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January 22, 2026

Via Hand Delivery & Electronic Mail

Mr. Brian Johnson
North Dakota Public Service Commission
600 E. Boulevard, Dept. 408
Bismarck, ND 58505-0480
ndpsc@nd.gov

In re: Minnesota Power
Longspur Wind 230-kV Transmission Line - Morton & Mercer Counties
Siting Application
Case No. PU-25-305
Our File No. 111345-000003

Dear Mr. Johnson:

Enclosed for filing in the above-referenced matter, please find eight copies of Minnesota Power's Response to the Request for Information dated January 6, 2026, including the following attachments:

1. Attachment A: Revised Table 3.2-1 Avoidance Area;
2. Attachment B: Bat Acoustic Activity Survey;
3. Attachment C: Class I and Class III Cultural Resources Inventory Report and NDSHPO Correspondence;
4. Attachment D: Noxious Weed Management Plan and County Communication; and,
5. Attachment E: Geotechnical Evaluation.

Please feel free to contact me if you have any questions. Thank you.

Sincerely,

Casey A. Furey

CAF/lh
Enc.
cc: Adam Renfandt (via email)
Jim Klempir (via email)
Alex Luman (via email)
Mitchell Bettenhausen (via email)
Erik Edison (via email)

42 PU-25-304 Filed 05/20/2026 Pages: 568
Exhibit 6 - 1-22-26 Response to PSC Information Request - Wind Project, Including Attchs A-E (Dkt #7)
Minnesota Power

43 PU-25-305 Filed 05/20/2026 Pages: 568
Exhibit 6 - 1-22-26 Response to PSC Information Request - Wind Project, Including Attchs A-E (Dkt #7)
Minnesota Power

7 PU-25-305 Filed 01/22/2026 Pages: 568
Response to January 6, 2026 Request for Additional Information - Redacted
Minnesota Power
Casey Furey, Crowley Fleck, PLLP

minnesota power

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Minnesota Power's Response to NDPSC Staff's Jan. 6, 2026 Request for Information
Case No. PU-25-305

Minnesota Power, an ALLETE Company, respectfully submits the following responses to the request for information dated January 6, 2026 regarding Minnesota Power's Application for a Certificate of Corridor of Compatibility and Route Permit Application filed with the North Dakota Public Service Commission (Commission) on December 30, 2025.

The Longspur Wind 230-kV Transmission Line Project (Project) provides the below definitions for reference.

Project Route	In accordance with N.D.C.C. Section 49-22-03(14), "Route" is defined as the location of an electric transmission facility within a designated corridor. The Project Route aligns with the transmission line centerline and is approximately 2.5 miles long.
Project Corridor	The area around the Project Route where easements were acquired (also referred to as the right-of-way). The Project Corridor is the typical easement that will be used during construction and maintained during the life of the Project. The Project Corridor is typically 158- to 510-feet-wide and encompasses approximately 74 acres.
Study Area	The Study Area analyzed for the Project is one-mile wide (0.5 mile on either side of the Project Route) and encompasses approximately 1,990 acres.
survey area	The survey area that the wildlife survey covered.

12. Table 3.1-1 / Table 3.2-1 indicates that archaeological/cultural/ historic resources are not present in the Project Corridor or Route. However, Section 5.4 indicates they are likely present. Please update the Table.

A. Section 6.4 notes that some sites may be eligible for the National Register of Historic Places; however, none are currently listed. Table 3.1-1 applies only to Commission designated exclusion areas including nationally or state-designated historic sites, landmarks, districts, markers, or archaeological sites. No national or state designated or registered historic sites, landmarks, districts, markers, or archaeological sites are present within the Study Area. Table 3.2-1 has been updated and is attached hereto. *See* Attachment A: Revised Table 3.2-1 Avoidance Area.

13. Do each of the wildlife surveys cover the entire Project Corridor? Please explain if not and the area they do cover.

A. Discussion regarding each of the wildlife surveys is provided below:

i. The Dakota skipper habitat survey, in accordance with United States Fish and Wildlife Service (USFWS) guidance and survey protocols, included an area that is approximately 15,417 acres and fully covered the Project Corridor.

ii. The 2024 and 2025 sharp-tailed grouse lek surveys, in accordance with North Dakota Game and Fish Department's (NDGFD) survey protocol in 2014 Management Plan and Conservation Strategies for Greater Sage-grouse in North Dakota and recommendations described in 2021 KeyWind Energy Development in North Dakota: Best Management Practices, included an area that is approximately 90,735 acres and fully covered the Project Corridor.

iii. The 2024 and 2025 eagle nest surveys, in accordance with survey design based off USFWS's Land-based Wind Energy Guidelines and Eagle Conservation Plan Guidance: Module 1 – Land-based Wind Energy and NDGFD's KeyWind Energy Development in North Dakota: Best Management Practices, included an area that is approximately 86,610 acres and fully covered the Project Corridor.

iv. The whooping crane habitat assessment, in accordance with communication from USFWS's North Dakota Ecological Field Office staff in 2024 and NDGFD's 2021 KeyWind Energy Development in North Dakota: Best Management Practices, included an area that is approximately 482,331 acres and fully covered the Project Corridor.

v. The northern long-eared bat habitat assessment, in accordance with communication from USFWS's North Dakota Ecological Field Office staff in 2024 and USFWS's 2024 Range-Wide Indiana Bat and Northern Long-eared Bat Survey Guidelines, included 30,696 acres which did not fully cover the Project Corridor and excluded approximately 5.75 acres within Mercer County.

vi. The northern long-eared bat presence/absence survey, in accordance with methods in the USFWS's 2024 Range-Wide Indiana Bat and Northern Long-eared Bat Survey Guidelines, included an area of 13 acres and was not preformed within the Project Corridor.

vii. The bat acoustic activity survey, attached hereto as Attachment B, and in accordance with USFWS's Land-based Wind Energy Guidelines and NDGFD's KeyWind Energy Development in North Dakota: Best Management Practices, included an area of approximately 25,933 acres which did not include approximately 9.4 acres within Mercer County.

14. Is Northern long-eared bat likely absent from the Project Corridor and Study Area Application refers to their absence from the "Project area." Please explain.

A. The northern long-eared bat habitat assessment was focused on areas within the Longspur Wind Project, covering most of the Project Corridor and Study Area. The results of the presence/absence survey and acoustic survey, were that no northern long-eared bats were recorded during the survey effort. In the presence/absence survey, no bats including federally threatened or endangered species captured. In the acoustic survey no federally listed species were identified and five species of Species of State concern may have been identified. Based off the results of the northern long eared bat habitat assessment, presence absence survey, and acoustic survey the northern long-eared bat is likely absent from the Project Corridor.

15. Page 41 of the application indicates that two eagle nests were found in the survey area and that none were in the Project Corridor. Were any in the Study Area of the transmission line?

A. The 2024 and 2025 eagle nest surveys did not identify any eagle nests within the Project Study Area. The nearest eagle nest is approximately 4.3 miles away from the Study Area.

16. Page 47 indicates that 7,813 acres of native, unbroken grasslands were surveyed in 2025, and of those 2,965 acres were identified as potential Dakota skipper habitat. How many acres were surveyed in the Project Corridor and were identified as potential habitat? What is meant by how 17 patches of suitable habitat resulted in 20.96 acres within the surveyed grasslands? Also, how does this relate to what was in the Project Corridor?

A. Within the Project Corridor, approximately 13.34 acres were initially identified as potential Dakota skipper habitat during the desktop review. However, field surveys did not confirm any suitable habitat within the Project Corridor itself. The reference to 17 patches of suitable Dakota skipper habitat pertains to the overall survey findings across the broader survey area, not within the Project Corridor. The nearest

confirmed suitable habitat is located approximately 70 feet outside the Study Area boundary.

17. Please confirm no leks are in the Study Area of the transmission line.

A. The 2024 and 2025 sharp-tailed grouse lek survey did not identify leks within the Study Area; the nearest lek is approximately 2,500 feet west of the Study Area.

18. How many acres of unbroken grassland are within the Project Corridor, and how many acres will be affected by construction?

A. The Project Corridor contains approximately 13.35 acres of unbroken grassland. Impacts on unbroken grasslands from the Project are anticipated to be negligible. Permanent impacts to unbroken grasslands are estimated to be approximately 0.0036 acres, and temporary impacts are anticipated to be approximately 1.4 acres.

19. Please file copies of all Class I and Class III Cultural Resource reports with the Commission.

A. A Class I and Class III Cultural Resources Inventory of the Minnesota Power Longspur Windfarm Project, Morton and Mercer Counties, North Dakota was submitted to the North Dakota State Historic Preservation Office (NDSHPO) for review on December 22, 2025. NDSHPO completed its review on January 15, 2026. A copy of the Class I and Class III Cultural Resources Inventory and NDSHPO's January 15, 2026 correspondence are attached a Attachment C hereto.

20. Please file copies of all architectural inventory reports with the Commission.

A. An Architectural Survey and Viewshed Report for the Minnesota Power Longspur Windfarm Project, Morton and Mercer Counties, North Dakota is in the process of being finalized and is anticipated to be filed with the NDSHPO in January 2026. The architectural inventory report, once submitted to NDSHPO, will be filed with the North Dakota Public Service Commission.

NDSHPO requested a Class II reconnaissance survey for structures 45 years or older in the visual area of the Longspur wind project. A two mile viewshed buffer of the proposed wind turbine sites was recommended by NDSHPO for the survey. The architectural survey was only conducted for the Longspur Wind Project, however the two mile viewshed buffer did fully cover the Project Corridor.

21. Please file a copy of the Noxious Weed Management Control Plan with the Commission and copies of correspondence with the Morton County and Mercer County Weed Boards related to its approval.

A. Minnesota Power has not yet finalized a Noxious Weed Management Plan with Morton and Mercer Counties. The current draft, recently shared with the Counties, is attached hereto as Attachment D along with records of correspondence with the Counties. An updated plan and records of coordination will be provided prior to construction.

22. File copies of the geotechnical and geophysical analysis that are to be performed when complete.

A. A geotechnical evaluation was completed for utility line structure locations, the report is attached hereto as Attachment E. No transmission line structure locations will be located within a historic landslide deposit area, as indicated by the North Dakota Geological Survey landslide mapping program.

Attachments
Attachment A: Revised Table 3.2-1 Avoidance Area
Attachment B: Bat Acoustic Activity Survey
Attachment C: Class I and Class III Cultural Resources Inventory Report and NDSHPO Correspondence
Attachment D: Noxious Weed Management Plan and County Communication
Attachment E: Geotechnical Evaluation

Attachment A

Revised Table 3.2-1 Avoidance Area

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30 West Superior Street | Duluth, MN 55802

Revised TABLE 3.2-1
Avoidance Areas

Transmission Facility Corridor and Route Criteria	Description if Present in or Applicable to the Project	Proposed Buffer	Section Addressed
2. Avoidance areas			
a. Designated or registered national: historic districts; wildlife areas; wild, scenic, or recreational rivers; wildlife refuges; and grasslands.	Not present within Corridor or Route	No impacts are anticipated, and no buffer is proposed.	6.5
b. Designated or registered state: wild, scenic, or recreational rivers; game refuges; game management areas; management areas; forests; forest management lands; and grasslands.	Not present within Corridor or Route	No impacts are anticipated, and no buffer is proposed.	6.5, Figure 7
c. Historical resources which are not specifically designated as exclusion or avoidance areas.	Yes there is a historical resource within the Project Corridor. No, that historical resource will not be impacted	No impacts are anticipated, and no buffer is proposed.	6.4, Figure 7[a]
d. Areas which are geologically unstable.	Present in Corridor. A geotechnical and geophysical analysis has been performed and areas which are geologically unstable are avoided and spanned as necessary. No transmission line structure locations will be located within a landslide deposit, as indicated by the North Dakota Geological Survey landslide mapping program.	No impacts are anticipated, and no buffer is proposed.	6.6, Figure 7
e. Within 500 feet of a residence, school, or place of business.	No residences, schools, or businesses are located within 500 feet of the Corridor.	No impacts are anticipated, and no buffer is proposed.	3.6, Figure 7
f. Reservoirs and municipal water supplies.	Not present within Corridor or Route	No impacts are anticipated, and no buffer is proposed.	6.7
g. Water sources for organized rural water districts.	Not present within Corridor or Route	No impacts are anticipated, and no buffer is proposed.	6.7
h. Irrigated land (note this is no longer part of the siting criteria (NDCC Sec. 49-22-05.1(2))).	Not applicable.	Not applicable.	Not applicable
i. Areas of recreational significance which are not designated as exclusion areas.	Not present within Corridor or Route	No impacts are anticipated, and no buffer is proposed.	6.5, 7.0

[a] Known archaeological sites are not depicted due to confidentiality.

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Attachment B

Bat Acoustic Activity Survey

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30 West Superior Street | Duluth, MN 55802

Bat Acoustic Activity Survey for the Longspur Wind Project in Morton County, North Dakota

Final Report

April 7 – November 2, 2025



Prepared for:

Minnesota Power

30 West Superior Street
Duluth, Minnesota 55802

Prepared by:

Western EcoSystems Technology, Inc.

4007 State Street, Suite 109
Bismarck, North Dakota 58503

January 8, 2026

WEST

Confidential Business Information

EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc., completed a bat acoustic activity survey (activity survey) for the Longspur Wind Project (Project) in Morton County, North Dakota, from April 7 – November 2, 2025. The objectives for this activity survey were to 1) record bat acoustic activity to assess seasonal, spatial, and temporal variation at the Project; and 2) document any acoustic evidence of northern long-eared bat and little brown bat. The activity survey followed recommendations from the US Fish and Wildlife Service's *Land-Based Wind Energy Guidelines*, Kunz et al., and the North Dakota Game and Fish Department's *Key Wind Energy Development in North Dakota: Best Management Practices*.

Two Wildlife Acoustics full-spectrum Song Meter SM3BAT ultrasonic detectors (detectors) with ultrasonic microphones were deployed throughout the Project. Each microphone sampled a discrete airspace defined as a survey station. Two survey stations were located in an area representative of where a turbine would be placed (representative stations). Both survey stations were ground stations, one of which was at the base of a meteorological tower.

Detectors recorded an average (± standard error) of 1.08 ± 0.15 bat passes per detector-night at the representative stations. Both sites experienced relatively little activity overall, and the LO1g site recorded slightly more activity (1.50 ± 0.25) compared to the LO2g site (0.66 ± 0.10).

Bat acoustic activity varied among seasons at representative stations, with summer and fall being the most active times. Bat acoustic activity peaked from mid-July through the end of September. Bat acoustic activity during the fall migration period (July 30 – October 14) averaged 2.10 ± 0.34 bat passes per night.

Approximately 74% of passes were classified as low-frequency bats (e.g., big brown, hoary, and silver-haired bats) and 26% of passes were classified as high-frequency bats (e.g., eastern red and little brown bats).

Northern long-eared bats have the potential to occur at the Project, but none were confirmed in the Project area. Little brown bat passes were qualitatively confirmed at both survey stations.

REPORT PARTICIPANTS

Martin Piorkowski	Project Manager
Elizabeth Baumgartner	Senior Reviewer
Richard Novy	Senior Bat Biologist Reviewer
Blake Struthers	Report Writer
Gina Zanarini	Bat Biologist
Terri Thorn	GIS Technician
Jaelyn Moore	Technical Editor

REPORT REFERENCE

Western EcoSystems Technology, Inc. (WEST). 2026. Bat Acoustic Activity Survey for the Longspur Wind Project in Morton County, North Dakota. Final Report: April 7 – November 2, 2025. Prepared for Minnesota Power, Duluth, Minnesota. Prepared by WEST, Bismarck, North Dakota, January 8, 2026.

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INTRODUCTION

Minnesota Power contracted Western EcoSystems Technology, Inc. (WEST), to complete a bat acoustic activity survey (activity survey) at the proposed Longspur Wind Project (Project) in Morton County, North Dakota (Figure 1). The objectives for this activity survey were to 1) record bat acoustic activity to assess seasonal, spatial, and temporal variation at the Project; and 2) document any acoustic evidence of northern long-eared bat (*Myotis septentrionalis*; NLEB) and little brown bat (*M. lucifugus*; LBBA). The activity survey followed recommendations from the US Fish and Wildlife Service's (USFWS's) *Land-Based Wind Energy Guidelines* (2012), Kunz et al. (2007), and the North Dakota Game and Fish Department's *Key Wind Energy Development in North Dakota: Best Management Practices* (2021). The Project area (Figure 1) was provided by Minnesota Power on October 10, 2024.

BACKGROUND

Eight bat species have the potential to occur within the Project area including NLEB and LBBA (BCI 2025, IUCN 2025, USFWS 2025; Table 1). Of the eight bat species that may occur in the Project area, one (NLEB) is federally listed. NLEB was federally listed as endangered effective March 31, 2023 (USFWS 2023). LBBA is currently under review by the USFWS for listing under the Endangered Species Act of 1973, with a listing decision anticipated in 2026 (USFWS 2024).

Table 1. Bat species with potential to occur at the Longspur Wind Project in Morton County, North Dakota.

Common Name	Scientific Name	Status (federal; state[1])
High Frequency (≥30 kHz)[2]		
eastern red bat	*Lasiurus borealis*	-; SGCN
little brown bat	*Myotis lucifugus*	under review for federal listing; SGCN
long-legged myotis bat	*Myotis volans*	-;-
northern long-eared bat	*Myotis septentrionalis*	federally endangered; SGCN
western small-footed bat	*Myotis ciliolabrum*	-;-
Low Frequency (≤30 kHz)[2]		
big brown bat	*Eptesicus fuscus*	-; SGCN
hoary bat	*Lasiurus cinereus*	-; SGCN
silver-haired bat	*Lasionycteris noctivagans*	-; SGCN

1. North Dakota Game and Fish Department Species of Greatest Conservation Need (2025).

2. Bats may produce pulses outside their typical frequency range.

kHz = kilohertz.

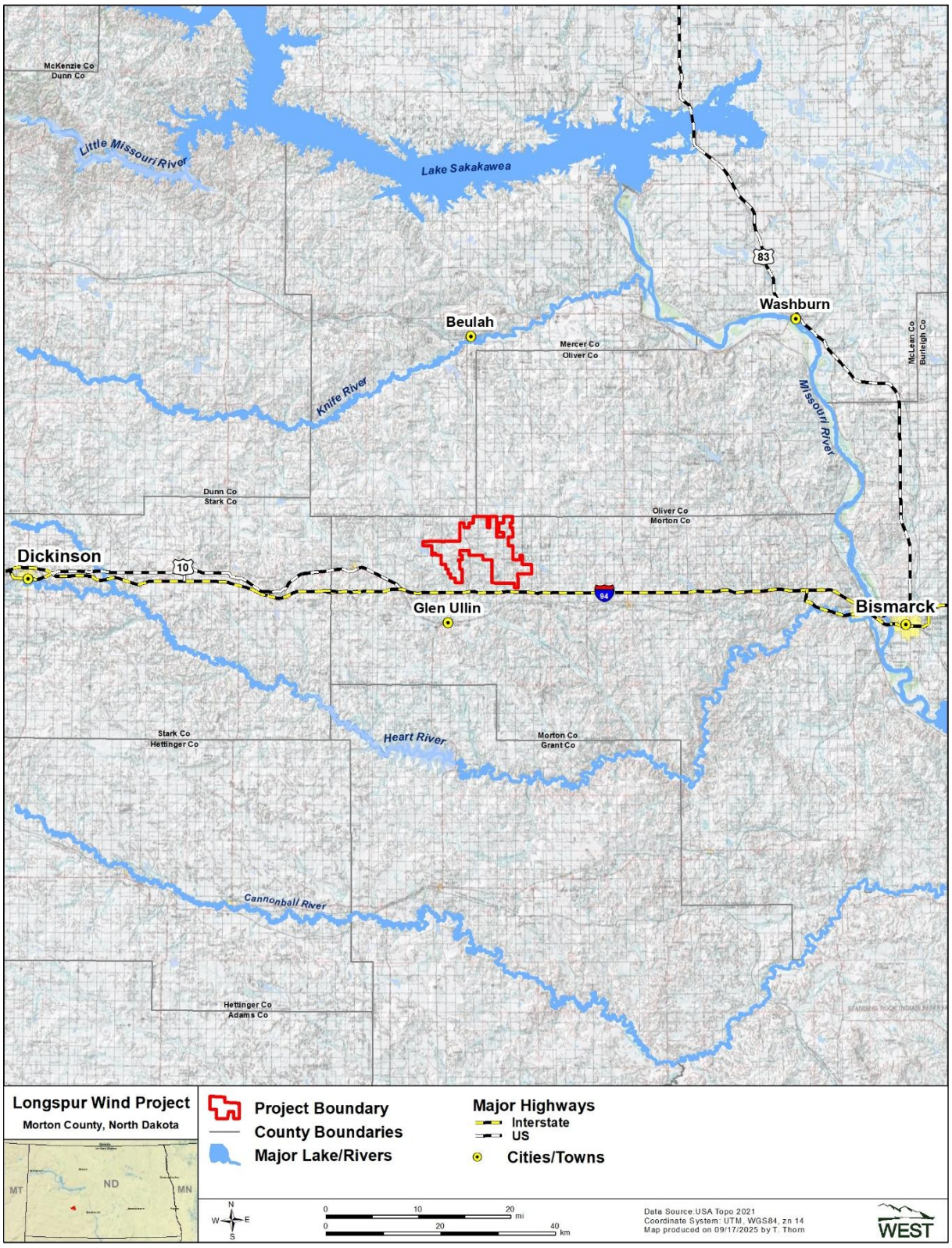


Figure 1. Location of the Longspur Wind Project in Morton County, North Dakota.

PROJECT DESCRIPTION

The proposed 25,933-acre Project is located in south-western North Dakota approximately four miles north of Glen Ullin in Morton County (Figure 1). The Project lies within the Level III Northwestern Great Plains Ecoregion (US Environmental Protection Agency 2012, 2013). According to the National Land Cover Database (2024), the main land cover types within the Project area are cultivated crops (55%), grassland/herbaceous (42%), developed (2%), and hay/pasture (1%; Table 2, Figure 2). The remaining land cover types each make up less than 1% of the Project area (Table 2).

Table 2. Land cover types, coverage, and percent (%) composition at the Longspur Wind Project in Morton County, North Dakota.

Land Cover Types	Coverage (acres)	% Composition
Cultivated Crops	14,165	55
Grassland/Herbaceous	10,904	42
Developed[1]	562	2
Hay/Pasture	205	1
Wetland/Open Water	64	<1
Shrub/Scrub	18	<1
Forest	14	<1
Barren	2	<1
Total	**25,933**	**100**

1. Developed Includes open space, low, medium, high intensity.

Sums of values may not equal totals shown due to rounding.

Source: National Land Cover Database (2024).

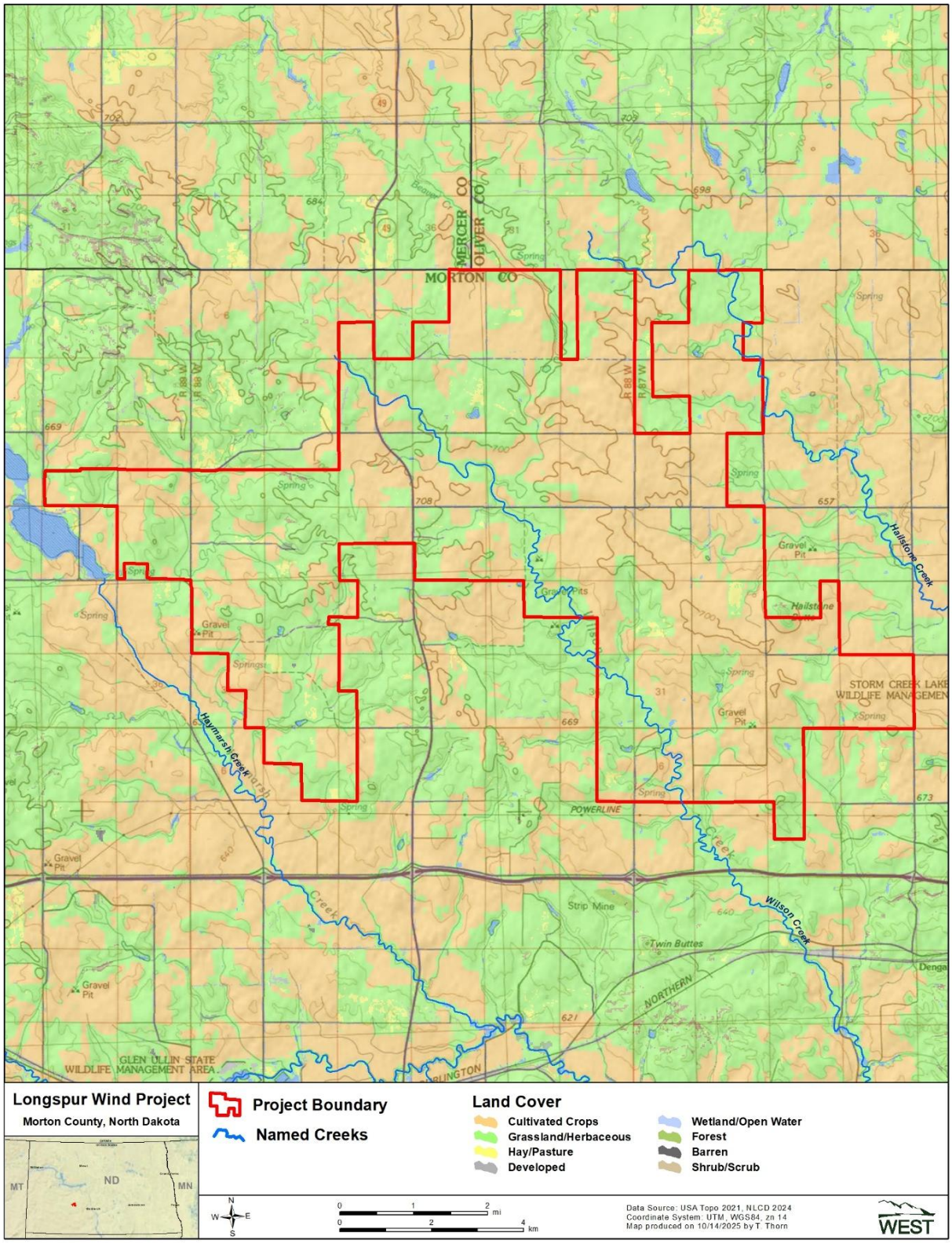


Figure 2. Land cover types within the Longspur Wind Project in Morton County, North Dakota.

METHODS

The activity survey was divided into three periods: spring (April 7 – May 14), summer (May 15 – August 15), and fall (August 16 – November 2) to highlight seasonal acoustic activity patterns. Detectors were programmed to turn on at 18:00 and off at 8:00 to capture bat acoustic activity throughout each night. If more than 30 minutes of the night was missed at a station, the station was classified as "non-operational" for that night.

Ultrasonic Detectors

The activity survey was completed using two full-spectrum Song Meter SM3BAT ultrasonic detectors (detectors; Wildlife Acoustics, Inc. [Wildlife Acoustics], Maynard, Massachusetts). The detectors were equipped with ultrasonic SMM-U1 microphones, which have a variable detection distance up to 98 feet (ft), influenced by atmospheric attenuation (e.g., changes with humidity, temperature, and air pressure), surrounding vegetation, and wind, as well as the bat's pulse frequency, amplitude, and direction (Blumstein et al. 2011, Adams et al. 2012, Chaverria and Quirós 2017, Goerlitz 2018). Microphones were placed approximately 10 ft above ground level. The microphones were secured atop a PVC[1] pole and connected via audio cables to the detector.

Survey Stations

For this Project, both detectors were placed in locations and habitats similar to where turbines have been proposed (representative stations). Both detectors were ground-only stations, one of which was at the base of a meteorological tower (LO1g; Figure 3; Appendix A).

Data Collection

The full-spectrum bat detectors recorded complete acoustic waveforms by sampling sound waves at a rate of 256 kilohertz (kHz). This high sampling rate enabled the detector to make high-resolution recordings of sound amplitude data at all frequencies up to 128 kHz. Detectors were generally checked every two weeks throughout the survey period to ensure each detector was functioning properly. Summary files associated with each recording session were reviewed to ensure each detector was operational and each microphone was initiating a recording (triggering) throughout the recording period. The detectors were set using a trigger window of five seconds and a maximum file length of 15 seconds. All microphones were fitted with windscreens. Microphones were tested prior to their deployment using an ultrasonic calibrator from Wildlife Acoustics to confirm they met factory thresholds.

[1] PVC = polyvinyl chloride.

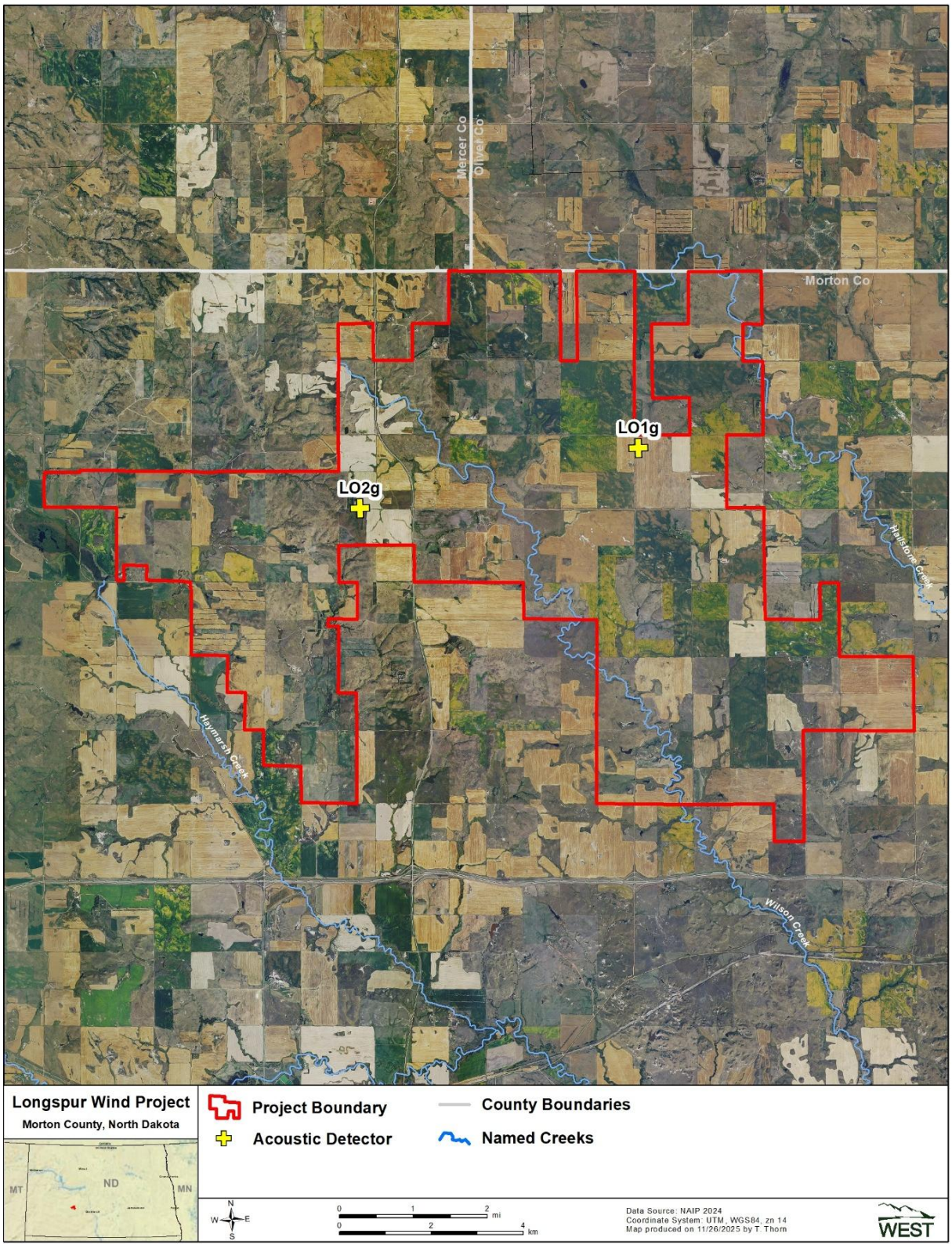


Figure 3. Location of survey stations within the Longspur Wind Project in Morton County, North Dakota.

Acoustic Analysis

Full-spectrum data were run through the automated identification feature in the program Kaleidoscope Pro 5.7.0 (Kaleidoscope; Wildlife Acoustics 2025) using the Bats of North America classifier 5.7.0 at a "0 balanced (neutral)" sensitivity setting. Kaleidoscope uses Hidden Markov Models and other statistical methods known for applications in temporal pattern recognition (Agranat 2012). Only the potentially occurring bat species listed in Table 1 were included in the Kaleidoscope identification model.

During the automated classification, full-spectrum data were also transformed into zero-crossing data using Kaleidoscope, allowing data to be viewed in Analook[2] software as digital sonograms that show changes in echolocation pulse frequency over time. Frequency versus time displays were used to separate bat pulses from other types of ultrasonic noise (e.g., wind, rain, insects) and to determine pulse frequency category. A bat pass was defined as a sequence of at least two echolocation pulses produced by an individual bat with no pause between pulses of more than one second, unless determined to be a single individual by an experienced acoustic analyst (Fenton 1980, Gannon et al. 2003).

Despite the capabilities of Kaleidoscope, many bat passes cannot be identified to species with absolute certainty, either because only pulse fragments were recorded due to the distance between the bat and microphone, or because many bat species produce similar pulses with overlapping characteristics that often cannot be distinguished. Therefore, automated bat identification is imperfect, and each identification has an associated error rate (Clement et al. 2014, Lemen et al. 2015, Russo and Voigt 2016, Rydell et al. 2017). The results of the Kaleidoscope analysis are termed "preliminary" for the reasons noted above and should not be considered an accurate depiction of the species present within the Project area.

For each survey station, bat passes were sorted into two groups based on the minimum pulse frequency. High-frequency (HF) bats (such as the NLEB and LBBA) have minimum frequencies (Fmin) usually greater than or equal to 30 kHz. Low-frequency (LF) bats (such as big brown [*Eptesicus fuscus*], silver-haired [*Lasionycteris noctivagans*], and hoary [*Lasiurus cinereus*] bats) typically emit echolocation pulses with Fmin from 15 to less than or equal to 30 kHz. Due to the flexible nature of bat echolocation, these frequency groups may overlap. While individual pulses may be above or below the cutoffs, the average Fmin for the whole bat pass is used for classification.

A qualified bat biologist with extensive acoustic identification experience in the Great Plains qualitatively reviewed all passes that Kaleidoscope identified as potential NLEB and LBBA. The bat biologist qualitatively identified echolocation passes through visual comparison of echolocation pulse metrics (e.g., Fmin, slope, and duration) to reference passes of known bats (O'Farrell and Gannon 1999, Murray et al. 2001, Yates and Muzika 2006). A second qualified bat biologist with extensive acoustic identification experience reviewed a subset of qualitative pulse

[2] AnaLook. Bat call analysis program. © 2004, C. Corben.

labels for quality assurance. If passes were not characteristic of the automated identification, or contained distinct pulses produced by a different species, or were of insufficient quality; the passes were reclassified.

Data Management

Data Compilation and Storage

A WEST-developed Microsoft® SQL Server database was used to store, organize, and retrieve survey data. Project data were keyed into the electronic database using a pre-defined format to facilitate subsequent quality assurance and quality control (QA/QC) and data analysis. WEST retained all data forms and electronic data files for reference.

Quality Assurance and Quality Control

WEST implemented QA/QC measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Multiple reviews were conducted as QA/QC measures throughout the study-life cycle. Following surveys, bat biologists were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field technicians and/or Project Managers. If any errors, omissions, or problems were identified in later stages of analysis or report writing, they were traced back to the raw data forms where appropriate changes and measures were implemented and documented.

Reporting and Review Process

WEST's reporting and review process included technical editing, senior technical review, and a final review by the Project Manager before delivery to the client.

Statistical Analysis

The standard metric used for measuring bat acoustic activity is the number of bat passes per detector-night. A detector-night was defined as one microphone at one detector operating for one entire night. This metric was used as an index of bat acoustic activity in the Project area and does not represent numbers of individuals. The use of bat passes per detector-nights as a metric for calculating bat acoustic activity controlled for differences in the sampling effort among individual detectors and provided unbiased estimates for the deployed nights. A bootstrap analysis was performed to assess variability in the metrics calculated. Bat passes per detector-night were calculated for HF and LF bats.

An experienced bat acoustic analyst determined the number of bat passes using AnaLook. Mean bat acoustic activity was calculated by station, season, week (pre-determined 7-day intervals beginning January 1), and overall. Overall averages were calculated as an unweighted average of total bat acoustic activity at each individual station and averaged within station type (i.e., overall representative).

Mean bat acoustic activity was calculated for a standardized Fall Migration Period (FMP), defined by WEST as July 30 – October 14. The FMP contains portions of both summer and fall seasons

and is used to compare bat acoustic activity with other wind projects with data collected and analyzed during the same time period.

RESULTS

Bat acoustic activity was monitored at two survey stations for 375 detector-nights from April 7 – November 2, 2025 (Table 3). Detectors and microphones were operating for 91% of the sampling period (Figure 4). The primary cause of lost data was an intermittently malfunctioning detector at LO1g.

Spatial Bat Activity

Bat acoustic activity within the Project area varied between stations (Table 3, Figure 5). Detectors at representative stations recorded a mean (± standard error) of 1.08 ± 0.15 bat passes per detector-night (Table 3). Station LO1g recorded slightly more bat passes per detector-night (1.50 ± 0.25) than station LO2g (0.66 ± 0.10), but activity was low at both stations overall (Table 3, Figure 5).

Table 3. Results of bat acoustic activity surveys completed at survey stations within the Longspur Wind Project in Morton County, North Dakota from April 7 – November 2, 2025.

Station	# of HF Bat Passes (%)	# of LF Bat Passes (%)	Total Bat Passes	Detector-Nights	Bat Passes/ Detector-Night[1]
LO1g	63 (24)	196 (76)	259	173	1.50 ± 0.25
LO2g	38 (28)	96 (72)	134	202	0.66 ± 0.10
Total (%)	**101 (26)**	**292 (74)**	**393**	**375**	**1.08 ± 0.15**

1. Calculated by total bat passes divided by total operational detector nights; ± bootstrapped standard error.

2. All bat passes were manually labelled as the appropriate group using AnaLook. A Label may be Noise, HF, LF, or a species code.

Note: Passes are separated by pulse frequency: high-frequency (HF; ≥30 kilohertz [kHz]) and low-frequency (LF; ≤30 kHz).

Seasonal Bat Activity

Bat acoustic activity varied among seasons at representative stations, with summer and fall being the most active times. Summer and fall activity were higher than in spring, but activity levels were generally low throughout the monitoring period (Figures 6 and 7, Table 4). Overall bat acoustic activity was highest (2.10 ± 0.34 bat passes/detector-night) during the FMP (Table 4). Weekly bat acoustic activity peaked from mid-July through the end of September for both HF and LF species (Figure 7). LF bat activity was generally higher than HF activity throughout the monitoring period (Figures 6 and 7).



Figure 4. Operational status of survey stations at the Longspur Wind Project in Morton County, North Dakota, from April 7 – November 2, 2025.

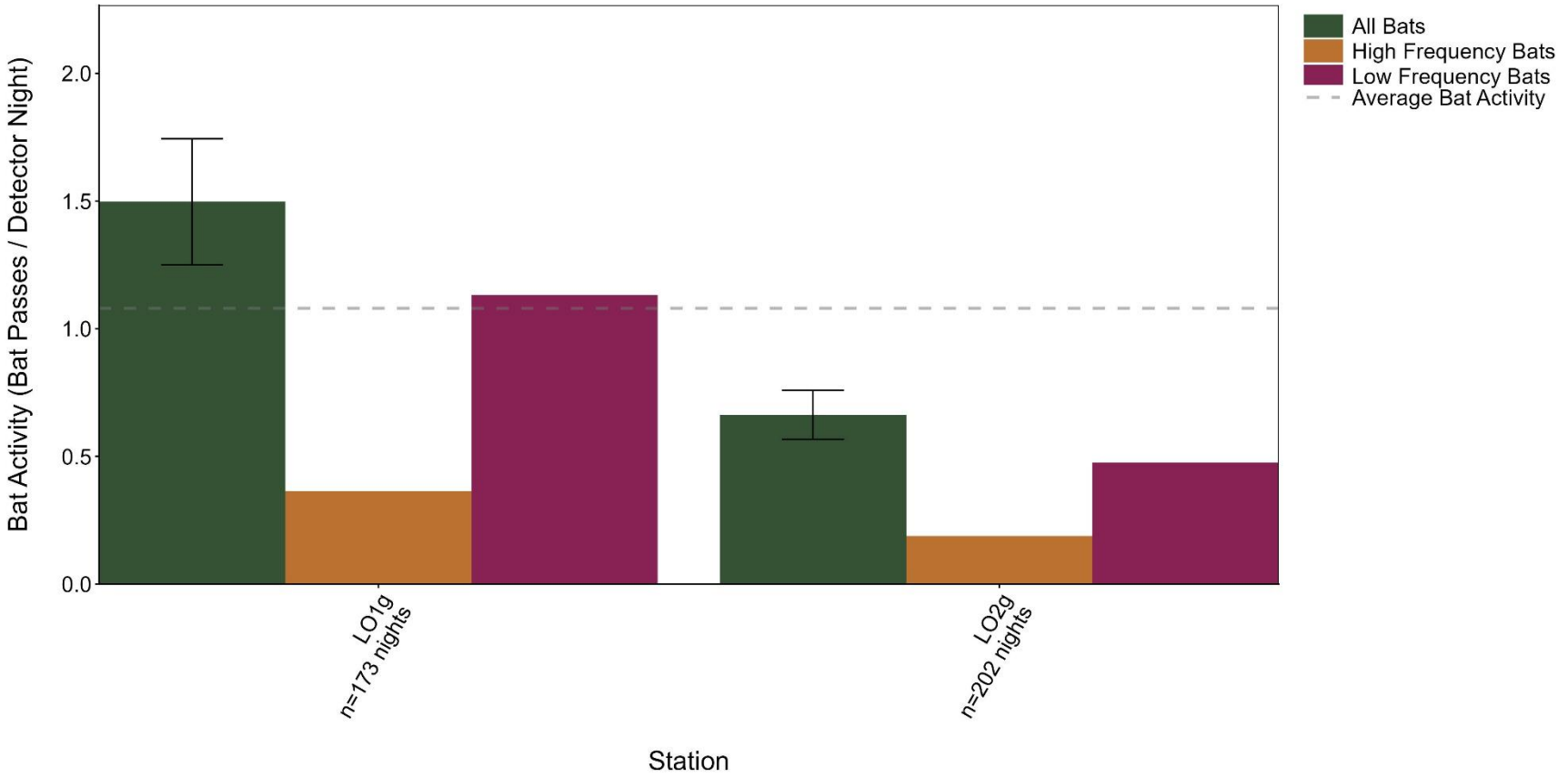


Figure 5. Number of high-frequency, low-frequency, and all bat passes per detector-night recorded at representative stations within the Longspur Wind Project in Morton County, North Dakota, from April 7 – November 2, 2025.

NOTE: The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

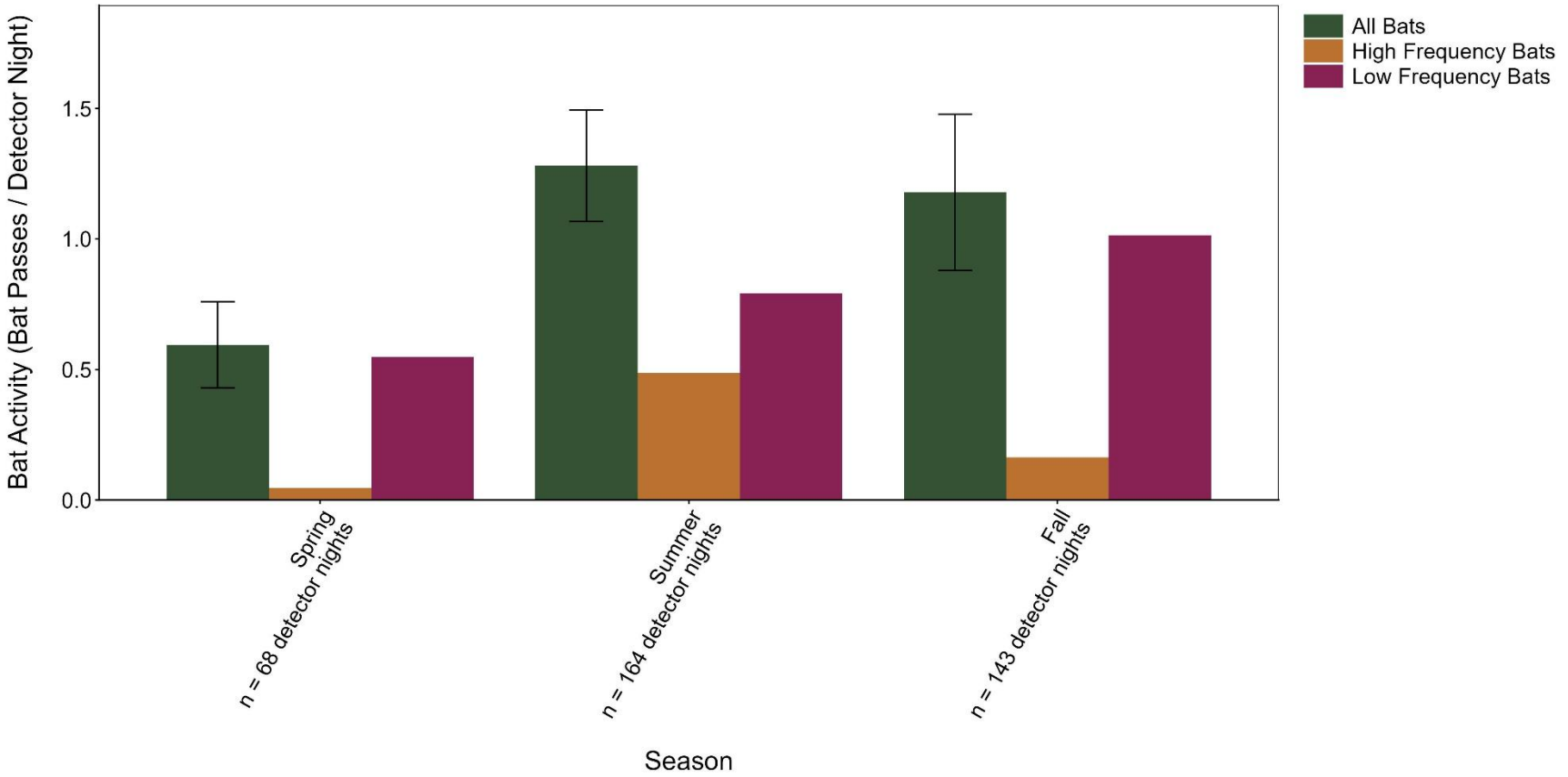


Figure 6. Seasonal bat acoustic activity by high-frequency, low-frequency, and all bats at representative stations at the Longspur Wind Project in Morton County, North Dakota, from April 7 – November 2, 2025.

NOTE: The bootstrapped standard errors are represented on the 'All Bats' columns.

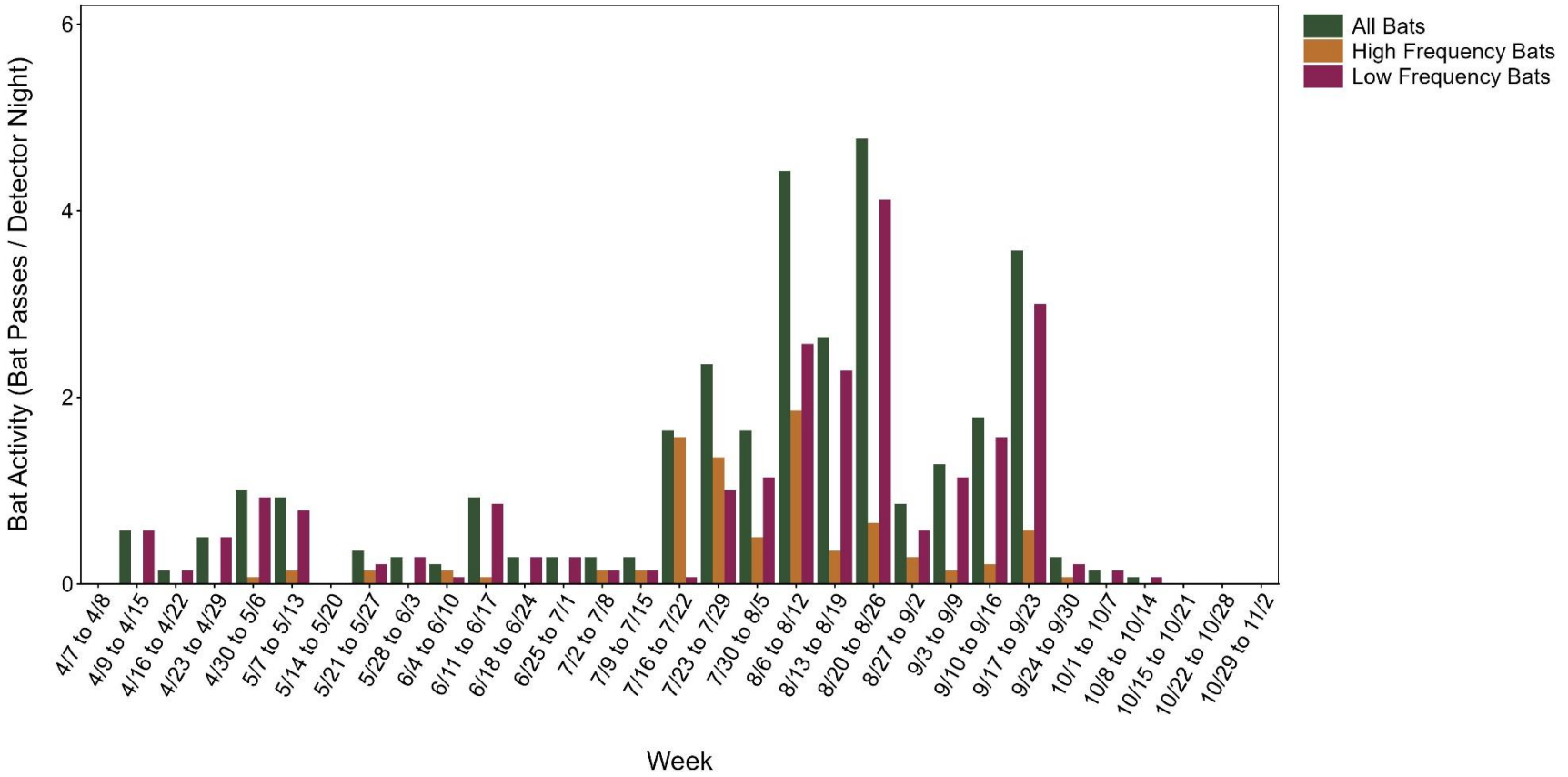


Figure 7. Weekly patterns of bat acoustic activity at representative stations by high-frequency, low-frequency, and all bats at the Longspur Wind Project in Morton County, North Dakota from, April 7 – November 2, 2025.

Table 4. The number of bat passes per detector-night during each season, separated by pulse frequency, recorded at representative stations within the Longspur Wind Project in Morton County, North Dakota from April 7 – November 2, 2025.

Station	Pulse Frequency[1]	Spring April 7 – May 14	Summer May 15 – Aug 15	Fall Aug 16 – Nov 2	Fall Migration Period Jul 30 – Oct 14
LO1gTotal	HF	0.03	0.76	0.13	0.65
	LF	0.26	1.34	1.42	2.61
	AB	0.29	2.10	1.55	3.26
LO2gTotal	HF	0.07	0.22	0.20	0.29
	LF	0.83	0.25	0.61	0.65
	AB	0.90	0.46	0.81	0.94
Overall	**HF**	**0.05 ± 0.02**	**0.49 ± 0.11**	**0.16 ± 0.05**	**0.47 ± 0.10**
	LF	**0.55 ± 0.16**	**0.79 ± 0.15**	**1.01 ± 0.26**	**1.63 ± 0.29**
	AB	**0.59 ± 0.17**	**1.28 ± 0.23**	**1.18 ± 0.29**	**2.10 ± 0.34**

[1.] high-frequency (HF), low-frequency (LF), and all bats (AB).

Error ranges indicate ± bootstrapped standard error.

Species Composition

NLEB were not identified within the Project area, and Kaleidoscope did not classify any passes as potential NLEB.

LBBA were identified within the Project area. Of the 10 potential bat passes, five passes were qualitatively identified as LBBA by a qualified bat biologist (Table 5). The remaining passes were reclassified from the original identification provided by Kaleidoscope, either to eastern red bat (*Lasiurus borealis*) or a frequency group (e.g., HF), because a diagnostic pulse characteristic was not present in the pass to determine the species that produced the pulse. Four of the confirmed LBBA passes were detected between August – September, and one was detected in June. Four of the LBBA were detected at the LO1g station and one at the LO2g station.

Of the total bat passes recorded at representative stations, approximately 74% were classified as LF (e.g., big brown, hoary, and silver-haired bats) during manual labeling, and approximately 26% were classified as HF (e.g., eastern red bats and LBBA; Table 3).

Table 5. Number of passes labeled as little brown bat by Kaleidoscope Pro 5.7.0 and after qualitative review at the Longspur Wind Project in Morton County, North Dakota from April 7 – November 2, 2025.

	# Little Brown Bat Passes	
Station	**Kaleidoscope**	**After Qualitative Review**
LO1g	7	4
LO2g	3	1
Total	**10**	**5**

No northern long-eared bats were detected by Kaleidoscope Pro (Wildlife Acoustics, Inc., 2025).

DISCUSSION

Pre-construction acoustic activity surveys provide useful information about bat spatial use, seasonal activity peaks, and species composition for a project. Monitoring at representative stations can provide relative bat activity levels across a project area in locations similar to where turbines may be erected. Although these data should not be used to determine siting, acoustic activity provides useful information that may offer insight into the possible impacts of wind development and inform potential mitigation strategies (Kunz et al. 2007, Weller and Baldwin 2012, Britzke et al. 2013, Goldenberg et al. 2021, Huang et al. 2024).

During the FMP, bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and mating behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008, Cryan 2008, Arnett and Baerwald 2013, Barclay et al. 2017, WEST 2023). While acoustic activity remained comparatively low throughout the monitoring period, activity peaked the weeks of August 6 and August 20 and may have been attributable to the arrival of a small migratory population of bats traveling between their summer grounds and overwintering habitat. This corresponds to the period when juvenile bats begin flying, as well as increased acoustic activity associated with preparation for fall migration. The increase in activity throughout August and September was driven by small increases in both LF and HF species and suggests migratory activity rather than resident bat populations remaining active for longer periods in the summer.

Of the eight species that have the potential to occur at the Project, no federally-listed species were identified at the Project. Species of State concern (i.e., Species of Greatest Conservation Need [NDGFD 2025]) may be present with the Project area and may include eastern red bat, little brown bat, big brown bat, hoary bat, and silver-haired bat. Only one federally listed species, NLEB, has the potential to occur in the Project; however none were identified during activity surveys. LBBA, a species under review for federal listing, was confirmed at both survey stations.

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Appendix A. Station Photographs for Bat Acoustic Activity Surveys for the Longspur Wind Project in Morton County, North Dakota, from April 7 – November 2, 2025



Appendix A1. Photographs of acoustic station LO1g.



Appendix A2. Photographs of acoustic station LO2g.

minnesota power

AN ALLETE COMPANY

Attachment C

Class I and III Cultural Resources Inventory Report

P: 218.722.2625 | W: www.mnpower.com
30 West Superior Street | Duluth, MN 55802

January 15, 2026

Damien Reinhart
Merjent Inc.
1 Main Street SE
Suite 300
Minneapolis, MN 55414

SHSND Ref.: 25-9058 Longspur Wind Project

Dear Damien,

We received the report for SHSND Ref: 25-9058, titled "A Class I and Class III Cultural Resources Inventory of the Minnesota Power Longspur Windfarm Project, Morton and Mercer Counties, North Dakota" and find this Merjent report by Damien Reinhart and Matthew Cox on the archaeological portion of the survey acceptable. We will add it to our Manuscript Collection.

Thank you for the opportunity to review this report. Please be advised that acceptance of this report does not constitute concurrence with the determinations therein. If you have any questions, please Lorna Meidinger, Lead Historic Preservation Specialist, at (701) 328-2089 or lbmeidinger@nd.gov.

Sincerely,



for William D. Peterson, PhD
Director, State Historical Society of North Dakota

25-9058

MANUSCRIPT DATA RECORD FORM

1. Manuscript Number: [SHPO assigns]

2. SHPO Reference #:

3. Author(s): Damien Reinhart, Matthew Cox

4. Title: A Class I and Class III Cultural Resources Inventory of the Minnesota Power Longspur Windfarm Project, Morton and Mercer Counties, North Dakota

5. Report Date: September 11, 2025

6. Number of Pages: 186

7. Type – I, T, E, O: I

   I=Inventory; T=Formal Testing; E=Excavation; O=Other

8. List formally tested or excavated sites (not probes):

9. Acres: 1,478

10. List the legal description* and study unit. For study unit assignment, use the township tables in the *State Plan*, http://history.nd.gov/hp/stateplan_arch.html.
    Study Units: LM, CB, KN, HE, SM, GA, JA, GR, NR, SR, SO, SH, YE

*For *inventory*, *formal testing,* and *excavation* projects, *list the CLASS III legal locations only*.

County	Township	Range	Section	Study Unit
Morton	139 N	87 W	4-5	SM
	139N	88W	3-5	SM
	140N	87W	6-8, 17-21, 28-34	SM
	140N	88W	1-3, 9-16, 18-25, 30-34	SM
	140N	89W	13, 24	SM
Mercer	141N	88W	36	SM



Minnesota Power

A Class I and Class III Cultural Resources Inventory of the Minnesota Power Longspur Windfarm Project

Morton and Mercer Counties, North Dakota

PREPARED BY

Merjent, Inc.
1 Main Street SE, Suite 300
Minneapolis, Minnesota 55414

Damien Reinhart, MA
Matthew Cox, MA, RPA

Damien S. Reinhart, MA
Principal Investigator

September 2025

EXECUTIVE SUMMARY

Minnesota Power, an ALLETE company, is developing a wind energy conversion facility, known as the Longspur Wind Project in Morton and Mercer Counties, North Dakota (Project). All Project turbines will be in Morton County and approximately 2.5 miles of 230-kilovolt (kV) transmission generator lead line (Transmission Line) will be installed to connect the Project to the proposed Point of Interconnect (POI) at an existing substation in Mercer County. The Project will require a Certificate of Site Compatibility from the North Dakota Public Service Commission (NDPSC) in accordance with the North Dakota Energy Conversion and Transmission Facility Siting Act (the Siting Act) (North Dakota Century Code [NDCC], Chapter 49-22). Because the Project's Transmission Line will have a capacity greater than 115 kV and is longer than one mile, the Project will also need a Certificate of Corridor Compatibility under the Siting Act. The Project will also require a Special Use Permit from Morton County and may require a Conditional Use Permit from Mercer County.

Minnesota Power contracted Merjent, Inc. (Merjent) to conduct a Class I and Class III cultural resources inventory on their behalf. Merjent completed a Class I file search in August 2024, with an update in January 2025, which identified one previously recorded historic archaeological site, one historic archaeological site lead, and three precontact isolated finds within the Project Survey Areas. The Class III pedestrian survey of the Project Survey Areas was completed on January 31, 2025, March 5 to 14, 2025, April 9, 2025, April 14 to 18, 2025, April 23, 2025, and May 26, 2025. During the survey, two new historic sites, two new precontact sites, and five new isolated finds were identified. Of the new sites, isolated finds, and previously identified sites, four are recommended as unevaluated or potentially eligible for listing on the National Register of Historic Places. Merjent recommends avoiding four, 32MO1719, 32MO1720, 32MO1721, and 32MO1722, of the nine new resources. Merjent searched for site lead 32MOX132, a historic camp site, but no evidence of past activity was identified during the survey for a proposed access road, which is an existing crowned and ditched county road; therefore, no further work is recommended for the resource in this area. Similarly, site 32MO233, a segment of stagecoach line, was originally noted as being covered in this area by a modern crowned and ditched county road. No evidence of past activity was identified during the survey for proposed operations and maintenance work areas to the north of the existing road. No further work is recommended for the previously recorded site in this area. The other eight sites and isolated finds are recommended as not eligible for listing. No further work or avoidance is recommended for those resources.

Merjent recommends that no significant sites will be affected by the proposed Project provided the avoidance measures recommended in this report are implemented. No further archaeological work is recommended for the Project as planned.

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ACRONYMS AND ABBREVIATIONS

ADLS	Aircraft Detection Lighting System
BP	Before Present
CE	Common Era
cm	Centimeter
cmbs	centimeters below surface
COD	commercial operation date
CFR	Code of Federal Regulations
EMMV	Extended Middle Missouri Variant
Gen Tie Line	transmission generator lead line
GLO	General Land Office
GSV	ground surface visibility
IMMV	Initial Middle Missouri Variant
KRF	Knife River flint
kV	kilovolt
Merjent	Merjent, Inc.
NDCC	North Dakota Century Code
NDPSC	North Dakota Public Service Commission
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
O&M	operations and maintenance
POI	Point of Interconnect
Project	Longspur Wind Project in Morton and Mercer Counties, North Dakota
Project Survey Area	proposed area of Class III pedestrian survey
PVC	polyvinyl chloride
SHPO	State Historic Preservation Office
SHSND	State Historical Society of North Dakota
SITS	Smithsonian Institution Trinomial System
SMRSU	Southern Missouri River Study Unit
Study Area	proposed Survey area plus a 1-mile radius
the Siting Act	North Dakota Energy Conversion and Transmission Facility Siting Act
USGS	U.S. Geological Survey
WPA	Works Progress Administration

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Minnesota Power, an ALLETE company, is developing a wind energy conversion facility, known as the Longspur Wind Project in Morton and Mercer Counties, North Dakota (Project). All Project turbines will be in Morton County and approximately 2.5 miles of 230-kilovolt (kV) transmission generator lead line (Transmission Line) will be installed to connect the Project to the proposed Point of Interconnect (POI) at an existing substation in Mercer County. The Project will require a Certificate of Site Compatibility from the North Dakota Public Service Commission (NDPSC) in accordance with the North Dakota Energy Conversion and Transmission Facility Siting Act (the Siting Act) (North Dakota Century Code [NDCC], Chapter 49-22). Because the Project's Transmission Line will have a capacity greater than 115 kV and is longer than one-mile, the Project will also need a Certificate of Corridor Compatibility under the Siting Act. The Project will also require a Special Use Permit from Morton County and may require a Conditional Use Permit from Mercer County. The Project has an anticipated commercial operation date (COD) of December 2027, with construction potentially starting in 2026.

In anticipation of compliance with state law and the NDPSC permitting process, Minnesota Power contracted Merjent to conduct a Class I file search within a 1-mile radius of the proposed Project Survey Areas (Study Area) and a Class III intensive cultural resource inventory of the Project's survey area (see Table 1.1-1 and Figure 1 in Appendix A). Minnesota Power identified turbine locations, access road corridors, a transmission line corridor, substation areas, work or staging areas, and communication tower locations. These locations and buffers surrounding them, which make up the Project Survey Area, were inventoried to identify the presence of historic properties with the goal of avoiding adverse effects to unevaluated, potentially eligible properties, or those already listed on the National Register of Historic Places (NRHP).

A total of 69 proposed turbine locations, a gen-tie transmission line, substation block, two operations and maintenance (O&M) facility locations, three meteorological evaluation towers (METs), an Aircraft Detection Lighting System (ADLS) tower location and associated access roads were inventoried on private lands (see Table 1.1-1 below).

Table 1.1-1

Class III Survey Areas, Results, and Acreages

Location Name	Legal Description	Vegetation	Ground Surface Visibility	Associated Access Road Miles	Survey Width	Sites Identified or Revisited	Total Class III Acreage
Gen-Tie Transmission Line	[redacted]	Grain stubble, corn stubble, mixed grass pastures	30-100	N/A	500 feet	32MO1721, 32MOX579, 32MOX580	143.5
Gen-Tie Workspace and Substation Blocks	[redacted]	Grain stubble, mixed grass pasture	20-50	N/A	N/A	32MO1720, 32MO1721	125.4
O&M Option 1	[redacted]	Grain stubble	50	N/A	N/A	32MO233	20

Table 1.1-1

Class III Survey Areas, Results, and Acreages

Location Name	Legal Description	Vegetation	Ground Surface Visibility	Associated Access Road Miles	Survey Width	Sites Identified or Revisited	Total Class III Acreage
O&M Option 2	[redacted]	Grain stubble	50	N/A	N/A	32MO233	19.8
MET Tower 1	NWNE, Sec. 2, T140N, R88W	Corn stubble	70	N/A	N/A	None	4.5
MET Tower 2	SESW, Sec. 14, T140N, R88W	Grain stubble, short grass pasture	30-70	N/A	N/A	None	4.5
MET Tower 3	SESE, Sec. 33, T140N, R87W	Grain stubble	50	N/A	N/A	None	4.5
ADLS Tower	SENW, Sec. 21, T140N, R88W	Mixed grass pasture, grain stubble, tree plantings	20-40	N/A	N/A	None	4.5
Turbine 01	SENW, Sec. 24. T140N, R89W	Grain stubble, short grass pasture	50-90	0.2	50	None	19.1
Turbine 02	SWSW, Sec. 13, T140N, R89W	Corn stubble, grain stubble	50-80	N/A	N/A	None	18
Turbine 03	NWSE, Sec. 13, T140N, 89W	Grain stubble, mixed grass pasture	25-50	0.1	50	None	18.6
Turbine 04	SESE, Sec. 13, T140N, R89W	Grain stubble, mixed grass pasture	25-60	N/A	N/A	None	18
Turbine 05	[redacted]	Grain stubble	50-70	0.05	50	32MOX803	18.3
Turbine 06	[redacted]	Grain and corn stubble, hay field	50-70	1.21	50	32MOX132	25.6
Turbine 07	SESW, Sec. 30, T140N, R88W	Grain stubble, tree plantings	50-70	0.2	50	None	19.2
Turbine 08	SESW, Sec. 30, T140N, R88W	Grain stubble, tree plantings	50-70	0.12	50	None	18.75
Turbine 09	SESE, Se. 19, T140N, R88W	Stubble field	80	0.1	50	None	18.65
Turbine 10	SWSW, Sec. 20, T140N, R88W	Mixed grass pasture	40	0.5	50	None	20.9
Turbine 11	SESW, Sec. 20, T10N, R88W	Grain stubble, mixed grass pasture	30-60	0.22	50	None	19.45
Turbine 12	SESE, Sec. 20, T140N, R88W	Grain stubble	50-70	1.07	50	None	20.17
Turbine 13	SENE, Sec. 31, T140N, R88W	Grain stubble	40-80	1.16	50	None	20.36
Turbine 14	SWNW, Sec. 32, T140N, R88W	Grain stubble	40-100	N/A	N/A	None	18

Table 1.1-1

Class III Survey Areas, Results, and Acreages

Location Name	Legal Description	Vegetation	Ground Surface Visibility	Associated Access Road Miles	Survey Width	Sites Identified or Revisited	Total Class III Acreage
Turbine 15	SWNE, Sec. 32, T140N, R88W	Canola stubble, stream crossing	60	0.58	50	None	19.19
Turbine 16	NENE, Sec. 32, T140N, R88W	Flax stubble, tree plantings	90	0.23	50	None	18.47
Turbine 17	SENW, Sec. 5, T139N, R88W	Stubble field	40	N/A	N/A	None	18
Turbine 18	SWNE, Sec. 5, T139N, R88W	Short grass pasture	25-60	0.74	50	None	19.54
Turbine 19	SWNW, Sec. 4, T139N, R88W	Flax stubble	70-80	1.42	50	None	20.86
Turbine 20	NENE, Sec. 3, T140N, R88W	Corn stubble	40	N/A (Within Gen-Tie Corridor	N/A	None	17.3
Turbine 21	SENW, Sec. 2, T140N, R88W	Disked hay field	50-75	0.27	50	None	19.74
Turbine 22	SWNE, Sec. 2, T140N, R88W	Corn stubble	40-70	0.13	50	None	18.82
Turbine 23	NENE, Sec. 1, T140N, R88W	Grain stubble	30-50	0.57	50	None	21.3
Turbine 24	NWSE, Sec. 1, T140N, R88W	Grain stubble	30-50	0.52	50	None	21.52
Turbine 25	SENE, Sec. 7, T140N, R87W	Corn stubble	30-75	N/A	N/A	None	18
Turbine 26	NWNW, Sec. 8, T140N, R87W	Corn stubble	50-75	0.79	50	None	23.43
Turbine 27	NENW, Sec. 8, T140N, R87W	Corn stubble	50-75	0.13	50	None	18.77
Turbine 28	NWSE, Sec. 9, T140N, R88W	Soybean stubble, pasture	80	N/A	N/A	None	18
Turbine 29	SENE, Sec. 10, T140N, R88W	Mixed grass pasture	25	0.03	50	None	18.28
Turbine 30	SESE, SENE, Sec. 10, T140N, R88W	Wheat stubble	50	1.25	50	None	25.96
Turbine 31	[redacted]	Mowed hay field	30-50	0.24	50	32MOX802	19.47
Turbine 32 (Removed)	N/A	N/A	N/A	N/A	N/A	N/A	0
Turbine 33	NESW, Sec. 12, T140N, R88W	Canola stubble	40-65	2.13	50	None	32
Turbine 34	NESE, Sec. 12, T140N, R88W	Corn stubble	60-100	N/A	N/A	None	18
Turbine 35	SENW, Sec. 14, T140N, R88W	Corn stubble	30-60	N/A	N/A	None	18
Turbine 36	NWSE, Sec. 14, T140N, R88W	Wheat stubble	30-60	0.63	50	None	22.4

Table 1.1-1

Class III Survey Areas, Results, and Acreages

Location Name	Legal Description	Vegetation	Ground Surface Visibility	Associated Access Road Miles	Survey Width	Sites Identified or Revisited	Total Class III Acreage
Turbine 37	SENE, Sec. 14, T140N, R88W	Stubble field	30-60	N/A	N/A	None	18
Turbine 38	NESW, Sec. 14, T140N, R88W	Wheat stubble	30-70	0.42	50	None	20.62
Turbine 39	SWNE, Sec. 14, T140N, R88W	Corn stubble	30-60	1.55	50	None	30.83
Turbine 40	NWSE, Sec. 18, T140N, R87W	Wheat stubble	40-60	0.21	50	None	19.36
Turbine 41	[redacted]	Corn stubble	75-100	N/A	N/A	32MOX804	18
Turbine 42	NESW, Sec. 17, T140N, R87W	Soybean stubble	50-80	N/A	N/A	None	18
Turbine 43	NESE, Sec. 16, T140N, R88W	Wheat stubble, cut hayfield	50	0.45	50	None	20.89
Turbine 44	[redacted]	Wheat stubble	30-70	0.12	50	32MO233	18.85
Turbine 45	SESW, Sec. 16, T140N, R88W	Corn stubble, grain stubble, planted trees	60-90	0.26	50	None	19.95
Turbine 46	NWNE, Sec. 21, T140N, R88W	Soybean stubble	50	0.15	50	None	19.16
Turbine 47	NWNW, Sec. 22, T140N, R88W	Wheat stubble	30-60	0.16	50	None	19.03
Turbine 48	SWSE, Sec. 22, T140N, R88W	Wheat stubble, mixed grass pasture	25-50	0.55	50	None	21.75
Turbine 49	NESE, Sec. 22, T140N, R88W	Wheat stubble	30-60	N/A	N/A	None	18
Turbine 50	SESW, Sec. 23, T140N, R88W	Wheat stubble	30-70	0.58	50	None	22.08
Turbine 51	SESW, Sec. 24, T140N, R88W	Wheat stubble	25-50	N/A	N/A	None	18
Turbine 52	[redacted]	Tilled field	75-100	0.97	50	32MO1722, 32MOX806	25.15
Turbine 53	[redacted]	Corn stubble	30-80	0.43	50	32MOX805	21.2
Turbine 54	SESE, Sec. 19, T140N, R87W	Corn stubble	40-80	N/A	N/A	None	18
Turbine 55	NWNE, Sec. 20, T140N, R87W	Grain stubble	35-65	N/A	N/A	None	18
Turbine 56	SWSE, Sec. 25, T140N, R88W	Tilled field	90-100	N/A	N/A	None	18

Table 1.1-1

Class III Survey Areas, Results, and Acreages

Location Name	Legal Description	Vegetation	Ground Surface Visibility	Associated Access Road Miles	Survey Width	Sites Identified or Revisited	Total Class III Acreage
Turbine 57	NWSE, Sec. 30, T140N, R87W	Mowed hay field	30-60	N/A	N/A	None	18
Turbine 58	SENE, Sec. 30, T140N, R87W	Corn stubble	30-100	3.1	50	None	38.32
Turbine 59	NESW, Sec. 29, T140N, R87W	Corn stubble	30-100	0.41	50	None	20.68
Turbine 60	NENW, Sec. 29, T140N, R87W	Canola stubble	25-70	N/A	N/A	None	18
Turbine 61	SESE, Sec. 29, T140N, R87W	Flax stubble	25-50	N/A	N/A	None	18
Turbine 62	[redacted]	Soybean stubble	35-50	1.9	50	32MO1719	38.27
Turbine 63	NWNE, Sec. 31, T140N, R87W	Barley stubble	40-60	0.84	50	None	24.07
Turbine 64	NWNE, Sec. 32 T140N, R87W	Soybean stubble	50	N/A	N/A	None	18
Turbine 65	NWSW, Sec. 32, T140N, R87W	Barley stubble	40-60	0.5	50	None	22.2
Turbine 66	NWSW, Sec. 33, T140N, R87W	Flax stubble	25-50	0.88	50	None	24.46
Turbine 67	[redacted]	Barley stubble	40-60	1.7	50	32MOX577	30.23
Turbine 68	NESW, Sec. 334, T140N, R87W	Grain stubble	35-65	0.44	50	None	21
Turbine 69	NENE, Sec. 5, T139N, R87W	Corn stubble	40-65	0.55	50	None	21.76
Turbine 70	NWSE, Sec. 5, T139N, R87W	Grain stubble	40	1.03	50	None	24.62
TOTAL				**23.89**			**1,478.41**

The Project Survey Area is 1,478.41 acres total, with 23.89 linear miles for access roads and the proposed transmission line, all of which were inventoried at the Class III level.

1.2 CLASS III SURVEY METHODS

Merjent applied industry best practices and adhered to the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Title 48 Code of Federal Regulations [CFR] 44716) and the North Dakota State Historic Preservation Office (SHPO) *Guidelines Manual for Cultural Resource Inventory Projects* (State Historical Society of North Dakota [SHSND] 2020). Fieldwork was conducted January 31, 2025, March 5-14, 2025, April 9, 2025, April 14-18, 2025, April 23, 2025, and May 26, 2025. The Class III inventory and limited shovel testing was led by

Damien Reinhart (Principal Investigator) with a crew consisting of Fred Sutherland, Cody Dobson, and Martha Mock. Mr. Reinhart meets the Secretary of the Interior's Professional Qualification Standards for Archaeology as published in 36 CFR Section 61.

1.3 CULTURAL RESOURCES WITHIN THE SURVEY AREA

See Table 1.3-1 below for a list of archaeological resources within the Project Survey Area. Merjent completed a file search in August 2024, which was updated in January 2025, and the results identified five previously recorded archaeological sites within the Project Survey Area (see Figure 1 of Appendix A). During the survey, two new historic sites, two new precontact sites, and five new isolated finds were identified. Of the new sites, isolated finds, and previously identified sites, four are recommended as unevaluated or potentially eligible for listing on the NRHP. Merjent recommends avoidance of two of the nine new resources (Smithsonian Institution Trinomial System [SITS] 32MO1720 and 32MO1721). Merjent searched for site lead 32MOX132, a historic camp site, but no evidence of past activity was identified during the survey for a proposed access road, which is an existing crowned and ditched county road; therefore, no further work is recommended for the resource in this area. Similarly, site 32MO233, a segment of stagecoach line, was originally noted as being covered in this area by a modern crowned and ditched county road. No evidence of past activity was identified during the survey for proposed O&M work areas to the north of the existing road. No further work is recommended for the resources in this area. The other 10 sites and isolated finds are recommended as not eligible for listing. No further work or avoidance is recommended for those resources.

TABLE 1.3-1

Summary of Cultural Resources in Study Area

SITS Number [a]	Resource Ty pe	New/Revisit	NRHP Recommendation
32MO233	Historic Stagecoach Line	Revisit	Unevaluated
32MOX132	Historic Camp Site-Site Lead	Revisit	Unevaluated
32MOX577	Precontact Isolated Find-Chipped Stone	Revisit	Not Eligible
32MOX579	Precontact Isolated Find-Chipped Stone	Revisit	Not Eligible
32MOX580	Precontact Isolated Find-Chipped Stone	Revisit	Not Eligible
32MO1719	Precontact Lithic Scatter	New	Unevaluated
32MOX802	Precontact Isolated Find-Chipped Stone	New	Not Eligible
32MO1720	Historic Farmstead	New	Unevaluated
32MOX803	Precontact Isolated Find-Chipped Stone	New	Not Eligible
32MOX804	Prehistoric Isolated Find-Chipped Stone	New	Not Eligible
32MOX805	Precontact Isolated Find-Chipped Stone	New	Not Eligible
32MOX806	Precontact Isolated Find-Chipped Stone	New	Not Eligible
32MO1721	Historic-Foundations and Material Scatter	New	Unevaluated
32MO1722	Precontact Lithic Scatter	New	Unevaluated

[a] SITS = Smithsonian Institution Trinomial System

2.0 ENVIRONMENTAL AND CULTURAL BACKGROUND

The Project Survey Area occurs in the Missouri Plateau subregion, west of the Missouri River, of the Northwestern Great Plains. This ecoregion encompasses the Missouri Plateau section of the

Great Plains. It is a semiarid rolling plain of shale, siltstone, and sandstone punctuated by occasional buttes and badlands. The topography of this ecoregion was largely unaffected by glaciation and retains its original soils and complex stream drainage pattern. Native grasslands persist in areas of steep or broken topography, but they have been largely replaced by spring wheat and alfalfa over most of the ecoregion. Agriculture is limited by erratic precipitation patterns and limited opportunities for irrigation (Bryce et al. 1996). Culturally, the Project Survey Area falls within the Southern Missouri River Study Unit (SMRSU), which includes upland till plains, breaks terrain, river terraces, river floodplains (Lehmer 1971:49–54). The Project Survey Area traverses "breaks terrain," associated with the eroded and steeply dissected margins of the Missouri River Trench, which provided the ideal terrain for precontact hunting and gathering (Ahler et al. 1981, 1982).

