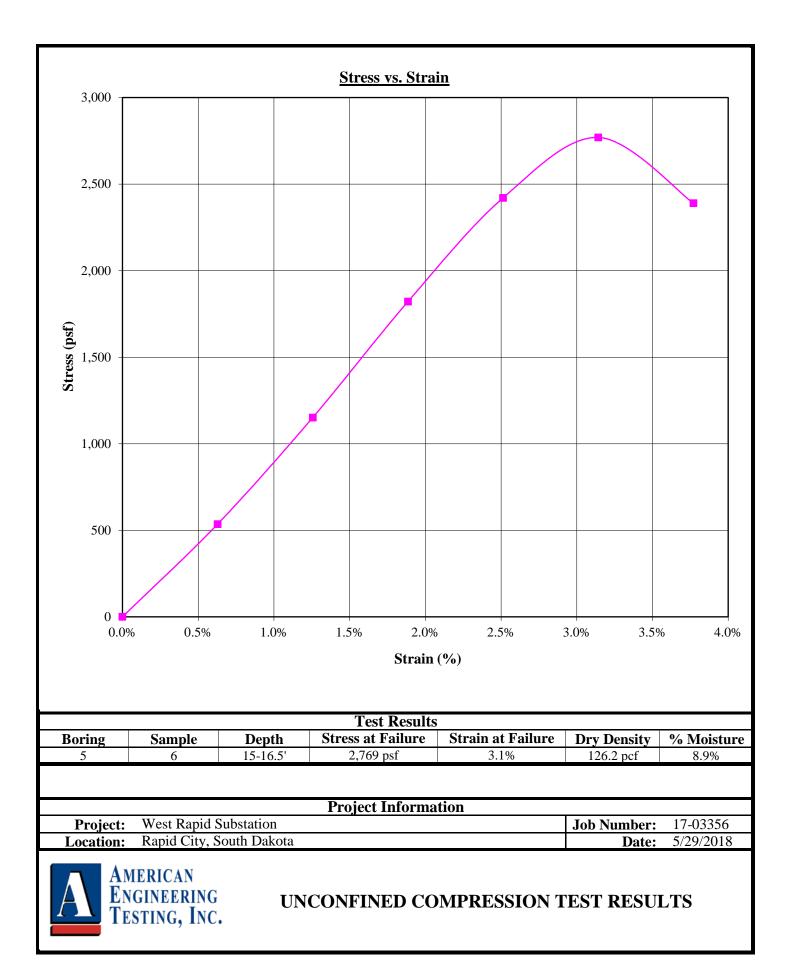


AET JOB NO: <b>17-03356</b>	_				LC	OG OF	F BO	RING N	10	B	-9	( <b>p.</b> 1	<b>of 1</b> )	)
PROJECT: West Rapid	Substation;	Rapid C	City, Sou	th Dakot	a									
DEPTH SURFACE ELEVATIO	N: 95.1			GEOLOGY			SA	MPLE	REC	FIELI	D & LA	BORA	TORY	TESTS
FEET MATERI	AL DESCRIPTI	ION			N	MC		MPLE TYPE	IN.	WC	DEN	LL	PL	PIE (ppn
LIMESTONE AGGE	REGATE SU	RFACING	´	JRFACING			ł							
1 - 10  inches $2 - FILL, Silty Lean Clay$	. reddish brov	wn to	_/ 💥 FI	LL			ł							
3 -  brown, gypsum and co	al fragments	present (CI	L) 🎆 –				Γl		10					
4 -					53	Μ		MC	18	19	103			14
5 -							1							
6 -					28	М		MC	18					5
7 —							Ł							
8 -					16	М		MC	18	26	99	46	25	76
9 —							И							
10 -							¥							
11 -					10	М		MC	18					<1
12 -							1							
13 SILTY LEAN CLAY			Al	LLUVIUM	20	М		MC	18	23	99			37
14 - very stiff, gypsum and present (CL)	claystone fra	gments					Ł							
15					10	М	И	MC	18					NSF
16 -					10	111	И	wie	10					1151
17 -							ł							
18 - 19 -							Ł							
20 -							Į							
					14	М		MC	18					<1
22 -							Ł							
23 -							Ħ							
24 -							H							
25 -							ł							
26 – CLAYSTONE, Silty I	ean Clay, rec	d, hard,			50/.4	М		MC	11					<1
27 – gypsum lenses present	(CL)		<b>F</b>	ORMATION			3							
28 -							ł							
29 -							ł							
$\frac{2}{5}$ 30 – Sampler R	efusal at 30.3	1			50/.3	M	R	MC_	4					NSI
	-10301 at 50.5													
DEPTH: DRILLING METHO	D		WATER	LEVEL MEA	ASUR	EMEN	VTS			·		NOTE:	REFE	R TO
	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAV	'E-IN PTH	FL.	DRILLII UID LE	NG VEL	WATI LEVE	ER	THE A	TTAC	HED
30.0 3.25" HSA	5/9/18	6:45	30.3	<b>30.0</b>		A		NA	,	Non		SHEE	ГS FOI	R AN
		5.10						1 1/ 1	$\rightarrow$	1,01		EXPLA	NATIO	ON OF
29 – 30 – Sampler R DEPTH: DRILLING METHO 30.0 3.25" HSA BORING COMPLETED: 5/9/18											T	ERMIN	IOLOG	GY ON
$\frac{1}{4}  \text{DR: } \mathbf{ES}  \text{LG: } \mathbf{JH}  \text{Rig: } \mathbf{RC-1}$									$\square$			TH	IS LO	G
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AET JC	DB NO: <b>17-03356</b>					LC	OG OF	F BO	RING	NO	B	-10	(p. 1	of 1	)
PROJE	CT: West Rapid Sul	bstation;	Rapid C	City, S	outh Dakot	a									
DEPTH	SURFACE ELEVATION:	GEOLOGY	N		SA	MPLE	REC	FIEL	D & L.	ABORATORY 1		TEST			
DEPTH IN FEET	MATERIAL			MC		MPLE TYPE	IN.	WC	DEN	LL	PL	PI (ppi			
1	LIMESTONE AGGRE	GATE SU	RFACINO	j	SURFACING			Ł							
1	<u> 10 inches</u> FILL, Silty Lean Clay, re	ddish brov	vn	_/ 🗱	FILL			ł							
3 - 3	claystone, gypsum and co	al fragmen	its present					1							
3 – 4 –	(CL)					NSR	. M		MC	0	21				NI
4 5 —								3							
6 -						42	М		MC	18	13				NS
7 -								Ł							
8 —						10	M	И	MC	10	15				NG
9 —						18	M		MC	18	15				NS
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11 -	SILTY LEAN CLAY, re- very stiff, claystone and g	ddish brow	n, stiff to		ALLUVIUM	12	Μ		MC	18	21	112			<1
12 —	present (CL)	, r						Ł							
13 —						16	M		MC	18					11
14 —								Р							
15 —	CLAYSTONE, Silty Lea	n Clav red	l hard		SPEARFISH	-	<u> </u>	¥							
16 —	gypsum lenses present (C	L)	, nuru,		FORMATION	61	W		MC	18					NI
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18 —								ł							
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20 -						53	M	E	MC	18	12	125			NI
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$\frac{27}{28}$ -								H							
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30 -		1 4 20 0						ł							<u> </u>
	Sampler Refu	sal at 30.0				NSR	M		MC	0					NS
29 – 30 – DEP	TH: DRILLING METHOD				ER LEVEL ME.				יי דוסר	NG	<b>W</b> 7 A T		NOTE:		
3	0.0 3.25" HSA	3.25" HSA         DATE         TIME         S           5/9/18         17:30         5         17:30         5		SAMPI DEPT	LED CASING H DEPTH	CAVE-IN DEPTH		N DRILLING H FLUID LEVEL			WATER LEVEL		THE ATTACHED		
				30.0	) 30.0	N	NA		NA		15.0		SHEETS FOR AN		
	2												EXPLA		
BORIN COMPI	G LETED: <b>5/9/18</b>											]	ERMIN		
DR: E	S LG: JH Rig: RC-1												TH	(IS LO	





# **Appendix B**

Geotechnical Report Limitations and Guidelines for Use

#### REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE<sup>1</sup>, of which, we are a member firm.

#### **RISK MANAGEMENT INFORMATION**

#### Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. No one, not even you, should apply the report for any purpose or project except the one originally contemplated.

#### **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

#### A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

#### Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

1 ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910 Telephone: 301/565-2733 : <u>www.asfe.org</u>

#### Most Geotechnical Findings Are Professional Opinions

Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

#### A Report's Recommendations Are Not Final

Do not over rely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

#### A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

#### Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

#### **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need to prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

#### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

#### **Geoenvironmental Concerns Are Not Covered**

The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.



December 5, 2018

Black Hills Energy 7001 Mt. Rushmore Road Rapid City South Dakota 57702

Attn: Ron Williams, PE

Subject: Investigative Borings – Proposed West Rapid Substation Rapid City Service Center Deadwood Avenue Rapid City, South Dakota AET Project No. 17-03356

Dear Ron,

As you are aware, AET recently completed the geotechnical services for the proposed West Rapid Substation project, and submitted our findings and recommendations in our Report No. 17-03356, dated May 31, 2018.

As requested, a total of forty-three (43) investigative auger borings were drilled at locations selected by DGR Engineering; thirty-eight (38) borings were drilled to depths of about 18 feet below grade and five (5) borings were drilled to depths of about 30 feet below grade. The boring location map, borings logs, and boring coordinate sheet are included at the end of this transmittal letter.

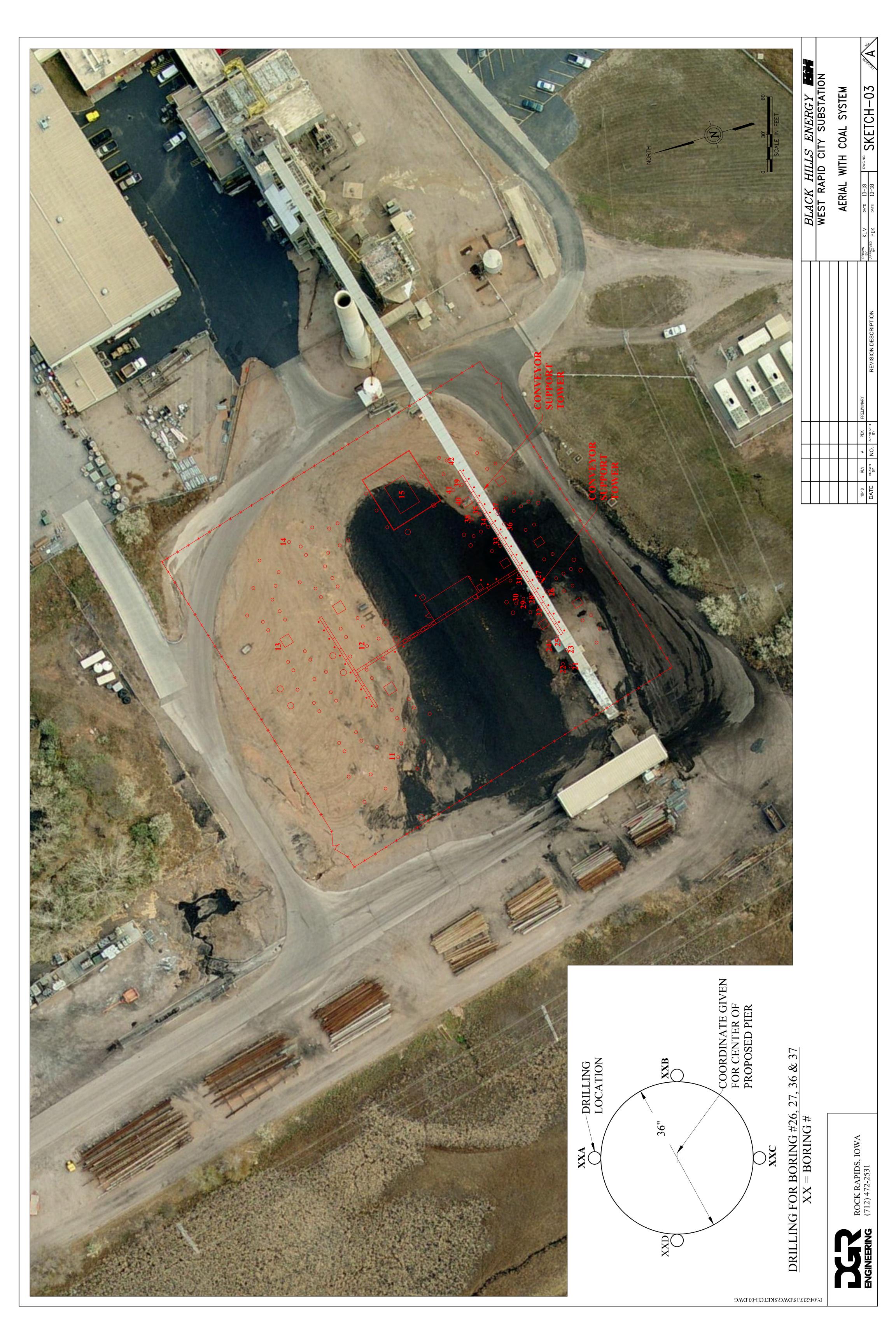
If you have any questions or we can be of further service, please contact our office at (605) 388-0029.

Sincerely, American Engineering Testing, Inc.

Walt Feeger, P.E. Senior Geotechnical Engineer

Robert Temme, P.E. Vice President Western Region

Attachments: Boring Location Map Coordinates Sheet Boring Logs



West Rapid City Substation Boring Location Coordinates Rev. 11-02-18

Boring #	Boring Location(s)	Depth	Northing	East	ting	Notes:
1	Geotech Report Boring B-1					
2	Geotech Report Boring B-2					
3	Geotech Report Boring B-3					
4	Geotech Report Boring B-4					
5	Geotech Report Boring B-5					
6	Geotech Report Boring B-6					
7	Geotech Report Boring B-7					
8	Geotech Report Boring B-8					
9	Geotech Report Boring B-9					
10	Geotech Report Boring B-10					
11	Additional for Geotech Report	30'	652883.8174	4	1198680.209	44.0873440°, -103.2638968°
12	Additional for Geotech Report	30'	652908.838	1	1198769.636	44.0874213°, -103.2635600°
13	Additional for Geotech Report	30'	652973.308	7	1198773.754	44.0875984°, -103.2635530°
14	Additional for Geotech Report	30'	652971.471	5	1198853.095	44.0876011°, -103.2632509°
15	Additional for Geotech Report	30'	652881.204	1	1198892.338	44.0873574°, -103.2630896°
21	Center of proposed pier	18'	652745.424	4	1198753.2	44.0869717°, -103.2636006°
22	Center of proposed pier	18'	652751.47		1198755.298	44.0869885°, -103.2635934°
23	Center of proposed pier	18'	652748.970		1198766.331	44.0869827°, -103.2635511°
24	Center of proposed pier	18'	652757.797		1198771.625	44.0870074°, -103.2635321°
25	Center of proposed pier	18'	652755.894		1198777.317	44.0870027°, -103.2635102°
26	Center of proposed pier	N/A	652764.396		1198813.327	44.0870295°, -103.2633744°
26A	N Quadrant of proposed 36" φ pier	18'	N/A	N/A	L .	
26B	S Quadrant of proposed 36" $\phi$ pier	18'	N/A	N/A		
26C	E Quadrant of proposed 36" φ pier	18'	N/A	N/A		
26D	W Quadrant of proposed 36" φ pier	18'	N/A	N/A		
27	Center of proposed pier	N/A	652769.727	5	1198821.788	44.0870450°, -103.2633429°
27A	N Quadrant of proposed 36" φ pier	18'	N/A	N/A	L Contraction of the second seco	
27B	S Quadrant of proposed 36" φ pier	18'	N/A	N/A	L.	
27C	E Quadrant of proposed 36" φ pier	18'	N/A	N/A	L.	
27D	W Quadrant of proposed 36" φ pier	18'	N/A	N/A	L .	
28	Center of proposed pier	18'	652777.217	3	1198811.159	44.0870645°, -103.2633844°
29	Center of proposed pier	18'	652783.139	8	1198807.428	44.0870803°, -103.2633994°
30	Center of proposed pier	18'	652789.062	2	1198803.696	44.0870962°, -103.2634144°
31	Center of proposed pier	18'	652786.812	7	1198826.389	44.0870922°, -103.2633277°
32	Center of proposed pier	18'	652770.820	4	1198801.006	44.0870459°, -103.2634221°
33	Center of proposed pier	18'	652801.738	7	1198850.078	44.0871355°, -103.2632396°
34	Center of proposed pier	18'	652811.334	1	1198865.308	44.0871633°, -103.2631830°
35	Center of proposed pier	18'	652817.73	1	1198875.46	44.0871818°, -103.2631452°
36	Quadrants of proposed 36" φ pier		652798.513	5	1198867.476	44.0871283°, -103.2631730°
36A	N Quadrant of proposed 36" φ pier	18'	N/A	N/A		
36B	S Quadrant of proposed 36" φ pier	18'	N/A	N/A		
36C	E Quadrant of proposed 36" φ pier	18'	N/A	N/A		
36D	W Quadrant of proposed 36" φ pier	18'	N/A	N/A		
37	Quadrants of proposed 36" $\phi$ pier		652803.844		1198875.936	44.0871437°, -103.2631416°
37A	N Quadrant of proposed 36" φ pier	18'	N/A	N/A		
37B	S Quadrant of proposed 36" φ pier	18'	N/A	N/A		
37C	E Quadrant of proposed 36" φ pier	18'	N/A	N/A		
37D	W Quadrant of proposed 36" φ pier	18'	N/A	N/A		
38	Center of proposed pier	18'	652824.499		1198871.196	44.0871999°, -103.2631624°
39	Center of proposed pier	18'	652832.657		1198899.15	44.0872026°, -103.2630560°
40	Center of proposed pad	18'	652828.561		1198885.151	44.0872124°, -103.2631098°
41	Center of proposed pier	18'	652839.425		1198894.886	44.0872431°, -103.2630743°
42	Center of proposed pier	18'	652844.923	5	1198918.624	44.0872605°, -103.2629847°



AET JO	OB NO: <b>17-03356</b>					LC	OG OF	BORING N	NO	B	-11 (	( <b>p.</b> 1	of 1	)
PROJE	ECT: West Rapid Sul	bstation;	Rapid (	City, S	outh Dakot	a								
DEPTH	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE	REC	FIEL	D & LA	BORA	TORY	TESTS
DEPTH IN FEET	MATERIAL	DESCRIPTI	ON			N	MC	SAMPLE TYPE	ĪN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGRE(	GATE SUI	RFACIN	;	SURFACIING									
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	_/ 🞆	FILL									
3 -	brown (CL)	,												
4 -	FILL, Gypsum boulder													
5 -	FILL, Silty Lean Clay, re	ddish brow	/n (CL)											
6 -	-													
7 -	-													
8 -	-						М							
9 -	-						IVI							
10 -	-													
11 -	-													
12 -	-													
13 -	_													
14 -														
15 -	SILTY LEAN CLAY, re	d-brown (C	CL)		ALLUVIUM									
16 - 17 -							$\square$							
17 - 18 -														
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26 -	-													
27 -														
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29 -	-													
29 – 30 – DEF BORIN COMP	Bottom of	Boring		////	1									
		1												
DEF	PTH: DRILLING METHOD			WAT	ER LEVEL MEA			TS			1	NOTE:	REFE	R TO
	30.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRILLI FLUID LE	NG VEL	WAT LEVI	ER EL	THE A	TTAC	HED
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3												XPLA	NATIO	ON OF
BORIN	NG PLETED: 11/27/18											ERMIN	IOLOG	GY ON
$DR: \mathbf{B}$												TH	IS LOO	3
	- 20.000 100.0001	1	1	1		I		1						