2.1 TOPOGRAPHY

Topography in the Project Survey Area ranges from gently rolling with low hills, knolls, to steep hillsides with broad ridges incised by intermittent drainages, which have been extensively farmed and grazed for at least 100 years.

2.2 HYDROLOGY

Haymarsh Creek occurs in the west portion of the Project Survey Area and is fed by several lower order, unnamed perennial and intermittent drainages that flow through the Project Survey Area. Hailstone Creek occurs in the eastern portion of the Project Survey Area and is fed by perennial and intermittent drainages similar to the western portion of the Project Survey Area. Haymarsh Creek drains into Big Muddy Creek, approximately 5-miles south of the Project Survey Area. Hailstone Creek drains into Big Muddy Creek approximately 15-miles southeast of the Project Survey Area. In turn, Big Muddy Creek drains into the Heart River approximately 30 miles southeast of the Project Survey Area. The Heart River has its confluence with the Missouri River at Mandan, North Dakota, approximately 40 miles east/southeast of the Project Survey Area.

2.3 GEOLOGY

The Project Survey Area occurs within the non-marine Paleocene-age Sentinel Butte Formation, a sedimentary bedrock dating to the Paleocene consisting primarily of poorly consolidated grayish brown silt, sand, clay, and sandstone, as thick as 600 feet (200 meters) (Bluemle 1988; Clayton 1980; North Dakota Geological Survey 2001). Incidental constituents include lignite, some of which are thick and being mined, for instance, at Beulah, Center, or Falkirk, suggest low-gradient and local poor-drainage conditions for much of the Sentinel Butte Formation. Both coalified and non-coalified fossil flora are abundant in the formation, with leaves, stems, and stalks commonly preserved or replicated along bedding surfaces. Petrified wood is very abundant in the formation, and logs and stumps are sometimes seen in their original growth position. Fossil invertebrates include both clams and snails. Vertebrate fossils are rare in Sentinel Butte strata but scattered remains recognized in the formation include fish vertebrae, bones, teeth, and scales, crocodile teeth, and mammal teeth and bones (Foreman 1986).

2.4 SOILS

A total of 84 soil series occurs within the Project Survey Area, 28 of which comprise less than 1 percent of the Project Survey Area (Natural Resources Conservation Service [NRCS] 2025) (see Table 2.4-1 below). Nearly all the soils are taxonomically defined as Mollisols, which indicate that

the landforms they occur on have been stable for hundreds of years (Fanning and Fanning 1989; Jenny 1941). Over 75 percent of the soils within the Project Survey Area are well drained.

TABLE 2.4-1

Soil Units Comprising Over 1 Percent of the Study Area

Unit Name	Landform	Percent of Survey Area	County
Belfield-Daglum complex, 0 to 2 percent slopes	hillslopes, drainageways	3.30%	Morton
Daglum-Rhoades complex, 0 to 6 percent slopes	hillslopes	7.70%	Morton
Daglum-Rhoades complex, 6 to 9 percent slopes	hillslopes	1.90%	Morton
Rhoades-Daglum-Rhoades, severely eroded complex, 0 to 9 percent slopes	hillslopes, drainageways	0.40%	Morton
Dogtooth-Janesburg complex, 0 to 6 percent slopes	hillslopes	0.10%	Morton
Belfield-Grail clay loams, 0 to 2 percent slopes	drainageways, swales	1.70%	Morton
Belfield-Wyola-Daglum complex, 2 to 6 percent slopes	hillslopes, drainageways	3.20%	Morton
Grail-Belfield clay loams, 2 to 6 percent slopes	flats	3.20%	Morton
Regent-Janesburg complex, 0 to 3 percent slopes	hillslopes	0.40%	Morton
Regent-Janesburg complex, 3 to 6 percent slopes	hillslopes	6.00%	Morton
Regent-Janesburg complex, 6 to 9 percent slopes	hillslopes	0.30%	Morton
Dogtooth-Janesburg-Cabba complex, 6 to 35 percent slopes	hillslopes, drainageways	3.70%	Morton
Grail silty clay loam, 0 to 2 percent slopes	swales, hillslopes	0.10%	Morton
Grail silt loam, 0 to 2 percent slopes	swales, hillslopes	0.00%	Morton
Wyola-Grail silty clay loams, 0 to 2 percent slopes	hillslopes, swales	0.20%	Morton
Wyola silty clay loam, 2 to 6 percent slopes	hillslopes, swales	1.90%	Morton
Wyola silty clay loam, 6 to 9 percent slopes	hillslopes, swales	0.10%	Morton
Virgelle complex, 0 to 6 percent slopes	stream terraces	0.10%	Morton
Moreau-Wayden silty clays, 6 to 9 percent slopes	ridges, rises of pediments	0.00%	Morton
Moreau-Barkof silty clays, 3 to 6 percent slopes	pediments	0.10%	Morton
Regent-Wyola silty clay loams, 0 to 3 percent slopes	hillslopes, swales	0.10%	Morton
Regent-Wyola silty clay loams, 3 to 6 percent slopes	hillslopes, swales	0.70%	Morton
Regent-Wyola silty clay loams, 6 to 9 percent slopes	hillslopes, swales	0.20%	Morton
Cohagen-Vebar-Parshall fine sandy loams, 9 to 35 percent slopes	hillslopes, drainageways	0.10%	Morton
Vebar-Cohagen fine sandy loams, 6 to 9 percent slopes	hillslopes, swales	7.20%	Morton
Vebar-Cohagen fine sandy loams, 9 to 15 percent slopes	hillslopes, swales	0.20%	Morton
Vebar-Flasher-Tally complex, 9 to 15 percent slopes	hillslopes, swales	3.90%	Morton
Beisigl-Flasher-Telfer loamy fine sands, 6 to 15 percent slopes	hillslopes, drainageways	0.10%	Morton
Flasher-Vebar-Parshall complex, 9 to 35 percent slopes	hillslopes	1.70%	Morton
Flasher-Rock outcrop-Vebar complex, 9 to 70 percent slopes	ridges, hills	0.20%	Morton
Beisigl-Lihen loamy fine sands, 0 to 6 percent slopes	pediments, alluvial fans, alluvial flats	0.60%	Morton
Vebar-Parshall fine sandy loams, 0 to 3 percent slopes	hillslopes, swales	0.50%	Morton
Vebar-Parshall fine sandy loams, 3 to 6 percent slopes	hillslopes, swales	3.90%	Morton
Lihen-Parshall complex, 0 to 6 percent slopes	alluvial flats, alluvial fans, swales	0.40%	Morton
Parshall fine sandy loam, 0 to 2 percent slopes	alluvial flats	0.50%	Morton
Tally-Parshall fine sandy loams, 2 to 6 percent slopes	alluvial flats	0.10%	Morton
Tally-Parshall fine sandy loams, 6 to 9 percent slopes	hills, ridges	0.00%	Morton
Arnegard loam, 0 to 2 percent slopes	swales	1.00%	Morton
Arnegard loam, 2 to 6 percent slopes	swales, hillslopes	0.10%	Morton
Shambo loam, 0 to 2 percent slopes	hillslopes, swales	0.20%	Morton

TABLE 2.4-1

Soil Units Comprising Over 1 Percent of the Study Area

Unit Name	Landform	Percent of Survey Area	County
Shambo loam, 2 to 6 percent slopes	hillslopes, swales	0.40%	Morton
Farland silt loam, 0 to 2 percent slopes	alluvial flats	1.60%	Morton
Farland silt loam, 2 to 6 percent slopes	alluvial flats, alluvial fans, terraces	1.90%	Morton
Farland silt loam, 6 to 9 percent slopes	hills, alluvial fans	0.20%	Morton
Amor-Cabba loams, 6 to 9 percent slopes	hillslopes	6.20%	Morton
Amor-Cabba loams, 9 to 15 percent slopes	hillslopes	5.40%	Morton
Cabba-Chama-Shambo loams, 9 to 50 percent slopes	hillslopes	2.30%	Morton
Chama-Cabba-Sen silt loams, 6 to 9 percent slopes	hillslopes, drainageways	3.80%	Morton
Cabba-Chama-Sen silt loams, 9 to 15 percent slopes	ridges, hills	2.40%	Morton
Werner-Chama-Sen silt loams, 9 to 15 percent slopes	ridges, hills	0.00%	Morton
Cabba-Rock outcrop-Chama complex, 15 to 70 percent slopes	pediments, rises	0.20%	Morton
Amor-Arnegard loams, 0 to 3 percent slopes	hillslopes, swales	0.50%	Morton
Amor-Shambo loams, 3 to 6 percent slopes	hillslopes, swales	3.00%	Morton
Reeder-Farnuf loams, 3 to 6 percent slopes	pediments, terraces, alluvial fans	2.60%	Morton
Chama-Sen-Cabba silt loams, 3 to 6 percent slopes	pediments	0.70%	Morton
Morton-Farland silt loams, 3 to 6 percent slopes	pediments, alluvial fans	1.90%	Morton
Morton-Cabba silt loams, 6 to 9 percent slopes	ridges, hills, swales, alluvial fans	2.50%	Morton
Sen-Chama silt loams, 3 to 6 percent slopes	hillslopes, drainageways	0.70%	Morton
Ringling-Daglum loams, 6 to 15 percent slopes	ridges, hills	0.10%	Morton
Searing-Ringling loams, 3 to 6 percent slopes	alluvial flats, alluvial fans, rises on alluvial fans	0.00%	Morton
Williams-Reeder loams, 3 to 6 percent slopes	rises, pediments	0.00%	Morton
Harriet loam, 0 to 2 percent slopes, occasionally flooded	alluvial flats, drainageways	2.20%	Morton
Korchea-Fluvaquents complex, channeled, 0 to 2 percent slopes, frequently flooded	flood plains, flood plain steps, drainageways	2.30%	Morton
Straw loam, 0 to 2 percent slopes, rarely flooded	flood plains	0.10%	Morton
Lehr-Stady loams, 2 to 6 percent slopes	terraces, stream terraces	0.20%	Morton
Wabek-Manning complex, 6 to 15 percent slopes	ridges on terraces, escaprments on stream terraces	0.10%	Morton
Wabek-Cabba-Shambo complex, 6 to 35 percent slopes	escarpments, ridges	0.30%	Morton
Shambo loam, gravelly substratum, 0 to 2 percent slopes	stream terraces	0.10%	Morton
Wanagan loam, 0 to 2 percent slopes	stream terraces	0.40%	Morton
Manning fine sandy loam, 2 to 6 percent slopes	stream terraces on river valleys	1.40%	Morton
Dimmick silty clay, 0 to 1 percent slopes	depressions	0.00%	Morton
Tonka silt loam, 0 to 1 percent slopes	depressions, swales, flats	0.10%	Morton
Water	n/a	0.10%	Morton
Belfield-Daglum complex, 0 to 2 percent slopes	hillslopes, drainageways	0.00%	Mercer
Daglum-Rhoades complex, 0 to 6 percent slopes	hillslopes	0.00%	Mercer
Regent-Janesburg complex, 3 to 6 percent slopes	hillslopes	0.00%	Mercer
Grail silt loam, 0 to 2 percent slopes	swales, hillslopes	0.00%	Mercer
Cohagen-Vebar-Parshall fine sandy loams, 9 to 35 percent slopes	hillslopes, drainageways	0.00%	Mercer
Vebar-Cohagen fine sandy loams, 6 to 9 percent slopes	hillslopes, swales	0.00%	Mercer
Vebar-Cohagen fine sandy loams, 9 to 15 percent slopes	hillslopes, swales	0.00%	Mercer
Vebar-Parshall fine sandy loams, 3 to 6 percent slopes	hillslopes, swales	0.00%	Mercer
Werner-Chama-Sen silt loams, 9 to 15 percent slopes	ridges, hills	0.00%	Mercer
Amor-Shambo loams, 3 to 6 percent slopes	hillslopes, swales	0.00%	Mercer

TABLE 2.4-1

Soil Units Comprising Over 1 Percent of the Study Area

Unit Name	Landform	Percent of Survey Area	County
Harriet loam, 0 to 2 percent slopes, occasionally flooded	hillslopes, swales	0.00%	Mercer
Total		99.8%	

Of the 85 soil units mapped within the Project Survey Area, only five represent 5 percent or more of the Project Survey Area. The Amor-Cabba loams (9 to 15 percent slopes), the Regent-Janesburg complex (3 to 6 percent slopes), the Amor-Cabba loams (6 to 9 percent slopes), and the Daglum-Rhoades complex (0 to 6 percent slopes), all occur on hillslopes. The Vebar-Cohagen fine sandy loams (6 to 9 percent slopes) occur on hillslopes and swales. The Amor-Cabba loams (9 to 15 percent slopes) and the Amor-Cabba loams (6 to 9 percent slopes) are derived from fine-silty residuum weathered from sedimentary rock. The Regent-Janesburg complex (3 to 6 percent slopes) is derived from residuum weathered from shale and siltstone. Similarly, the Vebar-Cohagen fine sandy loams (6 to 9 percent slopes) are derived from residuum weathered from sandstone. The Daglum-Rhoades complex (0 to 6 percent slopes) is derived from slope alluvium derived from shale and siltstone. Soil series mapped by the NRCS potentially provide clues but should be recognized as having considerable limitations in archaeological applications (Holliday 2004).

The potential for preservation of archaeological materials within or adjacent to the Project Survey Area has been impacted by farming and coal mining. Although the area has been farmed extensively over the last 100 plus years and mined for coal, relatively undisturbed precontact sites and features may still be found on the tops of hills, ridges, and knolls. Intact, precontact features may include cairns and other stone features on narrow, or otherwise undisturbed, ridges. Artifact scatters may be located on ridges and near floodplains, although reservoir waters may obfuscate some sites along floodplains. In some places, these land uses have resulted in increased ground visibility and removal of overburden, allowing for the identification of sites and an interpretation of relatively high site density. In other cases, these impacts have simply removed the archaeological materials and resulted in the identification of low site densities. In combination, these factors may have disrupted the context of a relatively high percentage of cultural materials.

2.5 FLORA AND FAUNA

The Project Survey Area is within the Missouri Plateau subregion of the Level III Northwestern Great Plains ecoregion, and consists semiarid rolling plains of shale, siltstone, and sandstone punctuated by occasional buttes and badlands. Native grasslands persist in areas of steep or broken topography, but they have been largely replaced by wheat (*Triticum* sp.) and alfalfa (*Medicago sativa*) over most of the ecoregion. Agriculture is limited by erratic precipitation patterns and limited opportunities for irrigation (Bryce et al. 1998). Vegetation known to occur in the Missouri Plateau subregion includes Blue grama (*Bouteloua gracilis),* western wheatgrass (*Pascopyrum smithii*), prairie sandreed (*Calamovilfa longifolia*) and some bluestem (*Andropogon gerardii*). Juniper (*Juniperus communis*) and deciduous trees are often found on north facing slopes, while cottonwood gallery forests often occur on floodplains (Bryce et al. 1998). Vegetation observed within the Study Area consisted of little bluestem (*Schizachyrium scoparium*), western snowberry (*Symphoricarpos occidentalis*), fringed sage (*Artemisia frigida*), buffaloberry (*Shepherdia*), and other grasses and forbs consistent with mixed-grass prairie. Most of the Class III area is currently used for agriculture.

Approximately 160 wildlife species are residents or seasonal visitors to the broader Missouri River ecosystem, and hundreds of native fish species live in the mainstem and tributaries. Some of the animal species that would have been common and available for human use in the Missouri River Valley area—both prehistorically and historically—include fur-bearing mammals such as beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), eastern cottontail (*Sylvilagus floridanus*), elk (*Cervus canadensis*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), pronghorn (*Antilocapra americana*), and bison (*Bison bison*), as well as bird and waterfowl species such as mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), sharp-tailed grouse (*Tympanuchus phasianellus campestris*), golden eagle (*Aquila chrysaetos*), and bald eagle (*Haliaeetus leucocephalus*) (Seabloom et al. 1978).

Prominent wildlife influencing lifeways within the broader SMRSU include white-tailed deer and mule deer, wolf (*Canis lupis*), coyote (*Canis latrans*), fox (*Vulpes*), beaver, catfish (*Ictalurus* sp.), turtles, and various mussels. Past inhabitants included bison, elk, and pronghorn (Gregg et al. 2021).

2.6 CULTURAL/HISTORICAL OVERVIEW

Culturally, the Project Survey Area is within the SMRSU, as defined in the *North Dakota Comprehensive Plan for Historic Prevention: Archaeological Component* (SHSND 2021), which comprises all or portions of Burleigh, Emmons, Kidder, Logan, McIntosh, McLean, Mercer, Morton, Oliver, Sheridan, Sioux, and Stutsman counties. The following discussion incorporates several sources to develop a precontact overview for the work conducted for this Project and includes information from the SMRSU in which the Project Survey Area is located. Numerous archaeological sites have been identified in the SMRSU, the majority of which were identified on upland till plain, breaks terrain, river terraces, and river floodplains (Gregg et al. 2021).

2.6.1 Paleoindian Tradition (ca. 11,500–7,900 BP)

While speculation exists regarding the likelihood of earlier habitation of the Great Plains, the Paleoindian tradition is the oldest accepted occupation of the region, and, generally, is associated with a hunting and gathering adaptation (Gregg 1985). The Paleoindian tradition is subdivided herein into six main complexes: Clovis, Goshen, Folsom, Hell Gap/Agate Basin, Alberta/Cody, and Parallel Oblique Flaked. Paleoindian sites in the general area, outside the SMRSU, include, but are not limited to, the Beacon Island site (32MN234A), the Beacon Island Agate Basin site (32MN234), the Moe site (32MN101), and 32ME946.

The Clovis complex (ca. 11,500–10,800 years Before Present [BP]) is characterized by large, fluted lanceolate projectile points and is the earliest unequivocal complex in North America. Clovis artifacts have been found with megafauna, such as mammoth, in buried contexts in the Southwest and Great Plains (Grayson and Meltzer 2002); however, although megafauna were probably dietary constituents, it is disputed to what degree early Paleoindians pursued large game (Cannon and Meltzer 2004; Grayson and Meltzer 2002). In the South Dakota Badlands, the Lange-Ferguson site yields the best evidence for proboscidean exploitation (Hannus 1990). There, modified mammoth bones are directly associated with a flake, and three projectile points were recovered from deposits similar to those containing mammoth, indicating that Clovis hunter-gatherers either killed the animals or scavenged their carcasses (Hannus 1990). Skeletal remains from a single mammoth were unearthed during building construction in 1988 near Powers Lake. These remains were shallowly buried, were not radiocarbon dated, and were not appraised for the potential of associated cultural remains (Gregg et al. 2021). Few Clovis sites have been

recorded in the region. Clovis artifacts were recovered from one site in the SMRSU, and in the western portion of the state, a single Clovis point base was recovered from 32ME946 (Floodman 1988), and Clovis points were recovered from the Beacon Island Agate Basin site (Ahler 2003).

Goshen (ca. 10,900–10,100 BP) is a technological complex first identified at Hell Gap, Wyoming (Irwin 1967, 1971), but it is also found at Mill Iron, Montana; Carter-Kerr/McGee, Wyoming; and the Jim Pitts site, located in the South Dakota Black Hills (Sellet 2001). Goshen is poorly understood—the basally thinned, unfluted projectile points share affinities with both Clovis and Folsom but are also similar to Southern Plains Planview points. In stratified deposits, Goshen materials typically underlie Folsom (Frison et al. 1996).

The Folsom complex (ca. 10,900–10,200 BP) is typified by distinctive fluted lanceolate projectile points. With most large grazers extinct by Folsom times and grasslands dominating the Great Plains, bison populations flourished, providing resources for Folsom hunters (Frison 1991). However, many high-elevation Folsom sites also demonstrate broad diets of diverse small prey (Hill 2007). Probable structures recorded at the Mountaineer and Barger Gulch sites in Colorado suggest long-term occupations in mountain settings (Stiger 2006; Surovell and Waguespack 2007). In North Dakota, there are numerous documented Folsom sites (Gregg 1985), including the Bobtail Wolf (32DU955A), Big Black (32DU955C), and Young-Man-Chief (32DU955D) sites (Root 2000; Shifrin 2000; William 2000). These sites are interpreted as camps, quarries, and lithic workshops where Knife River flint (KRF) was procured and used for tool production.

The Agate Basin (ca. 10,500–10,000 BP) and Hell Gap (ca. 10,000–9,500 BP) technocomplexes are both characterized by lanceolate projectile points with thick lenticular cross sections (Frison 1991). Based on morphological similarities and stratigraphic evidence, Hell Gap is technologically descended from Agate Basin. Agate Basin and Hell Gap hunter-gatherers were most likely specialized bison hunters. Sites like Agate Basin II (Hill 2001) and Casper (Todd et al. 1997) indicate more frequent extraction of marrow and within-bone nutrients, suggesting a greater focus on planning than previously evident. Some sites associated with this tradition have been recorded in North Dakota and South Dakota, but these mainly consist of isolated surface finds (Gregg 1985). One of the most significant Paleoindian sites is the Beacon Island Agate Basin site (Ahler 2003).

Alberta (9,800–9,000 BP) is a poorly dated technology that probably descends from Hell Gap and is documented at the Hell Gap, Wyoming, and Hudson-Meng, Nebraska sites (Agenbroad 1978; Frison 1991). Hudson-Meng is one of the largest documented bison kills and suggests that Alberta people focused on bison hunting (Agenbroad 1978); however, more recent work suggests that humans were not responsible for killing the bison and that they died of a natural event (Todd and Rapson 1999). The Cody Complex (9,200–8,800 BP), which includes stemmed/shouldered Eden and Scottsbluff projectile points and the distinctive Cody knife, seemingly arose from Alberta (Frison 1991). These sites are widespread across the northwestern and central Great Plains, with components at the Wyoming Horner I, Finley, and Medicine Lodge Creek sites (Frison and Todd 1986; Frison and Walker 2007) and the Mammoth Meadows, Myers-Hindman, and MacHaffie sites in Montana (Davis 1993). Such sites indicate that Cody adaptations were diverse and used large fauna as well as small prey and floral resources (Frison et al. 1996; Galvan 2007). Alberta/Cody sites have been recorded in North Dakota and South Dakota. In fact, Hudson-Meng contains extensive KRF, showing a strong connection to the Missouri River region.

The Parallel Oblique Flaked complex is a catch-all grouping of Paleoindian projectile point types (Gregg 1985), including Angostura, Milnesand, Browns Valley, Lusk, Allen, and Frederick, ranging in age between 9,400 and 7,900 BP. All types are lanceolate with parallel oblique flaking. Bison kill-butcheries became rare on the northwestern and northern Great Plains after approximately 8,000 BP (Frison 1998), perhaps due to severe ecological deterioration that could no longer support large bison populations. Complex excavated and surface sites have been recorded in the Dakotas, including sites on the Missouri River. A total of 15 Paleoindian sites have been recorded in the SMRSU (Gregg et al. 2021).

2.6.2 Plains Archaic Tradition (ca. 8,000–1,500 BP)

The transition from Paleoindian to Archaic is archaeologically visible as an abrupt shift from lanceolate forms to large notched projectile points (Frison 1991), perhaps indicating a shift to atlatl propelled darts from hand-thrown spears. This transition is also associated with warming/drying trends that prompted diverse subsistence adaptations among hunter-gatherers (Carlson 1994). Ground stone appears in the Archaic, suggesting a greater focus on processing botanical resources. In conjunction with the appearance of pithouses and storage pits in the western intermontane basins, this suggests a shift in subsistence base, a reduction in overall residential mobility, and more predictable seasonal rounds (Frison 1991).

The Logan Creek/Mummy Cave complex (5,600–4,000 BP) is the earliest example of large side-notched projectile points on the northern Great Plains. The blending of the Logan Creek and Mummy Cave for this complex is due to varied nomenclature used among archaeologists regionally for similar archaeological complexes (Gregg 1985). Settlement types associated with this complex include bison kills, transient camps, and some stone circle sites.

While the Oxbow complex (5,000–4,000 BP), typified by side-notched, deeply concave-based projectile points, is concentrated in northern Montana, Alberta, and Saskatchewan (Hannus 1994: 180), it is also common in North and South Dakota, with numerous sites within the Missouri River watershed. Oxbow subsistence centered on bison and sites include bison impoundments and jumps, encampments on stream terraces, stone circles, and processing areas (Hannus 1994; Reeves 1969). Numerous birds and small mammals were also probably exploited (Aaberg et al. 2006:174). Some northern Great Plains sites further yield evidence of complex cultural behavior including bundle burials with elaborate grave goods (Bryan 1991).

The McKean complex (ca. 4,500–3,400 BP) encompasses three distinct sub-phases: the McKean lanceolate, Duncan, and Hannah. The McKean complex is widespread across the Great Plains, and sites from this period can be found associated with bison kills, stone circles, lithic caching, and seasonal settlements (Frison 1991). Slab-lined pit hearths are common, as are ground stone artifacts suggesting a greater reliance on plant resources (Carlson 1994; Frison 1991). McKean complex sites often demonstrate evidence of lithic raw material exchange, including Swan River chert, Tongue River silicified sediment, and KRF (Gregg 1985).

Pelican Lake (ca. 3,000–2,700 BP), typified by broad, thin comer-notched projectile points, is likely a descendant of McKean and is found across the northern and central Great Plains (Frison 1991). This wide spatial distribution may indicate significant population growth in response to the favorable moist conditions of the Sub-Atlantic episode (Reeves 1983). Numerous communal bison kills, such as Head-Smashed-In (Frison 1991), indicate communal bison hunting, but this does not suggest it was an exclusive feature of their subsistence. Rather, Pelican Lake

populations probably relied on a broad-based economy across diverse ecozones (Hannus 1994). A total of 88 Archaic sites have been recorded in the SMRSU (Gregg et al. 2021).

2.6.3 Plains Woodland Tradition (ca. 2,000–450 BP)

Temporally overlapping with the northwestern Great Plains Late Archaic, the Plains Woodland tradition is characterized by increased sedentism, garden horticultural activity, expanding regional exchange networks with eastern Woodland populations (Adena and Hopewell), and the elaboration of ceremonial activities and mortuary practices, specifically mound burials (Griffin 1967). Significant technological advances such as bow and arrow and ceramics use are also apparent (Gregg 1985); however, the fundamental subsistence strategies of the Plains Woodland did not drastically differ from their Archaic predecessors (Zimmerman 1985). It is assumed that this tradition saw the beginning of horticultural practices in the region. For the purposes of this study, the complexes that are classed as belonging to the Plains Woodland include Besant, Sonota, Laurel, Avonlea, Old Woman's, and Blackduck. The Besant and Sonota components are well represented in the area.

The Besant complex (ca. 2,000–1,500 BP), typified by small- to medium-sized, side-notched triangular projectile points, represents the earliest presence of ceramics in North Dakota, probably resulting from eastern Woodland influence (Walde 2006). Besant ceramics are more common in the eastern half of the Dakotas; the vessels show a basic conoidal shape and suggest lump modeling manufacture with some coarse cording (Wood and Johnson 1973). Besant sites show extensive use of KRF (Reeves 1970). Site types include stone circle sites, habitations on stream and river terraces, and bison kills. Numerous communal kill sites, including the Ruby bison pound in Wyoming (Frison 1991), suggest that Besant people were sophisticated bison hunters. The Sonota complex (1,850–1,350 BP) appears to be a possible sub-complex of Besant but differs in that burial mounds are common at Sonota sites (Reeves 1983; Wood 1967). These mounds include rectangular subfloor pits/tombs with dismembered bodies and, commonly, articulated bison remains (Johnson and Johnson 1998). The presence of associated exotic artifacts is often cited as evidence of Hopewell influence on Middle Plains Woodland populations (Johnson and Johnson 1998).

Sites from the Laurel complex (2,100–850 BP) are generally found in the eastern portions of North Dakota, northern Minnesota, and southern Canada. Laurel pottery and mound building are distinct, but lithics associated with this complex tend to be various and lack a particular style (Gregg 1985).

Avonlea complex (ca 1,800–1,000 BP) sites occur across the northern Great Plains and are contemporaneous with Besant. This complex includes a variety of site types, including stone circles, bison kills, and rock shelter habitations (Reeves 1970). Avonlea represents the first regional complex to produce arrow points exclusively, suggesting a transition to bow and arrow technology (Frison 1988). Avonlea point types are small and indistinctly side-notched. Saskatchewan Basin Complex Early Variant pottery is often found at Avonlea sites (Byrne 1973). Avonlea subsistence in the north relied heavily on communal bison procurement, but in their southern range, bison hunting was supplemented by smaller game (e.g., pronghorn), fish, and seasonal plant exploitation (Smith and Walker 1988). Avonlea sites are relatively rare in the Dakotas (Vickers 1994). In North Dakota, the Evans site (32MN301) contained Avonlea projectile points and ceramics (Schneider and Kinney 1978).

Rare in North Dakota is the Old Woman's complex (Common Era [CE] 700–1300). This complex is contemporary with the Plains Village Tradition, so it seems likely that many associated sites would be granted the latter designation (Gregg 1985).

The Blackduck complex (CE 1150-1450) derives from northern Minnesota and was concentrated in southern Manitoba. It is contemporaneous with both Avonlea and Old Woman's complexes, and with Extended and Terminal Middle Missouri traditions. Some evidence of possible Blackduck pottery has been found along the Missouri River, which suggests trade between the Missouri River villagers and the Blackduck people to the north (Joyes 1970). A total of 74 Woodland sites have been recorded in the SMRSU (Gregg et al. 2021).

2.6.4 Plains Village Tradition (ca. 1,050–350 BP)

Lehmer (1971) defined the Plains Village Tradition as possessing the following diagnostic traits equal horticulture and hunting and gathering strategies, semi-permanent villages near the Missouri River floodplain, earthlodges, large storage and refuse pits, distinctive ceramics, abundant end scrapers and arrow points, bison scapula hoes, and a well-developed bone tool industry. The Plains Village Tradition is divided into the Middle Missouri Tradition (CE 969–1500) and the Coalescent Tradition (CE 1300–1650), discussed below.

Three primary Middle Missouri variants are recognized: Initial Middle Missouri (CE 969–1297), Extended Middle Missouri (CE 1075–1443), and Terminal Middle Missouri (CE 1300–1500) (Eighmy and LaBelle 1996). These represent a continuation and intensification of Northern Plains Woodland lifeways, and their appearance coincides with the onset of the Medieval Warm Period (Bryson et al. 1970) when an increase in moisture likely allowed horticulture in areas previously characterized by tenuous farming conditions (Wood 2001).

The Initial Middle Missouri Variant (IMMV) is thought to have developed as an outgrowth of the Great Oasis (Tiffany 2007) or via the arrival of eastern populations already exploiting a Plains Village lifeway (Lehmer 1971). The IMMV was concentrated in the southern portions of the Middle Missouri region and characterized by highly fortified villages of large, semi-subterranean rectangular houses (Lehmer 1971, Winham and Calabrese 1998).

The Extended Middle Missouri Variant (EMMV) is concentrated in the northern portions of the Middle Missouri region (Lehmer 1971). EMMV groups resided in small villages of semi-subterranean rectangular houses; southern villages were more often fortified than those in the north (Wood 2001). It is unclear whether the EMMV replaced the IMMV or represents a contemporaneous offshoot of the IMMV. Origins aside, it is assumed that IMMV populations were eventually absorbed into EMMV populations. The final expression of this tradition was the Terminal Middle Missouri (Winham and Calabrese 1998:282). These sites were concentrated in a smaller geographic area along the Missouri River in southern North Dakota and characterized by fewer, but much larger villages (Wood 2001). Sites again contained long, rectangular semi-subterranean houses, but were highly fortified (Wood 2001). A continuation of the Middle Missouri Tradition is recognized historically as the Siouan-speaking Mandan and Hidatsa (Wood 2001).

The Coalescent period is temporally divided into Initial (650–350 BP), Extended (500–300 BP), and Post-Contact Coalescent (300 BP–historic period) (Johnson 1998; Lehmer 1971). The Coalescent Tradition is thought to represent a geographic movement of Central Plains Tradition village-dwelling populations to the Missouri River Valley in South Dakota (Blakeslee 1993).

Central Plains Traditions might have migrated from Nebraska and Kansas in response to drought brought on by the Pacific climatic episode (Lehmer 1971). Similar to Middle Missouri Tradition groups, Coalescent populations practiced an economy split between mixed cultigen horticulture and bison hunting (Johnson 1998).

Initial Coalescent Variant sites are located on bluffs overlooking the Missouri River and its drainages in southern South Dakota. Populations lived in fortified villages consisting of subrectangular to circular/oval earthlodges and often surrounded by complex fortifications (Johnson 1998). Violence amongst Coalescent groups is evidenced at the Crow Creek site (39BF11) where approximately 486 individuals were killed in the village fortification ditch around 625 BP (Willey and Emerson 1993). Crow Creek is interpreted as evidence of internecine warfare amongst Initial Coalescent groups over land competition (Zimmerman and Bradley 1993) or, conversely, as evidence of warfare between immigrant Coalescent groups and resident Middle Missouri Tradition peoples (Johnson 1998). The Extended Coalescent Variant apparently descended from the Initial Coalescent sometime in the fifteenth century CE. Sites are concentrated along the Missouri River and its tributaries in central and northern South Dakota (Krause 2001). Extended Coalescent sites are far more abundant than during the Initial Coalescent and are characterized by a dispersed, unfortified village structure of circular earthlodges (Johnson 1998; Krause 2001; Lehmer 1971). The Extended Coalescent Variant evolved into the Post-Contact Coalescent during the Protohistoric and Historic periods; the Coalescent Tradition is recognized as the Ankara (Krause 2001). The last post-contact village was Like-a-Fishhook Village, occupied by the Ankara, Mandan, and Hidatsa; it was abandoned in 1886 when groups relocated to the Fort Berthold Indian Reservation (Smith 1972). A total of 236 late precontact sites have been recorded in the SMRSU (Gregg et al. 2021).

2.6.5 European Trade and Exploration (CE 1738–1858)

Perhaps the earliest attempts at exploring the northern Great Plains came as a result of the ventures of Pierre Gaultier de Varennes Sure de la Verendrye (Dill 1983). His travels from New France into North Dakota led him as far as the Missouri River (somewhere near Bismarck), and led to subsequent expeditions by his sons, which went farther south into South Dakota (near Pierre) and west towards the Black Hills. While the elder la Verendrye met the Mandan, his sons encountered the Arikara and other tribes in South Dakota. Their reports heightened interest in the region and the possibilities that existed for trade with its inhabitants.

Following the la Verendryes, a modest fur trade developed in the region, but until the expedition of Captains Meriwether Lewis and William Clark returned successfully from their voyage up the Missouri, the region was considered a wild unknown (Schulenberg 1957).

In 1807, Manuel Lisa established a short-lived post at the mouth of the Bighorn, and by 1809 his St. Louis Missouri Fur Company built posts among most of the tribes all along the Missouri River. Other notable companies, such as the Northwest Company, Hudson Bay Company, the Columbia Fur Company, and the American Fur Company, soon followed suit (Schulenberg 1957). The life of these posts tended to be short, but they did much to influence the tribes who frequented the Missouri River in both North and South Dakota. Fort Union—at the confluence of the Yellowstone and Missouri Rivers—was the last of the great posts, and its waning during the late 1850s saw the fur trade in the Dakotas in its last throes.

2.6.6 Post-Contact Tribal Overview (CE 1780–1900)

In addition to the tribes that arose from the Middle Missouri and Coalescent traditions (Mandan, Hidatsa, and Arikara), the northern Great Plains and the Missouri River were also used by countless other tribes since before European contact.

The Assiniboine were known to frequent the northern Missouri River (mainly near the confluence with the Yellowstone River) and were active in the fur trade throughout the eighteenth and nineteenth centuries. Also, the Cheyenne were pushed westward by the Chippewa during the middle of the eighteenth century and took up at least a temporary settlement period on the Missouri River. At least one earthlodge village has been attributed to the Cheyenne in eastern North Dakota, and some Cheyenne villages on the Missouri River were located between the Mandan to the north, and the Arikara to the south, where they built earthlodges and pursued horticulture and buffalo hunting (Schlesier 1968).

The Plains Cree and Plains Chippewa also frequented the northern Missouri—mainly near the confluence with the Yellowstone River, but also near Fort Clark. Both tribes traded actively with the Mandan and Hidatsa. The Crow, although more westerly in their territory, were related to the Hidatsa and would often trade and visit with the Missouri River tribes (Schulenberg 1957).

Based on linguistic evidence, the Sioux (or Dakota) originated from the southwest Great Lakes region (DeMallie 2001a). The timing of the migration is unclear, but ceramic evidence suggests that the Dakota were living on the plains several centuries before the arrival of Europeans (Hanson 1998). Based on linguistics, it is thought that the Assiniboine split from the Sioux sometime before the mid-seventeenth century (Hanson 1998). The Teton Dakota are divided into seven sub-tribes, including the Oglala, Brule, Sans Arc, Hunkpapa, Blackfeet, Miniconjou, and Two Kettles (Hanson 1998). According to DeMallie (2001a), by the mid-eighteenth century, the Teton Dakota hunted bison in the area east of the Missouri River, their movements limited in part by the Arikara stronghold along the Missouri River. However, a series of smallpox epidemics from 1771 to 1781 devastated the Arikara villages (Johnson 1998) and permitted the Teton Dakota to move west of the Missouri River. Like the Teton Dakota, the Yankton and Yanktonai Dakota occupied the prairies east of the Missouri River and north into Minnesota in the mid-seventeenth century (DeMallie 2001a). By the mid-nineteenth century, the Yankton and Yanktonai occupied the prairies east of the Missouri River from the mouth of the Big Sioux River in the south to the Red River in the north (DeMallie 2001b). The Reservation Period began in the 1860s and continues today.

2.6.7 Homesteading in the Dakotas (CE 1860–1930)

The first homestead in North Dakota was filed in 1868, which was the only homestead filed until 1871. The true rush for homesteads did not take place until 1885. This rush was spurred by the extension of the Northern Pacific Railroad across the Red River from Minnesota (Works Progress Administration [WPA] 1950). Western North Dakota, including Oliver County, did not see much settlement prior to the 1890s, and the major settlement of this region did not start in any great numbers until between 1900 and 1910. In general, those homesteaders who selected lands along the Missouri River were able to do some crop farming, but the majority of homesteads were arranged as ranch operations for sheep or cattle.

The North Dakota SHPO (2014) developed a NRHP context for farming. Relevant to site 32DU2530, it states that much of the initial Euro-American settlement in the region was due to a

large investment of eastern capital in railroads, banks, elevators, and farm equipment (Robinson 1966:157). Early twentieth-century agricultural experiment station bulletins recommended placing barns 100 to 150 feet away from the house and placing the house and barn so that the prevailing winds blow at right angles to a line connecting them. Typical farms of this period would have the main house in the foreground with the outbuildings to the side and rear (SHPO 2014). Gas tractors first came into general use for farm work in the northern Great Plains as a result of the labor shortages caused by World War I (SHPO 2014).

According to historian David Danbom, what had once been a career open to any average man with few specialized talents became at this time more mechanized, scientific, and capital intensive. By 1930 farming had become an industry in which a man with no experience or capital could not compete (Granger and Kelley 2005). U.S. Department of Agriculture specialists tried during the 1920s to change farming methods on the Plains (McDean 1980:22). The 1930s was a decade of drought and depression. In addition to reduced farm outputs, farmers had no control over market prices, causing thousands to lose their farms and at least one-third of the population of North Dakota to rely on Federal relief (Robinson 1966). Between 1945 and 1960, labor shortages during the war years encouraged further farm mechanization (Granger and Kelley 2005). Moving from the walking or riding plows, harrowers, grain seeders, corn planers, mowers, rakes, grain-binders, and wagons to mechanized versions of the same equipment allowed for still larger farms while also requiring more capital (Granger and Kelley 2005). Between 1945 and 1959, the number of small farms fell from 70,000 to 55,000 while individual farm size rose from 590 acres to 755 acres, largely due to increased mechanization of farm activities (Robinson 1966). Another factor which helped to modernize farms was the increase in rural electrification. In 1935, only 2.3 percent of North Dakota farms had electricity; by 1954, it was 90 percent (Robinson 1966).

In addition to the homesteading, which brought an increasing number of people to western North Dakota, the discovery of large deposits of lignite coal further boosted interest in the development of Oliver County and the surrounding area (WPA 1950). Although slow at first, the mining industry started to flourish during the 1930s. To this day, it remains a major focus of activity, which drives the economy of both the county and the state.

2.7 LITERATURE SEARCH

2.7.1 Previously Recorded Sites Within the Study Area

Records in the North Dakota Archaeology and Historic Preservation Files identify 51 cultural resources in the Study Area, which is the Project study area plus a 1-mile radius (see Tables 2.7.1-1 and 2.7.1-2 below). This sample includes archaeological sites, site leads (probable site locations), isolated finds, and architectural buildings or structures. Precontact period Native American cultural resources include 17 archaeological sites and 11 occurrences of isolated artifacts. Historical Euro-American resources include nine architectural properties, six archaeological sites, two multicomponent localities with both archaeology and standing buildings or structures, and eight site leads.

TABLE 2.7.1-1

Summary of Previously Recorded Cultural Resources in the Study Area.

Property Class	Property Type	Isolated Find	Site	Site Lead	Total
Architectural	Barn		2		2

TABLE 2.7.1-1

Summary of Previously Recorded Cultural Resources in the Study Area.

Property Class	Property Type	Isolated Find	Site	Site Lead	Total
Architectural	Bridge		2		2
Architectural	Church		1		1
Architectural	Habitation		2		2
Historic	Artifact scatter		1		1
Historic	Camp site			1	1
Historic	Habitation		4		4
Historic	Habitation/school			1	1
Historic	Mill			1	1
Historic	Mine			4	4
Historic	Post office			1	1
Historic	Road		1		1
Multicomponent Historic	Habitation		2		2
Precontact	Cairn		7		7
Precontact	Cairn with lithic scatter		1		1
Precontact	Flaked stone scatter	11	3		14
Precontact	Stone feature(s)		4		4
Precontact	Stone feature(s) with lithic scatter		2		2
	TOTAL	**11**	**32**	**8**	**51**

Native American components are characterized by occurrences of flaked stone artifacts and/or stone feature sites. Seventeen precontact components included flaked stone artifacts as isolates and scatters, with the most common site being a lithic isolate (n=11). There are three lithic scatter sites, and there is flaked stone associated with rock features at three other locations. There are eight rock cairn sites, one of which includes flaked stone. Six other archaeological sites are characterized by stone circles or features, and two of these have lithic artifacts. Generalizing, Native American components in the Project and Study Areas are low-duration and low-intensity occupations representing isolated, limited, and specialized activities, and perhaps temporary habitations. Some of these lands remain unbroken by mechanized agriculture, and the preservation of surface features like cairns and stone circles indicate that some of the Survey area sites retain their integrity. Cairns may be specialized features related to hunting, marking trails, communicating information, or denoting other important spots on the landscape, and the stone circles could represent campsites and ephemeral structure locations.

Particularly with the archaeological sites, few precontact Native American components have been evaluated for their NRHP eligibility. Eleven occurrences of isolated lithic artifact have been determined or are recommended as not meeting the eligibility requirements of the NRHP. Four precontact archaeological sites have been recommended or determined as eligible, one has been recommended as not eligible, and 12 precontact cultural resources are unevaluated. The four sites that are eligible for the NRHP include three cairn sites (one with associated lithics) and a stone circle locality. Preservation of integrity is important to support the eligibility of Native American sites in the region, and agriculture can have a deleterious effect on historic significance. The small sample of previously documented sites in the Study Area are probably very

representative of the types of Native American sites that are currently undetected in the Survey area.

Historic period Euro-American components in the Study Area include architectural properties and archaeological sites. There are seven resources with historical buildings or structures, six archaeological sites, eight site leads (possible sites), and two localities with both standing architecture and archaeological remains. Including architectural and archaeological components, the sample of previously recorded sites include seven habitation sites as residences, homesteads, or farmsteads. Two barns in the Study Area are complementary, and there are four coal mines and four bridges. With a single example each, other site types in the Study Area include a road (Bismarck and Fort Keogh Stage Road), church (St. Clement Oratory), post office, mill, camp site, an artifact scatter, and a one-room schoolhouse foundation (also associated with a house foundation).

About half of the historical resources in the Study Area have been evaluated for the NRHP, and the remainder are unevaluated. Two sites, a barn and St. Clements Oratory, have been determined or recommended as meeting eligibility requirements of the NRHP, and 10 resources have been evaluated as not eligible. Historical architecture is common in the Study Area, but most of these properties do not meet eligibility requirements of the NRHP, likely due to decades of refurbishment and remodeling that has affected their integrity and historic character. The significance of 11 historical resources has not been evaluated. One of these, the Bismark and Fort Keogh Stage Road, crosses the Survey area, and this feature would likely be an eligible property if evaluated, comprised of contributing and non-contributing segments depending on preservation and integrity.

The Project is within 1 mile of 51 previously recorded archaeological sites, site leads, architectural sites, and isolated finds (see Table 2.2-2 below). Of those resources, 32 are sites, 11 are isolated finds, and 8 are site leads. The sites are comprised of 17 precontact sites, 6 historic sites, 7 architectural sites, and 2 multi-component sites. A total of 10 sites are recommended as unevaluated regarding eligibility status for listing on the NRHP. A total of 12 sites are recommended as not eligible for listing on the NRHP. A total of 6 sites are recommended as eligible for listing on the NRHP. Four of the recommended eligible sites are precontact stone feature sites, and 2 are architectural sites consisting of a church and a barn. The isolated finds are comprised of 11 precontact finds. All 11 isolated finds have been recommended as not eligible for listing in the NRHP. The 8 site leads are all historic in nature. A total of 7 site leads are recommended as unevaluated regarding eligibility for listing in the NRHP, while 1 is recommended as not eligible for listing in the NRHP.

Within the Survey area there are a total of 17 previously recorded sites, site leads, and isolated finds (see Table 2.7-2 below and Appendix A). Seven sites consist of a historic stagecoach road, a historic farm site, an architectural house site, a cemetery, a precontact lithic scatter, and two precontact stone features sites. Five of the sites are unevaluated regarding eligibility for listing in the NRHP. One site, a church, has been recommended as eligible for listing in the NRHP. One site, a historic archaeological farm site and material scatter, has been recommended as not eligible for listing in the NRHP. There are three previously recorded site leads within the Survey area. The site leads consist of a camp site, a post office, and a coal mine. All site leads are unevaluated regarding eligibility for listing in the NRHP. Lastly there are six previously recorded precontact isolated finds that are all chipped stone. All isolated finds have been recommended as not eligible for listing in the NRHP.

TABLE 2.7.1-2

Previously Recorded Sites Within the 1-Mile Study Area

SITE ID	Type	Affiliation	SITE TYPE	NRHP Status
32MO189*	Site	Architectural	St. Clement's Church	Eligible
32MO214*	Site	Precontact	Lithic Scatter	Unevaluated
32MO233*	Site	Historic	Stagecoach Road- Abandoned Fort Keogh to Fort Lincoln	Unevaluated
32MO284*	Site	Precontact	Stone Circles, Lithic Scatter	Unevaluated
32MO346*	Site	Precontact	Stone Circle	Unevaluated
32MO387	Site	Architectural	Bridge-Hailstone Creek Bridge	Not Eligible
32MO1055	Site	Precontact	Lithic Scatter (Tested)	Not Eligible
32MO1388	Site	Architectural	House	Unevaluated (Potentially Eligible)
32MO1389	Site	Architectural	Barn	Unevaluated (Potentially Eligible)
32MO1390	Site	Historic	Foundations, Cultural Material Scatter	Not Eligible
32MO1393*	Site	Architectural	House-Earthen Brick	Unevaluated
32MO1397	Site	Precontact	Cairn	Unevaluated
32MO1398	Site	Precontact	Cairn	Unevaluated
32MO1400	Site	Precontact	Cairn	Unevaluated
32MO1401	Site	Precontact	Stone Circle	Unevaluated
32MO1402	Site	Precontact	Lithic Scatter	Unevaluated
32MO1403	Site	Precontact	Cairn	Unevaluated
32MO1447*	Site	Historic	Farmstead, Cultural Material Scatter	Not Eligible
32MO1515	Site	Multi-Component (Architectural, Historical)	Farmstead, Cultural Material Scatter	Not Eligible
32MO1516	Site	Historic	Cultural Material Scatter	Not Eligible
32MO1517	Site	Historic	Foundations, Cultural Material Scatter	Not Eligible
32MO1596	Site	Architectural	Bridge- Bridge #30-123-05.0	Not Eligible
32MOX102	Site Lead	Historic	Coal Mine- Richter Mine	Unevaluated
32MOX132*	Site Lead	Historic	"Camp 5"	Unevaluated
32MOX134*	Site Lead	Historic	Post Office- Haymarsh Post Office	Unevaluated
32MOX225	Site Lead	Historic	Mill – Geck Brothers Mill	Unevaluated
32MOX253	Site Lead	Historic	House and One Room School Foundations	Not Eligible
32MOX348	Site Lead	Historic	Coal Mine	Unevaluated
32MOX349*	Site Lead	Historic	Coal Mine	Unevaluated
32MOX350	Site Lead	Historic	Coal Mine- Filibeck Mine	Unevaluated
32MOX569	Isolated Find	Precontact	Chipped Stone	Not Eligible

TABLE 2.7.1-2

Previously Recorded Sites Within the 1-Mile Study Area

SITE ID	Type	Affiliation	SITE TYPE	NRHP Status
32MOX576*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX577*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX579*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX580*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX581*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX583*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32MOX629*	Isolated Find	Precontact	Chipped Stone	Not Eligible
32OL666	Site	Architectural	Barn	Eligible
32OL671	Site	Precontact	Stone Circles	Eligible
32OL672	Site	Precontact	Cairn, Lithic Scatter	Eligible
32OL673	Site	Precontact	Cairn	Eligible
32OL674	Site	Precontact	Cairn	Unevaluated
32OL690	Site	Precontact	Cairn	Eligible
32OL691	Site	Historic	Foundations, Depressions	Not Eligible
32OL710	Site	Precontact	Stone Features, Lithic Scatter	Unevaluated
32OLX263	Isolated Find	Precontact	Chipped Stone	Not Eligible
32OLX268	Isolated Find	Precontact	Chipped Stone	Not Eligible
32ME2404	Site	Multi-Component (Architectural, Historic)	Farmstead, Cultural Material Scatter	Not Eligible
32ME2495	Site	Precontact	Stone Features	Unevaluated
32MEX788	Isolated Find	Precontact	Chipped Stone	Not Eligible

* Sites Within the Survey area

Based on the review of known cultural resources in the Study Area, it is likely that additional resources exist in the Survey area, such as precontact period Native American archaeological sites, historical Euro-American architectural properties as buildings and structures, and historic period archaeological sites. Some lands in the Project Survey Area have not been cultivated, and this may foster site preservation and integrity. Native American sites, particularly those with preserved features, may meet eligibility requirements of the NRHP. Architectural properties are unlikely to retain their historic significance and sufficient integrity to support NRHP eligibility. Historic period archaeological sites are likely to be similar. Although there could be historical archaeological sites meeting the NRHP eligibility criteria in the Survey area, most would likely be determined as not eligible.

2.7.2 Previous Surveys Within the Study Area

Records curated with the SHSND Archaeology and Historic Preservation Files, document 44 previously completed cultural resources projects within the Project Survey Area and 1-mile Study Area. Conducted between 1979 and 2021, almost all the previous investigations are linear and small block surveys associated with infrastructure development (see Table 2.7.2-1 below). Over half of the cultural resource projects are related to wind energy development and road improvements. Other common survey types include oil and gas projects, bridge inventories, and electrical and water transmission developments. About three-quarters of the previous projects are contemporary and were completed after 2010. A total of 16 previous surveys cross within the proposed Survey area (see Table 2.7.2-1 below and Appendix A). The majority are for a windfarm adjacent to the Survey area, material borrow and road improvement projects, and rural water distribution lines. Other surveys were conducted for oil pipelines and a microwave project.

TABLE 2.7.2-1

Previous Survey Manuscripts Within the 1-Mile Study Area

MS Number	Report Title	Authors	Report Year
2600	Report on a Cultural Resources Survey of the Stanton and Preferred Transmission Line Corridors in ND and SD, Basin Electric Cooperative, Bismarck, ND, Vol. 2-North Dakota Sites in Emmons, Morton, & Mercer Counties	(Woolworth, Alan R. – Primary Author)	1979
3347*	Cultural Resource Surveys: Billings Microwave System in Golden Valley, Morton, Oliver, Mercer, Slope, Stark, & Billings Co., ND	(Phillips, Ben – Primary Author)	1983
3455	Archeology of the Northern Border Pipeline, North Dakota: Vol. 2, Pts. 1-3 Survey and Background Information, McIntosh, Emmons, Morton, Stark, Mercer, Dunn, McKenzie, & Williams Co., ND	(Gregg, Michael L. - Contributing Author); (Root, Matthew J. - Primary Author)	1983
5920	Historic Bridges in North Dakota	(Hufstetler, Mark – Contributing Author); (Johnson, Lon – Primary Author); (Quivik, Fredric L. – Contributing Author); (Roise, Charlene K. – Contributing Author)	1992
6509*	North Dakota Department of Transportation Material Source Projects Cultural Resource Review 1989-1994	(Borchert, Jeani L. – Primary Author)	1995
6880*	Safety Project Cultural Resource Review 1996	(Borchert, Jeani L. – Primary Author)	1997
7159*	Southwest Pipeline Phase II Cultural Resources Investigations in Portions of the Hebron-Glen Ullin Service Area, Morton and Stark Counties, ND UW #2036	(Klinner, Duane G. – Primary Author)	1998
7306	Interstate Engineering, Inc. Winkler Bridge Replacement (Morton County Bridge #122-03.03): A Class III Cultural Resource Inventory and Limited Testing, Morton County, ND	(Morrison, John G. – Primary Author)	1998
7677	Cultural Resources Inventory of Sioux Falls Tower Specialists Inc's Communication Towers in BA, BI, BL, CS, GV, KD, SK, SN, and MO Co., ND	(Rom, Lance W. – Primary Author)	2000
7725	Wrought Iron Cross Cemeteries in North Dakota – Continuing Survey, 1998-99 (Public Report)	(Isern, Thomas D. – Primary Author); (Nesemeier, Kevin – Contributing Author)	1999
9126	Bridge 30-122-04.0 Replacement Project: A Class III Cultural Resource Inventory in Morton Co., ND	(Klinner, Duane G. – Primary Author); (Morrison, John G. – Contributing Author)	2005

TABLE 2.7.2-1

Previous Survey Manuscripts Within the 1-Mile Study Area

MS Number	Report Title	Authors	Report Year
10128	Historic Bridges in North Dakota 2004 Revision	(Goff, Jennie – Contributing Author); (Hufstetler, Mark – Primary Author)	2005
10860	Kroh Gravel Pit: A Class III Cultural Resource Inventory in Morton Co., ND	(Stine, Edward – Primary Author)	2009
12568*	Bison 3 Wind Project: A Class III Cultural Resource Inventory, Oliver and Morton Cos, ND	(Burns, Christina G. – Primary Author)	2011
12680	Addendum to the Bison 3 Wind Project: A Class III Cultural Resource Inventory in Oliver and Morton Counties, North Dakota	(Burns, Christina G. – Contributing Author): (Suess, Bill – Primary Author)	2011
12901	Class III Cultural Resource Inventory for the Allete Energy 230kV Transmission Line Project in Mercer, Morton, and Oliver Counties, North Dakota	(Burns, Christina G. – Primary Author)	2012
13467	ACE Wind Energy Center: A Class III Cultural Resource Inventory, Mercer and Morton Counties, North Dakota	(Burns, Christina G. – Primary Author)	2012
13914	ND Highway 49, From Beulah to the Morton County Line: A Class III Cultural Resource Inventory, Mercer County, North Dakota-NDDOT Project Number: 5-049(014)082 PCN: 18686	(Morrison, John G. – Primary Author)	2012
14223	Bison 4 Wind Energy Center: A Class III Cultural Resource Inventory, Oliver, Morton, and Mercer Counties, North Dakota	(Burns, Chirstina G. – Primary Author)	2013
14224	Addendum to Bison 4 Wind Energy Center: A Class III Intensive Cultural Resources Inventory in Mercer and Oliver Counties, North Dakota	(Reiners, Linsey – Primary Author)	2013
14356	West Substation Location Survey: A Class III Intensive Cultural Resource Inventory in Mercer County, North Dakota	(Brooks, Brittany – Primary Author)	2013
14976*	2013 Survey Report Addendum: Center Service Area Rural Distribution Lines Supplemental Class II-III Cultural Resources Inventory Southwest Water Pipeline Project Mercer, Morton, and Oliver Counties, North Dakota SWPP Contract 7-9E	(Jackson, Michael A. – Primary Author); (Rokke, Nathan J. – Contributing Author); (Toom, Dennis L. – Contributing Author)	2014
15062	Addendum to Bison 4 Wind Energy Center Access Roads and Borrow Areas: A Class III Intensive Cultural Resource Inventory in Mercer and Oliver Counties, North Dakota	(Brooks, Brittany – Primary Author)	2014
15174	Addendum to Bison 4 Wind Energy Center Crane Paths: A Class III Intensive Cultural Resource Inventory in Oliver County, North Dakota	(Brooks, Brittany – Primary Author)	2014
15491	Addendum to Bison 4 Wind Energy Center Crane Path Reroutes II: A Class III Intensive Cultural Resource Inventory in Oliver County, North Dakota	(Brooks, Brittany – Primary Author)	2014
15636*	ND Highway 49 From Road Point 67 Near Glen Ullin North to the Morton County Line: A Class III Cultural Resource Inventory, Morton County, North Dakota	(Morrison, John G. – Primary Author)	2014
15707	Highway 21: From the Junction with ND Highway 31 East to the Junction with ND Highway 6: Class III Cultural Resource Inventory, Morton County, North Dakota	(Morrison, John G. – Primary Author)	2015
15938*	Dakota Access, LLC Dakota Access Pipeline Project (ND) 2014 Dakota Access Class II/III Cultural Resources Inventory	(Mueller, Andrew C. - Primary Author); (Picka, Craig M. - Contributing Author); (Sather, Dean T. - Contributing Author); (Terry, Matthew - Contributing	2015

TABLE 2.7.2-1

Previous Survey Manuscripts Within the 1-Mile Study Area

MS Number	Report Title	Authors	Report Year
		Author)	
16475*	MO-1057 Class III Inventory Report	(Wermers, Greg L. – Primary Author)	2016
16476*	MO-1055 and MO-1056 Class III Inventory Report	(Wermers, Greg L. – Primary Author)	2016
16512*	Dakota Access, LLC, Dakota Access Pipeline Project (ND) Volume 1, 2015 Dakota Access Class II/III Cultural Resources Inventory	(Mueller, Andrew C. - Primary Author); (Picka, Craig M. - Contributing Author); (Sather, Dean T. - Contributing Author); (Terry, Matthew - Contributing Author)	2015
16513	Dakota Access, LLC, Dakota Access Pipeline Project (ND) Volume III 2015 Dakota Access Cultural Resources Inventory	(Harrison, Abbie L. - Contributing Author); (Landt, Matthew J. - Primary Author); (McCord, Beth - Contributing Author); (Millward, Sara A. - Contributing Author); (Prouty, Michael J. - Contributing Author); (Trader, Patrick D. - Contributing Author)	2016
17092*	2015 Survey Report Addendum: Center Service Area Rural Distribution Lines Supplemental Class II and Class III Cultural Resources Inventories for the Southwest Water Pipeline Project, Oliver, Mercer, and Morton Counties, North Dakota, SWPP Contract 7-9E	(Cox, Matthew A. – Contributing Author); (Kromarek, Nicole – Primary Author)	2016
17305	Dan Feser Watershed Survey: A Class III Intensive Cultural Resources Inventory in Morton County, North Dakota	(Hanley, Raina – Primary Author)	2017
17456	Class III Cultural Resource Inventories for the Martin Construction, Inc. 2016 Material Source Areas in Mercer and Dunn Counties, North Dakota	(Brooks, Brittany – Primary Author); (Friend, Tara – Contributing Author)	2017
17593	Results of the Evaluative Testing for Eligible Sites Within the Cultural Resources Survey Corridor of the Dakota Access Pipeline, Dunn, Emmons, McKenzie, Mercer, Morton and Williams Counties, North Dakota	(Baltz, Chris – Contributing Author); (Kovacs, Jason – Contributing Author); (Landt, Matthew J. – Contributing Author); (Leone, Karen – Contributing Author); (Millward, Sara A. – Contributing Author); (Trader, Patrick D. – Primary Author)	2017
17608	A Class III Cultural Resource Inventory for the Glasser Field Clearing Piles in Mercer County, North Dakota	(Brooks, Brittany – Primary Author)	2017

TABLE 2.7.2-1

Previous Survey Manuscripts Within the 1-Mile Study Area

MS Number	Report Title	Authors	Report Year
18093*	Addendum to the Clean Energy I Wind Farm: A Class III Intensive Cultural Resource Inventory in Morton and Mercer Counties, North Dakota	(Atkinson, Alex – Primary Author)	2018
18192*	Addendum II to the Clean Energy I Wind Farm: A Class III Intensive Cultural Resource Inventory in Morton and Mercer Counties, North Dakota	(Brooks, Brittany – Primary Author)	2018
18200*	Class III Cultural Resource Inventories for the Border States Paving, Inc. 2017 Material Source Areas in McKenzie, Morton, and Richland Counties, North Dakota	(Beavers, Matthew – Primary Author); (Neumiller, Alex – Contributing Author)	2018
18332	A Class III Cultural Resource Inventory of the Glen Ullin Relo Communications Tower in Morton County, North Dakota	(Brooks, Brittany – Primary Author)	2019
18351	Addendum III to the Clean Energy I Wind Farm: A Class III Intensive Cultural Resource Inventory in Morton and Mercer Counties, North Dakota	(Abbott, Melody – Primary Author)	2019
18533*	Addendum IV to the Glen Ullin Energy Center: A Class III Intensive Cultural Resource Inventory in Morton and Mercer Counties, North Dakota	(Reich, Arielle – Primary Author)	2019
19389	A Class III Cultural Resource Inventory for the Bison & Glen Ullin Wind Project Radar Stations in Morton and Oliver Counties, North Dakota	(Altieri, Irene – Primary Author)	2021
* Surveys Within the Proposed Survey area			

2.7.3 U.S. Geological Survey and General Land Office Map Review

The region and Survey area are characterized by dispersed farms and ranches integrated around small community population centers, and this contemporary pattern began to take hold in the late nineteenth century. The U.S. Department of the Interior Bureau of Land Management General Land Office (GLO) surveyed these townships between 1880 and 1883, and these maps are the earliest large-scale depictions of the Survey area. When the GLO platted these sections, there was little development in the region. Acting as seed infrastructure that would support population growth and community development, the passes through the Project, and the Northern Pacific Railroad corridor lies 1.5 to 4.0 miles to the south and southwest.

The stage route generally followed the earlier Custer Trail of 1876 and was in service in 1878 as Post Office Route no. 35,051 with improved wagon road and stations every 18 miles (Pfaller 1955). The nearest stage stops were at Hebron, approximately 10 miles to the west, and on Hailstone Creek, two miles east of the Project. This is a region where the first railroads overlapped the last of the overland trails. The Northern Pacific Railroad met Bismarck in 1873, but it took until 1882 for the line to bridge the Missouri River and ultimately reach Miles City (Old Red Old Ten Scenic Byway 2024). In that same year, mail service was discontinued on the Fort Keogh trail, but it continued to be an important transportation route. It functioned as an early

highway as homesteaders pioneered the Dakota Territory and points west, and trappers, traders, and cattle ranchers moved goods to market. The Northern Pacific Railroad was important for the growth of towns and population, and land speculation was rampant along the corridor. The 1880s and 1890s brought rapid development, and this interval established the basic community framework of small farms and ranches, modest rural communities with schools, churches, and businesses, and the growth of larger regional towns.

George A. Ogle and Company atlases and plat maps show the Survey area region in the late 1910s (1917; 1918). The local landscape had been subdivided with the typical landholding being a quarter or half section. At this time, there were at least 55 homesteads or farms in the Study Area. Some of the identified features include ranches and a fruit farm. An approximation of the contemporary road network had already developed, and community infrastructure included four schools and a church and cemetery in the surrounding Study Area.

Small-scale U.S. Geological Survey (USGS) mapping from the 1950s shows few minor elements of the built environment, but apparently a few of the larger ranches were still depicted (Bismark 1:250K 1954). The Study Area included five schools and a church at this time. There were four quarries or surface mining operations in the overall Study Area and additional localities were dispersed to the south. Two of the Study Area features are marked as coal mines, and the other two may have been sand and gravel operations. Reflecting the local importance of ranching, the early USGS maps show a half dozen channel-bottom dams in tributaries of Wilson and Hailstone creeks. They may have functioned to some degree as erosional control structures, but the impoundments importantly created livestock tanks.

Later USGS mapping from 1960 and 1970 is very comparable to the depictions from the 1910s—the Project and surrounding area was characterized by dispersed rural residences as farms and ranches (Glen Ulin 1960; Dengate 1960; Glen Ulin 1970; Hailstone Butte 1970). These map sources show about 80 residential localities in the overall Study Area with half being in the immediate Survey area. Structures shown in the late historic period often correspond to those from the 1910s, and likely, some of these residences remain occupied today. Continuing or expanding the pattern from the 1950s, there are nine gravel pits in the Study Area with most lying along Wilson Creek. The only community development depicted was the St. Clements church, school, and cemetery, which is contiguous with the far northwestern perimeter of the Study Area. Officially known as St. Clement Oratory of Haymarsh, a small wood frame structure functioned as a church and post office in 1887, and the cemetery probably dates similarly (Bismarck Diocese 2024). After a catastrophic lightning-strike fire, a second church was built on the original foundation in 1905 along with a rectory. Both buildings burned in 1936, and the present church was built in 1937, again on the original rock foundation. The current property includes the 1937 church, a rectory, a tile-brick schoolhouse, an outdoor prayer space, and the cemetery. This property has been recommended as meeting eligibility requirements of the NRHP.

Contemporary land use is a mix of agricultural properties and unbroken grassland for pasture with narrow riparian zones flanking larger drainageways. Beginning with initial homesteading in the Survey area in the late nineteenth century, the mixed farming and ranching economy dominated this landscape. The earliest aerial photography for the Study Area is from 1957 and 1967, and these data are comparable to the contemporary pattern of land use. Over time, farmland acreage probably expanded at the expense of pasture and grassland as more capable farm equipment and methods, like terracing, were able to exploit more marginal, sloped lands for cultivation. Consistent from the early twentieth century on, a rural population of dispersed farm and ranch houses dot a landscape of fields and pasture.

3.0 CLASS III SURVEY METHODOLOGY

The general objective of a Class III inventory is to identify historic properties within the Project Survey Area that are at least 45 years of age. Historic property types considered for this investigation included both precontact and historic period archaeological sites, architectural sites, and earthworks that could provide information about human occupation. Such sites could be evident in artifacts or features on or below the current ground surface. The focus of this field investigation was to identify any eligible resources that could be present in the Project Survey Area.

Throughout all stages of the investigation, Merjent applied cultural resource management industry best practices and adhered to the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 CFR 44716), and North Dakota SHPO *Guidelines Manual for Cultural Resource Inventory Projects* (SHSND 2020).

The Project Survey Area was established based on files provided by Minnesota Power. Damien Reinhart (Principal Investigator), Fred Sutherland, Cody Dobson, and Martha Mock conducted the Class III inventory. Areas exhibiting obvious disturbance, inundation, or exhibiting slopes greater than 15 degrees were photo documented. The inventory was geographically oriented using Geographic Information System data in conjunction with a Trimble R1 Integrated Global Navigation Satellite System receiver. Field observations, including vegetation, ground surface visibility (GSV), slope, general topography, areas of soil disturbance or inundation, and stratigraphy, were described on field forms.

All portions of the Project Survey Area were walked using parallel transects spaced no more than 15 meters apart. When surface cultural material was observed along a transect, the interval was decreased to no more than 3 meters wide (and often less). Shovel probes were excavated in 10-meter radial intervals from the location of surface finds within newly recorded sites to characterize soils, delineate site boundaries, and determine the potential for the presence (or absence) of intact, subsurface cultural resource deposits. Excavation was discontinued after one or more sterile levels depending on soil characteristics and horizonation. In all cases, excavation extended below the Ap and A horizons. Sediments were screened through 0.25-inch hardware cloth mesh. Stone features, although none were identified or revisited, would have been plotted on field forms using a string grid to measure the diameter and height of both the feature and visible individual stones, so as not to disturb or alter provenience. No subsurface tests were excavated within the vicinity of any stone features. Artifacts were photographed and measured in the field; no artifacts were collected.

Merjent evaluated sites and their significance, as defined by criteria set forth in Title 36 CFR 60.4 (National Park Service 1991), which states:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A) that are associated with events that have made a significant contribution to the broad patterns of our history;
>
> B) that are associated with the lives of persons significant in our past;

C) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D) that have yielded, or may be likely to yield, information important in prehistory or history.

Sites that are not eligible are unlikely to contribute further data significant to our knowledge of prehistory or history and/or may no longer possess integrity.

Precontact lithic scatters/campsites (sites without any structures or association with known significant events or persons) generally will not require discussion of Criteria A, B, and C. Instead, for NRHP recommendation purposes, these properties are discussed for their potential to yield information significant to prehistory or the archaeological record under NRHP Criterion D. Special cases generally relate to Criterion A, where a precontact site type (such as a stone circle site) may not be recommended eligible for the NRHP from an archaeological perspective, but may be considered important to the cultures of Native American peoples.

Evaluation of the significance of archaeological sites under Criterion D involves considering general characteristics such as the nature, size, and diversity of the site assemblage; the potential presence or absence of subsurface cultural deposits; the nature of any features within the site (construction techniques, building materials, structural integrity); and, the age range reflected by the site assemblage. Sites considered to be significant generally contain an assemblage of cultural remains that reflect sufficient diversity to permit identification of activities and allow confirmation of the period of site use. Sites with the most potential to address research questions about human lifeways contain associated features, structures, and/or relatively intact and dateable artifacts.

Historic sites containing or consisting of preserved features or structures are evaluated primarily under Criteria A, B, and C. Historic trash scatters lacking associated features or structures are primarily evaluated under Criterion D. In general, these types of sites represent ephemeral prospecting or stock management activities, but they lack identifiable or important association with specific persons or events of regional or national history (Criteria A and B), and they lack the formal and structural attributes necessary to qualify as eligible under Criterion C. The evaluation of significance of historic archaeological sites under Criterion D focuses on the capacity of the sites or components to yield significant information regarding knowledge of history during the period(s) of site significance.

Evaluation of the significance of historic sites considers general characteristics such as the nature, size, and diversity of the site assemblage; the potential presence or absence of subsurface cultural deposits; the nature of any features within the site; construction techniques; building materials; structural integrity; and, the age range reflected by the site assemblage.

Historic sites considered to be significant under Criterion D generally contain an assemblage of cultural remains that reflect sufficient diversity to permit identification of activities and allow confirmation of the period of site use. Sites with the most potential to address research questions contain associated features, structures, and relatively intact and datable artifacts. Significant sites are those that could impart information not available solely from historical documents. Although archival research may provide an essential form of information, often historical records are

inaccurate or incomplete. For example, examination of construction techniques or household assemblages can provide information on economic slumps, reuse of structures for other than original purposes, and re-occupation cycles. As a result, insight may be gained into questions about human lifeways that are often asked in archaeology but rarely answered directly in historical documentation.

Non-archaeological historic sites or sites with non-archaeological components are those primarily assessed for NRHP eligibility under Criteria A, B, and C, rather than Criterion D, and typically are not subject to subsurface testing. Individual segments of significant historic sites are evaluated as contributing or non-contributing in terms of physical and environmental integrity. Examples of historic site types include linear historic features, such as transportation routes and water conduits, standing buildings, and structure sites. Historic site types potentially include any historic feature on an otherwise archaeological site, such as traditional cultural property features. Historic and ethnographic sites evaluated for potential contributions to history or cultural traditions for reasons beyond their possible future research value tend to have different evaluation and management considerations than archaeological sites. Typically, the integrity of historic sites is addressed using the guidelines presented in National Register Bulletin 15 (National Park Service 1991), which defines the seven elements of integrity as location, design, setting, materials, workmanship, feeling, and association. Properties are basically evaluated in consideration of their physical integrity and the integrity of their surroundings. Traditional cultural properties are also considered under the guidelines of National Register Bulletin 38 (Parker and King 1998).

4.0 CLASS III RESULTS AND RECOMMENDATIONS

This section presents the results of the Class III inventory conducted on January 31, 2025, March 5 to 14, 2025, April 9, 2025, April 14 to 18, 2025, April 23, 2025, and May 26, 2025 (see Figures 3.1 to 3.85 in Appendix A). During the Class III inventory, four new archaeological sites and five new isolated finds were recorded, while five previously recorded sites, site leads, and isolated finds were revisited.

At the time of each survey session, the Project Survey Area was characterized as mowed hay fields, agricultural lands containing stubble fields of wheat, corn, barley, flax, canola, and soybeans, and a small proportion of native or mixed grass pastures (see Photos 4.0-1, 4.0-2, and 4.0-3 below). The Project Survey Area is located approximately 4.5 miles north of the Town of Glen Ullin and 1.5 miles north of Interstate 94. The Project Survey Area is scattered throughout a large block that is bound on the west by 67th Avenue SW, on the south by 37th Street SW, on the east by 56th Avenue SW, and on the north generally by 30th Street SW. Highway 49 passes from north to south through the western third of the Project Survey Area.



Photo 4.0-1.
Project Survey Area Overview Facing East from Northwest Project Extent, Example of Wheat Stubble Fields in Project Survey Area.



Photo 4.0-2.
Project Survey Area Overview Facing West, Example of Corn Stubble Fields in Project Survey Area.



Photo 4.0-3.
Project Survey Area Overview Facing East, Example of Native Pastures in Project Survey Area.

4.1 Site 32MO1719

Site 32MO1719 consists of a sparse lithic scatter identified during pedestrian survey (see Figure 3.31 and 3.32). The site is located on a gentle hilltop sloping to the south, where there is currently a seasonal wetland, with Hailstone Butte directly to the north (see Photo 4.1-1). The site area is located within a stubble field with 60 to 100 percent GSV. The cultural material present consists of a broken KRF flake with modified edges, two tertiary KRF flakes, two secondary KRF flakes, and one primary KRF flake on the ground surface (see Photo 4.1-2). No artifacts were collected. Radial shovel tests were excavated around the site boundary (see Table 4.1-1 and Photo 4.1-3, Figure X). Each negative probe was bracketed until there were two consecutive negative probes to determine the horizontal site boundary (Figure 4.7). Additionally, a shovel probe was placed near the highest distribution of artifacts to examine soil deposition. Nine shovel probes were excavated. All shovel probes were negative.



Photo 4.1-1.
Overview of Site 32MO1719, Facing North.



Photo 4.1-2.
Overview of Tertiary Knife River Flint Flake.



Photo 4.1-3.
Representative Shovel Probe at Site 32MO1719..

TABLE 4.1-1

Site 32MO1719 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–18	Ap	2.5Y 5/3	Loam	Medium Brown
	18–41	B	2.5Y 6/2	Loam	Slightly Lighter Brown
SP 2A (North)	0-19	Ap	10YR 4/3	Loam	Medium Brown
	19-39	B	2.5Y 6/4	Loam	Light Brown to Gray
SP 2B (North	0-21	Ap	10YR 4/3	Loam	Medium Brown
	21-39	B	2.5Y 6/4	Loam	Light Brown to Gray
SP 3A (West)	0-19	Ap	10YR 5/3	Loam	
	19-36	B	2.5Y 6/4	Loam	
SP 3B (West)	0-21	Ap	2.5Y 6/4	Loam	Very Subtle Color Difference
	21-42	B	2.5Y 6/3	Loam	
SP 4A (East)	0-18	Ap	10YR 4/3	Loam	Subtle change to B Horizon.
	18-36	B	2.5Y 5/4	Loam	
SP 4B (East)	0-14	Ap	10YR 3/3	Loam	Not Compact. Clear Transition from Ap to B Horizon.
	14-40	B	10YR 4/4	Loam	
SP 5A (North)	0–16	Ap	10YR 4/4	Loam	Ap is Medium to Gray Brown. Bw1 is Orange Brown. Bw2 is Light Brown.
	16-22	Bw1	2.5Y 5/6	Loam	
	22-31	Bw2	10YR 6/2	Loam	
SP 5B (South)	0–12	Ap	10YR 3/2	Loam	Ap is Medium to Gray Brown. B is Grayish Brown.
	12–30	B	2.5Y 6/3	Loam	

[a] cmbs = centimeters below surface

Site 32MO1719 consists of a sparse lithic scatter located on the edge and top of a hilltop within a stubble field. The site maintains integrity of location and materials. Due to its location in a stubble field, the artifacts have been displaced due to mechanical cultivation, integrity of design, setting,

workmanship, association, and feeling have been compromised. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. The plow zone extends into the B horizon. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; or represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, although the resource consists of six, non-diagnostic, artifacts that are limited to the surface, with the plow zone extending through the A horizon and into the B, the potential presence of intact subsurface cultural deposits remain. This resource is recommended as *Unevaluated* for inclusion on the NRHP.

4.2 Site 32MO1720

Site 32MO1720 consists of a demolished farmstead [redacted] in what is now a mixed grass pasture (see Figure 3.6). There is a wetland on the east edge of the site, and the edge of the wetland has been modified to create a stock pond, which connects through a buried polyvinyl chloride (PVC) pipe west to an existing water tank and windmill and water pump (described on architectural form). The pond was constructed at some point around 1995 as evidenced by aerial imagery. The site currently consists of four features: a windmill (Feature 1), a large depression with dirt berms (Feature 2), a shallow rectangular depression (Feature 3), and the remains of a stacked stone corral (Feature 4).

Feature 1 consists of a steel frame windmill, pump, and modern water tank (with PVC pipe leaving the tank, buried, and extending east 350 feet to a modern stock pond (see Photo 4.2-1 below). The windmill is located approximately 80-125 feet southwest of a larger farm site where all structures have been razed. The tail of the windmill is intact, but the manufacturer is worn and illegible. There are indications in the aerial imagery from 1938 that indicate the windmill was in place at that time. The farm was active in that year, but by the next aerial image from 1957, the farm was clearly abandoned with all structures either partially or completely razed. The windmill is still being used, and it appears that around 2017 an effort was made to connect a pipe from a stock pond at the windmill, east, to a stock pond. The stock pond does not appear until the 1995 aerial, so it is not being included as a historic architectural feature. It appears that the tank, pipe, and stock dam were added in recent years due to the windmill no longer being able to drive the water pump.

Feature 2 is a large depression with dirt berms stacked up around the depression (see Photo 4.2-2). The feature measures 70 feet from north-south and 30 feet in width. The soil berms are stacked to heights of approximately 4 feet above the ground surface and are most prominent on the north and west sides of the depression. The depression has an irregular depth with a maximum depth of 2 feet. Aerial imagery from 1938 indicates this area held a rectangular outbuilding.

Feature 3 is a shallow rectangular depression filled with bottles and other refuse (see Photo 4.2-3). The feature lies 80 feet northeast of Feature 2. It is smaller in size, measuring 25 feet north-south by 15 feet east-west. Aerial imagery from 1938 is unclear about this area. A small structure that is heavily shadowed appears in this area, but details are difficult to discern. The depression is currently 2 feet in depth. There is an amalgamation of tin cans that have been deposited in this spot for so long they are corroding into one large pile. It is estimated that there are over 100 cans, bottles, metal buckets, tin cans, and appliance parts within the depression

along with field stones that were likely used as foundation material. A root beer bottle with a maker's mark indicated a date of 1968. It appears that the dumping ceased around this time.

Feature 4 represents the remains of a stacked stone corral that has largely collapsed (see Photo 4.2-4). Some of the north, west, and east walls remain. This corral system can be seen on the 1938 aerial image with a building on the southeast corner. No building remains. The corral is 115 feet southwest of Feature 3. The corral is generally 3.5 feet in height. Other debris adjacent to the feature includes a chassis for a Model T and a small scatter of associated car parts (90 feet to the SE of Feature 4) (see Photo 4.2-5). Signs of two other structures present on the aerial image have been razed.

Site 32MO1720 is a razed farmstead site situated on flat plains adjacent to a wetland and ephemeral drainages. The larger farm site is recommended *Unevaluated* for the NRHP pending further investigation. While the site maintains integrity of location, the site's design, setting, materials, workmanship, and feeling have been impacted through deterioration of the farm features on-site and nearby wind farm development. The site is originally associated with Karl Christian who was issued the original patent (No. ND1770.331) on October 27, 1904 under the Homestead Act [Act of May 20, 1862, Public Law 37-64 (12 STAT 392)]. It is likely the farm and windmill are associated with this individual. A search on ancestry.com, yielded results that indicated in the 1900 United States Federal Census, Karl was aged 54 and had been born in Hungary in December 1845 (Ancestry.com 2025). He was living in [redacted]; potentially on a nearby farmstead from this particular site, which he didn't purchase until 1904. The record indicates he was married to Katherine Christian, and they had married in 1869. She was also from Hungary. He was a naturalized citizen, a farmer, and could read and write, but spoke no English. He had a 15-year-old daughter at the time of the census named Abelonia. The site could not be associated with an important historic event or person, as Karl Christian was not noted as being of importance to local history (NDSU Libraries-Institute for Regional Studies & University Archives 2025). The features present at the site do not appear to meet the requirements of significance under Criterion C. Criterion D may still apply to the overall eligibility of the farmstead site due to potential subsurface deposits.



Photo 4.2-1.
View of Feature 1, Windmill and Water Tank, View Southwest, Site 32MO1720.



Photo 4.2-2.
View of Features 2 and 3 (Feature 2 in Background, Feature 3 in Foreground), View Southwest, Site 32MO1720.



Photo 4.2-3.
View of Feature 3, Depression with Garbage Dump, View North, Site 32MO1720.



Photo 4.2-4.
View of Feature 4, Stacked Stone Corral, View South, Site 32MO1720.



Photo 4.2-5.
View of Model T Chassis, Site 32MO1720.

4.3 Site 32MO1721

Site 32MO1721 consists of a demolished farmstead [redacted] in what is now a mixed grass pasture (see Figure 3.5). There is a stream 300 feet northeast of the site and a massive soil stockpile 400 feet to the west of the site. The site currently consists of two features and associated abandoned vehicles and a garbage deposit within a feature.

Feature 1 is the north and east foundations of a razed structure (see Photo 4.3-1). The north foundation measured roughly 25 feet. The east foundation was nearly the same length. The foundation is concrete with large stone aggregate and pieces of steel rebar protruding periodically for wall sill anchors. The thickness of the foundations were approximately 4 to 6 inches in thickness and standing approximately 10 to 12 inches above the surface. No depressions or evidence of other walls were identified.

Feature 2 is a large depression with dirt berms stacked up around the depression (see Photo 4.3-2. The feature measures 60 feet from north-south and 30 feet in width. The soil berms are stacked to heights of approximately 2 to 3 feet above the ground surface and are most prominent on the north, east, and west sides of the depression. The depression has an irregular depth with a maximum depth of 2 feet. The depression has turned into a deposit for farming-related garbage. There are over 100 large pieces of sheet metal likely the remains of a grain bin, rolls of fencing, farm implement and home appliance parts. The most recent appliances are of styles no later than the 1960s.

Aerial imagery from 1938 indicates this area was actively being used and had been worn by vehicle traffic. It is difficult to tell from this image if this was a stockyard or a farmstead with a

home. The image has black writing across the location, but it appears that there were five or six structures of various sizes in the vicinity with two roads/trails on the north and south ends. The 1957 aerial shows all structures razed and the foundations completely overgrown.

Other debris adjacent to the feature includes three car bodies that date from the 1940s and early 1960s (see Photo 4.3-3). A vehicle plate had the year 1962 as its last year of registration. No other signs of structures remained on the ground surface.



Photo 4.3-1.
View of Feature 1, Concrete Foundation, View West, Site 32MO1721.



Photo 4.3-2.
View of Feature 2, Depression and Garbage Dump, View North, Site 32MO1721.



Photo 4.3-3.
View of Vehicle Dump, 1940s and 1950s Automobiles, View East, Site 32MO1721.

Site 32MO1721 is a razed farmstead site situated on top and side of a small hill adjacent to a drainage. The site is recommended *Unevaluated* for the NRHP pending further investigation.

While the site maintains integrity of location, the site's design, setting, materials, workmanship, and feeling have been impacted through deterioration of the farm features on-site and nearby wind farm development. The site is originally associated with Nikolaus Weissman who was issued the original patent (No.187801) on April 4, 1911, under the Homestead Act [Act of May 20, 1862, Public Law 37-64 (12 STAT 392. It is likely the farm and windmill are associated with this individual. A search on ancestry.com, yielded results that indicated Nikolaus was born in 1882 in Hungary and arrived in the United States in September 1903 through New York City. The site could not be associated with an important historic event or person, as Nikolaus Weissman was not noted as being of importance to local history under Criteria A and B. The features present at the site do not appear to meet the requirements of significance under Criterion C. Criterion D may still apply to the overall eligibility of the farmstead site due to potential subsurface deposits.

4.4 Site 32MO1722

Site 32MO1722 consists of approximately 28 chipped stone artifacts identified during pedestrian survey (see Figure 3.41 and 3.42; Photo 4.4-1 below). The artifacts were located on a gentle hilltop within a canola stubble field with 75 to 100 percent GSV. The artifacts recorded consisted of: 18 tertiary flakes of KRF, 5 pieces of KRF shatter, two secondary flakes of KRF, one KRF core, one broken biface made from what appears to be porcellanite and has a lenticular shape, and a secondary flake of petrified wood (see Photo 4.4-2 and 4.4-3). The artifacts present indicate the breaking or testing of raw material, as well as the final stages of reduction in tool making, and one instance of a broken and discarded biface.

Radial shovel tests were excavated around the boundary (see Table 4.4-1 and Photo 4.4-4 below) (Figure 4.4). Each negative probe was bracketed until there were two consecutive negative probes to determine the horizontal boundary. A shovel probe was placed near the highest distribution of artifacts to examine soil deposition. Nine shovel probes were excavated. All were negative.

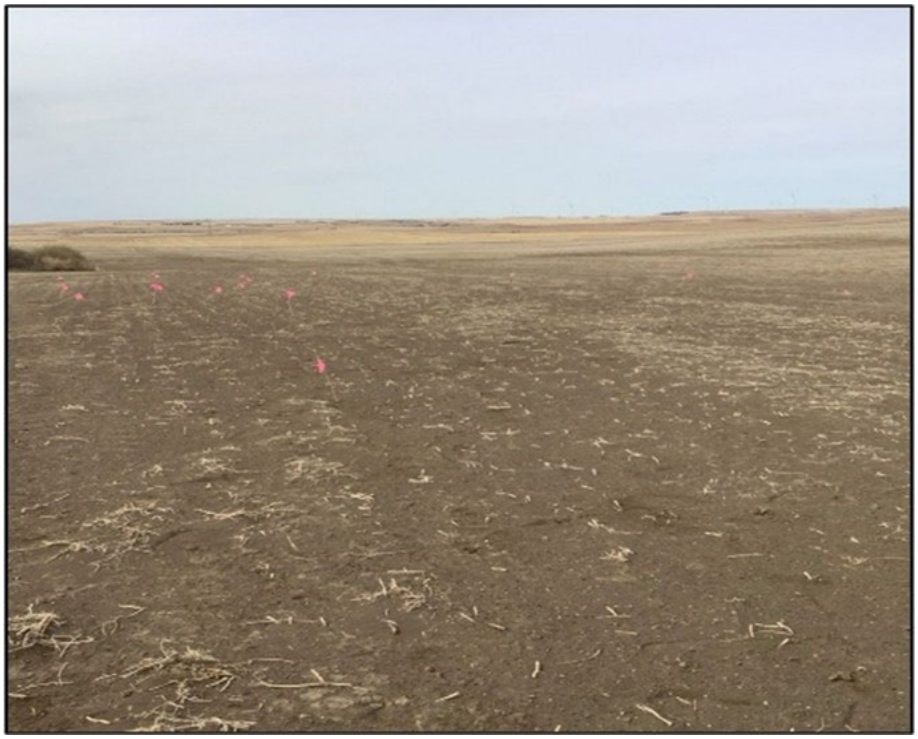


Photo 4.4-1.
Overview of Site 32MO1722, View West.



Photo 4.4-2.
View of Broken Biface, Porcellanite, Site 32MO1722.

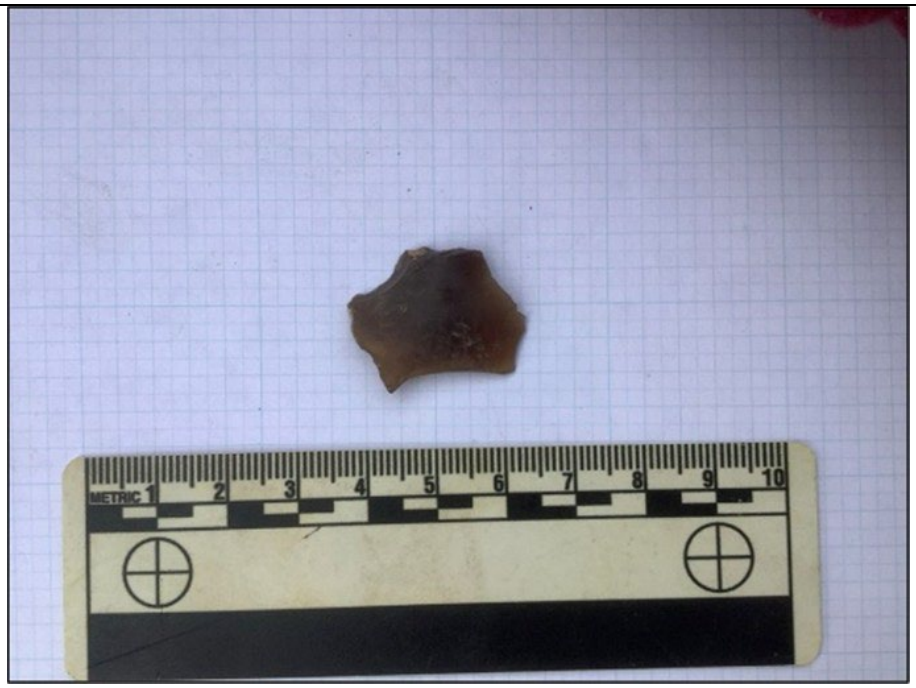


Photo 4.4-3.
View of Tertiary Flake, Knife River Flint, Site 32MO1722.



Photo 4.4-4.
Representative Negative Shovel Probe, Site 32MO1722.

TABLE 4.4-1

Site 32MO1722 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–15	Ap	10YR 3/3	Sitl Loam	More Small Inclusions in Ap. Gradual Sideslope.
	15–32	B	2.5Y 4/3	Silt Loam	
SP 2A (North)	0-17	Ap	10YR 3/3	Silt Loam	Flat Plain. Few to No Inclusions in Ap.
	17-53	B	2.5Y 4/3	Silt Loam	
SP 2B (North	0-15	Ap	10YR 3/3	Silt Loam	Flat Plain. Little to No Inclusions in Ap.
	15-38	B	2.5Y 4/3	Silt Loam	
SP 3A (West)	0-18	Ap	10YR 3/3	Silt Loam	Flat Plain. No Inclusions in Ap.
	18-37	B	2.5Y 4/3	Silt Loam	
SP 3B (West)	0-13	Ap	10YR 3/3	Silt Loam	Dry. No Inclusions. Plain North of Drainage.
	13-36	B	2.5Y 4/3	Silt Loam	
SP 4A (East)	0-20	Ap	10YR 3/3	Silt Loam	Few Inclusions in Ap. Thicker Ap.
	20-38	B	2.5Y 4/3	Silt Loam	
SP 4B (East)	0-11	Ap	10YR 3/3	Silt Loam	Few Inclusions in Ap.
	11-32	B	2.5Y 4/3	Silt Loam	
SP 5A (North)	0–16	Ap	10YR 3/3	Silt Loam	Chunky. Dry Ap. Few Inclusions of Siltstone.
	16-38	Bw1	2.5Y 4/3	Silt Loam	
SP 5B (South)	0–18	Ap	10YR 3/3	Silt Loam	Few Iron Concretions and Small Inclusions in Ap. Dry. Blocky.
	18–36	B	2.5Y 4/3	Silt Loam	

[a] cmbs = centimeters below surface

This site maintains integrity of location and materials. Due to its location in a stubble field and displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised.

Site 32MO1722 is a newly recorded lithic scatter located on the top of a gentle hilltop within a stubble field. The resource has been continually disturbed by plowing and disking. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. The plow zone extends into the B horizon. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, although the resource consists of approximately 28, non-diagnostic, artifacts that are limited to the surface, with the plow zone extending through the A horizon and into the B, the potential for intact subsurface deposits remain. This resource is recommended as *Unevaluated* for inclusion on the NRHP.

4.5 Isolated Find 32MOX804

Isolated Find 031025-DSR-IF consists of two KRF tertiary flakes identified during pedestrian survey (see Figure 3.43). The flakes were located on a gentle hilltop within a corn stubble field with 75 to 100 percent GSV (see Photos 4.5-1 and 4.5-2 below). Four radial shovel tests were excavated around the isolate and one shovel probe near the find, all with negative results (Figure 4.3). Each shovel probe was fairly similar in that a dark grayish brown (10YR 3/3) Ap horizon consisting of silt loam was present underlain by a light brownish (10YR 4/4) silty clay loam B horizon (see Table 4.5-1 and Photo 4.5-3 below). The soils were noted as having few inclusions

in the Ap horizon. Radial testing was conducted at 10-meter intervals in each cardinal direction from the surface find. No additional cultural materials were recovered in subsurface testing.



Photo 4.5-1.
Overview of Isolated Find 32MOX804, Facing West.



Photo 4.5-2.
Overview of Isolated Find, Tertiary Flake, Knife River Flint.



Photo 4.5-3.
Representative Shovel Probe of Isolated Find 030525-DSR-IF-001.

TABLE 4.5-1

Site 32MOX804 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–15	Ap	10YR 3/2	Silt Loam	Few Inclusions in Ap.
	15–36	B	10YR 6/2	Silty Clay Loam	
SP 2 (North)	0-19	Ap		Silt Loam	
	19-32	B		Silty Clay Loam	
SP 3 (West)	0–24	Ap	10YR 3/2	Silt Loam	
	24–36	B	10YR 4/3	Silty Clay Loam	
SP 4 (East)	0–22	Ap	10YR 3/2	Silt Loam	
	22–34	AB	10YR 5/2	Silty Clay Loam	
SP 5 (South)	0–22	Ap	10YR 3/2	Silt Loam	
	22–32	B	10YR 4/3	Silty Clay Loam	

[a] cmbs = centimeters below surface

Isolated Find 031025-DSR-IF is a newly recorded Isolated Find located on a hilltop within a corn stubble field. The resource has been continually disturbed by plowing and disking. This Isolated Find maintains integrity of location and materials. Due to its location in a corn stubble field the displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period

or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, the resource consists of two, non-diagnostic, artifacts that are limited to the surface; recordation exhausts its research value. This resource is recommended as *Not Eligible* for inclusion on the NRHP.

4.6 Isolated Find 32MOX802

Isolated Find 03062025-MRM-IF consists of a single KRF secondary flake identified during pedestrian survey (see Figure 3.6; Photos 4.6-1 and 4.6-2 below). The flake was located within the middle of a saddle between a hill to the north and one to the south within a two-track ranch road in short grass pasture with 30 to 70 percent GSV. There is some probability that the gravels present in the two-track were introduced at some point in the past due to the absence of similar gravel deposits in shovel probes outside of the two-track road.

Four radial shovel tests were excavated around the isolate and one shovel probe near the find, with negative results (Figure 4.1). Each shovel probe was fairly similar in that a (10YR 3/2) A horizon consisting of fine sandy loam was present underlain by a light brownish (7.5YR 4/3 and 4/4 and 2.5Y 5/4) fine sandy loam B horizon (see Table 4.6-1 and Photo 4.6-3 below). The center probe had a compact A horizon with gravel inclusions. Other probes lacked gravel aside from the east probe, which had baseball sized granite pieces in the B horizon. All probes were negative.



Photo 4.6-1.
Overview of Isolated Find 32MOX802, Facing East.



Photo 4.6-2.
Overview of Isolated Find, Secondary Flake, Knife River Flint.



Photo 4.6-3.
Representative View of Negative Shovel Probe.

TABLE 4.6-1

Site 32MOX802 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–20	A	10YR 3/2	Fine Sandy Loam	Gravel Inclusions in Ap. Slight Color Change Indicates B Horizon.
	20–26	Bw1	10YR 3/4	Fine Sandy Loam	
	26-47	Bw2	2.5Y 5/4	Fine Sandy Loam	
SP 2 (North)	0-25	A	10YR 3/2	Fine Sandy Loam	Almost No Inclusions in A. More on a Flat Area.
	25-45	B	7.5YR 4/4	Fine Sandy Loam	
SP 3 (West)	0–25	A	10YR 3/3	Fine Sandy Loam	Almost No Inclusions.
	25–50	B	2.5Y 5/4	Fine Sandy Loam	
SP 4 (East)	0–30	A	10YR 3/3	Fine Sandy Loam	Abundant Baseball-Sized Granite Pieces into B.
	30–48	B	7.5YR 4/3	Fine Sandy Loam	
SP 5 (South)	0–25	A	10YR 3/3	Fine Sandy Loam	Few Inclusions in Ap. Small.
	25–45	B	7.5YR 4/3	Fine Sandy Loam	

[a] cmbs = centimeters below surface

Isolated Find 03062025-MRM-IF is a newly recorded Isolated Find located in a saddle between two prominent hills within a two-track road. The resource has been disturbed by erosion from cattle grazing and the ruts of the two-track road. This Isolated Find maintains integrity of location and materials. Due to its location in a corn stubble field and displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised. Shovel probes terminating below the A horizon (approximately 20 centimeters [cm] into the B horizon) did not identify any subsurface artifacts or intact cultural deposits. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, the resource consists of one, non-diagnostic, artifact that is limited to the surface and may have been introduced as a gravel topping material for the two-track road; recordation exhausts its research value. This resource is recommended as *Not Eligible* for inclusion on the NRHP.

4.7 Isolated Find 32MOX803

Isolated Find 32MOX803 consists of a single KRF tertiary flake identified during pedestrian survey (see Figure 3.54; Photos 4.7-1 and 4.7-2 below). The flake was located on a gentle hilltop within a wheat stubble field with 50 to 70 percent GSV. Four radial shovel tests were excavated around the isolate and one shovel probe near the find, with negative results (Figure 4.2). Each shovel probe was fairly similar in that a dark grayish brown (10YR 3/2) Ap horizon consisting of silty clay loam was present underlain by a light brownish (10YR 5/4) silty clay B horizon (see Table 4.7-1 and Photo 4.7-3 below). It was noted the soils had shale or siltstone inclusions in the Ap horizon. Radial testing was conducted at 10-meter intervals in each cardinal direction from the surface find. All probes were negative.



Photo 4.7-1.
Overview of Isolated Find 32MOX803, View to North.



Photo 4.7-2.
Isolated Find 32MOX803, Tertiary Flake, Knife River Flint.



Photo 4.7-3.
Representative Shovel Probe at Isolated Find 32MOX803.

TABLE 4.7-1

Site 32MOX803 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–11	Ap	10YR 3/2	Silty Clay Loam	Ap Has Shale, Siltstone Inclusions. Clear Soil Transition with 5 cm of A Missing.
	11–30	B	10YR 5/4	Silty Clay	
SP 2 (North)	0-10	Ap	10YR 3/2	Silty Clay Loam	Pieces of Thin Shale Inclusions. Siltstone Breaks Easily in Ap.
	10-29	B	10YR 5/6	Silty Clay	
SP 3 (West)	0–15	Ap	10YR 3/2	Silty Clay Loam	Plow Zone is 0-15 cm. From 15-29 cmbs was a Cluster/Layer of Iron Concretions and Shale.
	15–29	Bt1	10YR 5/8	Sandy Silt Clay	
	29-36	Bt2	10YR 5/4	Silty Clay	
SP 4 (East)	0–16	Ap	10YR 3/2	Silty Clay Loam	Chunks of Shale and Siltstone Concetions in Ap. Less in B.
	16–35	AB	10YR 5/4	Silty Clay	
SP 5 (South)	0–16	Ap	10YR 3/2	Silty Clay Loam	Least Amount of Shale in Ap.
	16–36	B	10YR 5/4	Silty Clay	

[a] cmbs = centimeters below surface

Isolated Find 32MOX803 is a newly recorded Isolated Find located on a gentle hilltop within a wheat stubble field. The resource has been continually disturbed by plowing and disking. This Isolated Find maintains integrity of location and materials. Due to its location in a corn stubble field and displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. It is indeterminable whether the site is associated with events or persons significant in our past

(Criteria A and B); the resource does not embody the distinctive characteristics of a type, period or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, the resource consists of a single, non-diagnostic, artifact that is limited to the surface; recordation exhausts its research value. This resource is recommended as *Not Eligible* for inclusion on the NRHP.

4.8 Isolated Find 32MOX805

Isolated Find 32MOX805 consists of two KRF flakes identified during pedestrian survey (see Figure 3.41; Photos 4.8-1 and 4.8-2 below). The flakes, which consist of one tertiary flake and one secondary flake, were located on top of and slightly on the south downslope of a gentle hilltop within a corn stubble field with 70 to 100 percent GSV. Four radial shovel tests were excavated around the isolate and one shovel probe near the find, with negative results (Figure 4.6). Each of the shovel probes were fairly similar in that a thin, dark grayish brown (10YR 3/3) Ap horizon consisting of loam was present underlain by either a thin (8 to 10 cm) B horizon or from the Ap straight to a C horizon (see Table 4.8-1 and Photo 4.8-3 below). Radial testing was conducted at 10-meter intervals in each cardinal direction from the surface find. No additional cultural materials were recovered in subsurface testing.



Photo 4.8-1. Overview of Isolated Find 32MOX805, View to East.



Photo 4.8-2. Isolated Find 32MOX805, Secondary Flake, Knife River Flint.



Photo 4.8-3. Representative Shovel Probe at Isolated Find 32MOX805.

TABLE 4.8-1

Site 32MOX805 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–8	Ap	10YR 3/3	Loam	Slight Downslope. Ap is Thin, Bk is Mixed with Parent Material, C is Lighter Gray.
	8–18	Bk	2.5Y 4/2	Silt Loam	
	18-30	C	10YR 5/2	Silt Loam	
SP 2 (North)	0-13	Ap	10YR 3/3	Loam	Upslope, Near Top. Ap is Down to Shallow C. The C is orange to Brown
	13-32	C	10YR 6/3	Silt Loam	
SP 3 (West)	0–12	Ap	10YR 3/3	Loam	Ap Has Few Inclusions, Downslope. C Has Parent Material Reddish Throughout.
	12–24	Bk	2.5Y 4/3	Silt Loam	
	24-34	C	10YR 6/4	Silt Loam	
SP 4 (East)	0–12	Ap	10YR 3/3	Loam	Upslope. Ap is Medium Brown, Bk is Gone. C is Grayish Compact.
	12–35	C	10YR 6/3	Silt Loam	
	0–14	Ap	10YR 3/3	Loam	Downslope-Slight. Ap is Lighter Brown with Small Inclusions. Bk is Reddish Brown. C is White Redox and Parent.
	14–22	Bk	2.5Y 4/2	Silt Loam	
	22-37	C	10YR 5/2	Silt Loam	

[a] cmbs = centimeters below surface

Isolated Find 32MOX805 is a newly recorded Isolated Find located on a hilltop within a corn stubble field. The resource has been continually disturbed by plowing and disking. This Isolated Find maintains integrity of location and materials. Due to its location in a corn stubble field and displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, the resource consists of two, non-diagnostic, artifacts that are limited to the surface with disturbed soils into the B and C horizons; recordation exhausts its research value. This resource is recommended as *Not Eligible* for inclusion on the NRHP.

4.9 Isolated Find 32MOX806

Isolated Find 32MOX806 consists of four KRF flakes identified during pedestrian survey (see Figure 3.41; Photos 4.9-1 and 4.9-2 below). The flakes, which consist of two tertiary flakes, a primary flake, and one broken biface or preform, were located on top of and slightly on the southwest downslope of a hilltop within a canola stubble field with 90 to 100 percent GSV. The materials are sparse and spread across a broad area along the hill. Four radial shovel tests were excavated around the isolate and one shovel probe near the find, with negative results (Figure 4.5). Each shovel probe was fairly similar in that a thin, dark grayish brown (10YR 3/3) Ap horizon consisting of loam was present underlain by either a B horizon (see Table 4.9-1 and Photo 4.9-3 below). Radial testing was conducted at 10-meter intervals in each cardinal direction from the surface find. No additional cultural materials were recovered in subsurface testing.



Photo 4.9-1.
Overview of Isolated Find 32MOX806, View to Southeast.



Photo 4.9-2.
Isolated Find 32MOX806, Secondary Flake, Knife River Flint.



Photo 4.9-3.
Representative Shovel Probe at Isolated Find 32MOX806.

TABLE 4.9-1

Site 32MOX806 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–11	Ap	10YR 3/3	Loam	Few Inclusions in Top 5 cm. No Inclusions below. Orange Stains in B.
	11–31	B	10YR 5/4	Loam	
SP 2 (North)	0-13	Ap	10YR 3/3	Loam	Easy to Dig Loam. No Inclusions.
	13-32	B	10YR 5/4	Loam	
SP 3 (West)	0–19	Ap	10YR 3/3	Loam	Darker Loams in Ap and B. No Inclusions.
	19–37	B	10YR 5/4	Loam	
SP 4 (East)	0–14	Ap	10YR 3/3	Loam	Few Small Inclusions Within Top 5 cm.
	14–35	AB	10YR 5/4	Loam	
SP 5 (South)	0–17	Ap	10YR 3/3	Loam	Lighter Grayish Brown Ap and Light Tan B. No Inclusions.
	17–35	B	2.5Y 6/2	Loam	

[a] cmbs = centimeters below surface

Isolated Find 32MOX806 is a newly recorded Isolated Find located on a hilltop within a canola stubble field. The resource has been continually disturbed by plowing and disking. This Isolated Find maintains integrity of location and materials. Due to its location in a canola stubble field and displacement of the artifacts due to mechanical cultivation, integrity of design, setting, workmanship, association, and feeling have been compromised. Shovel probes terminating below the plow zone did not identify any subsurface artifacts or intact cultural deposits. It is indeterminable whether the site is associated with events or persons significant in our past (Criteria A and B); the resource does not embody the distinctive characteristics of a type, period

or method of construction; nor does it represent the work of a master; nor does it possess high artistic values; nor, represent a significant and distinguishable entity whose components may lack individual distinction (Criterion C). When considering Criterion D of the NRHP, the resource consists of four, non-diagnostic, artifacts that are limited to the surface with disturbed soils into the B horizon; recordation exhausts its research value. This resource is recommended as *Not Eligible* for inclusion on the NRHP.

4.10 32MO233 Site Revisit

Site 32MO233 was originally recorded in 1980 and consists of a segment of the abandoned Fort Keogh to Fort Lincoln stagecoach road (see Figure 3.46-3.49, 3.38; Photo 4.10-1 below). The original form indicated that the line in this area was now the improved county road located along the south edge of the site boundary. The site was originally recommended as unevaluated in regard to eligibility for listing on the NRHP in 1980 and the recorder recommended that any information that could be gained about the history of the stagecoach line within the current site boundary could be ascertained from review of aerial photography. Historical aerials going back to 1938 and 1957 were reviewed by Merjent, but no evidence of the stagecoach road could be found (DWR 2025). Merjent recommends that the stagecoach line no longer exists in the Project Survey Area, and no further work is recommended for the resource in this area. Ground surface visibility was approximately 75 percent during the revisit. The stagecoach line may exist undisturbed in other places outside of the current Project Survey Area.



Photo 4.10-1.
Overview of Site 32MO233 Revisit, Facing Northeast.

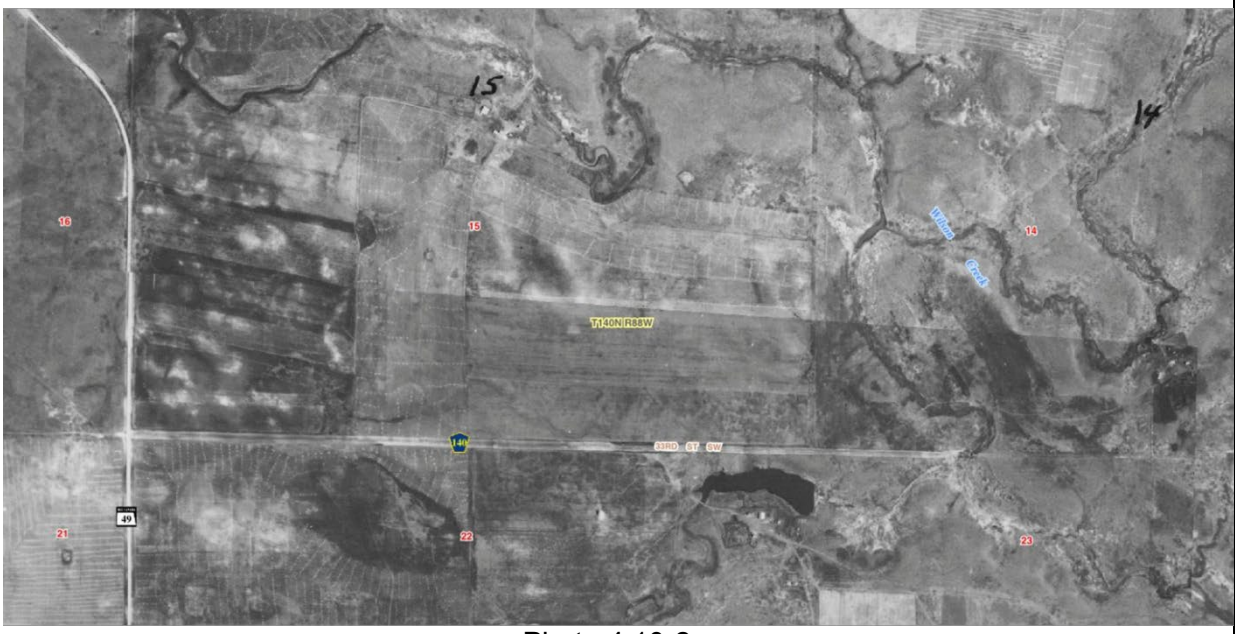


Photo 4.10-2.
1938 Aerial image of project location (DWR 2025).

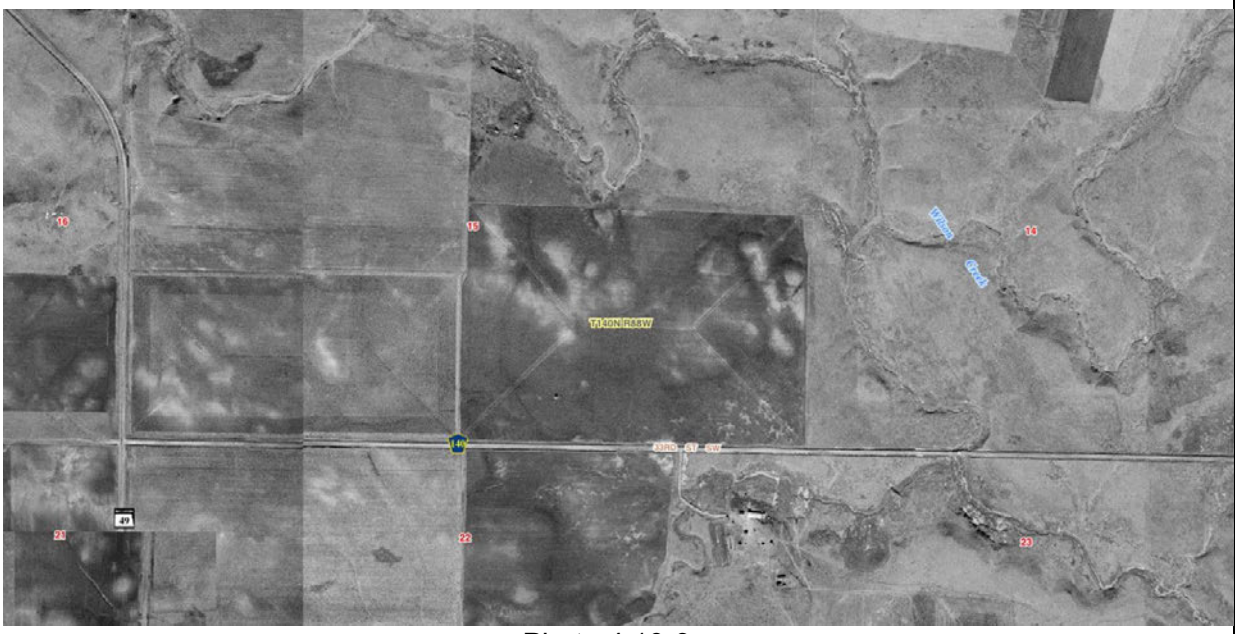


Photo 4.10-3.
1957 Aerial image of project location (DWR 2025).

4.11 32MOX132 Site Revisit

Site Lead 32MOX132 was originally recorded in 1980 by Benson as "Camp 5" (see Figure 3.56 and 3.59; Photo 4.11-1 below). Other supporting information was lacking. The portion of the site lead boundary within the current Project Survey Area consists of a well-established, east-west trending gravel county road. Ground surface visibility was approximately 80 percent during the revisit. No evidence of a camp site exists within the survey area, and any historic camp site is likely located south of the Project Survey Area in a flat to gently rolling plain; therefore, no further work is recommended for the resource in this area.



Photo 4.11-1. Overview of Site Lead 32MOX132 Revisit, Facing East.

4.12 32MOX577 Site Revisit

Site 32MOX577 was originally recorded in 2015 and consisted of four KRF flakes within a two-track road adjacent to an agricultural field (see Figure 3.37 and 3.38; Photo 4.12-1 below). During revisit to the isolated find for the current survey, only one flake was observed of the four original artifacts. Ground surface visibility was approximately 50 percent during the revisit. Four radial shovel probes were placed in the cardinal directions and one probe near the original finds (see Table 4.12-1 below). All probes were negative. Soil profiles indicate that plowing in the adjacent field has disturbed the A horizon down to the B (see Photo 4.12-2 below). Within the two-track, the A horizon is compact due to erosion and rutting. The landscape is little changed since the original recording. Due to the lack of artifacts within shovel probes, the disturbed A horizon directly adjacent to the two-track road, and the eroded and disturbed nature of the two-track road where artifacts were originally identified, Merjent concurs with the prior recommendation of *Not Eligible* for listing in the NRHP and no further work is proposed.

TABLE 4.12-1

Site 32MOX577 Shovel Test Profiles

Shovel Probe	Depth (cmbs)[a]	Horizon	Munsell	Soil	Notes
SP 1 (Center)	0–36	Ap	10YR 3/2	Silt Loam	Redox and Concretion Streaks in B.
	36–48	B	7.5YR 4/3	Silt Loam	
SP 2 (North)	0-33	Ap	10YR 3/2	Silt Loam	
	33-48	B	7.5YR 4/3	Silt Loam	
SP 3 (West)	0–22	A	10YR 3/2	Silt Loam	Compact. Center of Two-Track.
	22–33	Bw	7.5YR 4/3	Silt Loam	
SP 4 (East)	0–26	Ap	10YR 3/2	Silt Loam	No Inclusions.
	26–40	B	7.5 YR 4/3	Silt Loam	
SP 5 (South)	0–20	Ap	10YR 3/2	Silt Loam	
	20–30	Bw	7.5YR 4/3	Silt Loam	
	30-40	Bk	2.5Y 5/4	Silt Loam	

[a] cmbs = centimeters below surface



Photo 4.12-1.
Overview of Isolated Find 32MOX577, Facing West.



Photo 4.12-2.
Representative Shovel Probe at 32MOX577.

4.13 32MOX579 Site Revisit

Site 32MOX579 was originally recorded in 2015 and consisted of a single KRF biface (see Figure 3.5; Photo 4.13-1 below). No new lithic resources were noted during the revisit and the originally recorded artifact was not observed. Ground surface visibility was approximately 20 percent during the revisit. The landscape appears to remain largely unchanged since 2015. The original recorder had placed five shovel probes around the find and all were negative. Due to the previous work done at the isolated find and no chipped stone material being identified during the revisit, Merjent concurs with the prior recommendation of *Not Eligible* for the NRHP and no further work proposed.



Photo 4.13-1.
Ground View Near Isolated Find 32MOx579, Facing North.

4.14 32MOX580 Site Revisit

Site 32MOX580 was originally recorded in 2015 and consisted of a single biface of knife river flint (see Figure 3.5; Photo 4.14-1 below). No new lithic resources were noted during the revisit and the originally recorded artifact was not observed. Ground surface visibility was approximately 20 percent during the revisit. The landscape appears to remain largely unchanged since 2015. The original recorder had placed 15 shovel probes around the find and all were negative. Due to the previous work done at the isolated find and no chipped stone material being identified during the revisit, Merjent concurs with the prior recommendation of *Not Eligible* for the NRHP and no further work proposed.



Photo 4.14-1.
Overview of Isolated Find 32MOX580, Facing South.

5.0 SUMMARY AND RECOMMENDATIONS

A Class I file search completed in August 2024, with an update in January 2025, identified one previously recorded historic archaeological site, one historic archaeological site lead, and three precontact isolated finds within the Project Survey Area. The Class III pedestrian survey of the Project Survey Area was completed on January 31, 2025, March 5 to 14, 2025, April 9, 2025, April 14 to 18, 2025, April 23, 2025, and May 26, 2025. During the survey, two new historic sites, two new precontact sites, and five new isolated finds were identified. Of the new sites, isolated finds, and previously identified sites, four are recommended as unevaluated or potentially eligible for listing on the NRHP (refer to Table 5.0-1 below). Merjent recommends avoidance of four of the nine new resources. Merjent searched for site lead 32MOX132, a historic camp site, but no evidence of past activity was identified during the survey for a proposed access road, which is an existing crowned and ditched county road; therefore, no further work is recommended for the resource in this area. Similarly, site 32MO233, a segment of stagecoach line, was originally noted as being covered in this area by a modern crowned and ditched county road. No evidence of past activity was identified during the survey for proposed O&M work areas to the north of the existing road. No further work is recommended for the resource in this area. The other 10 sites and isolated finds are recommended as not eligible for listing. No further work or avoidance is recommended for those resources. Merjent recommends that no historic properties will be affected by the proposed Project provided the above-mentioned avoidance measures are implemented. No further archaeological work is recommended for the Project as planned.

TABLE 5.0-1

Summary of NRHP and Management Recommendations by Resource

SITS No.	Cultural Affiliation	Resource Type	NRHP Recommendation	Management Recommendation
32MO233	Historic	Stagecoach Road	Unevaluated	No Further Work (Not in Study Area)
32MOX132	Historic	Camp	Unevaluated	No Further Work (Not in Study Area)
32MOX577	Precontact - Unknown	Lithic Scatter	Not Eligible	No Further Work
32MOX579	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MOX580	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MO1719	Precontact - Unknown	Lithic Scatter	Unevaluated	Avoidance or Further Work
32MO1720	Historic	Farmstead	Unevaluated	Avoidance or Further Work
32MO1721	Historic	Farmstead	Unevaluated	Avoidance or Further Work
32MO1722	Precontact - Unknown	Lithic Scatter	Unevaluated	Avoidance or Further Work
32MOX804	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MOX802	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MOX803	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MOX805	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work
32MOX806	Precontact - Unknown	Isolated Find	Not Eligible	No Further Work

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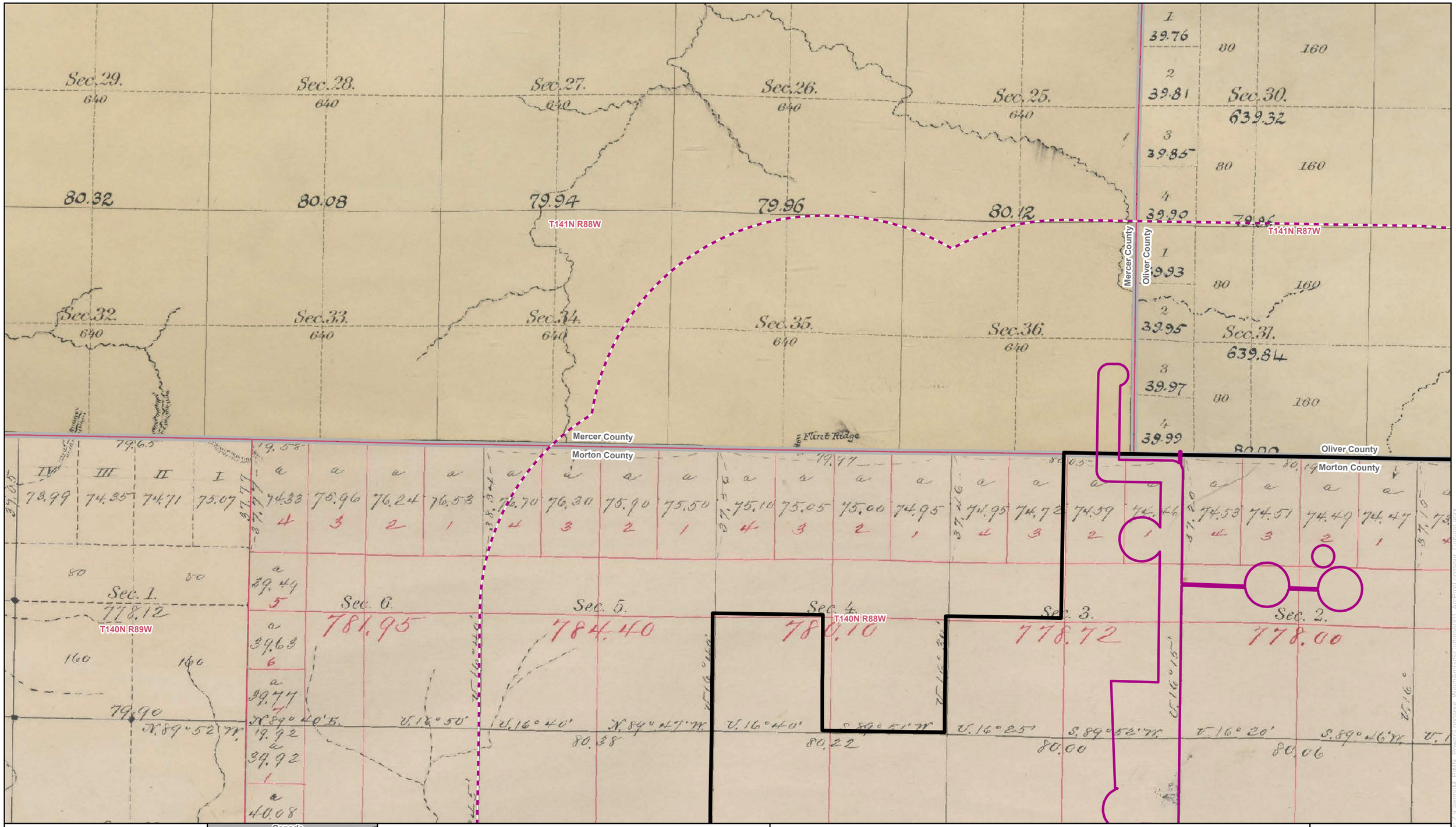
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APPENDIX A

Figures



For Environmental Review Purposes Only

Figure 2.1: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Mercer, Morton, and Oliver Counties, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Oliver County
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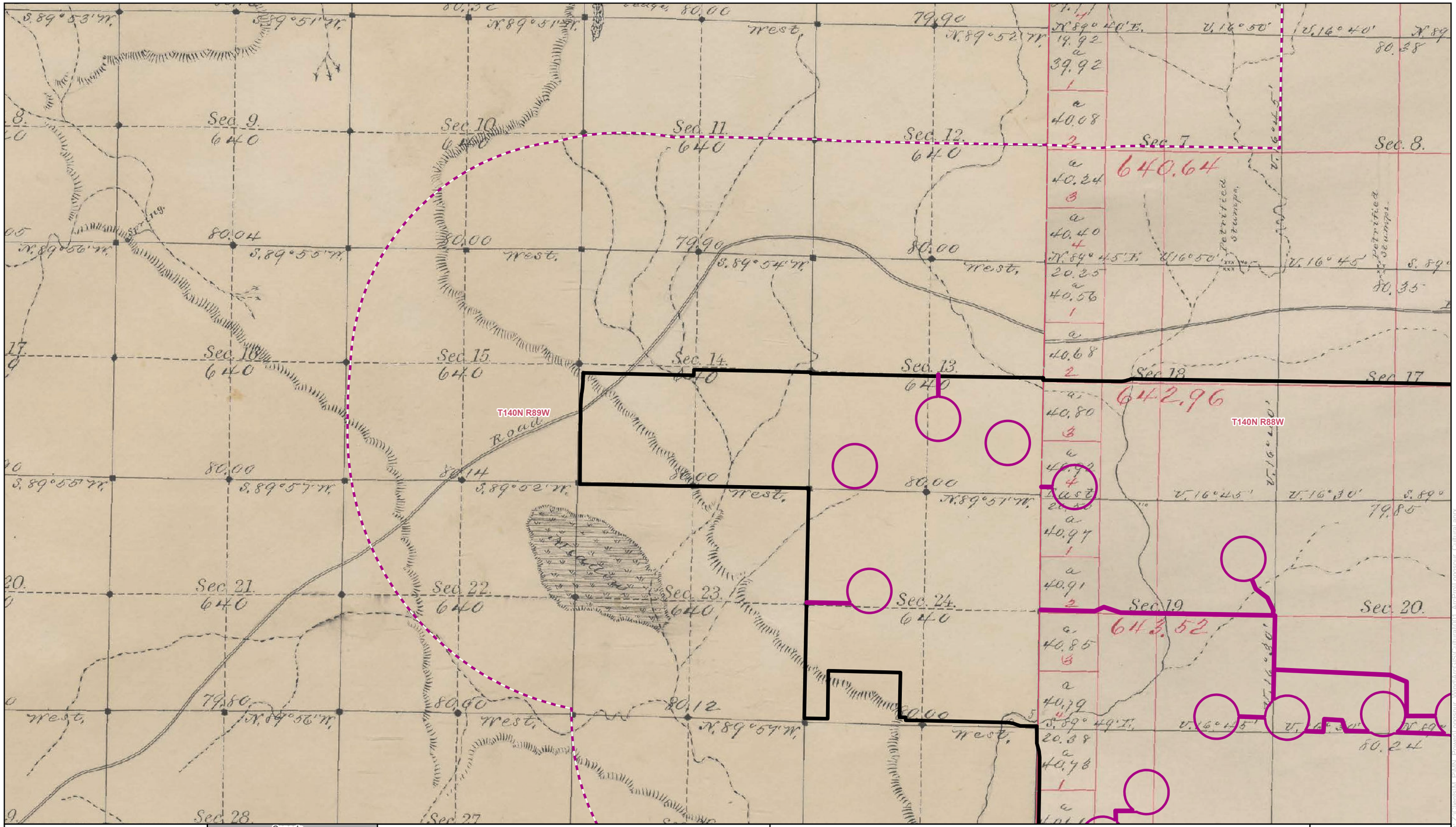
Figure 2.2: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton and Oliver Counties, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Figure 2.3: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

- Project Area
- One-Mile Buffer
- Project Boundary
- Township Boundary
- County Boundary

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For Environmental Review Purposes Only

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Figure 2.4: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Figure 2.5: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Figure 2.6: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

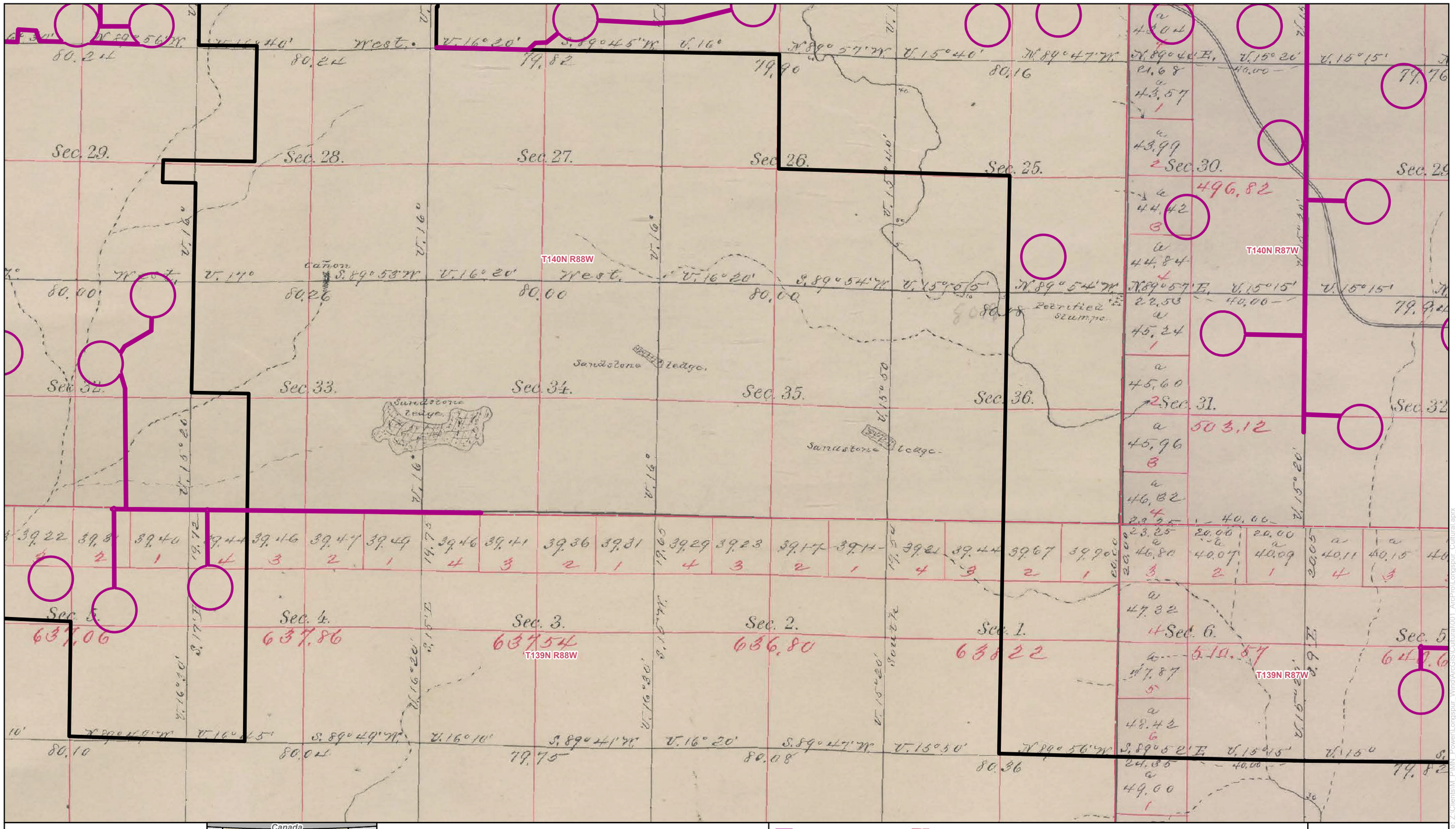
Project Area
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Project Boundary
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Figure 2.7: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Figure 2.8: 1880-1883 GLO Map

Minnesota Power
Longspur Wind Project
Morton County, North Dakota

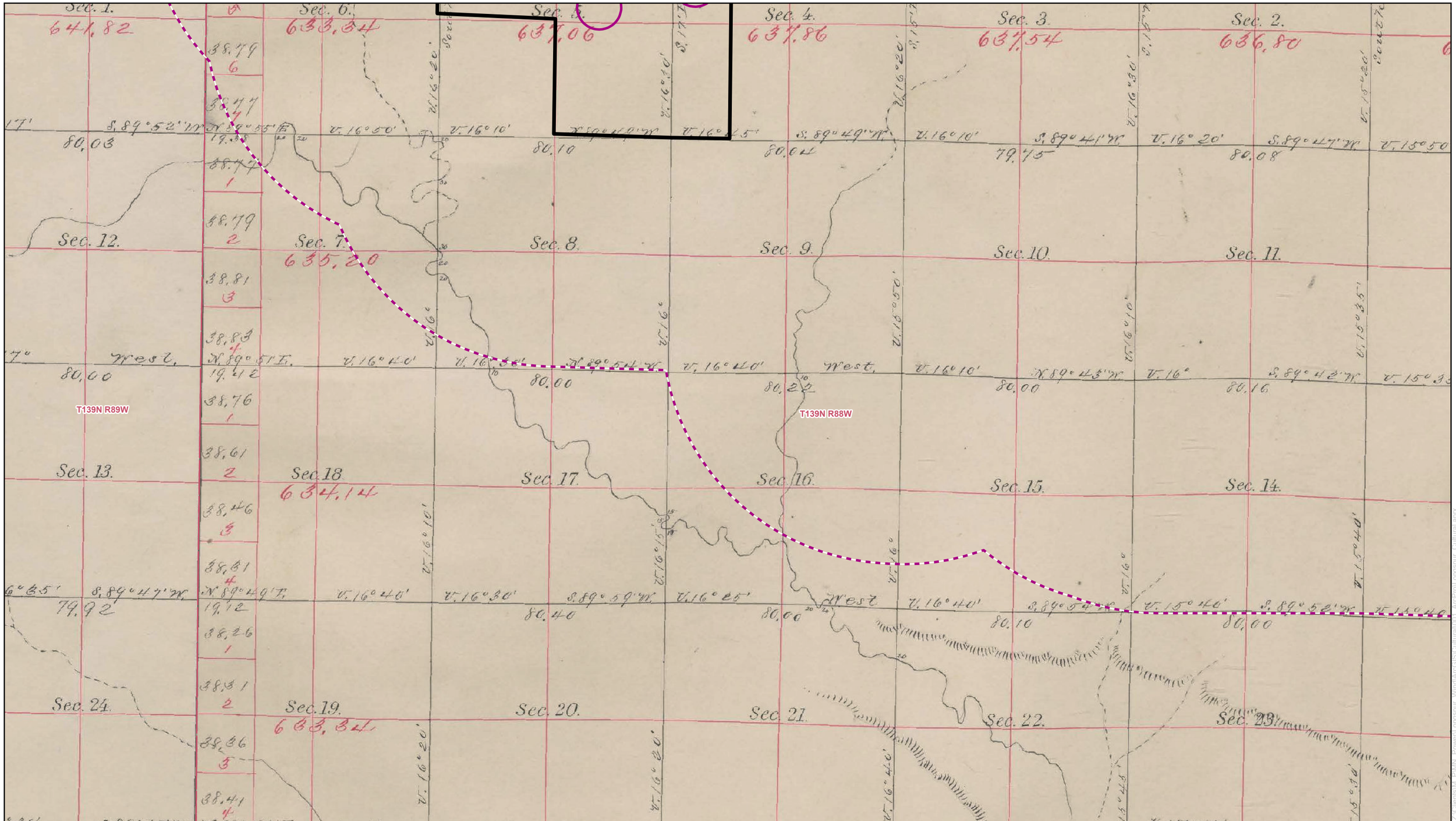
Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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Figure 2.9: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

- Project Area
- One-Mile Buffer
- Project Boundary
- Township Boundary
- County Boundary

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For Environmental Review Purposes Only



Figure 2.10: 1880-1883 GLO Map
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Township Boundary
County Boundary

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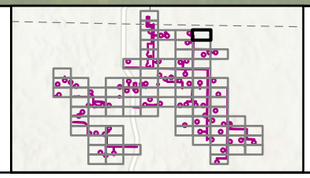


Figure 3.6: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
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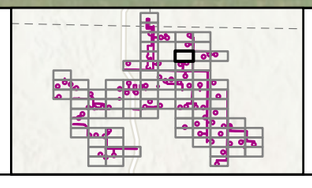


Figure 3.11: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Figure 3.13: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

- Project Area
- One-Mile Buffer
- Project Boundary
- Proposed Turbine
- Section Boundary

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Figure 3.18: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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For Environmental Review Purposes Only



Figure 3.19: Survey Results

Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Previous Survey
Section Boundary

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Date: 10/7/2025

T140N, R87W, Sec. 7

T140N, R87W, Sec. 8

59th Ave

60th Ave

T140N, R87W, Sec. 18

T140N, R87W, Sec. 17

016512

0 150 300 Feet

1:3,600

N

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For Environmental Review Purposes Only

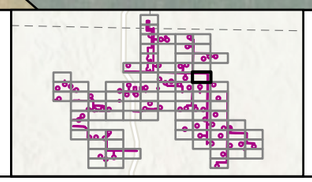


Figure 3.23: Survey Results

Minnesota Power
Longspur Wind Project
Morton County, North Dakota

- Project Area
- One-Mile Buffer
- Project Boundary
- Previous Survey
- Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx

Date: (8/7/2025)



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For Environmental Review Purposes Only

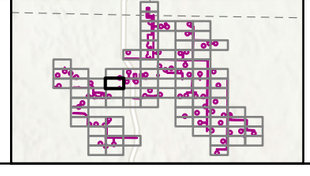


Figure 3.36: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

merjent

Contains Privileged Information
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Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\Arc\GIS\Cultural\007_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)



0 150 300 Feet
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For Environmental Review Purposes Only

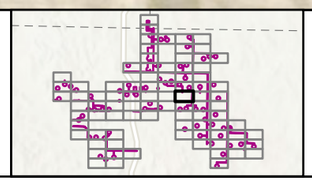


Figure 3.39: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

- Project Area
- One-Mile Buffer
- Project Boundary
- Previous Survey
- Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx

Date: 10/7/2025

T140N, R87W, Sec. 18

016512

33rd St

015938

T140N, R87W, Sec. 17

014976

59th Ave

T140N, R87W, Sec. 19

T140N, R87W, Sec. 20

0 150 300 Feet

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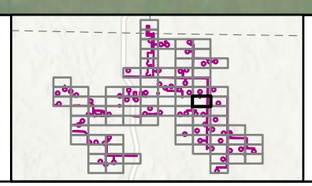


Figure 3.40: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Previous Survey
Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\007_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)

T140N, R88W, Sec. 19

T140N, R88W, Sec. 20

T140N, R88W, Sec. 30

T140N, R88W, Sec. 29

0 150 300 Feet

1:3,600

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For Environmental Review Purposes Only

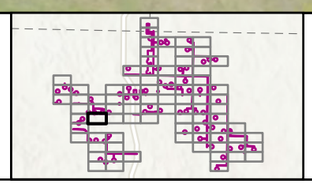


Figure 3.51: Survey Results

Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx

Date: (8/7/2025)



0 150 300 Feet

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For Environmental Review Purposes Only

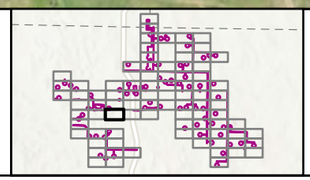


Figure 3.52: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)

T140N, R88W, Sec. 21

T140N, R88W, Sec. 22

State Hwy 49

006880

T140N, R88W, Sec. 28

016476

T140N, R88W, Sec. 27

0 150 300 Feet

1:3,600

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For Environmental Review Purposes Only

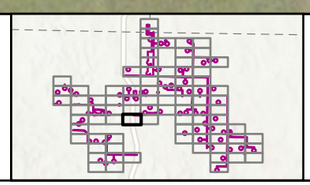


Figure 3.53: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Previous Survey
Section Boundary

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Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)

T140N, R88W, Sec. 22

T140N, R88W, Sec. 23

T140N, R88W, Sec. 27

T140N, R88W, Sec. 26

0 150 300 Feet

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For Environmental Review Purposes Only

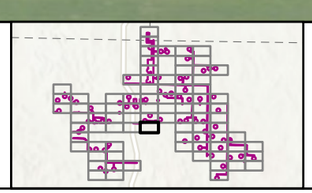


Figure 3.54: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Contains Privileged Information
Do Not Distribute

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Date: (8/7/2025)

T140N, R88W, Sec. 24

T140N, R87W, Sec. 19

T140N, R88W, Sec. 25

T140N, R87W, Sec. 30

0 150 300 Feet

1:3,600

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For Environmental Review Purposes Only

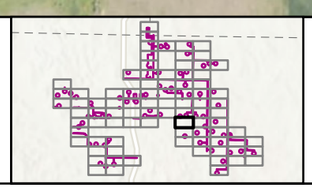


Figure 3.55: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Contains Privileged Information
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Date: (8/7/2025)

T140N, R89W, Sec. 25

T140N, R88W, Sec. 30

T140N, R89W, Sec. 36

66th Ave

T140N, R88W, Sec. 31

0 150 300 Feet

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For Environmental Review Purposes Only

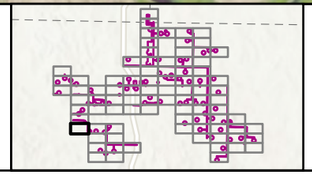


Figure 3.63: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx

Date: (8/7/2025)

T140N, R87W, Sec. 28

T140N, R87W, Sec. 27

35th St

016512

T140N, R87W, Sec. 33

57th Ave

015938

T140N, R87W, Sec. 34

0 150 300 Feet

1:3,600

N W E S

For Environmental Review Purposes Only

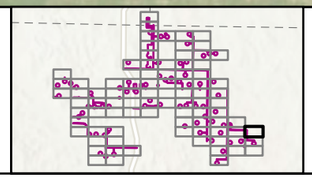


Figure 3.70: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Previous Survey
Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

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Date: (8/7/2025)



0 150 300 Feet
1:3,600

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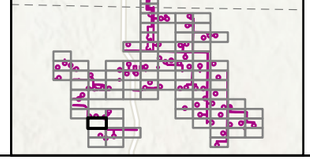


Figure 3.71: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

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Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\01_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)



0 150 300 Feet
1:3,600

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For Environmental Review Purposes Only

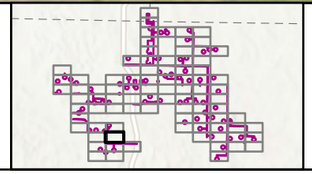


Figure 3.72: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_PWN_PowerLongspur_WindArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)

T140N,
R87W,
Sec. 31

T140N,
R87W,
Sec. 32

0 150 300 Feet
1:3,600

N
W E
S

For Environmental Review Purposes Only

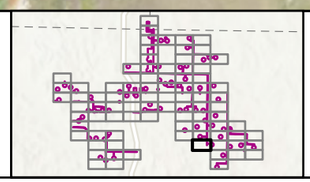


Figure 3.73: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

merjent

Contains Privileged Information
Do Not Distribute

Source: Z:\Clients\M_P\MN_PowerLongspur_Wind\ArcGIS\Cultural\001_ArcPro\Longspur_Cultural.aprx
Date: (8/7/2025)

T140N,
R88W,
Sec. 33

T140N,
R88W,
Sec. 34

36th St

State Hwy 49

006880

T139N,
R88W,
Sec. 4

T139N,
R88W,
Sec. 3

0 150 300 Feet
1:3,600

N
W E
S

For Environmental Review Purposes Only

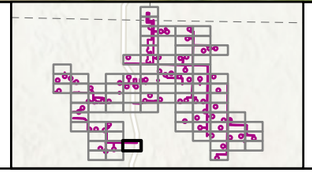


Figure 3.79: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Previous Survey
Section Boundary

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Date: 10/7/2025

T140N,
R87W,
Sec. 33

T139N,
R87W,
Sec. 4

0 150 300 Feet
1:3,600

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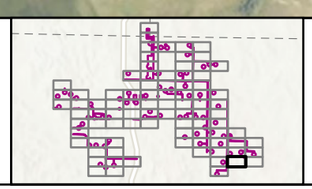


Figure 3.81: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Section Boundary

merjent

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Do Not Distribute

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Date: (8/7/2025)



0 150 300 Feet

1:3,600

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For Environmental Review Purposes Only

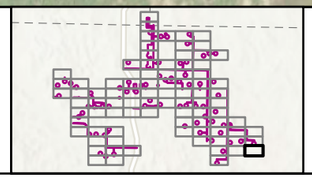


Figure 3.82: Survey Results
Minnesota Power
Longspur Wind Project
Morton County, North Dakota

Project Area
One-Mile Buffer
Project Boundary
Previous Survey
Section Boundary

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Date: (8/7/2025)

APPENDIX B

Site Forms (Detached)

minnesota power

AN ALLETE COMPANY

Attachment D

Noxious Weed Management Plan and County Communication

P: 218.722.2625 | W: www.mnpower.com
30 West Superior Street | Duluth, MN 55802

Weed Management Plan
Longspur Wind Project
Morton and Mercer Counties, North Dakota

Prepared for:

Minnesota Power

30 West Superior Street
Duluth, Minnesota 55802

Prepared by:

Western EcoSystems Technology, Inc.

4007 State Street, Suite 109
Bismarck, North Dakota

January 8, 2026



Confidential Business Information

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Michael Van Laeken	Senior Reviewer
Carla DeMasters	Technical Reviewer
Andy Valencia	Technical Editor

REPORT REFERENCE

Western EcoSystems Technology, Inc. (WEST). 2026. Weed Management Plan, Longspur Wind Project, Morton and Mercer Counties, North Dakota. Prepared for Minnesota Power, Duluth, Minnesota. Prepared by WEST, Bismarck, North Dakota. January 8, 2026.

TABLE OF CONTENTS

1 INTRODUCTION 1
2 PROJECT DESCRIPTION 1
3 STATE AND LOCAL REGULATIONS 4
4 WEED MANAGEMENT 4
4.1 General Weed Management Practices 8
4.2 Post-construction Noxious Weed Monitoring 9
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1 INTRODUCTION

Minnesota Power is considering the development of the Longspur Wind Project (Project) in Morton County, North Dakota (Figure 1) with additional transmission line development in Mercer County. At the request of Minnesota Power, Western EcoSystems Technology, Inc. (WEST), prepared the following Weed Management Plan (Plan) as part of the conditions of the Wildlife Conservation Strategy, to provide guidance for preventing and controlling the spread of state- and/or county-listed noxious weeds on lands owned, leased, and managed by the Project, while complying with state and local noxious weed management regulations, as applicable.

Noxious weeds are spread by a variety of means including vehicles, construction equipment, livestock, and wildlife. Physical disturbance and chemical alterations of the soil create opportunities for the introduction, infestation, and spread of noxious weeds. Implementation of preventative measures is the most cost-effective management approach to control the spread of noxious weeds. This Plan has been developed using information and guidance from several State resources, as well as existing noxious weed management plans and experience gained from other noxious weed control programs in Wyoming, Colorado, South Dakota, and North Dakota. Monitoring and treatment of weeds both prior to construction and during the operational phase, as applicable, will ensure that goals to achieve the Project's vegetation performance standards by reducing and controlling weeds. Noxious weed control measures will be established during Project development, implemented during construction and operation of the Project, and refined through adaptive management.

2 PROJECT DESCRIPTION

The Project is anticipated to consist of 45 4.5-megawatt (MW) turbines, with a nameplate generation capacity of approximately 202.5 MW, and a planned commercial operation date of 2027. Additional infrastructure at the Project will include 19.5 miles (mi) of new access roads, 52.1 mi of underground electrical collector lines and cables, 5.1 acres (ac) of facility substations, an interconnection substation, a 2.7-mi 230-kilovolt transmission line interconnecting to the Tri County Substation, one permanent meteorological tower, and one operations and maintenance facility.

The Project Area encompasses 25,933 ac in southwestern North Dakota, approximately four mi north of Glen Ullin in Morton County, along with the transmission line that extends north of the Project Area approximately 0.3 mi into Mercer County (Figure 1). This Plan applies to all areas of the Project footprint that are anticipated or have been disturbed with the focus being weed management.

The Project Area is within the Missouri Plateau Level IV Ecoregion, which consists of semi-arid rolling plains punctuated by buttes and badlands (US Environmental Protection Agency [USEPA] 2012, 2013). The Missouri Plateau Ecoregion's rolling to somewhat flat topography was mostly unaffected by glaciation, with natural vegetation primarily consisting of semiarid grasses, including western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), blue grama (*Bouteloua gracilis*), and buffalograss (*B. dactyloides*; Bryce et al. 1998). Although large areas of the Missouri Plateau Ecoregion have been converted to agricultural crop production, areas of unbroken native grasslands remain, which are typically used for livestock grazing (USEPA 2012, 2013).

Topography within the Project Area is gently rolling to flat (USA Topo 2021). Cultivated crops and grassland/herbaceous make up approximately 89% of the Project Area (National Land Cover Database [NLCD] 2024). Shrub/scrub, hay/pasture, developed land cover types make up approximately 10% of the Project Area; wooded areas and wetlands compose the remainder cover within the Project Area (NLCD 2024).

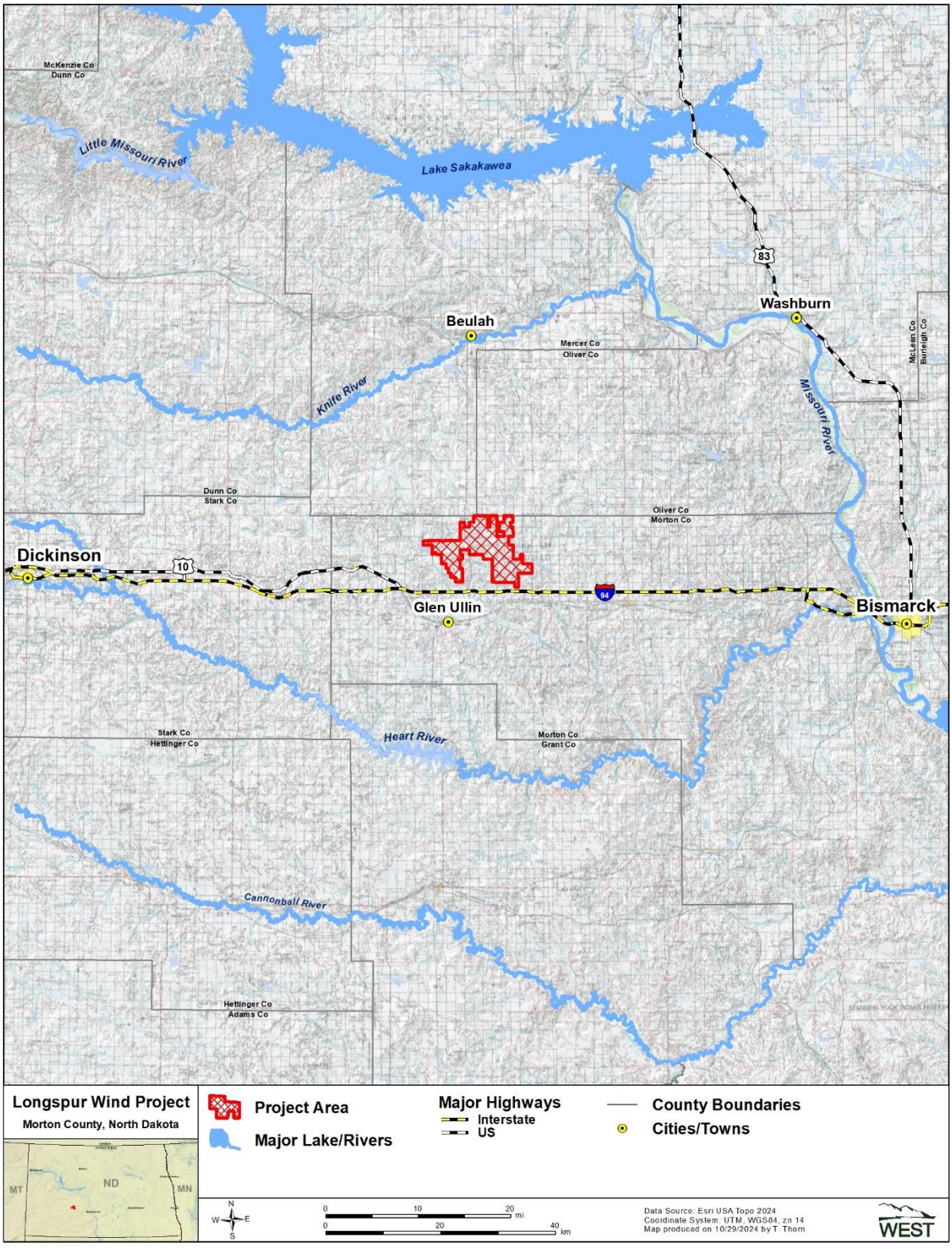


Figure 1. Location of the Longspur Wind Project Area in Morton County, North Dakota.

3 STATE AND LOCAL REGULATIONS

North Dakota Century Code (NDCC) §4.1-47, *Noxious Weed Control*, defines noxious weed as "*a plant propagated by either seed or vegetative parts and determined to be injurious to public health, crops, livestock, land, or other property*" by the North Dakota Agriculture Commissioner or by a county or city weed board (NDCC §4.1-47-01). The North Dakota Department of Agriculture (NDDA) also identifies the following 13 species as state-declared noxious weeds: absinth wormwood (*Artemisia absinthium*), Canada thistle (*Cirsium arvense*), dalmatian toadflax (*Linaria genistifolia* subsp*. dalmatica*), diffuse knapweed (*Centaurea diffusa*), houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), musk thistle (*Carduus nutans*), Palmer amaranth (*Amaranthus palmeri*), purple loosestrife (*Lythrum salicaria and L. virgatum*), Russian knapweed (*C. repens*), saltcedar (*Tamarisk* spp.), spotted knapweed (*C. maculosa*), and yellow toadflax (*Linaria vulgaris*; NDDA 2021).

Under North Dakota law (NDCC §4.1-47-02) every person is required to "*do all things necessary and proper to control the spread of noxious weeds*" and the NDDA coordinates with county and city weed boards for weed control programs (NDDA 2021). State law also allows counties and cities to adopt additional noxious weed species if they are approved through the statutory process. Morton and Mercer counties maintain active county weed boards responsible for implementing and enforcing the state noxious weed law but based on the most recent *County and City Listed Noxious Weed* (NDDA 2023), neither county has adopted any additional noxious weed species beyond the 13 species designated at the state level. Morton County incorporates noxious weed control into its zoning requirements, including a provision that noxious weeds on certain properties must be maintained at a maximum of 10 inches high; Mercer County does not have expanded ordinances beyond state requirements.