PROJECT: West Rapid Substation; Rapid City, South Dakota  POINT SURFACE ELEVATION: MATERIAL DESCRIPTION GEOLOGY N MC SMPLE REF INTERNATION FEE GYPSUM, white GYPSUM, white CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  GYPSUM, white GYPSUM	f 1)
N     SCRACE LEVATION       MATERIAL DESCRIPTION     MATERIAL DESCRIPTION       LIMESTONE AGGREGATE SURFACING GYPSUM, white     SURFACING SURFACING GYPSUM, white       -     -       - <t< th=""><th></th></t<>	
LIMESTONE AGGREGATE SURFACING 10 inches 3 - 4 - 5 - 6 - 7 - 8 - CLAYSTONE, Silty Lean Clay, red, gypsum 9 - lenses and laminations present (CL) 11 - 12 - 13 - 14 - 15 - 16 - 17 - CLAYSTONE, Silty Lean Clay, red, gypsum 19 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - CLAYSTONE, Silty Lean Clay, red, gypsum 19 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - CLAYSTONE, Silty Lean Clay, red, gypsum 10 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - CLAYSTONE, Silty Lean Clay, red, gypsum 10 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - CLAYSTONE, Silty Lean Clay, red, gypsum 10 - 10 - 1	RY TES
10 inches     SPEARPISH       2     GYPSUM, white       3     Q       4     Q       5     Q       6     Q       7     Q       8     CLAYSTONE, Silty Lean Clay, red, gypsum       10     M       11     Q       12     Q       13     Q       14     Q       15     Q       16     Q       17     GYPSUM, white       18     Q       19     CLAYSTONE, Silty Lean Clay, red, gypsum       10     Q       12     Q       13     Q       14     Q       15     Q       16     Q       17     GYPSUM, white       18     Q       19     CLAVSTONE, Silty Lean Clay, red, gypsum       10     Q       12     Q       23     Q       24     Q       25     Q       26     Q       27     Q       28     Q       29     Q       30     Bottom of Boring	PL %-#2
2 - GYPSUM, white     →     →     →       3	
CLAYSTONE, Silty Lean Clay, red, gypsum enses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum enses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum Lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum Lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum Lenses and laminations present (CL)  CLAYSTONE, Silty Lean Clay, red, gypsum Lenses and laminations present (CL)  CLAYSTONE, Silty Lea	
5     -       6     -       7     -       8     CLAYSTONE, Silty Lean Clay, red, gypsum       10     -       11     -       12     -       13     -       14     -       15     -       16     -       17     GYPSUM, white       18     -       19     CLAYSTONE, Silty Lean Clay, red, gypsum       19     CLAYSTONE, Silty Lean Clay, red, gypsum       19     -       20     -       21     -       22     -       23     -       24     -       25     -       26     -       27     -       28     -       29     -       30     Bottom of Boring	
6     7       8     CLAYSTONE, Silty Lean Clay, red, gypsum       9     lenses and laminations present (CL)       10     M       11     M       12     M       13	
7   8   CLAYSTONE, Silty Lean Clay, red, gypsum   10   11   12   13   14   15   16   17   GYPSUM, white   19   CLAYSTONE, Silty Lean Clay, red, gypsum   19   CLAYSTONE, Silty Lean Clay, red, gypsum   10   12   13   14   15   16   17   GYPSUM, white   18   19   CLAYSTONE, Silty Lean Clay, red, gypsum   10   10   11   20   11   21   22   23   24   25   26   27   28   29   30   Bottom of Boring	
7   8   CLAYSTONE, Silty Lean Clay, red, gypsum   10   11   12   13   14   15   16   17   GYPSUM, white   18   19   CLAYSTONE, Silty Lean Clay, red, gypsum   10   11   12   13   14   15   16   17   GYPSUM, white   10   12   13   14   15   16   17   GYPSUM, white   18   19   CLAYSTONE, Silty Lean Clay, red, gypsum   10   10   11   12   13   14   15   16   17   GYPSUM, white   10   10   11   12   13   14   15   15   16   16   17   18   19   10   10   10   11   12   12   13   14   15   16   17   18   19   10   10   10   11   12   12   14   15   16   17   18	
8       CLAVSTONE, Silty Lean Clay, red, gypsum         10       Insest and laminations present (CL)         11       Insest and laminations present (CL)         12       Insest and laminations present (CL)         13       Insest and laminations present (CL)         14       Insest and laminations present (CL)         15       Insest and laminations present (CL)         16       Insest and laminations present (CL)         17       CLAVSTONE, Silty Lean Clay, red, gypsum         18       Insest and laminations present (CL)         19       CLAVSTONE, Silty Lean Clay, red, gypsum         20       Insest and laminations present (CL)         21       Insest and laminations present (CL)         22       Insest and laminations present (CL)         23       Insest and laminations present (CL)         24       Insest and laminations present (CL)         30       Bottom of Boring         30       Bottom of Boring	
10       Image: Second s	
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13     -       14     -       15     -       16     -       17     GYPSUM, white       18     -       19     CLAYSTONE, Silty Lean Clay, red, gypsum       20     -       21     -       22     -       23     -       24     -       25     -       26     -       27     -       28     -       29     -       30     Bottom of Boring	
14       -	
15       -         16       -         17       GYPSUM, white         18       -         19       CLAYSTONE, Silty Lean Clay, red, gypsum         20       -         21       -         22       -         23       -         24       -         25       -         26       -         27       -         28       -         29       -         30       Bottom of Boring	
16     GYPSUM, white       19     CLAYSTONE, Silty Lean Clay, red, gypsum       19     CLAYSTONE, Silty Lean Clay, red, gypsum       20     lenses and laminations present (CL)       21	
17     GYPSUM, white       18     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       19     CLAYSTONE, Silty Lean Clay, red, gypsum       20     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       21     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       22     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       23     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       24     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       25     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       26     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       27     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       28     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       30     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       31     Image: CLAYSTONE, Silty Lean Clay, red, gypsum       32     Image: CLAYSTONE, Silty Lean Clay, red, gypsum	
18       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         20       lenses and laminations present (CL)         21       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         21       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         22       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         23       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         24       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         25       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         26       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         26       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         27       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         28       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         30       Image: CLAYSTONE, Gypsum         31       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         32       Image: CLAYSTONE, Gypsum         33       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         34       Image: CLAYSTONE, Gypsum         35	
19       CLAYSTONE, Silty Lean Clay, red, gypsum         20       lenses and laminations present (CL)         21	
20 -  lenses and laminations present (CL) $21 - 22 - 23 - 24 - 25 - 26 - 27 - 28 - 29 - 30 - Bottom of Boring$ $W W W W W W W W W W W W W W W W W W W$	
22 - 23 - 24 - 25 - 26 - 27 - 28 - 29 - 30 Bottom of Boring	
23 - 24 - 25 - 26 - 27 - 28 - 29 - 30 Bottom of Boring	
24 -       25 -         26 -       27 -         28 -       29 -         30       Bottom of Boring	
25 -     26 -       27 -     28 -       29 -     30       Bottom of Boring	
26     27     W     W       28     29     W     W       30     Bottom of Boring     W     W	
27 - 28 - 29 - 30 Bottom of Boring Bottom of	
28 -     29 -       30     Bottom of Boring	
29 -     30     Bottom of Boring	
30 Bottom of Boring	
Bottom of Boring	
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS	
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS	
DATE TIME SAMPLED CASING CAVE-IN DRILLING WATER THE AT	
	FOR AN
EXPLAN	TION C
BORING COMPLETED: 11/27/18	LOGY C
DR: BT LG: JR Rig: RC-1	LOG



AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORING 1	NO	B	-13	(p. 1	of 1	)
PROJE	CT: West Rapid Sul	bstation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	ABORA	TORY	TESTS
FËET								ТҮРЕ	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREC	GATE SUI	RFACING	; / 🔜	SURFACIING									
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	-/ 🞆	FILL									
3 -	brown (CL)													
4														
5 —	GYPSUM, white				SPEARFISH									
6 -	GIISUNI, WINC				FORMATION									
7 —	_													
8 -	CLAYSTONE, Silty Lea	n Clav. red	. gypsum	<u> </u>										
9	lenses and laminations pro	esent (CL)	, 87 P <sup>3</sup>											
10 -														
11 -														
12 -														
13 -														
14 -														
15 -							M							
16 -	_													
17 -														
18 -														
19 -														
20 - 21 - 21 - 21 - 21 - 21 - 21 - 21 -														
21 - 22 -	color grading to reddish b	rown												
22 23 -														
24 -														
25 -														
26 -														
27 -	-													
28 -	-													
29 -														
30 -	Bottom of	Boring												
	Dottoin of	Doring												
DEP	PTH: DRILLING METHOD			WAT	ER LEVEL MEA	SUR	L EMEN	ITS				NOTE:	DEEE	
		DATE	TIME	SAMPI DEPT		CAV	/E-IN	DRILLI	NG	WAT	ER	THE A		
3	30.0 4" FA	11/27/18	15:25	DEPT 30.0			PTH I <b>A</b>	FLUID LE NA	VEL	LEVE Non		SHEET		
		11/2//10	13:23	50.0						1101		EXPLA		
29 – 30 – DEP 3	IG 11/07/10											ERMIN		
	<u>LETED: 11/27/18</u>												IS LO	
DR: <b>B</b>	T LG: JR Rig: RC-1													



AET JO	OB NO: <b>17-03356</b>					LC	OG OF	BORING 1	NO	B	-14	(p. 1	of 1	)
PROJE	ECT: West Rapid Sub	ostation;	Rapid C	City, S	outh Dakot	a								
DEPTH	SURFACE ELEVATION:				GEOLOGY		MC	SAMPLE	REC	FIEL	D & LA	BORA	TORY	TESTS
IN FEET	MATERIAL	DESCRIPTI	ON			N	MC	SAMPLE TYPE	ĪN.	WC	DEN	LL	PL	<b>%-</b> #20
1 -	LIMESTONE AGGREC	GATE SUI	RFACINO		SURFACIING	ľ								
2 -	FILL, Coal, black			-/ 🗱	FILL									
3 -	FILL, Silty Lean Clay, re	ddish brow	m (CL)											
4 -	FILL, Sinty Lean Ciay, ie	ddisii biow												
5 -														
6 -	-													
7 -														
8 - 9 -														
10 -	-													
11 -		n Class 1			CDE A DEIGU	-								
12 -	<b>CLAYSTONE</b> , Silty Lean lenses and laminations pre-	n Clay, red esent (CL)	, gypsum		SPEARFISH FORMATION	r								
13 -	-													
14 -	-													
15 -							М							
16 -														
17 -	-													
18 -	increasing gypsum lenses	with depth	l											
20 -														
21 -	-													
22 -														
23 -														
24 -	-													
25 -														
26 -	GYPSUM, white			- 0										
27 -					4									
28 - 29 - 29 - 29 - 29 - 29 - 29 - 29 -					-									
30 -		<u> </u>		$\rightarrow$	•									
	Bottom of	Boring												
	PTH: DRILLING METHOD			WAT	ER LEVEL MEA	 ASUR	EMEN							
29 – 29 – 30 – 30 – DEI – DEI – BORIN COMP		DATE	TIME	SAMP				DRILLII FLUID LE	NG	WAT LEVI		NOTE: THE A		
	30.0 4" FA								VEL			SHEET		
		11/27/18	8:40	30.	) NA		<b>IA</b>	NA		Non	C	EXPLA		
BORIN	NG 11/27/19											ERMIN		
$\frac{COMP}{1}$	<u>LETED: 11/27/18</u> T LG: <b>JR</b> Rig: <b>RC-1</b>								-+		-		IS LO	
<u>{ рк: в</u>	I LU: JK KIG: KU-I													



AET JOB NO: <b>17-03356</b>					LC	OG OF	BORING 1	NO	B	-15	( <b>p.</b> 1	of 1	)
PROJECT: West Rapid Su	bstation;	Rapid (	City, S	outh Dakot	a								
DEPTH SURFACE ELEVATION:				GEOLOGY			SAMPLE	REC	FIEL	D & LA	BORA	TORY	TESTS
FEET MATERIAL					N	MC	SAMPLE TYPE	ĪN.	WC	DEN	LL	PL	<b>%-</b> #20
LIMESTONE AGGREO 1 - 10 inches	GATE SUI	RFACIN	G	SURFACIING									
2 – <b>FILL</b> , Silty Lean Clay, da	ark reddish	brown to	-/ 🗱	FILL									
3 - black (CL)													
4													
5 —													
6 LEAN CLAY, brown (Cl	[.)			ALLUVIUM	-								
7 -	_)												
8 -													
9 -						M							
11 - 12 -													
15													
15 - SILTY LEAN CLAY, re	ddish brow	m (CL)											
17 —													
18 -						$ \underline{\vee} $	┝┫┥						
19 —													
20 -													
21 -													
22 -													
23 -													
24 -						W							
25 -													
26 - 27 -													
20													
	<b>D</b> :												
BORING COMPLETED: 11/27/18	Boring												
DEPTH: DRILLING METHOD			WAT	ER LEVEL MEA		EMEN							
DEFIN. DKILLING METHOD		<b>TD</b> (7)	1					NG	WAT		NOTE:		
30.0 4" FA	DATE	TIME	SAMPI DEPT			/E-IN PTH	DRILLI FLUID LE	VEL	WAT] LEVE		THE A		
	11/27/18	16:10	30.0	) NA	N	A	NA		18.0	,	SHEET		
BORING											XPLA		
											ERMIN TH		
DR: <b>BT</b> LG: <b>JR</b> Rig: <b>RC-1</b>											IH	IS LOO	



#### SUBSURFACE BORING LOG

AET JO	DB NO	17-03356					LC	OG OF	BOR	ING N	IO	B	-21	(p. 1	of 1	)
PROJE	CT:	West Rapid Sul	ostation;	Rapid C	City, S	outh Dakot	a									
DEPTH IN FEET	S	URFACE ELEVATION:				GEOLOGY	N	MC	SAN	IPLE PE	REC	FIELI	D & LA	BORA	TORY	TEST
FEET		MATERIAL	DESCRIPTI	ON				MC	TY	'PE	IN.	WC	DEN	LL	PL	%-#20
1		<b>IESTONE AGGREO</b>	GATE SUI	RFACINO		SURFACIING	ſ									
		nches IL, Silty Lean Clay wi	th Sand re	ddish	-/ 🗱	FILL										
$\begin{vmatrix} 2 \\ 3 \\ - \end{vmatrix}$	brov	vn, gypsum, claystone	and coal f	fragments												
4 -		sent (CL) NCRETE, 6 inches														
5 -	FIL	L, Silty Lean Clay wi	th Sand, re	ddish	-/ 💥											
6 -	brov	wn, gypsum, claystone ent (CL)	and coal f	fragments				М								
7 –		NCRETE, 6 inches														
8	FIL	L, Silty Lean Clay wi	th sand, re	ddish			-									
9 –		wn, gypsum, claystone ent (CL)	and coal f	ragments		ALLUVIUM										
10 -		TY LEAN CLAY, red	d (CL)													
11 -																
12 -																
13 —																
14 —																
15 —								W								
16 -																
17 —																
18 -		Bottom of	Boring													
		Doutoin of	Doring													
DEP	TH:	DRILLING METHOD			WAT	ER LEVEL MEA	ASUR	EMEN	TS				1	NOTE:	REFE	ER TO
1	80	/" FA	DATE	TIME	SAMPI DEPT	LED CASING H DEPTH	CAV	/E-IN PTH		RILLIN ID LE		WATI LEVE		THE A	TTAC	HED
	8.0	4" FA	11/28/18	15:35	18.0			A		NA	,	12.0		SHEET	TS FOI	R AN
			11/20/10	15.55	10.0			11		1171		14.(		XPLA	NATIO	ON OF
DEP 1 BORIN COMP	IG	. 11/ <b>7</b> 0/10									-+		T	ERMIN	IOLO	GY OI
		D: 11/28/18													IS LO	
DR: <b>B</b>	1 L	G: JR Rig: RC-1														



AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORING 1	NO	B	-22	(p. 1	of 1	)
PROJE	CT: West Rapid Sul	ostation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	BORA	TORY	TESTS
FEET							wie	TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1	LIMESTONE AGGREC	GATE SUI	RFACINO		SURFACIING	-								
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	-/ 🗱	FILL									
3 -	brown, gypsum, claystone (CL)	e and coal f	ragments											
4														
5 —	SILTY LEAN CLAY, red	A (CL)			ALLUVIUM									
6 -		u (CL)												
7 —							Μ							
8 -														
9 —														
10 -														
11 -														
12 -														
13 -							$\left  \sum \right $							
14 -							<u> </u>							
15 -							W							
16 — 17 —	<b>CLAYSTONE</b> , Silty Least lenses present (CL)	n Clay, red	, gypsum		SPEARFISH FORMATION		vv							
17 - 18 -					TORMATION									
10	Bottom of	Boring												
1														
DEP	TH: DRILLING METHOD			WAT	ER LEVEL MEA	SUR	EMEN	ITS	1	1	, ו	NOTE:	REFF	R TO
		DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV	/E-IN PTH	DRILLI FLUID LE	NG	WATI LEVI		THE A		
	18.0 4" FA	11/28/18	16:00	18.				FLUID LE NA	VEL	14.0		SHEET		
		11/20/10	10:00	10.			A	INA		14.(	,	EXPLA		
DEP 1 BORIN COMP	IG 11/20/10											ERMIN		
	LETED: 11/28/18												IS LOO	
DR: B	T LG: JR Rig: RC-1													



#### SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	DG OF	BORING 1	NO	B	-23	(p. 1	of 1	)
PROJE	ECT: West Rapid Sub	ostation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	BORA	TORY	TESTS
FEET							wic	TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1 -	LIMESTONE AGGREC	GATE SUI	RFACINO	; ; ;	SURFACIING									
2 -	FILL, Silty Lean Clay with	th Sand, re	ddish	-/ 🞆	FILL									
3 -	brown, gypsum, claystone present (CL)	and coal f	fragments											
4														
5 -	-													
6 -	SILTY LEAN CLAY, red	d (CL)			ALLUVIUM		M							
7 —														
8 -	-													
9 - 10 -	]													
12 -	-													
13 -	-						$ \underline{\nabla} $							
14 -	-													
15 -	-						W							
16 -	CLAYSTONE, Silty Lear	n Clay, red	, gypsum		SPEARFISH		vv							
17 -	lenses present (CL)		, 651		FORMATION									
18 -	Bottom of	Boring												
0 10														
		Γ												
DEF	PTH: DRILLING METHOD			1	ER LEVEL MEA							NOTE:	REFE	ER TO
	18.0 4" FA	DATE	TIME	SAMPI DEPT	ED CASING H DEPTH	CAV DE	/E-IN PTH	DRILLI FLUID LE	NG EVEL	WATI LEVE	ER EL	THE A	TTAC	HED
		11/28/18	15:15	18.0	) NA	N	A	NA		13.0	)	SHEET	S FO	R AN
												EXPLA		
BORIN COMP	NG PLETED: <b>11/28/18</b>										Т	ERMIN		
$\overline{\mathbf{H}}$ DR: <b>B</b>	BT LG: JR Rig: RC-1											TH	IS LO	