4 WEED MANAGEMENT

Noxious Weed field surveys for the Project have not been conducted; however, any of the 13 state-listed noxious weed species have the potential to be present within the Project Area and, therefore, are included in this Plan. Characteristics relevant for control and treatment options for each of these 13 noxious weeds are presented in Table 1; species characteristics and recommendations are based on information from *Invasive and Troublesome Weeds in North Dakota* (North Dakota State University [NDSU] and NDDA 2023), supplemented when applicable by the *North Dakota Weed Control Guide* (NDSU and NDDA 2025).

Herbicides should be used only in accordance with their registered use and shall be used or applied only by appropriately certified applicators according to federal and state laws and regulations. The treatment recommendations presented in Table 1 are not the direct recommendations of WEST but are based on information from sources including NDSU and NDDA.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Absinth wormwood	*Artemisia absinthium*	IPF	CH, MD	• Apply herbicides when plants are at least 10 inches tall and actively growing. • Herbicides can be used in fall, but plants should be mowed in early to mid-summer first to promote active regrowth before using herbicide. • The following herbicides are effective for controlling this species: clopyralid, dicamba, aminopyralid, 2,4-D, picloram, and glyphosate. • Small infestations can be controlled by digging up plants.
Canada thistle	*Cirsium arvense*	IPF	CH, MD, MM, BI, CU	• The following herbicides are effective for controlling this species: glyphosate, clopyralid, picloram, dicamba, aminocyclopyrachlor, and aminopyralid. Herbicide application in the early bud growth stage (early summer) or to rosettes in the fall is most effective. Multiple years of treatment are recommended for control of this species. • Cultivation in winter when temperatures are below 20 degrees Fahrenheit can be effective. Cultivate before plants are three inches tall and repeat after regrowth is less than three inches before the soil freezes. • Repeated mowing can be effective at controlling this species. Mow several times per year before plants flower and as close to the ground as possible. Mowing for multiple years is recommended, along with following up with an herbicide application. • There are biological control agents available for this species, but none of them are effective at reducing infestations on a large scale.
Dalmatian toadflax	*Linaria genistifolia* subsp. *dalmatica*	IPF	CH, BI	• The following herbicides are effective for controlling this species when applied during flowering or late fall: picloram, imazapic, and chlorsulfuron. • Maintain proper livestock stocking rates and do not overgraze to maintain competitive forage and reduce the spread of this species. • Two biological control insects have been successful at reducing infestations of this species.
Diffuse knapweed	*Centaurea diffusa*	IPF	MD, CH, BI	• Small infestations can be controlled by hand pulling (wear gloves) or by digging. • Effective herbicides include: aminopyralid, picloram, and dicamba. • Treat an additional area 10–15 feet around knapweed patches to control missed seedlings. • Follow up treatments are essential for successful eradication. • There are several biological control agents permitted for use on knapweed species and consultation with the North Dakota Department of Agriculture is recommended.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Houndstongue	*Cynoglossum officinale*	BF	CH, MD	• Products containing the active ingredient metsulfuron can be applied throughout the growing season. First-year plants can be treated with 2,4-D from late May to mid-June. Imazapic at high rates can be used for pre- and post-emergent treatments. • A root weevil has been released for control in Canada but has not been approved for release in the United States. • Small infestations can be controlled by digging up plants.
Leafy spurge	*Euphorbia esula*	IPF	CH, BG, BI, MM	• A combination of control methods is most effective for managing this plant. • Mowing or grazing followed by herbicide treatment can be effective at controlling this species • The following herbicides are effective for controlling this species: dicamba, quinclorac, aminocyclopyrachlor, and picloram. There are several herbicide combinations that have also shown effective control. • Glyphosate can be effective when applied after seed-filling in mid-summer or after fall regrowth but before a killing frost. • Grazing with sheep or goats can control top growth in pasture and rangeland areas; however, grazing alone will not eradicate this species. • Many species of biological control are available for this species, and six species are established within North Dakota.
Musk thistle	*Carduus nutans*	BF	CH, MM, BI	• Controlling plants prior to flowering is essential for successful management of this species. • Apply the following herbicides to rosettes in fall or spring for best results: aminopyralid, clopyralid, picloram, aminocyclopyrachlor, or dicamba. Metsulfuron is effective when applied in spring and can be applied when plants are bolting or budding. • Mowing can be effective if done repeatedly before plants are flowering. • There are two biological control insects and one rust fungus that provide control of this species; however, interstate transport of the insect species is not permitted.
Palmer amaranth	*Amaranthus palmeri*	IAF(W)	MP, CH	• This species is resistant to multiple classes of herbicides and modes of action. • Use preemergent herbicide. • The following herbicides are effective for controlling this species applied when growth reaches 2–3 inches in height: 2,4-D, atrazine, chloroacetamide, dicamba, diphenylethers, glufosinate, and glyphosate. • Pulling plants can also be effective if the infestation is small. • Mowing is not recommended.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Purple loosestrife	*Lythrum salicaria, Lythrum virgatum,* and all cultivars	IPF	MD, CH, BI	• Small infestations and younger plants can be controlled by digging up plants. • If plants are in or near water, use herbicides approved and labeled for aquatic use. • Apply glyphosate from July-September. • Triclopyr, aminopyralid and a combination of triclopyr and aminopyralid also provide effective control of this species. • There are three biological control insects that are effective at controlling purple loosestrife.
Russian knapweed	*Centaurea repens*	IPF	CH, BI	• Apply picloram following several hard frosts (mid-October). Application in mid-September or during flowering in midsummer provides shorter-term control than late applications. • Metsulfuron and aminopyralid are also effective. • Mowing and cultivation are not recommended. • There are two biological control insects available for control of Russian knapweed.
Saltcedar	*Tamarisk* spp.	T/B	CH	• Imazapyr is the most widely used herbicide for this species. Imazapyr can also be used in combination with glyphosate. Triclopyr applied in spring or late fall is also effective. • If plants are in or near water, use herbicides approved and labeled for aquatic use. • Do not remove top growth for three years following herbicide application to prevent resprouting. • Biological control of this species is not recommended in North Dakota.
Spotted knapweed	*Centaurea maculosa*	IPF	See diffuse knapweed	See diffuse knapweed.
Yellow toadflax	*Linaria vulgaris*	IPF	Not Applicable	• The following herbicides are effective for controlling this species: metsulfuron-methyl and picloram. • Planting competitive vegetation can help stop yellow toadflax from spreading in grazing lands. • Biological controls have not been effective in North Dakota.

[1] IAF(W) = introduced warm season annual forb; N/IPF = native/introduced perennial forb; BF = biennial forb; T/B = tree/bush.

[2] Mechanical methods: MM = Mowing; MP = Pulling; MC = Cutting; MD = Digging/Tilling.
Biological methods: BI = Insects; BG = Grazing Animals.
Chemical methods: CH = Herbicides.
Cultural methods: CU = Cultivate (uprooting young weeds and incorporating them into the soil).

* The North Dakota Department of Agriculture identifies the 13 species listed in this table as state-declared noxious weeds.

Source: North Dakota State University and North Dakota Department of Agriculture (2023, 2025), Agri Care Hub 2025.

4.1 General Weed Management Practices

Weed management is a long-term iterative process that considers site-specific physical, biological, and land use characteristics. Weed management must be accomplished through several integrated practices that include prevention, monitoring, and treatment to address noxious weed incidence, occurrence, and control (DiTomaso et al. 2013). The following best management practices are recommended to limit opportunities for weeds to enter the Project, get established, and/or spread during Project construction and operation:

- Follow all label instructions for recommended grazing practices following vegetation treatment and application of any herbicide.
- Delineate a "baseline" of large noxious weed infestations within construction areas that will need to be treated prior to disturbance.
- Minimize soil disturbance as much as possible and revegetate disturbed areas when possible.
- Excavations, placement of fill soil, or other areas of surface disturbance will be revegetated with appropriate site seed mix within 14 days of completion of the disturbance.
- Avoid driving through or over any untreated and marked noxious weed areas.
- Avoid noxious plant areas until after treated with the appropriate herbicides.
- A weed-resistant seed mix for restoration of temporarily disturbed areas consisting of a combination of competitive native grass and forb species (including pollinator plant species) will be used, to the extent possible.
- Soil from areas with noxious weed populations will not be removed or introduced to the construction site, to avoid transport of weed seeds or other propagules.
- All seed, soil, and mulch imported onto the Project site will be certified as weed-free.
- Preferentially salvage topsoil only for locations dominated by native vegetation; avoid known noxious weed infestation areas when salvaging topsoil to the maximum extent practicable.
- Store salvaged topsoil in a manner to discourage weed establishment, (e.g., by covering, mulching, or stabilizing with weed-free seed).
- Where practicable, use locally sourced topsoil if additional topsoil is needed.
- Train on site staff to identify noxious weed species for successful long-term vegetation management.
- Discourage weed establishment during construction through regular site inspections and targeted herbicide application as needed.
- Herbicide application will be by qualified applicators using approved herbicides.
- Herbicide applications will follow all instructions on the label including application rates and preparation and application requirements.

- Minnesota Power will require its contractors to:
    - Inspect vehicles and equipment undercarriages and tires for mud, dirt, plant materials, and seeds before entering work areas.
    - If vehicle or equipment is not clean, it must be cleaned with high-pressure washer equipment before entering the Project.
    - Use only designated cleaning station locations or commercial car wash facilities.
    - Soil from areas with noxious weed populations will not be removed or introduced to the construction site, to avoid transport of weed seeds or other propagules.
    - Where practicable, avoid or minimize travel through or parking in areas infested with noxious weeds to avoid spreading seeds or plant parts.

Minnesota Power will provide training to its contractors to maintain compliance with the weed management plan.

4.2 Post-construction Noxious Weed Monitoring

Monitoring noxious weed populations in impacted areas within the Project Area for up to three years post-construction is recommended to compare baseline and post-construction weed populations. A memorandum, reporting management actions and monitoring results, should be prepared each year when surveys occur and adaptive management implemented as necessary to control noxious weeds. Additional noxious weed treatment and monitoring may be required if eradication of noxious weeds is not successful. Consultation with Morton and Mercer counties weed boards are being performed to determine appropriate noxious weed control measures.

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Alex Luman (MP)

From: Cody Schnabel <cody.schnabel@mortonnd.gov>
Sent: Tuesday, January 20, 2026 11:45 AM
To: Alex Luman (MP)
Subject: [EXTERNAL MAIL] RE: Minnesota Power Longspur Wind Noxious Weed Management Plan Review



[EXTERNAL EMAIL] This email was sent from someone outside the company.

It may be cold out, but cyber-attacks don't slow down! Remember to freeze, think twice, and never click links, download attachments, or reply with personal information unless you recognize the sender and know the content is safe.

Hi Alex,
I have reviewed the plan, and it looks pretty good so far. It lays out that the weeds will be monitored, and how to control each one of them, but I didn't see if it specifies who will be enforcing the policy, who will be doing the monitoring or who will be making herbicide applications where they are needed. A statement could be added for each of these steps such as, "When noxious weeds are discovered in the project area, a certified applicator / contractor will be hired to make herbicide applications."

Thanks.

CODY SCHNABEL
MORTON COUNTY WEED CONTROL OFFICER & PARKS DIRECTOR
2916 37th St NW, Mandan, ND 58554
Cody.Schnabel@mortonnd.gov
701.391.8006
www.mortonnd.gov

From: Alex Luman (MP) <aluman@mnpower.com>
Sent: Monday, January 19, 2026 3:32 PM
To: Cody Schnabel <cody.schnabel@mortonnd.gov>
Subject: Minnesota Power Longspur Wind Noxious Weed Management Plan Review

Hello Cody,

My name is Alex Luman I am with Minnesota Power on the Longspur Wind Project in Morton County. I'm following up on the voicemail I left on January 8.

I've attached our draft Noxious Weed Management Plan, Minnesota Power would like to ensure that its plan for controlling noxious weeds aligns with Morton County's goals and expectations. If you could review the plan and provide any feedback, that would be greatly appreciated.

Please let me know if you have any additional questions.

Thank you,
Alexander Luman
Environmental Compliance Specialist
ALLETE Inc. 30 West Superior Street
Duluth, MN 55802
Cell 218-481-2796

minnesota power

AN ALLETE COMPANY

AFFIDAVIT OF MAILING

State of Minnesota)

) SS.

County of St. Louis)

I, Alexander Luman, Herby certify that on the 16th day of January 2026, I directed to be sent Via U.S. Mail a true and correct copy of the Noxious Weed Management Plan for the Longspur Project attached hereto as Exhibit 1 to the Mercer County Weed Control Officer.

Alexander Luman
ALLETE/Minnesota Power

Subscribed and sworn to before me
this 16th day of January 2026.

,Notary Public

DONNALEE LINDA BRAATEN
NOTARY PUBLIC - MINNESOTA
MY COMMISSION EXPIRES 01/31/29

P: 218.722.2625 | W: www.mnpower.com
30 West Superior Street | Duluth, MN 55802

Exhibit 1

minnesota power
AN ALLETE COMPANY

January 15, 2025

Brad Seifert
Weed Control Officer
Mercer County
PO Box 550
Beulah, ND 58523

Hello Brad,

Minnesota Power respectfully submits the attached Noxious Weed Management Plan for Mercer County's review. Minnesota Power is proposing to construct an approximately 0.3-mile-long, 230-kilovolt Transmission Infrastructure Project (Project) within Mercer County. The entire transmission Line is approximately 2.7 miles. The Project will begin at the existing Tri County 230 kV Substation in Mercer County and extend south into Morton County.

The portion of the Project within Mercer County is located entirely on Minnesota Power property, except for the overhead road crossing.

Minnesota Power would like to ensure that its plan for controlling noxious weeds aligns with Mercer County's goals and expectations. Please review the attached plan for additional details.

Please let me know if you have any questions at aluman@mnpower.com or 218.481.2796

Thank you,

Alexander Luman
Environmental Compliance Specialist
ALLETE/Minnesota Power
30 W Superior St
Duluth, MN 55802

Attachments
Noxious Weed Management Plan

Weed Management Plan
Longspur Wind Project
Morton and Mercer Counties, North Dakota

Prepared for:

Minnesota Power

30 West Superior Street
Duluth, Minnesota 55802

Prepared by:

Western EcoSystems Technology, Inc.

4007 State Street, Suite 109
Bismarck, North Dakota

January 8, 2026



Confidential Business Information

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Carla DeMasters	Technical Reviewer
Andy Valencia	Technical Editor

REPORT REFERENCE

Western EcoSystems Technology, Inc. (WEST). 2026. Weed Management Plan, Longspur Wind Project, Morton and Mercer Counties, North Dakota. Prepared for Minnesota Power, Duluth, Minnesota. Prepared by WEST, Bismarck, North Dakota. January 8, 2026.

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1 INTRODUCTION

Minnesota Power is considering the development of the Longspur Wind Project (Project) in Morton County, North Dakota (Figure 1) with additional transmission line development in Mercer County. At the request of Minnesota Power, Western EcoSystems Technology, Inc. (WEST), prepared the following Weed Management Plan (Plan) as part of the conditions of the Wildlife Conservation Strategy, to provide guidance for preventing and controlling the spread of state- and/or county-listed noxious weeds on lands owned, leased, and managed by the Project, while complying with state and local noxious weed management regulations, as applicable.

Noxious weeds are spread by a variety of means including vehicles, construction equipment, livestock, and wildlife. Physical disturbance and chemical alterations of the soil create opportunities for the introduction, infestation, and spread of noxious weeds. Implementation of preventative measures is the most cost-effective management approach to control the spread of noxious weeds. This Plan has been developed using information and guidance from several State resources, as well as existing noxious weed management plans and experience gained from other noxious weed control programs in Wyoming, Colorado, South Dakota, and North Dakota. Monitoring and treatment of weeds both prior to construction and during the operational phase, as applicable, will ensure that goals to achieve the Project's vegetation performance standards by reducing and controlling weeds. Noxious weed control measures will be established during Project development, implemented during construction and operation of the Project, and refined through adaptive management.

2 PROJECT DESCRIPTION

The Project is anticipated to consist of 45 4.5-megawatt (MW) turbines, with a nameplate generation capacity of approximately 202.5 MW, and a planned commercial operation date of 2027. Additional infrastructure at the Project will include 19.5 miles (mi) of new access roads, 52.1 mi of underground electrical collector lines and cables, 5.1 acres (ac) of facility substations, an interconnection substation, a 2.7-mi 230-kilovolt transmission line interconnecting to the Tri County Substation, one permanent meteorological tower, and one operations and maintenance facility.

The Project Area encompasses 25,933 ac in southwestern North Dakota, approximately four mi north of Glen Ullin in Morton County, along with the transmission line that extends north of the Project Area approximately 0.3 mi into Mercer County (Figure 1). This Plan applies to all areas of the Project footprint that are anticipated or have been disturbed with the focus being weed management.

The Project Area is within the Missouri Plateau Level IV Ecoregion, which consists of semi-arid rolling plains punctuated by buttes and badlands (US Environmental Protection Agency [USEPA] 2012, 2013). The Missouri Plateau Ecoregion's rolling to somewhat flat topography was mostly unaffected by glaciation, with natural vegetation primarily consisting of semiarid grasses, including western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), blue grama (*Bouteloua gracilis*), and buffalograss (*B. dactyloides*; Bryce et al. 1998). Although large areas of the Missouri Plateau Ecoregion have been converted to agricultural crop production, areas of unbroken native grasslands remain, which are typically used for livestock grazing (USEPA 2012, 2013).

Topography within the Project Area is gently rolling to flat (USA Topo 2021). Cultivated crops and grassland/herbaceous make up approximately 89% of the Project Area (National Land Cover Database [NLCD] 2024). Shrub/scrub, hay/pasture, developed land cover types make up approximately 10% of the Project Area; wooded areas and wetlands compose the remainder cover within the Project Area (NLCD 2024).

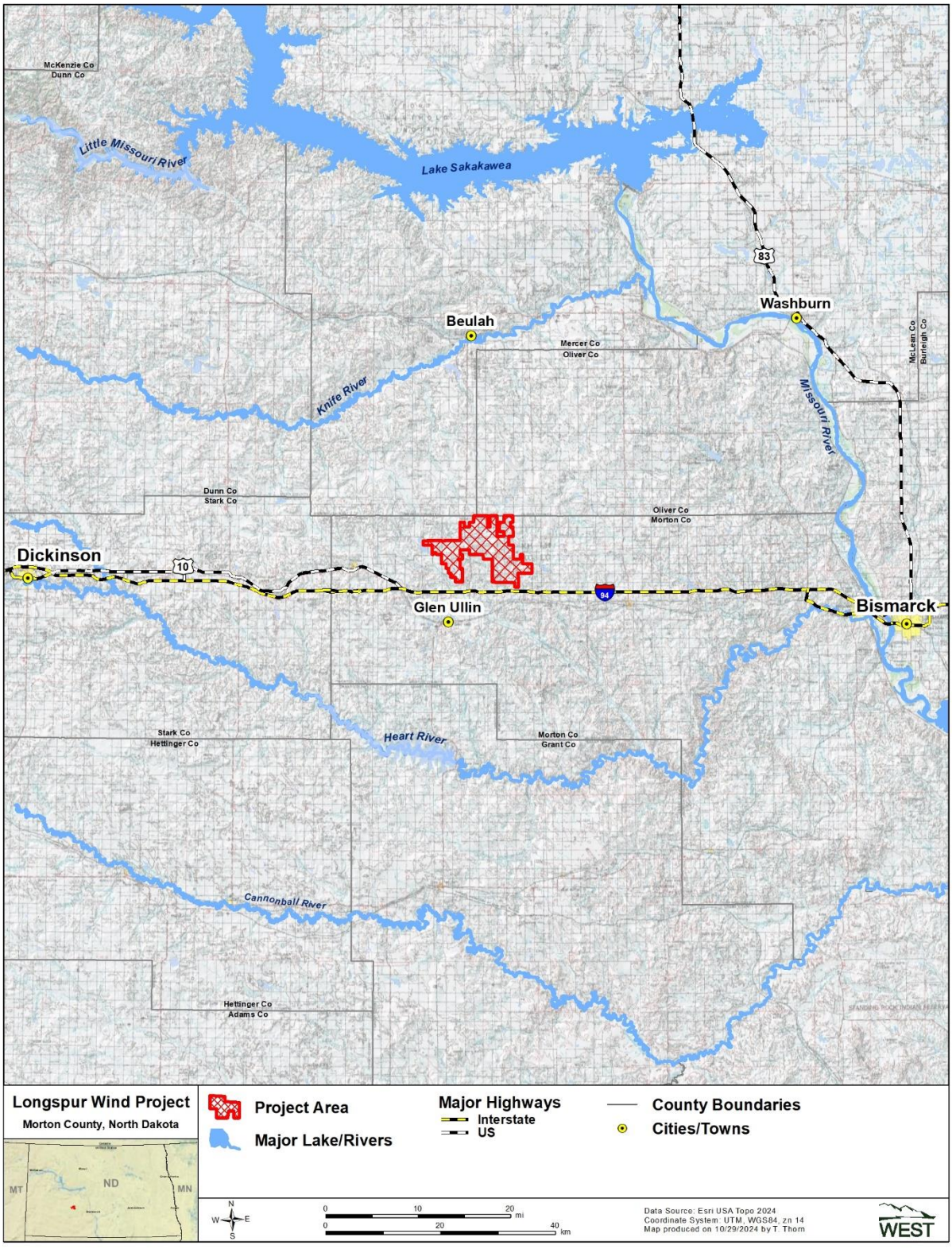


Figure 1. Location of the Longspur Wind Project Area in Morton County, North Dakota.

3 STATE AND LOCAL REGULATIONS

North Dakota Century Code (NDCC) §4.1-47, *Noxious Weed Control*, defines noxious weed as "*a plant propagated by either seed or vegetative parts and determined to be injurious to public health, crops, livestock, land, or other property*" by the North Dakota Agriculture Commissioner or by a county or city weed board (NDCC §4.1-47-01). The North Dakota Department of Agriculture (NDDA) also identifies the following 13 species as state-declared noxious weeds: absinth wormwood (*Artemisia absinthium*), Canada thistle (*Cirsium arvense*), dalmatian toadflax (*Linaria genistifolia* subsp*. dalmatica*), diffuse knapweed (*Centaurea diffusa*), houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), musk thistle (*Carduus nutans*), Palmer amaranth (*Amaranthus palmeri*), purple loosestrife (*Lythrum salicaria and L. virgatum*), Russian knapweed (*C. repens*), saltcedar (*Tamarisk* spp.), spotted knapweed (*C. maculosa*), and yellow toadflax (*Linaria vulgaris*; NDDA 2021).

Under North Dakota law (NDCC §4.1-47-02) every person is required to "*do all things necessary and proper to control the spread of noxious weeds*" and the NDDA coordinates with county and city weed boards for weed control programs (NDDA 2021). State law also allows counties and cities to adopt additional noxious weed species if they are approved through the statutory process. Morton and Mercer counties maintain active county weed boards responsible for implementing and enforcing the state noxious weed law but based on the most recent *County and City Listed Noxious Weed* (NDDA 2023), neither county has adopted any additional noxious weed species beyond the 13 species designated at the state level. Morton County incorporates noxious weed control into its zoning requirements, including a provision that noxious weeds on certain properties must be maintained at a maximum of 10 inches high; Mercer County does not have expanded ordinances beyond state requirements.

4 WEED MANAGEMENT

Noxious Weed field surveys for the Project have not been conducted; however, any of the 13 state-listed noxious weed species have the potential to be present within the Project Area and, therefore, are included in this Plan. Characteristics relevant for control and treatment options for each of these 13 noxious weeds are presented in Table 1; species characteristics and recommendations are based on information from *Invasive and Troublesome Weeds in North Dakota* (North Dakota State University [NDSU] and NDDA 2023), supplemented when applicable by the *North Dakota Weed Control Guide* (NDSU and NDDA 2025).

Herbicides should be used only in accordance with their registered use and shall be used or applied only by appropriately certified applicators according to federal and state laws and regulations. The treatment recommendations presented in Table 1 are not the direct recommendations of WEST but are based on information from sources including NDSU and NDDA.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Absinth wormwood	*Artemisia absinthium*	IPF	CH, MD	• Apply herbicides when plants are at least 10 inches tall and actively growing. • Herbicides can be used in fall, but plants should be mowed in early to mid-summer first to promote active regrowth before using herbicide. • The following herbicides are effective for controlling this species: clopyralid, dicamba, aminopyralid, 2,4-D, picloram, and glyphosate. • Small infestations can be controlled by digging up plants.
Canada thistle	*Cirsium arvense*	IPF	CH, MD, MM, BI, CU	• The following herbicides are effective for controlling this species: glyphosate, clopyralid, picloram, dicamba, aminocyclopyrachlor, and aminopyralid. Herbicide application in the early bud growth stage (early summer) or to rosettes in the fall is most effective. Multiple years of treatment are recommended for control of this species. • Cultivation in winter when temperatures are below 20 degrees Fahrenheit can be effective. Cultivate before plants are three inches tall and repeat after regrowth is less than three inches before the soil freezes. • Repeated mowing can be effective at controlling this species. Mow several times per year before plants flower and as close to the ground as possible. Mowing for multiple years is recommended, along with following up with an herbicide application. • There are biological control agents available for this species, but none of them are effective at reducing infestations on a large scale.
Dalmatian toadflax	*Linaria genistifolia* subsp. *dalmatica*	IPF	CH, BI	• The following herbicides are effective for controlling this species when applied during flowering or late fall: picloram, imazapic, and chlorsulfuron. • Maintain proper livestock stocking rates and do not overgraze to maintain competitive forage and reduce the spread of this species. • Two biological control insects have been successful at reducing infestations of this species.
Diffuse knapweed	*Centaurea diffusa*	IPF	MD, CH, BI	• Small infestations can be controlled by hand pulling (wear gloves) or by digging. • Effective herbicides include: aminopyralid, picloram, and dicamba. • Treat an additional area 10–15 feet around knapweed patches to control missed seedlings. • Follow up treatments are essential for successful eradication. • There are several biological control agents permitted for use on knapweed species and consultation with the North Dakota Department of Agriculture is recommended.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Houndstongue	*Cynoglossum officinale*	BF	CH, MD	• Products containing the active ingredient metsulfuron can be applied throughout the growing season. First-year plants can be treated with 2,4-D from late May to mid-June. Imazapic at high rates can be used for pre- and post-emergent treatments. • A root weevil has been released for control in Canada but has not been approved for release in the United States. • Small infestations can be controlled by digging up plants.
Leafy spurge	*Euphorbia esula*	IPF	CH, BG, BI, MM	• A combination of control methods is most effective for managing this plant. • Mowing or grazing followed by herbicide treatment can be effective at controlling this species • The following herbicides are effective for controlling this species: dicamba, quinclorac, aminocyclopyrachlor, and picloram. There are several herbicide combinations that have also shown effective control. • Glyphosate can be effective when applied after seed-filling in mid-summer or after fall regrowth but before a killing frost. • Grazing with sheep or goats can control top growth in pasture and rangeland areas; however, grazing alone will not eradicate this species. • Many species of biological control are available for this species, and six species are established within North Dakota.
Musk thistle	*Carduus nutans*	BF	CH, MM, BI	• Controlling plants prior to flowering is essential for successful management of this species. • Apply the following herbicides to rosettes in fall or spring for best results: aminopyralid, clopyralid, picloram, aminocyclopyrachlor, or dicamba. Metsulfuron is effective when applied in spring and can be applied when plants are bolting or budding. • Mowing can be effective if done repeatedly before plants are flowering. • There are two biological control insects and one rust fungus that provide control of this species; however, interstate transport of the insect species is not permitted.
Palmer amaranth	*Amaranthus palmeri*	IAF(W)	MP, CH	• This species is resistant to multiple classes of herbicides and modes of action. • Use preemergent herbicide. • The following herbicides are effective for controlling this species applied when growth reaches 2–3 inches in height: 2,4-D, atrazine, chloroacetamide, dicamba, diphenylethers, glufosinate, and glyphosate. • Pulling plants can also be effective if the infestation is small. • Mowing is not recommended.

Table 1. State-listed noxious weeds likely to be present within the Longspur Project Area in Morton and Mercer counties, North Dakota, and treatment methods.*

Common Name	Species Name	Life Form[1]	Treatment Method[2]	Management Notes
Purple loosestrife	*Lythrum salicaria, Lythrum virgatum,* and all cultivars	IPF	MD, CH, BI	• Small infestations and younger plants can be controlled by digging up plants. • If plants are in or near water, use herbicides approved and labeled for aquatic use. • Apply glyphosate from July-September. • Triclopyr, aminopyralid and a combination of triclopyr and aminopyralid also provide effective control of this species. • There are three biological control insects that are effective at controlling purple loosestrife.
Russian knapweed	*Centaurea repens*	IPF	CH, BI	• Apply picloram following several hard frosts (mid-October). Application in mid-September or during flowering in midsummer provides shorter-term control than late applications. • Metsulfuron and aminopyralid are also effective. • Mowing and cultivation are not recommended. • There are two biological control insects available for control of Russian knapweed.
Saltcedar	*Tamarisk* spp.	T/B	CH	• Imazapyr is the most widely used herbicide for this species. Imazapyr can also be used in combination with glyphosate. Triclopyr applied in spring or late fall is also effective. • If plants are in or near water, use herbicides approved and labeled for aquatic use. • Do not remove top growth for three years following herbicide application to prevent resprouting. • Biological control of this species is not recommended in North Dakota.
Spotted knapweed	*Centaurea maculosa*	IPF	See diffuse knapweed	See diffuse knapweed.
Yellow toadflax	*Linaria vulgaris*	IPF	Not Applicable	• The following herbicides are effective for controlling this species: metsulfuron-methyl and picloram. • Planting competitive vegetation can help stop yellow toadflax from spreading in grazing lands. • Biological controls have not been effective in North Dakota.

[1] IAF(W) = introduced warm season annual forb; N/IPF = native/introduced perennial forb; BF = biennial forb; T/B = tree/bush.

[2] Mechanical methods: MM = Mowing; MP = Pulling; MC = Cutting; MD = Digging/Tilling.
Biological methods: BI = Insects; BG = Grazing Animals.
Chemical methods: CH = Herbicides.
Cultural methods: CU = Cultivate (uprooting young weeds and incorporating them into the soil).

* The North Dakota Department of Agriculture identifies the 13 species listed in this table as state-declared noxious weeds.

Source: North Dakota State University and North Dakota Department of Agriculture (2023, 2025), Agri Care Hub 2025.

4.1 General Weed Management Practices

Weed management is a long-term iterative process that considers site-specific physical, biological, and land use characteristics. Weed management must be accomplished through several integrated practices that include prevention, monitoring, and treatment to address noxious weed incidence, occurrence, and control (DiTomaso et al. 2013). The following best management practices are recommended to limit opportunities for weeds to enter the Project, get established, and/or spread during Project construction and operation:

- Follow all label instructions for recommended grazing practices following vegetation treatment and application of any herbicide.
- Delineate a "baseline" of large noxious weed infestations within construction areas that will need to be treated prior to disturbance.
- Minimize soil disturbance as much as possible and revegetate disturbed areas when possible.
- Excavations, placement of fill soil, or other areas of surface disturbance will be revegetated with appropriate site seed mix within 14 days of completion of the disturbance.
- Avoid driving through or over any untreated and marked noxious weed areas.
- Avoid noxious plant areas until after treated with the appropriate herbicides.
- A weed-resistant seed mix for restoration of temporarily disturbed areas consisting of a combination of competitive native grass and forb species (including pollinator plant species) will be used, to the extent possible.
- Soil from areas with noxious weed populations will not be removed or introduced to the construction site, to avoid transport of weed seeds or other propagules.
- All seed, soil, and mulch imported onto the Project site will be certified as weed-free.
- Preferentially salvage topsoil only for locations dominated by native vegetation; avoid known noxious weed infestation areas when salvaging topsoil to the maximum extent practicable.
- Store salvaged topsoil in a manner to discourage weed establishment, (e.g., by covering, mulching, or stabilizing with weed-free seed).
- Where practicable, use locally sourced topsoil if additional topsoil is needed.
- Train on site staff to identify noxious weed species for successful long-term vegetation management.
- Discourage weed establishment during construction through regular site inspections and targeted herbicide application as needed.
- Herbicide application will be by qualified applicators using approved herbicides.
- Herbicide applications will follow all instructions on the label including application rates and preparation and application requirements.

- Minnesota Power will require its contractors to:
    - Inspect vehicles and equipment undercarriages and tires for mud, dirt, plant materials, and seeds before entering work areas.
    - If vehicle or equipment is not clean, it must be cleaned with high-pressure washer equipment before entering the Project.
    - Use only designated cleaning station locations or commercial car wash facilities.
    - Soil from areas with noxious weed populations will not be removed or introduced to the construction site, to avoid transport of weed seeds or other propagules.
    - Where practicable, avoid or minimize travel through or parking in areas infested with noxious weeds to avoid spreading seeds or plant parts.

Minnesota Power will provide training to its contractors to maintain compliance with the weed management plan.

4.2 Post-construction Noxious Weed Monitoring

Monitoring noxious weed populations in impacted areas within the Project Area for up to three years post-construction is recommended to compare baseline and post-construction weed populations. A memorandum, reporting management actions and monitoring results, should be prepared each year when surveys occur and adaptive management implemented as necessary to control noxious weeds. Additional noxious weed treatment and monitoring may be required if eradication of noxious weeds is not successful. Consultation with Morton and Mercer counties weed boards are being performed to determine appropriate noxious weed control measures.

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0 750 1,500 Feet

1:18,000

N
W E
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- Project Route
- Project Corridor
- Existing TriCounty Substation
- County Boundary

Map 1 - Project Location

Minnesota Power Transmission Infrastructure Project

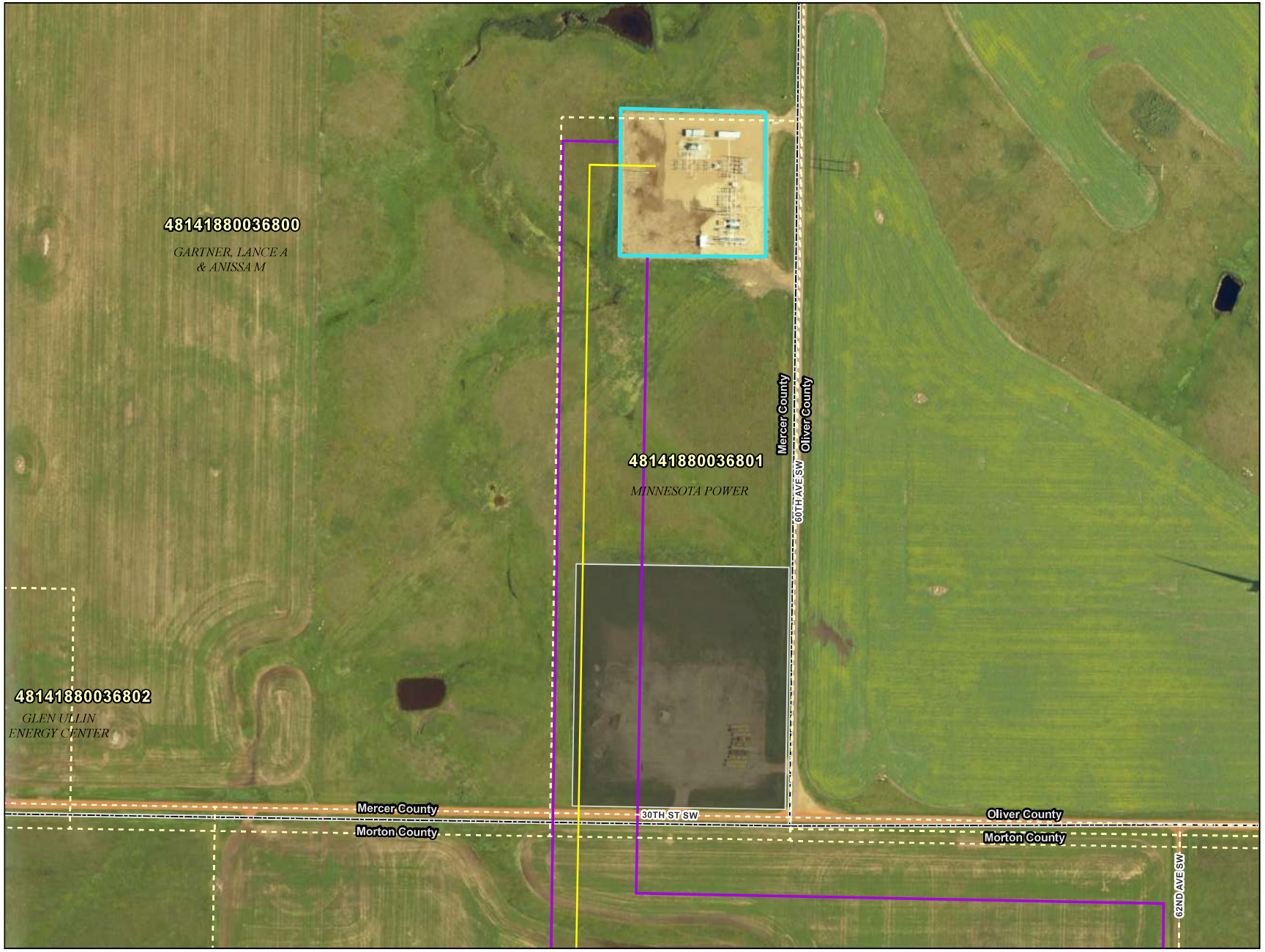
Minnesota Power

Mercer County, North Dakota

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For Environmental Review Purposes Only

Data Accuracy: Source: Z:\Drive\1_MN_Powerlines\1_Working\Permitting\GIS\Arcmap_Documents\Line_Lines_Mercer_Co_1.Parts





0 150 300 Feet

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N
W E
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- Project Route
- Project Corridor
- Construction Laydown Area / Parking
- Existing TriCounty Substation
- Parcel Owned by Minnesota Power
- Parcel Boundary
- County Boundary

Map 2 - Land Ownership

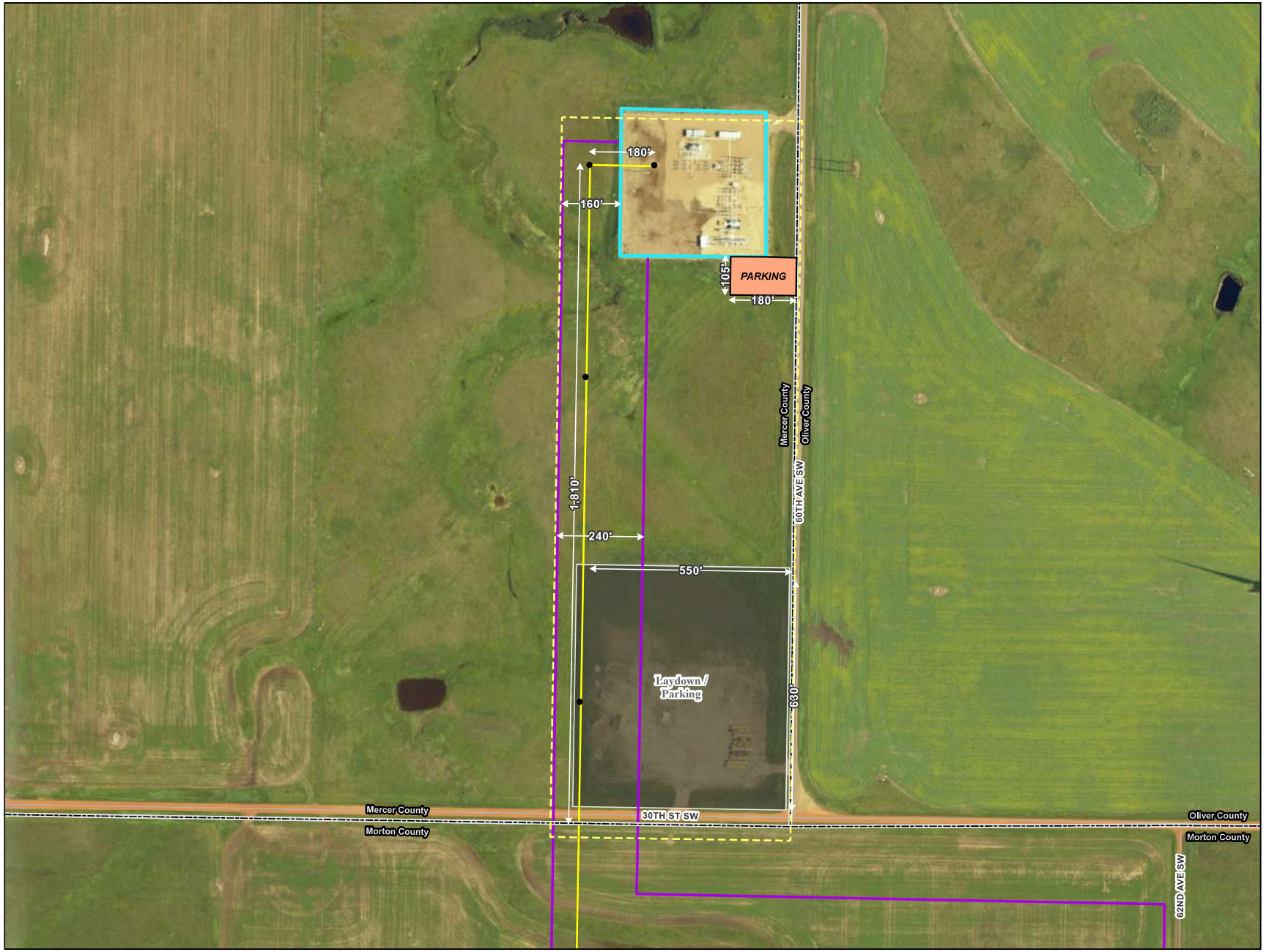
Minnesota Power Transmission Infrastructure Project

Minnesota Power

Mercer County, North Dakota

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

For Environmental Review Purposes Only





0 150 300 Feet

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N
W E
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- Proposed Structure
- Project Route
- Project Corridor
- Existing TriCounty Substation
- Construction Laydown Area / Parking
- Property Boundary
- Parking
- County Boundary

Map 3 - Project Design

Minnesota Power Transmission Infrastructure Project

Minnesota Power

Mercer County, North Dakota

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AN ALLETE COMPANY

Attachment E

Geotechnical Evaluation

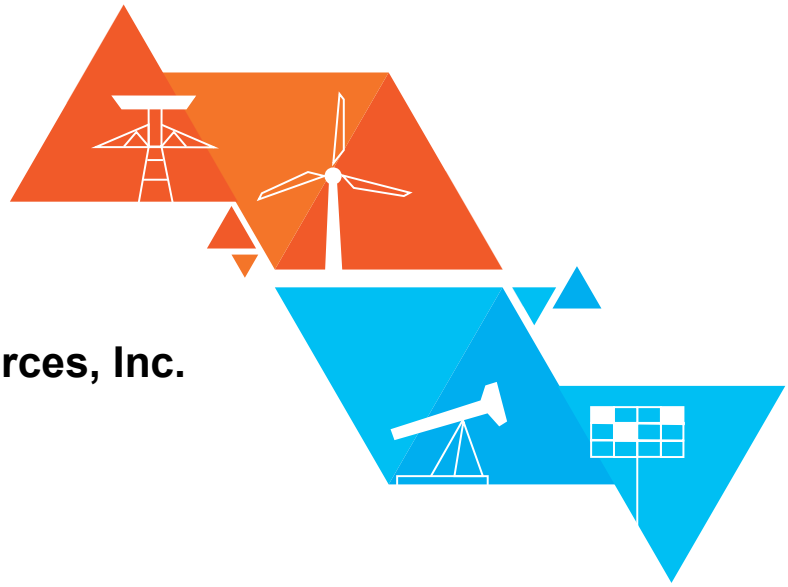
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Geotechnical Report

Longspur Wind Project

Morton County, North Dakota



PREPARED FOR

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RRC Project No. GE2503026
September 19, 2025

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September 19, 2025

Minnesota Power
c/o Allete Renewable Resources, Inc.
30 Superior Street
Duluth, MN 55802

Attn: Mitchell Bettenhausen

Re: Geotechnical Report
Longspur Wind Project
Morton County, North Dakota
RRC Project No. GE2503026

RRC Power & Energy, LLC (RRC) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Longspur Wind Project. The purpose of this geotechnical engineering study was to explore and evaluate the subsurface conditions at various locations on the site and develop geotechnical design and construction recommendations for the project. The attached report contains:

- A description of our findings from the field exploration and laboratory-testing program;
- Our engineering interpretation of the results with respect to the project characteristics; and
- Geotechnical engineering parameters for the design of foundation systems and access roadways.

Should you have any questions concerning this Geotechnical Report, please do not hesitate to contact us. Your business is always appreciated.

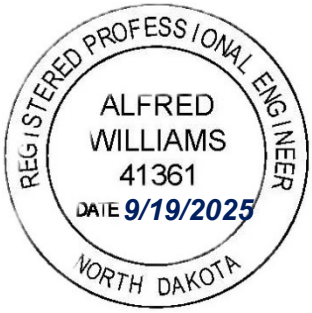
Sincerely,

RRC Power & Energy, LLC

Manoj Keerthipati, P.E.
Geotechnical Engineer

REVISION HISTORY

Revision	Description	Performed by	Reviewed by	Issued Date
0	Draft Geotechnical Report	Manoj Keerthipati	Alfred Williams	6/19/2025
0	Final Geotechnical Report	Manoj Keerthipati	Alfred Williams	9/19/2025



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Reviewed by

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FIRM REGISTRATION NO. ND 1788PE

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GEOTECHNICAL REPORT

1.0 INTRODUCTION

RRC Power and Energy LLC (RRC) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Longspur Wind Project. This Report includes subsurface information and geotechnical design recommendations. The site is located 5 miles north of the City of Glen Ullin, in Morton County, North Dakota. The approximate boundaries of the project site are shown on Figure 1, Site Location Map.

The purpose of this geotechnical investigation and report was to:

- Explore subsurface soil, bedrock, and groundwater conditions;
- Conduct field and laboratory tests to characterize the subsurface soil and bedrock properties at selected locations across the site; and
- Provide geotechnical engineering parameters for the design of foundation systems and access roadways.

2.0 PROPOSED CONSTRUCTION

It is understood that the Longspur Wind project will consist of 67 wind turbine generators (WTG). The WTGs will be comprised of VESTAS 4.5 MW, 163-meter rotor diameter models with a hub height of 113 meters. The project team anticipates WTGs will be supported on gravity foundation systems with an embedment depth of about thirteen (13) feet below finished grade. RRC assumes finished turbine pad grade is at or slightly above current existing site grade.

3.0 SITE EXPLORATION

Facilities associated with the project are anticipated to include electrical collection lines, overhead transmission lines, MET tower, Permanent Meteorological Mast (PMM), substation, operations and maintenance (OM) building, and access roadways. Private-access roadways will most likely be surfaced with imported road-base materials from nearby quarry pits.

The exploration was based on turbine Array Turbine/Boring ID (L011_04.26.25) which included 67 turbines, a substation, transmission line, MET tower, PMM structure, ADLS and an O&M building. Laboratory and geophysical data completed as part of the initial investigation is included within the appendices of this report.

RRC's complete subsurface exploration program consisted of:

- Drilled 67 borings at WTG locations;
- Drilled 10 borings and 14 Hand Auger borings at the substation;
- Drilled 18 borings along the Transmission Line;

- Drilled 1 borings at the MET tower location;
- Drilled 3 borings at Permanent Meteorological Mast (PMM) locations;
- Drilled 1 boring at ADLS location;
- Drilled one boring at the O&M Building;
- Installed 4 temporary piezometers at select WTG locations and 1 temporary piezometer within the substation;
- Obtained bulk samples at 14 locations for laboratory thermal resistivity (TR) testing;
- Obtained bulk samples at 2 locations for California Bearing Ratio (CBR) testing;
- Completed 18 Electrical Resistivity (ER) surveys; and
- Completed six Multi-Channel-Analysis-of-Surface-Waves (MASW) surveys.

Figures 1 to 13 in Appendix A consist of maps for the various borings relative to sample, geophysical survey and thermal resistivity test locations, site geology, and soil survey and groundwater data. A summary of subsurface exploration is provided within Table A2 within Appendix A.

3.1 Field Exploration and Testing

RRC geologists staked the boring locations using GPS coordinates provided by Allette Renewable Resources, Inc. Drill crews under RRC's direction drilled the borings within 15 feet of each staked location.

The borings were advanced with truck and track mounted drill rigs utilizing continuous flight hollow stem augers. During the field operations, the drill crew observed for groundwater levels. Following the completion of the drilling operations, the drillers backfilled each bore with soil cuttings in accordance with state regulations. At some locations, we added bentonite chips to supplement the soil cuttings.

Standard Penetration Test (SPT) samplers obtain disturbed soil samples. RRC documented each penetration resistance value in accordance with *ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. This test consists of driving the sampler into the ground with a 140-pound hammer free-falling 30 inches. The number of blows required to advance the SPT sampler 18 inches is counted and recorded, with the sum of the blows to drive the last 12 inches referred to as the standard penetration resistance value (N-value). Results of the field tests are shown on the logs of boring under the "Field Data" column and are preceded by the letter "N." Each soil sample from the SPT samplers collected in the field were visually classified, placed in plastic bags to preserve moisture content, and labeled as to location and depth. All SPT samples were arranged in core boxes and transported to our laboratory facility in Round Rock, Texas for further analysis.

RRC's field geologist directed sampling of cohesive soils at selected depths using Shelby tube samplers. These are 3-inch (OD) diameter stainless steel, thin-walled tubes in accordance with ASTM D1587: Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical

Purposes. The intent of this sampling technique is to obtain relatively undisturbed samples. Soil samples obtained using Shelby tubes were tested for consistency utilizing a pocket-sized penetrometer, with the reading included on the log of boring, as identified by the preceded letter "P." Readings in excess of 4.5 tons per square feet (tsf), if any, indicate that the capacity of the device has been exceeded. Note that the penetrometer reading is only an approximation of general cohesion. Pocket penetrometers are not a measurement for either shear strength, unconfined compressive strength, or bearing capacity.

Modified California (MC) split-spoon samplers were used to obtain relatively undisturbed samples of both cohesive and non-cohesive soils. RRC's field geologist and/or field engineer directed drill crews to obtain these samples at intermittent locations. The Modified California sampler is similar to the SPT sampler except that the Modified California sampler obtains 2.5-inch diameter samples in a steel sleeve. The Modified California sampler is driven like the SPT sampler and the blow counts are counted and recorded similarly. Results of the field tests are also shown on the Logs of Boring under the "Field Data" column and are preceded by the letter "N". When conducting an analysis of the stratum, a correlation is needed to convert the Modified California N-value to an SPT N-value. For 3-inch outside diameter MC sampler, conversion factor is in the range of 0.45 (Lacroix and Horn, 1773 method) to 0.65 (Burmister, 1948 method). Based on the experience, RRC uses a conversion factor of 0.5 when performing soil density analysis of N-values for the Modified California sampler. A plastic cap was placed on each end of the Modified California sample to seal the sample's moisture. The sample was labeled as to location and depth. All Modified California samples were arranged in core boxes and transported to our laboratory facility in Round Rock, Texas for further analysis.

RRC classifies soils in general accordance with the Unified Soil Classification System (USCS); *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. The soil and bedrock classification symbols appear on the logs of boring and are briefly described in Appendix A. Bedrock materials were classified in general accordance with the general notes for rock classification included as part of *ASTM D5878: Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes*.

RRC's field geologist prepared field logs for each boring. The logs of boring contain classification of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples.

The project engineer/geologist reviewed all the field logs, soil samples, and lab test data to make appropriate modifications to the logs of boring, as necessary. Final Logs of Boring and laboratory testing completed to date are provided in Appendix A. The logs of boring describe the strata encountered, their approximate thickness, SPT results, soil and rock classifications, the various depths at which the samples were obtained, as well as the presence of groundwater.

Temporary piezometers were installed at five locations to allow for subsequent groundwater measurements. We installed the piezometers to an approximate depth of 18-feet below the ground surface. Each piezometer consisted of either 1 or 2-inch diameter schedule 40 PVC pipe.

We situated the piezometers an offset distance of about 5 to 10 feet from the boring location. The piezometers include a bottom screen/slotted section that is 5-feet long and backfilled with sand that extends about one-foot above the screened section. The remainder of the piezometer is 15-feet of PVC that extends two-feet above ground. We used bentonite to backfill the upper portion of the piezometer. Groundwater levels measured to date within the temporary piezometers are discussed in Section 4.4 of this report. At locations where piezometers were not installed the borings were backfilled with soil cuttings in accordance with the state of North Dakota regulations. The temporary piezometer locations are mapped on Figure 13 in Appendix A.

3.2 Laboratory Tests

The soil samples were returned to the laboratory, examined by the project engineer/geologist, and applicable laboratory testing was assigned on selected soil samples. Laboratory testing was performed in general accordance with ASTM and locally accepted practices. The following laboratory methods of analyses were generally utilized, where sample quality allowed:

- Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System): ASTM D2487;
- Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass: ASTM D2216;
- Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils: ASTM D4318;
- Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-µm) Sieve: ASTM D1140;
- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort: ASTM D698;
- Standard Test Methods for Unconfined Compressive Strength of Cohesive Soils: ASTM D2166;
- Standard Test Methods for CBR (California Bearing Ratio) of Laboratory-Compacted Soils: ASTM D1883;
- Standard Test Method for Measurement of Soil Resistivity using the Two-Electrode Soil Box Method: ASTM G187;
- Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing: ASTM G51; and
- Sulfate and Chlorides Content: EPA 300/300.1.

4.0 SUBSURFACE CONDITIONS

4.1 Geology

The geologic interpretations contained herein are based on available geological maps and literature, and review of the logs of excavation as part of this study. The Longspur Wind project site is located within the Missouri Plateau Section of the Great Plains Province, which includes western Northern Dakota, western South Dakota, northeastern Wyoming, and Montana. It is an area characterized by generally low relief with gentle slopes interrupted by low buttes and ridges.

The northern half of the site is glaciated, while the lower half of the site is unglaciated. (Reference 1).

At the project site, bedrock includes thick beds of Tertiary aged sandstone (Reference 2). The bedrock is covered by thin surficial unconsolidated sediments composed mostly of silt, clay, and sand. These are river, lake, and swamp deposits that range from 10 to 30 feet in thickness (Reference 2).

The Geologic map of North Dakota: U.S. Geological Survey, scale 1:500,000 (Reference 2) indicates the bedrock materials of the site consist of the following geologic units of the listed geologic time periods.

Quaternary Period

- **Oahe Formation River Sediment** (Qor): This unit consists of river and stream sediments made of dark clay and silt. The sediments are bedded and overlies crossbedded sand. It is on the plains of modern streams. The thickness of this unit ranges from 10 to 30 feet.

Tertiary Period

- **Golden Valley Formation** (Tg): The upper part of the unit contains yellowish brown micaceous sandstone and fluvial sediments consisting of sand, silt, and clay. The lower part of the unit consists of white or yellow clay, silt, and sand. This unit is about 265 feet.

- **Sentinel Butte Formation** (Ts): This unit consists of river, lake, and swamp sediments containing grayish brown silt, sand, clay, sandstone, and lignite. This unit is 600 feet thick.

- **Bullion Creek Formation** (Tb): This unit consists of river, lake, and swamp sediments containing yellowish brown silt, sand, clay, sandstone, and lignite. This unit is 600 feet thick.

Figure 6 and Figure 7 in Appendix A shows the geologic units within the project site.

4.2 Subsurface Stratigraphy

As indicated on the logs of boring, the soil stratigraphy at the site generally consisted of topsoil underlain by either clay or sand layers.

The soil layers can generally be described as:

- Soft to hard, Lean and Fat Clay soils with varying amounts of sand and gravel.
- Medium stiff to hard, Silt soils with varying amounts of sand and gravel.
- Dense sands with varying amounts of silt, clay and gravel.

Bedrock where encountered, consisted of sandstone, shale, and mudstone.

Lignite seams/layers were also noted in some of the borings. Approximate thickness and consistency of these seams/layers are noted on the logs of boring within Appendix A.

Detailed Logs of Boring present detailed stratum descriptions, soil classifications, types of sampling used, laboratory test data, and additional field data. Bore logs are presented in Appendix A. The lines separating stratum types on the Logs of Boring do not necessarily represent distinct lines of demarcation because transitions can be gradual. The Boring Log Key, defining the terms and descriptive symbols used on each log of boring, is also presented in Appendix A

4.3 Laboratory Test Results

RRC obtained the service of Beyond Engineering & Testing, LLC to conduct laboratory tests. Lab test results completed to date are presented below and discussed in subsequent sections.

Laboratory test results indicate the native soils possess in-situ moisture contents in the range from about 2 to 55%, with an average of 19%.

The native soils have Plasticity Indices (PI) ranging from non-plastic to 48%. Clay soils with a PI less than 15 are generally considered to exhibit a low expansive potential provided their moisture contents are stable. High plasticity clay soils with a PI greater than 25 are generally considered to exhibit a high expansive potential if their moisture contents undergo a significant moisture change

We performed 14 moisture/density relationships (proctors) to determine the maximum dry unit weight and optimum moisture content in accordance with ASTM D698 (standard method). We also conducted Atterberg Limits on these samples to assess the soil type. A summary of the test results is presented below.

Table 4.3.1 Summary of Proctors and Atterberg Test Results

Sample Location	Depth (feet)	Material Type	Liquid Limit (%)	Plasticity Index (%)	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
GEO-01	2 to 4	CH	63	41	99.5	22.2
GEO-08	2 to 4	CH	57	38	107	18.2
GEO-10	2 to 4	CH	71	47	92.4	27.6
GEO-19	2 to 4	CL	30	12	111.8	16.3
GEO-22	2 to 4	SC-SM	22	6	115.6	12.7
GEO-33	2 to 4	CH	61	42	100.4	20.8
GEO-46	2 to 4	CL	41	23	112.1	15.4
GEO-48	2 to 4	CH	71	48	99.1	20.7
GEO-53	2 to 4	CH	54	35	103.1	19.5
GEO-59	2 to 4	CH	54	34	104.8	20.2
GEO-62	2 to 4	SC	26	8	113.9	12.3
GEO-67	2 to 4	CL	43	22	105.9	18.1
GEO-70	2 to 4	CH	61	41	100.6	20.8

Sample Location	Depth (feet)	Material Type	Liquid Limit (%)	Plasticity Index (%)	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
SUB-2	2 to 4	CL	37	23	116.1	13.7

Notes: pcf = pounds per cubic foot; CL = Lean Clay; CH = Fat Clay; SC = Clayey Sand, SM = Silty Sand;

Results of Unconsolidated-Undrained Triaxial (UU) Compression testing are presented in Table 4.3.2. These tests are performed in accordance with ASTM D2166 on relatively undisturbed samples.

Table 4.3.2 Summary of UU Triaxial Test Results

Sample Location	Depth (feet)	Material Type	Confining Pressure (psi)	In-situ Dry Unit Weight (pcf)	Undrained Shear Strength, s_u (psf)
GEO-04	12	CL	10.0	103.0	1,960
GEO-07	12	CL	10.0	99.0	6,920
GEO-46	12	CL	10.0	104.0	6,210
GEO-62	12	CL	10.0	105.0	4,510
GEO-66	12	SC	10.0	104.0	6,240
SUB-3	4	CL	3.0	108.0	1,620
OMM-1	7	SC	5.5	100.0	320

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; CL = Lean Clay; SC = Clayey Sand.

Results of Unconfined Compressive Strength (UC) tests are presented in Table 4.3.3. These tests are performed in accordance with ASTM D2166 on relatively undisturbed samples.

Table 4.3.3 Summary of Unconfined Compressive Strength Test Results

Sample Location	Sample Type	Depth (feet)	Material Type	In-situ Dry Unit Weight (pcf)	In-situ Moisture Content (%)	Undrained Shear Strength, s_u (psf)
GEO-01	MC	14	CL	111.2	20.2	5,280
GEO-04	ST	19	CL	102.3	22.1	2,600
GEO-33	MC	17	CL	111.3	16.6	9,450
GEO-36	ST	17	CL	92.9	29.9	940
GEO-37	ST	12	CL	65.1	47.0	2,660
GEO-69	ST	12	CL	95.1	24.8	4,600

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; MC = Modified California; ST = Shelby tube; CL = Lean Clay.

Results of swell test performed in accordance with ASTM D4546 are presented in Table 4.3.4.

Table 4.3.4 Summary of Swell/ Collapse Test Results

Sample Location	Depth (feet)	Material Type	Dry Density (pcf)	Moisture Content (%)	Surcharge Load (psf)	Collapse Strain (%)
SUB-6	4	SM	101.2	18.8	500	-0.8

Notes: pcf = pounds per cubic foot; SM = Silty Sand.

We performed two California Bearing Ratio (CBR) tests on select samples. The test specimens soaked for 96 hours prior to the CBR load test. A summary of the CBR test results is presented in Table 4.3.5. Design CBR values represent strength at 95% compaction relative to the maximum dry density as determined by ASTM D698. CBR increases with increased density.

Table 4.3.5 Summary of CBR Test Results

Sample Location	Depth (feet)	Material Type	Design Dry Unit Weight (pcf)	Design CBR (%)
GEO-48	1 to 4	CH	94.1	0.8
GEO-62	1 to 4	SC	108.2	8.2

Notes: pcf = pounds per cubic foot; CH = Fat Clay; SC = Clayey Sand.

Results of water-soluble sulfate and chloride testing performed on shallow soil samples are presented in Table 4.3.6.

Table 4.3.6 Summary of Sulfate and Chloride Contents

Sample Location	Depth (feet)	Material Type	Chloride Contents (% by weight)	Sulfate Contents (% by weight)
GEO-04	1 to 13	CL	0.008	0.222
GEO-10	1 to 13	CH	0.008	0.0672
GEO-25	1 to 13	CL	0.0059	0.26
GEO-50	1 to 13	CL/CH	0.0079	0.439
GEO-64	1 to 13	CL	0.0076	0.2740
SUB-3	1 to 4	CL	0.0305	0.0240

Notes: CL = Lean Clay; CH = Fat Clay.

Results of Minimum Soil Box Resistivity and pH tests performed on shallow soil samples are summarized in Table 4.3.7.

Table 4.3.7 Summary of Minimum Soil Box Resistivity and pH Tests

Sample Location	Depth (feet)	Material Type	Minimum Resistivity (ohm-cm)	pH
GEO-04	1 to 13	CL	589	7.1
GEO-10	1 to 13	CH	746	6.6
GEO-25	1 to 13	CL	455	7.5
GEO-50	1 to 13	CL/CH	408	7.6
GEO-64	1 to 13	CL	294	7.3
SUB-3	1 to 4	CL	805	9.1

Notes: CL = Lean Clay; CH = Fat Clay.

A summary of laboratory tests is presented in Appendix B.

4.4 Groundwater Conditions

Based upon information obtained from the borings drilled to date and historical water data for the region, it is RRC's opinion static groundwater level will affect the construction and design of shallow gravity foundation systems at select locations. Groundwater was encountered at the time

of drilling at depths in the range of about 7 to 49 feet below site grade in 37 of the 115 borings completed as part of this study. Groundwater observations for each WTG location are presented on Table A1 in Appendix A.

Temporary piezometers were installed within the foundation footprint of four select turbine sites and within the substation area to facilitate additional groundwater level measurements. Based on water measurements collected to date, the groundwater table (GWT) in 5 piezometers were found to be at depths in the range of about 1 foot to 12 feet below existing site grade. Groundwater level measurements in the piezometers were recorded immediately after installation, and approximately 24 to 72 hours after installation. A summary of the groundwater levels measured in the piezometers are presented in Table A4 within Appendix A.

RRC reviewed published water well logs for Morton County, North Dakota that were available from the North Dakota Department of Water Resources. Historical water well logs surrounding the project site reported ground water levels between 1.4 and 278.8 feet below the ground surface. The shallowest groundwater level was recorded in the year 2020 at about 1.4 feet below the ground surface at Well Report No. 9006.

It is important to note that water well records may not accurately represent seasonal fluctuations in static groundwater level or perched groundwater conditions, which should be considered during WTG foundation design.

It is also imperative to note that short-term groundwater level observations presented in this study are not an accurate evaluation of the variable groundwater conditions that may be present at each of the turbine locations. This Report is not to be interpreted as a comprehensive groundwater study. Groundwater levels are highly dependent on climatic and hydrologic conditions before and after construction, and site development including irrigation demands, drainage and other factors. As such, the presence of water during construction may vary relative to this report. It is understood that the presence of groundwater may influence certain construction activities and long-term performance of foundations and pavements; if a detailed groundwater study is desired, a groundwater hydrologist should be retained to perform these services.

RRC recommends implementing a groundwater level monitoring program to assess the impact of shallow groundwater levels on foundation design and construction.

4.5 Geohazard Assessment

The following subject items represent geologic or physical hazards to the project. Within each subject, we address the level of risk associated with the particular hazard to the project.

4.5.1 Flood Hazard

The Federal Emergency Management Agency (FEMA) has not completed a study to determine the flood hazard for Morton County, North Dakota.

The project civil engineer should review the structure locations within the project site, especially for those located near drainage features to verify if additional studies are needed. The design of

flood-proofing as well as the need for scour/erosion protection is the responsibility of the project Civil Engineer or Hydrology Engineer.

4.5.2 Expansive Soils

Based upon review of the logs of boring, laboratory testing results, available geological maps and literature, expansive soils are anticipated to be encountered across the project site. Expansive soils have a potential to shrink or swell when the moisture content is allowed to change significantly. WTG foundations are anticipated to have an embedment depth of approximately 13 feet, which is likely beyond the depth of moisture variations for this project site. It is our opinion that expansive soil will not cause significant movement for WTG foundation systems. The potential of expansive soils negatively impacting WTG foundations can be considered as a low risk. It is imperative that the exposed subgrade is not allowed to dry out significantly prior to concrete seal slab placement.

4.5.3 Soil Collapse Due to Windblown Soils

The project site can be classified as having a low susceptibility risk of collapse prone soils. Soil collapse is a geological feature associated with windblown soils. Windblown soil particles can be angular and when deposited lightly, they can form with high void ratios. Windblown soil is also quickly deposited and may become partially cemented. Both of these factors tend to preserve the high void ratio. When wetted and loaded, these soils can then collapse. Typically, we can identify these soils by low SPT N values and low dry densities.

Based on the log of borings and publicly available geological mapping within the project area, the potential for soil collapse is considered low.

4.5.4 Frost Penetration Depth

Based on Reference 3, the average frost penetration depth for Morton County is approximately 48 inches. Therefore, we recommend that the spread or strip footings at the site should have a minimum embedment of 48 inches below finished site grade for confinement and frost penetration.

4.5.5 Corrosion Potential

Published maps indicate that surficial soils within the project site have a low to high risk for concrete corrosion. Figure 10 in Appendix A is a map that attempts to indicate concrete corrosion risk boundaries. RRC cautions that this published map only estimates the boundaries based on soil types and cannot be precise. Based on the lab testing completed, the soils within the upper 12 feet exhibit, the risk for concrete corrosion is low to moderate..

Published maps indicate that the project site has a low to high risk for steel corrosion. Refer to Figure 11 for approximate steel corrosion risk boundaries. Again, we caution that this map is not precise and are only generalizations based on soil types. Based on the lab testing completed, the soils within the upper 12 feet exhibit “Very Corrosive” electrical characteristics with regards to galvanic corrosion of steel.

Section 5.4 discusses in greater detail laboratory test results for concrete and steel corrosion.

4.5.6 Karst Potential

Water soluble rocks located near or exposed at the surface have potential for development of karst and dissolution features. Rocks or mineral deposits, such as limestone, dolomite, gypsum/anhydrite, and salt are all susceptible to dissolution when in contact with circulating water. These soluble deposits pose the greatest risk when located within 20 feet of the ground surface, and a moderate risk when located within 20 to 100 feet of the surface Based upon review of geologic maps and literature, bedrock formations of this project area predominately consist of sandstone, shale and mudstone, which are typically not subject to karst and dissolution features.

Based upon review of the logs of boring, available geological maps and literature, karst potential can be considered low.

4.5.7 Slope Stability

Within the project area, the site consists of broader flat to gently rolling plains. Where most of the site exhibits gradual to moderate slopes, occasional steeper slopes may exist near drainage features. For native slopes greater than 2.5:1 (horizontal:vertical), RRC recommends that the turbines are offset one foundation diameter or more from the slope crest; otherwise, it is recommended that a detailed slope stability analysis be performed. Based on current existing site topography and RRC's observations during the geotechnical field exploration, slope stability is not anticipated to be a major concern for this project site, assuming minimum site grading occurs during construction phase.

4.5.8 Seismicity Hazards

North Dakota is generally a region of relatively low seismicity. At the project area, the site modified peak ground acceleration (PGA_m) was computed to be 0.039 g for Site Class D. This is based on the *Hazards Program*, a web-based program developed by the ASCE Hazard Tool (Reference 5) in accordance with ASCE 7-16. Based on the 2021 IBC (Reference 4), the Seismic Design Category for the site is anticipated to be category "A". Therefore, the seismic hazard risk is considered very low at the project site.

4.6 Geophysical Properties

RRC performed One-Dimensional Multi-Channel Analysis of Subsurface Waves (MASW) surveys at 6 WTG locations. The purpose of MASW surveys is to obtain shear wave velocity (V_s) profiles. The MASW survey locations are mapped on Figure 5 in Appendix A. The MASW survey methodologies and results are discussed in Section 4.6.1.

RRC also completed Earth Electrical Resistivity (ER) surveys at 18 locations across the site, including five surveys within the substation area. The test locations are mapped on Figure 5 in Appendix A. RRC conducted these surveys using the Wenner four-pin method. The electrical resistivity survey methodologies are presented in Section 4.6.2.

4.6.1 MASW Survey

The Multi-Channel-Analysis-of-Surface-Waves (MASW) method is a non-intrusive/non-destructive technique which uses Rayleigh waves to evaluate the stiffness of subsurface strata. Rayleigh waves of different wavelengths (or frequencies) travel at different velocities as they

propagate through different soils. The waves also bounce along the surface of different layers, called dispersion. MASW reports are presented in Appendix C.

For a 1-D MASW survey, twenty-four geophones with a 5-foot spacing are laid out in a linear array. The total length of the array is approximately 115 feet. A 16-pound sledgehammer striking a metal plate is employed as the seismic source located 10, 25 and 40 feet away from the first geophone. RRC uses SurfSeis 4.04 software to collect and process the seismic data.

The shear wave velocities are used to determine certain soil and bedrock characteristics based on simple equations. For example, the soil/bedrock shear modulus can be calculated using the following equation:

$$G = \rho V_S^2$$

Where: G = Shear Modulus (psf);
ρ = Mass density (pcf/(ft/sec.^{2})); and
V_s = Shear wave velocity (ft/sec.)

Young's Modulus, E, can also be calculated from the shear wave velocity data using the following equation:

$$E = 2G(1 + v)$$

Where: E = Young's Modulus (psf);
G = Shear Modulus (psf); and
v = Poisson's Ratio.

The weighted average is calculated based on the following formula based on the 2021 International Building Code (IBC) (reference 4):

$$\overline{V_S} = \frac{\sum_i^n d_i}{\sum_i^n \frac{d_i}{V_{si}}}$$

Where: d_i = Thickness of any layer between 0 and 100 feet; and
V_{si} = Shear wave velocity of a layer.

Note the measured shear wave velocity using MASW may not be available down to a depth of 100 feet. In the case where measured shear wave velocity is less than 100 feet, the weighted shear wave velocity is calculated based on available depths.

To determine the rotational stiffness of the underlying soil and bedrock, the parameters outlined in Table 4.6.1.1 can be used to compute the elastic and shear moduli. These values are generic values from published sources and typical for the respective soil type.

Table 4.6.1.1 Recommended Soil Parameters for Rotational Stiffness

Soil/ Material Type	Poisson's Ratio [1]	Average Total Unit Weight (pcf) [1,2]
Saturated Clay and Silt Soils	0.45	115
Unsaturated Clay and Silt Soils	0.35	105
Loose to Medium Dense Sand Soils	0.35	115
Medium Dense to Dense Sand Soils	0.30	120
Structural Fill	0.30	120
Bedrock	0.30	165

Note: (1) Based on Reference 6 (see page 123 for Poisson's ratio and page 163 for unit weight).
(2) Based on laboratory measurements (see Section 4.3).

Computed parameters from the MASW surveys represent soil behavior at small strain. The foundation designer should incorporate appropriate reduction factors to determine the rotational stiffness of the foundation system. The MASW survey results completed to date are included in Appendix C.

4.6.2 Earth Electrical Resistivity Surveys

RRC performed a total of 18 field electrical resistivity (ER) surveys using the Wenner 4-pin array method. The electrical resistivity surveys were completed at 13 WTG locations and 5 surveys within the substation. The electrical resistivity survey locations are mapped on Figure 5 included in Appendix A. Each survey consists of two perpendicular arrays, both centered at the same location. Results of electrical resistivity surveys are presented in Appendix C.

Interpretation of the electrical resistivity surveys is beyond the scope of this study and should be performed by the electrical design team.

4.6.3 Thermal Resistivity of Soils

RRC obtained bulk soil samples at 14 locations to conduct laboratory thermal resistivity (TR) tests. The samples consist of subsurface soils collected at depths of 2 to 4 feet below existing site grade. RRC obtained the services of Beyond Engineering & Testing to conduct laboratory thermal resistivity (TR) tests in accordance with IEEE 442 Method. The test locations are mapped on Figure 5 in Appendix A.

The thermal resistivity tests were performed on remolded samples targeting 92% compaction of the maximum dry density as determined by ASTM D698 at the "as-received" moisture content. Thermal resistivity samples were then tested at a series of moisture contents from "as-received" moisture content to 0% moisture content. The result is a thermal resistivity dry-out curve. Thermal resistivity test results are included in Appendix C.

Interpretation of the thermal resistivity tests results is beyond the scope of this study and should be performed by the design team.

5.0 GEOTECHNICAL RECOMMENDATIONS

It is understood the Longspur Wind Project will consist of the construction of 67 WTGs and associated facilities, including a substation, transmission line, PMM structure, MET tower and O&M building. We assume WTGs will be supported on gravity foundation systems and will bear on native soils with an embedment depth of about 13 feet below finished grade. RRC assumes finished turbine pad grade is at or slightly above current existing site grade.

The extent and location of site grading is also unknown. RRC should be retained to review the civil drawings and cross-sections for each turbine location and other critical areas along the proposed roadways. This will allow us to evaluate the need for additional studies such as slope stability analyses. If current site grade is changed at a WTG location, we can assess whether our original recommendations apply.

RRC's geotechnical recommendations presented in this report should be verified when information on the foundation design and site grading become available.

5.1 General Turbine Foundation Expectations

RRC performed bearing capacity and settlement calculations in general accordance with methodologies outlined in the 2nd Edition of *Guidelines for Design of Wind Turbines* (Reference 7). We also used generally accepted standard of care and practice along with experience with similar soil conditions in this type of geological setting. Detailed discussions of bearing capacity and settlement for WTG bearing on native soils are outlined in the following subsections. A summary of anticipated conditions that will require particular attention in the design and construction is presented below:

- RRC based our design parameters and construction recommendations to allow for foundations to bear at about 13 feet below the existing ground surface for an allowable end bearing capacity of 2,500 psf, with a total settlement of 2.5-inches and a maximum differential settlement or tilt potential of 0.15 degree across the foundation. Table A1, *Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendation*s in Appendix A provides net allowable end bearing capacity for each turbine site. Some locations are not capable of supporting a net allowable bearing capacity of 3,000 psf. Alternate foundation designs may be required. Otherwise, remediation of the foundation supporting soils is necessary.

- The depths of remediation required to obtain the bearing capacity and/or settlement values listed above are provided in Table A1. RRC assumes an embedment depth of 13 feet or greater. Should an embedment depth of less than 13 feet be used, RRC should be consulted to determine if additional locations require soil improvement to achieve the bearing capacity and/or settlement values listed above. These depths to remediation are based relative to naturally existing grade and foundations bearing about nine feet below grade. If final

elevations result in the foundation bearing at a different depth, then adjustments should be made to the depth of remediation.

- Over-excavation and replacement with structural fill materials may be considered for soil improvement depths up to about 16 feet below existing ground surface, if feasible. For soil improvements greater than 16 feet below existing ground surface, the cost for performing over-excavation and replacement will likely be excessive; therefore, deep soil improvement measures such as Rammed Aggregate Piers (RAP), compaction grouting or other equivalent ground improvement techniques are appropriate.

- It is anticipated excavations may be advanced with conventional earth moving equipment where native soils extend below foundation bearing elevations.

- Excavation contractors and/or underground utility installers should consider performing test pits or probing tests to evaluate proper means and methods for advancing excavations. Potential caving/sloughing within narrow and shallow utility trenches may require sidewalls of trenches to be sloped in order to install utilities. Excavated trench bottoms should be thoroughly cleaned prior to cable placement and backfilling.

- It is crucial to maintain a uniform foundation subgrade support below the turbine foundation to reduce the potential of excessive differential foundation settlement. If compacted structural fill is used below the turbine foundation, the thickness of structural fill below the turbine foundation shall be a minimum of 6 inches; the structural fill thickness shall be kept as uniform as possible with no abrupt thickness change, with an overall thickness difference of 2 feet or less across the turbine foundation footprint. Either the bedrock portion of the foundation subgrade may be excavated, or the lower portion of the soil subgrade excavation may be filled with lean concrete so that the structural fill thickness difference can be kept at 2 feet or less across the foundation width.

- Turbine foundations located adjacent to natural or man-made slopes should be setback laterally from the top of the slope. The minimum setback distance should be 25 feet or one turbine foundation diameter, whichever is larger, away from the edge of foundation to the crest of any natural or man-made slopes. Proper drainage measures should be taken to reduce impacts to man-made cut and fill slopes as well as all undisturbed natural slopes.

It is imperative that a professional geotechnical engineer, or their representative, observe each foundation excavation to verify that the exposed foundation soil bearing conditions meet the intent of this Report. This observation allows the geotechnical engineer to assess the need and limits of removal and replacement. Detailed construction recommendations and/or specifications are outlined in Section 6 of this report.

5.1.1 Bearing Capacity and Settlement of Gravity Foundation System

A net allowable bearing pressure of 3,000 psf can be used for the structural design for turbine foundations bearing directly on undisturbed native soils. The allowable bearing values are based

on a safety factor of three for general shear failure. These net allowable bearing pressure values may be increased by 25% when considering short duration loading conditions such as extreme wind and seismic forces. Some locations will require remedial measures outlined in Section 6 in order to achieve the full allowable bearing pressure.

The estimated total turbine foundation settlement is expected to be about 1.5 to 2.5 inches under normal operating loading conditions at the center of the foundation. The estimated differential settlement or tilt across the foundation diameter is less than 0.15 degrees under both dead load and normal operating loading conditions.

Table 5.1.1.1 Geotechnical Design Parameters for Gravity Foundation

Parameters/Soil Type*	Recommended Values
Min. Undrained Shear Strength / Very Stiff Clay	1,500 (psf)
Min. Internal Friction Angle / Sand	30 (deg.)
Min. Net Allowable Bearing Capacity (Normal Operating Load, Fs=3.0)	3,000 (psf)
Poisson's Ratio	0.35

Table 5.1.1.2 presents a summary of Modulus of Subgrade Reaction for different soil, bedrock, and structural fill materials.

Table 5.1.1.2 Recommended Soil and Structural Fill Design Parameters

Soil/ Material Type	Friction Coefficient[(1)]	Modulus of Subgrade Reaction, k_s(pci)
Firm Clay Soils	0.35	75
Stiff to Hard Clay Soils	0.35	100
Medium Dense Sand Soils	0.35	150
Dense to Very Dense Sand Soils	0.45	200
Structural Fill Materials (Min. 1-foot thick)	0.45	225

Note: [(1)] If necessary, lateral passive earth pressures can be considered to develop additional resistance. The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

To determine the rotational stiffness of the underlying soils/bedrock, the foundation designer should reference the results of the MASW testing performed as part of this study. The results of these surveys completed as part of this study are presented in Appendix C.

5.1.2 Overburden Backfill on Turbine Foundation

The use of native soil/rock as backfill materials placed above and against the side of turbine foundations is acceptable. RRC recommends the backfill materials placed over the turbine foundations be compacted to dry densities of at least 95% of the maximum dry density as determined by ASTM D698. This compaction is necessary to support a crane pad, reduce erosion and deter settlement. RRC recommends using an average long-term moisture content of 10% for native soils used as overburden. Contractor should place overburden backfill material in accordance with specifications outlined in Section 6.4.4 of this report.

Using the Standard Proctor tests listed in Table 4.3.1, the recommended overburden backfill unit weight values for turbine foundation design are presented in Table 5.1.2.1 below.

Table 5.1.2.1 Overburden Backfill Density Range Requirement

Soil/ Material Type	Dry Backfill Unit Weight Range, γ_d (pcf)	Moist Backfill Unit Weight Range, γ_{total} (pcf)
Native Soils	88-116	118-134

Note: pcf= pounds per cubic foot;

It should be noted that some turbine sites have shallow surficial soils which are classified as fat clay soils. In areas where fat clay soils are encountered within the foundation excavation zone, increased compaction efforts or mixing with heavier soil may be required to achieve the proposed turbine foundation backfill requirements.

5.2 Substation, O&M Building, MET Tower and ADLS Tower Shallow Foundation Systems

Final grade elevations for the Substation, O&M Building, ADLS, and PMM were not available. RRC has assumed the finished grade will be near or slightly above the existing ground surface. Surficial soils at these locations predominantly comprise lean and fat clay soils with varying amounts of sand. These clay soils range from medium stiff to very stiff in terms of consistency.

Shallow foundations shall bear a minimum of 48 inches below the ground surface. 48 inches was selected based on the *Building and Design Criteria* for Morton County, North Dakota. We recommend that continuous footings have a minimum width of 18-inches to allow cleaning, inspection, and placement of rebar.

Shallow foundations embedded 48 inches below the ground surface at the substation, O&M Building, ADLS, and PMM can use a net allowable bearing pressures shown in the tables below. These net allowable bearing capacities include a factor of safety of 3 for general shear failure.

For reinforced concrete slabs bearing at finished grade, we recommend over-excavation of foundation subgrade soils to a minimum of four feet below the finished grade and replacement with non-frost susceptible structural fill material or flowable fill (controlled low strength material) having compressive strength of at least 150 psi. The non-frost susceptible materials should meet the requirements of Section 6.2. The excavation should extend at least four feet beyond the perimeter of the foundation.

Table 5.2.1 Soil Parameters for Substation

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	7
Average Total Unit Weight (pcf)	115
Modulus of Subgrade Reaction of Select Fill Pad (pci)	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf) with 0.5-inch settlement	1,500
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf) with 1-inch settlemment	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf) with 0.5-inch settlement	1,500
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf) with 1-inch settlement	2,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf) with 0.5-inch settlement	1,350
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf) with 1-inch settlement	1,800

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.
* For a 1 ft. x 1 ft. Plate.

Table 5.2.2 Soil Parameters for O&M Building

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	18
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	1,500

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.
* For a 1 ft. x 1 ft. Plate.

Table 5.2.3 Soil Parameters for ADLS Locations

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	20
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,500
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	3,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	2,500

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.
* For a 1 ft. x 1 ft. Plate.

Table 5.2.4 Soil Parameters for PMM Locations

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	20
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	2,500
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	2,000

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.
* For a 1 ft. x 1 ft. Plate.

Site grading should ensure positive drainage away from the structures. This will prevent pooling of water near the foundations which could result in significant moisture changes of the soils beneath the foundations. Poorly graded sand (classified as SP) and gravel are highly permeable and allow water entry. These soils make poor overburden backfill. If the backfilled material around the structures consists of SP or Gravel, RRC recommends adding a 12-inch-thick clay cap. This clay cap should extend at least five feet beyond the foundation excavation.

5.3 Substation, Transmission Line, MET Tower and ADLS Tower Deep Foundation Systems

Structure elements with heavy axial loads and/or large overturning moments may utilize drilled pier foundations. Pier lengths will likely be dictated by overturning resistance. Allowable end bearing pressures and allowable skin friction values for the substation, transmission line and

MET/ADLS tower structures are presented in Appendix D. Allowable end bearing pressures and allowable skin frictions utilize a factor of safety of 3 and 2.5, respectively.

Skin friction values should be reduced by 25% when calculating pull-out resistance, where applicable. Settlement associated with drilled piers is anticipated to be about ½ to 1 inch. For proper installation of steel rebar and to monitor cleanliness, drilled shafts should have a minimum diameter of 1½ feet. The structural engineer should determine the length of the drilled piers to satisfy axial, uplift, and lateral loading.

Lateral load analysis may be performed using the LPILE computer program. LPILE uses a p-y curve finite difference technique for predicting the soil-structure interaction and response. RRC provides detailed LPILE parameters within Appendix D to evaluate drilled piers under lateral loads.

Vertical steel reinforcement to resist tensile loads caused by uplift forces should extend the full length of the pier shaft. Additional reinforcement required by structural demands for axial compressive loads, lateral loads, or minimum reinforcement required by design codes should also be satisfied.

Transmission line pole foundation systems may consist of directly embedded pre-stressed concrete pole foundation systems and would likely be designed using EPRI's MFAD computer software. Compacted granular backfill material in the annulus can be assumed to exhibit the following parameters outlined in Table 5.3.1. These values assume backfill to be compacted to a relative density of 65% of greater.

Table 5.3.1 Parameters for Compacted Anulus Backfill

Parameter	Compacted Granular Aggregate
Total Unit Weight (pcf)	125
Internal Angle of Friction (degree)	35
Horizontal Modulus of Elasticity (ksi)	1.6

5.4 Corrosivity of Soils

Water-soluble sulfate and chloride test results are presented in Table. 4.3.6. The test results indicate the soils in the upper 12 feet possess a "Negligible" to "Moderate" risk for sulfate exposure and corrosion potential to concrete. Published maps indicate that in general, the area has low to moderate risk for corrosion to concrete. Foundation concrete should be designed in accordance with *ACI 318: Building Code Requirements for Structural Concrete and Commentary*.

Minimum Soil Box Electrical Resistivity and pH testing results are presented in Table 4.3.7 of this report. Soil Box Electrical Resistivity results indicate soils within the upper 12 feet exhibit "Very Corrosive" electrical characteristics with regards to galvanic corrosion of steel. Cathodic protection for buried metal pipe should be designed by a qualified corrosion engineer.

Table 5.4.1 Effect of Soil Box Electrical Resistivity on Corrosion

Aggressiveness	Resistivity in ohm-cm
Very Corrosive	< 700
Corrosive	700 – 2,000
Moderately Corrosive	2,000 – 5,000
Mildly Corrosive	5,000 – 10,000
Non-Corrosive	> 10,000

5.5 Lateral Earth Pressures

Lateral earth pressures will apply in soil strata. The WTG foundations will be designed to resist all lateral movements; therefore, the “at rest” lateral earth pressure will apply. The following “at rest” equivalent fluid pressures are recommended in Table 5.5.1. The lightweight range is more conservative and necessary for the “at rest” and “passive” condition. The heavier weights are more conservative for the “active” condition.

RRC applied unit weights listed in Table 5.2.1.3 for overburden backfill soils with minimal compaction and low moisture content. The lightweight range is more conservative and necessary for the “at rest” and “passive” condition. The heavier weights are more conservative for the “active” condition.

Table 5.5.1 Equivalent Fluid Pressures

Soil Type	Condition	Equivalent Fluid Pressure (psf/ft)
Clay Soils ϕ=20, γ_t=97 to 136 pcf	At Rest, k_o= 0.65	63 to 88
	Active, k_a= 0.49	68
	Passive, k_p= 2.0	195
Sand Soils ϕ=34, γ_t=103 to 132 pcf	At Rest, k_o= 0.44	41 to 53
	Active, k_a= 0.28	40
	Passive, k_p= 3.5	365

We note that for clay soils, the angle of internal friction is adjusted to correct for shear versus a lower friction angle. Theoretical correlations for the at-rest coefficient of clays are a property of Plasticity Index. For large variations in clay plasticity, RRC can provide alternate k_o coefficients. Because we expect that there will only be one foundation design, we expect that the lateral earth pressure will be dictated by the sandy condition.

Passive and active earth pressure resistance will only mobilize after significant movement of the foundation. The passive case occurs where a structural element tends to move into the soil mass. The active case occurs when the element tends to move away from the soil mass. Both cases are applicable for unrestrained foundation elements.

The above earth pressure values do not include safety factors. We recommend a minimum safety factor of 2.0 be applied when using passive earth pressure for lateral load resistance. Surcharge loads should also be considered where appropriate. The values apply only to cases where the ground surface is level. We should be contacted to provide suitable values for cases where the ground surface is sloped. Similarly, if a structure is submerged below water, then the earth pressures change dramatically and require a different analysis.

5.6 Seismic Design

RRC provides seismic design using 2021 International Building Code (IBC) (reference 4). Based on Logs of Boring, we recommend using a Site Class D for stiff soils. The Mapped Spectral Response Acceleration for the 1 second (S_1) and short periods (S_S) were computed using the ASCE Hazard Tool, which is a web-based application program (reference 5). The table below summarizes recommended seismic parameters to be used in the design.

Table 5.6.1 Recommended Seismic Parameters

Parameter	Recommended Value
S_S – Mapped Spectral Response Acceleration at Short Period (0.2-Second)	0.053 g
S_1 – Mapped Spectral Response Acceleration at 1-Second Period	0.023 g
F_a (Site Coefficient) – Site Class D	1.6
F_v (Site Coefficient) – Site Class D	2.4
Site Modified Peak Ground Acceleration	0.039 g
Seismic Design Category	A

6.0 FOUNDATION CONSTRUCTION CRITERIA

6.1 Site Preparation

Prior to construction, we recommend adequate positive drainage be provided to maintain a relatively dry condition in the area of proposed construction. This will be very important if any work is attempted during periods of prolonged rainfall or heavy snow fall followed by warmer days. Ponding of water in the areas of construction should be avoided. Winter conditions can also impact the construction process. Newly placed fill should not be placed on frozen subgrade and frozen material should not be used for fill.

During excavation of the turbine foundations, every effort should be made to avoid disturbing subgrade materials at the planned foundation bearing elevation. When the subgrade is disturbed, the resulting surface should be re-compacted to achieve a minimum compaction of 98% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content or drier. Soft lignite layers encountered at or near foundation bearing elevation shall be removed and replaced with suitable on-site soils or structural fill. A qualified

representative of the geotechnical engineer should verify the stability of the subgrade prior to foundation installation.

6.2 Structural Fill Specifications

Structural fill material beneath foundations, where required, should consist of a non-expansive, well-graded material with sufficient binder for compaction purposes and should be in general accordance with the meets *North Dakota Department of Transportation, Section 816, Aggregate Class 5,* or better. RRC's intent is to make Structural Fill interchangeable with road base.

Structural fill should be compacted to a minimum of 95% of ASTM D1557. The structural fill should be moisture conditioned within 2% of optimum moisture content. Typically, 9-inch lifts are a maximum, but if a contractor can complete thicker lifts and it can be verified that full densification occurs throughout the lift, then lifts to 12-inches are possible.

6.3 Native Soils as Select Fill below Foundations

RRC understands the importance of using native soils whenever feasible. The following specifications allow reasonable native soil reuse while maintaining structural requirements for end bearing capacity and settlement. Modification of unsuitable foundation soils shall consist of over-excavation and replacement with any of the following materials:

All soils that possess the following properties qualify as Select Fill that may be used under foundations: maximum plasticity index of 15 and a maximum liquid limit of 40, and classify as SC-SM, SC, Sandy CL, well-graded GC, and well-graded GS.

Select Fill placement under turbines should be limited to two-feet thick. Deeper replacement must be approved by the Geotechnical Engineer in order to assess settlement potentials for that specific location. Otherwise, use Structural Fill.

When dealing with subgrade pumping, rutting, or moisture, and the remediation has a maximum thickness of 12-inches, then the excavated soils may be scarified and reused to complete the remediation. Deeper remediation requires either Select Fill or Structural Fill.

All reused and Select Fill soils used under foundations shall be compacted to a minimum of 98% of the maximum dry density as determined by ASTM D698 and shall be moisture conditioned within 3% of optimum moisture content.

6.4 Turbine Earthwork Requirements

RRC reviewed each log of boring for the presence of soft to medium stiff clays, loose sand layer(s) and/or non-competent materials below and near the anticipated foundation bearing elevation. In *Table A1, Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations* within Appendix A, we list locations that we expect will require

remediation. Following are various options and methods to remediate subsurface soils to support the intended gravity foundations. We also present other earthwork requirements related to the turbines, such as overburden backfill and crane pads on overburden fill.

6.4.1 Verification of Turbine Foundation Subgrade

Prior to placing a mud mat and rebar, the bearing surface should be verified for stability. This verification applies under all soil, fill, or rock conditions. There is a preference to perform a proof-roll test using a fully loaded water truck, or similar equipment. Conduct the proof-roll test in at least two directions with a minimum of two passes per area. Proof-roll tests should not exceed 1-inch of deflection, rutting, or pumping. Areas that fail this proof-roll shall be excavated and the removed soils be recompacted or replaced.

Where the foundation design allows for relatively soft soils with a bearing capacity below 3,000 psf, or where shallow groundwater deters the proof-roll, then the Geotechnical Engineer shall consider alternate verification methods. Alternates might consist of Dynamic Cone Penetrometer for sandy/gravelly soils or Static Cone Penetrometer for clay with low sand content.

6.4.2 Subgrade Remediation Methods

A representative of the Geotechnical Engineer should observe and verify over-excavations. In some cases, additional over-excavation may be necessary. In some cases, less excavation is sufficient.

In order to disperse the foundation load over a larger area, structural fill pads should be larger than the foundation. Deeper remediation also requires a wider distance. The over-excavated areas should extend laterally a distance such that the edge is at least a distance equal to the pad thickness. Foundation stresses extend downward and outward at a 45-degree angle through the structural fill. For example, a 3-foot thick remediation will require a pad that is 3-feet beyond the edge of the foundation.

If compacted structural fill or select fill is used below the turbine foundation, the fill thickness shall be kept uniform with a maximum thickness difference of two feet across the foundation footprint. This uniform thickness is to deter differential settlement. Where subgrade is a combination of bedrock and soil, then either excavate the rock or replace the soil with lean concrete or structural fill.

It is possible to encounter suitable soils at shallower depths. It is also feasible to verify that suspect soils are suitable to support the foundation design intent. If Table A1 recommends excavation to a depth, it is because this is the anticipated bottom of the suspect stratum. Contractor may choose to conduct additional tests to verify whether the suspect soils meet strength requirements. These tests should extend through the suspect layer. For the stiff and dense soils at this site, RRC can recommend Dynamic Cone Penetrometer (DCP) tests to conduct this verification. Once a foundation design is complete, the geotechnical team can work with the quality assurance team to devise a suitable DCP test procedure and minimum DCP test values.

The stability of the subgrade at foundation bearing elevation may be affected by the proximity to shallow groundwater levels and/or “Perched” Groundwater conditions. In areas where bearing capacity and settlement are not the concern, such as a thin layer of mud, the contractor may establish a stable platform using the following options:

- Dewater the site. Means and methods for dewatering are the responsibility of the contractor.

- Use geogrid/geotextile in combination with structural fill to create a stable surface. Obtain design input from the product manufacturer.

- Use coarse rip rap to bridge wet soils. Compact rip rap to bed the aggregate within the wet soils. Cap the rip rap with compacted structural fill then verify overall stability using a proof-roll method.

It is crucial to maintain a uniform foundation subgrade support below the turbine foundation to reduce differential foundation settlement. In areas where a combination of soil and bedrock are exposed at the foundation bearing elevation, the soil portion should be over-excavated to competent bedrock and replaced with either compacted structural fill or lean concrete having a 28-day compressive strength of 1,000 psi or higher. Do not use select fill or native soils. Alternatively, the entire foundation footprint can be over-excavated for a depth of 2 feet below the foundation bearing elevation and replaced with compacted structural fill.

Should boulders be exposed at foundation bearing elevation during excavation, remove the boulder and replace with structural fill. Foundations bearing on exposed boulders have the potential to create point loads at the bottom of the foundations. This increases differential foundation stress.

6.4.3 Excavated Materials as Overburden Backfill

The use of native clay and sand soils is acceptable as overburden backfill materials placed above and against the sides of turbine foundations. All backfill should be free of significant organics, roots, and deleterious materials and should be properly processed and compacted. See specifications below.

Overburden Backfill Placement:

- The backfill materials should be placed in loose lifts not exceeding 12 inches.

- Each lift of backfill should be moisture conditioned, compacted, and tested to meet the minimum and maximum dry and moist unit weight values specified in the foundation design drawings. If not on the drawings, refer to Section 5.1.2 of this report for target overburden weights.

- Each lift of backfill materials over turbine foundations should be compacted to dry densities of at least 95% of the maximum dry density as determined by ASTM D698. Even if this level of compaction is greater than the minimum target weights from item 2 above. This compaction reduces fill settlement, erosion, and provides support for the transformer and crane pad.

Poorly graded sand (classified as SP) and gravel is highly permeable and allow water entry. These soils make poor overburden backfill. If overburden material consists of SP or Gravel, then RRC recommends adding a 12-inch thick clay cap. This clay cap should extend at least five feet beyond the turbine foundation excavation. Alternately, the contractor can consider mixing clayey soils into the overburden backfill materials in order to create a less permeable mixture. The Geotechnical Engineer should be allowed to review such mixtures.

The top surface of the backfill should have a minimum 2% drainage slope away from the turbine to allow surface water runoff.

6.4.4 Crane Pads on Overburden

In areas where crane pads extend over the overburden backfill zone, then the crane operator's bearing capacity requirements also must apply. As a general guideline, RRC suggests a minimum three feet (in thickness) of the overburden backfill below crane pads be compacted to a minimum of 98% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content. Refer to Section 7.2 of this Report for additional recommendations related to crane pads.

6.5 Substation, Transmission Line, MET Tower, PMM, ADLS and O&M Building Structures

This section provides construction recommendations and specifications related to shallow and deep foundations for structures not consisting of turbines. This section is intended to apply for all electrical substation, switchyard, and transmission line structures. If future, more specific geotechnical studies for those facilities are conducted, then disregard this section and refer to the recommendations in those more specific studies.

6.5.1 Shallow Foundation Construction

The following construction criteria and general guidance should be observed during foundation construction:

- All foundation excavations should be observed by the engineer's qualified representative to assess proper bearing materials are present at foundation bearing elevation in accordance with the recommendations given herein, and to assess the need for densification of the subgrade materials.

- Care should be taken to protect the exposed soils from being disturbed, freezing or desiccation.

- The foundation excavation should be sloped sufficiently to create internal sumps for runoff collection and removal. Foundation excavations subject to rainfall and possible deterioration from accumulated water should be protected using a protective “mud-slab” (lean concrete). If surface runoff water or groundwater seepage accumulates at the bottom of the foundation excavation, it should be collected and removed and not allowed to adversely affect the quality of the bearing surface.

- The foundation excavations should be checked for size and cleaned prior to the placement of reinforcing steel. Take precautions during the placement of reinforcement and concrete to prevent the loose material from falling into the excavation.

6.5.2 Drilled Shaft Foundation Construction

The following items are important for the successful completion of drilled shaft foundations:

- The engineer’s representative should observe all drilled shaft excavations. This inspection is to verify proper depth, bearing stratum, cleanliness, verticality (plumbness) and to record other observations regarding the drilled shaft construction.

- If water is present within the shaft, it is imperative that the contractor use proper construction methods to account for the water. Either the water must be removed, or the contractor must use tremies or pumps to allow concrete placement under water.

- Prompt placement of concrete in the excavation as it is completed, cleaned, and inspected is strongly recommended. Under no circumstances should a shaft be drilled, that cannot be filled with concrete before the end of the workday.

- The reinforcement steel cage placed in the shaft should be designed to be stable and centered during the placement of concrete.

- Varying subsurface soil conditions may be encountered. A Geotechnical Engineer or his representative should observe subsurface conditions during installation of any drilled piers to verify subsurface conditions match the design criteria.

- Drilled shaft construction should follow applicable industry standard. Means and methods of construction shall be determined by the contractor.

6.5.3 Directly Embedded Pole Construction

The following items are important for the successful completion of directly embedded foundations:

- The Geotechnical Engineer or their representative should observe all excavations. Directly embedded pole construction observations are recommended to observe proper depth, bearing stratum and to record other observations regarding the construction.

- Excavations should be checked for size, and to determine all loose material and free water has been removed prior to the placement of the poles and annulus with crushed rock. Precautions should be taken during the placement of the poles and annulus materials to prevent loose excavated material from falling into the excavation.

- Prompt placement of the pole and annulus material in the excavation as it is completed, cleaned, and inspected is strongly recommended. Under no circumstances should a shaft excavation be drilled that cannot be filled with the pole and annulus material before the end of the workday.

- The pole placed in the shaft excavation should be designed to be stable and centered during the placement of the annulus backfill materials.

- Varying subsurface soil conditions may be encountered. A Geotechnical Engineer or his representative should observe subsurface conditions during installation of any drilled piers to verify subsurface conditions match the design criteria.

6.6 Open Excavations

With all excavations in soils, sloped excavations and trench shields are required for excavations greater than four feet in depth. The contractor's "Competent Person" (as defined by OSHA) must inspect each trench wall to determine the type of bench or slope that is required. With all excavations, only a "Competent Person" shall determine whether sloped, benched, or trench shields can be used. OSHA and applicable state and local standards should be observed and followed. Site safety is the responsibility of the contractor. For general planning purposes, RRC offers the following:

- The surficial cohesive clay soils across this site are generally stiff. This soil type classifies as an OSHA Type A material that requires the excavation's sidewall be sloped at 3/4H:1V (or flatter).

- The sandy soils at the site possess low to zero cohesion. This soil type classifies as an OSHA Type B material that requires the excavation's sidewall be sloped at a 1H:1V slope (or flatter). The silt content may give the appearance of cohesion when first excavated, but this is not correct.

- The presence of water within any excavation automatically creates a Type C classification. All Type C class excavations require a 1.5H:1V slope or bench.

- Stable Rock is a natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed, such as Limestone or Sandstone.

Protect construction slopes and permanent embankment slopes from surface runoff water. Design site grading to deter surface water from flowing down unprotected slopes. The contractor should avoid surcharge loads, either static or dynamic, adjacent to an excavation slope. Prevent construction equipment from traveling along or near the top of the excavation slope. The contractor's "Competent Person" must monitor temporary slopes, trenches, and dewatering during construction in order to detect early warnings of movement. Site safety is the responsibility of the contractor.

6.7 Drainage and Construction Dewatering

Proper drainage should be provided away from the foundation elements during all phases of construction and post-construction grading. Proper drainage is essential to the long-term stability of the structures. Ponding of water near the foundation elements from improper drainage should not be permitted.

Based on the available groundwater information, shallow groundwater should not be a concern for WTG foundation excavations. If rain causes perched water conditions, we anticipate the groundwater re-charge rate should be slow enough to conduct excavation dewatering with conventional sumps and pumps.

7.0 ACCESS ROADWAYS AND CRANE PADS

Private access roadways will be built for construction and maintenance purposes. Traffic volumes during construction are anticipated to be frequent with heavy equipment utilizing the access roadways. Following the construction period, the traffic volumes will be light and vehicles accessing the roadways will generally consist of pickup trucks and occasional single and multi-axle truck traffic. The section thickness design should be based upon the methodology outlined by the American Association of State Highways and Transportation Officials (AASHTO) for design of aggregate-surfaced roadways (reference 8).

Crane pads require sufficient bearing capacity to support the large cranes used to lift the turbine sections. The design intent for these crane pads is not related to regular traffic.

7.1 Pavement Section Thickness Recommendations

Based on the field exploration, lean clay, fat clay and clayey sand soils were encountered at the ground surface across the site. Clay soils are considered to be poor subgrades for roadways. The Contractor and the Civil Engineer should coordinate on traffic expectations for different roadways such as to value engineer road design for different areas of the facility.

Soaked CBR tests are compacted to 95% of the maximum dry density at optimum moisture content as determined by ASTM D698. Soaked CBR values of native soils ranged from 0.8% to 8.2%. RRC used a design CBR value of 2.0 %, which is correlated to a subgrade resilient modulus (M_R) value of 3,980 psi. It is important to understand that these CBR values are for soils without

topsoil. Leaving topsoil within the road subgrade will significantly reduce the CBR values, thus negating the recommendations below.

RRC anticipates that the project team will use crushed stone for the roadways. RRC recommends using crushed limestone that meets *North Dakota Department of Transportation, Section 816, Aggregate Class 5,* or better. Aggregate base materials should be compacted to a minimum of 95% of ASTM D1557. The thickness of the crushed stone base course is dependent on the traffic loads, traffic frequency, duration, and performance expectations. Crushed stone 'pavement' is not an engineered pavement and can be expected to require regular maintenance regardless of thickness. This is especially true if traffic is allowed onto it when saturated.

The following section provides a summary of design recommendations for aggregate base course roadways based on the 1993 AASHTO Design Manual. We used AASHTO's design chart for low-volume aggregate base surface roads, which designs based on acceptable rutting. Traffic 18-kip Equivalent Single-Axle Loads (ESAL) were estimated based upon our experience with similar type projects. For this project we estimate 1,000 ESAL for each turbine. AASHTO's 1993 nomograph from low-volume aggregate pavement design was utilized to calculate the required aggregate base layer thickness for the corresponding ESAL traffic load, with the following design parameters: 30,000 psi for the Modulus of Aggregate Base Layer (E_{BS}), 3,980 psi for the Resilient Modulus (M_R), and 2.0 and 3.0 inches for an Allowable Rut Depth. A summary of design parameters and recommended aggregate base course thickness are presented in Table 7.1.1.

Table 7.1.1 Summary of Aggregate Base Course Thickness

Number of WTG Sites per Private Access Roadway	ESAL	Aggregate Base Thickness (in.) - 2.0-inch Allowable Rutting	Aggregate Base Thickness (in.) - 3.0-inch Allowable Rutting
3 or less	3,000	5.0	4.0
5	5,000	5.5	4.5
10	10,000	7.5	5.5

RRC cautions that a 3-inch rut is essentially a failure for a roadway. Trucking and turbine providers typically reject this amount of rutting. We provide these values because it is part of the AASHTO method, and it provides the team with comparisons for the performance of different pavement cross-sections.

Strip and remove topsoil and vegetation prior to the placement of the aggregate base materials. Topsoil and organics could be up to about 8 inches or more in thickness in some areas and should not be allowed for use in structural areas or along roadway alignments. The exposed subgrade should then be compacted, and proof rolled to assess the presence of soft areas and the need for remedial measures, if any. Proof-roll test with at least two passes using a fully loaded water truck or similar. Maximum deflection or pumping should be less than one inch. In areas where excessive pumping of the subgrade is observed, removal unsuitable soils and re-compaction and/or replacement with road base. Aggregate base materials should be compacted to a minimum of 95% of ASTM D1557 where moisture content is not a pass/fail criteria.

As an alternative, consider placing geogrid (Tensar Biaxial Type 2 or equivalent) on top of geotextile (Mirafi HP 570 or equivalent) in areas where excessive pumping is observed. Consideration could also be given to performing a cement or lime mix design to stabilize the subgrade soils supporting pavement structures as an alternative. A formal cement or lime mix design should be performed prior to construction to determine design CBR values and aggregate base thicknesses.

7.2 Crane Pads Design and Construction Recommendations

This Section 7.2 works in conjunction with Section 6.4.3 within the turbine earthwork requirements. That previous section defines earthwork requirements for the overburden backfill. In areas where the crane pad does not overlap with the overburden backfill, then follow the subgrade requirements below.

The crane pad should extend at least two feet beyond the footprint of the crane tracks. Strip and remove topsoil, vegetation, and other deleterious materials. When the subgrade consists of soils, scarify and rework the resulting subgrade to a depth of 12 inches. Compact the reworked soils to a minimum of 98% of the maximum dry density per ASTM D698. Also, the contractor's use of mats can affect the necessary compaction requirement.

After verifying subgrade density, perform a proof-roll test using a fully loaded water truck, or similar equipment. Conduct the proof-roll in two directions and perform at least two passes per location. Maximum allowable deflection under the proof-roll is 1-inch. If higher deflections are observed, the subgrade soil should be over-excavated to suitable material and replaced with either Select Fill or Structural Fill, defined in Section 6.

Once a suitable subgrade condition has been achieved, use flexible road base aggregate materials (structural fill) to construct the crane pad. The pad should be at least 9-inches thick. The aggregate base should conform to the requirements of Section 6.2 of this report. Compact to a minimum of 95% of the maximum dry density as determined in accordance with ASTM D1557. Moisture is not a test criteria.

These recommendations are expected to provide an ultimate bearing capacity of 5,000 psf at the finished surface. This value assumes a crane track width of six feet, treated as a mat bearing on the ground surface.

For cranes that impart loads more than that provided above, alternate designs will be necessary. The crane operators can consider load distribution mats, such as timber mats or composite mats. If crane mats are to be used, RRC should be retained to review the design of the crane mats to check that bearing capacities are met. Otherwise, an alternate crane pad cross section may be necessary.

8.0 LIMITATIONS

Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory tests, and our present knowledge of the proposed construction. It is likely soil conditions will vary between or beyond the points explored. If soil conditions are encountered during construction that differ from those described herein, we should be notified immediately in order to provide supplemental recommendations (if needed). If the scope of the proposed construction, including the proposed loads or structural locations, changes from those described in this report, our data should also be reviewed.

We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report assume RRC will conduct an adequate program of tests and observations during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the client and only for the purposes stated, within three years from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client, or the client's design team members for this project, who wishes to use this report shall notify RRC of such intended use. Based on the intended use of the report, RRC may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release RRC from any liability resulting from the use of this report by any unauthorized party.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference," as that latter term is used relative to contracts or other matters of law.

9.0 REFERENCES

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APPENDIX A

Table A1 - Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Groundwater During Drilling (ft,bgs)	Groundwater Immediately After Drilling (ft,bgs)	Minimum Piezometer Groundwater Level (bgs,ft.)	Estimated Design Groundwater Depth (bgs,ft.)	Net Allowable Bearing Capacity (qnet all) Under Normal Operating Load Conditions Based on Foundation Bearing Elevation 13 ft. (psf)	Required Soil Improvement Depth Below Existing Ground Surface (ft,bgs)	Recommended Soil Improvement to Achieve a Net Allowble Bearing Capacity of 3,000 psf (ft,bgs)	Remarks
GEO-001	46.928605	-101.860052	T01			--	20.0	2,000		14	Recommended ground improvement / Over-excavation and Replacement w/ Structural Fill
GEO-002	46.936340	-101.861568	T02			--	20.0	3,500			
GEO-003	46.939368	-101.854080	T03			--	20.0	3,000			
GEO-004	46.937945	-101.847728	T04			--	20.0	3,500	25		Deep Soil Improvement
GEO-005	46.935278	-101.841595	T05			--	20.0	3,500			
GEO-006	46.930996	-101.826168	T06			--	20.0	3,500			
GEO-007	46.913460	-101.838517	T07			--	20.0	3,000			
GEO-008	46.916400	-101.834600	T08			--	20.0	3,500			
GEO-009	46.921153	-101.828370	T09			--	20.0	3,500			
GEO-010	46.921172	-101.821962	T10			--	20.0	3,500			
GEO-011	46.921497	-101.813248	T11			--	20.0	3,250			
GEO-012	46.921525	-101.806480	T12			12.0	11.0	3,500			
GEO-013	46.900807	-101.826790	T13			--	20.0	3,500			
GEO-014	46.900966	-101.819722	T14			--	20.0	3,500			
GEO-015	46.900394	-101.810586	T15			--	20.0	3,500			
GEO-016	46.904707	-101.805945	T16			--	20.0	2,500			
GEO-017	46.886948	-101.814793	T17			--	20.0	3,500			
GEO-018	46.885050	-101.808962	T18			--	20.0	3,500			
GEO-019	46.886566	-101.800295	T19			--	20.0	3,500			
GEO-020	46.976011	-101.763598	T20			--	20.0	3,500			
GEO-021	46.973311	-101.752139	T21			--	20.0	3,500			
GEO-022	46.973116	-101.745499	T22			--	20.0	3,500			
GEO-023	46.975381	-101.721823	T23			--	20.0	3,500			
GEO-024	46.968427	-101.723739	T24			--	20.0	3,500			
GEO-025	46.959730	-101.706249	T25			--	20.0	3,500			
GEO-026	46.961450	-101.700128	T26			--	20.0	3,500			
GEO-027	46.961464	-101.693477	T27			--	20.0	3,500			
GEO-028	46.953950	-101.786611	T28			--	20.0	3,500			
GEO-029	46.959220	-101.764704	T29			12.0	11.0	3,500			
GEO-030	46.951333	-101.765145				--	20.0				Not Investigated
GEO-031	46.954390	-101.753974	T31			--	20.0	3,250			
GEO-032	46.955296	-101.743890				--	20.0				Not Investigated
GEO-033	46.954002	-101.730960	T33			--	20.0	3,500	18		Deep soil improvement
GEO-034	46.954983	-101.724356	T34			--	20.0	3,500			
GEO-035	46.944218	-101.753027	T35			--	20.0	3,500			
GEO-036	46.941605	-101.746654	T36			1.3	0.3	3,500	20		Deep soil improvement
GEO-037	46.942772	-101.740419	T37			--	20.0	3,500	15		Over-Excavation and Replacement w/ Structural Fill
GEO-038	46.940588	-101.731712	T38			--	20.0	3,000			
GEO-039	46.945336	-101.725459	T39			--	20.0	3,500			
GEO-040	46.939113	-101.709620	T40			--	20.0	3,500			
GEO-041	46.938437	-101.721078	T41								Not Investigated
GEO-042	46.940888	-101.695081	T42			--	20.0	3,500			
GEO-043	46.939567	-101.785665	T43			--	20.0	3,500			
GEO-044	46.937839	-101.767572	T44			--	20.0	2,500			
GEO-045	46.935204	-101.795228	T45			--	20.0	3,500			
GEO-046	46.932590	-101.787606	T46			--	20.0	3,500			
GEO-047	46.932651	-101.777749	T47			--	20.0	3,500			
GEO-048	46.922343	-101.767967	T48			--	20.0	3,500			
GEO-049	46.926427	-101.762739	T49			--	20.0	2,500			
GEO-050	46.923447	-101.751849	T50			--	20.0	3,500			
GEO-051	46.922422	-101.730508	T51			--	20.0	3,250			
GEO-052	46.923094	-101.724068	T52			--	20.0	3,500			
GEO-053	46.922764	-101.713804	T53			--	20.0	2,750	15		Over-excavation and Replacement w/ Structural Fill
GEO-054	46.922576	-101.705791	T54			--	20.0	3,000			
GEO-055	46.930926	-101.689845				--	20.0				Not Investigated
GEO-056	46.907994	-101.725116	T56			--	20.0	3,500			
GEO-057	46.910611	-101.712133	T57			--	20.0	3,500			
GEO-058	46.915340	-101.703733	T58			--	20.0	3,500			
GEO-059	46.911737	-101.695736	T59			--	20.0	3,500			
GEO-060	46.918971	-101.692605				--	20.0	3,500			Removed from L011
GEO-061	46.909107	-101.683665	T61			2.3	1.3	3,500			
GEO-062	46.908347	-101.677053	T62			--	20.0	3,000			
GEO-063	46.903391	-101.708698	T63			--	20.0	3,250			
GEO-064	46.903570	-101.686788	T64			--	20.0	3,500			
GEO-065	46.897699	-101.696096	T65			--	20.0	3,500			

Updated on ***9/19/2025***

Table A1 - Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Groundwater During Drilling (ft,bgs)	Groundwater Immediately After Drilling (ft,bgs)	Minimum Piezometer Groundwater Level (bgs,ft.)	Estimated Design Groundwater Depth (bgs,ft.)	Net Allowable Bearing Capacity (qnet all) Under Normal Operating Load Conditions Based on Foundation Bearing Elevation 13 ft. (psf)	Required Soil Improvement Depth Below Existing Ground Surface (ft,bgs)	Recommended Soil Improvement to Achieve a Net Allowble Bearing Capacity of 3,000 psf (ft,bgs)	Remarks
GEO-066	46.896434	-101.676574	T66			--	20.0	3,000			
GEO-067	46.897586	-101.664957	T67			--	20.0	3,500			
GEO-068	46.896070	-101.651180	T68			--	20.0	3,000			
GEO-069	46.890090	-101.683948	T69			--	20.0	3,000			
GEO-070	46.881269	-101.690206	T70			--	20.0	3,500			
GEO-071	46.951278	-101.767572	T30			--	20.0	3,500			

NE = Not Encountered

Table A2 - Summary of Subsurface Exploration and Geographic Coordinates

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Turbine/Boring ID (L009_03.19.25)2	MASW Survey	Electrical Resistivity Testing	Thermal Resistivity Samples	Piezometer Location	Piezometer Installation Date	Test/ Drilling Date	Auger (ft)	Air/Mud Rotary (ft)	Total Depth (ft)	Groundwater During Drilling (ft.)	Groundwater Immediately After Drilling (ft.)	Groundwater 24-Hours After Drilling (ft.)	Remarks
GEO-001	46.928605	-101.860052	T01	T01		5/14/2025	4/25/2025			04/25/25	55.5	0.0	55.5	30	52	NA	
GEO-002	46.936340	-101.861568	T02	T02						04/25/25	55.0	0.0	55.0	NE	NE	NA	
GEO-003	46.939368	-101.854080	T03	T03						04/24/25-04/25/25	55.5	0.0	55.5	NE	NE	NA	
GEO-004	46.937945	-101.847728	T04	T04	5/10/2025					04/25/25	55.0	0.0	55.0	NE	NE	NA	
GEO-005	46.935278	-101.841595	T05	T05						04/26/25	55.5	0.0	55.5	34	48	NA	
GEO-006	46.930996	-101.826168	T06	T06						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-007	46.913460	-101.838517	T07	T07						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-008	46.916400	-101.834600	T08	T08		5/14/2025	4/23/2025			04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-009	46.921153	-101.828370	T09	T09						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-010	46.921172	-101.821962	T10	T10		5/14/2025	4/24/2025			04/23/25 - 04/24/25	55.0	0.0	55.0	NE	NE	NA	
GEO-011	46.921497	-101.813248	T11	T11						04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-012	46.921525	-101.806480	T12	T12				X	4/24/2025	04/24/25	55.5	0.0	55.5	19	44	NA	
GEO-013	46.900807	-101.826790	T13	T13						04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-014	46.900966	-101.819722	T14	T14	5/10/2025					04/22/25	55.5	0.0	55.5	34	48	NA	
GEO-015	46.900394	-101.810586	T15	T15						04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-016	46.904707	-101.805945	T16	T16						04/21/25 - 04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-017	46.886948	-101.814793	T17	T17						04/21/25	55.5	0.0	55.5	49	52	NA	
GEO-018	46.885050	-101.808962	T18	T18	5/10/2025					04/21/25	55.5	0.0	55.5	44	44	NA	
GEO-019	46.886566	-101.800295	T19	T19		5/17/2025	4/21/2025			04/21/25	55.5	0.0	55.5	NE	NE	NA	
GEO-020	46.976011	-101.763598	T20	T20						04/30/25	55.5	0.0	55.5	NE	NE	NA	
GEO-021	46.973311	-101.752139	T21	T21						05/11/25	54.5	0.0	54.5	39	23	NA	
GEO-022	46.973116	-101.745499	T22	T22		5/6/2025	5/9/2025			05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-023	46.975381	-101.721823	T23	T23						05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-024	46.968427	-101.723739	T24	T24						05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-025	46.959730	-101.706249	T25	T25						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-026	46.961450	-101.700128	T26	T26						05/08/25	55.5	0.0	55.5	39	50	NA	
GEO-027	46.961464	-101.693477	T27	T27						05/09/25	55.0	0.0	55.0	NE	NE	NA	
GEO-028	46.953950	-101.786611	T28	T28						04/26/25	55.5	0.0	55.5	35	52	NA	
GEO-029	46.959220	-101.764704	T29	T29	5/10/2025			X	4/29/2025	04/29/25	55.5	0.0	55.5	9	55	NA	
GEO-030	46.951333	-101.765145		T30													**Relocated ~ 600 ft. from L011, See GEO-071**
GEO-031	46.954390	-101.753974	T31	T31						05/02/25	55.5	0.0	55.5	49	49	NA	
GEO-032	46.955296	-101.743890		T32													**Removed From L011**
GEO-033	46.954002	-101.730960	T33	T33	5/9/2025	5/18/2025	5/3/2025			05/03/25	55.5	0.0	55.5	NE	NE	NA	
GEO-034	46.954983	-101.724356	T34	T34						05/04/25	55.0	0.0	55.0	NE	NE	NA	
GEO-035	46.944218	-101.753027	T35	T35						04/03/25	55.5	0.0	55.5	30	NE	NA	
GEO-036	46.941605	-101.746654	T36	T36				X	5/5/2025	05/05/25	55.5	0.0	55.5	12	47	NA	
GEO-037	46.942772	-101.740419	T37	T37						05/04/25 - 04/05/25	54.5	0.0	54.5	NE	NE	NA	
GEO-038	46.940588	-101.731712	T38	T38						05/01/25	42.5	0.0	42.5	NE	NE	NA	
GEO-039	46.945336	-101.725459	T39	T39						05/04/25	55.5	0.0	55.5	49	54	NA	
GEO-040	46.939113	-101.709620	T40	T40						04/27/25	55.0	0.0	55.0	NE	NE	NA	
GEO-041	46.938437	-101.721078	T41	T41													**Non Participating Landowner per email 04.04.25**
GEO-042	46.940888	-101.695081	T42	T42						05/10/25	55.5	0.0	55.5	30	54	NA	
GEO-043	46.939567	-101.785665	T43	T43						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-044	46.937839	-101.767572	T44	T44						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-045	46.935204	-101.795228	T45	T45						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-046	46.932590	-101.787606	T46	T46		5/13/2025	4/26/2025			04/26/25	55.0	0.0	55.0	NE	NE	NA	
GEO-047	46.932651	-101.777749	T47	T47						04/27/25	55.5	0.0	55.5	45	48	NA	
GEO-048	46.922343	-101.767967	T48	T48		5/18/2025	5/5/2025			05/05/25	52.5	0.0	52.5	NE	NA	NA	
GEO-049	46.926427	-101.762739	T49	T49						05/06/25	55.5	0.0	55.5	NE	NE	NA	
GEO-050	46.923447	-101.751849	T50	T50						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-051	46.922422	-101.730508	T51	T51						05/10/25	55.0	0.0	55.0	NE	NE	NA	
GEO-052	46.923094	-101.724068	T52	T52						05/08/25 - 05/09/202	55.5	0.0	55.5	NE	NE	NA	
GEO-053	46.922764	-101.713804	T53	T53		5/18/2025	5/6/2025			05/06/25	55.5	0.0	55.5	NE	NE	NA	
GEO-054	46.922576	-101.705791	T54	T54						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-055	46.930926	-101.689845		T55													**Removed From L011**
GEO-056	46.907994	-101.725116	T56	T56						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-057	46.910611	-101.712133	T57	T57						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-058	46.915340	-101.703733	T58	T58						4/27/2025 - 05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-059	46.911737	-101.695736	T59	T59		5/17/2025	4/26/2025			04/26/25	55.5	0.0	55.5	34	NA	NA	
GEO-060	46.918971	-101.692605	T60	T60						04/25/25 - 04/26/25	55.5	0.0	55.5	NE	NE	NA	**Removed From L011**
GEO-061	46.909107	-101.683665	T61	T61				X	4/25/2025	04/25/25	55.5	0.0	55.5	24	NE	NA	
GEO-062	46.908347	-101.677053	T62	T62		5/17/2025	5/7/2025			05/06/25	55.5	0.0	55.5	34	52	NA	
GEO-063	46.903391	-101.708698	T63	T63						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-064	46.903570	-101.686788	T64	T64	5/9/2025					04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-065	46.897699	-101.696096	T65	T65						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-066	46.896434	-101.676574	T66	T66						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-067	46.897586	-101.664957	T67	T67		5/17/2025	4/26/2025			04/25/25	55.5	0.0	55.5	45	NA	NA	
GEO-068	46.896070	-101.651180	T68	T68						04/23/25	54.5	0.0	54.5	NE	NE	NA	
GEO-069	46.890090	-101.683948	T69	T69						04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-070	46.881269	-101.690206	T70	T70		5/11/2025	4/24/2025			04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-071	46.951278	-101.767572	T30							05/03/25	55.5	0.0	55.5	25	NE	NA	
TL-01	46.986205	-101.766771								04/29/25	50.5	0.0	50.5	NE	NE	NA	

Table A2 - Summary of Subsurface Exploration and Geographic Coordinates

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Turbine/Boring ID (L009_03.19.25)2	MASW Survey	Electrical Resistivity Testing	Thermal Resistivity Samples	Piezometer Location	Piezometer Installation Date	Test/ Drilling Date	Auger (ft)	Air/Mud Rotary (ft)	Total Depth (ft)	Groundwater During Drilling (ft.)	Groundwater Immediately After Drilling (ft.)	Groundwater 24-Hours After Drilling (ft.)	Remarks
TL-02	46.984606	-101.766776								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-03	46.982158	-101.766783								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-04	46.980259	-101.766789								04/29/25	50.5	0.0	50.5	NE	NE	NA	
TL-05	46.980257	-101.763791								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-06	46.980255	-101.760946								04/30/25	50.5	0.0	50.5	NE	NE	NA	
TL-07	46.978169	-101.760927								04/30/25	30.5	0.0	30.5	NE	NE	NA	
TL-08	46.976028	-101.760909								04/30/25	30.5	0.0	30.5	NE	NE	NA	
TL-09	46.973915	-101.760890								05/01/25	30.5	0.0	30.5	NE	NE	NA	
TL-10	46.971640	-101.760870								05/01/25	30.5	0.0	30.5	24	24	NA	
TL-11	46.969358	-101.760850								05/01/25	30.5	0.0	30.5	29	28	NA	
TL-12	46.967150	-101.760831								05/02/25	30.5	0.0	30.5	7	6.5	NA	
TL-13	46.964992	-101.760811								05/02/25	50.5	0.0	50.5	NE	NE	NA	
TL-14	46.964315	-101.761887								05/02/25	50.5	0.0	50.5	NE	NE	NA	
TL-15	46.962040	-101.761888								05/06/25	30.5	0.0	30.5	24	NA	NA	
TL-16	46.960133	-101.761890								04/29/25	30.5	0.0	30.5	25	27	NA	
TL-17	46.958219	-101.761891								04/29/25	30.5	0.0	30.5	12	54	NA	
TL-18	46.956549	-101.761892								04/29/25	50.5	0.0	50.5	10	47	NA	
MET-01	46.975132	-101.747075															
MET-02	46.937508	-101.754410															
MET-03	46.894016	-101.661035								04/23/25	34.5	0.0	34.5	NE	NE	NA	
PMM1	46.976921	-101.747421								05/11/25	35.5	0.0	35.5	NE	NE	NA	
PMM2	46.938197	-101.755101								05/05/25	35.5	0.0	35.5	NE	NE	NA	**Moved ~120 ft. to avoid transmission line**
PMM3	46.894397	-101.662007								05/07/25	34.5	0.0	34.5	NE	NE	NA	
ADLS-01	46.927989	-101.795361															
ADLS-02	46.927981	-101.795351								05/07/25	35.5	0.0	35.5	NE	NE	NA	
DSR-1	46.955511	-101.761935				5/12/2025				5/12/2025							
DSR-2	46.957204	-101.763285				5/12/2025				5/12/2025							
TSR-1	46.954950	-101.762055				5/13/2025				5/13/2025							
TSR-2	46.955006	-101.760905				5/13/2025				5/13/2025							
TSR-3	46.955567	-101.760980				5/12/2025				5/12/2025							
HA-1	46.955771	-101.762488								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-2	46.955782	-101.761487								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-3	46.955793	-101.760486								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-4	46.955223	-101.762475								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-5	46.955234	-101.761474								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-6	46.955245	-101.760473								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-7	46.954675	-101.762462								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-8	46.954686	-101.761461								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-9	46.954697	-101.760460								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-10	46.954106	-101.761659								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-11	46.954113	-101.760954								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-12	46.953608	-101.761295								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-13	46.953102	-101.761635								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-14	46.953110	-101.760931								05/01/25	5.0	0.0	5.0	NE	NE	NA	
SB-1	46.955712	-101.761785								05/01/25	40.5	0.0	40.5	19.8	33	NA	
SB-2	46.955535	-101.762072					5/6/2025			05/01/25	40.5	0.0	40.5	14	35	NA	
SB-3	46.955049	-101.762273						X	5/1/2025	04/30/25	40.5	0.0	40.5	14	35	NA	
SB-4	46.955054	-101.761848								04/30/25	40.5	0.0	40.5	12	33	NA	
SB-5	46.954784	-101.761958								04/29/25	40.5	0.0	40.5	12.5	30	NA	
SB-6	46.955549	-101.760791								05/01/25	40.5	0.0	40.5	19	29	NA	
SB-7	46.955058	-101.761344								04/30/25	40.5	0.0	40.5	13	34	NA	
SB-8	46.954797	-101.760801								04/30/25	40.5	0.0	40.5	19	35	NA	
SB-9	46.953917	-101.761302								05/01/25	15.5	0.0	15.5	NE	NE	NA	
SB-10	46.953298	-101.761288								05/01/25	15.5	0.0	15.5	NE	NE	NA	
O&M -1	46.950414	-101.762334								05/03/25	35.0	0.0	35.0	18	25	NA	

NE = Not Encounter, NA = Not Available

Table A3: Well Log Information Obtained from the North Dakota Department of Water Resources

Well Report No. (NDDWR)	**Latitude**	**Longitude**	**Well Depth** (feet below land surface)	**Water Level Record** (feet below land surface)	**Date of Record** (YYYY/MM/DD)
9060	46.944751	-101.785024	890	278.8	1978/07/24
20703	46.944751	-101.785024	400	225.9	1977/10/12
9064	46.935761	-101.896039	380	13.4	1978/07/07
9066	46.899611	-101.845919	400	42.7	1993/12/07
8467	46.982237	-101.897894	380	27.7	1978/06/30
9056	46.954666	-101.699212	N/D	20.0	1967/06/20
9046	46.94992	-101.577623	N/D	10.0	1967/05/15
9049	46.954421	-101.542125	154.0	84.0	1967/06/04
9006	46.863352	-101.932869	380.0	1.4	2020/05/29
9009	46.861534	-101.930243	N/D	1.9	1973/10/24
8985	46.846777	-101.635774	360.0	104.3	1994/05/04
8988	46.878104	-101.827556	N/D	39.7	1975/08/05
8989	46.848936	-101.779908	360.0	42.6	1973/08/24

N/D = No Data Available

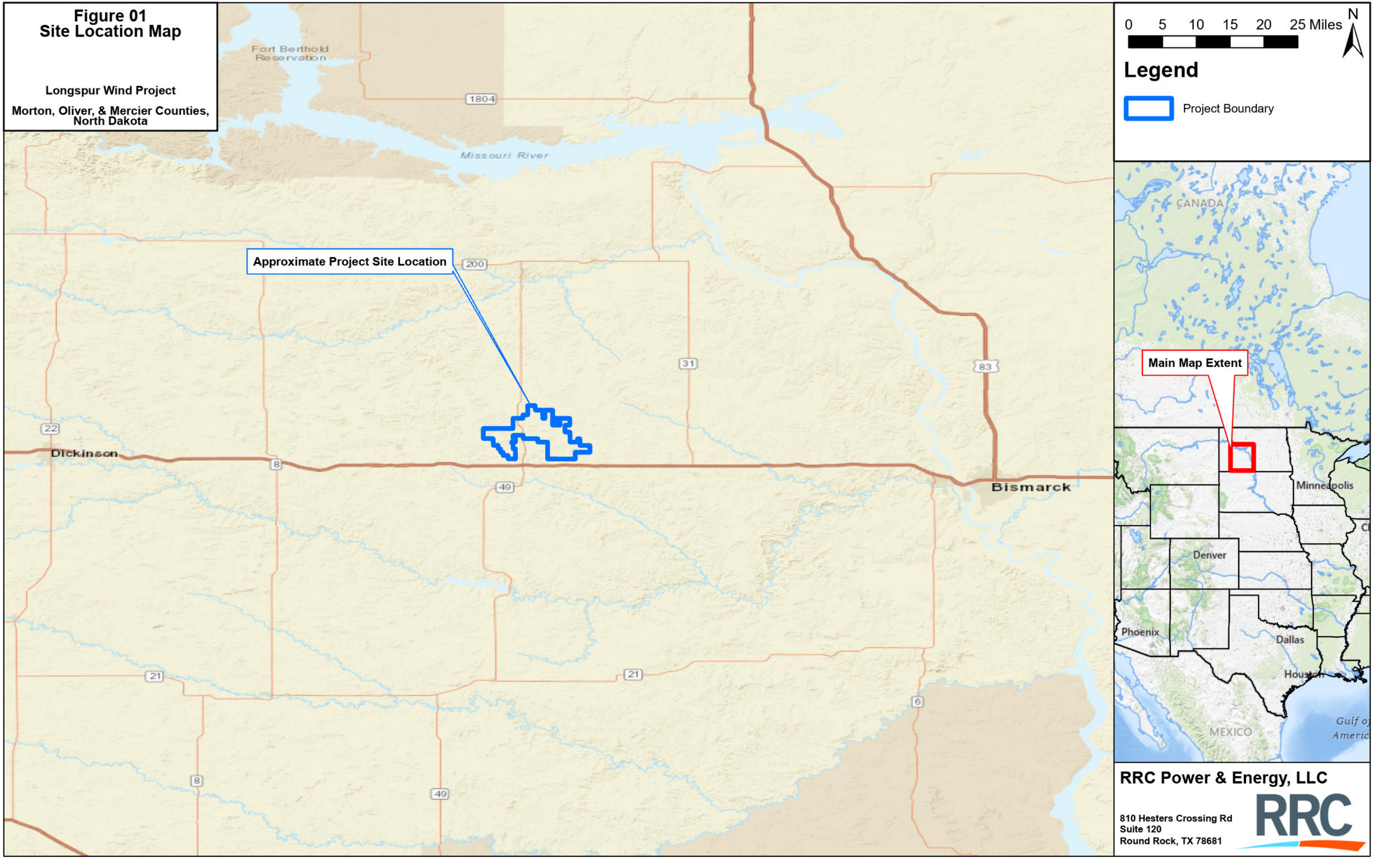
Table A4 - Summary of Measured Groundwater Levels in Temporary Piezometers Installed at Selected WTG Sites

Temp Piezometer No.	Latitude	Longitude	Date Installed	Total Depth of Temporary Piezometer (ft.) Below Existing Ground Surface	Height of Temp Piezometer Stick-up (ft.) Above Existing Site Grade	GWL (ft.) After Installation	GWL (ft.) 24 hrs after Installation	GWL (ft.) 48 hrs after Installation	GWL (ft.) 72 hrs after Installation	GWL (ft.) (05/18/25)	Minimum GWL (ft.)
GEO-012	46.921525	-101.806480	04/24/2025	18.00	2.00	NE	15.25	15.42	14.00	12.00	12.00
GEO-029	46.959220	-101.764704	04/29/2025	18.00	2.00	15.80	14.20	13.70	13.00	12.00	12.00
GEO-036	46.941605	-101.746654	05/05/2025	18.00	2.00	3.50	1.25	1.92	2.00	2.00	1.25
GEO-061	46.909107	-101.683665	04/25/2025	18.00	2.00	7.30		2.33		3.00	2.33
SB-4	46.955049	-101.762273	05/01/2025	18.00	2.00	7.00	7.50	9.33	9.42	7.00	7.00

Figure 01
Site Location Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



RRC Power & Energy, LLC

810 Hesters Crossing Rd
Suite 120
Round Rock, TX 78681

Figure 02
WTG Boring Locations on a Topographic Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota

0 0.5 1 1.5 2 Miles

N

Legend

- Turbine locations (L011)
- Turbine locations removed from (L011)
- Project Boundary

GEO-001, GEO-002, GEO-003, GEO-004, GEO-005, GEO-006, GEO-007, GEO-008, GEO-009, GEO-010, GEO-011, GEO-012, GEO-013, GEO-014, GEO-015, GEO-016, GEO-017, GEO-018, GEO-019, GEO-020, GEO-021, GEO-022, GEO-023, GEO-024, GEO-025, GEO-026, GEO-027, GEO-028, GEO-029, GEO-031, GEO-033, GEO-034, GEO-035, GEO-036, GEO-037, GEO-038, GEO-039, GEO-040, GEO-042, GEO-043, GEO-044, GEO-045, GEO-046, GEO-047, GEO-048, GEO-049, GEO-050, GEO-051, GEO-052, GEO-053, GEO-054, GEO-056, GEO-057, GEO-058, GEO-059, GEO-060, GEO-061, GEO-062, GEO-063, GEO-064, GEO-065, GEO-066, GEO-067, GEO-068, GEO-069, GEO-070, GEO-071

MORTON CO, MERCER CO, OLIVER CO

POWERLINE

Beaver Cr, Haymarsh Creek, Strip Mine, Gravel Pit, Gravel Pits, Hailstone, Spring, Springs

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Figure 03
Substation & O&M Boring Locations on a Topographic Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota

0 0.5 1 1.5 2 Miles

N

Legend

- Substation Borings
- O&M Boring Locations
- Project Boundary

HA-1 SB-1 HA-2 HA-3 SB-2 SB-6 HA-4 HA-5 HA-6 SB-3 SB-4 SB-7 SB-8 HA-7 HA-8 HA-9 SB-5 HA-10 HA-11 SB-9 HA-12 SB-10 HA-13 HA-14

O&M -1

0 500 1,000 1,500 Feet

MERCER CO

OLIVER CO

MORTON CO

R 88 W

R 87 W

Beaver Cr

Spring

Gravel Pit

Gravel Pits

Hailstone Butte

STORM CREEK LAKE STATE WILDLIFE MANAGEMENT AREA

POWERLINE

Strip Mine

Creek

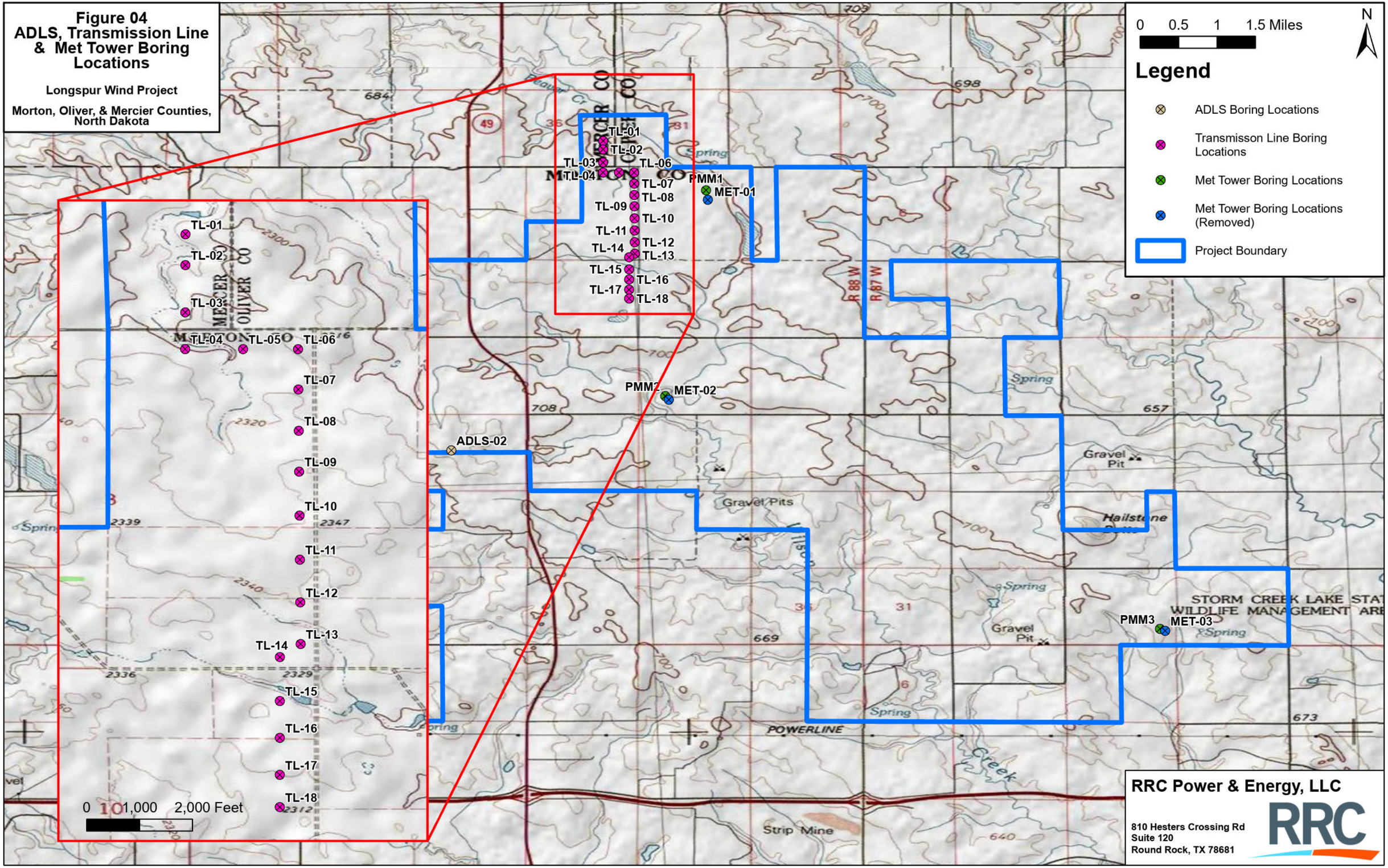
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Figure 04
ADLS, Transmission Line & Met Tower Boring Locations

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



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Figure 05
MASW, Electrical Resistivity (ER) and Thermal Resistivity (TR) Testing Locations Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota

0 0.5 1 1.5 2 Miles

N

Legend

- MASW Survey Locations
- TR & ER Survey Locations
- MASW, TR, & ER Survey Locations
- Project Boundary

GEO-029

GEO-033

GEO-004

GEO-014

GEO-018

GEO-064

Mercer

Morton

Morton

49

94

Highway 49

Hailsone Creek

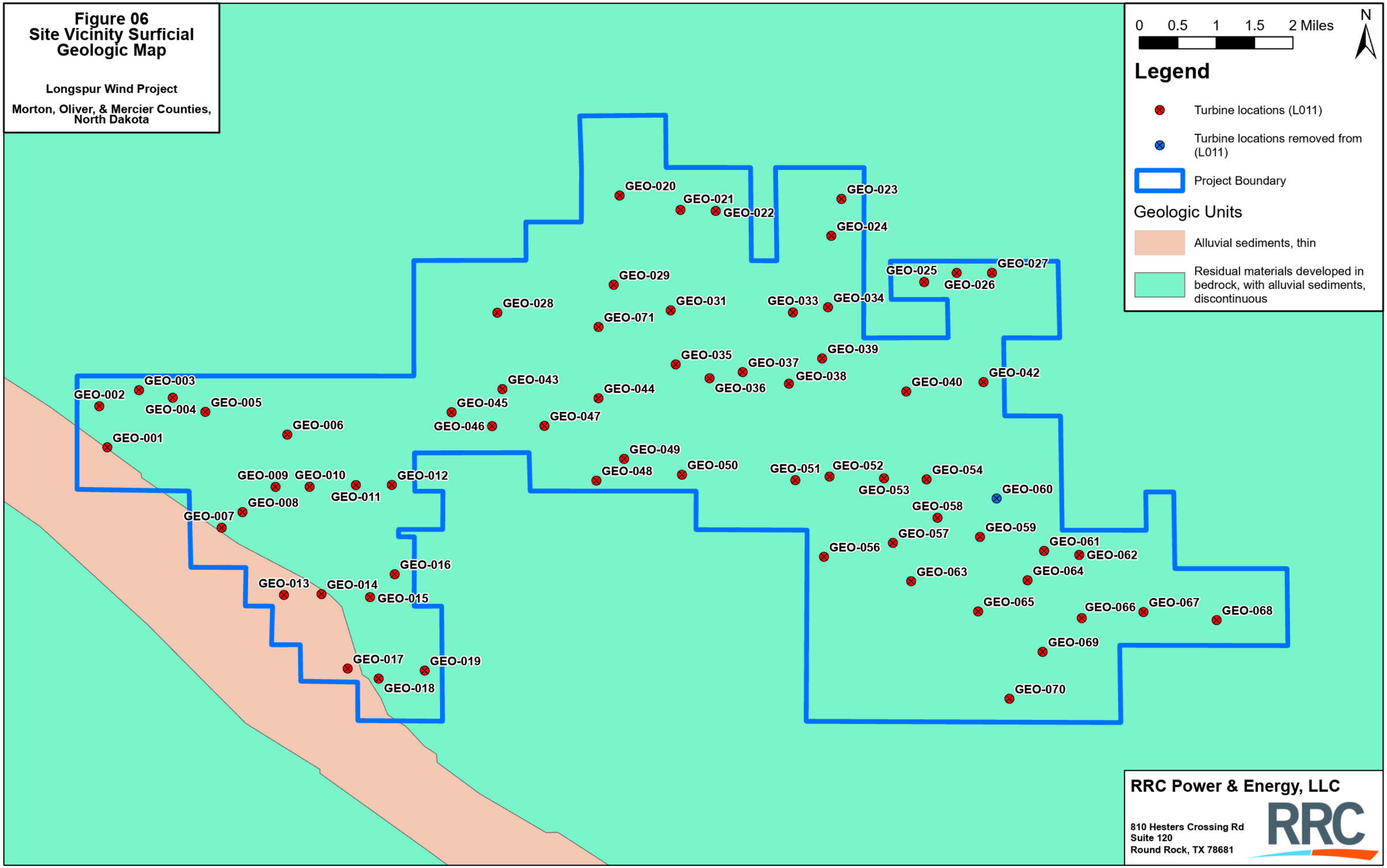
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Figure 06
Site Vicinity Surficial Geologic Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



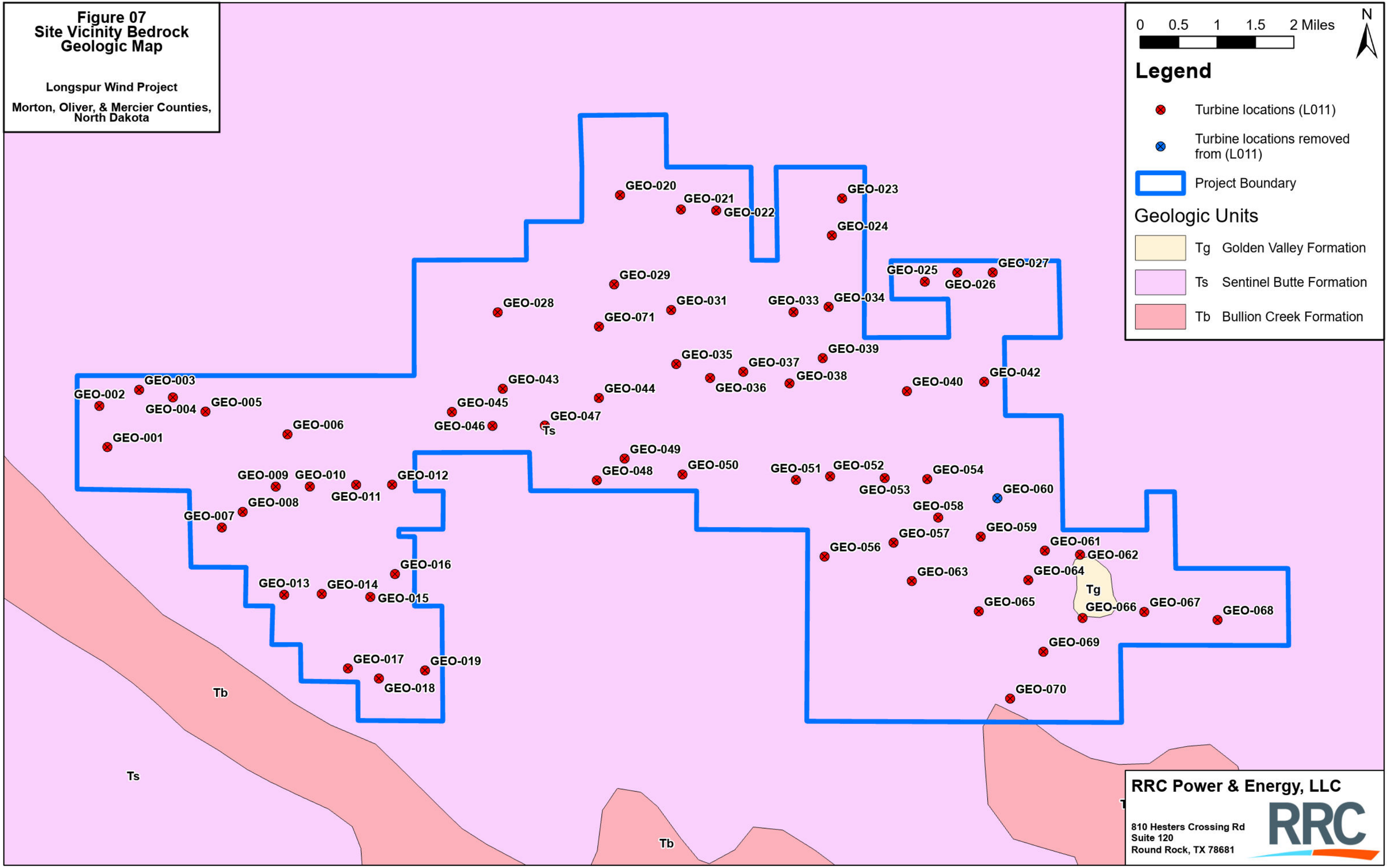
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Figure 07
Site Vicinity Bedrock Geologic Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



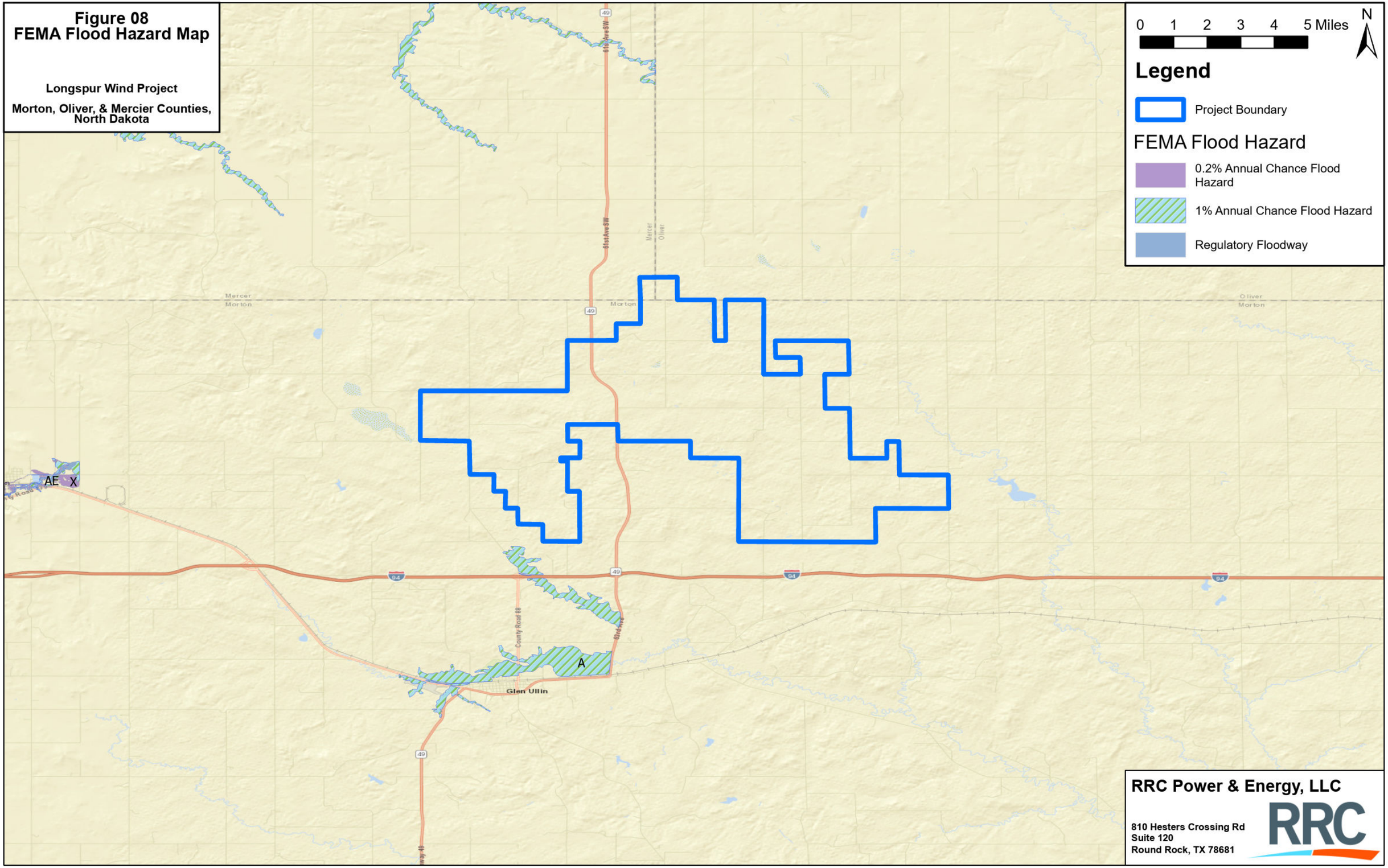
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Figure 08
FEMA Flood Hazard Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



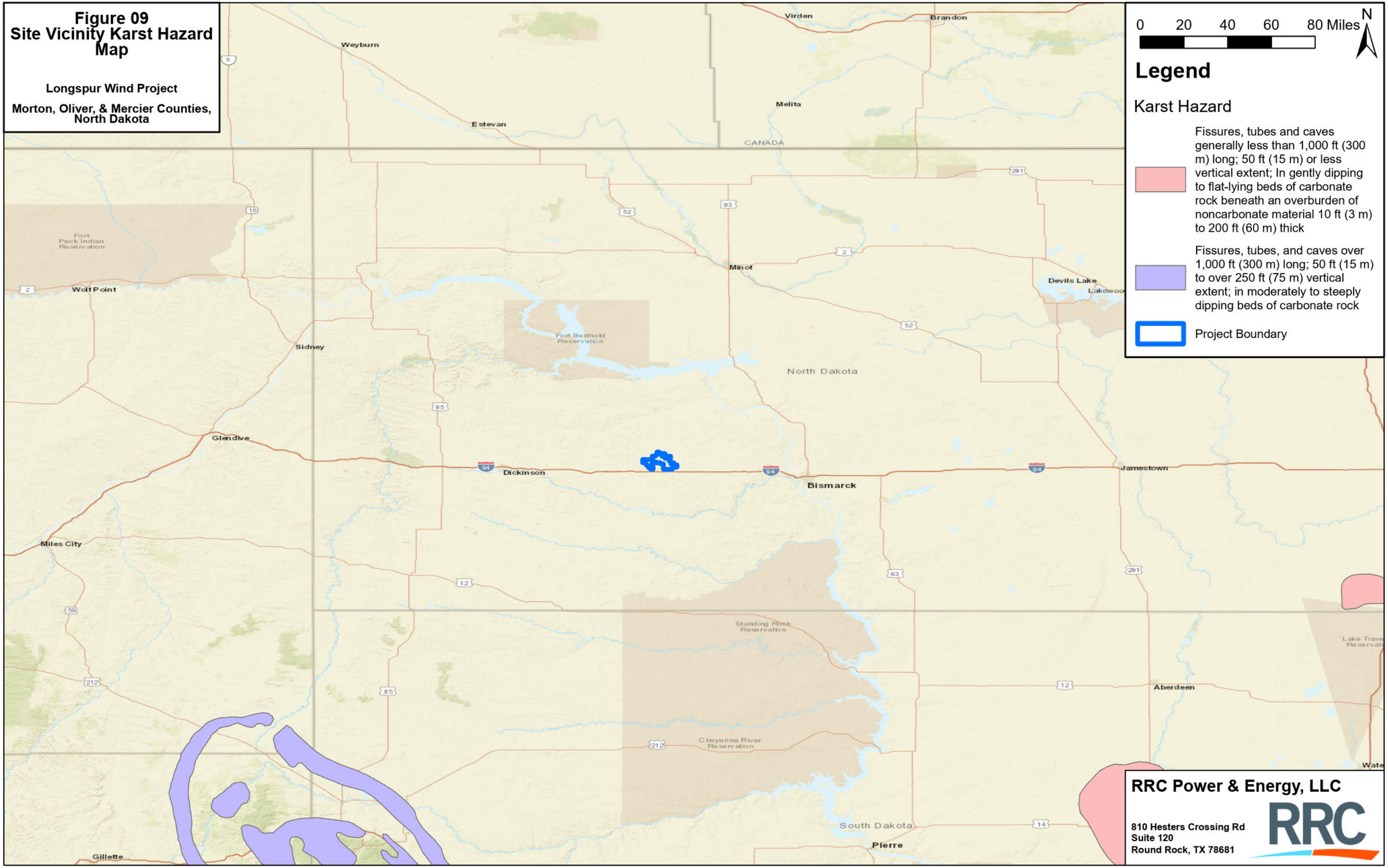
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Figure 09
Site Vicinity Karst Hazard Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