West Rapid Substation; Rapid City, South Dakota         DEPTH FFFT       SURFACE ELEVATION: MATERIAL DESCRIPTION       GEOLOGY       N       MC       SMPLF       PLC       IPULD & LABORATOR TOTST MATERIAL DESCRIPTION         1       LIMESTORE ACCRECATE SURFACING 7       SURFACING FILL       SURFACING 7       SUR	AET JOB NO: <b>17-03356</b>						LC	OG OF	BOI	RING N	NO	B	-24	(p. 1	of 1	)
LIMESTONE ACGREGATE SURFACING LIMESTONE ACGREGATE SURFACING TILL Silly Lean Clay with Sand, reddish brown, gypsun, claysione and coal fragments present (CL) SILTY LEAN CLAY, red (CL) SILTY LEAN CLAY, red (CL) ALLUVIUM M SPEARFISH tenses present (CL) Bottom of Boring DEPTH: DRILLING METHOD LAYSTONE Silly Lean Clay, red, gypsum Bottom of Boring DEPTH: DRILLING METHOD NOTE: REFER TO 18.0 4" FA 11/28/18 DATE 11/28/18 DEPTH: DRILLING METHOD DEPTH: DRILLING METHOD NOTE: REFER TO THE ATTACHED SMETT FOR AN NOTE: REFER TO THE ATTACHED SMETT FOR AN NA NA NA NA NA NA NA NA NA	PROJECT: West Rapid Su	bstation;	Rapid (	City, S	outh D	akot	a									
LIMESTONE ACGREGATE SURFACING LIMESTONE ACGREGATE SURFACING TILL Silly Lean Clay with Sand, reddish brown, gypsun, claysione and coal fragments present (CL) SILTY LEAN CLAY, red (CL) SILTY LEAN CLAY, red (CL) ALLUVIUM M SPEARFISH tenses present (CL) Bottom of Boring DEPTH: DRILLING METHOD LAYSTONE Silly Lean Clay, red, gypsum Bottom of Boring DEPTH: DRILLING METHOD NOTE: REFER TO 18.0 4" FA 11/28/18 DATE 11/28/18 DEPTH: DRILLING METHOD DEPTH: DRILLING METHOD NOTE: REFER TO THE ATTACHED SMETT FOR AN NOTE: REFER TO THE ATTACHED SMETT FOR AN NA NA NA NA NA NA NA NA NA	DEPTH SURFACE ELEVATION	:			GEOLO	OGY	N	MC	SA	MPLE	REC	FIELI	D & LA	ABORA	TORY	TESTS
10       inches       FILL       Image: style sty		. DESCRIPTI						MC	T	YPE	ĪN.		DEN	LL	PL	%-#20
2       FILL, Silly Lean Clay with Sand, reddish present (CL)       Image: Clay of the second coal fragments present (CL)         3       -       -       -         4       -       -       -         5       -       -       -         6       -       -       -         7       SILTY LEAN CLAY, red (CL)       -       -         8       -       -       -         9       -       -       -         10       -       -       -         11       -       -       -         12       -       -       -         13       -       -       -         14       -       -       -         15       -       -       -         16       CLAYSTONE, Silly Lean Clay, red, gypsum       SPEARFISH       W         17       lenses present (CL)       -       -       -         18       Bottom of Boring       -       -       -       -         18.0       4" FA       DATE       Time       SAMELDP       CASING       CAVEAN       VATER         000000000000000000000000000000000000	LIMESTONE AGGRE	GATE SU	RFACINO	; <b>=</b>		CIING										
3       present (CL)       ALLUVIUM       M         5       5       5       5         6       5       5       5         7       SILTY LEAN CLAY, red (CL)       ALLUVIUM       M         9       9       5       5         10       -       -       5         12       -       -       5         13       -       -       -         14       -       -       -         16       CLAYSTONE Silty Lean Clay, red, gypsum       SPEARFISH       W         17       Enses present (CL)       -       W       -         18       Bottom of Boring       -       -       -         18.0       4" FA       DATE       TIME       SAMPLED CASING       CAVE-IN       PRILLING       WATER         11/28/18       11/28/18       18.0       NA       NA       NA       EXPLANATION OF	2 - <b>FILL</b> , Silty Lean Clay w	vith Sand, re	ddish	_/ 🎆	FILL											
4 - 5       - <td>brown, gypsum, claystor</td> <td>e and coal t</td> <td>fragments</td> <td></td> <td>×.</td> <td></td>	brown, gypsum, claystor	e and coal t	fragments		×.											
$\begin{array}{c c c c c c c c c c c c c c c c c c c $					Ň											
7       SILTY LEAN CLAY, red (CL)       ALLUVIUM       M       M         9       -       -       -       -         10       -       -       -       -         11       -       -       -       -       -         12       -       -       -       -       -       -         13       -       -       -       -       -       -         14       -       -       -       -       -       -         15       -       -       -       -       -       -       -         16       CLAVSTONE, Silty Lean Clay, red, gypsum lenses present (CL)       SPEARFISH FORMATION       W       W       -       -       -         18       Bottom of Boring       -	5 —				X											
SILITY LEAN CLAY, red (CL)       ALLOVION       M       M       I       I       I         9       0       I	6 —				X											
9       -	7 - SILTY LEAN CLAY, r	ed (CL)			ALLUV	IUM		м								
10       -		- ()						IVI								
11       -	9 -															
12       -																
13 -       -																
14 -       15 -       SPEARFISH       W       W       I																
15       -																
16 17 18       CLAYSTONE, Silty Lean Clay, red, gypsum       SPEARFISH FORMATION       W       I       <								$\square$								
17 -       Image: Second condition of Boring       Image: Second condit on Boring       Image: Second condition of Boring	16															
18       Bottom of Boring       I	CLAYSIONE, Silty Le	an Clay, rec	l, gypsum					W								
Bottom of Boring       Image: Sector of Boring	10	<u></u>														
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted	Bottom o	f Boring														
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted																
18.0 4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL       11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Incompleted     Incompleted     Incompleted     Incompleted		-1														
11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Image: Complete the second sec	DEPTH: DRILLING METHOD 18.0 4" FA BORING COMPLETED: 11/28/18		1								,			NOTE:	REFE	R TO
11/28/18     15:00     18.0     NA     NA     NA     15.0       BORING COMPLETED:     11/28/18     Image: Complete the second sec	18.0 4" FA	DATE	TIME	SAMP DEP	LED CAS TH DE	SING PTH	CAV DE	/E-IN PTH	D FLU	RILLI JID LE	NG VEL	WATI LEVE	ER EL	THE A	TTAC	HED
BORING COMPLETED: 11/28/18		11/28/18	15:00							NA	$ \uparrow$			SHEET	ΓS FOI	R AN
COMPLETED: 11/28/18	<u> </u>										+			EXPLA	NATIO	ON OF
THISLOG	BORING COMPLETED: 11/28/18												T	ERMIN	IOLOG	GY ON
														TH	IS LO	<b>G</b>



#### SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	DG OF	BORING	NO	B	-25	(p. 1	of 1	)
PROJE	ECT: West Rapid Sul	ostation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPL TYPE	E REC	; <b></b>	D & LA	ABORA	TORY	TESTS
FEET							IVIC	TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1	LIMESTONE AGGREC	GATE SUI	RFACINO	; /	SURFACIING FILL									
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	-' 🎆	FILL									
3 -	brown, gypsum, claystone present (CL)	and coal f	fragments											
4 -														
5 —	-													
6 -	-													
7 -	SILTY LEAN CLAY, red	d (CL)			ALLUVIUM		М							
8 – 9 –														
10 -														
11 -	1													
12 -	-													
13 -	-													
14 -	-						$\bigtriangledown$							
15 —	-						<u> </u>							
16 -	CLAYSTONE, Silty Lean	n Clay, red	l, gypsum		SPEARFISH	- r	W							
17 — 18 —	lenses present (CL)				FORMATION									
10	Bottom of	Boring												
,														
ž 1														
DEP	PTH: DRILLING METHOD			WAT	ER LEVEL MEA	L ASUR	EMEN	TS			l   ,	NOTE:	REE	
		DATE	TIME	SAMPI DEPT			/E-IN PTH	DRILI FLUID	ING	WAT LEVI		THE A		
	18.0 4" FA	11/28/18	14:35	18.			JA	FLUID I NA		15.0		SHEET		
		11/20/10	14:33	10.				112	1	13.		EXPLA		
DEP 1 BORIN COMP	NG PLETED: <b>11/28/18</b>										T	ERMIN	IOLOG	GY ON
$DR: \mathbf{B}$												TH	IS LO	G
	- 20. 01 Mg. 100-1	1	1	1		1		1						



AET JOB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	B	-26	(p. 1	of 1	)
PROJECT: West Rapid Su	bstation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET SURFACE ELEVATION: MATERIAL				GEOLOGY	N	MC	SAMPL TYPE	E REC		D & LA	BORA	TORY	TESTS
						MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
LIMESTONE AGGRE( $1 \rightarrow 10$ inches	GATE SUF	RFACING	; / 🔜	SURFACIINC FILL	ĩ								
7 - FILL, Silty Lean Clay wi	th Sand, re	ddish	-' 🞆	FILL									
3 - brown, gypsum, claystone present (CL)	e and coal f	ragments											
5 -													
6 -													
						М							
9 SILTY LEAN CLAY, re 10 -	d (CL)			ALLUVIUM	1								
12 -													
13 —													
14 —													
15 —													
16 —													
	<u> </u>					$\frac{}{\overline{W}}$							
18 - CLAYSTONE, Silty Lea	n Clay, red	, gypsum		SPEARFISH FORMATION									
Bottom of	Boring												
	1												
DEPTH: DRILLING METHOD	ļ,			ER LEVEL ME							NOTE:	REFE	R TO
18.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRILI FLUID I	.ING .EVEL	WAT LEVI	ER EL	THE A	TTAC	HED
	11/28/18	12:20	18.		N	A	NA	1	17.0	)	SHEET	TS FOR	R AN
										E	XPLA	NATIO	ON OF
DEPTH: DRILLING METHOD 18.0 4" FA BORING COMPLETED: 11/28/18										T	ERMIN		
DR: BT LG: JR Rig: RC-1												1S LOO	



AET JOB NO: <b>17-03356</b>					Ι	.OG OF	BORI	NG NO.	B-	26A	<b>(p.</b> ]	lof	1)
PROJECT: West Rapid Sul	bstation;	Rapid C	City, S	outh Dak	ota								
DEPTH IN FEET SURFACE ELEVATION: MATERIAL				GEOLOG	Y N	MC	SAMI	LE RE		D & LA	BORA	TORY	TESTS
							TYF	PE IN	WC	DEN	LL	PL	%-#20
LIMESTONE AGGREO 1 - 10 inches	GATE SUF	RFACING	; / 🔜	SURFACII FILL	NG								
7 - FILL, Silty Lean Clay wi	th Sand, re	ddish	- 🎆	TILL									
3 - brown, gypsum, claystone present (CL)	e and coal f	ragments											
4 -													
5 -													
6 -													
						М							
$\begin{array}{c c} & 9 \\ \hline & \\ 10 \\ \hline \\ 10 \\ \hline \end{array}$	d (CL)			ALLUVIU	M								
12 -													
13 —													
14 —													
15 —													
16 -													
17 – 18 – CLAYSTONE, Silty Lea	n Class nod			SPEARFIS	ш	$\overline{\overline{W}}$							
l lenses present (CL)		, gypsum		FORMATI									
Bottom of	Boring												
	1												
DEPTH: DRILLING METHOD 18.0 4" FA BORING COMPLETED: 11/28/18			1	ER LEVEL N							NOTE:	REFE	R TO
18.0 4" FA	DATE	TIME	SAMP DEP	LED CASIN FH DEPT	G CA	VE-IN EPTH	DRI FLUII	LLING D LEVEL	WAT LEVI	ER EL	THE A	TTAC	HED
	11/28/18	12:05	18.	0 NA		NA	1	NA	17.	0	SHEET	FS FOI	R AN
											XPLA		
BORING COMPLETED: 11/28/18										Т	ERMIN		
DR: <b>BT</b> LG: <b>JR</b> Rig: <b>RC-1</b>												IS LO	



AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORING	NO.	B-	26B	<b>(p.</b> 1	lof	1)
PROJE	CT: West Rapid Sul	bstation;	Rapid C	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLI TYPE	EREC	FIEL	D & LA	BORA	TORY	TESTS
FEET	MATERIAL						MC	ТҮРЕ	IN.	WC	DEN	LL	PL	%-#20
1	LIMESTONE AGGREO	GATE SUF	RFACINO	; ;	SURFACIING	-								
2 -	FILL, Silty Lean Clay wi	th Sand, re-	ddish	_/ 🞆	FILL									
3 —	brown, gypsum, claystone present (CL)	e and coal f	ragments											
4 —	present (CL)													
5 —														
6 —														
7 —														
8 —							М							
9 —	SILTY LEAN CLAY, re	d (CL)			ALLUVIUM		101							
10 —														
11 —														
12 -														
13 —														
14 -														
15 — 16 —														
16 -							$\square$							
18	CLAYSTONE, Silty Lea	n Clay, red	gypsum		SPEARFISH		- <u>v</u> W							
10	\lenses present (CL)				FORMATION	1								
	Bottom of	Boring												
DEP'	TH: DRILLING METHOD			WAT	ER LEVEL MEA	ASUR	EMEN	TS			1	NOTE:	REFE	R TO
1	8.0 4" FA	DATE	TIME	SAMP	LED CASING TH DEPTH	CAV	/E-IN PTH	DRILL FLUID L	ING EVEI	WAT LEVI	ER	THE A	TTAC	HED
	ο.υ 4 Γ <b>Α</b>	11/28/18	12:55	18.			A	NA		17.0		SHEET	TS FOI	R AN
								1,11	-	1.1.		XPLA	NATIO	ON OF
BORIN	G LETED: <b>11/28/18</b>											ERMIN	IOLOG	GY OI
DR: <b>B</b>												TH	IS LOO	Ĵ
	- 20. 01 Mg. 10-1	1		1									01 DI	



AET JOB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	<b>B-</b> 2	26C	<b>(p.</b> ]	lof	1)
PROJECT: West Rapid S	ubstation;	Rapid (	City, S	outh Dakot	a								
DEPTH IN FEET SURFACE ELEVATIO MATERIA	N:			GEOLOGY	N	MC	SAMPLE	REC		D & LA	BORA	TORY	TESTS
	L DESCRIPTI					MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
LIMESTONE AGGR $1 \rightarrow 10$ inches	EGATE SUI	RFACINO	; /	SURFACIING FILL	Ì								
FILL, Silty Lean Clay	with Sand, re	ddish	- 🎆										
3 - brown, gypsum, clayste	one and coal 1	tragments											
4 —													
5 -													
0					-	М							
$\begin{bmatrix} 9 \\ 10 \\ - \end{bmatrix}$ SILTY LEAN CLAY,	red (CL)			ALLUVIUM									
11 -													
12 -													
13 -													
15 - 16 - 16 - 16 - 16 - 16 - 16 - 16 -													
						$\left  \sum \right $							
18 - CLAYSTONE, Silty L	ean Clay, red	l, gypsum		SPEARFISH		Ŵ							
lenses present (CL) Bottom	of Boring			FORMATION									
	or boring												
DEPTH: DRILLING METHO 18.0 4" FA BORING COMPLETED: 11/28/18	D		WAT	ER LEVEL MEA			ITS				NOTE:	REFE	R TO
18.0 4" FA	DATE	TIME	SAMP DEP	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRILLI FLUID LI	NG EVEL	WATI LEVE	ER EL	THE A	TTAC	HED
	11/28/18	13:35	18.	0 NA		A	NA		17.(	)	SHEET	TS FOI	R AN
										E	XPLA	NATIO	ON OF
BORING COMPLETED: 11/28/18										Т	ERMIN		
DR: BT LG: JR Rig: RC-1												IS LOO	



AET JC	OB NO	17-03356						LC	OG OF	BO	RING	NO	<b>B-</b> 2	26D	<b>(p.</b> 1	lof	l)
PROJE	CT:	West Rapid Sub	ostation;	Rapid (	City, S	out	h Dakota	a									
DEPTH IN FEET	S	URFACE ELEVATION:				G	EOLOGY	N	MC	SA	MPLE	REC	FIELI	D & LA	BORA	TORY	TESTS
FEET		MATERIAL							MC	1	FYPE	IN.	WC	DEN	LL	PL	%-#20
1	LIN ∖10 i	IESTONE AGGREC	GATE SUF	RFACINO	; <u> </u>		RFACIING										
2 -	FIL	L, Silty Lean Clay wi	th Sand, re	ddish	-/ 🎆	FIL	L.										
3 -	brow	vn, gypsum, claystone ent (CL)	and coal f	ragments		<sup>2</sup>											
4 —	pres					X											
5 —						×											
6 -						×											
7 —						×											
8 -						X			М								
9 —	SIL	TY LEAN CLAY, red	1 (CL)			AL	LUVIUM		111								
10 -		,	( _)														
11 -																	
12 -																	
13 -																	
14 -																	
15 - 16 -																	
10 - 17 -									$\Box$								
	$\neg CL$	AYSTONE, Silty Lear	n Clay, red	gypsum		SPI	EARFISH		$\overline{\overline{W}}$								
10	lens	es present (CL)				FO	RMATION										
		Bottom of	Boring														
DEP	TH:	DRILLING METHOD			WAT	ER L	LEVEL MEA	SUR	EMEN	ITS				1	NOTE:	REFE	R TO
1	8.0	4" FA	DATE	TIME	SAMP	LED TH	CASING DEPTH	CAV DE	/E-IN PTH	FL	DRILLII UID LE	NG VEL	WATI LEVE	ER   EL	THE A	TTAC	HED
	0.0	т Г <i>А</i>	11/28/18	12:25	18.		NA		A		NA		17.0		SHEET	TS FOF	R AN
						-	- • • •				1,11		- / • (		XPLA	NATIO	ON OF
DEP 1 BORIN COMPI	IG LETEI	D: <b>11/28/18</b>						1							ERMIN	IOLOG	GY ON
DR: B		G: JR Rig: RC-1								-					TH	IS LOO	3
02/2011	- D				1					I				1			



AET JOB NO: <u>17-03356</u> LOG OF BORING NO. <u>B</u> -	-21	(p. 1	of 1)	)
PROJECT: West Rapid Substation; Rapid City, South Dakota				
DEPTH IN FEET     SURFACE ELEVATION:     GEOLOGY     N     MC     SAMPLE TYPE     REC IN.     FIELD WC	D & LA	ABORAT	ORY 1	FESTS
TEET WATERIAE DESCRIPTION WC	DEN	LL	PL 9	<b>%-</b> #20
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				
FILL, Silty Lean Clay with Sand, reddish				
brown, gypsum, claystone and coal fragments present (CL)				
13     CLAYSTONE, Silty Lean Clay, red, gypsum     SPEARFISH       14 – lenses present (CL)     FORMATION				
18 Bottom of Boring				
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS	1	NOTE:	REFEI	R TO
18.04" FADATETIMESAMPLED DEPTHCASING DEPTHCAVE-IN DEPTHDRILLING FLUID LEVELWATH LEVEL	ER EL	THE AT	ГТАСН	HED
11/28/18 10:35 18.0 NA NA NA NA		SHEET	S FOR	AN
		EXPLAN	JATIO	N OF
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS 18.0 4" FA DATE TIME SAMPLED DEPTH CASING CAVE-IN DRILLING WATH 11/28/18 10:35 18.0 NA NA NA NA NO BORING COMPLETED: 11/28/18	T	ERMIN	OLOG	YON
DR: BT LG: JR Rig: RC-1		THI	S LOG	ŕ



#### SUBSURFACE BORING LOG

AET J	OB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	<b>B-</b> 2	27A	<b>(p.</b> ]	l of 1	l)
PROJE	ECT: West Rapid Sub	ostation;	Rapid C	'ity, So	outh Dakota	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	BORA	TORY	TESTS
FEET							wie	TYPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREC	FATE SUI	RFACING		SURFACIING FILL									
2 -	FILL, Silty Lean Clay with brown, gypsum, claystone	th Sand, re	ddish	-	TILL									
3 -	present (CL)		ragments											
4 -	_													
5 -	-													
6 -														
7 - 8 -														
9-							М							
10 -	_													
11 -	_													
12 -	-													
13 -	CLAYSTONE, Silty Lear	n Clay, red	, gypsum		SPEARFISH									
14 -	lenses present (CL)	<u> </u>	, 6, 1		FORMATION									
15 -	-													
16 -	-													
17 -														
18 -	Bottom of	Boring												
2/3/18														
IIINO CORP 17/3336 GPU AFI + CPI + MELL.GOU 12/3/18 IIINO COMP	PTH: DRILLING METHOD			WATE	ER LEVEL MEA	SIIP		  TS						
	TIII. DKILLING METHOD							DRILLI	NG	WAT		NOTE:		
	18.0 4" FA	DATE	TIME	SAMPL DEPT			/E-IN PTH	FLUID LI	EVEL	WAT] LEVE		THE A		
-03356		11/28/18	10:55	18.0	) NA	N	A	NA		Non	C	SHEET		
	NG											XPLAI ERMIN		
	PLETED: 11/28/18										I.		IS LOC	
$\overline{\mathbf{A}}$ DR: <b>B</b>	BT LG: JR Rig: RC-1													



AET J	JOB NO: <b>17-03356</b>					LC	OG OF	BORING	NO.	<b>B-</b> 2	27B	<b>(p.</b> ]	l of 1	1)
PROJE	ECT: West Rapid Su	bstation;	Rapid Ci	ity, S	outh Dakot	a								
DEPTH IN FEET	I SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPL TYPE	E REC	FIEL	D & LA	BORA	TORY	TESTS
FEET		DESCRIPTIO					MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGRE	GATE SUI	RFACING		SURFACIING									
2 -	<b>FILL</b> , Silty Lean Clay w	ith Sand, re	ddish	′ 🞆	FILL									
3 -	brown, gypsum, clayston present (CL)	e and coal f	ragments											
4 -														
5 -	_													
6 -	-													
7 -	-													
8 -	_													
9 -							М							
10 -	-													
11 -	-													
12 -	-													
13 -	CLAYSTONE, Silty Lea	n Clay, red	, gypsum		SPEARFISH FORMATION									
14 -	1 ( )				FORMATION									
16 -														
17 -														
18 -		<u></u>							_					
	Bottom of	Boring												
2														
		1									<u> </u>			
BORIN COMF	EPTH: DRILLING METHOD		I		ER LEVEL MEA							NOTE:	REFE	R TO
	18.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRILI FLUID I	.ING .EVEL	WATI LEVE	ER   EL	THE A	TTAC	HED
		11/28/18	11:18	18.	0 NA	N	A	NA	<b>\</b>	Non	ie	SHEET	TS FOF	R AN
2											Ē	EXPLA	NATIO	ON OF
BORIN COMF	NG PLETED: <b>11/28/18</b>										T	ERMIN	IOLOC	TY ON
	1 L L L L D. $11/20/10$	1 1	1						1					



	AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORING	NO.	<b>B-</b> 2	27C	<b>(p.</b> 1	l of i	1)
	PROJE	CT: West Rapid Sub	ostation;	Rapid C	City, S	outh Dakota	a								
Ι	DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPL TYPE	E REC		1	ABORA		
┢	FEET	MATERIAL I				SURFACIING					WC	DEN	LL	PL	%-#20
	1 -	√10 inches			/ 🐹	FILL									
	2 –	<b>FILL</b> , Silty Lean Clay wit brown, gypsum, claystone	h Sand, re and coal f	ddish fragments											
	3 -	present (CL)		8											
	4 - 5 -														
	6 -														
	7 -														
	8 –														
	9 –							М							
	10 -														
	11 -														
	12 -														
	13 -	CLAYSTONE, Silty Lear	n Clay, red	, gypsum		SPEARFISH FORMATION									
	14 — 15 —	lenses present (CL)				FORMATION									
	16 -														
	17 -														
	18 -	Bottom of I	Boring												
			Doring												
18															
12/3															
L.GDI															
CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18															
H-CP	DEP	TH: DRILLING METHOD			WAT	ER LEVEL MEA	SUR	EMEN	TS	1			NOTE:	REFE	R TO
PJ AE	1	8.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV	/E-IN PTH	DRILI FLUID I	ING EVEI	WAT LEVI		THE A		
356.GI	1	18.0 4" FA	11/28/18	11:40	18.0			A	N/		Non		SHEET	ſS FOI	R AN
17-03													EXPLA	NATIO	ON OF
ORP 0	BORIN	NG LETED: <b>11/28/18</b>										T	ERMIN	IOLOG	GY ON
	DR: <b>B</b> '												TH	IS LO	3



#### SUBSURFACE BORING LOG

AET JOB NO: <b>17-03356</b>					LC	OG OF	BORING	NO.	<b>B-</b> 2	27D	<b>(p.</b> ]	l of 1	1)
PROJECT: West Rapid Sul	bstation;	Rapid C	'ity, S	outh Dakota	a								
DEPTH SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLI TYPE	E REC	FIEL	D & LA	BORA	TORY	TESTS
FEET MATERIAL	DESCRIPTIO					MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
LIMESTONE AGGREO $1 \rightarrow 10$ inches	GATE SUF	RFACING		SURFACIING FILL									
2 – <b>FILL</b> , Silty Lean Clay wi	th Sand, re	ddish	-′ 🞆	FILL									
3 - brown, gypsum, claystone present (CL)	e and coal f	ragments											
5 —													
6 —													
7 —													
8 -													
9 -						M							
12	<u> </u>												
CLAYSTONE, Silty Lea 14 – lenses present (CL)	n Clay, red	, gypsum		SPEARFISH FORMATION									
15 -													
16 -													
17 —													
18 Bottom of	Boring												
DEPTH: DRILLING METHOD 18.0 4" FA BORING COMPLETED: 11/28/18			WAT	ER LEVEL MEA	SUR	EMEN	TS		·	1	NOTE:	REFE	R TO
18.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV	/E-IN PTH	DRILL FLUID L	ING EVEI	WATI LEVE	ER	THE A	TTAC	HED
10.0 4 FA	11/28/18	11:10	18.			A	NA		Non		SHEET	ſS FOF	R AN
		•				-					XPLA	NATIC	ON OF
BORING COMPLETED: 11/28/18										T	ERMIN	IOLOC	GY ON
DR: <b>BT</b> LG: <b>JR</b> Rig: <b>RC-1</b>											TH	IS LOO	3
02/2011				1								01 DI	



IN       SURFACE ELEVATION:       GEOLOGY       N       MC       SAMPLE TYPE       REC IN.       WC       I         FEET       MATERIAL DESCRIPTION       SURFACING       SURFACING       WC       I         1       10 inches       III.       III.       III.       III.       III.	& LABOR DEN LL		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			TOTO
LIMESTONE AGGREGATE SURFACING     SURFACING       1 - \10 inches     Image: Surfacing fill	DEN LL	PL %	ESIS
$1 \rightarrow 10$ inches			6-#20
2 – FILL, Silty Lean Clay with Sand, reddish			
brown, gypsum, claystone and coal fragments			
<sup>3 –</sup> present (CL) <sub>4 –</sub> with metal debris			
5 -			
9 -			
12 SILTY LEAN CLAY, reddish brown (CL) ALLUVIUM			
13 $16$ $W$ $W$			
Bottom of Boring			
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS		E: REFER	<b>R</b> ТО
18.0     4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     CAVE-IN DEPTH     DRILLING LEVEL     WATER LEVEL	THE	ATTACH	IED
11/28/18 10:15 18.0 NA NA NA 14.0	SHE	ETS FOR	AN
	EXPL	ANATIO	N OF
DEPTH:DRILLING METHODWATER LEVEL MEASUREMENTS18.04" FADATETIMESAMPLED DEPTHCASING DEPTHCAVE-IN DEPTHDRILLING FLUID LEVELWATER LEVEL11/28/1810:1518.0NANANA14.0BORING COMPLETED:11/28/18IIIIII	TERM	INOLOG	Y ON
DR: BT LG: JR Rig: RC-1	T	HIS LOG	



AET JOB N	io: <b>17-03356</b>					LC	OG OF	BORIN	G NO	B	-29	(p. 1	of 1	)
PROJECT:	West Rapid Sul	ostation;	Rapid C	City, So	outh Dakot	a								
DEPTH	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPI	E REC	FIEL	D & LA	ABORA	TORY	TESTS
FEET	MATERIAL						MC	SAMPI TYPE	E REC	WC	DEN	LL	PL	%-#20
$1 \rightarrow 10$	MESTONE AGGREC	GATE SUI	RFACINO	¢ ر	SURFACIING									
$2 - \overline{FI}$	LL, Silty Lean Clay wi	th Sand, re	ddish	-/ 🞆	FILL									
$3 - \frac{bro}{pro}$	own, gypsum, claystone esent (CL)	e and coal f	fragments				M							
4 -							IVI							
5 -														
6 -	th metal debris at 7'													
7 - WI	Auger Refs	ual at 7'		-/										
	C													
<u>o</u>														
DEPTH:	DRILLING METHOD			WATI	ER LEVEL MEA	L ASUR	I EMEN	TS			L	NOTE:	REFE	R TO
		DATE	TIME	SAMPI DEPT	LED CASING H DEPTH	CAN	/E-IN PTH	DRIL	LING	WAT LEVE		THE A		
DEPTH: <b>7.0</b> BORING COMPLETI	4" FA	11/28/18	9:20	18.0			A A	FLUID		Non		SHEET		
20		11/20/10	9.20	10.0			A	11.	<b>A</b>			EXPLA		
BORING	ED. 11/30/10											ERMIN		
	ED: 11/28/18												IS LOO	
DR: <b>BT</b>	LG: JR Rig: RC-1													



West Rapid Substation; Rapid City, South Dakota         DEPTH FPET       SURFACE LEVATION: MATERIAL DESCRIPTION       GROLONY       N       NC       SAMPLE TO TO TO TO TO TO TO TO TO TO TO TO TO	AET JOB NO:	17-03356					LC	OG OF	BORING	NO	B	-30	(p. 1	of 1	)
Matrix     Subsection     General Description     General Description     WC     DPN     L1     PL     wc       LIMESTONE AGGREGATE SURFACING Description     Subsection     Subsection     Subsection     WC     DPN     L1     PL     wc       1     LIMESTONE AGGREGATE SURFACING Description     Subsection     Subsection     Subsection     WC     DPN     L1     PL     wc       2     FILL     Sity Lean Clay with Sand, reddish present (CL)     FILL	PROJECT:	West Rapid Sul	ostation;	Rapid C	lity, S	outh Dakot	a								
LIMESTONE ACGREGATE SURFACING 1 UInhos FILL, Silty Lean Clay with Sand, reddish brown, gypsum, claysione and coal fragments 5 6 7 7 6 7 7 6 7 7 6 7 7 6 7 7 6 7 7 7 6 7 7 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	DEPTH SURI	FACE ELEVATION:				GEOLOGY	N	MC	SAMPLE	REC	FIELI	D & L/	ABORA	TORY	TESTS
12 inches       - [12 inches]       - [12 inches]       - [12 inches]         2       - [12 inches]       - [12 inches]       - [12 inches]       - [12 inches]         1       - [12 inches]         4       - [12 inches]         6       - [12 inches]								WIC	TYPE	IN.	WC	DEN	LL	PL	%-#20
2       -       FILL, Sity Lean Clay with Sand, reddish present (CL)       Image: Classifier of the second secon			GATE SUF	RFACING			_								
3       -	2 - FILL, S	Silty Lean Clay wi	th Sand, re	ddish	-⁄ 🞆	FILL									
4 - 5 - 7 - 8       GYPSUM, white       - 5 - 5 SPEARFISH       M         10 - 11 - 12 - 12 - 13 - 112       - 6 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7	3 - brown,	gypsum, claystone	e and coal f	ragments											
G       GYPSUM, white       FPEARFISH         9       GYPSUM, white       FORMATION         10       FORMATION       M         11       CLAYSTONE, Silty Lean Clay, red, gypsum       FORMATION         14       CLAYSTONE, Silty Lean Clay, red, gypsum       FORMATION         16       FORMATION       M         17       FORMATION       M         18       Bottom of Boring       FORMATION         18       Bottom of Boring       FORMATION         18.0       4" FA       DATE         11/28/18       9:45       18.0       NA       NA         EORING       FORMATION       FORMATION       FORMATION       FORMATION         EORING       FORMATION       FORMATION       FORMATION       FORMATION	l 1														
7       -       -       SPEARFISH       M	5 —														
Berth:       Derth:       Derth:       Date       Time:       South and the sout	6 —														
GYPSUM, white     GYPSUM,	7 —														
9       -		U <b>M</b> , white			<u>××××</u>		-								
11       -	9 -				$\geq -$		1	M							
12					$\left  \right\rangle \stackrel{\checkmark}{}{}$	4									
13       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         16       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum         Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, gypsum       Image: CLAYSTONE, Gypsum         Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Gypsum       Image: CLAYSTONE, Gypsum         Image: CLAYSTONE, Silty Lean Clay, red, gypsum       Image: CLAYSTONE, Silty Lean Clay, red, g					$\downarrow$										
14       CLAYSTONE Silty Lean Clay, red, gypsum															
15       Ienses present (CL)       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum         16       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum         18       Bottom of Boring       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum         DEPTH:       DRILLING METHOD       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum       Image: CLAYSTONE, Stirty Lean Clay, red, gypsum         18.0       4" FA       Date       Time       SAMPLED CASING CAVE-IN FULLING WATER       Note: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF THE ATTACHED SHEETS FOR AN EXPLANATION OF COMPLETED:       Image: Stirty Sti	14				-0-										
16       -	CLAY	STONE, Silty Lear	n Clay, red	, gypsum											
17 - 18       Bottom of Boring       I <td></td> <td>present (CL)</td> <td></td>		present (CL)													
18       Bottom of Boring       I															
Bottom of Boring       Bottom of Boring       Bottom of Boring       Bottom of Boring         Bottom of Boring       Bottom of Boring       Bottom of Boring       Bottom of Boring         Depth:       DRILLING METHOD       VIEW       Bottom of Boring       Bottom of Boring         DEPTH:       DRILLING METHOD       VIEW       VIEW       Bottom of Boring       NOTE: REFER TO         18.0       4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING WATER       THE ATTACHED         11.0       11/28/18       9:45       18.0       NA       NA       NOTE       SHEETS FOR AN         BORING       COMPLETED:       11/28/18       9:45       18.0       NA       NA       NOTE         BORING       COMPLETED:       11/28/18       0       I       I       I       I       I		2	<u> </u>												
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c		Bottom of	Boring												
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c															
18.0 4" FA       DATE       TIME       SAMPLED DEPTH       CASING DEPTH       DRILLING LEVEL       WATER LEVEL       THE ATTACHED         11/28/18       9:45       18.0       NA       NA       NA       Na       SHEETS FOR AN         BORING COMPLETED: 11/28/18       Image: Completed bit in the c			1												
Introduction     Internation     Internat	DEPTH: DF 18.0 4'' BORING COMPLETED: 1	RILLING METHOD	ļ,										NOTE:	REFE	R TO
Introduction     Internation     Internat	18.0 4"	' FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRILLI FLUID LI	NG EVEL	WATI LEVE	ER EL	THE A	TTAC	HED
BORING COMPLETED: 11/28/18 TERMINOLOGY OF THIS LOC		• • •	11/28/18				N	A	NA		Non	e	SHEET	TS FOF	R AN
COMPLETED: 11/28/18													EXPLA	NATIO	ON OF
THISLOC	BORING COMPLETED:	11/28/18										Т	ERMIN	IOLOC	GY OI
													TH	IS LOO	G



PROJE		856				LC	OG OF	BORING N	10	B	-31	(p. 1	01 1	)
1	ECT: West Ra	pid Substation;	Rapid C	lity, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEV	VATION:			GEOLOGY	N	MC	SAMPLE TYPE	REC	FIELI	) & LA	BORA	TORY	TESTS
FEET		ATERIAL DESCRIPTION				1	MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
	LIMESTONE A	GGREGATE SUF	RFACING		SURFACING FILL									
2 -	FILL, Silty Lean	Clay with Sand, red	ddish	-/ 🞆	TILL									
3 -	brown, gypsum, c present (CL)	claystone and coal f	ragments											
4 -														
5 —	-													
6 -	-													
7 -	1													
8 -	CLAYSTONE, S	Silty Lean Clay, red	, gypsum		SPEARFISH									
9 -	lenses present (C	L)			FORMATION		М							
10 - 11 -														
11 - 12 -														
13 -	-													
14 -	-													
15 —	-													
16 -	-													
17 -	-													
18 -	Bo	ottom of Boring												
		C												
DEP 1 BORIN COMP														
DEP	PTH: DRILLING M	IETHOD		WAT	ER LEVEL MEA	SUR	EMEN	TS		·		NOTE:	REFE	R TO
1		DATE	TIME	SAMPI DEP1	LED CASING H DEPTH	CAV	'E-IN PTH	DRILLIN FLUID LE	NG VEL	WATI LEVE	ER	THE A		
	18.0 4" FA	11/28/18	9:10	18.0			[ <b>A</b>	NA		Non		SHEET	S FOF	R AN
							-					EXPLA	NATIO	ON OF
BORIN	NG PLETED: <b>11/28/18</b>			·				1			T	ERMIN	IOLOC	GY ON
DR: B		RC-1										TH	IS LOO	3



AE	ET JOB N	IO: 17-03356					LC	OG OF	BORING	NO	B	-32	( <b>p.</b> 1	<b>of 1</b>	)
PR	OJECT:	West Rapid Sub	ostation;	Rapid C	City, S	outh Dakot	a								
DEP' IN FEE	TH	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC		D & LA		TORY	TESTS
FEF		MATERIAL I							IYPE	IN.	WC	DEN	LL	PL	%-#20
	1 - 10	IMESTONE AGGREC	JATE SUI	KFACING	; / 🗮	SURFACIING FILL									
	$2 - \overline{\mathbf{FI}}$	LL, Silty Lean Clay wit	th Sand, re	ddish	-										
	$3 - \frac{\text{br}}{\text{pr}}$	esent (CL)		ragments											
	4 –														
	5 -														
	6 -														
	7 - 8 -														
	8 - 9 -							М							
	10 -														
	1 -														
1	12 -														
1	13 + C	LAYSTONE, Silty Lear	n Clay red	ovnsum		SPEARFISH									
1	4 - lei	nses present (CL)	i ciuy, icu	, gypsum		FORMATION									
	15 -														
	6 –														
	17 —														
	18	Bottom of	Boring												
3/18															
11 12															
ELL.GI															
1W+															
	DEPTH:	DRILLING METHOD			1	ER LEVEL MEA							NOTE:	REFE	R TO
	18.0	4" FA	DATE	TIME	SAMPI DEPT	ED CASING H DEPTH	CAV DE	/E-IN PTH	DRILL FLUID L	ING EVEL	WAT LEVI	ER EL	THE A	TTAC	HED
CORP 17-03356.GPJ AET+CPT+WELL.GDT 12/3/18 OO	10.0		11/28/18	10:05	18.0			A	NA		Non	e	SHEET	S FOF	R AN
17-0(												E	XPLA	NATIC	ON OF
BO CO	ORING OMPLET	ED: <b>11/28/18</b>										T	ERMIN	IOLOC	GY ON
		LG: JR Rig: RC-1												IS LOO	G ID OC



## ENGINEERING TESTING, INC.

AET JOB N	IO: <b>17-03356</b>					LC	OG OF	BO	RING N	10	B	-33	(p. 1	of 1	)
PROJECT:	West Rapid Sul	ostation;	Rapid C	lity, S	outh Dakot	a									
DEPTH	SURFACE ELEVATION:				GEOLOGY	N	MC	SA	MPLE	REC	FIELI	) & LA	BORA	TORY	TESTS
DEPTH IN FEET	MATERIAL	DESCRIPTI	ON			N	MC	T	MPLE YPE	ĪN.	WC	DEN	LL	PL	%-#20
$1 \rightarrow 10$	MESTONE AGGREO	GATE SU	RFACING	; 	SURFACIING										
	LL, Silty Lean Clay wi	th Sand, re	ddish	-/ 🞆	FILL										
br	own, gypsum, claystone	and coal t	fragments												
	esent (CL)														
5		1 (61)													
6 - <b>SI</b>	LTY LEAN CLAY, red	d (CL)			ALLUVIUM										
7 —															
8 -							Μ								
9 —															
10 -															
11 -															
12 -															
13 -															
14 —							$\nabla$								
15 -							<u> </u>								
16 -							W								
17 -															
18	Bottom of	Boring													
5															
DEPTH: 18.0 BORING COMPLET	DRILLING METHOD			WAT	ER LEVEL MEA	SUR	 EMEN							DEFE	
			TDAT			-		р	RILLIN	NG	WATI	ER	NOTE:		
18.0	4" FA	DATE	TIME	SAMPI DEPT			/E-IN PTH	FLI	UID LE	VEL	LEVE	EL	THE A		
		11/29/18		18.0	) NA	N	A		NA		15.0	,	SHEET		
BODING													XPLA		
	ED: <b>11/29/18</b>											T	ERMIN		
DR: <b>BT</b>	LG: <b>BB</b> Rig: <b>RC-1</b>												TH	IS LOO	



	AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORIN	G NO.	B	-34	(p. 1	of 1	)
I	PROJE	CT: West Rapid Sub	station;	Rapid Ci	ity, S	outh Dakot	a								
Dł	EPTH IN EET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMP TYP	E REC	- i		ABORA	TORY	TESTS
F	ÊÊT				=	SURFACIING				E IN.	WC	DEN	LL	PL	%-#20
	1 -	LIMESTONE AGGREG			/ 🗮	FILL									
	2 -	<b>FILL</b> , Silty Lean Clay with brown, gypsum, claystone	h Sand, re and coal f	ddish Fragments											
	3 - 4 -	present (CL)		U											
	5														
	6 -														
	7 —														
	8 -														
	9 — 10 —							M							
	10	SILTY LEAN CLAY, rec	l (CL)			ALLUVIUM									
	12 -	CLAYSTONE, Silty Lear	Clav red	gynsum		SPEARFISH									
	13 -	lenses present (CL)	r ciay, red	, gypsum		FORMATION									
	14 -														
	15 – 16 –														
	17 -														
	18 -	Bottom of	Roring												
		Dottoin of	Doring												
Ω															
12/3/															
L.GUI															
CORP 17-03356.GPJ AE1+CP1+WELL.GDI 12/3/18															
	DEP	TH: DRILLING METHOD				ER LEVEL MEA			TS				NOTE:	REFE	R TO
GPJ A	1	8.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV DE	/E-IN PTH	DRII FLUID	LING LEVEL	WAT LEVI	ER EL	THE A	TTAC	HED
13356.0			11/29/18		18.	) NA	Ň	A	Ň	A	Nor		SHEET		
	BORIN	IG											EXPLA		
	COMP	LETED: 11/29/18										-	ERMIN TH	IS LOC	
Į I	DR: <b>B</b> '	<b>T</b> LG: <b>BB</b> Rig: <b>RC-1</b>													



AET JC	DB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	B	-35	(p. 1	of 1	)
PROJE	CT: West Rapid Sul	ostation;	Rapid C	ity, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLI TYPE	E REC	FIELI	) & LA	ABORA	TORY	TESTS
FEET							MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
1	LIMESTONE AGGREC	JATE SUF	RFACING		SURFACIING FILL	i I								
2 -	FILL, Silty Lean Clay wi	th Sand, red	ddish	′ 🞆	TILL									
3 —	brown, gypsum, claystone present (CL)	e and coal f	ragments											
4 -														
5 -														
6 -														
7 -														
8 - 9 -							М							
							141							
11 -	SILTY LEAN CLAY, red	ddish brown	n (CL)		ALLUVIUM									
12 -														
13 -														
14 -														
15 -														
16 -														
17 -														
18 -	Bottom of	Boring								1				
DEP 1 BORIN COMPI	TH: DRILLING METHOD	 	Γ		ER LEVEL MEA					117 4 77		NOTE:	REFE	R TO
1	8.0 4" FA	DATE	TIME	SAMPI DEP1	LED CASING TH DEPTH	DE	/E-IN PTH	DRILL FLUID L	ING EVEL	WATI LEVE	EL	THE A		
		11/29/18		18.	) NA	N	A	NA		Non	C	SHEET		
	IC											EXPLA		
	LETED: 11/29/18										T	ERMIN		
DR: <b>B</b> '	T LG: BB Rig: RC-1											IH	$\frac{15 \text{ LOC}}{01 \text{ DI}}$	



AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	B	-36	(p. 1	of 1	)
PROJE	CT: West Rapid Sul	ostation;	Rapid C	ity, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLI TYPE	E REC	FIEL	D & LA	ABORA	TORY	TESTS
FEET		DESCRIPTIO	ON				MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREO	GATE SUF	RFACINĢ		SURFACIING	-								
2 -	FILL, Silty Lean Clay wi	th Sand, red	ddish	┘ 🞆	FILL									
3 -	brown, gypsum, claystone present (CL)	e and coal f	ragments											
4														
5 —														
6 -														
7 -														
8 -														
9 -							М							
10 - 11 -	SILTY LEAN CLAY, re	ddish brow	n (CL)		ALLUVIUM	1								
11 - 12 -														
13 -														
14 -														
15 -														
16 -														
17 —														
18 -	Bottom of	Boring			1									
		8												
2														
DEP	TH: DRILLING METHOD			WAT	ER LEVEL MEA	L ASUR	L EMEN	TS				NOTE:	REEE	R TO
		DATE	TIME	SAMP DEP	LED CASING TH DEPTH	CAV	/E-IN PTH	DRILL	ING	WAT LEVE		THE A		
	8.0 4" FA	11/29/18		18.			РТН [ <b>А</b>	FLUID L		Non		SHEET		
		11/29/10		10.			A			TION	C	EXPLA		
DEP DEP BORIN COMP	IG LETED. 11/30/10											ERMIN		
$\frac{COMP}{UR: \mathbf{B}}$	<u>LETED: 11/29/18</u> T LG: BB Rig: RC-1											TH	IS LOO	3
	I LO. DD Kig: KU-I													TD 04