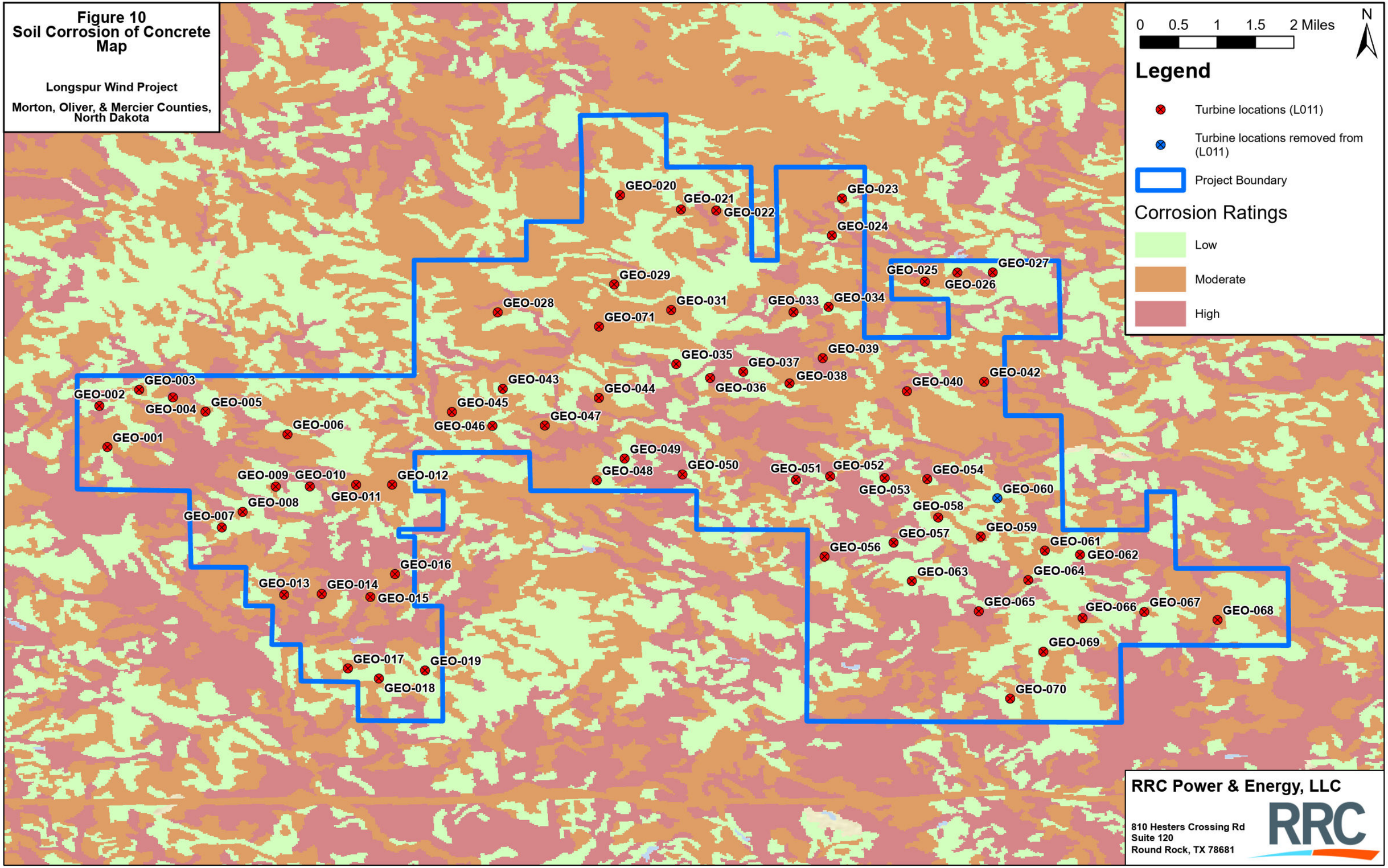
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Figure 10
Soil Corrosion of Concrete Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



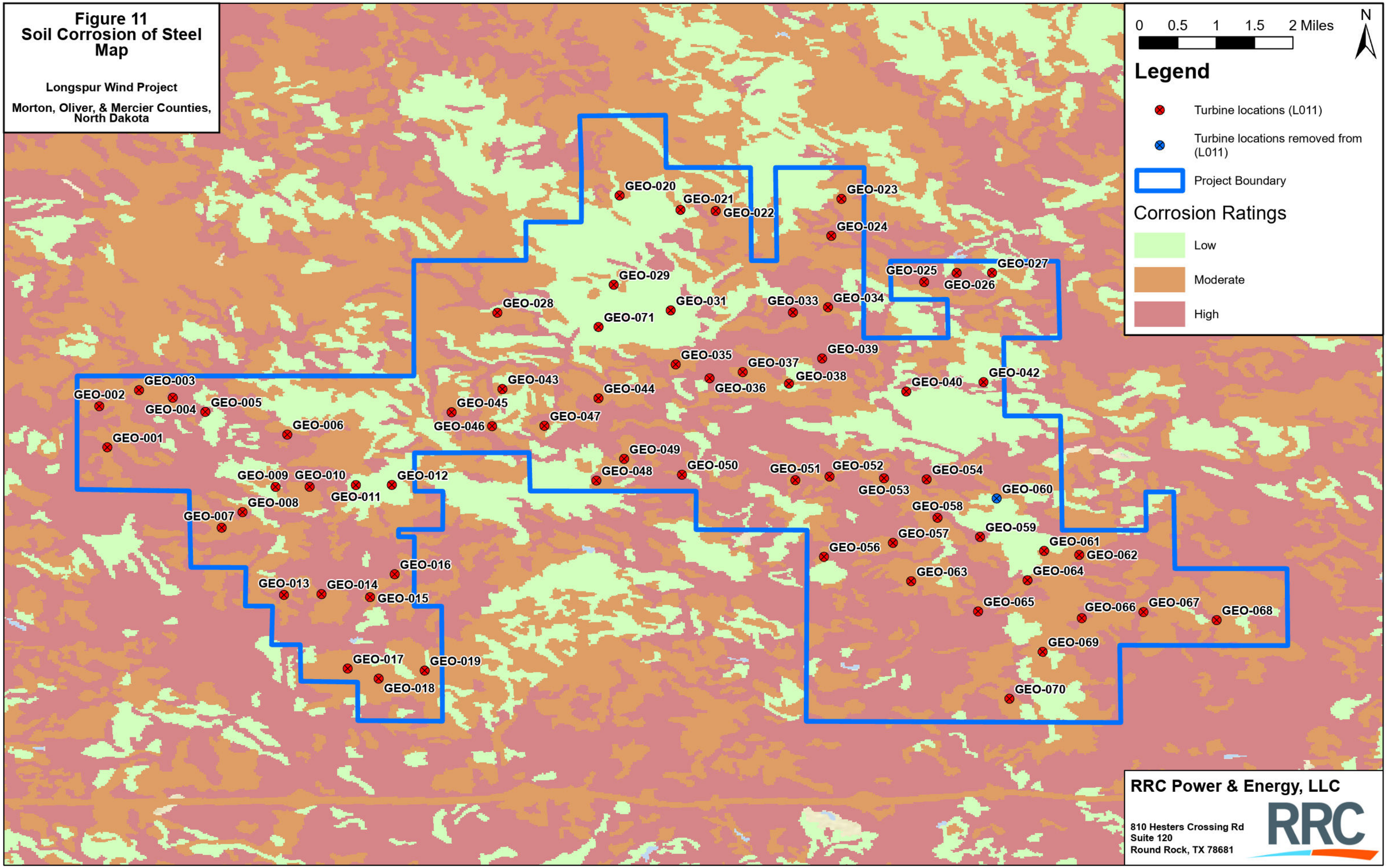
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Figure 11
Soil Corrosion of Steel Map

Longspur Wind Project

Morton, Oliver, & Mercier Counties, North Dakota



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Round Rock, TX 78681

Figure 12
Water Well Locations Obtained from the North Dakota Water Development Board

Longspur Wind Project
Morton, Oliver, & Mercier Counties, North Dakota

0 1 2 3 4 Miles

N

Legend

- Project Boundary
- Local Well
- 00 Water Level Record

8467
27.7

9064
13.4

278.8
9060
225.9
20703

20
9056

10
9046

84
9049

9066
42.7

8988
39.73

1.4
9006
1.9
9009

8989
42.57

8985
104.3

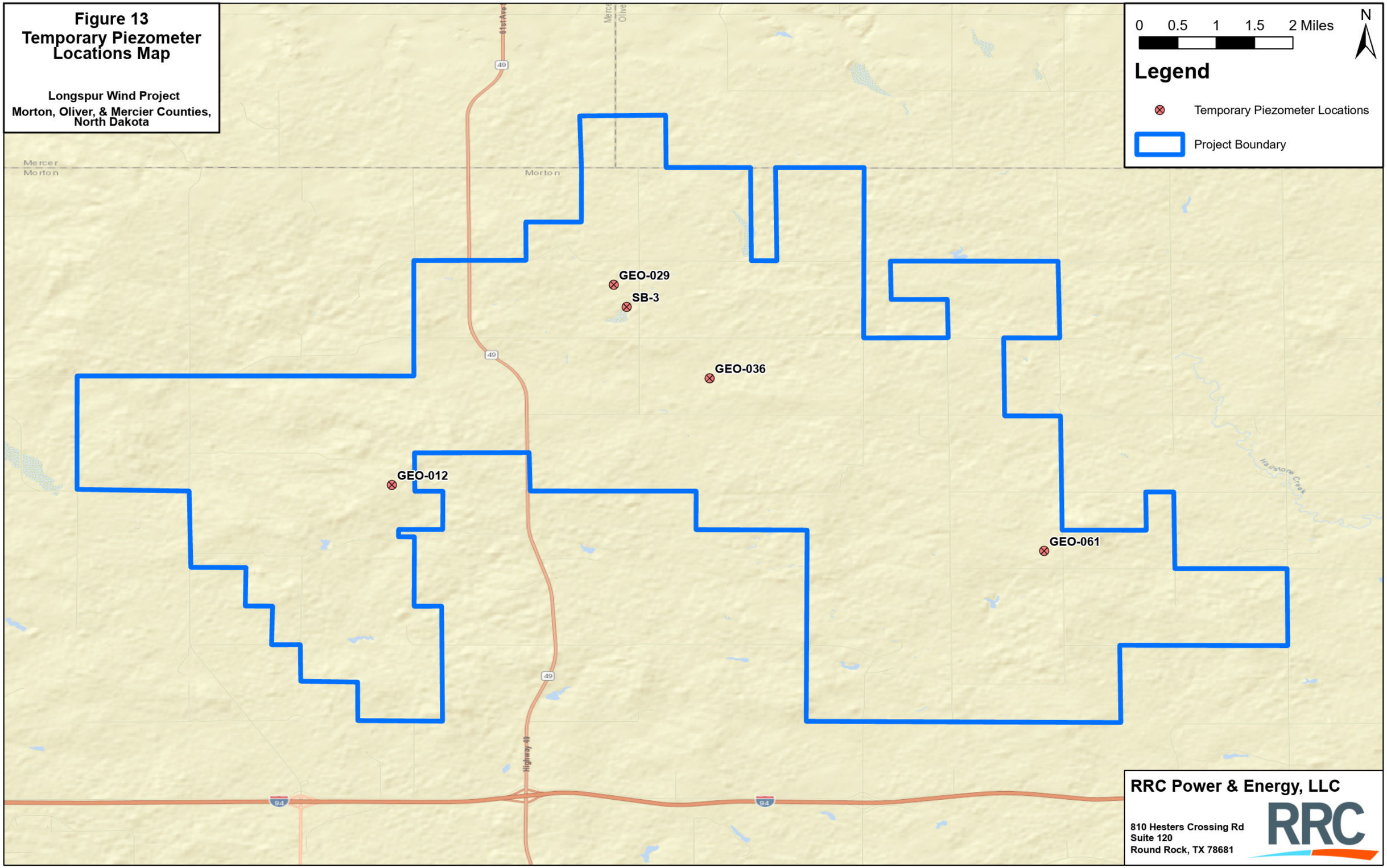
Mercer
Morton
Oliver
61st Ave SW
49
94
County Road 88
63rd Ave
Glen Ullin

RRC Power & Energy, LLC

810 Hesters Crossing Rd
Suite 120
Round Rock, TX 78681

Figure 13
Temporary Piezometer Locations Map

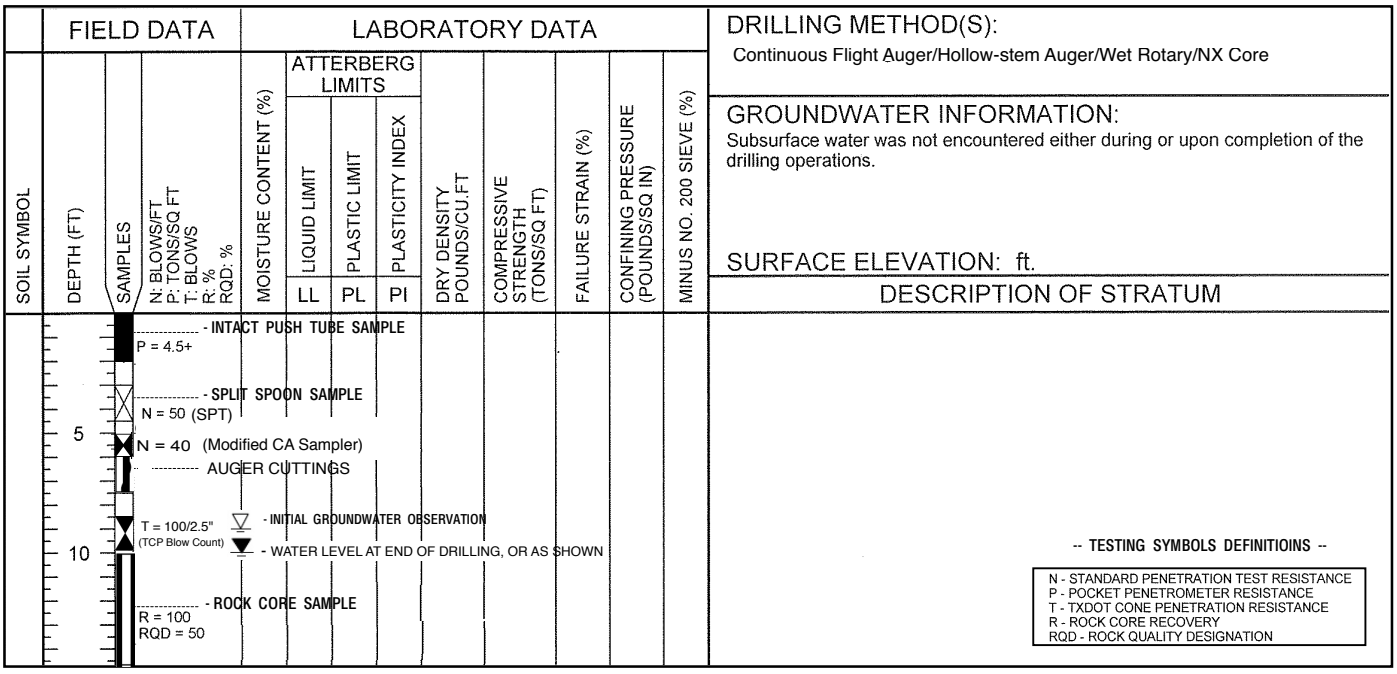
Longspur Wind Project
Morton, Oliver, & Mercier Counties, North Dakota



RRC Power & Energy, LLC

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Suite 120
Round Rock, TX 78681

BORING LOG KEY



TYPICAL SOIL AND ROCK SYMBOLS (USCS CLASSIFICATION)

- Lean Clay (CL)
- Fat Clay (CH)
- Silt (ML)
- Elastic Silt (MH)
- Silty Sand (SM)
- Clayey Sand (SC)
- Silty, Clayey Sand (SC-SM)
- Poorly-Graded Sand (SP)
- Well-Graded Sand (SW)
- Poorly-Graded Gravel (GP)
- Well-Graded Gravel (GW)
- Clayey Gravel (GC)
- Silty Gravel (GM)
- Silty Clay (CL-ML)
- Claystone
- BASALT
- Limestone
- Sandstone
- Siltstone
- Fill Material
- Shale

DEGREE OF WEATHERING

1) Unweathered: No evidence of any chemical or mechanical alteration.
2) Slightly weathered: Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the rock volume altered.
3) Moderately weathered: Discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10% to 50% of the rock volume altered.
4) Highly weathered: Entire mass discolored, alteration pervading nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away.
5) Decomposed: rock reduced to a soil with relicit rock texture, generally molded and crumbled by hand.

SOIL STRUCTURE

Calcareous..... Containing calcium carbonate

Slickensided..... The presence of planes of weakness having a slick and glossy appearance

Interbedded..... Alternating layers of varying material

LOG OF BORING GEO-01

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 30 ft. during drilling and measured at 52 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 12	23									FAT CLAY (CH), trace Sand, brown to light gray, stiff to hard, moist
				24	63	22	41					100	
	5		N = 16	19									
			N = 15	28									Grading light brown, iron stained
	10		N = 30	29									Grading dark brown to brown, with organics
			N = 9	47									Grading with Lignite
	15		N = 50	20	52	20	32	111	5.28	7.3	0.0	81	Grading with Sand Grading brown to gray
	20		N = 35										CLAYEY SAND (SC), light gray to gray, dense, dry to moist, fine grained
	25		N = 16										LEAN CLAY (CL), trace Sand, dark gray to gray, very stiff to hard, dry to moist
	30		N = 32										Grading trace Lignite and organics Grading wet
	35		N = 32										
	40		N = 50/3"										SHALE, dark brown, hard to very hard, moist to wet, with Lignite
	45		N = 50/6"										
	50		N = 64										Grading gray
	55		N = 42										MUDSTONE, light gray to gray, medium hard, moist to wet, trace organics Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.928605, Long. -101.860051

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:58 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-02

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 10	18									SANDY LEAN CLAY (CL), gray, stiff to very stiff, moist, calcareous
	5		N = 16	22									
			N = 21	20									CLAYEY SAND (SC), light brown to gray, medium dense, moist, fine grained, iron stained, trace organics
	10		N = 30	19									
			N = 22	22									
	15		N = 32										LEAN CLAY (CL), with Sand, gray, hard, dry to moist, trace Lignite
	20		N = 50/3"										
	25		N = 47										
	30		N = 36										Grading trace Sand
	35		N = 46										
	40		N = 67										
	45		N = 81/11"										SILTSTONE, gray to light brown, very hard, dry to moist, with Shale interbeddings, trace Lignite
	50		N = 50/6"										Shale interbedding grades out
	55		N = 50/6"										
													Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.936340, Long. -101.861568

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LOG OF BORING GEO-03

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025 - 4/25/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 24	11									LEAN CLAY (CL), trace Sand, brown, very stiff, dry to moist, calcareous
	5		N = 15	16									SANDY LEAN CLAY (CL), brown, stiff to very stiff, moist, iron stained
			N = 19	16									Grading trace organics
	10		N = 15	19									Grading dark brown, trace Lignite
			N = 38	16				96					
	15		N = 42										LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, iron stained, calcareous
	20		N = 62										
	25		N = 36										Grading trace organics
	30		N = 27										LIGNITE, black, very stiff, dry to moist
	35		N = 79										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	40		N = 43										
	45		N = 49										
	50		N = 50/3"										LIGNITE, black, hard, dry to moist
	55		N = 92										SANDSTONE, gray, very hard, dry to moist, fine grained
													Total Depth = 55.5 ft.

FIELD DATA / LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.939368, Long. -101.854080

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LOG OF BORING GEO-04

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 15	14									LEAN CLAY (CL), with Sand, light brown, soft to very stiff, dry to moist, calcareous
	5		N = 9	19									
			N = 5	23 22									
	10		N = 4	23									
			P = 2.5	23	47	18	29	103	1.96	14.8	10.0	85	
	15		N = 5										
	20		P = 2.5	22				102	2.59	7.8	0.0		
	25		N = 13										
	30		N = 10										SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, calcareous
	35		N = 29										SILTY SAND (SM), light brown to gray, medium dense to dense, dry to moist, fine grained
	40		N = 35										
	45		N = 50/6"										SANDSTONE, light brown to gray, very hard, dry to moist, fine grained
	50		N = 50/5"										
	55		N = 50/6"										
													Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.937945, Long. -101.847728

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LOG OF BORING GEO-05

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/26/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 34 ft. during drilling and measured at 48 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 21	16									CLAYEY SAND (SC), brown, medium dense to dense, dry to moist, fine grained, iron stained
	5		N = 27	15									
			N = 25	17									Grading trace organics
	10		N = 28	19									
			N = 34	17									
	15		N = 32										
	20		N = 33										
	25		N = 46										
	30		N = 42										
	35		N = 42										Grading wet
	40		N = 32										LIGNITE, dark brown, hard, moist to wet
	45		N = 38										SILT (ML), trace Sand, gray, hard, moist to wet
	50		N = 60										LEAN CLAY (CL), with Sand, gray, hard, moist, trace organics
	55		N = 82										Grading gray to brown
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.935278, Long. -101.841595

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LOG OF BORING GEO-06

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 11	14									LEAN CLAY (CL), with Sand, brown, stiff to hard, dry to moist, calcareous
	5		N = 9	30									Grading iron stained, trace organics
			N = 13	27									Grading trace Sand, gray
	10		N = 11	30									Grading with Lignite interbeddings
			N = 33										
	15		N = 31										
	20		N = 39										
	25		N = 51										
	30		N = 41										
	35		N = 44										POORLY-GRADED SAND (SP), light brown to gray, dense, dry to moist, fine grained
	40		N = 57										LEAN CLAY (CL), trace Sand, gray to brown, hard, dry to moist
	45		N = 83										
	50		N = 59										
	55		N = 75										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.930996, Long. -101.826168

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LOG OF BORING GEO-07

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 11	25									SANDY LEAN CLAY (CL), light brown, stiff, moist, iron stained, calcareous
	5		N = 14	22									FAT CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, trace organics
			N = 14	26									Grading trace Sand, gray
	10		N = 18	27									
			N = 28	27	64	23	41	99	6.92	6.3	10.0	100	
	15		N = 20										
	20		N = 45										
	25		N = 50/1"										Grading with Gravel
	30		N = 36										
	35		N = 27										Organic grades out; grading gray
	40		N = 41										
	45		N = 38										
	50		N = 77										LIGNITE, dark gray to dark brown, hard, dry to moist
	55		N = 84										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.913460, Long. -101.838517

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LOG OF BORING GEO-08

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 9	25									FAT CLAY (CH), trace Sand, light brown to brown, stiff to very stiff, dry to moist, trace roots
				22	57	19	38					99	
	5		N = 15	22									Grading brown, iron stained
			N = 19	24									
	10		N = 22	23									
			N = 38										
	15		N = 27										CLAYEY SAND (SC), light brown to brown, medium dense, dry to moist, fine grained
	20		N = 26										LEAN CLAY (CL), trace Sand, gray to bluish gray, very stiff to hard, dry to moist
	25		N = 37										
	30		N = 27										
	35		N = 50/4"										LIGNITE, black, hard, dry to moist
	40		N = 37										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	45		N = 41										SILT (ML), trace Sand, gray to dark gray, hard, dry to moist
	50		N = 64										LIGNITE, black, hard, dry to moist
	55		N = 43										SILT (ML), trace Sand, gray to light gray, hard, dry to moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.916400, Long. -101.834600

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LOG OF BORING GEO-09

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													8 in. Topsoil
			N = 9	16									LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist
	5		N = 17	23									Grading light brown, iron stained
			N = 20	25									Grading trace Sand
	10												
			N = 50/6"										
	15		N = 26										Grading dark gray to gray
	20		N = 28										
	25		N = 35										Iron stain grades out
	30		N = 50/6"										Grading dark brown to brown
	35		N = 38										SANDY LEAN CLAY (CL), light gray to dark gray, hard, dry to moist, trace Lignite
	40		N = 50/6"										LIGNITE, dark brown to black, hard, dry to moist
	45		N = 56										LEAN CLAY (CL), with Sand, light gray to gray, hard, dry to moist, with Lignite
	50		N = 52										Lignite grades out
	55		N = 71										Grading trace Sand
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.921153, Long. -101.828369

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-10

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025 - 4/24/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 21	14									FAT CLAY (CH), trace Sand, light brown to brown, very stiff to hard, moist
				16	71	24	47					91	
	5		N = 40	15									Grading with Sand, yellowish brown to brown, calcareous, trace roots
			N = 26	17 16									
	10		N = 26	17									Grading trace Sand, dark gray to gray, iron stained
			N = 32	41									Grading with Lignite interbeddings
	15		N = 50/6"										LIGNITE, black, hard, dry to moist
	20		N = 38										LEAN CLAY (CL), trace Sand, light gray to dark brown, hard, dry to moist
	25		N = 40										Grading trace Lignite
	30		N = 40										
	35		N = 73										Grading with Sand, light gray to brown
	40		N = 50/6"										SANDY LEAN CLAY (CL), light brown to light gray, hard, dry to moist
	45		N = 88/9"										CLAYEY SAND (SC), light brown to gray, very dense, dry to moist, fine grained
	50		N = 50/6"										
	55		N = 50/6"										
													Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.921172, Long. -101.821962

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-11

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5	13									3 in. Topsoil LEAN CLAY (CL), with Sand, light brown, medium stiff, moist, trace roots
	5		N = 12	12									CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine to medium grained
			N = 18	7									Grading light gray
	10		N = 50/4"	4									Grading light brown to gray
			N = 35	13									
	15		N = 13										LEAN CLAY (CL), trace Sand, light brown, stiff to very stiff, dry to moist, calcareous
	20		N = 37										Grading trace organics
	25		N = 37										SANDY LEAN CLAY (CL), light brown to gray, hard, dry to moist, iron stained
	30		N = 31										CLAYEY SAND (SC), dark gray to light gray, dense to very dense, dry to moist, fine grained, trace organics
	35		N = 51										Organic grades out; grading brown, iron stained
	40		N = 46										LEAN CLAY (CL), with Sand, gray, hard, dry to moist, with Lignite interbeddings
	45		N = 34										Lignite interbedding grades out; grading Lignite beddings
	50		N = 50/1"										SILTSTONE, gray, very hard, dry to moist, calcareous
	55		N = 35										SANDY CLAYSTONE, light gray, medium hard, dry to moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.921497, Long. -101.813248

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LOG OF BORING GEO-12

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and measured at 44 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 4	12									SANDY LEAN CLAY (CL), dark brown, soft, dry to moist
	5		N = 9	11									CLAYEY SAND (SC), trace Gravel, dark brown to gray, loose to medium dense, dry to moist, fine to coarse grained, calcareous
			N = 11	9									Calcareous feature grades out
	10		N = 29	16									Grading iron stained
			N = 37	16									SILTY SAND (SM), gray to brown, dense, dry to moist, fine grained
	15		N = 40										
	20		N = 37										Grading trace Gravel, wet, fine to coarse grained
	25		N = 29										LEAN CLAY (CL), with Sand, gray to brown, very stiff to hard, moist to wet
	30		N = 33										Grading calcareous
	35		N = 60/9"										Grading iron stained, with Lignite interbeddings
	40		N = 50/3"										LIGNITE, black, hard, moist
	45		N = 40										LEAN CLAY (CL), trace Sand, gray, hard, moist
	50		N = 36										
	55		N = 59										POORLY-GRADED SAND (SP), gray, very dense, moist, fine to medium grained
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.921525, Long. -101.806480

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LOG OF BORING GEO-13

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/22/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 4	20									SANDY LEAN CLAY (CL), light brown, soft, moist
	5		N = 8	26									CLAYEY SAND (SC), light brown, loose, moist, fine grained, iron stained
			N = 15	21									LEAN CLAY (CL), trace Sand, light brown, stiff to hard, dry to moist, iron stained
	10		N = 17	24									Grading with Sand, trace organics
			N = 18	30									Grading trace Sand, gray to dark brown
	15		N = 30										
	20		N = 42										Grading light brown
	25		N = 35										SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist
	30		N = 58										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, iron stained
	35		N = 48										Grading brown, trace organics
	40		N = 66										Grading light gray
	45		N = 58										Grading gray to dark gray
	50		N = 81										SILTSTONE, light gray to gray, very hard, dry to moist
	55		N = 90/11"										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.900807, Long. -101.826790

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LOG OF BORING GEO-14

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/22/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 34 ft. during drilling and measured at 48 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6	19									5 in. Topsoil LEAN CLAY (CL), trace Sand, light brown, medium stiff to very stiff, moist
	5		N = 20	22									
			N = 21	23									Grading with Sand, light brown to gray, calcareous, trace organics
	10		N = 23	22									Organic grades out
			N = 28	18									SANDY LEAN CLAY (CL), light gray, very stiff, moist
	15		N = 21										CLAYEY SAND (SC), light gray, medium dense, dry to moist, fine grained
	20		N = 16										LEAN CLAY (CL), trace Sand, dark brown, very stiff to hard, dry to moist, with Lignite interbeddings
	25		N = 42										Grading with Sand, brown to light brown, iron stained, trace organics
	30		N = 50										Grading trace Sand, light gray
	35		N = 49										Grading with Sand, wet
	40		N = 34										Grading gray to dark gray
	45		N = 39										
	50		N = 37										
	55		N = 37										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.900966, Long. -101.819722

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LOG OF BORING GEO-15

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/22/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 22	7									4 in. Topsoil SILT (ML), trace Sand, light brown, very stiff, dry to moist, calcareous
	5		N = 52	11									LEAN CLAY (CL), trace Sand, light brown, stiff to hard, dry to moist
			N = 12	24									Grading light gray, with Lignite interbeddings
	10		N = 20	23									Grading calcareous, trace organics
			N = 36	19									Grading light brown to brown, iron stained
	15		N = 34										CLAYEY SAND (SC), light gray to brown, dense, dry to moist, fine grained
	20		N = 29										LEAN CLAY (CL), trace Sand, dark brown to black, very stiff to hard, dry to moist, with Lignite interbeddings, trace organics
	25		N = 72/11"										
	30		N = 48										CLAYEY SAND (SC), light gray to gray, dense, dry to moist, fine grained, trace organics
	35		N = 48										
	40		N = 35										LEAN CLAY (CL), with Sand, light brown to gray, very stiff to hard, dry to moist
	45		N = 28										
	50		N = 36										Grading calcareous
	55		N = 30										CLAYEY SAND (SC), dark gray to light gray, medium dense, dry to moist, fine grained
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.900394, Long. -101.810586

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LOG OF BORING GEO-16

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/21/2025 - 4/22/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 69	3									SILT (ML), trace Sand, light brown, hard, dry to moist, calcareous
	5		N = 12	36									CLAYEY SAND (SC), dark brown, medium dense, moist, fine grained, trace organics
			N = 28	23									Grading brown
	10		N = 31	23									SANDY ELASTIC SILT (MH), dark brown to brown, stiff to hard, dry to moist
			N = 12	31	76	46	30					56	Grading with Lignite interbeddings
	15		N = 23										Grading with Shale beddings, trace organics
	20		N = 78/10"										
	25		N = 47										LEAN CLAY (CL), with Sand, gray, hard, dry to moist
	30		N = 34										Grading light gray
	35		N = 38										
	40		N = 43										
	45		N = 69										CLAYSTONE, dark brown to black, hard, dry to moist, trace organics
	50		N = 89										SILTSTONE, light gray to gray, very hard, dry to moist
	55		N = 81/11"										
													Total Depth = 55.5 ft.

FIELD DATA | LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.904707, Long. -101.805945

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LOG OF BORING GEO-17

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/21/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 49 ft. during drilling and measured at 52 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 11	13									SILT (ML), trace Sand, light brown, medium stiff to stiff, dry to moist, calcareous
	5		N = 7	12									Grading trace organics
			N = 4	14									LEAN CLAY (CL), trace Sand, dark brown, soft to hard, dry to moist, calcareous, trace organics
	10		P = +4.5										
			N = 16	17									Grading light brown
	15		N = 50/1"										Grading with Sand
	20		N = 37										Grading trace Sand
	25		N = 45										
	30		N = 42										Grading with Sand
	35		N = 33										
	40		N = 36										
	45		N = 36										
	50		N = 43										Grading trace Sand, gray, wet
	55		N = 37										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.886948, Long. -101.814793

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LOG OF BORING GEO-18

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/21/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 44 ft. during drilling and measured at 44 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 24	7									CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine grained
	5		N = 39	9									
			N = 51	9									
	10		N = 72	10									
			N = 86	6									
	15		N = 39										
	20		N = 50/6"										
	25		N = 93/11"										
	30		N = 71										
	35		N = 56										SANDY LEAN CLAY (CL), dark brown to brown, hard, dry to moist, iron stained
	40		N = 36										Grading trace organics
	45		N = 45										CLAYEY SAND (SC), dark brown to brown, dense, wet, fine grained, iron stained
	50		N = 42										
	55		N = 32										LEAN CLAY (CL), with Sand, gray to brown, hard, moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.885050, Long. -101.808962

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LOG OF BORING GEO-19

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/21/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 30	8									
		C		6	30	18	12					97	LEAN CLAY (CL), trace Sand, light brown, very stiff, dry to moist
	5		N = 26	20									Grading with Sand, light brown to brown, iron stained
			N = 24	29									Grading trace Sand, gray to brown, with Lignite interbeddings
	10		N = 25	21									
			N = 36	19									SANDY LEAN CLAY (CL), light gray, very stiff to hard, dry to moist
	15		N = 25										
	20		N = 28										Grading iron stained, trace organics
	25		N = 24										LEAN CLAY (CL), trace Sand, gray to light gray, very stiff to hard, dry to moist, iron stained, trace organics
	30		N = 50/1"										Grading with Sand, brown, with occasional Sandstone fragments
	35		N = 37										Grading trace Sand, gray to brown
	40		N = 33										Grading dark brown to black
	45		N = 39										Organic grades out; grading light gray to gray
	50		N = 39										Grading dark brown to black, trace organics
	55		N = 50										Grading gray to light gray
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.886567, Long. -101.800295

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LOG OF BORING GEO-20

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 5	21									CLAYEY SAND (SC), light brown, loose, moist, fine grained
													SILT (ML), trace Sand, light brown, dry to moist
	5		N = 15	22									CLAYEY SAND (SC), light brown to brown, medium dense, moist, fine grained
			N = 20	22									LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained
	10		N = 21	22									
			P = +4.5										
	15		N = 29										
	20		N = 33										CLAYEY SAND (SC), gray, dense to very dense, dry to moist, fine grained
	25		N = 35										Grading light gray
	30		N = 41										
	35		N = 58										Grading fine to medium grained
	40		N = 40										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	45		N = 47										SILT (ML), trace Sand, gray, hard, dry to moist
	50		N = 55										
	55		N = 36										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
													Total Depth = 55.5 ft.

FIELD DATA / LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.976011, Long. -101.763598

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LOG OF BORING GEO-21

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/11/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 39 ft. during drilling and measured at 23 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 9	8									6 in. Topsoil SANDY LEAN CLAY (CL), brown, stiff, dry to moist, trace roots
	5		N = 10	7									CLAYEY SAND (SC), light brown to brown, loose, dry to moist, fine grained, iron stained
			N = 10	6									POORLY-GRADED SAND (SP), brown, loose to dense, dry to moist, fine to medium grained, iron stained
	10		N = 35	7									
			N = 65										
	15		N = 43										Grading light brown
	20		N = 47										CLAYEY SAND (SC), light brown to brown, dense to very dense, dry to moist, fine to medium grained, iron stained
													Grading wet
	25		N = 42										
	30		N = 50										
	35		N = 48										Grading gray to brown
	40		N = 64										Grading dark gray
	45		N = 58										Iron stain grades out; grading gray
	50		N = 79										
			N = 50/5"										Grading gray to brown, fine to coarse grained, trace organics Total Depth = 54.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.973311, Long. -101.752139

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LOG OF BORING GEO-22

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/9/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 17	10									SILTY, CLAYEY SAND (SC-SM), light brown, medium dense, dry to moist, fine grained
				17	22	16	6					37	
	5		N = 17	23									Grading trace Sand, light gray, iron stained, calcareous
			N = 15	22									SANDY SILT (ML), light brown, medium dense, moist, calcareous
	10		N = 18	21									SANDY LEAN CLAY (CL), brown, very stiff, moist, iron stained
			N = 37										SILTY SAND (SM), light brown, medium dense, dry to moist, fine grained, iron stained, trace organics
	15		N = 30										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist, iron stained
	20		P = +4.5										
	25		N = 34										CLAYEY SAND (SC), brown, dense, dry to moist, fine grained, trace organics
	30		N = 50/3"										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, calcareous, trace organics
	35		N = 36										Grading with Lignite beddings
	40		N = 44										SANDY SILT (ML), gray, dense, dry to moist
	45		N = 53										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	50		N = 55										Grading with Shale beddings
	55		N = 49										SANDY LEAN CLAY (CL), gray, hard, dry to moist, trace organics
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.973116, Long. -101.745499

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LOG OF BORING GEO-23

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/9/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 8	13									LEAN CLAY (CL), with Sand, light brown, medium stiff to hard, dry to moist, calcareous
	5		N = 9	21									
			N = 19	20									Grading trace Sand, yellowish brown, iron stained
	10		N = 23	21									Grading trace organics
			P = +4.5										
	15		N = 22										Grading with Sand, light brown
	20		N = 45										CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine grained, iron stained
	25		N = 79/9"										
	30		N = 37										LEAN CLAY (CL), trace Sand, gray to bluish gray, hard, dry to moist
	35		N = 78										
	40		N = 51										Grading gray to black, with Lignite interbeddings
	45		N = 75/8"										Grading light gray to gray
	50		N = 95/10"										Grading with Sand, calcareous
	55		N = 62										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.975381, Long. -101.721823

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LOG OF BORING GEO-24

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/9/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 9	21									SANDY LEAN CLAY (CL), light brown to gray, stiff to very stiff, moist
	5		N = 21	19									Grading iron stained
			N = 17	21									LEAN CLAY (CL), trace Sand, gray to brown, very stiff to hard, dry to moist, iron stained, trace organics
	10		N = 23	21									Grading light brown to yellowish brown, calcareous
			P = +4.5										Grading with Sand
	15		N = 28										Grading trace Sand, light brown to gray
	20		N = 22										Grading with Lignite
	25		N = 41										Grading dark brown
	30		N = 52										Grading gray to dark gray, with Lignite interbeddings
	35		N = 54										Organic grades out; grading light gray
	40		N = 61										SANDY LEAN CLAY (CL), light gray, hard, dry to moist
	45		N = 62										LEAN CLAY (CL), with Sand, dark gray, hard, dry to moist, trace organics
	50		N = 78/10"										CLAYEY SAND (SC), light gray to gray, very dense, dry to moist, fine grained
	55		N = 55										LEAN CLAY (CL), trace Sand, dark gray to gray, hard, dry to moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.968427, Long. -101.723739

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LOG OF BORING GEO-25

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 10	19									LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, calcareous
	5		N = 14	21									Grading trace Sand, trace organics
			N = 15	16 20									Grading iron stained
	10		N = 19	21									
			P = +4.5										
	15		N = 33										
	20		N = 46										Organic grades out
	25		N = 56										SILT (ML), trace Sand, light brown, hard, dry to moist
	30		N = 43										LEAN CLAY (CL), trace Sand, brown to gray, hard, dry to moist, iron stained
	35		N = 48										SILT (ML), with Sand, light brown, hard, dry to moist, calcareous
	40		N = 43										LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, trace organics
	45		N = 72/9"										
	50		N = 36										CLAYEY SAND (SC), gray, dense, dry to moist, fine grained
	55		N = 47										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.959730, Long. -101.706249

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LOG OF BORING GEO-26

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 39 ft. during drilling and measured at 50 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 13	18									5 in. Topsoil LEAN CLAY (CL), with Sand, light brown, stiff, moist
	5		N = 22	16									SANDY LEAN CLAY (CL), light brown to brown, very stiff, moist, iron stained
			N = 16	18									LEAN CLAY (CL), trace Sand, light gray to brown, very stiff to hard, dry to moist, iron stained
	10		N = 20	21									Grading with Sand, trace organics
			N = 62										Grading trace Sand, gray to light gray
	15		N = 28										Grading with Sand, gray to brown, with Lignite interbeddings
	20		N = 55										CLAYEY SAND (SC), light gray, very dense, dry to moist, fine grained
	25		N = 50/1"										Grading light brown to gray, calcareous
	30		N = 82/11"										
	35		N = 78										Grading light brown to yellowish brown, with Lignite
	40		N = 58										LEAN CLAY (CL), trace Sand, dark brown to black, hard, wet, with Lignite interbeddings
	45		N = 75/9"										Grading dark gray to black
	50		N = 59										Grading light gray to black, trace organics
	55		N = 68										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.961450, Long. -101.700128

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LOG OF BORING GEO-27

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/9/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 11	16									LEAN CLAY (CL), with Sand, light brown, stiff, moist, calcareous
	5		N = 10	15									SANDY LEAN CLAY (CL), dark brown, stiff, moist, iron stained, trace organics
			N = 25	15									CLAYEY SAND (SC), light brown, medium dense to dense, moist, fine grained, trace organics
	10		N = 42	14									Grading light brown to brown, iron stained
			N = 33	15									Grading light brown to gray
	15		N = 32										LEAN CLAY (CL), trace Sand, brown, hard, dry to moist, iron stained, trace organics
	20		N = 39										
	25		N = 55										Grading dark brown, with Lignite
	30		N = 65										CLAYEY SAND (SC), gray, very dense, dry to moist, fine grained
	35		N = 74										
	40		N = 78										
	45		N = 50/6"										LIGNITE, black to dark brown, hard, dry to moist, trace organics
	50		N = 70										
	55		N = 50/6"										Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.961464, Long. -101.693477

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LOG OF BORING GEO-28

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/26/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 35 ft. during drilling and measured at 52 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 6	15									LEAN CLAY (CL), with Sand, light brown, medium stiff to hard, dry to moist
	5		N = 7	20									Grading iron stained, calcareous
			N = 10	22									Grading trace organics
	10		N = 32	20									
			N = 50/5"	7									
	15		N = 62										SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, iron stained
	20		N = 41										CLAYEY SAND (SC), light gray to brown, dense, dry to moist, fine grained
	25		N = 35										Grading iron stained
	30		N = 40										Grading trace Lignite
	35		N = 43										Organic grade out; grading dark gray Grading wet
	40		N = 33										LEAN CLAY (CL), trace Sand, gray, hard, moist to wet
	45		N = 35										
	50		N = 47										Grading calcareous
	55		N = 73										SILTSTONE, gray to light gray, hard, moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953950, Long. -101.786611

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LOG OF BORING GEO-29

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 9 ft. during drilling and measured at 55 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 2	19									CLAYEY SAND (SC), light brown, very loose to dense, dry to moist, fine grained
	5		N = 2	21									
			P = 2.5										
	10		N = 31	19									Grading wet Grading brown to gray, iron stained
			N = 36	20									
	15		N = 42										Grading light brown to gray
	20		N = 34										Grading dark gray to gray
	25		N = 22										LEAN CLAY (CL), with Sand, light brown to gray, very stiff to hard, moist to wet
	30		N = 39										
	35		N = 50/6"										CLAYEY SAND (SC), gray to bluish gray, very dense, moist to wet, fine grained
	40		N = 35										LEAN CLAY (CL), trace Sand, dark gray to gray, hard, moist to wet
	45		N = 51										Grading with organics
	50		N = 45										Organic grades out
	55		N = 67/11"										Grading with Lignite interbeddings
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.959220, Long. -101.764704

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LOG OF BORING GEO-31

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/2/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 49 ft. during drilling and measured at 49 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 8	7									CLAYEY SAND (SC), light brown to brown, loose to medium dense, dry to moist, fine grained
	5		N = 7	7									
			N = 21	7									
	10												Grading iron stained
			N = 15	15									LEAN CLAY (CL), trace Sand, gray to light brown, very stiff to hard, dry to moist
			P = 4.5										
	15		N = 20										
	20		P = +4.5										
	25		N = 31										Grading with Sand
	30		N = 32										
	35		N = 55										Grading trace Sand, dark gray
	40		N = 38										Grading gray
	45		N = 50/5"										Grading dark brown, trace organics
	50		N = 40										Grading gray, wet
	55		N = 41										SILT (ML), trace Sand, gray, hard, moist
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954390, Long. -101.753974

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LOG OF BORING GEO-33

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/3/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 14	14									FAT CLAY (CH), trace Sand, gray to brown, stiff to hard, moist, iron stained
				17	61	19	42					98	
	5		N = 14	25									Grading trace organics
			N = 16	21									
	10		N = 52/8"	23									
			N = 21	19									SANDY LEAN CLAY (CL), light brown, medium stiff to hard, dry to moist
	15		N = 6										Grading dark brown to black, with Lignite interbeddings and organics
			N = 80/9"	17				111	9.45	2.9	0.0		Grading brown to gray, iron stained
	20		N = 33										LEAN CLAY (CL), with Sand, light brown, hard, dry to moist
	25		N = 58										Grading trace Sand, brown, trace Lignite and organics
	30		N = 35										Grading with Sand, dark gray to gray
	35		N = 42										
	40		N = 82/11"										SANDSTONE, gray to dark gray, very hard, dry to moist, fine grained
	45		N = 50/5"										
	50		N = 93/8"										
	55		N = 50/6"										
													Total Depth = 55 ft.

FIELD DATA | LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954002, Long. -101.730960

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LOG OF BORING GEO-34

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/4/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												5 in. Topsoil
		N = 14	15									CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained, calcareous
5		N = 17	12									Grading brown, iron stained
		N = 11	32									LEAN CLAY (CL), trace Sand, light brown to gray, stiff, moist
10		N = 23	22									CLAYEY SAND (SC), light brown to gray, medium dense, moist, fine grained
		N = 32	24									LEAN CLAY (CL), with Sand, brown, hard, moist, iron stained
15		N = 33										CLAYEY SAND (SC), light brown to brown, dense, dry to moist, fine grained
20		N = 23										LEAN CLAY (CL), trace Sand, dark brown to brown, very stiff, dry to moist, iron stained, trace organics
25		N = 27										Grading light brown, with Lignite interbeddings
30		N = 61										SILT (ML), trace Sand, gray to light gray, hard, dry to moist
35		N = 78/9"										SHALE, dark brown to black, very hard, dry to moist, with Lignite interbeddings
40		N = 56										SILTSTONE, dark brown, medium hard to hard, dry to moist, trace organics
45		N = 48										Organic grades out; grading gray to light gray
50		N = 90/8"										CLAYSTONE, dark gray to gray, very hard, dry to moist, trace Lignite
55		N = 50/6"										Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954983, Long. -101.724356

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LOG OF BORING GEO-35

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/3/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 30 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5	30									5 in. Topsoil LEAN CLAY (CL), trace Sand, dark brown, medium stiff, moist, trace organics
	5		N = 8	24									SANDY LEAN CLAY (CL), dark brown, medium stiff, moist, iron stained, trace organics
			N = 7	51									LEAN CLAY (CL), with Sand, brown, medium stiff to very stiff, dry to moist, iron stained, with Lignite interbeddings, trace organics Grading gray
	10		N = 29	26									
			N = 27	23									
	15		N = 24										
	20		N = 35										POORLY-GRADED SAND (SP), dark brown, dense, dry to moist, fine grained
	25		N = 44										Grading iron stained
	30		N = 21										LEAN CLAY (CL), trace Sand, gray, very stiff to hard, moist to wet, trace organics
	35		N = 26										
	40		N = 24										
	45		N = 46										
	50		N = 31										
	55		N = 37										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.944218, Long. -101.753027

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LOG OF BORING GEO-36

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/5/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12 ft. during drilling and measured at 47 ft. immediately after drilling

SURFACE ELEVATION (FT):

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												6 in. Topsoil
		N = 18	14									LEAN CLAY (CL), with Sand, brown to dark gray, very stiff, moist, iron stained, trace organics
5		N = 6	16									CLAYEY SAND (SC), brown to gray, very loose to very dense, dry to moist, fine grained
		N = 9	21									
10		N = 50/2"	6									
		N = 50/2"	10									Grading wet
15		N = 1										Grading trace organics
		P = 4.0	30	63	26	37	93	0.93	4.1	0.0	100	FAT CLAY (CH), trace Sand, gray, medium stiff to hard, moist to wet, trace organics
20		N = 24										Grading with Sand, brown
25		N = 21										
30		N = 25										
35		N = 21										
40		N = 32										
45		N = 35										Grading dark gray
50		N = 29										Grading dark brown
55		N = 34										
												Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.941605, Long. -101.746654

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LOG OF BORING GEO-37

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/4/2025 - 5/5/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 13	21									LEAN CLAY (CL), trace Sand, light brown, stiff to very stiff, moist, iron stained
	5		N = 20	22									
			N = 17	24									
	10		N = 5	97									LIGNITE, black, medium stiff to very stiff, moist, trace organics
			N = 43	47				65	2.66	3.5	0.0		
	15		N = 17										LEAN CLAY (CL), trace Sand, gray, very stiff, dry to moist
	20		N = 49										
	25		N = 33										POORLY-GRADED SAND (SP), gray, dense, dry to moist, fine grained
	30		N = 50/6"										LIGNITE, black, hard, dry to moist
	35		N = 50/6"										
	40		N = 43										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	45		N = 43										SILT (ML), trace Sand, gray, hard, dry to moist
	50		N = 42										
			N = 50/2"										Total Depth = 54.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.942772, Long. -101.740419

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LOG OF BORING GEO-38

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/4/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13	12									LEAN CLAY (CL), with Sand, light brown to brown, soft to hard, dry to moist, trace roots
	5		N = 5	15									Grading dark brown
			N = 4	23									Grading brown
	10		P = +4.5										Grading light brown
			N = 14	21	38	17	21					85	Grading trace Sand, brown, iron stained
	15		N = 26										Grading light brown to brown
	20		N = 22										CLAYEY SAND (SC), brown, medium dense to very dense, dry to moist, fine grained, iron stained
	25		N = 38										
	30		N = 53										
	35		N = 68/10"										
	40		N = 71/9"										SANDSTONE, gray, very hard, dry to moist, fine grained
			N = 50/2"										Total Depth = 42.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.940587, Long. -101.731712

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LOG OF BORING GEO-39

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/4/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 49 ft. during drilling and measured at 54 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 7	19									6 in. Topsoil LEAN CLAY (CL), with Sand, dark brown to brown, medium stiff, moist
	5		N = 13	20									SILT (ML), trace Sand, light gray, stiff, moist
			N = 18	20									LEAN CLAY (CL), trace Sand, brown to light gray, very stiff to hard, dry to moist
	10		N = 19	21									
			N = 56										
	15		N = 25										Grading with Sand, dark brown to brown
	20		N = 46										CLAYEY SAND (SC), brown, dense to very dense, dry to moist, fine grained
	25		N = 67										Grading trace Gravel, fine to coarse grained
	30		N = 79/11"										SANDSTONE, brown to light brown, very hard, dry to moist, fine grained, iron stained
	35		N = 75/10"										Grading dark gray to brown
	40		N = 48										SANDY CLAYSTONE, gray, medium hard, dry to moist SANDSTONE, gray, medium hard to very hard, fine grained
	45		N = 81/8"										
	50		N = 68										Grading wet
	55		N = 79/8"										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.945336, Long. -101.725459

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LOG OF BORING GEO-40

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												6 in. Topsoil
		N = 9	9									SANDY SILT (ML), light brown, loose, dry to moist
												SILTY SAND (SM), light brown, dry to moist, fine grained
5		N = 7	15									LEAN CLAY (CL), with Sand, brown to light brown, medium stiff, moist
		N = 13	17									CLAYEY SAND (SC), brown, medium dense to dense, dry to moist, fine to medium grained, iron stained
10		N = 17	16									
		N = 67										
15		N = 49										
												POORLY-GRADED SAND (SP), light brown to yellowish brown, dense to very dense, dry to moist, fine grained
20		N = 42										
25		N = 57										
30		N = 33										
35		N = 50/6"										
40		N = 95										
45		N = 87										
50		N = 50/6"										
55		N = 50/5"										
												Total depth = 55 ft.

FIELD DATA | LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.939113, Long. -101.709620

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LOG OF BORING GEO-42

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/10/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 30 ft. during drilling and measured at 54 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 12	18									5 in. Topsoil LEAN CLAY (CL), trace Sand, brown, stiff, moist, iron stained, calcareous
	5		N = 11	22									SANDY LEAN CLAY (CL), brown, stiff to hard, dry to moist, calcareous
			N = 17	22									Grading iron stained
	10		N = 21	21									
			P = +4.5										
	15		N = 23										
			N = 28										
	20		N = 38										CLAYEY SAND (SC), brown, dense to very dense, dry to moist, fine grained
	25		N = 37										
	30		N = 47										Grading gray, trace organics Grading wet
	35		N = 76/11"										
	40		N = 75/11"										
	45		N = 44										
	50		N = 46										
	55		N = 48										Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.940888, Long. -101.695081

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LOG OF BORING GEO-43

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 11	13									CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, calcareous
	5		N = 29	14									Grading brown, iron stained
			N = 33	13									
	10		N = 35	12									Grading gray to brown
			N = 80										
	15		N = 44										
	20		N = 52										Grading light brown to brown
	25		N = 69										
	30		N = 62										
	35		N = 92										
	40		N = 80										Grading gray to brown
	45		N = 85/10"										
	50		N = 81/10"										
	55		N = 71										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.939567, Long. -101.785665

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LOG OF BORING GEO-44

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 14	15									LEAN CLAY (CL), with Sand, light brown, stiff to very stiff, moist, calcareous
	5		N = 19	22									Grading trace organics
			N = 93/9"	19									CLAYEY SAND (SC), brown, very dense, dry to moist, fine grained, iron stained
	10		N = 50/5"	2									
			N = 27	21									SANDY LEAN CLAY (CL), brown to gray, very stiff, dry to moist, iron stained, trace organics
	15		N = 23										
	20		N = 53										LEAN CLAY (CL), trace Sand, brown to light brown, hard, dry to moist
	25		N = 9										LIGNITE, black, stiff to hard, dry to moist
			N = 80/11"										
	30		N = 29										SILT (ML), trace Sand, gray, stiff to hard, dry to moist, trace Lignite
	35		N = 35										
	40		N = 34										
	45		N = 34										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	50		N = 64										Grading with Sand
	55		N = 83										Grading Lignite beddings
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.937839, Long. -101.767572

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LOG OF BORING GEO-45

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 20	16									CLAYEY SAND (SC), light brown, medium dense, moist, fine grained, calcareous
	5		N = 22	20									SANDY LEAN CLAY (CL), light brown to brown, very stiff, moist, iron stained, calcareous, trace organics
			N = 17	23									LEAN CLAY (CL), trace Sand, light brown, very stiff, moist, iron stained, calcareous, trace organics
	10		N = 18	18									SANDY LEAN CLAY (CL), light brown to gray, very stiff to hard, dry to moist, iron stained
			N = 38										
	15		N = 34										CLAYEY SAND (SC), gray to brown, dense, dry to moist, fine grained, iron stained
	20		N = 23										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist, iron stained, trace organics
	25		N = 59										Grading gray
	30		N = 56										
	35		N = 58										
	40		N = 83/11"										SANDSTONE, light brown, very hard, dry to moist, fine grained
	45		N = 84/9"										
	50		N = 93/10"										
	55		N = 88/10"										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.935204, Long. -101.795228

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LOG OF BORING GEO-46

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/26/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 14	12									LEAN CLAY (CL), with Sand, light brown, stiff to very stiff, moist, trace Lignite
				16	41	18	23					84	
	5		N = 29	19									Grading light brown to brown, iron stained
			N = 15	31									Grading trace Sand, gray to brown, trace organics
	10		N = 17	19									
			N = 34	23	69	18	51	104	6.21	10.1	10.0	82	FAT CLAY (CH), with Sand, gray to brown, hard, moist
	15		N = 30										SANDY LEAN CLAY (CL), light gray to brown, very stiff, dry to moist
	20		N = 18										LEAN CLAY (CL), trace Sand, light gray to dark brown, very stiff to hard, dry to moist, trace organics
	25		N = 38										Grading with Sand
	30		N = 47										SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, iron stained
	35		N = 65										Grading light gray
	40		N = 78/10"										SANDY CLAYSTONE, light gray to brown, very hard, dry to moist
	45		N = 50/5"										SANDSTONE, light gray to brown, very hard, dry to moist, fine to medium grained, weakly cemented
	50		N = 50/6"										
	55		N = 50/4"										
													Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.93259, Long. -101.787606

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LOG OF BORING GEO-47

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 45 ft. during drilling and measured at 48 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
			N = 18	8									CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, calcareous
	5		N = 74	7									
			N = 58	11									SANDY LEAN CLAY (CL), light brown, hard, dry to moist
	10		N = 51	14									
			N = 49	13									CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained
	15		N = 39										SANDY LEAN CLAY (CL), light brown, hard, dry to moist
	20		N = 50										CLAYEY SAND (SC), light brown, dense to very dense, dry to moist, fine grained
	25		N = 52										Grading gray
	30		N = 47										
	35		N = 45										
	40		N = 58										
	45		N = 56										Grading wet
	50		N = 66										LIGNITE, dark brown, hard, moist
	55		N = 36										LEAN CLAY (CL), with Sand, gray, hard, moist, calcareous
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.932651, Long. -101.777749

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LOG OF BORING GEO-48

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/5/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13	20									FAT CLAY (CH), trace Sand, brown to gray, stiff to hard, moist
		M		23	71	23	48					96	
	5		N = 15	22									Grading with Sand, iron stained
			N = 19	22									
	10		N = 31	17									
			N = 37	19									CLAYEY SAND (SC), brown to gray, dense, dry to moist, fine grained, iron stained
	15		N = 42										Grading yellowish brown
	20		N = 55										LEAN CLAY (CL), trace Sand, brown to dark brown, hard, dry to moist, with Lignite, trace organics
	25		N = 33										Grading gray
	30		N = 83										POORLY-GRADED SAND (SP-SM), with Silt, yellowish brown, very dense, dry to moist, fine grained
	35		N = 50/1"										SANDSTONE, light yellowish brown, very hard, dry to moist, calcareous
	40		N = 67										SANDSTONE, yellowish brown, hard to very hard, dry to moist, fine grained, weakly to moderately cemented
	45		N = 93/11"										
	50		N = 91/7"										
			N = 25/0"										Refusal at 52 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.922342, Long. -101.767967

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LOG OF BORING GEO-49

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/6/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 18	12									LEAN CLAY (CL), with Sand, light brown, very stiff, dry to moist, calcareous
	5		N = 6	22									SANDY LEAN CLAY (CL), light brown to yellowish brown, medium stiff to stiff, moist
			N = 14	21									Grading brown to gray
	10		N = 14	22									LEAN CLAY (CL), with Sand, brown to gray, stiff to hard, dry to moist, iron stained
			N = 55										Grading trace organics
	15		N = 34										SANDY ELASTIC SILT (MH), brown to gray, medium stiff to hard, dry to moist, iron stained, calcareous
	20		N = 28										Grading trace organics
	25		N = 40										Calcareous feature and organic grades out; grading with Lignite
	30		N = 6	81	88	69	19					62	
			N = 50/4"										Grading dark brown
	35		N = 32										LEAN CLAY (CL), trace Sand, dark brown to gray, very stiff to hard, dry to moist, iron stained, trace Lignite and organics
	40		N = 30										Organic grades out; grading with Sand, calcareous
	45		N = 31										
	50		N = 33										SANDY LEAN CLAY (CL), gray, hard, dry to moist, calcareous
	55		N = 32										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.926427, Long. -101.762738

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LOG OF BORING GEO-50

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 9	19									LEAN CLAY (CL), trace Sand, brown to gray, stiff, moist, calcareous
	5		N = 12	22									Grading iron stained
			N = 7	26 37									FAT CLAY (CH), trace Sand, dark brown to gray, medium stiff to hard, dry to moist, calcareous, with Lignite
	10		N = 16	23									Grading brown
			P = +4.5										Grading with Shale
	15		N = 39	20	52	20	32	107				99	
	20		N = 29										
	25		N = 34										Grading brown to gray
	30		N = 86										SANDY LEAN CLAY (CL), dark brown to gray, hard, dry to moist, trace Lignite
	35		N = 46										LEAN CLAY (CL), trace Sand, dark brown to gray, hard, dry to moist, trace Lignite
	40		N = 41										
	45		N = 40										SANDY LEAN CLAY (CL), gray, hard, dry to moist
	50		N = 57										CLAYEY SAND (SC), gray, dense to very dense, dry to moist, fine grained
	55		N = 36										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.923447, Long. -101.751849

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LOG OF BORING GEO-51

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/10/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 9	12									5 in. Topsoil SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, iron stained, calcareous
	5		N = 13	26									LEAN CLAY (CL), with Sand, gray to brown, stiff to hard, dry to moist, iron stained
			N = 19	23									Grading trace Sand, light brown to yellowish brown, trace organics
	10		N = 16	22									Grading light brown to brown
			P = +4.5										
	15		N = 18										
	20		N = 72/7"										
	25		N = 30										Grading light gray
	30		N = 42										Grading with Sand, light brown to gray
	35		N = 40										Grading trace Sand, gray to dark gray
	40		N = 40										
	45		N = 44										
	50		N = 59										Grading with Lignite interbeddings
	55		N = 50/6"										
													Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.922422, Long. -101.730508

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-52

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025 - 5/10/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 15	16									SANDY LEAN CLAY (CL), brown to gray, stiff, moist, calcareous
	5		N = 21	17									LEAN CLAY (CL), with Sand, brown to gray, stiff to very stiff, moist
			N = 14	20									Grading trace Sand, light brown to light gray, trace organics
	10		N = 22	48									Grading dark brown, with Lignite
			N = 50	19									CLAYEY SAND (SC), light brown, dense, moist, fine grained, trace organics
	15		N = 32										LEAN CLAY (CL), trace Sand, brown, hard, dry to moist, iron stained
	20		N = 50/6"										SILTY SAND (SM), brown, very dense, dry to moist, fine grained, trace organics
	25		N = 43										LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, with Lignite, trace organics
	30		N = 36										SANDY LEAN CLAY (CL), brown, hard, dry to moist, iron stained
	35		N = 81										CLAYEY SAND (SC), light brown, dense to very dense, dry to moist, fine grained
	40		N = 69										Grading brown to gray
	45		N = 42										
	50		N = 37										Grading light brown to gray
	55		N = 56										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.923094, Long. -101.724068

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LOG OF BORING GEO-53

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/6/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 11	16									FAT CLAY (CH), trace Sand, light brown, medium stiff to stiff, moist, calcareous
				17	54	19	35					93	
	5		N = 7	22									Calcareous feature grades out; grading with Sand, iron stained
			N = 6	23									Grading trace organics
	10		P = +4.5										SANDY SILT (ML), black, loose, dry to moist, trace organics
			N = 13	98	NP	NP	NP	34				66	
	15		N = 34										LEAN CLAY (CL), trace Sand, gray to brown, stiff to hard, dry to moist, iron stained, with Lignite
	20		N = 9										Grading dark brown, with Lignite interbeddings
			P = +4.5	26				94					
	25		N = 35										Grading gray, calcareous
	30		N = 28										Grading dark gray
	35		N = 35										Lignite grades out
	40		N = 42										
	45		N = 33										
	50		N = 51										Grading with Lignite interbeddings
	55		N = 59										CLAYEY SAND (SC), gray, very dense, dry to moist, fine grained
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.922764, Long. -101.713804

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LOG OF BORING GEO-54

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 21	22									LEAN CLAY (CL), with Sand, yellowish brown, very stiff, moist, iron stained
	5		N = 20	22									SILTY SAND (SM), light brown, dry to moist, fine grained
													LEAN CLAY (CL), with Sand, light brown, very stiff, moist
			N = 34	18									CLAYEY SAND (SC), light brown to brown, medium dense to dense, moist, fine grained, iron stained
	10		N = 25	21									
			N = 15	56									LEAN CLAY (CL), trace Sand, dark brown to black, stiff, moist, with Lignite interbeddings
	15		N = 89										SANDY LEAN CLAY (CL), light brown, hard, dry to moist, with Lignite beddings
	20		N = 21										CLAYEY SAND (SC), brown to gray, medium dense, dry to moist, fine grained
	25		N = 50										LEAN CLAY (CL), trace Sand, light gray, hard, dry to moist, trace organics
	30		N = 54										Grading light gray to dark gray
	35		N = 45										Organic grades out
	40		N = 37										
	45		N = 55										
	50		N = 40										
	55		N = 40										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.922576, Long. -101.705791

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LOG OF BORING GEO-56

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 18	16									LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist
	5		N = 20	19									
			N = 27	26									Grading dark brown, with occasional Shale fragments, trace organics
	10		N = 18	42									Grading gray to dark brown
			P = +4.5										
	15		N = 39										Grading with Sand, brown to gray, iron stained
	20		N = 84/10"										
	25		N = 57										Grading trace Sand, dark gray to gray, with Lignite interbeddings
	30		N = 72										
	35		N = 47										SANDY LEAN CLAY (CL), light gray to gray, hard, dry to moist, trace organics
	40		N = 34										LEAN CLAY (CL), trace Sand, light gray to gray, hard, dry to moist
	45		N = 41										Grading light gray to black, with Lignite interbeddings
	50		N = 54										Grading with Sand, trace organics
	55		N = 35										SANDY LEAN CLAY (CL), dark gray to gray, hard, dry to moist, trace organics
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.907994, Long. -101.725116

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LOG OF BORING GEO-57

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 19	11									LEAN CLAY (CL), with Sand, light brown, very stiff to hard, dry to moist, calcareous
	5		N = 50/2"	14									
			N = 29	20									Grading trace Sand, light brown
	10		N = 24	20									
			N = 29	19									Grading light brown to gray
	15		N = 33										
	20		N = 74/9"										LIGNITE, black, hard, dry to moist
													LEAN CLAY (CL), trace Sand, light gray to gray, hard, dry to moist, trace organics
	25		N = 38										Grading dark gray to gray, with Lignite interbeddings
	30		N = 50/4"										Grading gray to black
	35		N = 40										Grading light gray
	40		N = 42										
	45		N = 50/3"										Grading gray
	50		N = 39										
	55		N = 47										Lignite and organic grades out
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.910611, Long. -101.712133

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LOG OF BORING GEO-58

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/27/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 11	21									LEAN CLAY (CL), with Sand, light brown, stiff, moist
	5		N = 10	24									
			N = 38	13									CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained
	10		N = 25	10									
			N = 37	24									SANDY LEAN CLAY (CL), brown to gray, hard, dry to moist
			N = 50/1"										
			N = 33										
			N = 35										LEAN CLAY (CL), trace Sand, gray to brown, hard, dry to moist, iron stained, trace Lignite
			N = 43										SANDY LEAN CLAY (CL), brown, very stiff to hard, dry to moist, iron stained
			N = 27										Grading dark brown, trace organics
			N = 41										LEAN CLAY (CL), trace Sand, dark brown to black, hard, dry to moist, with Lignite bedding
			N = 44										CLAYEY SAND (SC), light gray to gray, dense, dry to moist, fine grained
			N = 39										LEAN CLAY (CL), trace Sand, light gray to gray, hard, dry to moist
			N = 59										
			N = 42										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.915340, Long. -101.703733

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LOG OF BORING GEO-59

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/26/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 34 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												6 in. Topsoil
		N = 11	17 21	54	20	34					98	FAT CLAY (CH), trace Sand, light brown, stiff to very stiff, moist
5		N = 17	20									LEAN CLAY (CL), trace Sand, light brown to gray, very stiff, moist, iron stained
		N = 20	22									Grading with Sand, trace calcite
10		N = 25	13									SANDY SILT (ML), light brown, medium dense to dense, dry to moist
		N = 65										
15		N = 49										SILTY SAND (SM), light brown, dense, dry to moist, fine grained
20		N = 56										LEAN CLAY (CL), trace Sand, light brown, hard, dry to moist
25		N = 72										SILTY SAND (SM), light brown to gray, very dense, dry to moist, fine to medium grained
30		N = 60										
												POORLY-GRADED SAND (SP), light brown, very dense, moist to wet, fine grained
35		N = 59										Grading brown
40		N = 68										Grading Lignite and Shale bedding
45		N = 55										
50		N = 23										LEAN CLAY (CL), with Sand, gray, very stiff to hard, moist, with Lignite bedding
55		N = 35										
												Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.911737, Long. -101.695736

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LOG OF BORING GEO-60

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025 - 4/26/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 5	9									SILTY SAND (SM), light brown, loose to medium dense, dry to moist, fine grained
	5		N = 15	21									
			N = 24	25									SANDY LEAN CLAY(CL), light brown, very stiff, dry to moist
	10		N = 19	25									Grading calcareous
			N = 49										
	15		N = 24										Grading brown to dark brown
	20		N = 30										Grading brown to gray
	25		N = 37										LEAN CLAY (CL), trace Sand, gray to brown, hard, dry to moist
	30		N = 36										Grading gray to light gray, trace organics
													SILT (ML), trace Sand, gray, hard, dry to moist, with Lignite and Sandstone interbeddings
	35		N = 60										
	40		N = 42										
	45		N = 50/5"										LEAN CLAY (CL), with Sand, gray, hard, dry to moist
	50		N = 46										
	55		N = 42										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.918971, Long. -101.692604

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-61

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 24 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 8	19									6 in. Topsoil SANDY LEAN CLAY (CL), dark brown to brown, medium stiff, moist
	5		N = 22	15									CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, iron stained
			N = 26	14									Grading light brown to brown
	10		N = 23	27									
			N = 54										
	15		N = 40										Grading dark brown to brown
	20		N = 42										
	25		N = 70										Grading wet
	30		N = 42										
	35		N = 79										Grading gray to brown
	40		N = 58										SANDY LEAN CLAY (CL), gray to light gray, hard, moist
	45		N = 67/11"										LEAN CLAY (CL), trace Sand, gray to light gray, hard, moist, with Lignite interbeddings
	50		N = 52										Grading dark brown, with Lignite beddings Grading light gray
	55		N = 44										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.909107, Long. -101.683665

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING GEO-62

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/6/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 34 ft. during drilling and measured at 52 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
		M	N = 4	13									CLAYEY SAND (SC), light brown, loose, dry to moist, fine grained, calcareous
		C		8	26	18	8					49	
	5		N = 9	12									
			N = 4	27									SANDY LEAN CLAY (CL), brown, soft, moist
	10		N = 19	22									FAT CLAY (CH), trace Sand, brown, very stiff to hard, dry to moist
			N = 29	21	56	23	33	105	4.51	6.6	10.0	91	Grading dark brown to gray
	15		N = 39										Grading light gray
	20		N = 21										Grading iron stained
	25		P = +4.5	25				101					
	30		N = 34										
	35		N = 32										Grading wet
	40		N = 47										
	45		N = 39										
	50		N = 70/7"										Grading gray
	55		N = 35										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.908346, Long. -101.677053

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LOG OF BORING GEO-63

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 19	9									LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, calcareous
	5		N = 11	28									Grading light brown to yellowish brown, iron stained
			N = 17	21									Grading trace Sand
	10		N = 22	20									
			N = 16	23									Grading with Sand, brown
	15		N = 35										
	20		N = 21										Grading trace Sand, gray to dark brown, with Lignite interbedding
	25		N = 36										
	30		N = 32										Grading dark brown to light brown
	35		N = 31										Grading brown
	40		N = 34										
	45		N = 28										CLAYEY SAND (SC), gray to brown, medium dense, dry to moist, fine grained
	50		N = 47										SANDY LEAN CLAY (CL), light gray, hard, dry to moist
	55		N = 42										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.903390, Long. -101.708697

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LOG OF BORING GEO-64

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 9	17									SANDY LEAN CLAY (CL), light brown, stiff to very stiff, moist
	5		N = 27	21									
			N = 28	22									LEAN CLAY (CL), with Sand, light brown, very stiff to hard, dry to moist, iron stained
				23									
	10		N = 27	23									Grading trace Sand, with Lignite seems
			N = 28	26									Grading dark gray to gray
	15		N = 34										Grading dark brown, with Lignite bedding
	20		N = 31										
	25		N = 50/4"										LIGNITE, dark brown, hard, dry to moist
													SILT (ML), with Sand, gray, hard, dry to moist
	30		N = 42										SANDY LEAN CLAY (CL), gray to dark gray, hard, dry to moist
	35		N = 36										
	40		N = 39										
	45		N = 96/10"										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, with Lignite bedding
	50		N = 44										
	55		N = 41										
													Total Depth = 55.5 ft.

FIELD DATA | LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.903570, Long. -101.686788

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LOG OF BORING GEO-65

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/8/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													5 in. Topsoil
			N = 11	11									SANDY LEAN CLAY (CL), light brown, medium stiff to stiff, dry to moist, calcareous
	5		N = 8	27									Grading trace organics
			N = 6	33									CLAYEY SAND (SC), brown, loose, moist, fine grained, trace organics
	10		N = 31	25									LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist
			N = 32	25									Grading light brown
	15		N = 16										Grading trace Sand
	20		N = 48										
	25		N = 22										Grading dark gray, iron stained
	30		N = 34										
	35		N = 27										
	40		N = 34										
	45		N = 69/10"										
	50		N = 50/5"										
	55		N = 33										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.897699, Long. -101.696096

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LOG OF BORING GEO-66

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													9 in. Topsoil
			N = 5	15									SANDY LEAN CLAY (CL), light brown, medium stiff to stiff, moist, calcareous, trace roots
	5		N = 6	20									
			N = 14	17									Grading light brown to gray
	10		N = 11	28									FAT CLAY (CH), trace Sand, light gray to brown, stiff to hard, dry to moist, iron stained
			P = 4.5	22	52	22	30	104	6.24	5.8	10.0	100	
	15		N = 25										
	20		N = 26										SANDY LEAN CLAY (CL), light gray to brown, very stiff, dry to moist, iron stained
	25		N = 37										LEAN CLAY (CL), trace Sand, light gray to brown, hard, dry to moist, iron stained
	30		N = 48										SANDY LEAN CLAY (CL), light gray to brown, hard, dry to moist, iron stained
	35		N = 56										LEAN CLAY (CL), with Sand, light brown, hard, dry to moist, iron stained
	40		N = 55										
	45		N = 58										
	50		N = 35										SILT (ML), trace Sand, dark gray to gray, hard, dry to moist
	55		N = 54										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.896434, Long. -101.676574

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LOG OF BORING GEO-67

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/25/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 45 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13	14									LEAN CLAY (CL), trace Sand, light brown to brown, stiff to very stiff, dry to moist, calcareous
		M		14	43	21	22					97	
	5		N = 26	20									
		M											
			N = 26	20									Grading iron stained
	10		N = 25	18									
			N = 48										
	15		N = 23										SANDY LEAN CLAY (CL), brown, very stiff, dry to moist, iron stained
	20		N = 32										LEAN CLAY (CL), with Sand, light brown to brown, hard, dry to moist
	25		N = 38										Grading trace Sand, iron stained
	30		N = 46										Grading light gray to brown
	35		N = 41										Iron stain grades out; grading dark gray to gray
	40		N = 72/11"										
	45		N = 60										SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, trace organics Grading wet
	50		N = 34										LEAN CLAY (CL), with Sand, bluish gray to gray, hard, moist
	55		N = 40										SANDY LEAN CLAY (CL), bluish gray to gray, hard, moist
													Total Depth = 55.5 ft.