## ENGINEERING TESTING, INC.

AET JO	DB NO: <b>17-03356</b>				LC	OG OF	BORING	NO	B-	36A	<b>(p.</b> ]	lof	1)
PROJE	CT: West Rapid Sub	ostation; Rapid	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:			GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	BORA	TORY	TESTS
FËÈT		DESCRIPTION					TYPE	IN.	WC	DEN	LL	PL	%-#20
1	LIMESTONE AGGREC	GATE SURFACI	NG	SURFACIING FILL	Ì								
2 -	FILL, Silty Lean Clay wit	th Sand, reddish		TILL									
3 —	brown, gypsum, claystone present (CL)	and coal fragment	ts										
4 -													
5 —													
6 -													
7 -													
8 — 9 —						М							
10 -		11.11				101							
11 -	SILTY LEAN CLAY, rec	idish brown (CL)		ALLUVIUM									
12 -													
13 -	-												
14 —													
15 —													
16 -													
17 -													
18 -	Bottom of	Boring											
5													
DEP	PTH: DRILLING METHOD		WAT	ER LEVEL MEA	L ASUR	L EMEN						DEEE	
		DATE TIME	CAMD			/E-IN PTH	DRILLI FLUID LI	NG	WAT] LEVE		NOTE: THE A		
	18.0 4" FA							EVEL			SHEET		
		11/29/18	18.	0 NA		A	NA		Non	e	XPLA		
DEP DEP BORIN COMP	NG 1 ETED. 11/20/19										ERMIN		
	LETED: 11/29/18 T LG: BB Rig: RC-1											IS LO	
DR: B	I LU: DD Kig: KU-I												



AET JO	DB NO: <b>17-03356</b>				LC	DG OF	BORING N	NO	B-	36B	<b>(p.</b> 1	l of 1	l)
PROJE	CT: West Rapid Sul	ostation; Rapid	City, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:		_	GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	ABORA	TORY	TESTS
FËET		DESCRIPTION				me	ТҮРЕ	IN.	WC	DEN	LL	PL	%-#20
1	LIMESTONE AGGREC	GATE SURFACI	NG =	SURFACIINC FILL	Î -								
2 -	FILL, Silty Lean Clay wi	th Sand, reddish		TILL									
3 -	brown, gypsum, claystone present (CL)	e and coal fragmen	ts	X									
4 -				×									
5 —				×									
6 -				×									
7 -				×									
8 - 9 -				×		М							
10 -		11.11				141							
11 -	SILTY LEAN CLAY, red	ddish brown (CL)		ALLUVIUM									
12 -													
13 -													
14 -													
15 -													
16 -	-												
17 -													
18 -	Bottom of	Boring											
0													
DEP DEP	PTH: DRILLING METHOD		WAT	ER LEVEL ME	L ASUR	EMEN	UTS				NOTE:	REEE	R TO
		DATE TIME	CAM			/E-IN PTH	DRILLI FLUID LE	NG	WAT LEVE		THE A		
	18.0 4" FA	11/29/18	18.			A NA	FLUID LE NA	VEL	Non		SHEET		
		11/2/10	10.			1.51		-+	1101		EXPLA		
BORIN	NG LETED: <b>11/29/18</b>									T	ERMIN	IOLOC	GY ON
$\frac{1}{2}$ DR: <b>B</b>											TH	IS LOO	3
	- 20.20 100.001	I I			I		I						



## ENGINEERING TESTING, INC.

#### SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	OG OF	BORIN	G NO.	B-	36C	<b>(p.</b> ]	lof	1)
PROJE	ECT: West Rapid Su	bstation;	Rapid Ci	ty, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMI TYP	LE RE		D & LA	BORA	TORY	TESTS
FEET		DESCRIPTIO					me	TYP	E IN	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGRE	GATE SUR	RFACING		SURFACIING FILL	-								
2 -	<b>FILL</b> , Silty Lean Clay w	ith Sand, rec	ddish	′ 🞆	FILL									
3 -	brown, gypsum, clayston present (CL)	e and coal fi	ragments											
4 -														
5 -	-													
6 -	-													
7 -	-													
8 - 9 -	]						М							
9 – 10 –							IVI							
11 -	SILTY LEAN CLAY, ro	eddish brown	n (CL)		ALLUVIUM									
12 -	-													
13 -	-													
14 -	-													
15 -	-													
16 -	-													
17 -	_													
18 -	Bottom of	f Boring												
5														
DEF	PTH: DRILLING METHOD	   T			ER LEVEL MEA					MI A T		NOTE:	REFE	R TO
1	18.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	DE	/E-IN PTH	FLUII	LLING DLEVEL	WAT LEVI		THE A		
		11/29/18		18.	) NA	N	A	I	IA	Nor	le	SHEET		
	NG											EXPLA		
	NG PLETED: <b>11/29/18</b>										T	ERMIN		
DR: B	BT LG: BB Rig: RC-1												IS LO	



### ERING G. INC.

## SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	OG OF	BOI	RING N	10	<b>B-</b>	36D	<b>(p.</b> 1	l of 1	1)
PROJE	ECT: West Rapid Sul	bstation; R	apid Cit	y, So	outh Dakota	a									
DEPTH	SURFACE ELEVATION:				GEOLOGY	N	MC	SA	MPLE YPE	REC	FIELI	) & LA	BORA	TORY	TESTS
IN FEET	MATERIAL	DESCRIPTION		_			MC	T	YPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREO	GATE SURF	FACING		SURFACIING FILL										
2 -	FILL, Silty Lean Clay wi	th Sand, redd	lish		FILL										
3 -	brown, gypsum, claystone present (CL)	e and coal fra	gments												
4 -															
5 -	-														
6 -	-														
7 -	1														
8 -	1						1.4								
9 - 10 -	]						Μ								
10 -	SILTY LEAN CLAY, re	ddish brown	(CL)		ALLUVIUM										
12 -	-														
13 -															
14 -	-														
15 -	-														
16 -	-														
17 -															
18 -	Bottom of	Boring													
2															
		1													
DEI	PTH: DRILLING METHOD				ER LEVEL MEA								NOTE:	REFE	R TO
	18.0 4" FA	DATE	TIME SA	AMPL DEPT	ED CASING H DEPTH	CAV DE	/E-IN PTH	D FLU	RILLIN JID LE	NG VEL	WATI LEVE	ER   , EL	THE A	TTAC	HED
		11/29/18		18.0			A		NA		Non	e	SHEET	S FOF	R AN
												E	XPLA	NATIC	ON OF
DEI DEI BORIN COMP	NG PLETED: <b>11/29/18</b>											T	ERMIN		
$DR: \mathbf{B}$	T LG: BB Rig: RC-1													$\frac{15 \text{ LOC}}{01 \text{ DI}}$	



## SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	G OF	BORING	NO	B	-37	(p. 1	<b>of 1</b> ]	)
PROJE	ECT: West Rapid Sub	ostation; R	apid City	y, So	outh Dakota	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIELI	) & LA	ABORA	TORY	TESTS
FEET		DESCRIPTION	1				MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREC	GATE SURF			SURFACIING									
2 -	FILL, Silty Lean Clay with	th Sand, redd	lish		FILL									
3 -	brown, gypsum, claystone present (CL)	and coal frag	gments											
4 -														
5 —	-													
6 -	-													
7 -	-													
8 -	-													
9 -	-						M							
10 - 11 -	SILTY LEAN CLAY, red	ldish brown (	(CL)		ALLUVIUM									
11 - 12 -														
13 -	_													
14 -														
15 -	_													
16 -	-													
17 —	_													
18 -	Bottom of	Boring												
		8												
2														
10121														
2														
DEP	PTH: DRILLING METHOD		v	VATE	ER LEVEL MEA	SUR	EMEN	ITS	1	1	 	NOTE:	BEEE	R TO
		DATE		MPL DEPT			'E-IN PTH	DRILL	NG	WATI LEVE		THE A		
	18.0 4" FA	11/29/18						FLUID L				SHEET		
		11/27/10		18.0	NA	1	A	NA		Non	C	EXPLA		
DEP DEP	NG 1 ETED. 11/20/19											ERMIN		
$\frac{COMP}{\frac{1}{2}}$ DR: <b>B</b>	<u>LETED: 11/29/18</u> T LG: <b>BB</b> Rig: <b>RC-1</b>												IS LOO	
	T LG: BB Rig: RC-1		I											



## SUBSURFACE BORING LOG

AET JO	DB NO: <b>17-03356</b>						LC	OG OF	BO	RING N	NO	<b>B-</b>	37A	<b>(p.</b> )	lof	1)
PROJE	CT: West Rapid Sul	ostation;	Rapid C	ity, S	outh	Dakot	a									
DEPTH IN FEET	SURFACE ELEVATION:				GEO	LOGY	N	MC	SA	MPLE YPE	REC	FIEL	D & L/	ABORA	TORY	TESTS
FEET	MATERIAL	DESCRIPTI	ON				IN	MC	T	YPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1 -	LIMESTONE AGGREO	GATE SUI	RFACING			ACIING	-									
$\begin{vmatrix} 1 \\ 2 \\ - \end{vmatrix}$	FILL, Silty Lean Clay wi	th Sand, re	ddish	-/ 🞆	FILL											
3 -	brown, gypsum, claystone	e and coal f	fragments		X											
4 -	present (CL)				×											
5																
6 -					×.											
7 —					×.											
8 -					X											
9								М								
10 -	SILTY LEAN CLAY, re	ddish brow	m (CL)	-))))	ALLU	VIUM										
11 -			II (02)													
12 -																
13 -																
14 -																
15 —																
16 -																
17 -																
18 -	Bottom of	Boring														
2																
-																
DEP	TH: DRILLING METHOD			WAT	ER LEV	EL MEA	L ASUR	EMEN			I	1	<u> </u>	NOTE:	REE	
		DATE	TIME	SAMP DEP		ASING DEPTH		'E-IN PTH	Г	RILLI	NG	WAT LEVE		THE A		
DEP DEP	18.0 4" FA								FL	UID LE	VEL			SHEET		
		11/29/18		18.	U	NA		A		NA		Non		EXPLA		
BORIN	NG 14/20/40								-					ERMIN		
	LETED: 11/29/18												<sup>1</sup>		IS LO	
DR: B	T LG: BB Rig: RC-1															



## RING

PROJECT: West Rapid Substation; Rapid City, South Dakota         DEPTH INFEET       SURFACE ELEVATION: MATERIAL DESCRIPTION       GEOLOGY       N       MC       SAMPLE TYPE       REC IVE       FIELD & LABORATON         UP       LIMESTONE AGGREGATE SURFACING 10 inches       SURFACING       SURFACING SURFACING       N       MC       SAMPLE TYPE       REC IV.       FIELD & LABORATON         2       -       LIMESTONE AGGREGATE SURFACING 0 brown, gypsum, claystone and coal fragments present (CL)       -       SURFACING FILL       -	
LIMESTONE AGGREGATE SURFACING 1 - U0 inches FILL, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments resent (CL) 4 - 5 - 6 - 7 - 8 - 9 - 10 SILTY LEAN CLAY, reddish brown (CL) ALLUVIUM M M M M M M	
LIMESTONE AGGREGATE SURFACING 1 - U0 inches FILL, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments resent (CL) 4 - 5 - 6 - 7 - 8 - 9 - 10 SILTY LEAN CLAY, reddish brown (CL) ALLUVIUM M M M M M M	Y TEST
1 10 inches   2 FILL, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL)   4   5   6   7   8   9   10   11   12   13   14   15   16   17   18	<b>~</b> %-#20
FILL, Silty Lean Clay with Sand, reddish brown, gypsum, claystone and coal fragments present (CL) 4 - 5 - 6 - 7 - 8 - 9 - 10 11 - 12 - 13 - 14 - 15 - 16 - 17 -	
3 - present (CL)         4 -         5 -         6 -         7 -         8 -         9 -         10         SILTY LEAN CLAY, reddish brown (CL)         ALLUVIUM         M         11 -         12 -         13 -         14 -         15 -         16 -         17 -         18	
4 - 5 - 6 - 7 - 8 - 9 - 9 - 9 - 9 - 9 - 10 - <b>SILTY LEAN CLAY</b> , reddish brown (CL) ALLUVIUM M M M - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 14 - 15 - 16 - 17 - 18 - 14 - 15 - 16 - 17 - 18 - 14 - 15 - 16 - 17 - 18 - 18 - 18 - 18 - 18 - 18 - 18	
6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 -	
7 -       8 -         9 -       9 -         10       SILTY LEAN CLAY, reddish brown (CL)         11 -       12 -         13 -       14 -         15 -       16 -         17 -       18 -	
$ \begin{array}{c} 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ 13 \\ 14 \\ 15 \\ 16 \\ 16 \\ 17 \\ 18 \\ \end{array} $ M M M M M M M M M M M M M M M M M M	
9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18	
10       SILTY LEAN CLAY, reddish brown (CL)         11 -         12 -         13 -         14 -         15 -         16 -         17 -         18	
SILTY LEAN CLAY, reddish brown (CL) 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18	
$ \begin{array}{c} 11 - \\ 12 - \\ 13 - \\ 14 - \\ 15 - \\ 16 - \\ 17 - \\ 18 \end{array} $	
$ \begin{array}{c} 13 - \\ 14 - \\ 15 - \\ 16 - \\ 17 - \\ 18 \end{array} $	
$ \begin{array}{c} 14 - \\ 15 - \\ 16 - \\ 17 - \\ 18 \end{array} $	
Bottom of Boring	
DEPTH: DRILLING METHOD WATER LEVEL MEASUREMENTS NOTE: RE	FER TO
18.0     4" FA     DATE     TIME     SAMPLED DEPTH     CASING DEPTH     DRILLING DEPTH     WATER LEVEL	CHED
1010     111       11/29/18     18.0     NA     NA     None     SHEETS F	OR AN
EXPLANA'	
DEPTH:       DRILLING METHOD       VATER LEVEL MEASUREMENTS       NOTE: RE         18.0       4" FA       DATE       TIME       SAMPLED       CASING       CAVE-IN       DRILLING       WATER       THE ATTA         11/29/18       18.0       NA       NA       NA       None       EXPLANATION	TION OF
DR: BT LG: BB Rig: RC-1 THIS I	



AET JOB NO:	17-03356					LC	OG OF	BO	RING N	IO	<b>B-</b> .	37C	<b>(p.</b> 1	lof	1)
PROJECT:	West Rapid Sul	ostation;	Rapid Ci	ity, S	outh Dakot	a									
DEPTH IN FEET SURI	FACE ELEVATION:				GEOLOGY	N	MC	SA	MPLE YPE	REC	FIELI	) & LA	BORA	TORY	TESTS
	MATERIAL						MC	Т	YPE	IN.	WC	DEN	LL	PL	%-#20
$1 \rightarrow 10$ inch	STONE AGGRE(	GATE SUF	RFACING		SURFACIING	Ì									
2 - FILL,	Silty Lean Clay wi	th Sand, re	ddish	′	FILL										
3 - brown, present	gypsum, claystone	e and coal f	ragments												
4 - present															
5 —															
6 —															
7 —															
8 -															
9 —							М								
10 SILTY	LEAN CLAY, red	ddish brow	n (CL)		ALLUVIUM	-									
11 -															
12 -															
13 - 14 -															
16 -															
17 -															
18		D :						I							
	Bottom of	Boring													
DEPTH: DI	RILLING METHOD				ER LEVEL MEA	1					117 4 777		NOTE:	REFE	R TO
18.0 4'	' FA	DATE	TIME	SAMP DEP	LED CASING TH DEPTH		/E-IN PTH	FLU	ORILLIN UID LE	VEL	WATI LEVE	EL	THE A		
		11/29/18		18.	0 NA	N	A		NA		Non	e	SHEET		
													XPLA		
DEPTH: DI 18.0 4' BORING COMPLETED:	11/29/18											T	ERMIN		
DR: <b>BT</b> LG:	BB Rig: RC-1													IS LOO	



AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BOI	RING N	IO	<b>B-</b> .	37D	<b>(p.</b> 1	lof	1)
PROJE	CT: West Rapid Su	bstation; R	apid City, S	Sout	h Dakota	a									
DEPTH IN FEET	SURFACE ELEVATION:			Gl	EOLOGY	N	MC	SA	MPLE YPE	REC	FIELI	) & LA	BORA	TORY	TESTS
FEET		DESCRIPTION					MC	Т	YPE	IN.	WC	DEN	LL	PL	%-#20
1	LIMESTONE AGGRE	GATE SURF	ACING		RFACIING										
2 -	FILL, Silty Lean Clay wi	th Sand, redd	ish 🛛	FIL	L										
3 -	brown, gypsum, clayston present (CL)	e and coal frag	gments	8											
4				8											
5 —				8											
6 -				8											
7 —				8											
8				8											
9 —				8			М								
10 -	SILTY LEAN CLAY, re	ddish brown (	(CL)	ALI	LUVIUM										
11 -															
12 -															
13 -															
14 — 15 —															
15 -															
17 -															
18 -		~ .													
10	Bottom of	Boring													
5															
1															
DEP	TH: DRILLING METHOD		WA	TER L	EVEL MEA	SUR	EMEN	TS				N	IOTE:	REFE	R TO
1		DATE	TIME SAMI	PLED	CASING DEPTH	CAV	'E-IN PTH	D	RILLIN JID LE	NG VEI	WATI LEVE	ER ,	ГНЕ А	TTAC	HED
	18.0 4" FA	11/29/18	18		NA		[ <b>A</b>		NA	·	Non	_	SHEET		
				••	11/1	1			1 1 <b>1 1</b>	-+	1 1011		XPLA	NATIO	ON OF
DEP DEP	NG LETED: <b>11/29/18</b>											TI	ERMIN	IOLOC	GY ON
$\frac{1}{2}$ DR: <b>B</b>										-+			TH	IS LOO	3
	1 10. DD Mg. NC-1														ID A



## SUBSURFACE BORING LOG

AET JOB NO: <b>17-03356</b>					LC	G OF	BORING	NO	B	-38	(p. 1	of 1	)
PROJECT: West Rapid Su	bstation;	Rapid C	ity, S	outh Dakot	a								
DEPTH IN FEET SURFACE ELEVATION: MATERIAL				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIELI	) & LA	BORA	TORY	TESTS
	DESCRIPTIO					WIC	TYPE	IN.	WC	DEN	LL	PL	%-#20
$1 \rightarrow 10 \text{ inches}$	GATE SUR	RFACINĢ		SURFACIING									
7 – <b>FILL</b> , Silty Lean Clay w	ith Sand, rec	ddish	- 🎆	FILL									
3 - brown, gypsum, clayston present (CL)	e and coal fi	ragments											
4 -													
5 —													
6 —													
7 —													
8 -						М							
9 -													
10 - SILTY LEAN CLAY, re	ddish brown	n (CL)		ALLUVIUM	1								
15 -													
16 CLAYSTONE, Silty Lea	m Class and			SPEARFISH	-								
17 - lenses present (CL)	in Clay, red,	, gypsum		FORMATION		$ \frac{\bigvee}{\bar{W}} $							
18 Bottom of	Boring					w							
	201118												
DEPTH: DRILLING METHOD 18.0 4" FA BORING COMPLETED: 11/29/18			WAT	ER LEVEL MEA		EMEN	  TS						
DEFTII. DRILLING METHOD	DATE					EMEN E-IN	DRILLI	NG	WATI	7D	NOTE:		
18.0 4" FA	DATE	TIME	SAMPI DEPT		DE	РТН	FLUID LI	ËVEL	LEVE	EL	THE A		
	11/29/18		18.0	) NA	N	A	NA		17.(	,	SHEET		
BORING											EXPLA		
										1	ERMIN	IS LOC	
DR: BT LG: BB Rig: RC-1											IH		