FIELD DATA | LABORATORY DATA | DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.897586, Long. -101.664957

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LOG OF BORING GEO-68

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													9 in. Topsoil
			N = 19	15									LEAN CLAY (CL), with Sand, light brown, very stiff, moist, iron stained, calcareous
	5		N = 26	20									
			N = 35	20									SANDY LEAN CLAY (CL), brown to gray, hard, moist, iron stained
	10		N = 32	19									LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained, with Lignite
			N = 25	22									Grading trace Sand, calcareous, trace Lignite
	15		N = 54										
	20		N = 28										Lignite grades out; grading trace Calcite
	25		N = 39										
	30		N = 42										Calcite grades out
	35		N = 46										Grading light brown to gray
	40		N = 81/11"										
	45		N = 50										Grading with Sand
	50		N = 73										
			N = 50/4"										Total Depth = 54.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.896070, Long. -101.651180

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LOG OF BORING GEO-69

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 20	24									SILTY SAND (SM), light brown, medium dense, moist, fine grained
	5		N = 25	17									Grading dark brown, with Lignite seams
			N = 18	23									LEAN CLAY (CL), with Sand, light gray to brown, very stiff to hard, moist, iron stained, trace Calcite
	10		N = 18	25									Grading trace Sand
			P = N/A	25				95	4.60	3.5	0.0		
	15		N = 22										SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist
	20		N = 68										SILT (ML), trace Sand, light brown, hard, dry to moist Grading dark brown, with Lignite beddings
	25		N = 26										LEAN CLAY (CL), with Sand, dark brown, very stiff, dry to moist, with Lignite beddings
	30		N = 32										SILTY SAND (SM), gray, dense, dry to moist, fine grained
	35		N = 39										LEAN CLAY (CL), trace Sand, light gray to gray, very stiff to hard, dry to moist, with Lignite seams
	40		N = 41										
	45		N = 30										
	50		N = 39										
	55		N = 40										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.890090, Long. -101.683948

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LOG OF BORING GEO-70

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/24/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 34 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LABORATORY DATA: ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 22	14 16	61	20	41					99	FAT CLAY (CH), trace Sand, light brown, very stiff, moist, calcareous
	5		N = 20	19									SANDY SILT (ML), light brown, medium dense, dry to moist
			N = 22	11									SANDY LEAN CLAY (CL), light brown to gray, very stiff, dry to moist, calcareous
	10		N = 18	15									LEAN CLAY (CL), trace Sand, light brown to gray, stiff to very stiff, dry to moist
			N = 34	26									
	15		N = 14										Grading dark brown, trace Lignite bedding
	20		N = 26										SANDY LEAN CLAY (CL), light brown to gray, very stiff to hard, dry to moist
	25		N = 33										Grading brown
	30		N = 43										
	35		N = 50/4"										LIGNITE, dark brown, hard, moist to wet
													SILT (ML), trace Sand, gray, hard, moist to wet
	40		N = 37										
	45		N = 35										SANDY LEAN CLAY (CL), gray, hard, moist
	50		N = 49										LEAN CLAY (CL), trace Sand, dark gray to light gray, hard, moist
	55		N = 51										
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.881269, Long. -101.690206

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LOG OF BORING GEO-71

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/3/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 25 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
			N = 7	14									CLAYEY SAND (SC), brown, loose to very dense, dry to moist, fine grained, iron stained
	5		N = 8	11									Grading light brown
			N = 50/3"	12									
	10		N = 34	14									SANDY LEAN CLAY (CL), light brown to gray, hard, moist, trace organics
			N = 30										CLAYEY SAND (SC), gray, medium dense, dry to moist, fine grained
	15		N = 17										LEAN CLAY (CL), with Sand, gray to brown, very stiff, dry to moist, trace organics
	20		N = 25										Organic grades out; grading iron stained
			N = 41										
	25		N = 28										Grading trace Sand, dark gray to light gray, trace organics Grading wet
	30		N = 38										CLAYEY SAND (SC), light gray to gray, dense, moist, fine grained
	35		N = 30										LEAN CLAY (CL), with Sand, light gray, very stiff to hard, moist
	40		N = 36										Grading light gray to gray, trace organics
	45		N = 61										Grading trace Sand, gray to dark gray
	50		N = 44										Grading light gray to gray
	55		N = 38										Organic grades out
													Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.951278, Long. -101.767572

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING SUB-1

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19.5 ft. during drilling and measured at 33 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 6	11									SILTY SAND (SM), light brown, loose, dry to moist, fine grained
	5		N = 30	14									POORLY-GRADED SAND (SP), light brown to dark brown, medium dense, dry to moist, fine to medium grained
			N = 16										Grading iron stained
	10		N = 49										
			N = 30										CLAYEY SAND (SC), light gray to brown, medium dense to dense, dry to moist, fine to medium grained
	15		N = 40										
	20		N = 38										Grading gray Grading wet
	25		N = 73										LIGNITE, gray, hard, moist to wet
	30		N = 26										LEAN CLAY (CL), trace Sand, light gray to dark brown, very stiff to hard, moist to wet
	35		N = 38										
	40		N = 41										
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955712, Long. -101.761785

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LOG OF BORING SUB-2

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling and measured at 35 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
			N = 7	7									SANDY LEAN CLAY (CL), dark brown, medium stiff, dry to moist
				14	37	14	23					51	
	5		N = 9	14	NP	NP	NP					20	SILTY SAND (SM), light brown, loose, moist, fine grained
			N = 32										POORLY-GRADED SAND (SP), brown, medium dense, dry to moist, fine to medium grained, iron stained
	10		N = 27										CLAYEY SAND (SC), light gray to brown, medium dense to dense, dry to moist, fine to medium grained
			N = 52										Grading dark brown
	15		N = 39										Grading wet
	20		N = 40										POORLY-GRADED SAND (SP), dark brown, dense, moist to wet, fine grained, trace Lignite and organics
	25		N = 85										CLAYEY SAND (SC), dark brown to brown, very dense, moist to wet, fine to medium grained, with Lignite interbeddings
	30		N = 41										LEAN CLAY (CL), trace Sand, dark brown to brown, hard, moist to wet
	35		N = 51										CLAYEY SAND (SC), light gray, dense to very dense, moist to wet, fine grained
	40		N = 45										
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955535, Long. -101.762072

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LOG OF BORING SUB-3

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling and measured at 36 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA				LABORATORY DATA								
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												2 in. Topsoil
			N = 6										SILTY, CLAYEY SAND (SC-SM), dark brown to brown, loose, dry to moist, fine grained
	5		P = 1.5	15	21	16	5	108	1.62	14.3	3.0	20	Grading light brown
			N = 14										CLAYEY SAND (SC), dark brown to brown, medium dense to dense, dry to moist, fine to medium grained, iron stained
	10		N = 28										
			N = 33										
	15		N = 42										Grading gray, wet
	20		N = 44										Grading light gray
	25		N = 29										LEAN CLAY (CL), trace Sand, light gray to gray, very stiff to hard, moist to wet
	30		N = 33										
	35		N = 50										SANDY LEAN CLAY (CL), light gray to gray, hard, moist to wet
	40		N = 79										
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955049, Long. -101.762273

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LOG OF BORING SUB-4

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12 ft. during drilling and measured at 33 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5										2 in. Topsoil SANDY LEAN CLAY (CL), dark brown to brown, medium stiff, dry to moist, trace roots
	5		N = 5										CLAYEY SAND (SC), light brown to gray, loose to dense, dry to moist, fine grained
			N = 22										
	10		N = 23										
			N = 37										Grading wet
	15		N = 46										
	20		N = 33										
	25		N = 39										Grading dark gray, fine to medium grained
	30		N = 46										Grading trace organics
	35		N = 38										LEAN CLAY (CL), trace Sand, dark gray to gray, very stiff to hard, moist
	40		N = 30										
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955054, Long. -101.761848

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LOG OF BORING SUB-5

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12.5 ft. during drilling and measured at 30 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 5										3 in. Topsoil SANDY LEAN CLAY (CL), light gray to gray, medium stiff, dry to moist
	5		N = 6										CLAYEY SAND (SC), dark brown to light gray, loose to dense, dry to moist, fine grained, iron stained
			N = 14										
	10		N = 9										
			N = 30										Grading wet
	15		N = 36										Grading dark gray
	20		N = 31										
	25		N = 44										LEAN CLAY (CL), trace Sand, dark brown, hard, moist to wet
	30		N = 41										Grading light gray
	35		N = 35										
	40		N = 42										
													Total Depth = 40.5 ft.

FIELD DATA / LABORATORY DATA

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954784, Long. -101.761958

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LOG OF BORING SUB-6

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and measured at 29 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 11										SILTY SAND (SM), light brown, medium dense to dense, dry to moist, fine grained, iron stained
	5		P = 2.5	6	NP	NP	NP	101				27	
			N = 12										
	10		N = 30										
			N = 31										
	15		N = 50/6"										LEAN CLAY (CL), with Sand, brown, hard, dry to moist
	20		N = 50										CLAYEY SAND (SC), light brown to dark brown, dense to very dense, moist to wet, fine to medium grained, iron stained
	25		N = 59										Iron stain grades out; grading gray
	30		N = 59										
	35		N = 24										LEAN CLAY (CL), trace Sand, gray, very stiff to hard, moist
	40		N = 44										Grading with Sand, trace organics
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955549, Long. -101.760791

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LOG OF BORING SUB-7

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 13 ft. during drilling and measured at 34 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
			N = 3										SANDY LEAN CLAY (CL), brown, soft, dry to moist, trace roots
	5		N = 14										CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine to medium grained
			N = 26										
	10		N = 28										Grading dark brown
			N = 31										Grading wet
	15		N = 70/10"										Grading trace organics
	20		N = 62										Grading gray
	25		N = 68										
	30		N = 58										LEAN CLAY (CL), trace Sand, dark brown to gray, hard, moist to wet, with Lignite interbeddings
	35		N = 44										Grading with Sand, light gray
	40		N = 46										
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.9550580, Long. -101.761344

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LOG OF BORING SUB-8

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and measured at 35 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 12										CLAYEY SAND (SC), brown, medium dense, dry to moist, fine grained, iron stained
	5		P = 3.0										
			N = 30										POORLY-GRADED SAND (SP), light brown to dark brown, medium dense to dense, dry to moist, fine grained
	10		N = 32										
			N = 35										CLAYEY SAND (SC), brown, dense to very dense, moist, fine to medium grained, iron stained
	15		N = 35										
			N = 40	▽									Grading wet
	20												
			N = 47										Grading light brown to gray
	25												
			N = 64										
	30												
			N = 36	▼									LEAN CLAY (CL), with Sand, dark gray to dark brown, hard, moist to wet, with Lignite interbeddings
	35												
			N = 36										Grading trace organics
	40												
													Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954797, Long. -101.760801

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LOG OF BORING SUB-9

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
			N = 11	6									CLAYEY SAND (SC), light brown to brown, loose to dense, dry to moist, fine grained, iron stained
	5		N = 8	6	24	16	8					23	Grading dark brown, trace roots
			N = 28										
	10		N = 27										Grading light brown, fine to medium grained
			N = 30										
	15		N = 49										
													Total Depth = 15.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953917, Long. -101.761302

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LOG OF BORING SUB-10

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 11										CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained
	5		N = 20										Grading brown
			N = 28										
	10		N = 33										Grading dark brown
			N = 42										
	15		N = 39										
													Total Depth = 15.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953298, Long. -101.761288

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:47 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-1

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
													SILTY SAND (SM), light brown, dry to moist, fine grained
	1												
	2												
	3												
	4												
	5												Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955771, Long. -101.762488

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-2

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
													SILTY SAND (SM), light brown, dry to moist, fine grained
	1												
	2												
	3												
	4												
	5												
													Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955782, Long. -101.761487

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-3

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													4 in. Topsoil
	1												SILT (ML), trace Sand, reddish brown, dry to moist
	2												Grading light brown
	3												SILTY SAND (SM), light brown, dry to moist, fine grained
	4												
	5												Total Depth = 5 ft.

FIELD DATA / LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955793, Long. -101.760486

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-4

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
													LEAN CLAY (CL), trace Sand, dark brown, dry to moist
	1												
	2												
	3												CLAYEY SAND (SC), light brown, dry to moist, fine grained
	4												
	5												Total Depth = 5 ft.

FIELD DATA / LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955223, Long. -101.762475

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-5

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
	1												SILT (ML), trace Sand, dark brown, dry to moist
	2												
	3												SILTY SAND (SM), light brown, dry to moist, fine grained
	4												
	5												Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955234, Long. -101.761474

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-6

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
	1												SILT (ML), trace Sand, light brown, dry to moist
	2												
	3												
	4												
	5												Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.955245, Long. -101.760473

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-7

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA				LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
	1												CLAYEY SAND (SC), light brown, dry to moist, fine grained
	2												
	3												
	4												
	5												Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954675, Long. -101.762462

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-8

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA				LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
	1												SILTY SAND (SM), dark brown, dry to moist, fine grained
	2												
	3												CLAYEY SAND (SC), light brown, dry to moist, fine grained
	4												
	5												Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954686, Long. -101.761461

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-9

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
	1												SILT (ML), trace Sand, light brown, dry to moist
	2												
	3												
	4												
	5												Total Depth = 5 ft.

FIELD DATA | LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954697, Long. -101.760460

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-10

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA			LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
	1											
	2											
	3											
	4											
	5											

DESCRIPTION OF STRATUM

SILTY SAND (SM), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954105, Long. -101.761659

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-11

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													SILTY SAND (SM), light brown, dry to moist, fine grained
	1												
	2												
	3												
	4												
	5												Total Depth = 5 ft.

FIELD DATA / LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.954113, Long. -101.760954

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-12

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA			LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
	1											
	2											
	3											
	4											
	5											

DESCRIPTION OF STRATUM

SILTY SAND (SM), dark brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953607, Long. -101.761294

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-13

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA			LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
	1											
	2											
	3											
	4											
	5											

DESCRIPTION OF STRATUM

SILTY SAND (SM), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953102, Long. -101.761635

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING HA-14

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													SILTY SAND (SM), dark brown, dry to moist, fine grained
	1												
	2												
	3												
	4												
	5												Total Depth = 5 ft.

FIELD DATA / LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.953109, Long. -101.760930

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-1

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 23										SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist
	5		N = 42										CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained
			N = 50/3"										
	10		N = 29										
			N = 20										
	15		N = 23										LEAN CLAY (CL), with Sand, light brown, very stiff to hard, dry to moist, iron stained
	20		N = 31										Grading trace Sand, dark brown to brown, trace organics
	25		N = 36										Grading gray to dark gray
	30		N = 48										
	35		N = 35										
	40		N = 50/4"										MUDSTONE, dark gray to gray, hard to very hard, dry to moist, trace organics
	45		N = 58										
	50		N = 67										
													Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.986205, Long. -101.766771

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-2

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 5										FAT CLAY (CH), with Sand, light brown to gray, medium stiff to hard, dry to moist
	5		P = 4.5										
			N = 24										LEAN CLAY (CL), with Sand, brown to light brown, very stiff, dry to moist, iron stained
	10		N = 22										
			N = 30										
	15		N = 26										Grading trace Sand, light gray to gray
	20		N = 41										LIGNITE, dark brown to black, hard, dry to moist
	25		N = 74										LEAN CLAY (CL), with Sand, gray, hard, dry to moist
	30		N = 61										
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.984606, Long. -101.766776

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LOG OF BORING TL-3

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 9										CLAYEY SAND (SC), brown, loose, dry to moist, fine grained
	5		N = 18										FAT CLAY (CH), trace Sand, light brown to gray, stiff to hard, dry to moist
			N = 20										
	10		P = 4.5										SILT (ML), with Sand, light brown to gray, hard, dry to moist
			N = 26										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist
	15		N = 30										
	20		N = 23										Grading iron stained, trace calcite and Lignite bedding
	25		N = 33										Iron stained and Lignite grade out; grading calcareous
	30		N = 26										LIGNITE, dark brown to black, very stiff, dry to moist
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.982158, Long. -101.766783

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-4

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 6										LEAN CLAY (CL), with Sand, light brown to gray, medium stiff to hard, dry to moist
	5		P = 0.75										
			N = 8										Grading trace Sand, light gray
	10		P = 2.0										
			N = 24										Grading with Sand, gray to brown
	15		N = 33										
	20		N = 39										
	25		N = 48										
	30		N = 44										SANDY LEAN CLAY (CL), gray to dark gray, hard, dry to moist
	35		N = 55										Grading dark gray
	40		N = 60										Grading with organics
	45		N = 54										CLAYEY SAND (SC), dark gray, very dense, dry to moist, fine grained, with organics
	50		N = 54										Organic grades out
													Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.980259, Long. -101.766789

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LOG OF BORING TL-5

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 12										LEAN CLAY (CL), trace Sand, light brown, stiff to very stiff, dry to moist, trace calcium
	5		N = 9										Grading with Sand
			P = 2.75										
	10		N = 13										Grading trace Sand
			N = 14										Grading iron stained
	15		N = 26										SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist
	20		N = 51										CLAYEY SAND (SC), light brown, very dense, dry to moist, fine grained
	25		N = 78										SILT (ML), with Sand, light brown to gray, hard, dry to moist
	30		N = 34										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.980257, Long. -101.763791

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LOG OF BORING TL-6

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 8										CLAYEY SAND (SC), light brown, loose to medium dense, dry to moist, fine grained
	5		N = 30										
			N = 8										LEAN CLAY (CL), with Sand, light brown to gray, medium stiff to hard, dry to moist, trace Lignite
	10		P = 4.5										
			N = 14										
	15		N = 39										Lignite grades out
	20		N = 23										
	25		N = 36										CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained
	30		N = 33										
	35		N = 37										Grading gray
	40		N = 40										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	45		N = 41										SILT (ML), trace Sand, gray, hard, dry to moist
	50		N = 84/10"										
													Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.980255, Long. -101.760946

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LOG OF BORING TL-7

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 5										SANDY FAT CLAY (CH), light brown, medium stiff, dry to moist
	5		P = 3.5										LEAN CLAY (CL), with Sand, light brown, very stiff, dry to moist
			N = 16										Grading trace Sand
	10		N = 20										
			N = 27										CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained
	15		N = 24										
	20		N = 43										
	25		N = 41										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	30		N = 36										SILT (ML), trace Sand, gray, hard, dry to moist
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.978169, Long. -101.760927

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LOG OF BORING TL-8

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/30/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 7										6 in. Topsoil SILTY SAND (SM), light brown, loose, dry to moist, fine grained
	5		N = 5										CLAYEY SAND (SC), light brown, loose to medium dense, dry to moist, fine grained
			N = 43										
	10		N = 36										
			N = 3										LEAN CLAY (CL), trace Sand, dark brown, soft to very stiff, dry to moist, trace organics
	15		N = 16										Grading with Sand, light brown
	20		N = 38										CLAYEY SAND (SC), light brown to light gray, dense, dry to moist, fine to medium grained, iron stained
	25		N = 42										LEAN CLAY (CL), trace Sand, gray to dark gray, hard, dry to moist
	30		N = 40										Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.976028, Long. -101.760909

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-9

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 15										CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained, iron stained
	5		N = 14										
			P = +4.5										SANDY LEAN CLAY (CL), brown to gray, very stiff to hard, dry to moist
	10		N = 24										CLAYEY SAND (SC), gray, medium dense to dense, dry to moist, fine grained
			N = 32										
	15		N = 30										
	20		N = 44										
	25		N = 43										Grading light brown to brown, trace organics
	30		N = 26										Grading light brown to gray
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.973915, Long. -101.760890

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-10

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 24 ft. during drilling and measured at 24 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 7										6 in. Topsoil CLAYEY SAND (SC), light brown, very loose to very dense, dry to moist, fine grained
	5		N = 2										
			N = 47										Grading iron stained
	10		N = 32										
			N = 23										
	15		N = 32										
			N = 51										
	20												
			N = 44										Grading wet
	25												
			N = 59										
	30												Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.971640, Long. -101.760870

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-11

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/1/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 29 ft. during drilling and measured at 28 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 18										CLAYEY SAND (SC), light brown, loose to very dense, dry to moist, fine grained
	5		N = 8										
			N = 17										
	10		N = 33										
			N = 29										Grading iron stained
	15		N = 28										
	20		N = 31										Grading brown
	25		N = 61										Grading gray to light brown
	30		N = 58										Grading wet
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.969358, Long. -101.760850

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING TL-12

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/2/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling and measured at 6.5 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 8										CLAYEY SAND (SC), light brown, loose, moist, fine grained
	5		N = 6										Grading brown
			N = 8										SANDY LEAN CLAY (CL), light brown, medium stiff, moist to wet, iron stained
	10		N = 18										POORLY-GRADED SAND (SP-SC), with Clay, brown, medium dense, moist, fine to medium grained
			N = 27										CLAYEY SAND (SC), brown to light brown, medium dense to dense, moist, fine to medium grained
	15		N = 33										
	20		N = 31										
	25		N = 15										SILT (ML), trace Sand, dark gray, stiff, moist
	30		N = 42										CLAYEY SAND (SC), trace Gravel, gray, dense, moist, fine to coarse grained
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.967150, Long. -101.760831

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LOG OF BORING TL-13

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/2/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13										CLAYEY SAND (SC), brown, medium dense, dry to moist, fine grained, iron stained, trace roots
	5		N = 19										SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, iron stained
			N = 22										CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained
	10		N = 13										FAT CLAY (CH), trace Sand, brown, stiff to hard, dry to moist, trace organics
			P = 4.5										
	15		N = 17										LEAN CLAY (CL), trace Sand, gray to dark gray, very stiff, dry to moist
	20		N = 27										Grading with Sand
	25		N = 50/5"										CLAYSTONE, gray, medium hard to very hard, dry to moist
	30		N = 68										Grading dark gray
	35		N = 36										
	40		N = 77/11"										LIGNITIC SHALE, dark brown, medium hard to very hard, dry to moist
	45		N = 57										Grading gray to dark gray
	50		N = 34										
													Total Depth = 50.5 ft.

FIELD DATA | LABORATORY DATA | DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.964992, Long. -101.760812

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LOG OF BORING TL-14

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/2/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 8										CLAYEY SAND (SC), brown, loose to medium dense, dry to moist, fine grained, iron stained, trace roots
	5		N = 5										Grading light brown, fine to medium grained, micaceous
			N = 21										
	10		N = 25										
			N = 25										
	15		N = 15										LEAN CLAY (CL), with Sand, gray to light brown, stiff to hard, dry to moist, iron stained
			P = 4.5										
	20		N = 27										Grading trace Sand
	25		N = 26										Grading with Sand
	30		N = 23										Grading trace Sand
	35		N = 31										
	40		N = 50/2"										LIGNITIC SHALE, dark brown, medium hard to very hard, dry to moist
	45		N = 49										Grading gray to dark gray
	50		N = 48										Grading light gray
													Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.964315, Long. -101.761880

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LOG OF BORING TL-15

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/6/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 24 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13										SILTY SAND (SM), brown, medium dense, dry to moist, fine grained
	5		N = 16										CLAYEY SAND (SC), light brown, loose, dry to moist, fine grained, iron stained
			N = 10										
	10		N = 45										SANDY LEAN CLAY (CL), brown, hard, dry to moist, iron stained
			N = 50/6"										Grading trace Sandstone fragments
													SILT (ML), trace Sand, light brown, hard, dry to moist
	15		N = 53										POORLY-GRADED SAND (SP), light brown, dense to very dense, dry to moist, fine grained, iron stained, micaceous
	20		N = 50										
	25		N = 55										Grading wet
	30		N = 32										Grading dark gray
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.962040, Long. -101.761888

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LOG OF BORING TL-16

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 25 ft. during drilling and measured at 27 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													2 in. Topsoil
			N = 14										CLAYEY SAND (SC), light brown to brown, medium dense to dense, dry to moist, fine grained, iron stained, trace roots
	5		N = 14										Grading light gray
			N = 49										Grading brown to dark brown
	10		N = 43										
			N = 42										
	15		N = 45										
			N = 47										
	20												
			N = 50										Grading wet
	25												
	30		N = 91/10"										SANDSTONE, brown, very hard, moist, fine grained, weakly cemented
													Total Depth = 30.5 ft.

FIELD DATA | LABORATORY DATA

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.960133, Long. -101.761890

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LOG OF BORING TL-17

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12 ft. during drilling and measured at 24 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 6										3 in. Topsoil LEAN CLAY (CL), with Sand, dark brown, medium stiff, dry to moist
	5		N = 4										CLAYEY SAND (SC), light brown to light gray, loose to dense, dry to moist, fine to medium grained
			N = 8										Grading gray
	10		N = 19										Grading brown, iron stained
			N = 59										Grading dark gray, wet
	15		N = 30										
	20		N = 33										
	25		N = 35										LEAN CLAY (CL), with Sand, dark brown to gray, hard, moist to wet, trace organics
	30		N = 35										Grading trace Sand, dark gray
													Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.958219, Long. -101.761891

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LOG OF BORING TL-18

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/29/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 10 ft. during drilling and measured at 47 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													3 in. Topsoil
			N = 4										CLAYEY SAND (SC), light brown, very loose to very dense, dry to moist, fine grained
	5		N = 3										Grading gray
			N = 12										
	10		N = 27	▽									Grading wet
			N = 36										
	15		N = 49										Grading trace Lignite
	20		N = 50/6"										Grading gray
	25		N = 41										LIGNITE, dark brown, hard, moist to wet
	30		N = 50										LEAN CLAY (CL), with Sand, gray, hard, moist to wet
	35		N = 38										
	40		N = 51										SILT (ML), trace Sand, gray, hard, moist to wet
	45		N = 37	▼									LEAN CLAY (CL), with Sand, gray, hard, moist to wet
	50		N = 41										Grading trace Lignite
													Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.956549, Long. -101.761892

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING MET-3

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 4/23/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													9 in. Topsoil
			N = 11										SANDY LEAN CLAY (CL), light brown, stiff to hard, dry to moist, iron stained, calcareous
	5		P = 4.5										
			N = 26										SANDY SILT (ML), light brown to light gray, medium dense, dry to moist, iron stained
	10		N = 21										LEAN CLAY (CL), trace Sand, brown to gray, very stiff, dry to moist, iron stained, trace organics
			N = 21										LIGNITE, dark brown, very stiff, dry to moist
	15		N = 27										LEAN CLAY (CL), trace Sand, gray to brown, very stiff, dry to moist, iron stained, trace Lignite
	20		N = 39										SANDY LEAN CLAY (CL), light brown to gray, hard, dry to moist, iron stained
	25		N = 65										Grading with Sandstone beddings
	30		N = 43										LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, trace Lignite
			N = 50/4"										LIGNITE, dark brown, hard, dry to moist, iron stained, trace organics
													Total Depth = 34.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.894016, Long. -101.661035

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LOG OF BORING PMM-1

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/11/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 14										LEAN CLAY (CL), with Sand, dark brown, stiff to very stiff, dry to moist
	5		N = 10										Grading trace Sand, gray to brown, calcareous
			N = 31										Grading iron stained
	10		N = 23										SANDY LEAN CLAY (CL), light brown to brown, very stiff, dry to moist, iron stained
			N = 32										CLAYEY SAND (SC), light brown to brown, medium dense to dense, dry to moist, fine grained, iron stained
	15		N = 21										
	20		N = 26										Grading gray to brown
	25		N = 29										
	30		N = 27										LEAN CLAY (CL), trace Sand, gray to dark gray, very stiff to hard, dry to moist, with Lignite
	35		N = 38										Grading light gray
													Total Depth = 35.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.976921, Long. -101.747421

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING PMM-2

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/5/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 18										SANDY LEAN CLAY (CL), with Gravel, brown to light brown, very stiff, dry to moist, iron stained, calcareous
	5		N = 8	25	77	22	55					100	FAT CLAY (CH), trace Sand, light brown to gray, medium stiff to hard, dry to moist
			P = 3.0										
	10		N = 14										Grading with Sand
			N = 17										Grading trace Sand, iron stained
	15		N = 18										
	20		N = 20										
	25		N = 22										Grading calcareous, trace organics
	30		N = 34										
	35		N = 50/5"										Grading dark brown, with Lignite
													Total Depth = 35 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.938197, Long. -101.755101

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING PMM-3

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N = 19										4 in. Topsoil SANDY SILT (ML), light brown, medium dense, dry to moist, calcareous
	5		N = 19										LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained
			N = 65										Grading trace Sand, dark brown
	10		N = 34										
			N = 47										
	15		N = 47										Grading trace organic
	20		N = 43										
	25		N = 40										
	30		N = 52										Grading dark brown to gray
			N = 50/6"										LIGNITE, black, hard, dry to moist, trace organics Total Depth = 34.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.894397, Long. -101.662007

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING ADLS-2

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/7/2025

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													6 in. Topsoil
			N = 13										SILTY SAND (SM), light brown, medium dense to dense, dry to moist, fine grained
	5		N = 32										
			N = 36										
	10		N = 56										
			N = 22										LEAN CLAY (CL), trace Sand, gray, very stiff, dry to moist, iron stained, trace organics
	15		N = 37										SILTY SAND (SM), light brown, dense, dry to moist, fine grained
	20		N = 39										CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained
	25		N = 36										LEAN CLAY (CL), trace Sand, dark gray to gray, hard, dry to moist, iron stained, calcareous
	30		N = 37										SILT (ML), trace Sand, gray, hard, dry to moist, iron stained, calcareous
	35		N = 43										LEAN CLAY (CL), trace Sand, dark gray, hard, dry to moist
													Total Depth = 35.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.927981, Long. -101.795351

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHNVILLARINO\RRC COMPANIES\GEOTECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

LOG OF BORING O&M-1

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026
DATE(S) DRILLED: 5/3/2025

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 18 ft. during drilling and measured at 25 ft. immediately after drilling

SURFACE ELEVATION (FT):

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												4 in. Topsoil
		N = 6	17									CLAYEY SAND (SC), dark brown, loose to medium dense, dry to moist, fine grained, calcareous
5		N = 17	10									Grading brown, iron stained
		N = 9	19				100	0.32	1.8	5.5		
10		N = 23										Calcareous feature grades out; grading gray to light brown
		N = 50/3"										POORLY-GRADED SAND (SP-SM), with Silt, gray to light brown, very dense, dry to moist, fine grained
15		N = 30										CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained
												Grading wet
20		N = 42										Grading light brown to brown, iron stained
25		N = 20										LEAN CLAY (CL), with Sand, dark gray, very stiff, moist to wet
30		N = 21										Grading gray, trace organics
35		N = 50/5"										SANDY CLAYSTONE, gray, very hard, moist
												Total Depth = 35 ft.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:
GPS COORDINATES: Lat. 46.950414, Long. -101.762334

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www.RRCcompanies.com

810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78661
512.992.2087

APPENDIX B

MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

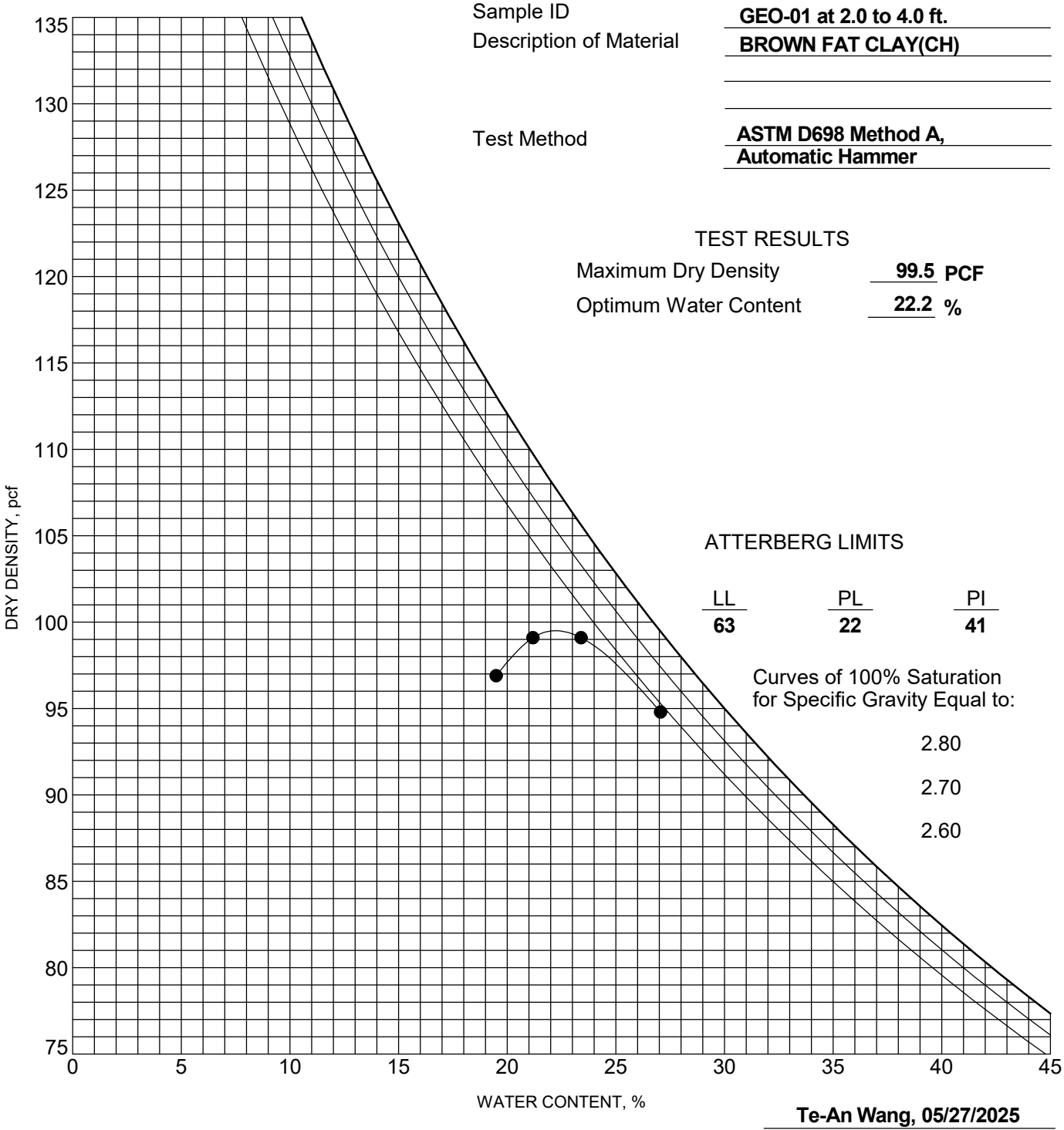
CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-01 at 2.0 to 4.0 ft.**
Description of Material: **BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**99.5**	**PCF**
Optimum Water Content	**22.2**	**%**



ATTERBERG LIMITS

LL	PL	PI
63	**22**	**41**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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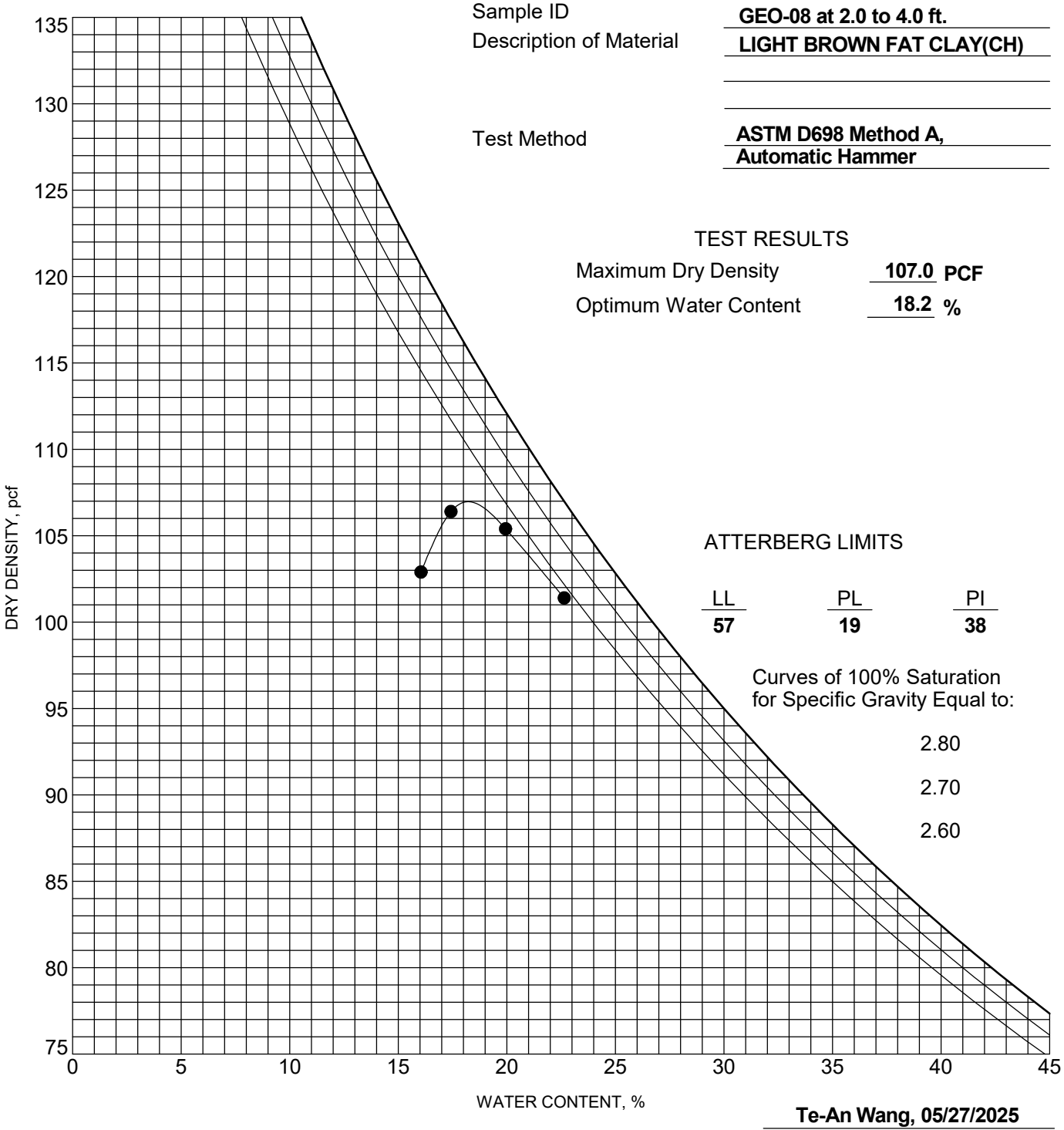
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-08 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**107.0**	**PCF**
Optimum Water Content	**18.2**	**%**

ATTERBERG LIMITS

LL	PL	PI
57	**19**	**38**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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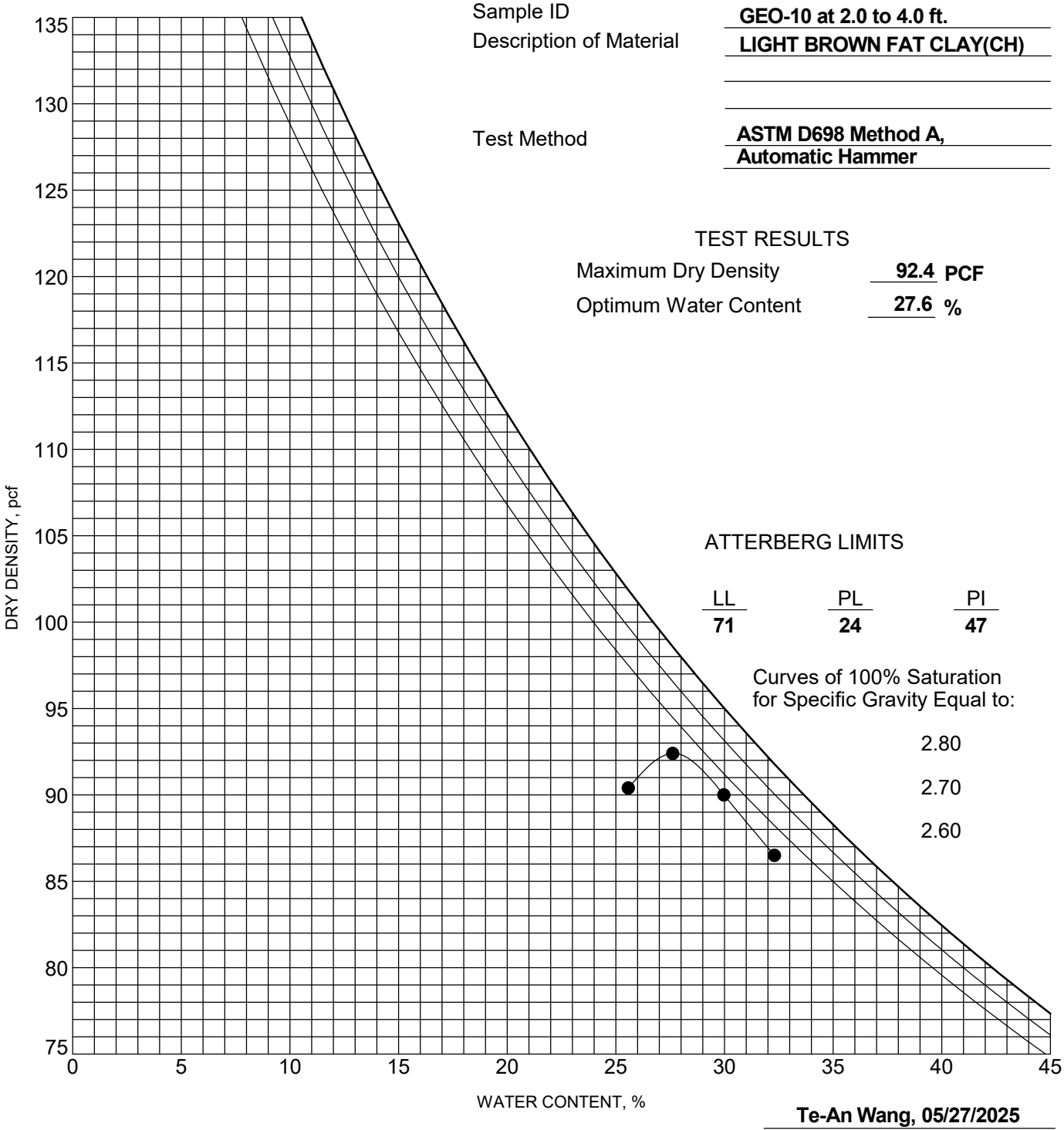
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-10 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**92.4**	**PCF**
Optimum Water Content	**27.6**	**%**

ATTERBERG LIMITS

LL	PL	PI
71	**24**	**47**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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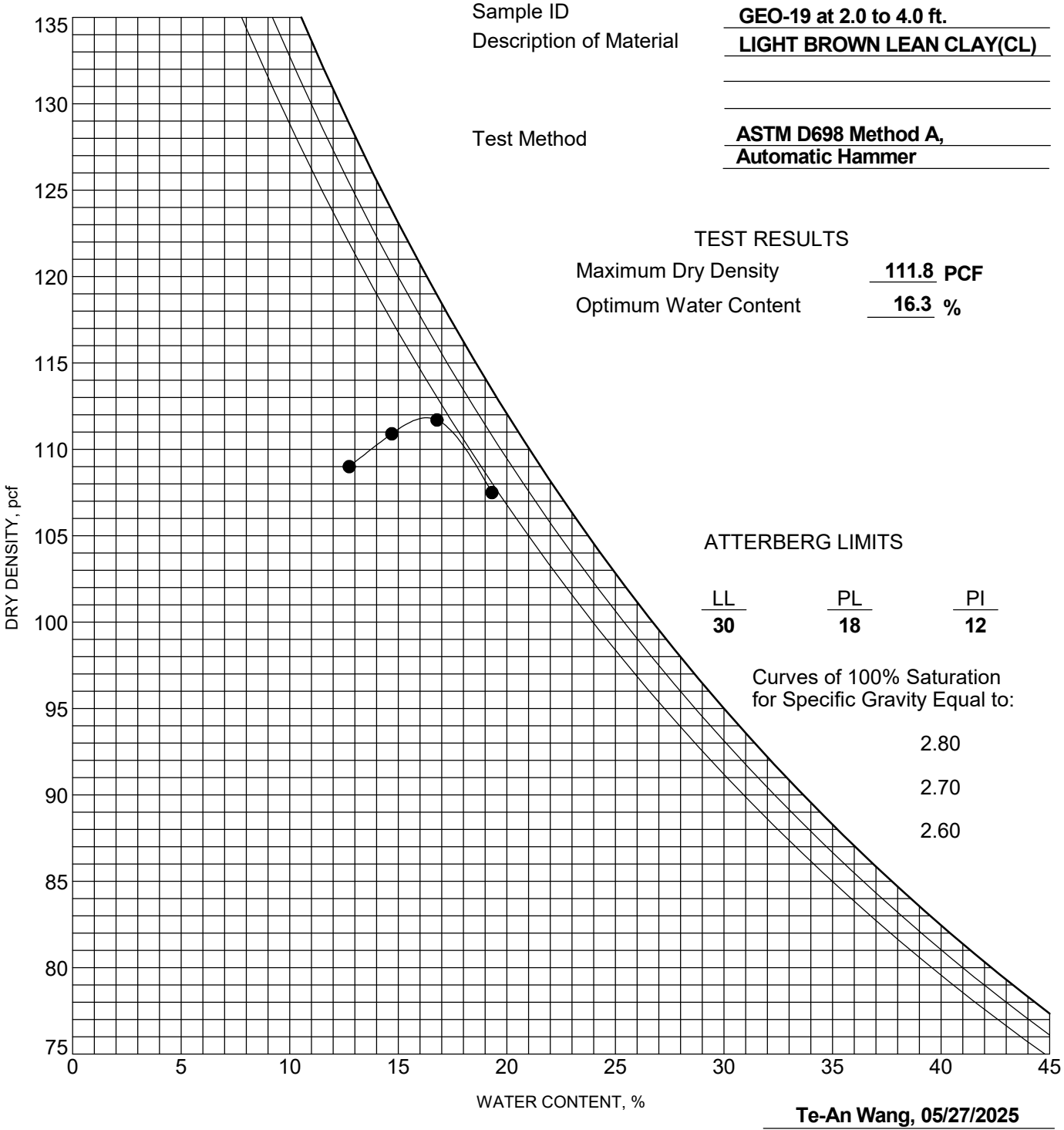
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-19 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN LEAN CLAY(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**111.8**	**PCF**
Optimum Water Content	**16.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
30	**18**	**12**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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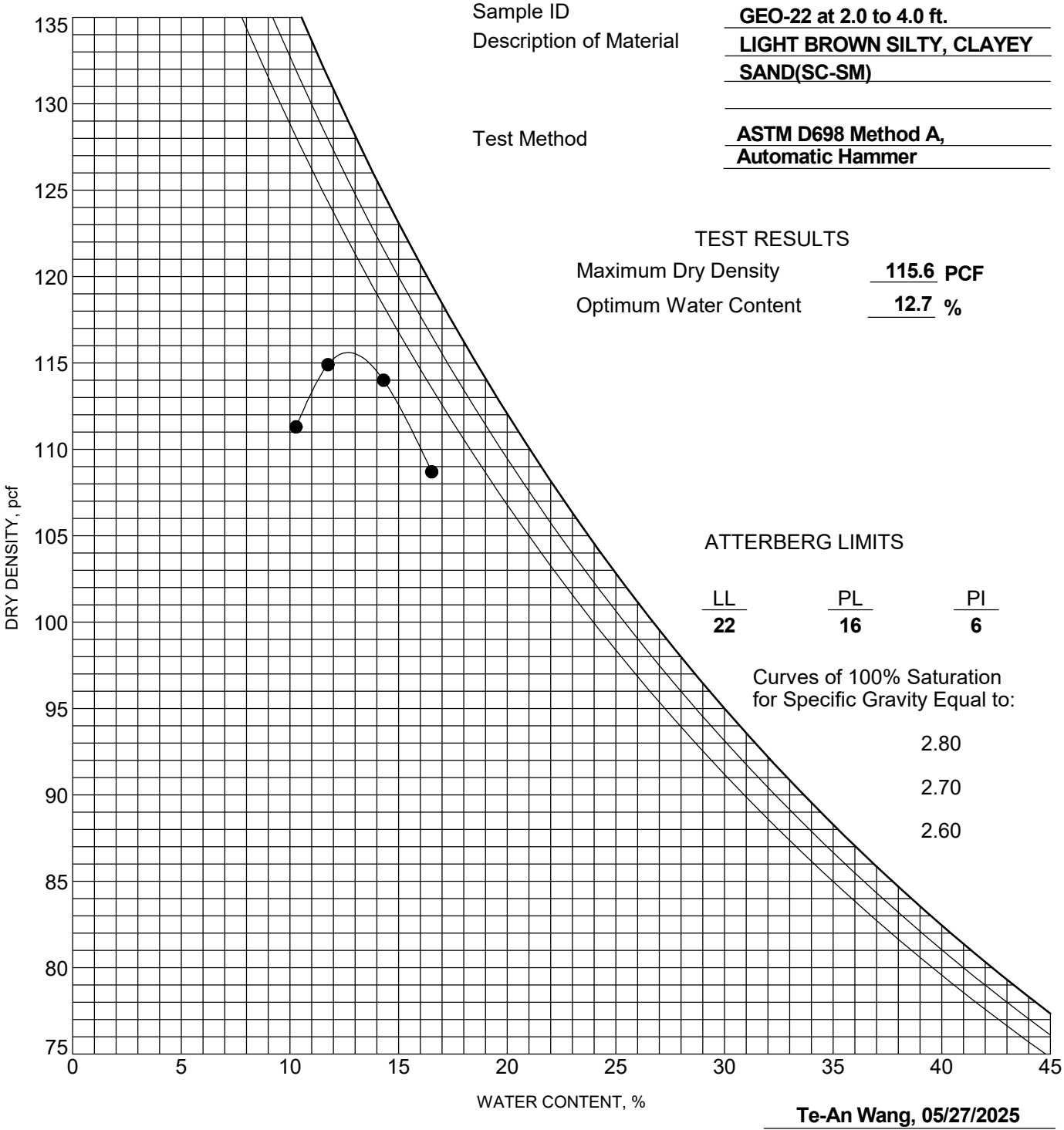
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-22 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN SILTY, CLAYEY SAND(SC-SM)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**115.6**	**PCF**
Optimum Water Content	**12.7**	**%**

ATTERBERG LIMITS

LL	PL	PI
22	**16**	**6**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

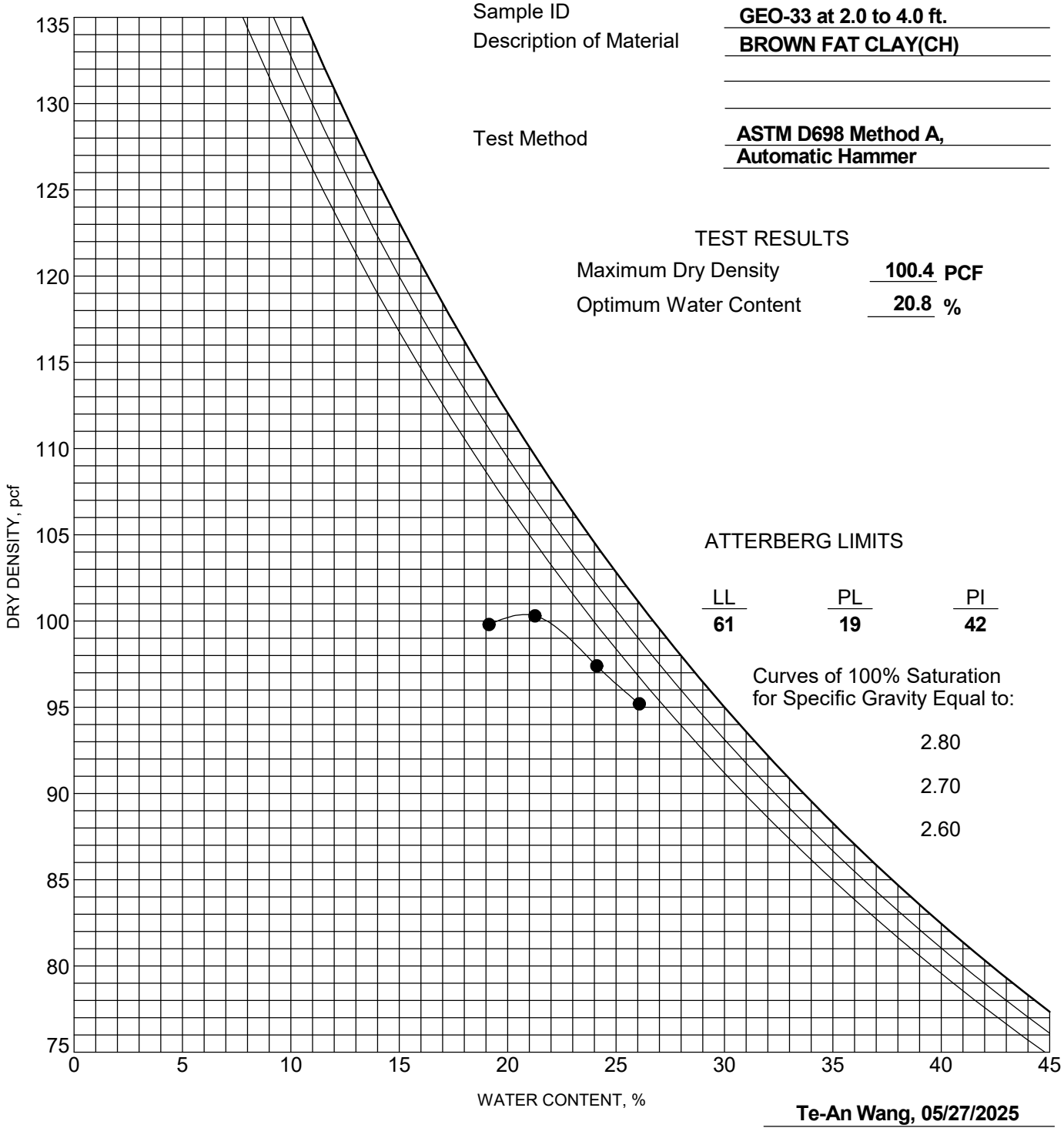
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **GEO-33 at 2.0 to 4.0 ft.**
Description of Material: **BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**100.4**	**PCF**
Optimum Water Content	**20.8**	**%**

ATTERBERG LIMITS

LL	PL	PI
61	**19**	**42**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

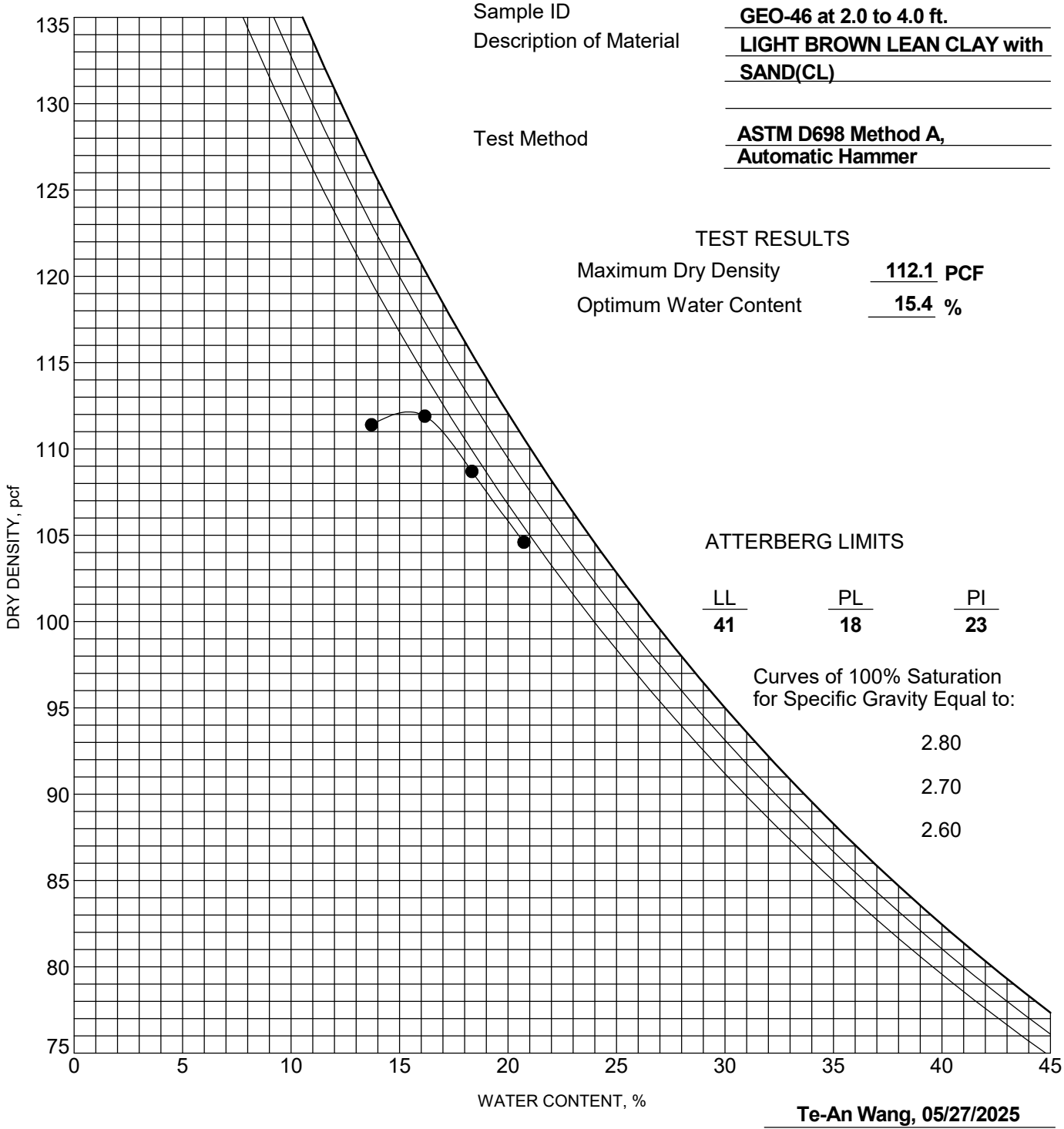
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **GEO-46 at 2.0 to 4.0 ft.**

Description of Material: **LIGHT BROWN LEAN CLAY with SAND(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**112.1**	**PCF**
Optimum Water Content	**15.4**	**%**

ATTERBERG LIMITS

LL	PL	PI
41	**18**	**23**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

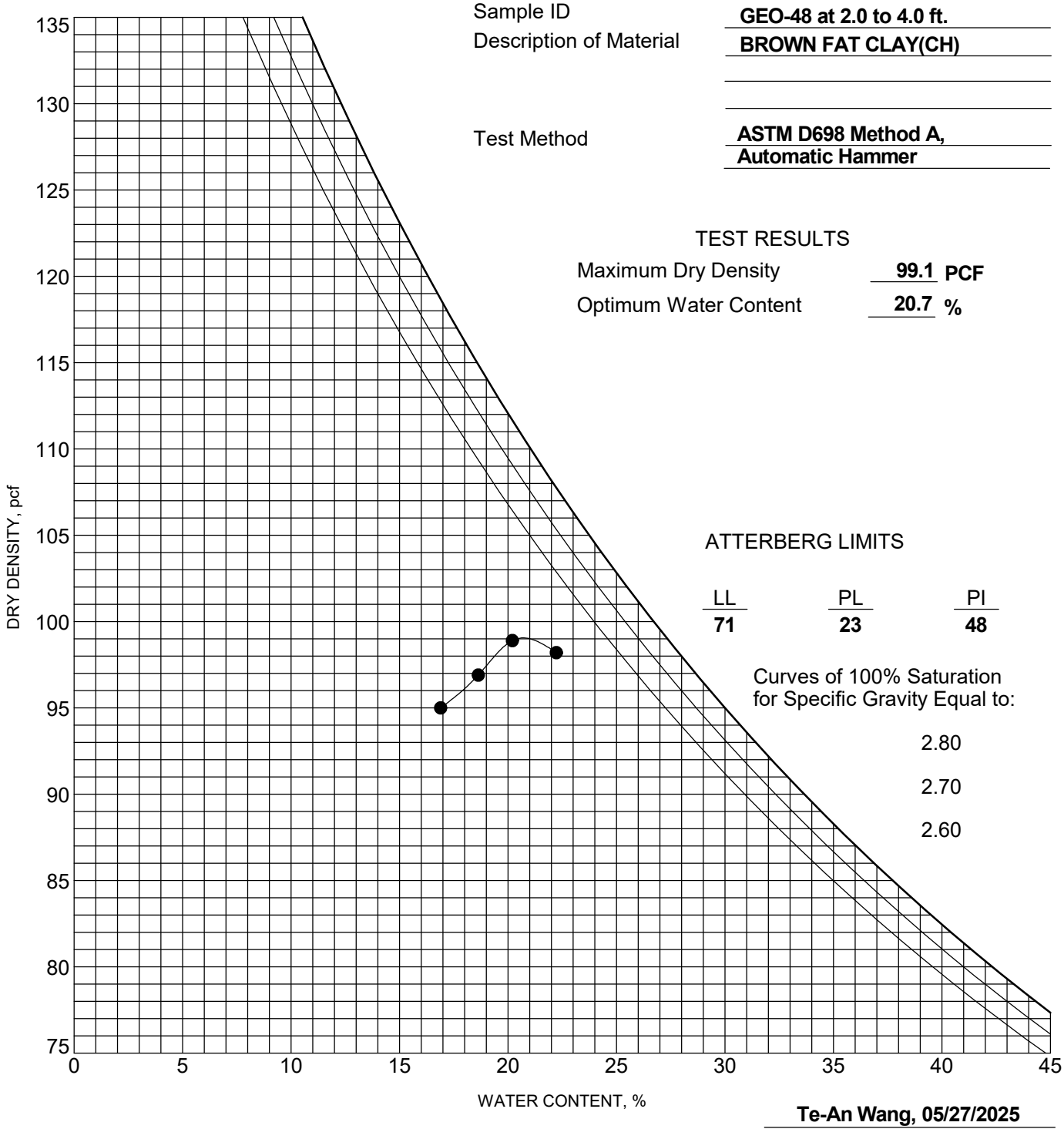
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **GEO-48 at 2.0 to 4.0 ft.**
Description of Material: **BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**99.1**	**PCF**
Optimum Water Content	**20.7**	**%**

ATTERBERG LIMITS

LL	PL	PI
71	**23**	**48**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must recieve prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

MOISTURE-DENSITY RELATIONSHIP

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Telephone: (512) 358-6048

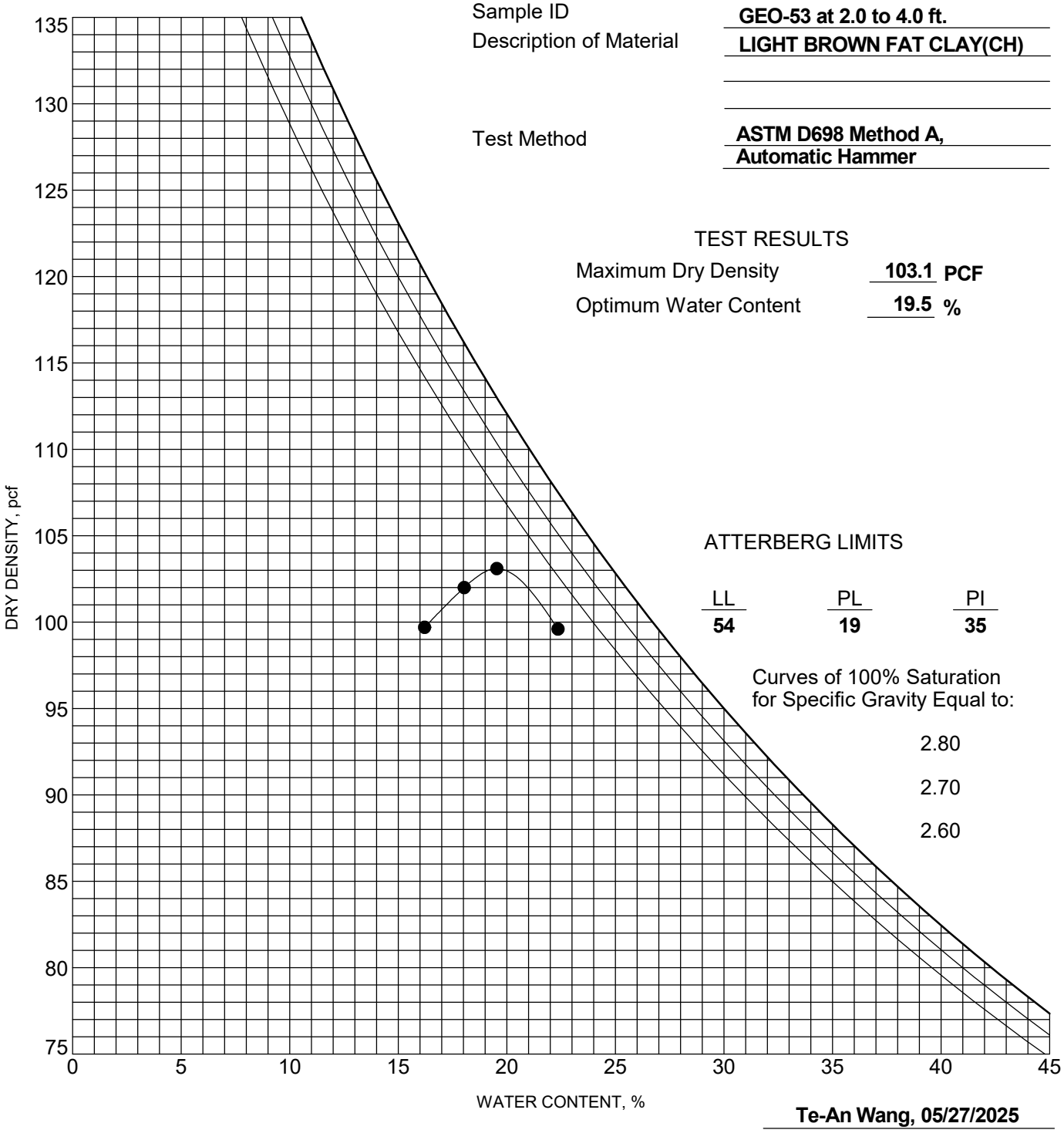
CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-53 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**103.1**	**PCF**
Optimum Water Content	**19.5**	**%**



ATTERBERG LIMITS

LL	PL	PI
54	**19**	**35**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

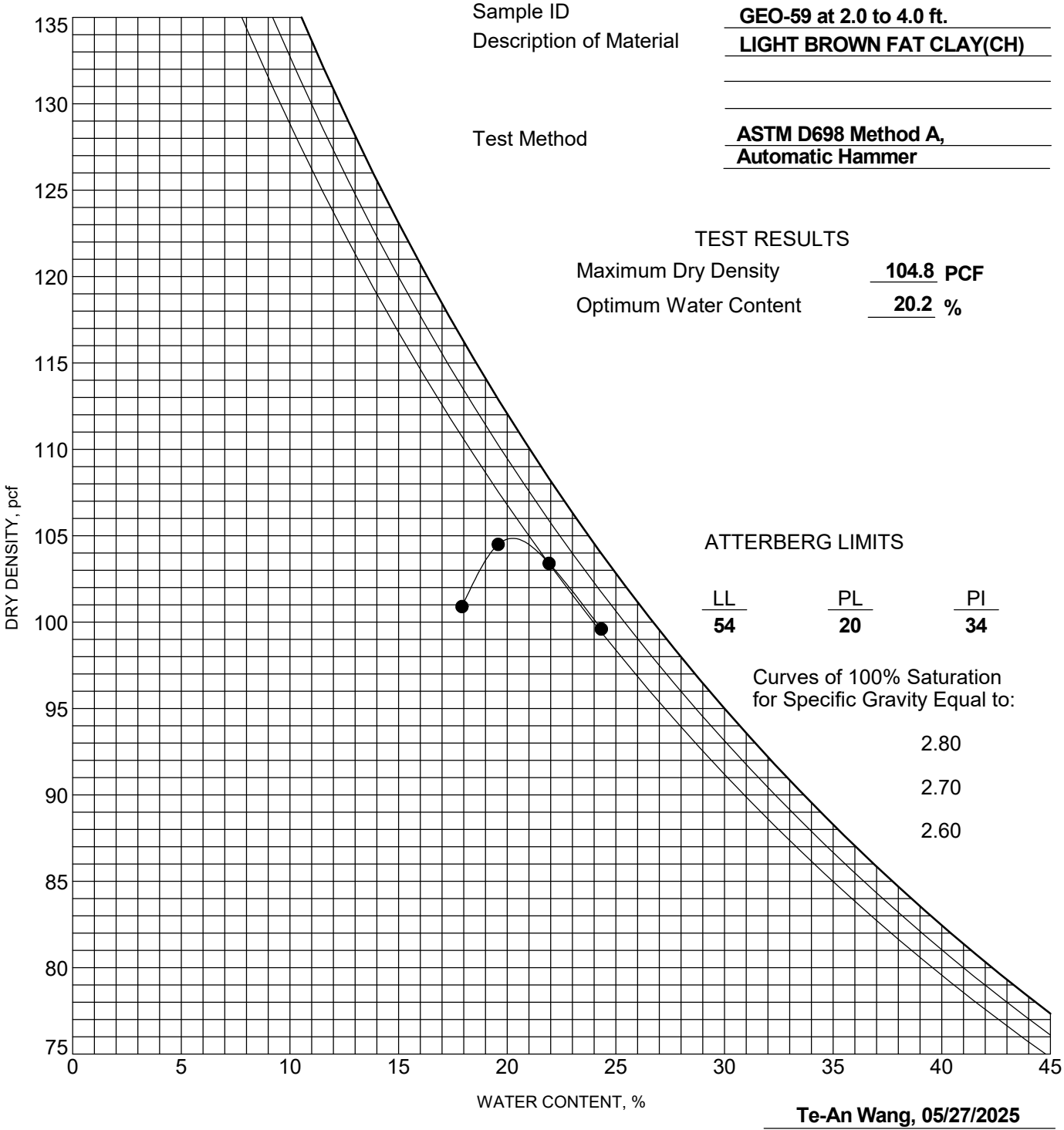
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **GEO-59 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**104.8**	**PCF**
Optimum Water Content	**20.2**	**%**

ATTERBERG LIMITS

LL	PL	PI
54	**20**	**34**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

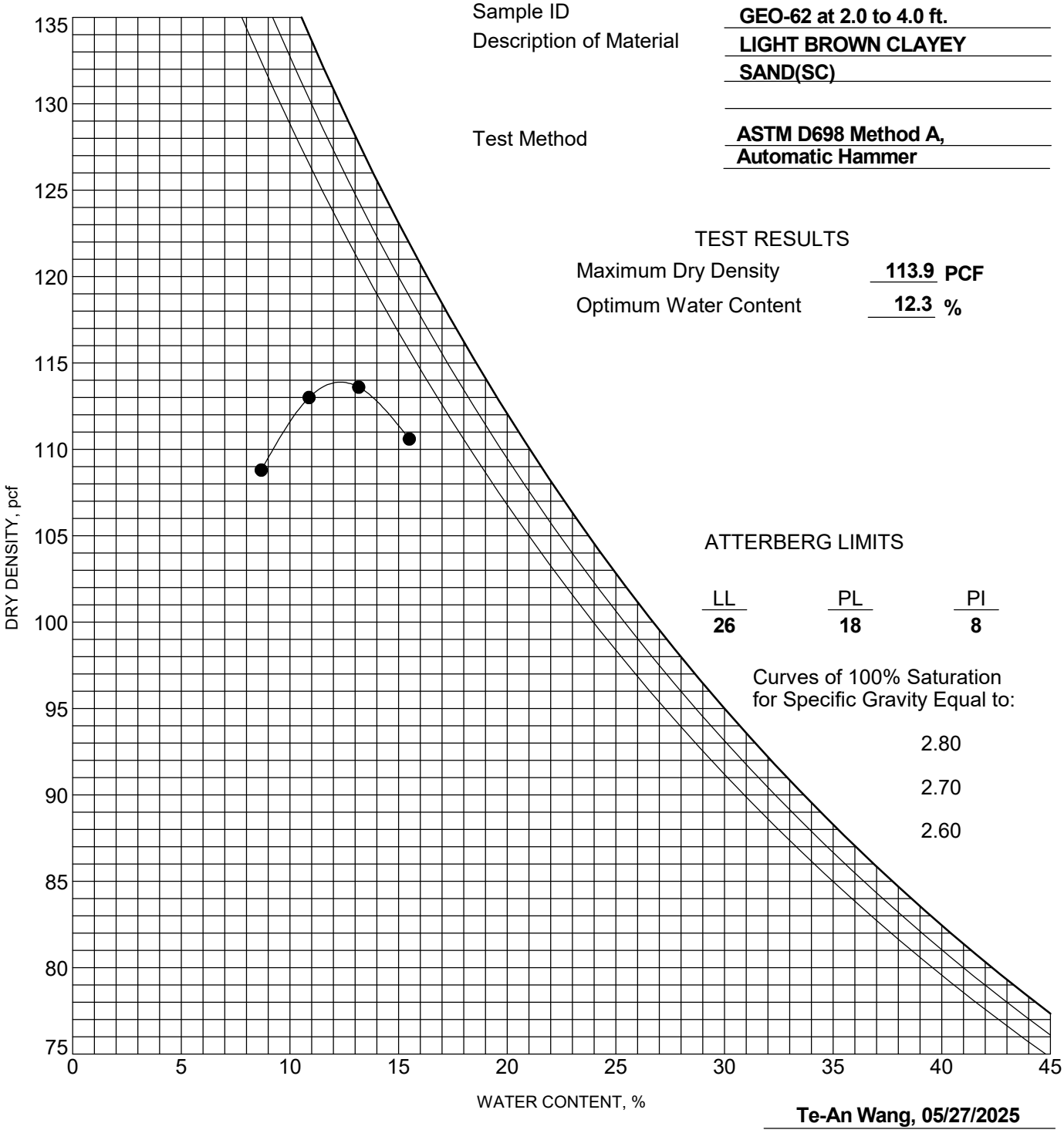
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

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3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **GEO-62 at 2.0 to 4.0 ft.**

Description of Material: **LIGHT BROWN CLAYEY SAND(SC)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**113.9**	**PCF**
Optimum Water Content	**12.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
26	**18**	**8**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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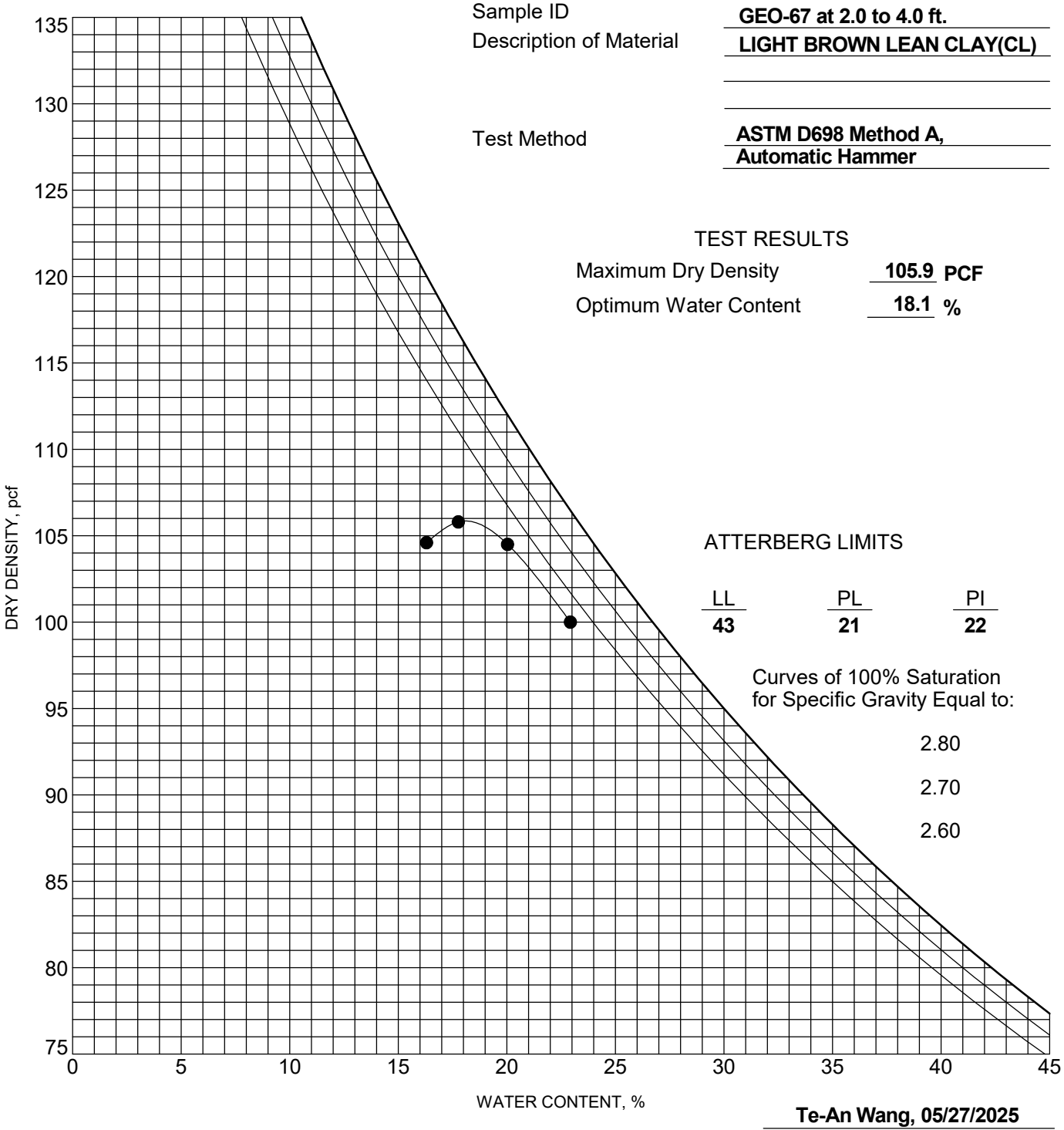
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-67 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN LEAN CLAY(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**105.9**	**PCF**
Optimum Water Content	**18.1**	**%**

ATTERBERG LIMITS

LL	PL	PI
43	**21**	**22**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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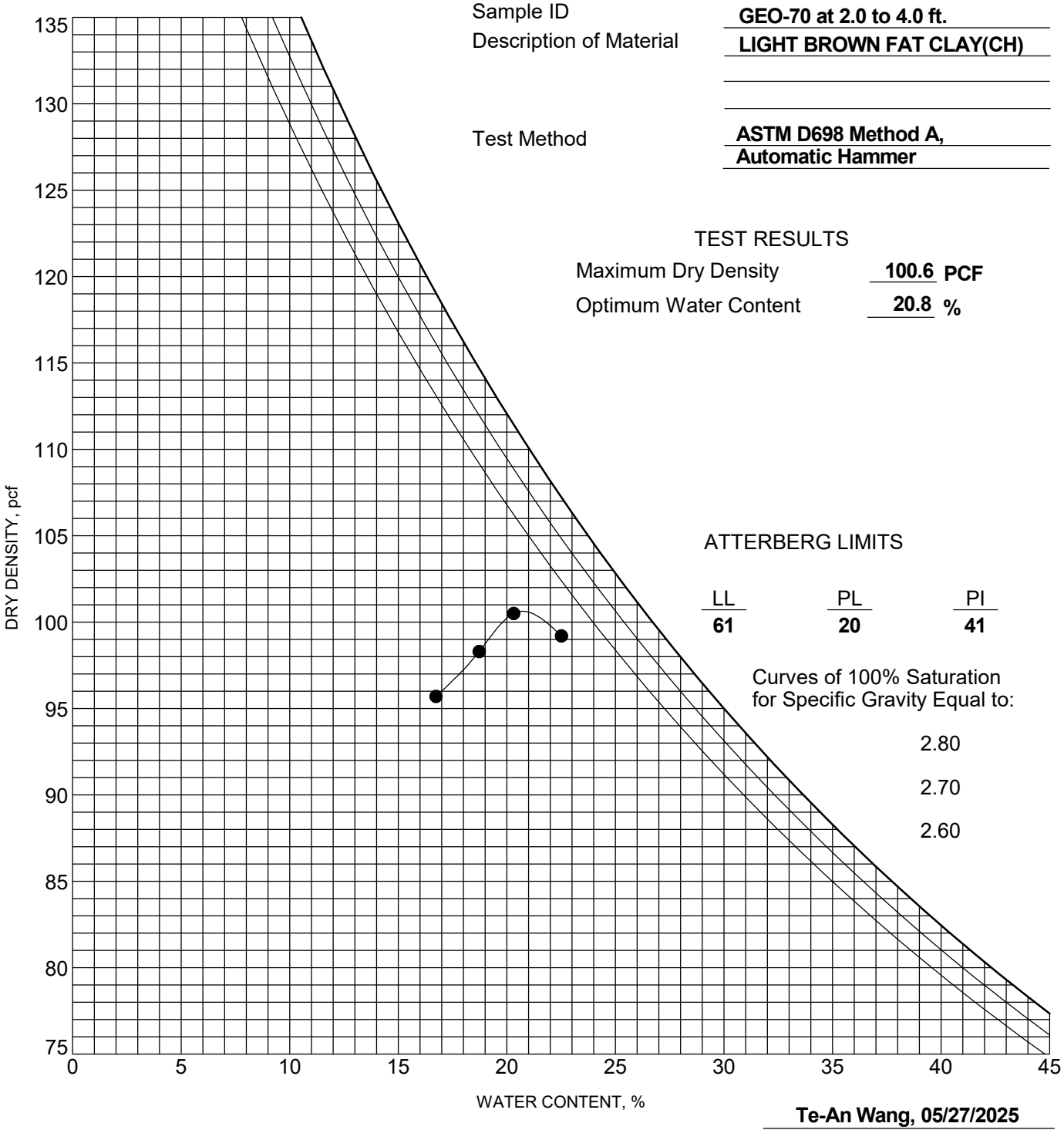
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Sample ID: **GEO-70 at 2.0 to 4.0 ft.**
Description of Material: **LIGHT BROWN FAT CLAY(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**100.6**	**PCF**
Optimum Water Content	**20.8**	**%**

ATTERBERG LIMITS

LL	PL	PI
61	**20**	**41**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

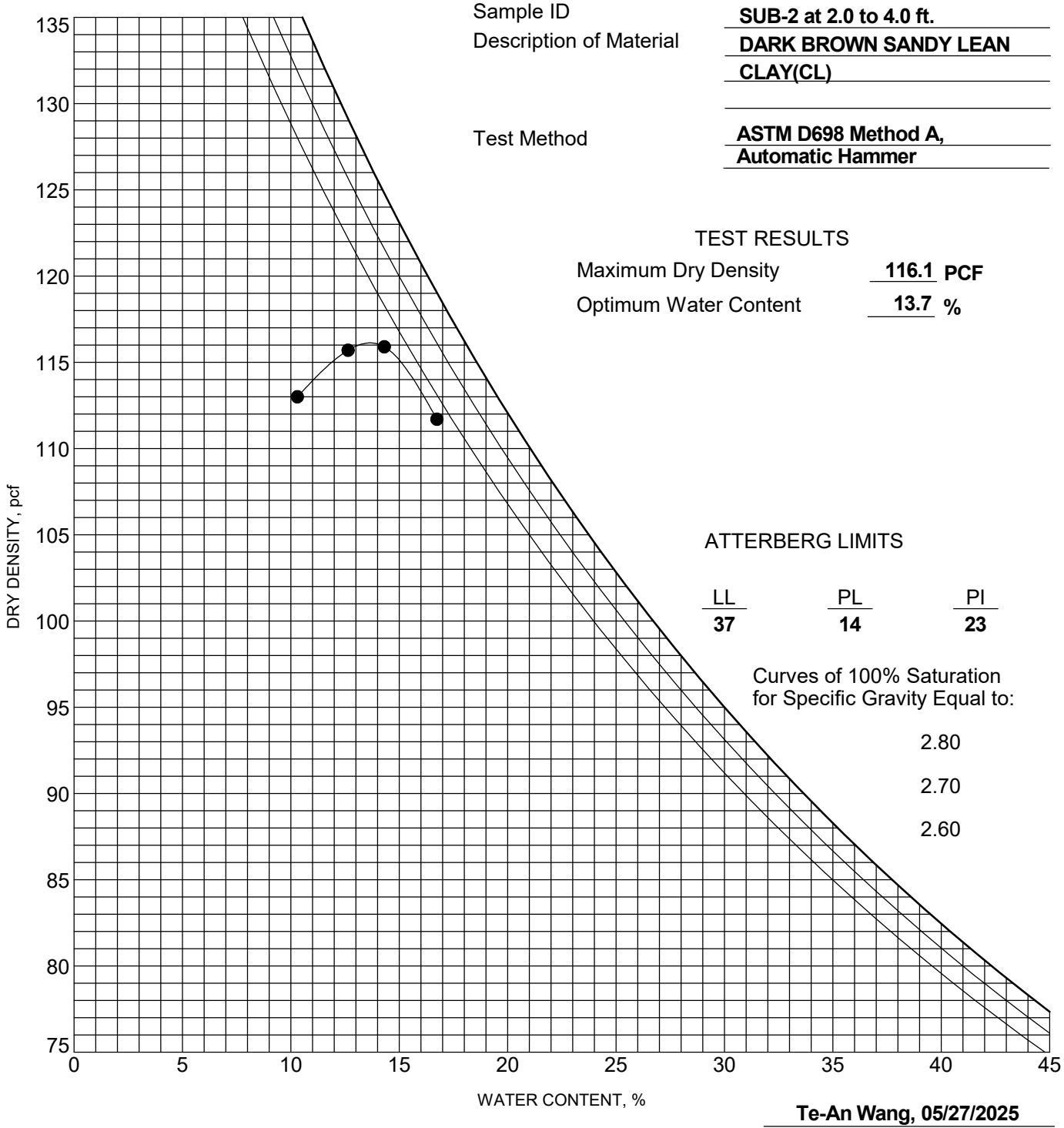
Specimens prepared by: T.W.