AET J	OB NO: <b>17-03356</b>					LO	DG OF	BORIN	G NO.	B	-39	(p. 1	of 1	)
PROJE	ECT: West Rapid Sul	ostation;	Rapid C	ity, S	outh Dakot	a								
DEPTH	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPI TYPE	LE REC	FIEL	D & LA	ABORA	TORY	TESTS
IN FEET	MATERIAL						IVIC	TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1 -	LIMESTONE AGGREC	GATE SUI	RFACING		SURFACIINC FILL	Ĭ								
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	- 🎆	FILL									
3 -	brown, gypsum, claystone present (CL)	and coal f	ragments											
4 -	with possible gypsum bou	lder presei	nt											
5 -		p												
6 -	-													
7 -	-													
8 - 9 -							М							
10 -			(											
11 -	SILTY LEAN CLAY, red	dish brow	m (CL)		ALLUVIUM									
12 -	-													
13 -	-													
14 -	-													
15 -														
16 -	with strong hydrocarbon of <b>CLAYSTONE</b> , Silty Leas				SPEARFISH		<u> </u>							
17 -	lenses present (CL)	il Clay, Icu	, gypsum		FORMATION	I	W							
18 -	Bottom of	Boring			-									
81/6/														
IIAO CORP 17/33365 GPJ AET+CPT +WELL-GDJ 12/3718 IIAO COMP														
DEI	PTH: DRILLING METHOD				ER LEVEL ME					<b>-</b>		NOTE:	REFE	R TO
GPJ -	18.0 4" FA	DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH		VE-IN PTH	DRIL FLUID	LING LEVEL	WAT LEVI	ER EL	THE A	TTAC	HED
3356.		11/29/18		18.	0 NA	N	IA	N	A	16.	0	SHEET	ΓS FOF	R AN
											E	EXPLA	NATIO	ON OF
BORIN COMP	NG PLETED: <b>11/29/18</b>										Т	ERMIN		
DR: B	BT LG: BB Rig: RC-1												IS LOO	



AET JO	OB NO: <u>17-03356</u>					LC	OG OF	BORING	NO	B	-40	(p. 1	of 1	)
PROJE	ECT: West Rapid Sul	ostation;	Rapid C	ity, So	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIEL	D & LA	BORA	TORY	TESTS
FEET							MC	TYPE	IN.	WC	DEN	LL	PL	%-#20
1 -	LIMESTONE AGGREC	GATE SUI	RFACING	_	SURFACIING FILL									
2 -	FILL, Silty Lean Clay wi	th Sand, re	ddish	- XXX	TILL									
3 -	brown, gypsum, claystone present (CL)	e and coal f	ragments											
4 -														
5 -	-													
6 -	-													
7 - 8 -							М							
8 – 9 –	-													
10 -		1.1. 1. 1												
11 -	SILTY LEAN CLAY, red	adish brow	m (CL)		ALLUVIUM									
12 -														
13 -	-													
14 -	-													
15 -							$  \underline{\nabla}  $							
16 -	<b>CLAYSTONE</b> , Silty Lear	n Clay, red	, gypsum		SPEARFISH FORMATION		W							
17 - 18 -	lenses present (CL)				FORMATION									
10	Bottom of	Boring												
DEF	PTH: DRILLING METHOD			WATE	ER LEVEL MEA	SUR	I EMEN	TS	<u> </u>		,   ,	NOTE:	REFE	
		DATE	TIME	SAMPL DEPT	ED CASING H DEPTH	CAV	/E-IN PTH	DRILLI FLUID L	NG	WAT] LEVI	ER	THE A		
	18.0 4" FA	11/29/18		18.0			РТН [ <b>А</b>	FLUID L		15.5		SHEET		
		11/4/10		10.0		1	11	11/1		13.		XPLA	NATIO	ON OF
DEF 1 BORIN COMP	NG PLETED: <b>11/29/18</b>										T	ERMIN	IOLOG	GY OI
$DR: \mathbf{B}$												TH	IS LO	G
			ı – – – – – – – – – – – – – – – – – – –					1						



## SUBSURFACE BORING LOG

AET JOB	NO: <b>17-03356</b>						LO	G OF	BORI	NG NO		B	-41	( <b>p.</b> 1	<b>of 1</b>	)
PROJECT	West Rapid Sub	ostation;	Rapid C	ity, S	outh I	Dakot	a									
DEPTH IN FEET	SURFACE ELEVATION:				GEOI	LOGY	N	MC	SAM	PLE R PE I	EC	FIELI	) & LA	BORA	TORY	TESTS
	MATERIAL							WIC	TYI	'E I	N.	WC	DEN	LL	PL	%-#20
	LIMESTONE AGGREC	GATE SUF	RFACING			ACIING										
	FILL, Silty Lean Clay wit	th Sand, red	ddish	′	FILL											
$3 - \frac{1}{r}$	prown, gypsum, claystone present (CL)	and coal f	ragments													
4 -																
5 —																
6 -																
7 —																
8 -								М								
9 -																
10 5	SILTY LEAN CLAY, red	ldish brow	n (CL)		ALLU	VIUM										
11 -																
12 — 13 —																
13 - 14 -																
14 - 15 -																
10		~1						$\sum$								
	CLAYSTONE, Silty Lean enses present (CL)	n Clay, red,	, gypsum		SPEAF FORM	RFISH ATION		W								
18	Bottom of	Doning														
	Bottom	Doring														
DEPTH 18. BORING COMPLE									TC							
DEPTH	H: DRILLING METHOD				ER LEV						,	W/ A TT	7D	NOTE:		
18.	0 4" FA	DATE	TIME	SAMPI DEPT		ASING EPTH	DE	'E-IN PTH	FLUII	LLING D LEVI	EL	WATE LEVE	L	THE A		
		11/29/18		18.	0	NA	N	Α	]	NA		16.0		SHEET		
Dopper														XPLA		
	TED: <b>11/29/18</b>												T	ERMIN		
DR: <b>BT</b>	LG: <b>BB</b> Rig: <b>RC-1</b>														IS LOO	



## SUBSURFACE BORING LOG

AET JO	OB NO: <b>17-03356</b>					LC	OG OF	BORING	NO	B	-42	(p. 1	<b>of 1</b>	)
PROJE	ECT: West Rapid Sul	bstation; F	Rapid Ci	ity, S	outh Dakot	a								
DEPTH IN FEET	SURFACE ELEVATION:				GEOLOGY	N	MC	SAMPLE TYPE	REC	FIELI	) & LA	BORA	TORY	TESTS
FEET		DESCRIPTIO					WIC	TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #20
1 -	LIMESTONE AGGREC	GATE SUR	FACINĢ		SURFACIING									
2 -	FILL, Silty Lean Clay wi	th Sand, red	dish	┘ 💥	FILL									
3 -	brown, gypsum, claystone present (CL)	e and coal fra	agments											
4 -	()													
5 -	-													
6 -	-													
7 -	-													
8 -	-						М							
9 -														
10 - 11 -	SILTY LEAN CLAY, re	ddish brown	(CL)		ALLUVIUM									
11 - 12 -	]													
13 -														
14 -	-													
15 -	-													
16 -	CLAYSTONE, Silty Lea	n Clay rad	aunalum)		SPEARFISH									
17 -	lenses present (CL)	li Clay, Ieu,	gypsum		FORMATION		$\frac{1}{\bar{W}}$							
18 -	Bottom of	Boring					vv							
		8												
2														
DEF	PTH: DRILLING METHOD			WAT	ER LEVEL MEA	I ASURI	EMEN	TS			 	NOTE:	REFE	R TO
		DATE	TIME	SAMPI DEPT	LED CASING H DEPTH	CAV	E-IN	DRILLI	NG	WATI	ER	THE A		
	18.0 4" FA	11/29/18		18.0			РТН [ <b>А</b>	FLUID LI NA		LEVE 17.(	э <b>г</b>	SHEET		
		11/23/10		10.0			A	INA		1/.(	,	EXPLA		
DEF	NG NG ETED. 11/30/19											ERMIN		
$\overline{F}$ DR: <b>B</b>	<u>PLETED: 11/29/18</u> BT LG: BB Rig: RC-1												IS LOO	
	LU. DD KIG: KU-I													



**CONSULTANTS** 

- **GEOTECHNICAL**
- **MATERIALS**
- **ENVIRONMENTAL**
- **FORENSICS**



## **REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW**

WEST RAPID SUBSTATION TRANSMISSION LINE POLES RAPID CITY, SOUTH DAKOTA

AET No. 17-03356

Date:

January 16, 2019

**Prepared for:** 

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57702



January 16, 2019

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57702

Attn: Mr. Ron Williams, PE

RE: Geotechnical Exploration and Review West Rapid Substation Transmission Line Poles Rapid City, South Dakota Report No.17-03356

Dear Ron,

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed transmission line poles to be constructed as part of the West Rapid Substation project, in Rapid City, South Dakota. These services were performed in general accordance with our proposal dated December 5, 2018 and the signed Statement of Services No. 38863, Change Order No. 4, dated December 17, 2018. We are submitting one (1) electronic copy of the report to you.

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in the Appendix entitled "Geotechnical Report Limitations and Guidelines for Use".

Please contact our office if you have any questions about the report. We can also be contacted to arrange the observation and testing services during construction of the project.

Sincerely, American Engineering Testing, Inc.

Walt Feeger, P.E. Senior Geotechnical Engineer Phone: (605) 388-0029 wfeeger@amengtest.com

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#### SIGNATURE PAGE

Prepared for:

Black Hills Energy 7001 Mt. Rushmore Road Rapid City, South Dakota 57701

Attn: Mr. Ron Williams, PE

Prepared by:

American Engineering Testing, Inc. 1745 Samco Road Rapid City, South Dakota 57702

Report Authored By:

Walt Feeger, P.E. Senior Geotechnical Engineer



Peer Review Conducted By:

Robert Temme, P.E. Vice President – Western Region

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#### **1.0 INTRODUCTION**

We understand a new transmission line will be constructed as part of the proposed West Rapid Substation project in Rapid City, South Dakota. Please refer to the Site Location Map in Appendix A for the approximate location of the sites. To assist with the planning and design, American Engineering Testing, Inc. (AET) has been authorized to conduct a subsurface exploration program at the locations of the transmission poles, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services, and provides our engineering recommendations based on this data.

#### 2.0 SCOPE OF SERVICES

AET's services were performed in general accordance with our proposal dated December 5, 2018.

The authorized scope consists of the following:

- Eight (8) standard penetration test (SPT) borings at the proposed transmission pole locations to depths of about 50 feet below existing grade.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination.

#### **3.0 PROJECT INFORMATION**

AET recently completed the geotechnical services for the proposed West Rapid Substation project, and submitted our findings and recommendations in our Report No. 17-03356, dated May 31, 2018. We understand that, as part of the new substation, a transmission line will also be required. Furthermore, we understand these types of pole structures are typically placed on reinforced concrete drilled piers (caissons). The following loading information at the respective boring locations was provided by HDR Engineering, Inc.

• B-1

Moment: 13,000 ft-k Shear Force: 185 kips Vertical Force: 85 kips

• B-3

Moment: 18,900 ft-k Shear Force: 205 kips Vertical Force: 125 kips

- B-4 Moment: 11,100 ft-k Shear Force: 135 kips Vertical Force: 65 kips
   B-5
  - Moment: 3,000 ft-k Shear Force: 35 kips Vertical Force: 65 kips
  - B-6 Moment: 2,000 ft-k Shear Force: 40 kips Vertical Force: 25 kips
    - B-7 Moment: 5,300 ft-k Shear Force: 75 kips Vertical Force: 35 kips
- B-8

•

Moment: 3,500 ft-k Shear Force: 55 kips Vertical Force: 100 kips

The previously stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

#### 4.0 SUBSURFACE EXPLORATION AND TESTING

#### 4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of eight (8) SPT borings which were drilled on December 19-21 and 27, 2018. The borings were located in the field by HDR personnel at the approximate locations shown on the Boring Location Map within Appendix A. Surface elevations at the boring locations were also provided by HDR.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

#### 4.2 Laboratory Testing

The laboratory test program included water content, dry density, unconfined compression, swell-consolidation. The laboratory test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed with the exception of the unconfined compression and swell-consolidation tests, which can be found on separate sheets within Appendix A of this report.

#### **5.0 SITE CONDITIONS**

#### **5.1 Surface Observations**

At the time of our field work, the areas surrounding the proposed transmission pole locations consisted of the existing Black Hills Energy Service Center (Borings B-3 through B-8) facility as well as vacant tracts of property around Borings B-1 and B-2, which were vegetated with native grasses and weeds.

#### 5.2 Subsurface Soils/Geology

Underlying a thin layer of gravel surfacing or topsoil, the following subsurface conditions were encountered at the boring locations:

Boring B-1: Approximately 19<sup>1</sup>/<sub>2</sub> feet of alluvium comprised of medium dense silty sands, firm to hard sandy lean clays, and dense to very dense sandy gravels overlying shale bedrock, associated with the Sundance Formation, which extended to the total depth explored.

Boring B-2: Approximately 7 feet of alluvium comprised of very stiff fat clay and hard silty lean clay overlying stiff to very stiff weathered to hard, competent shale bedrock, associated with the Spearfish Formation, which extended to the total depth explored.

Boring B-3: Approximately 9½ feet of alluvium comprised of hard silty lean clays and very dense sandy gravels overlying hard shale of the Sundance Formation, over gypsum and hard siltstone bedrock of the Gypsum Spring Formation, which extended to the total depth explored.

Boring B-4: Near surface hard shale of the Sundance Formation was encountered overlying gypsum, and interbedded hard siltstone and shale bedrock of the Gypsum Spring Formation, which extended to the total depth explored.

Boring B-5: Approximately 14 feet of lean to fat clay fill was encountered overlying about 3<sup>1</sup>/<sub>2</sub> feet of firm sandy lean clay alluvium. The alluvium in underlain by hard weathered to competent shale of the Spearfish Formation, which extended to the terminal boring depth.

Boring B-6: About 9 feet of silty lean clay fill overlying approximately 13<sup>1</sup>/<sub>2</sub> feet of alluvium comprised of soft to firm lean clays. The alluvium is underlain by stiff to hard weathered to competent shale, associated with the Spearfish Formation.

Boring B-7: Near surface stiff to hard weathered to competent shale bedrock, associated with the Spearfish Formation was encountered to the total depth explored. Approximately 10 feet of gypsum was encountered at a depth of about 25 feet below grade.

Boring B-8: Approximately 4<sup>1</sup>/<sub>2</sub> feet of lean clay fill was encountered overlying about 9<sup>1</sup>/<sub>2</sub> feet of alluvium comprised of very stiff fat clay and very stiff lean clay. The alluvium is underlain by hard weathered to competent shale bedrock of the Spearfish Formation.

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A of this report.

#### 5.3 Groundwater

At the time of our field work, measurable groundwater was encountered at the approximate noted depths in the following borings:

B-1: 7½ feet below grade (BG)B-2: 15 feet BGB-5: 8 feet BGB-6: 11 feet BGB-7: 20 feet BG

The presence or lack of groundwater noted at the boring locations should not be taken as an accurate representation of the actual groundwater levels. Groundwater level fluctuations occur due to seasonal variations in the amount of precipitation, surface drainage, local irrigation practices, level of water in Rapid Creek, and other factors not evident at the time the borings were performed. Due to the relatively low permeability of the clay/silt soils and shale/siltstone bedrock encountered in the borings, a relatively long period of time may be needed for a groundwater level to develop and/or stabilize in the borings.

The possibility of encountering groundwater and associated fluctuations in groundwater levels should be considered when developing the design and construction plans for the project.

#### 6.0 RECOMMENDATIONS

#### 6.1 Discussion

Our recommendations in the following sections are based on our understanding of the project details at this time. The geotechnical engineer should be allowed to review the final project plans to verify the following recommendations remain applicable for construction.

Based on the field and laboratory data, it is our opinion drilled pier foundations can be used to support the proposed transmission line poles. For drilled piers, loadings should provide a theoretical safety factor of 2 or more with total and differential movements not exceeding 1-inch and 1/2-inch, respectively.

Additionally, it should be noted that gypsum is a common geologic feature found in the Spearfish Formation derived soils at this site. Once exposed, gypsum material can degrade which could cause future movement related distress to the structures, especially if water is introduced to the gypsum matrix. Therefore, drilled pier foundations <u>should not</u> terminate (end bear) on gypsum.

#### **6.2 Drilled Pier Foundation Recommendations**

Based on the results of the borings, laboratory testing, and our analysis, we have developed the following design parameters. We recommend all drilled piers bear at least 5 feet into the noted bedrock stratum with the recommended minimum length.

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
Lean Clay Alluvium	300	na
Gravel Alluvium	200	na
Shale Bedrock	1,000	20,000 (minimum pier length – 25')

#### **Boring B-1**

#### **Boring B-2**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
Lean Clay Alluvium	300	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier Length – 28')

#### **Boring B-3**

Soil Type	Soil Type Allowable Skin Friction Allow (psf)	
Frost Zone $(0-5')$	Ignore	Ignore
Lean Clay Alluvium	300	na
Gravel Alluvium	200	na
Shale Bedrock	1,000	20,000 (minimum pier length – 15') Do not end bear in gypsum formation
Siltstone Bedrock	750	20,000

#### **Boring B-4**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
Gypsum	na	na
Siltstone Bedrock	750	20,000 (minimum pier length – 20')

#### **Boring B-5**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone (0 – 5')	Ignore	Ignore
Lean to Fat Clay Fill	150	na
Lean Clay Alluvium	200	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 28')

#### **Boring B-6**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
Lean Clay Fill	150	na
Lean Clay Alluvium	200	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 43')

#### **Boring B-7**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
W. Shale Bedrock	300	na
Shale Bedrock	1,000	na
Gypsum	na	na
Shale Bedrock	1,000	20,000 (minimum pier length 40')

#### **Boring B-8**

Soil Type	Allowable Skin Friction (psf)	Allowable End Bearing Pressure (psf)
Frost Zone $(0-5')$	Ignore	Ignore
Lean to Fat Clay Alluvium	300	na
W. Shale Bedrock	300	na
Shale Bedrock	1,000	20,000 (minimum pier length – 23')

In designing to resist uplift,  $\frac{2}{3}$  of the allowable side friction values provided for compressive loading could be used along with the effective weight of the drilled shafts. Straight shaft piers with a minimum diameter of 18-inches are recommended. Proper reinforcing steel should be included in the drilled shaft designs.

Lateral deflections of drilled shafts should be evaluated using an appropriate design procedure, and would be dependent on shaft diameter, length, configuration, stiffness and "fixed head" or "free head" conditions.

Single pier lateral load capacity can be estimated using the following design parameters for the soil profile in a p-y analysis such as conducted using the computer program LPILE:

#### **Boring B-1**

Design Parameter	Lean Clay Alluvium	Gravel Alluvium	Shale Bedrock
Moist Unit Weight (pcf)	115	130	125
Undrained Shear Strength (psf)	500	na	4,000
Friction Angle (degrees)	18	34	15
Static Soil Modulus Parameter, k (pci)	100	125 (submerged)	2,000
Strain, ε <sub>50</sub> (in/in)	0.010	na	0.005

#### **Boring B-2**

Design Parameter	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock	
Moist Unit Weight (pcf)	115	120	125	
Undrained Shear Strength (psf)	1,000	1,500	4,000	
Friction Angle (degrees)	18	15	15	
Static Soil Modulus Parameter, k (pci)	500	500	2,000	
Strain, ε50 (in/in)	0.005	0.005	0.004	

#### **Boring B-3**

Design Parameter	Lean Clay Alluvium	Gravel Alluvium	Shale Bedrock	Gypsum	Siltstone Bedrock
Moist Unit Weight (pcf)	115	120	125	na	120
Undrained Shear Strength (psf)	1,000	na	4,000	na	6,000
Friction Angle (degrees)	18	34	10	na	15
Static Soil Modulus Parameter, k (pci)	500	225	2,000	na	2,000
Strain, ɛ50 (in/in)	0.005	na	0.005	na	0.004

#### **Boring B-4**

Design Parameter	Gypsum	Siltstone Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	na	120	125
Undrained Shear Strength (psf)	na	4,000	6,000
Friction Angle (degrees)	na	15	18
Static Soil Modulus Parameter, k (pci)	na	1,000	2,000
Strain, 850 (in/in)	na	0.004	0.004

#### **Boring B-5**

Design Parameter	Lean to Fat Clay Fill	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	110	115	120	125
Undrained Shear Strength (psf)	250	500	1,500	6,000
Friction Angle (degrees)	18	110         115         120         12           250         500         1,500         6,0           18         18         15         1           100         100         500         2,0	15	
Static Soil Modulus Parameter, k (pci)	100	100	500	2,000
Strain, ɛ50 (in/in)	0.020	0.010	0.005	0.004

#### **Boring B-6**

Design Parameter	Lean Clay Fill	Lean Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	110	110	120	125
Undrained Shear Strength (psf)	250	250	1,000	6,000
Friction Angle (degrees)	18	18	15	15
Static Soil Modulus Parameter, k (pci)	100	30	1,000	2,000
Strain, 850 (in/in)	0.010	0.020	0.005	0.004

#### **Boring B-7**

Design Parameter	W. Shale Bedrock	Shale Bedrock	Gypsum	Shale Bedrock
Moist Unit Weight (pcf)	120	120	na	125
Undrained Shear Strength (psf)	1,000	2,000	na	6,000
Friction Angle (degrees)	18	18	na	15
Static Soil Modulus Parameter, k (pci)	500	1,000	na	2,000
Strain, 850 (in/in)	0.005	0.005	na	0.004

#### **Boring B-8**

Design Parameter	Lean to Fat Clay Alluvium	W. Shale Bedrock	Shale Bedrock
Moist Unit Weight (pcf)	115	120	125
Undrained Shear Strength (psf)	1,000	1,500	6,000
Friction Angle (degrees)	18	15	15
Static Soil Modulus Parameter, k (pci)	500	500	2,000
Strain, 250 (in/in)	0.005	0.005	0.004

Drilling to design depths should be possible with conventional large drilled pier equipment. Difficult drilling should be anticipated where gypsum masses are encountered which may require rock cutting teeth and/or coring in order to advance the drilled pier hole. We highly recommend a separate bid item be provided in the bid documents that addresses drilling through the gypsum.

Additionally, it should be noted that cobbles and boulders as well as wet, sloughing soils should be expected within the gravel alluvium encountered in Boring B-1. The drilled pier contractor should have the proper muck buckets, casing and dewatering equipment on-site prior to advancing the pier holes. Additionally, auger flites and cutting teeth should be capable of removing cobble to boulder sized rock from the pier holes. Care should be taken so that the sides and bottom of the shaft excavations are not disturbed during drilling. The bottom of the shaft excavations should be free of loose material and water when concrete is placed. Concrete should be placed as soon as possible after the foundation excavation is completed to reduce the potential for disturbance of the bearing surface.

Groundwater was encountered at the time of our field work; therefore, the use of temporary casing will likely be required. The need for casing will depend on the conditions encountered at the time the pier excavations are made. A sufficient head of plastic concrete having a minimum slump on the order of 6-8 inches should be maintained inside the casing as it is withdrawn to prevent concrete arching and the influx of soil and water (if encountered) and creation of voids in the pier shaft.

Drilled shaft construction should be constructed in accordance with applicable portions of ACI 336.3R-93 or other similar, approved specification. Concrete mix should be designed utilizing cement to have a minimum 28-day compressive strength of 4,000 psi and a maximum water cement ratio of 0.45. A super plasticizer may be necessary to increase concrete slump/flow temporarily for drilled shaft placement.

Concrete should be on-site and ready for placement as soon as practical after each pier excavation is completed. Concrete placement in pier excavations should occur on the same day as pier excavation is completed.

We do not recommend free-fall concrete placement in piers. The use of a bottom-dump hopper, tremie, or pump, discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

A representative from AET should observe all drilled shaft excavations to evaluate the suitability of the bearing materials and to verify that conditions in the drilled shaft excavations are consistent with those encountered in the test borings. If unsuitable materials are encountered at planned depths, it may be necessary to deepen the shaft.

#### 7.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use".



AET Project No. 17-03356

Boring Log Notes Unified Soil Classification System Site Location Map Boring Location Map Subsurface Boring Logs Unconfined Compression Test Results Swell-Consolidation Test Results

#### A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling standard penetration test borings. The locations of the borings appear on the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

#### A.2 SAMPLING METHODS

#### A.2.1 Ring-lined barrel Samples - Calibrated to N<sub>60</sub> Values

Standard penetration (ring-lined barrel) samples were collected in general accordance with ASTM: D3550. The ASTM test method consists of driving a 2.5-inch O.D. thick-walled, split-barrel sampler lined with brass rings into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

#### A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

#### A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

#### A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

Visual-manual judgment of the AASHTO Soil Group is also noted as a part of the soil description. A chart presenting details of the AASHTO Soil Classification System is also attached.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

#### A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

#### A.5 LABORATORY TEST METHODS

#### A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

#### A.5.2 Atterberg Limits Tests

Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

#### A.5.3 Sieve Analysis of Soils (thru #200 Sieve)

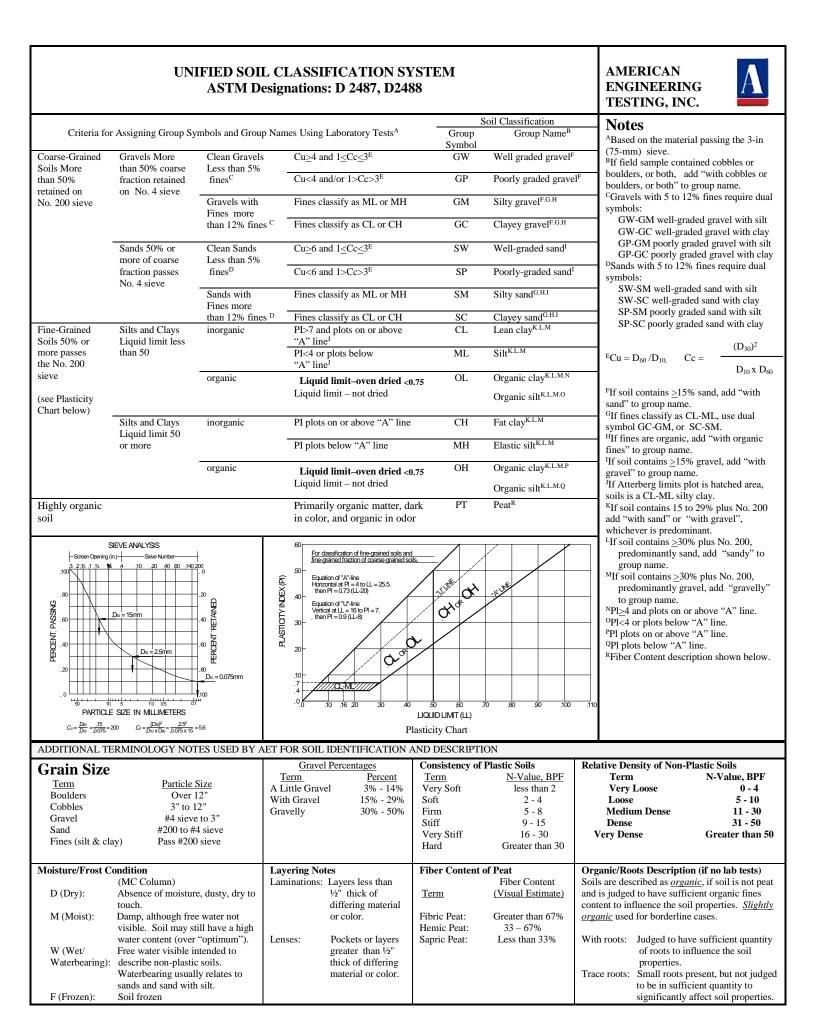
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

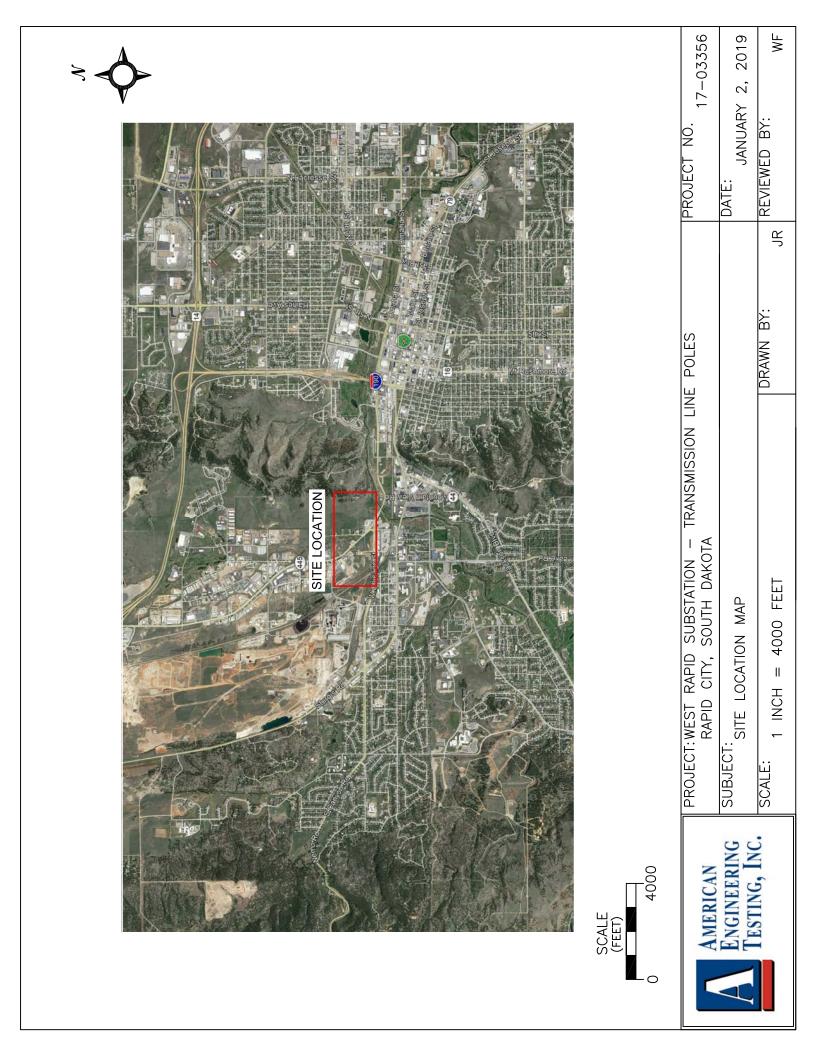
#### A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

#### A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.









AET JO	B NO: <b>17-03356</b>					LO	G OF	во	RING N	NO	B	-1 (	( <b>p.</b> 1	of 1	)
PROJE	CT: West Rapid Sul	bstation -	- Transm	ission <b>I</b>	ine Poles	; Ra	pid	Cit	y, So	uth I	Dako	ta			
DEPTH IN	SURFACE ELEVATION:	3256.3			GEOLOGY	N	MC	SA	MPLE	REC	FIELI	D & LA	BORA	TORY	TES
FEET	MATERIAL	DESCRIPTI	ON				MC	T	MPLE YPE	ĪN.	WC	DEN	LL	PL	<b>%-</b> #2
1 - 2 - 3 - 4 - 4	TOPSOIL SILTY SAND, brown, m present (SM)	edium dens	se, gravel		OPSOIL LLUVIUM	14	М		MC	18	11				
5 — 6 — 7 —	SANDY LEAN CLAY, b hard to firm, gravel preser		rk brown,			31	M	R	MC	18	6				
8 — 9 —		. ,				5	₩ W	R	MC	18					
10 - 11 - 12 - 12 - 12	SANDY GRAVEL, brow dense (GP)	n, dense to	very			34	W	R	MC	18					
13 - 14 - 15 - 15 - 100 - 10	with cobbles					68	W	ł	MC	18					
16 — 17 — 18 — 19 —						50/.3	W	2222	MC	10					
$\begin{array}{c} 20 \\ 21 \\ -22 \\ -23 \\ -24 \\ -25 \\ -25 \\ -26 \\ \end{array}$	SHALE, Silty Lean Clay, (CL)	, greenish g	gray, hard		UNDANCE ORMATION	50/.4	М	4 22222	MC	5					
$\begin{array}{c} 26 \\ -27 \\ -28 \\ -29 \\ -30 \\ -31 \\ -32 \\ -33 \\ -34 \\ -35 \\ -36 \\ -\end{array}$						50/.4	М	VILLA VILLA	МС	5					
$\begin{array}{r} 37 - \\ 38 - \\ 39 - \\ 40 - \\ 41 - \\ 42 - \\ 43 - \\ 44 - \\ 45 - \\ 46 - \\ 47 - \end{array}$						50/.4	М	LILL LILLA	MC	5					
48 49 50						50/.4	M	ł	_MC_	5					
	Bottom of	Boring													
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		DATE	TIME	SAMPLEI DEPTH			ENILI E-IN PTH	-	RILLI	NG	WATH LEVE		NOTE: THE A		
5	0.0 3.25" HSA			DEPTH 50.4						VEL	1.5		SHEET		
		12/27/18	15:00	30.4		-	-	-			7.5		XPLA		
BORIN	G LETED: <b>12/27/18</b>												ERMIN		
								-						IS LO	
DR: ES	<b>5</b> LG: <b>BB</b> Rig: <b>RC-2</b>													01-D	



PROJE	CT: West Rapid Sul										B				
DEPŢH		bstation -	- Transm	ission	Line Poles	; Ra	pid	Cit	ty, So	uth l	Dako	ta			
	SURFACE ELEVATION:	3289.8			GEOLOGY			SA	MDI F	REC	FIELI	D & LA	BORA	TORY	TEST
IN FEET		DESCRIPTION			GEOLOGI	N	MC		MPLE TYPE	IN.	WC	DEN	LL	PL	<b>%-</b> #2
1 -	TOPSOIL				TOPSOIL			R							
2 —	FAT CLAY, tan, very stit	ff (CH)			ALLUVIUM			1							
3 - 4 - 4						22	Μ		MC	18	13				
5 - 6 -	SILTY LEAN CLAY, tai	n-brown, h	ard, sand			80	М	5	MC	18	7				
7 —	and gravel present (CL)	~ 11						ł							
8 - 9 -	WEATHERED SHALE, very stiff to stiff (CL)	Silty Lean	Clay, red,	Ħ	SPEARFISH FORMATION	29	М		MC	18	16	111			
10 - 11 -						14	М	5	MC	18	19				
12 -				Ħ				R							
13 — 14 —	with concretions			Ħ		14	$\frac{M}{\nabla}$		MC	18	17				
15 —				Ħ		11	$\frac{}{\overline{W}}$	4	MC	18					
16 — 17 —	-			Ħ			••	Ł	me	10					
18 — 19 —				Ħ				H							
20 -				Ħ		39	М	¥	MC	18					
21 - 22 -						39	IVI	Я	MC	10					
23 —	SHALE, Silty Lean Clay,	red. hard.	siltstone					ł							
24 - 25 -	lenses present (CL)							5		_					
26 - 27 -						50/.4	Μ		MC	5					
28 -								ł							
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43 - 44 -	_							Į							
44 - 45 -	-						** 7	Ł		NGD					
46 - 47 -						50/.4	W	И	MC	NSR					
48 —	_							X							
49 - 50 -						50/.4	W	1	MC	NSR					
00	Bottom of	Boring				-50/.4									
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DODE													XPLA		
COMP	NG LETED: <b>12/27/18</b>											Т	ERMIN		
DR: E	S LG: BB Rig: RC-2													IS LO 01-D	G



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PROJE	CT: West Rapid S	ubstation - T	ransmis	sion	Line Poles	s; Ra	pid		ty, So	uth I					
EPTH IN EET	SURFACE ELEVATION				GEOLOGY	N	MC	SA	MPLE YPE	REC			ABORA		
EET		L DESCRIPTION							YPE	IN.	WC	DEN	LL	PL	<b>%-</b> #
1 -	<b>TOPSOIL</b> SILTY LEAN CLAY, 1		/		TOPSOIL	1		Į							
2 - 3 - 3 - 3	present (CL)	red, nard, gypsu	111			37	М	Þ	MC	18					
4 -							141	Ł	wie	10					
5 - 6 - 6						50/.5	М		MC	18	5				
7	SANDY GRAVEL, gra	v verv dense o	obbles			50/ 4	м	Ł	MC	18	4				
9 –	present (GP)	y, very dense, et	000103	=		50/.4	М	Я	MC	18	4				
10 - 11 - 11 - 11 - 10 - 10 - 10 - 10 -	SHALE, Fat Clay, gray	-green, hard (CH	H)		SUNDANCE FORMATION	62	М		MC	18	23	98			
12 – 13 –					TOKMATION		м	Ł	MG	10					
14 -						80	Μ	Р	MC	18					
15 – 16 –						86/.9	М		MC	17	23	97			
17 — 18 —								Ł							
19 –								ł							
20 - 21 - 21								Į							
22 -								Ľ							
23 – 24 –								ł							
25 - 26 -	GYPSUM, white, very	dense			GYPSUM	50/.4	М	5	MC	5					
27 -	· · · ·				SPRING FORMATION			R							
28 — 29 —								Į							
30 - 31 - 31 - 31 - 31 - 31 - 31 - 31 -								ß							
32 –				$\left[ \diamond \right]$				ł							
33 — 34 —				$  \diamond  $				ł							
35 -						50/.1	М	И	MC	2					
36 – 37 –				$\rightarrow$		00/.1	1.11	R	me						
38 – 39 –								ß							
40 +	SILTSTONE, Silt, red,	hard (ML)		× ×				Ł							
41 – 42 –	511151 61 (1, 510, 100,			$\begin{array}{c} \times & \times \\ \times & \times \\ \times & \times \end{array}$				ł							
43 – 44 –				× × × × × ×				Ħ							
45 –						50/.3	М	R	MC	4					
46 – 47 –				$\left \begin{array}{c} \times & \times \\ \times & \times \\ \times & \times \end{array}\right $		50/.5	IVI	R	WIC	-					
48 – 49 –				× × × ×				Ł							
50 -	Sampler Re	fusal at 50.1'		× × × ×		50/.1	M	꿘	MC	2					
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		12/19/18 1	5:00	50.1		-	-	-			Non		EXPLA		
ORIN	G							-					ERMIN		
OMPI	LETED: 12/19/18							-				1		IS LO	
R: ES	<b>S</b> LG: <b>BB</b> Rig: <b>RC-2</b>													01-D	



AET JC	DB NO: <b>17-03356</b>					LO	G OF	BO	RING	NO	B	-4 (	<b>p.</b> 1	of 1	)
PROJE	CT: West Rapid Sul	bstation -	Transm	nission	Line Poles	s; Ra	pid	Cit	ty, So	uth I	Dako	ta			
DEPTH IN	SURFACE ELEVATION:		GEOLOGY		MC	SA	MPLE	REC	FIELI	D & LA	LABORATORY				
FEET	MATERIAL	DESCRIPTI	ON				WIC	TYPE		IN.	WC	DEN	LL	PL	%-#2
1 -	CRUSHED LIMESTON	E AGGRI	EGATE, 12	2	SURFACING SUNDANCE			ß							
2 - 3 - 3 - 3	SHALE, Fat Clay, green-	gray, hard	(CH)		FORMATION	50/0	М	¥	MC	NSR					
4 — 5 —						50/.0	141	R	wie						
6 —	GYPSUM, white, very de	ense			- GYPSUM SPRING	50/.4	М		MC	5					
7 — 8 —				-0-	FORMATION	50/.1	М	4	MC	2					
9 — 10 —						00/11		ß	me	_					
11 -						50/.1	Μ		MC	2					
12 - 13 - 13 - 13				$\rightarrow$ - $\langle$		50/.1	М	5	MC	2					
14 — 15 —		1(2)(7)		- \> - 				ß							
16 - 17 -	SILTSTONE, Silt, red, h	ard (ML)				50/.4	Μ	R	MC	5					
18 -								ł							
19 — 20 —								Ħ							
21 - 22 - 22								Į							
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28 -				x x				ł							
29 - 30 -								Ħ							
31 - 32 - 32								Ħ							
33 —								ß							
34 - 35 - 35	SHALE, Fat Clay, green-	grov hard	(CH)			50/4	M	Ł	MC	_					
36 - 37 -	SITALE, Fat Clay, green-	glay, fiaru	(CII)			50/.4	M	Я	MC	5					
38 -								ł							
39 - 40 -								ł							
41 - 42 - 42 - 42 - 42 - 42 - 42 - 42 -								Ħ							
43 — 44 —								Į							
45 —	SILTSTONE, Silt, red, h	ard (ML)			SPEARFISH	50/.4	М	R	MC	5					
46 — 47 —		uru (1112)		× × × × × × × × × × × × × ×	FORMATION	50/.4	IVI	R	WIC						
48 — 49 —								ß							
50 -	Sampler Refu	sal at 50 1'				50/.1	M	Ш	-MC-	2					
	Sumptor Rora	Sur ut 2011													
DEP	TH: DRILLING METHOD			WAT	ER LEVEL MEA	ASURI	EMEN	VTS		I			NOTE:	REF	R TO
_		DATE	TIME	SAMPI DEPT	LED CASING TH DEPTH	CAV	'E-IN PTH	I	ORILLI UID LE	NG	WATI LEVE		THE A		
5	0.0 3.25" HSA							FL		VEL			SHEET		
		12/21/18	12:30	50.1	l		-	-			Non	C	XPLA		
BORIN	G LETED: <b>12/21/18</b>							-					ERMIN		
								-						IS LO	
DR: E	<b>S</b> LG: <b>BB</b> Rig: <b>RC-2</b>													01-D	



# SUBSURFACE BORING LOG

AET JO	DB NO: <b>17-03356</b>					LO	G OF	BO	RING N	NO	B	- 5	(p. 1	of 1	)	
PROJE	CT: West Rapid Su	bstation -	· Transm	ission I	ine Poles	s; Ra	pid	Cit	y, So	uth I	Dako	ta				
DEPTH IN	SURFACE ELEVATION:			GEOLOGY		N MC		SAMPLE		REC	FIELI	) & L	& LABORATORY T			
FEET	MATERIAL	DESCRIPTI	ON			N	MC	SAMPLE TYPE		IN.	WC	DEN	LL	PL	<b>%-</b> #2	
1 -	CRUSHED LIMESTON	E AGGR	EGATE, 7		OAD URFACING			ł								
2 - 3 - 3 - 3	FILL, Lean Clay, black, a	ash/slag pro	esent (CL)		LL	10	М	Ľ	MC	18						
4 — 5 —		01				10	141	R	wie	10						
6 —	gravel present					13	M		MC	18						
7 - 8 - 8	FILL, Fat Clay, brown-g	ray (CH)				6	+	5	MC	18						
9 — 10 —								ł								
11 — 12 —						2	W	И	MC	18						
13 — 14 —						3	W		MC	18						
15 —	SANDY LEAN CLAY, r	ed-brown,	firm,	A	LLUVIUM	6	w	ł	MC	18						
16 — 17 —	gravel present (CL)						vv	Ł	IVIC	10						
18 — 19 —	WEATHERED SHALE	Silty Lean	Clay, red,	<u>SI</u>	PEARFISH	T		¥.								
20 - 21 - 21	hard (CL)				ORMATION	43	М	И	MC	18						
22 —								Ł		-						
23 — 24 —	SHALE, Silty Lean Clay,	, red, hard (	(CL)					ł								
25 - 26 -						50/.4	М	И	MC	5						
27 — 28 —								B								
$\frac{20}{29} - 30 - 30$								ł								
31 —								ł								
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36 - 37 - 37						50/.4	М		MC	5	12	128				
38 -								Ŧ								
39 — 40 —								Ħ								
41 — 42 —								Ħ								
43 — 44 —																
45 —						50/.4	М	R	MC	5						
46 — 47 —							141	Ł	1110							
48 — 49 —	•															
50 —	Bottom of	Boring				50/.4	M		MC	_5_						
DEP	TH: DRILLING METHOD			WATER	LEVEL ME	-							NOTE:	REF	ER TO	
5	50.0 3.25" HSA	DATE	TIME	SAMPLEI DEPTH	D CASING DEPTH	CAV DEI	'E-IN PTH	FL <sup>1</sup>	ORILLII UID LE	NG VEL	WATH LEVE	ER EL	THE ATTACHED			
		3.25" HSA 12/19/18 14:40						-				8.0		SHEETS FOR AN		
												1	EXPLA	NATI	ON C	
BORIN COMP	NG LETED: <b>12/19/18</b>											Г	ERMI		GY C	
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01-DHR-060



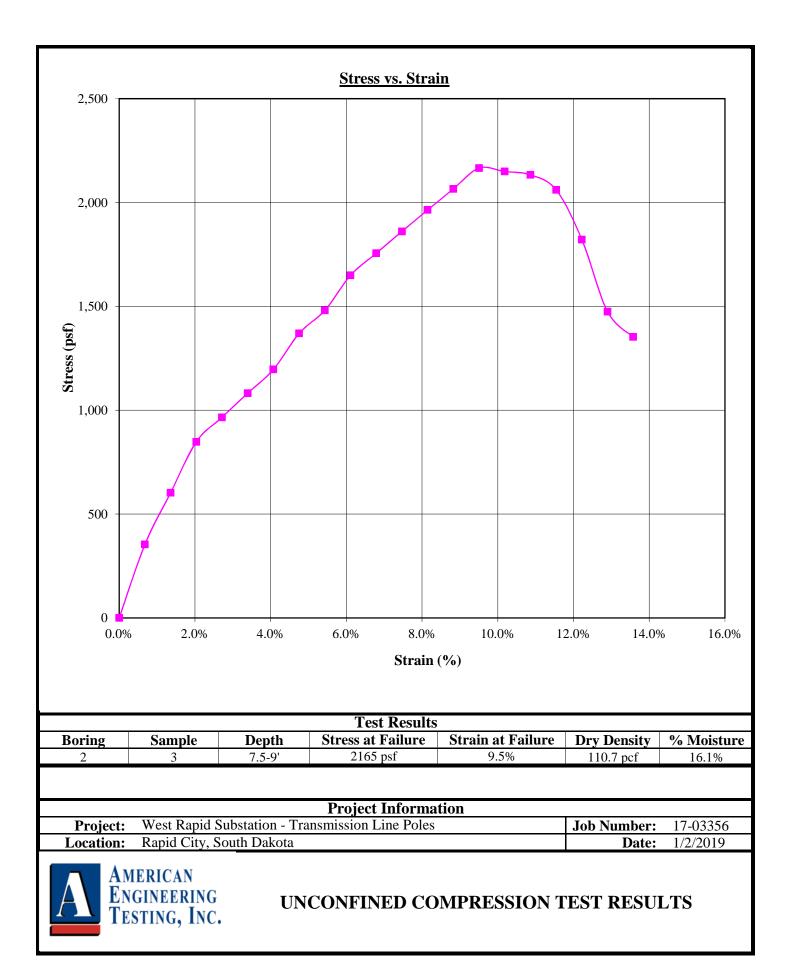
AET JO	DB NO: <b>17-03356</b>					LC	OG OF	BO	RING N	NO	B	-6(	<b>p.</b> 1	of 1	)	
PROJE	CT: West Rapid Sul	ostation -	Transmi	ssior	Line Pole	s; Ra	pid	Cit	ty, So	uth l	Dako	ta				
DEPTH IN	SURFACE ELEVATION:	RFACE ELEVATION: <u>3292.0</u> GEOLOGY	N	MC	SA	MPLE	REC	FIELI	) & LA	LABORATORY TE						
FEET	MATERIAL					IN	MC	TYPE		IN.	WC	DEN	LL	PL	%-#2	
1 -	<b>FILL</b> , Lean Clay with gra <b>FILL</b> , Silty Lean Clay, re	/ 🗱	FILL			Ħ										
2 - 3 - 3 - 3	(CL)	u, organics	s present			22	М		MC	18	17					
4 5								Ł								
6 — 7 —	gypsum present					13	M	Р	MC	18	19					
8 — 9 —						8	М		MC	18	27					
10 — 11 —	LEAN CLAY, brown-gra organics present (CL)	y, firm to s	soft,		ALLUVIUM	6	$\mathbf{W}$	4	MC	18						
12 - 13 - 13 - 13	organics present (CL)							Ł								
14 —						3	W	R	MC	18						
15 — 16 —						4	W		MC	18						
17 — 18 —	SILTY LEAN CLAY, red	d-brown fi	rm (CL)					ł								
19 — 20 —	SILT I LEAN CLAI, IN					1		10								
21 - 22 -						6	W	R	MC	18						
23 — 24 —	WEATHERED SHALE,	Silty Lean	Clay, red,		SPEARFISH	_		Ħ								
$\frac{25}{26} - \frac{25}{26} - 25$	stiff to very stiff (CL)			Ħ	FORMATION	16	М	Ц	MC	18						
27 – 28 –				Ħ				Ł								
29 -								ł								
30 - 31 - 32				Ħ		27	М		MC	18						
32 - 33 - 33 - 33								Ħ								
34 - 35 - 35				Ħ				1		10						
36 - 37 -						26	M	R	MC	18						
$\frac{38}{39} - \frac{38}{39} - 38$	SHALE, Silty Lean Clay,	red, hard (	(CL)					ł								
40 - 41 -						50/.3	М	Þ	MC	4						
42 - 43 - 43 - 43 - 43 - 43 - 43 - 43 -								ł								
44 —								ł								
45 - 46 - 47								ł								
47 — 48 —								ł								
49 — 50 —	-					50/.3	M	¥	MC_	4						
	Bottom of	Boring														
DEP	TH: DRILLING METHOD			WAT	ER LEVEL ME.	ASUR	EMEN	VTS			1	א   א	I IOTE:	REFF	ER TC	
E				SAMPI DEPT	LED CASING TH DEPTH	CAV	'E-IN PTH	FI	ORILLII UID LE	NG	WATI LEVE		NOTE: REFER TO THE ATTACHED			
3	30.0 3.25" HSA	12/19/18	10:30	50.3			DEPTH		FLUID LEVEL				SHEETS FOR AN			
													XPLA	NATIO	ON OI	
BORIN COMP	G LETED: <b>12/19/18</b>												ERMIN			
DR: <b>E</b>														IS LO $01-D$		

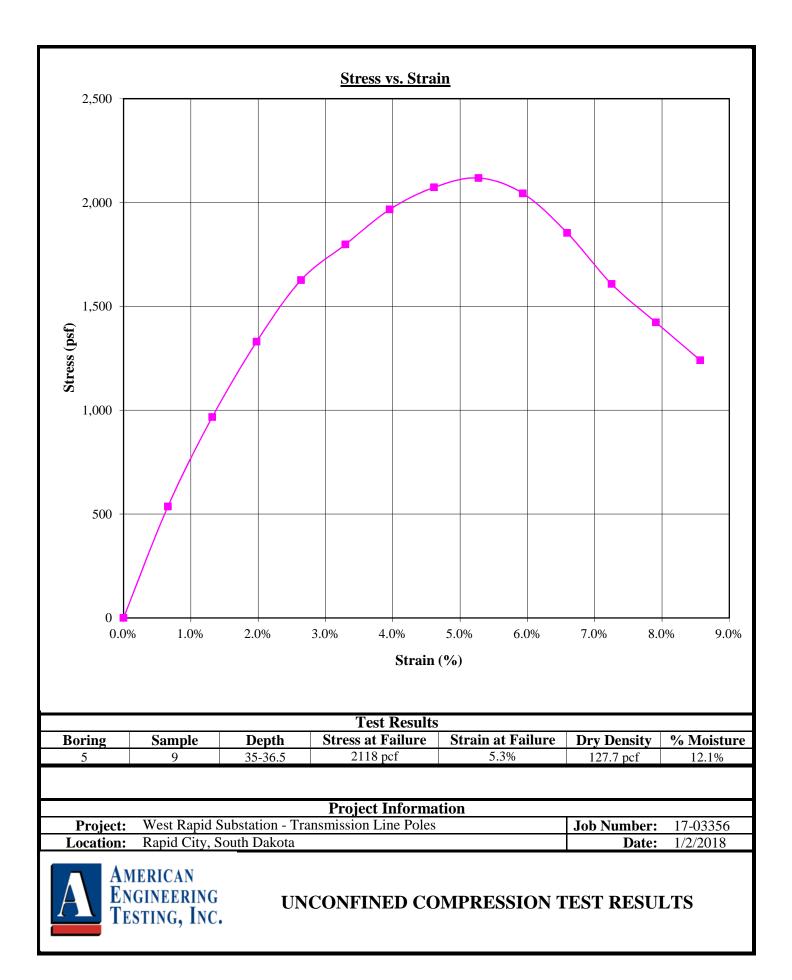


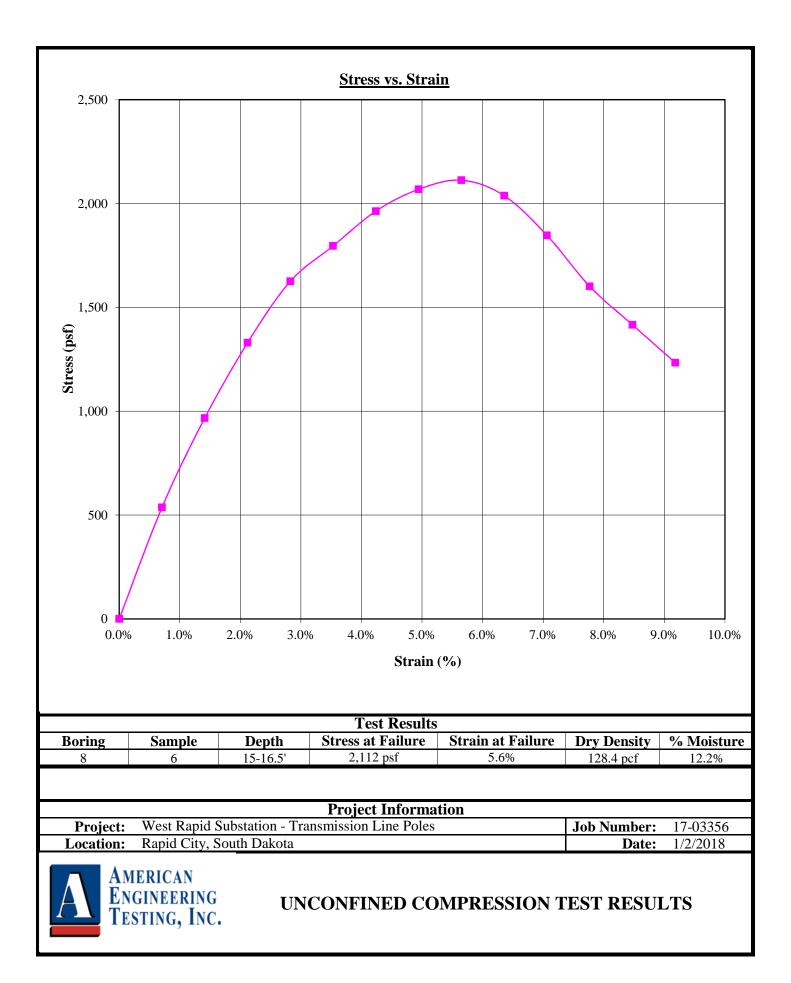
AET JO	DB NO: <b>17-03356</b>					LC	G OF	F BO	RING N	NO	B	-7 (	( <b>p.</b> 1	of 1	)	
PROJE	CT: West Rapid Sul	bstation -	Transm	ission	Line Poles	s; Ra	pid	Cit	y, So	uth l	Dako	ta				
DEPTH IN	SURFACE ELEVATION:	E ELEVATION: GEOLOGY				N	MC	SA	MPLE	REC	FIELI	) & LA	LABORATORY TE			
EET	MATERIAL	DESCRIPTI	ON			N	MC	T	MPLE YPE	IN.	WC	DEN	LL	PL	<b>%-</b> #2	
1 - 2 - 3 - 4 - 4	CRUSHED LIMESTON inches WEATHERED SHALE, stiff to hard (CL)				SURFACING SPEARFISH FORMATION		М	777	МС	18						
5 - 6 -				Ħ		22	М	Ł	MC	18	16					
7 — 8 — 9 —						11	М	R	MC	18	22					
10 - 11 - 12 -						19	М	R	MC	18	21	115				
13 — 14 — 15 —	with gypsum					46	М	R	MC	18						
16 - 17 - 18 - 18 - 18						32	М	ł	MC	18						
19 - 20 - 21 - 22 - 23 - 24 - 24 - 24 - 24 - 25 - 25 - 25 - 25	SHALE, Silty Lean Clay, interbedded siltstone and	, red, hard, gypsum pro	esent (CL)			73/.8	$\frac{\sum}{\bar{M}}$	111	MC	16	14					
25	GYPSUM, white, hard	und haud				50/.4	М		MC	5						
$\begin{array}{r} 36 - \\ 37 - \\ 38 - \\ 39 - \\ 40 - \\ 41 - \\ 42 - \\ 43 - \\ 44 - \\ 45 - \\ 46 - \\ 47 - \\ 48 \end{array}$	SHALE, Silty Lean Clay, interbedded siltstone and	gypsum pro	esent (CL)			50/.4	М		MC	5						
48 — 49 — 50 —	Bottom of	Boring				50/.3	M	ł	MC	4						
DEP'	TH: DRILLING METHOD			W/ATT	R LEVEL ME											
		DATE	TIME	SAMPL DEPT		-	EMEr Æ-IN PTH	-	RILLI UID LE	NG	WATI LEVE		NOTE: REFER TO			
5	0.0 3.25" HSA					DE	PTH	FL		VEL			THE A			
		12/20/18	10:15	50.3		-	-				20.0	,	XPLA			
BORIN	G												ERMIN			
	G LETED: <b>12/20/18</b>													IS LO		
DR: <b>E</b> S 2011	<b>S</b> LG: <b>BB</b> Rig: <b>RC-2</b>													01-D		



AET JC	DB NO: <b>17-03356</b>					LC	G OF	BO	RING N	NO	B	- 8 (	( <b>p.</b> 1	of 1	)		
PROJE	CT: West Rapid Sul	bstation -	Transm	issior	Line Pole	s; Ra	pid	Cit	ty, So	uth ]	Dako	ta					
DEPTH IN	SURFACE ELEVATION:		GEOLOGY			51	MPLE	REC	FIEL	D & LA	BORA	TORY	TES				
IN FEET		DESCRIPTIO	3310.1 DESCRIPTION		GLOLOGI	N	MC		YPE	IN.	WC	DEN	LL	PL	<b>%-</b> #2		
1 -	CRUSHED LIMESTON	E AGGRI	EGATĘ 6	/ 🗱	SURFACING			Ł									
2 - 3 - 3 - 3	inches FILL, Silty Lean Clay, re	A(CL)		] 🎆	FILL			5		10							
4 —	<b>FILL</b> , Sitty Lean Clay, le	u (CL)				21	М	И	MC	18							
5 — 6 —	FAT CLAY, gray-red, ve	ry stiff (CH	I)	Ĩ	ALLUVIUM	17	М	S I	MC	18	20						
7 —								R									
8 — 9 —						20	Μ	И	MC	18	23	110					
10 - 11 - 11 - 11	LEAN CLAY, red, very s (CL)	stiff, gypsu	m present			25	М	<u>s</u>	MC	18	21	114					
12 - 13 - 13 - 13	SILTY LEAN CLAY, red	d, very stift	f,					Ł		10	1.5						
14 —	hydrocarbon odor noted (	CL)	-			24	Μ	И	MC	18	17						
15 — 16 —	WEATHERED SHALE, hard, siltstone lenses pres	Ħ	SPEARFISH FORMATION	50	М		MC	18	12	128							
17 - 18 - 18 - 18	_			Ħ				Ł									
19 —	<b>SHALE</b> , Silty Lean Clay, lenses present (CL)	red, hard,	siltstone					ł									
20 - 21 - 21 - 21	lenses present (CL)			50/.1	М	И	MC	8									
22 —								Ł									
23 - 24 - 24								F									
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26 - 27 - 27 - 27 - 27 - 27 - 27 - 27 -								X									
28 - 29 - 29 - 29 - 200 - 20								1									
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39 -								Ħ									
40 - 41 - 41 - 41 - 40 - 41 - 40 - 41 - 40 - 40	gypsum present					50/.3	М	5	MC	4							
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46 47								H									
48 -								I									
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		12/19/18	17:00	50.3	3					Non	C	SHEETS FOR AN EXPLANATION OF					
יאותסם				<u> </u>		_											
COMPI	BORING COMPLETED: 12/19/18												ERMIN				
DR: E	S LG: BB Rig: RC-2							1					TH	IS LO	G		

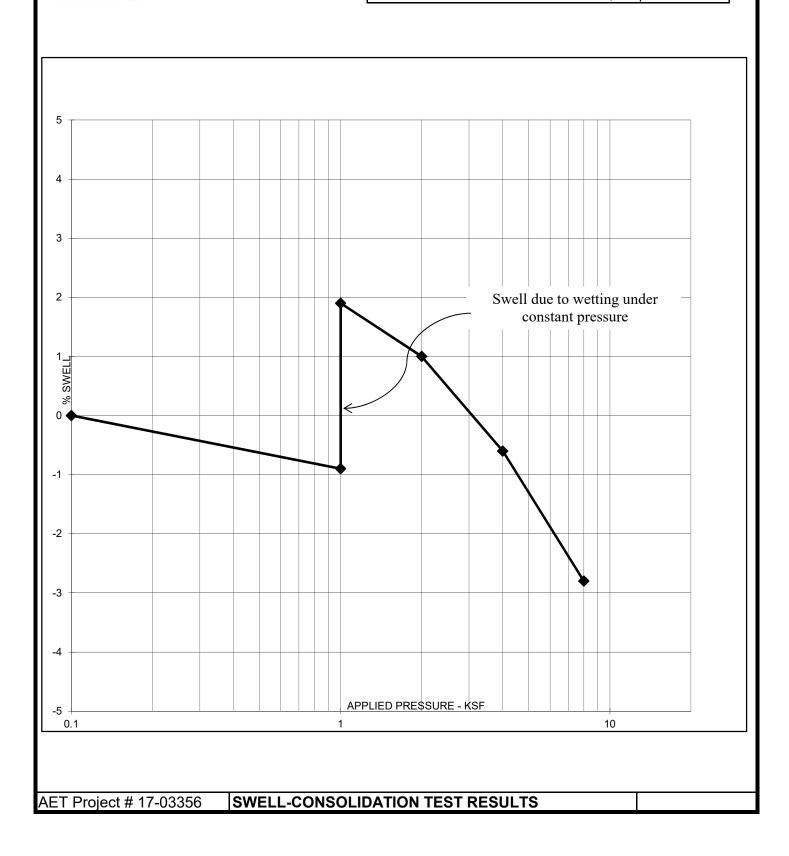








MOISTURE CONTENT:22.8 percentDRY UNIT WEIGHT:96.57 pcfBORING/DEPTH:B-3 15'SOIL DESCRIPTION:Fat Clay, gray (CH)% Swell2.8Swell Pressure4,500 psf



# **Appendix B**

Geotechnical Report Limitations and Guidelines for Use

#### REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE<sup>1</sup>, of which, we are a member firm.

#### **RISK MANAGEMENT INFORMATION**

#### Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. No one, not even you, should apply the report for any purpose or project except the one originally contemplated.

#### **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

#### A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

#### Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

1 ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910 Telephone: 301/565-2733 : <u>www.asfe.org</u>

#### Most Geotechnical Findings Are Professional Opinions

Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

#### A Report's Recommendations Are Not Final

Do not over rely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

#### A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

#### Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

#### **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need to prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

#### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

#### **Geoenvironmental Concerns Are Not Covered**

The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.