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MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026



Sample ID: **SUB-2 at 2.0 to 4.0 ft.**

Description of Material: **DARK BROWN SANDY LEAN CLAY(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density: **116.1** PCF

Optimum Water Content: **13.7** %

ATTERBERG LIMITS

LL	PL	PI
37	14	23

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Te-An Wang, 05/27/2025
Analysis & Quality Review/Date

Specimens prepared by: T.W.

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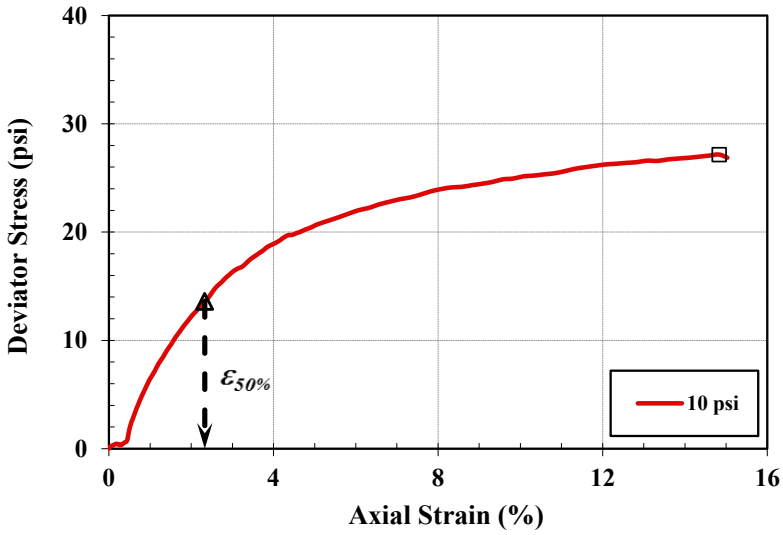
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: GEO-04 at 12 ft

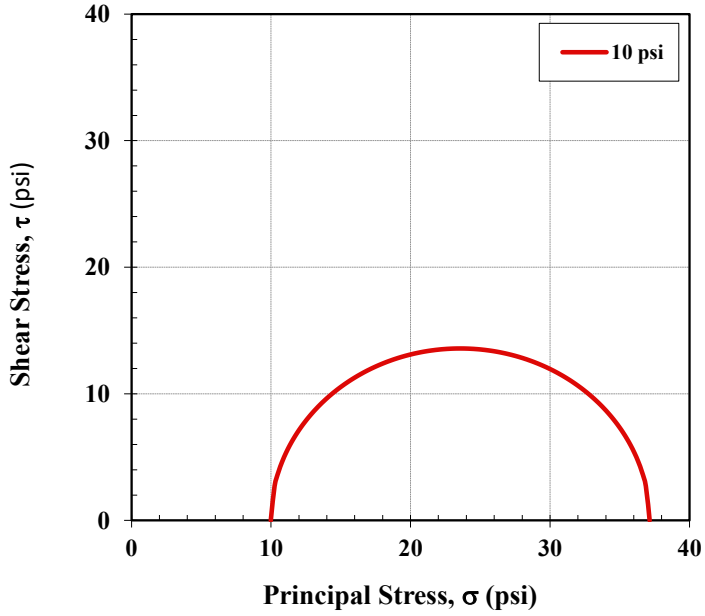
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/3/2025

Type of Specimen: Shelby Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D_o	2.86
Avg. Height (in)	H_o	5.55
In-situ Water Content (%)	w_o	23.0
Total Unit Weight (pcf)	γ_{total}	126.7
Dry Unit Weight (pcf)	γ_{dry}	103.0
Saturation (%)	S_r	97.6
Void Ratio	e_o	0.64
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	27.2
Axial Strain at Failure (%)	14.8
Axial Strain at 50% of q_u, ε_{50} (%)	2.3
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	37.1
Minor Principal Stress, σ_3 (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	1.96

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/04/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must recieve prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: GEO-04 at 12 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/03/25





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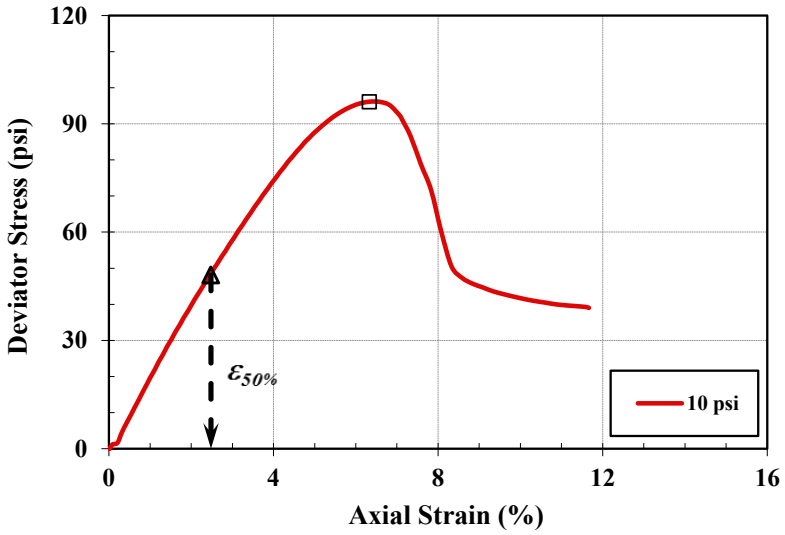
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: GEO-07 at 12 ft

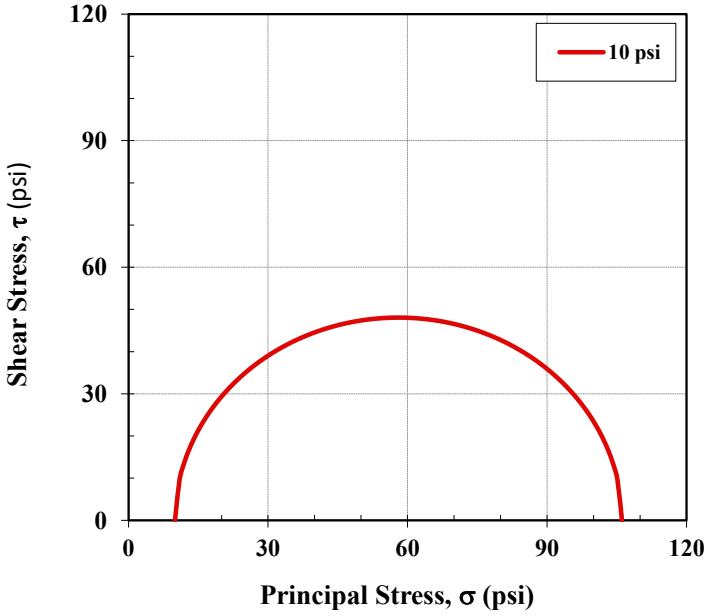
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/3/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.87
In-situ Water Content (%)	w_o	27.2
Total Unit Weight (pcf)	γ_{total}	125.9
Dry Unit Weight (pcf)	γ_{dry}	98.9
Saturation (%)	S_r	100.0
Void Ratio	e_o	0.70
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	96.1
Axial Strain at Failure (%)	6.3
Axial Strain at 50% of q_u, ε_{50} (%)	2.5
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	106.1
Minor Principal Stress, σ_3 (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ (tsf)	6.92

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

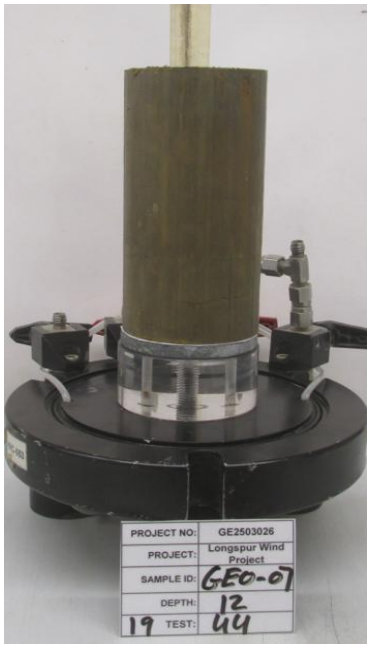
Kainat Batool, 06/04/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: GEO-07 at 12 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/03/25





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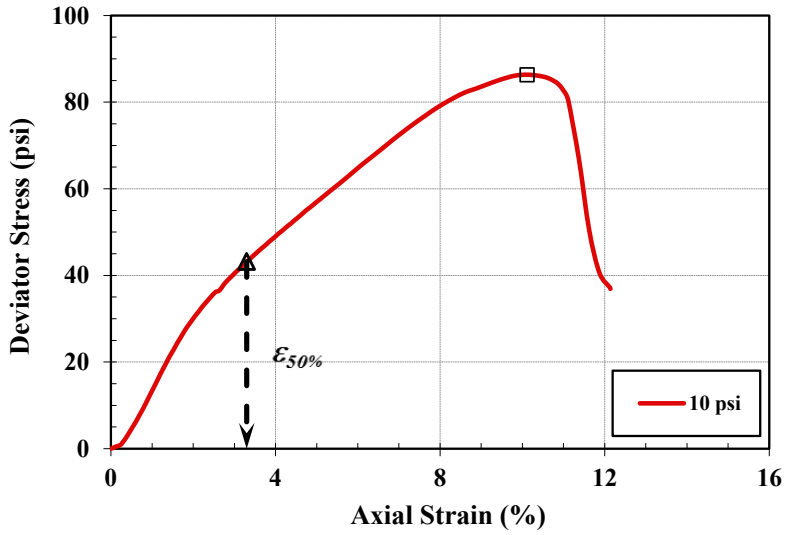
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: GEO-46 at 12 ft

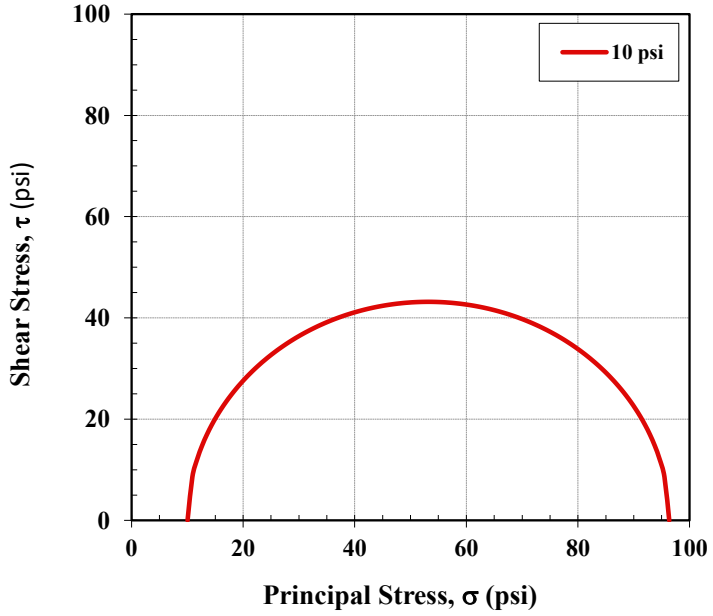
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/5/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.84
In-situ Water Content (%)	w_o	22.6
Total Unit Weight (pcf)	γ_{total}	127.8
Dry Unit Weight (pcf)	γ_{dry}	104.3
Saturation (%)	S_r	99.0
Void Ratio	e_o	0.62
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	86.3
Axial Strain at Failure (%)	10.1
Axial Strain at 50% of q_u, ε_{50} (%)	3.3
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	96.4
Minor Principal Stress, σ_3 (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	6.22

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: GEO-46 at 12 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/05/25





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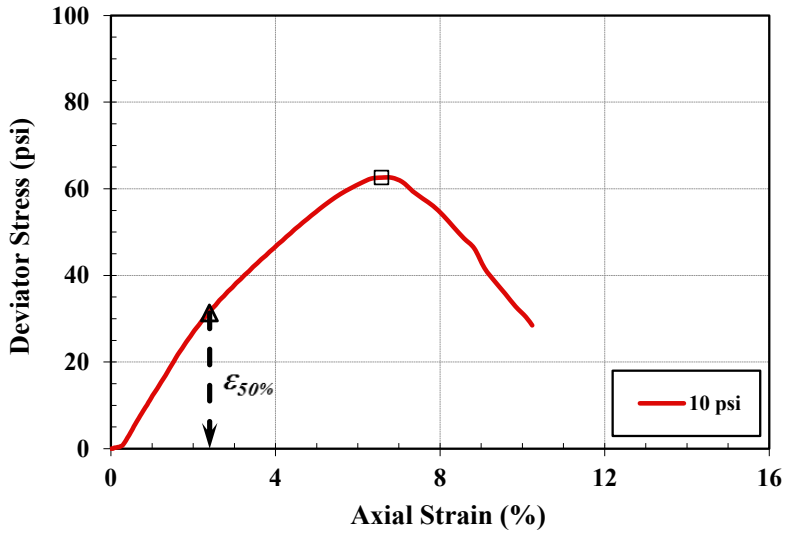
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: GEO-62 at 12 ft

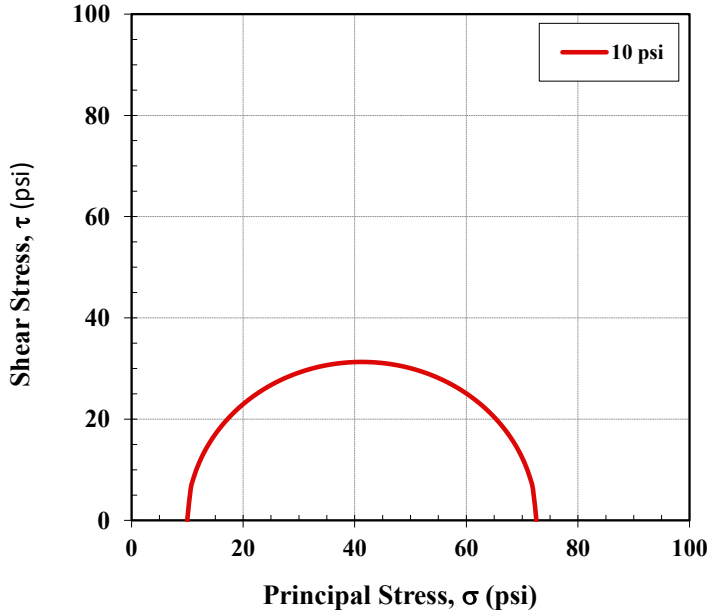
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/6/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.81
In-situ Water Content (%)	w_o	21.3
Total Unit Weight (pcf)	γ_{total}	127.5
Dry Unit Weight (pcf)	γ_{dry}	105.1
Saturation (%)	S_r	95.3
Void Ratio	e_o	0.60
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	62.6
Axial Strain at Failure (%)	6.6
Axial Strain at 50% of q_u, ε_{50} (%)	2.4
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	72.6
Minor Principal Stress, σ_3 (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	4.51

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: GEO-62 at 12 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/06/25





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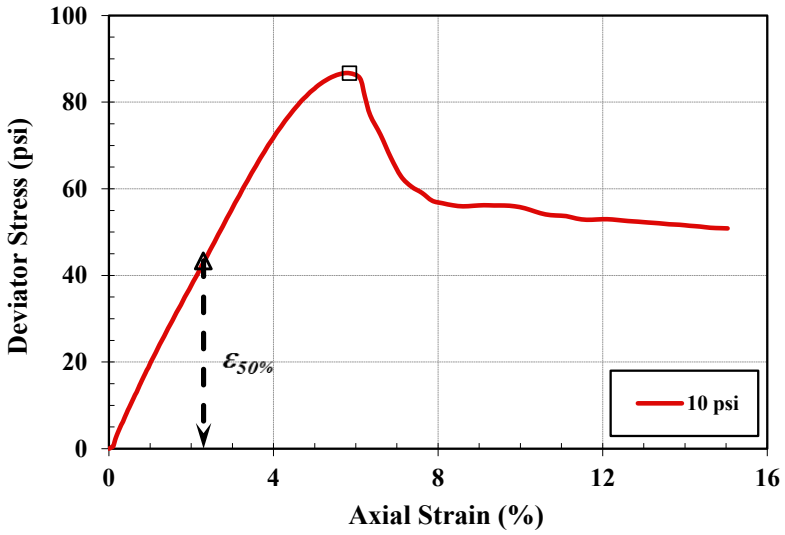
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: GEO-66 at 12 ft

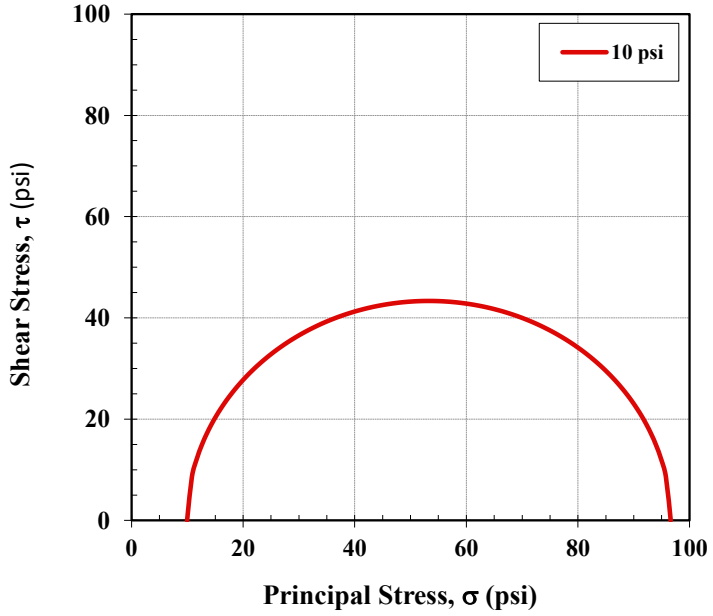
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/6/2025

Type of Specimen: Shelby Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D_o	2.86
Avg. Height (in)	H_o	5.64
In-situ Water Content (%)	w_o	21.5
Total Unit Weight (pcf)	γ_{total}	126.6
Dry Unit Weight (pcf)	γ_{dry}	104.2
Saturation (%)	S_r	93.9
Void Ratio	e_o	0.62
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	86.7
Axial Strain at Failure (%)	5.8
Axial Strain at 50% of q_u, ε_{50} (%)	2.3
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	96.6
Minor Principal Stress, σ_3 (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	6.24

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: GEO-66 at 12 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/06/25





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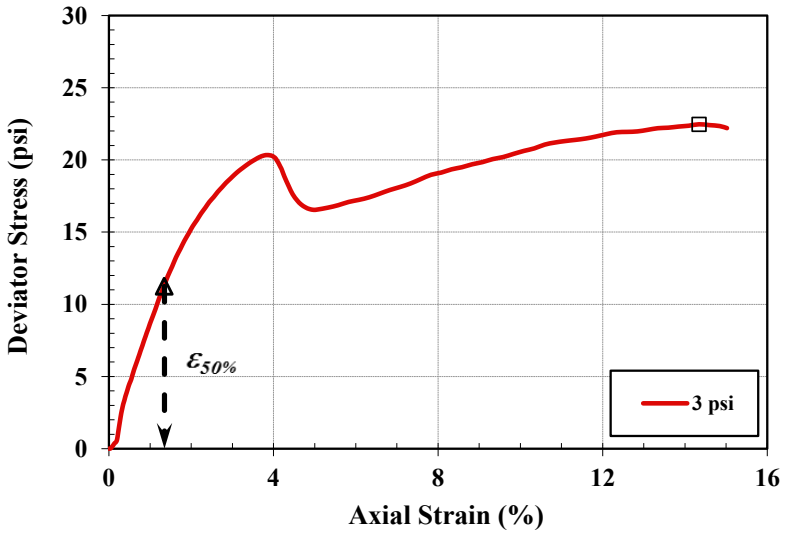
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: SUB-3 at 4 ft

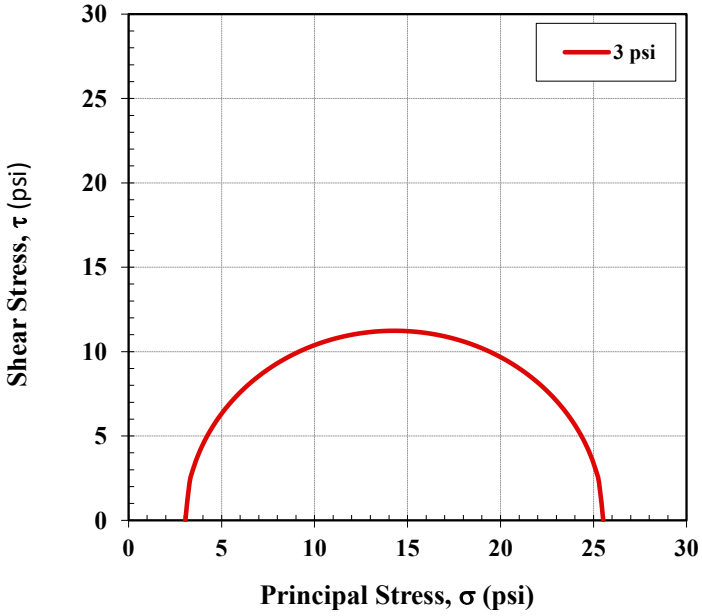
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/6/2025

Type of Specimen: Shelby Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		3.0
Avg. Diameter (in)	D_o	2.89
Avg. Height (in)	H_o	5.64
In-situ Water Content (%)	w_o	14.8
Total Unit Weight (pcf)	γ_{total}	123.7
Dry Unit Weight (pcf)	γ_{dry}	107.7
Saturation (%)	S_r	70.9
Void Ratio	e_o	0.56
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	22.5
Axial Strain at Failure (%)	14.3
Axial Strain at 50% of q_u, ε_{50} (%)	1.4
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	25.5
Minor Principal Stress, σ_3 (psi)	3.1

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	1.62

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: SUB-3 at 4 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/06/25





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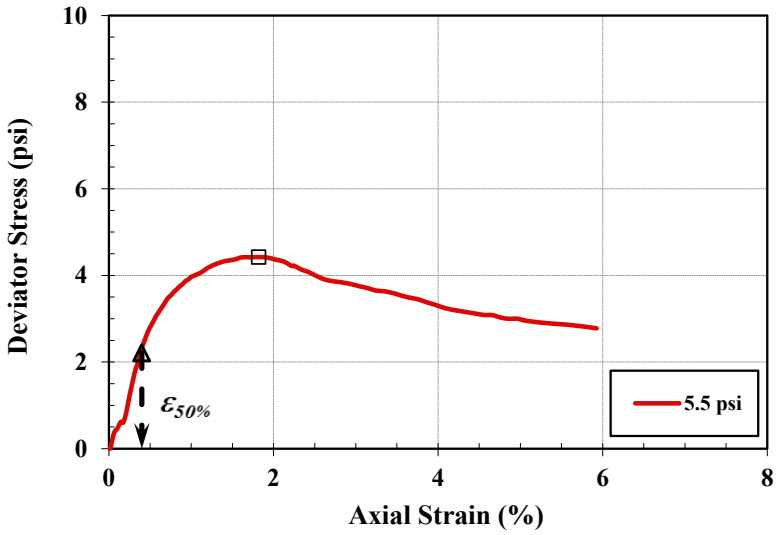
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No.: O&M-1 at 7 ft

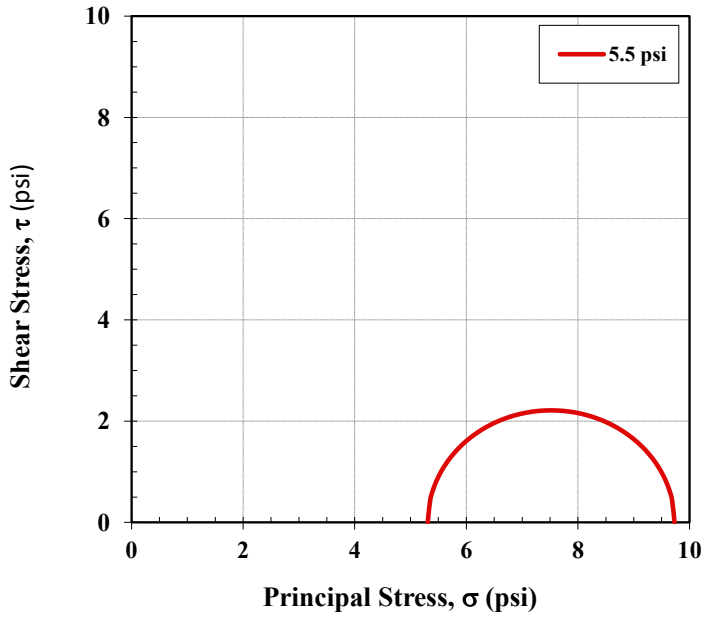
Project No.: GE2503026
Type of Test: Q-Test
Test Date: 6/6/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min
Test Method: ASTM D2850

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		5.5
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.83
In-situ Water Content (%)	w_o	18.9
Total Unit Weight (pcf)	γ_{total}	119.3
Dry Unit Weight (pcf)	γ_{dry}	100.3
Saturation (%)	S_r	75.2
Void Ratio	e_o	0.68
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	4.4
Axial Strain at Failure (%)	1.8
Axial Strain at 50% of q_u, ε_{50} (%)	0.4
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	9.7
Minor Principal Stress, σ_3 (psi)	5.3

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	0.32

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

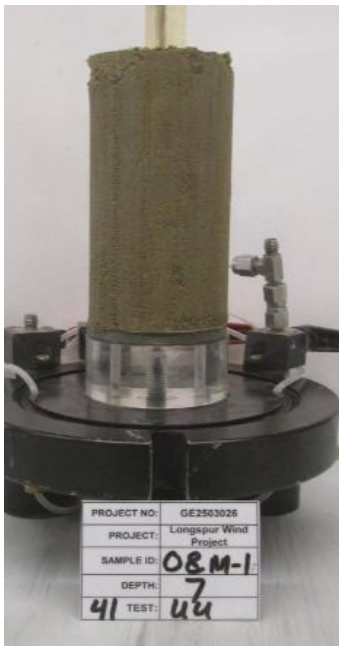
Te-An Wang, EIT, 06/09/25
Analysis & Quality Review/Date
Specimen Prepared by: A.B.

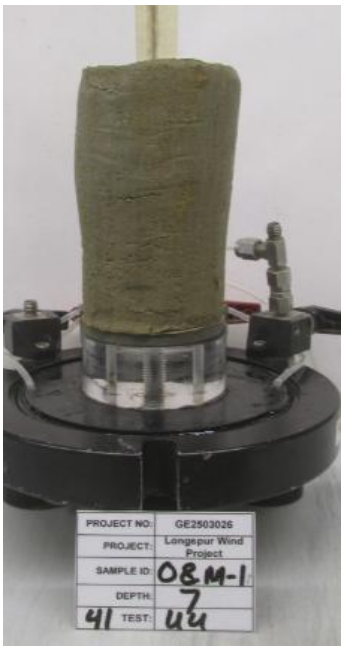
The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must recieve prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Specimen: O&M-1 at 7 ft

Project No.: GE2503026
Test Method: ASTM D2850
Test Date: 06/06/25





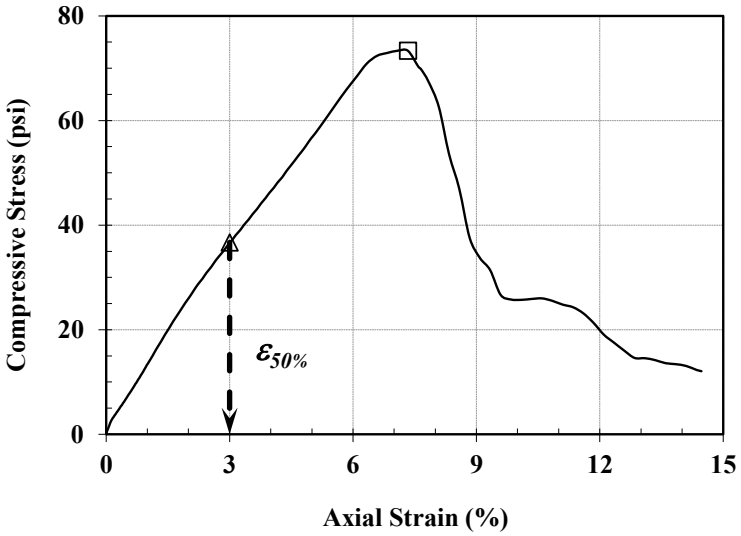
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Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample I.D.: GEO-01 at 14 ft

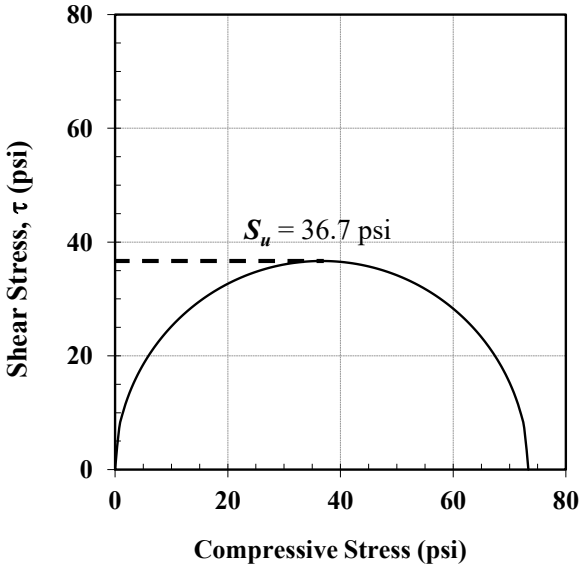
Project No.: GE2503026
Test Method: ASTM D2166
Test Date: 6/4/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.41
Avg. Height (in)	H_o	4.84
In-situ Moisture Content (%)	w_o	20.2
Total Unit Weight (pcf)	γ_{total}	133.6
Dry Unit Weight (pcf)	γ_{dry}	111.2
Saturation (%)	S_r	100.0
Void Ratio	e_o	0.52
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	73.3
Axial Strain at Failure (%)	7.3
Axial Strain at 50 % of q_u (%)	3.0
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	73.3
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	2.64

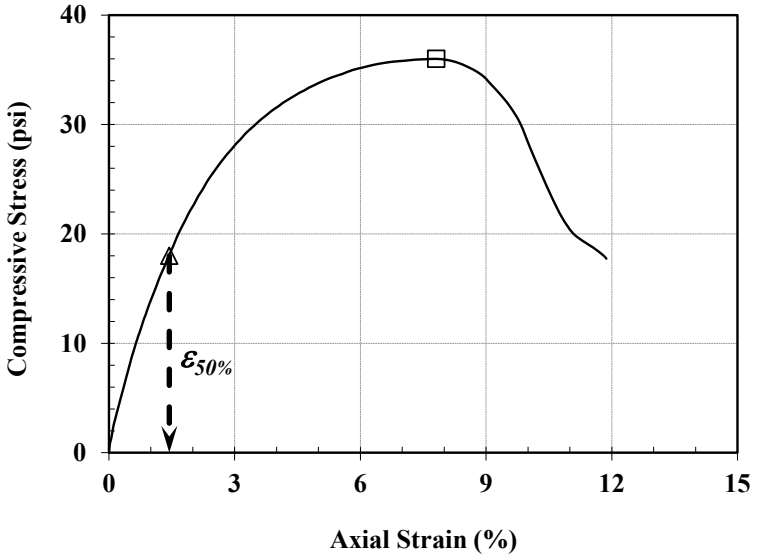
Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/06/25
Quality Review/Date
Specimen prepared & tested by: A.B.

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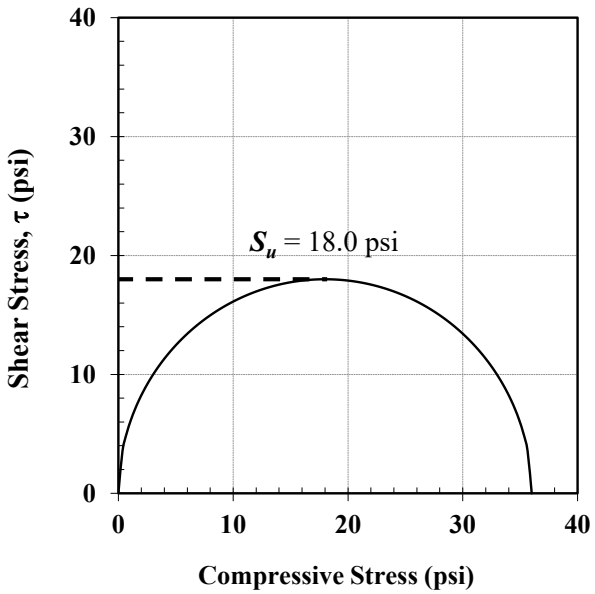
Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project No.: GE2503026
Type of Specimen: Shelby Tube
Project: Longspur Wind Project
Test Method: ASTM D2166
Strain Rate: 1.0 %/min
Sample I.D.: GEO-04 at 19 ft
Test Date: 6/10/2025



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.87
Avg. Height (in)	H_o	5.62
In-situ Moisture Content (%)	w_o	22.1
Total Unit Weight (pcf)	γ_{total}	124.9
Dry Unit Weight (pcf)	γ_{dry}	102.3
Saturation (%)	S_r	92.0
Void Ratio	e_o	0.65
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	36.0
Axial Strain at Failure (%)	7.8
Axial Strain at 50 % of q_u (%)	1.4
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	36.0
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	1.30

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/10/25
Quality Review/Date
Specimen prepared & tested by: A.B.

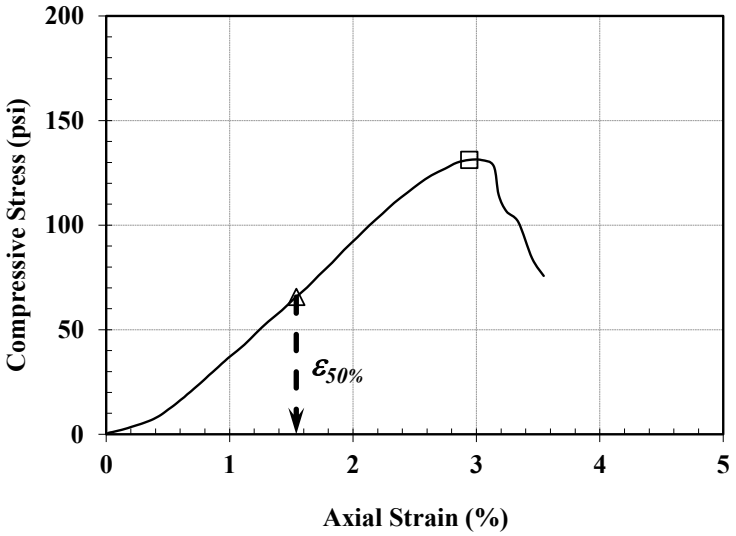
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Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample I.D.: GEO-33 at 17 ft

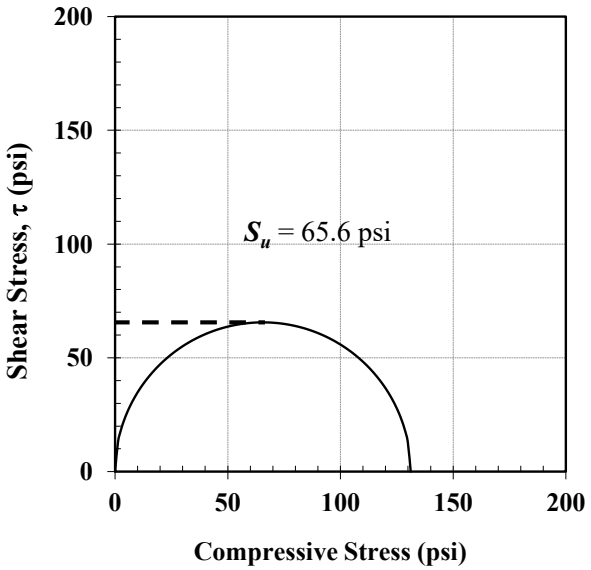
Project No.: GE2503026
Test Method: ASTM D2166
Test Date: 6/4/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.85
In-situ Moisture Content (%)	w_o	16.9
Total Unit Weight (pcf)	γ_{total}	130.0
Dry Unit Weight (pcf)	γ_{dry}	111.3
Saturation (%)	S_r	88.4
Void Ratio	e_o	0.51
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	131.2
Axial Strain at Failure (%)	2.9
Axial Strain at 50 % of q_u (%)	1.5
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	131.2
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	4.72

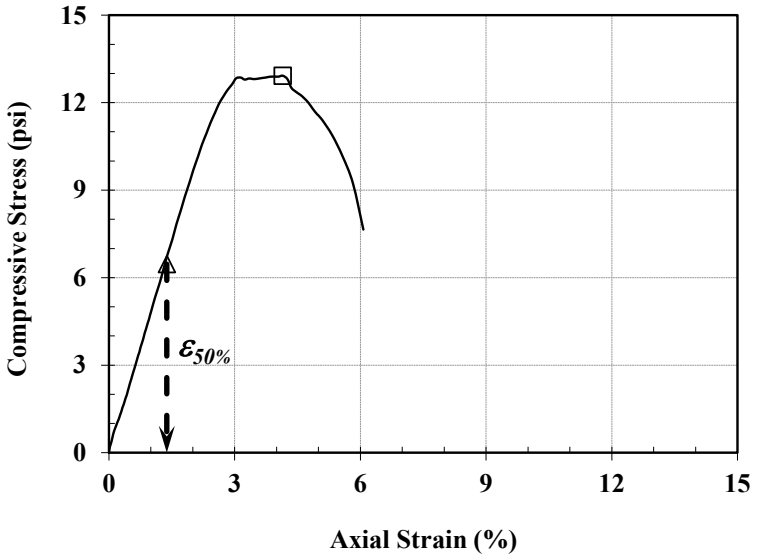
Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/06/25
Quality Review/Date
Specimen prepared & tested by: A.B.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must recieve prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

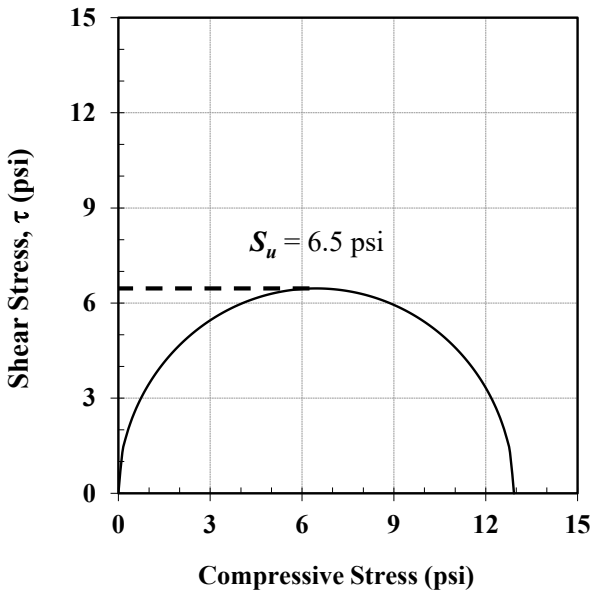
Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project No.: GE2503026
Type of Specimen: Shelby Tube
Project: Longspur Wind Project
Test Method: ASTM D2166
Strain Rate: 1.0 %/min
Sample I.D.: GEO-036 at 17 ft
Test Date: 6/10/2025



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.87
Avg. Height (in)	H_o	5.63
In-situ Moisture Content (%)	w_o	29.9
Total Unit Weight (pcf)	γ_{total}	120.7
Dry Unit Weight (pcf)	γ_{dry}	92.9
Saturation (%)	S_r	99.2
Void Ratio	e_o	0.81
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	12.9
Axial Strain at Failure (%)	4.1
Axial Strain at 50 % of q_u (%)	1.4
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	12.9
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	0.47

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/10/25
Quality Review/Date
Specimen prepared & tested by: A.B.

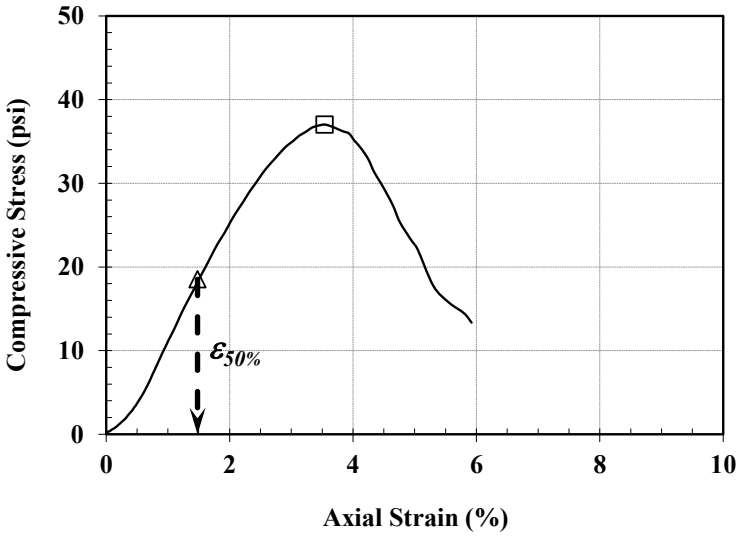
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Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample I.D.: GEO-37 at 12 ft

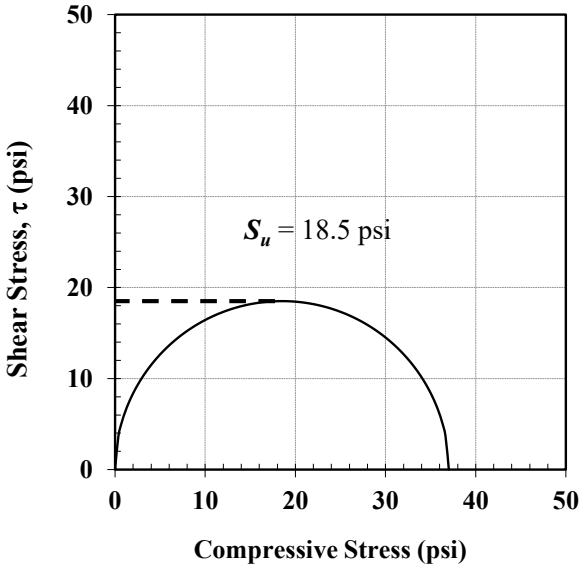
Project No.: GE2503026
Test Method: ASTM D2166
Test Date: 6/4/2025

Type of Specimen: Modified CA Tube
Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.40
Avg. Height (in)	H_o	4.85
In-situ Moisture Content (%)	w_o	47.0
Total Unit Weight (pcf)	γ_{total}	95.8
Dry Unit Weight (pcf)	γ_{dry}	65.1
Saturation (%)	S_r	80.0
Void Ratio	e_o	1.59
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	37.0
Axial Strain at Failure (%)	3.5
Axial Strain at 50 % of q_u (%)	1.5
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	37.0
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	1.33

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/09/25
Quality Review/Date
Specimen prepared & tested by: A.B.

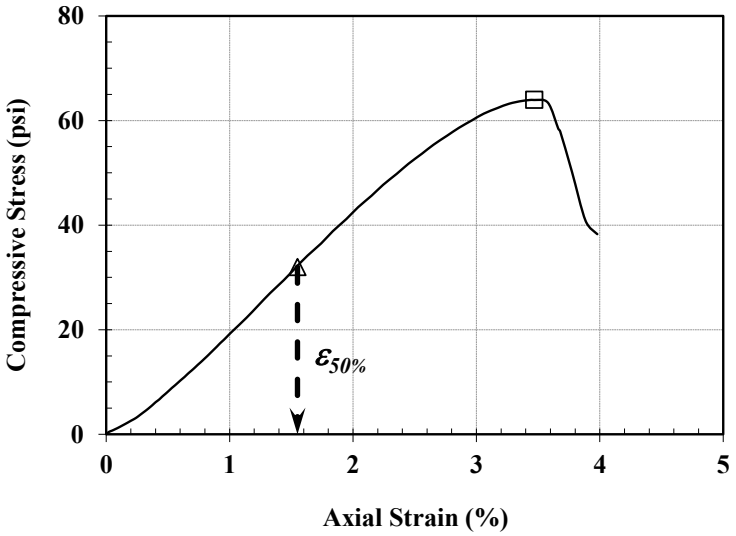
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Unconfined Compression Test Report

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample I.D.: GEO-69 at 12 ft

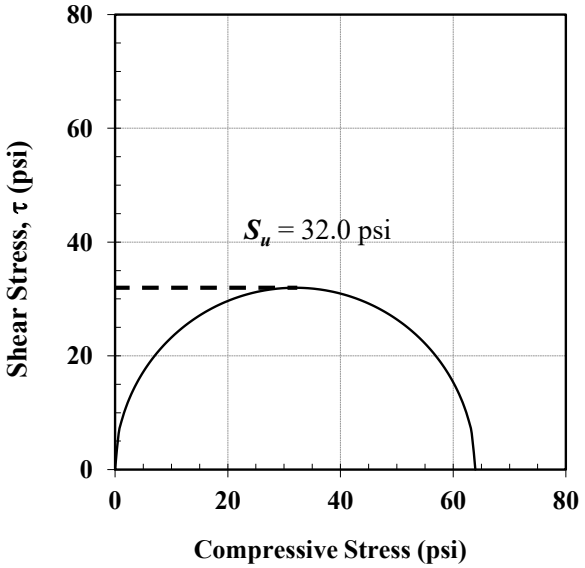
Project No.: GE2503026
Test Method: ASTM D2166
Test Date: 6/6/2025

Type of Specimen: Shelby Tube
Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.89
Avg. Height (in)	H_o	5.63
In-situ Moisture Content (%)	w_o	24.8
Total Unit Weight (pcf)	γ_{total}	118.8
Dry Unit Weight (pcf)	γ_{dry}	95.1
Saturation (%)	S_r	86.9
Void Ratio	e_o	0.77
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	63.9
Axial Strain at Failure (%)	3.5
Axial Strain at 50 % of q_u (%)	1.6
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	63.9
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	2.30

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/09/25
Quality Review/Date
Specimen prepared & tested by: A.B.

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Beyond Engineering Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

One-Dimensional Swell or Collapse of Soils

Client: RRC Power & Energy, LLC
Project Name: Longspur Wind Project
Sample ID: SUB-6 at 4 ft

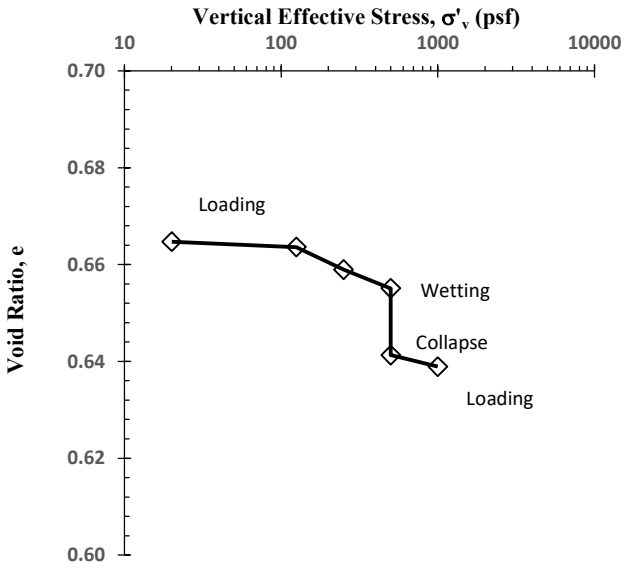
Beyond Project No.: GE2503026
Test Method: ASTM D4546, Method C
Test Date: 9/13/25-9/15/25

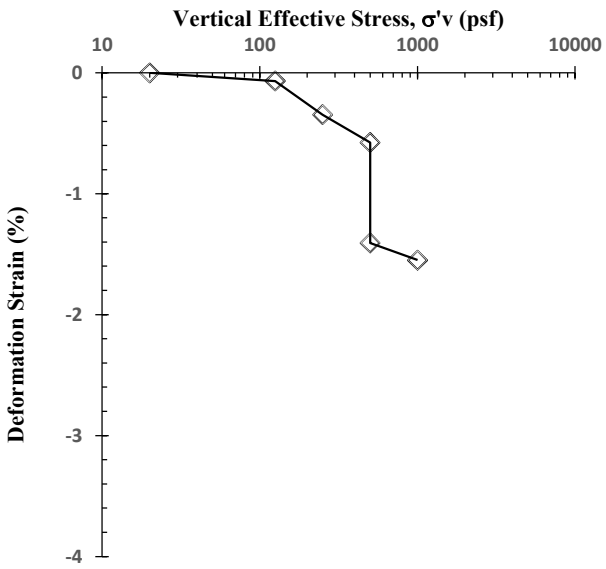
Specimen Conditions	
Avg. Water Content of Trimmings (%)	5.6
Final Specimen Water Content (%)	18.8
Initial Specimen Height (in)	0.798
Final Specimen Height (in)	0.785
Initial Dry Unit Weight, γ_o (pcf)	101.2
Final Dry Unit Weight, γ_f (pcf)	102.8
Initial Void Ratio, e_o	0.665
Final Void Ratio, e_f	0.639
Initial Degree of Saturation (%)	22.8
Final Degree of Saturation (%)	79.4
Collapse Strain (%)	-0.8

Specimen was inundated with tap water during testing. Loading increment duration was minimum 24 hours. . The calculation included the machine deflections that measured in each loading steps.

Gs assumed to be 2.70

Specimen Diameter: 2.493 inches





	Dry				Inundated	
Stage No.	1	2	3	4	5	6
σ'_v (psf)	20	125	250	500	500	1000
Height (inch)	0.798	0.797	0.795	0.793	0.787	0.785
Void Ratio, e	0.665	0.664	0.659	0.655	0.641	0.639
Axial Strain (%)	0.00	-0.07	-0.35	-0.58	-1.41	-1.55

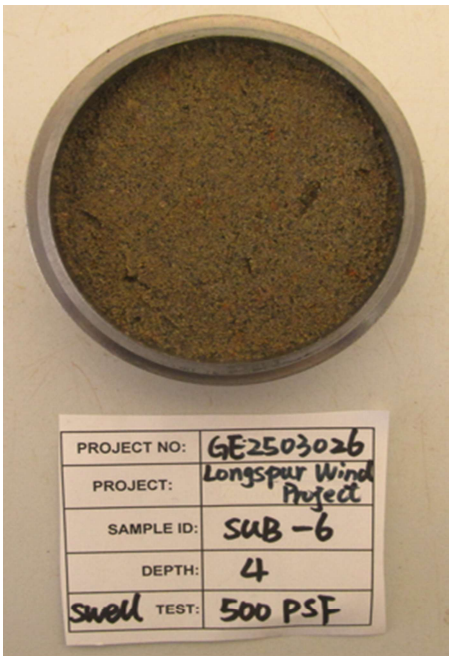
Huamiao Cao, P.E. 09/16/25
Analysis & Quality Review/Date
Specimen prepared and tested by: J.Z.

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Beyond Engineering Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

One-Dimensional Swell or Collapse of Soils

Client:	RRC Power & Energy, LLC	**Beyond Project No.:**	GE2503026
Project Name:	Longspur Wind Project	**Test Method:**	ASTM D4546, Method C
Sample ID:	SUB-6 at 4 ft	**Test Date:**	9/13/25-9/15/25



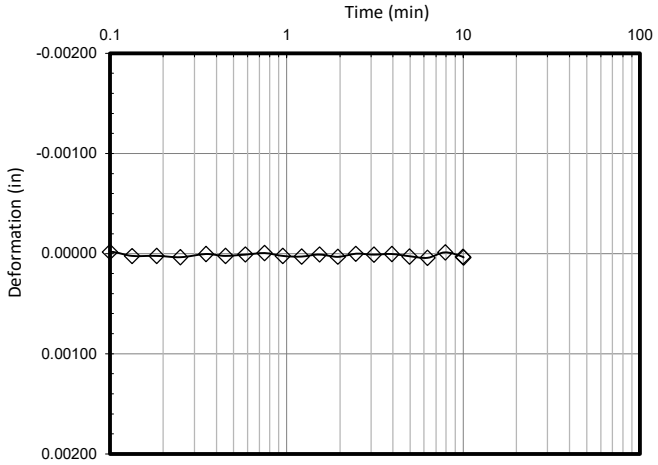


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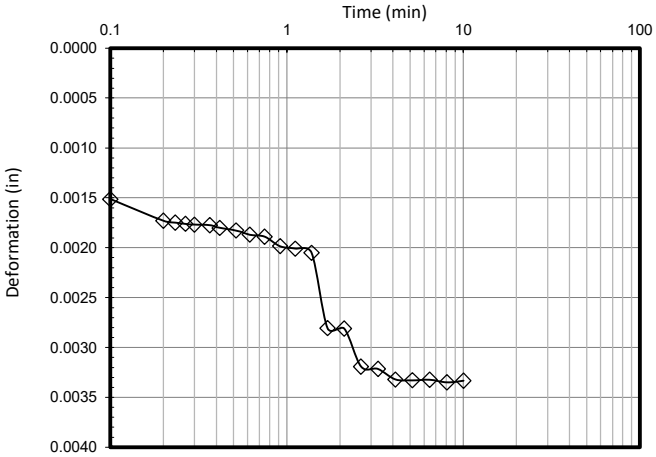
One-Dimensional Swell or Collapse of Soils

Client:	RRC Power & Energy, LLC	**Beyond Project No.:**	GE2503026
Project Name:	Longspur Wind Project	**Test Method:**	ASTM D4546, Method C
Sample ID:	SUB-6 at 4 ft	**Test Date:**	9/13/25-9/15/25

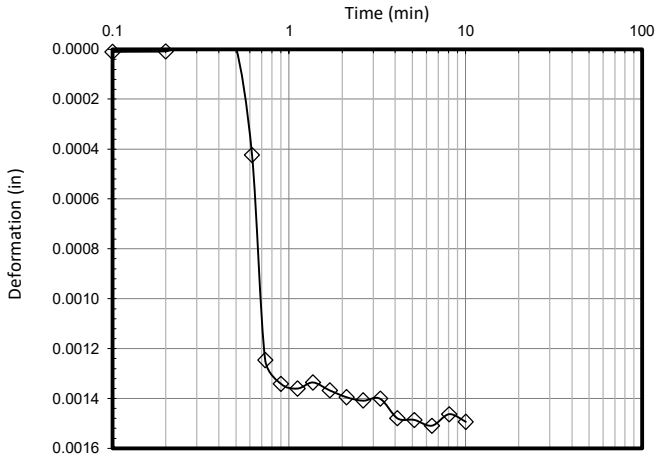
20-psf Load (Seating Load)



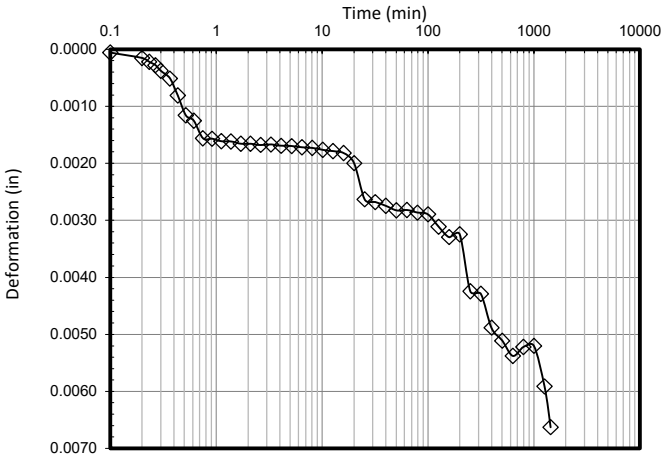
500-psf Load



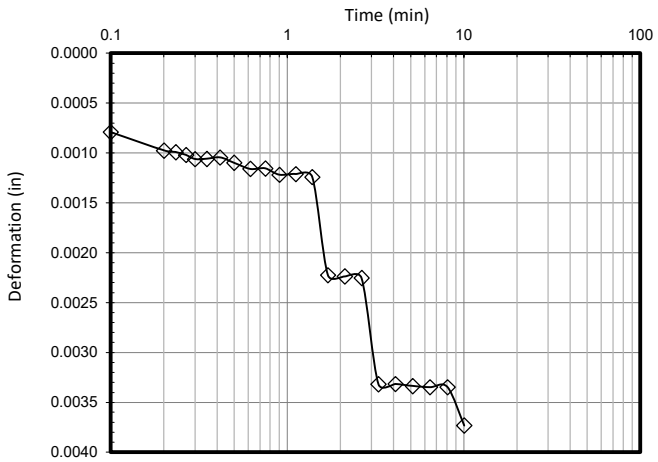
125-psf Load



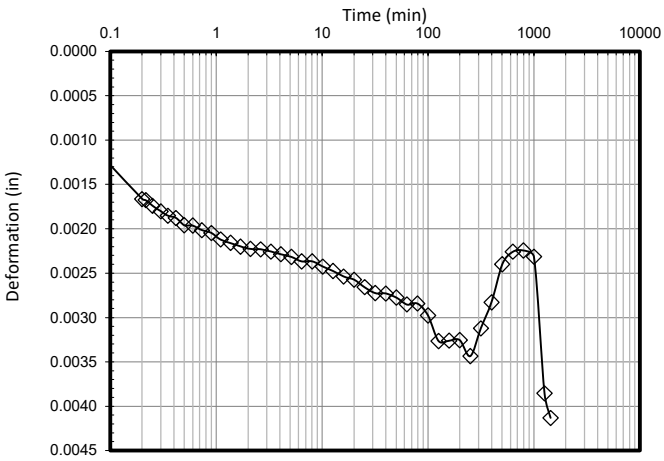
500-psf Load (inundated)



250-psf Load



1000-psf Load (inundated)



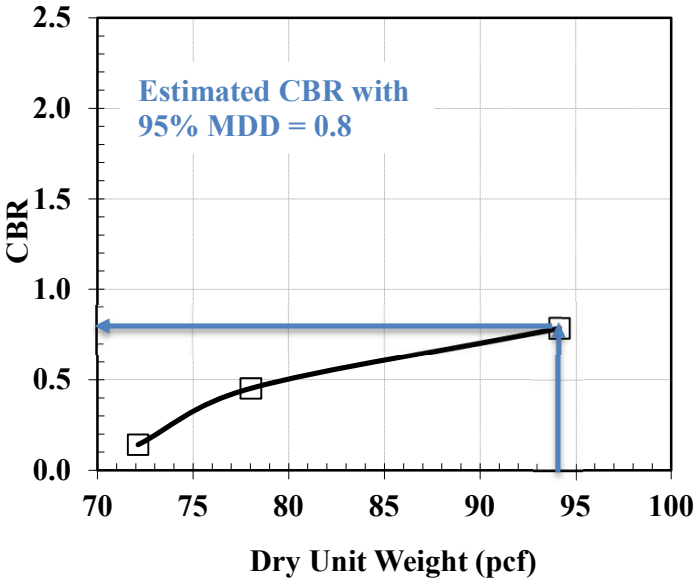
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

CBR (California Bearing Ratio) Test

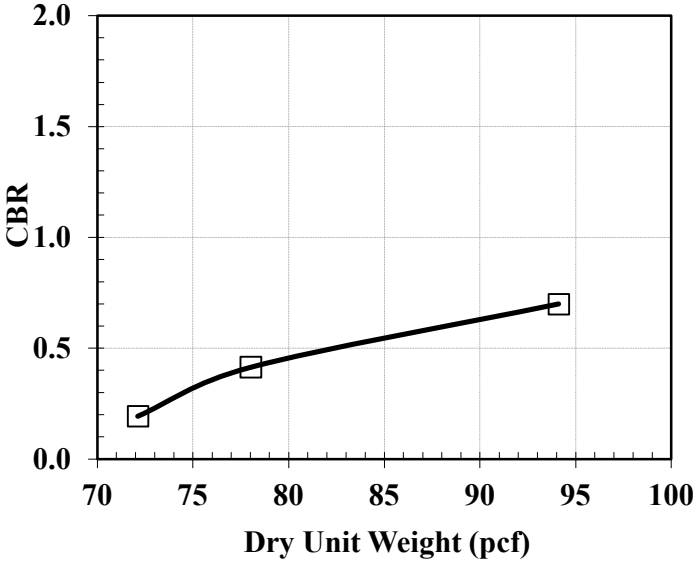
Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No: GEO-048 at 1-4 ft

Beyond Project No.: GE2503026
Test Method: ASTM D1883
Test Date: 6/17/2025
Rate of Penetration: 0.05 in/min

CBR for 0.100-in Penetration



CBR for 0.200-in Penetration



Initial Conditions			
Specimen No.	1	2	3
Blows per Layer	15	30	60
Surcharge Weight (lbs)	10	10	10
Water Content (%)	20.6	20.9	21.3
Dry Unit Weight (pcf)	72.1	78.0	94.1
Percent Compaction (%)	72.8	78.7	95.0
Final Conditions (soaked)			
Water Content (%) at top 1-in layer after soaking	40.9	47.0	37.3
Swell (% of initial height)	4.1	6.4	5.1
Bearing Ratio of Sample at 0.100 in penetration	0.1	0.5	0.8
Bearing Ratio of Sample at 0.200 in penetration	0.2	0.4	0.7

Note: Soil specimens were molded to a range of densities using 15, 30 and 60 blows at optimum moisture content as per ASTM D 1883 to develop the CBR versus dry density curve. It was allowed the specimens to soak for 96 hrs prior bearing test. Removed the free water and allow the specimens to drain out for 15 min. The 10-lbs surcharge load was placed during bearing test.

HuaMiao Cao, P.E., 6/18/25
Analysis & Quality Review/Date
Specimens prepared and tested by: A.S.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must recieve prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

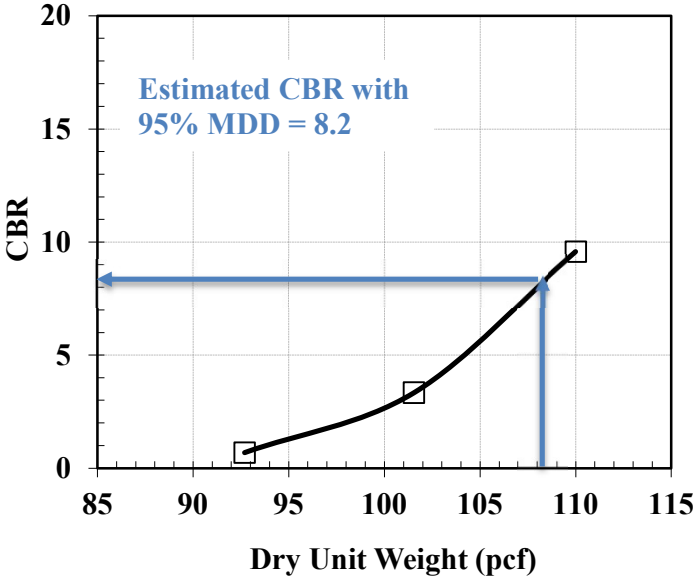
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

CBR (California Bearing Ratio) Test

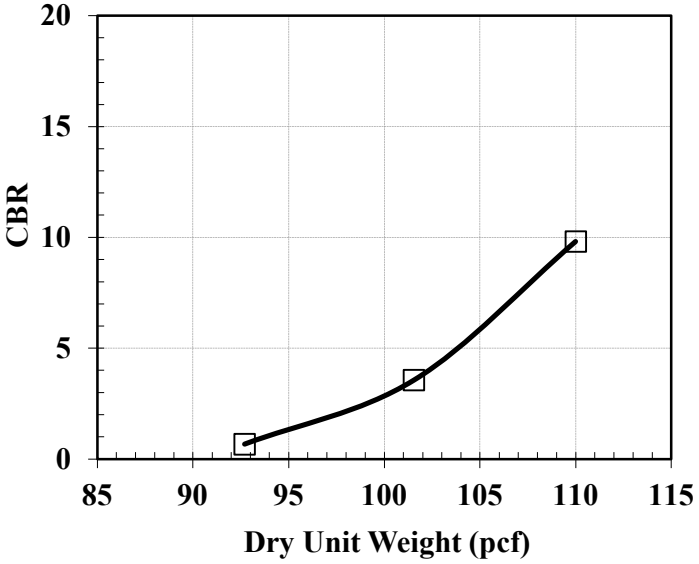
Client: RRC Power & Energy, LLC
Project: Longspur Wind Project
Sample No: GEO-062 at 1-4 ft

Beyond Project No.: GE2503026
Test Method: ASTM D1883
Test Date: 6/17/2025
Rate of Penetration: 0.05 in/min

CBR for 0.100-in Penetration



CBR for 0.200-in Penetration



Initial Conditions			
Specimen No.	1	2	3
Blows per Layer	10	25	60
Surcharge Weight (lbs)	10	10	10
Water Content (%)	12.2	12.0	12.4
Dry Unit Weight (pcf)	92.7	101.5	110.0
Percent Compaction (%)	81.4	89.2	96.6
Final Conditions (soaked)			
Water Content (%) at top 1-in layer after soaking	25.1	21.8	19.3
Swell (% of initial height)	0.5	0.8	0.5
Bearing Ratio of Sample at 0.100 in penetration	0.7	3.3	9.6
Bearing Ratio of Sample at 0.200 in penetration	0.7	3.6	9.8

Note: Soil specimens were molded to a range of densities using 10, 25 and 60 blows at optimum moisture content as per ASTM D 1883 to develop the CBR versus dry density curve. It was allowed the specimens to soak for 96 hrs prior bearing test. Removed the free water and allow the specimens to drain out for 15 min. The 10-lbs surcharge load was placed during bearing test.

HuaMiao Cao, P.E., 6/18/25

Analysis & Quality Review/Date
Specimens prepared and tested by: A.S.

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Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Client: RRC Power & Energy, LLC
Project: Longspur Wind Project

RRC Project No.: GE2503026
Testing Method: EPA 300/300.1
Test Date: 6/9/2025

No.	Sample ID & Depth	Sulfate Content (mg SO_4/kg)	Chloride Content (mg/kg)
1	GEO-04 at 1-13 ft	2,220	79.9
2	GEO-10 at 1-13 ft	672	82.8
3	GEO-25 at 1-13 ft	2,600	59.3
4	GEO-50 at 1-13 ft	4,390	78.6
5	GEO-64 at 1-13 ft	2,740	76.4
6	SUB-3 at 1-4 ft	240	305
7			
8			
9			
10			

HuaMiao Cao, 6/10/25
Quality Review/Date
Tested by: XENCO

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SUMMARY OF LABORATORY RESULTS

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-01	1.0		23												
GEO-01	2.0	CH	24		100	63	22	41							
GEO-01	4.0		19												
GEO-01	7.0		28												
GEO-01	10.0		29												
GEO-01	12.0		47												
GEO-01	14.0	CH	20	111	81	52	20	32	5.28	7.3	0.0				
GEO-02	1.0		18												
GEO-02	4.0		22												
GEO-02	7.0		20												
GEO-02	10.0		19												
GEO-02	12.0		22												
GEO-03	1.0		11												
GEO-03	4.0		16												
GEO-03	7.0		16												
GEO-03	10.0		19												
GEO-03	12.0		16	96											
GEO-04	1.0		14												
GEO-04	1.0		23									0.0080	0.2220	7.1	589
GEO-04	4.0		19												
GEO-04	7.0		22												
GEO-04	10.0		23												
GEO-04	12.0	CL	23	103	85	47	18	29	1.96	14.8	10.0				
GEO-04	19.0		22	102					2.59	7.8	0.0				
GEO-05	1.0		16												
GEO-05	4.0		15												
GEO-05	7.0		17												
GEO-05	10.0		19												
GEO-05	12.0		17												
GEO-06	1.0		14												
GEO-06	4.0		30												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-06	7.0		27												
GEO-06	10.0		30												
GEO-07	1.0		25												
GEO-07	4.0		22												
GEO-07	7.0		26												
GEO-07	10.0		27												
GEO-07	12.0	CH	27	99	100	64	23	41	6.92	6.3	10.0				
GEO-08	1.0		25												
GEO-08	2.0	CH	22		99	57	19	38							
GEO-08	4.0		22												
GEO-08	7.0		24												
GEO-08	10.0		23												
GEO-09	1.0		16												
GEO-09	4.0		23												
GEO-09	7.0		25												
GEO-10	1.0		14												
GEO-10	1.0		17									0.0083	0.0672	6.6	746
GEO-10	2.0	CH	16		91	71	24	47							
GEO-10	4.0		15												
GEO-10	7.0		16												
GEO-10	10.0		17												
GEO-10	12.0		41												
GEO-11	1.0		13												
GEO-11	4.0		12												
GEO-11	7.0		7												
GEO-11	10.0		4												
GEO-11	12.0		13												
GEO-12	1.0		12												
GEO-12	4.0		11												
GEO-12	7.0		9												
GEO-12	10.0		16												

ND Not Detected; **D** Diluted;
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SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-12	12.0		16												
GEO-13	1.0		20												
GEO-13	4.0		26												
GEO-13	7.0		21												
GEO-13	10.0		24												
GEO-13	12.0		30												
GEO-14	1.0		19												
GEO-14	4.0		22												
GEO-14	7.0		23												
GEO-14	10.0		22												
GEO-14	12.0		18												
GEO-15	1.0		7												
GEO-15	4.0		11												
GEO-15	7.0		24												
GEO-15	10.0		23												
GEO-15	12.0		19												
GEO-16	1.0		3												
GEO-16	4.0		36												
GEO-16	7.0		23												
GEO-16	10.0		23												
GEO-16	12.0	MH	31		56	76	46	30							
GEO-17	1.0		13												
GEO-17	4.0		12												
GEO-17	7.0		14												
GEO-17	12.0		17												
GEO-18	1.0		7												
GEO-18	4.0		9												
GEO-18	7.0		9												
GEO-18	9.0		10												
GEO-18	12.0		6												
GEO-19	1.0		8												

ND Not Detected; **D** Diluted;
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RRC Power & Energy, LLC
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SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-19	2.0	CL	6		97	30	18	12							
GEO-19	4.0		20												
GEO-19	7.0		29												
GEO-19	9.0		21												
GEO-19	12.0		19												
GEO-20	1.0		21												
GEO-20	4.0		22												
GEO-20	7.0		22												
GEO-20	9.0		22												
GEO-21	1.0		8												
GEO-21	4.0		7												
GEO-21	7.0		6												
GEO-21	9.0		7												
GEO-22	1.0		10												
GEO-22	2.0	SC-SM	17		37	22	16	6							
GEO-22	4.0		23												
GEO-22	7.0		22												
GEO-22	10.0		21												
GEO-23	1.0		13												
GEO-23	4.0		21												
GEO-23	7.0		20												
GEO-23	10.0		21												
GEO-24	1.0		21												
GEO-24	4.0		19												
GEO-24	7.0		21												
GEO-24	10.0		21												
GEO-25	1.0		19												
GEO-25	1.0		16									0.0059	0.2600	7.5	455
GEO-25	4.0		21												
GEO-25	7.0		20												
GEO-25	10.0		21												

ND Not Detected; **D** Diluted;
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Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-26	1.0		18												
GEO-26	4.0		16												
GEO-26	7.0		18												
GEO-26	10.0		21												
GEO-27	1.0		16												
GEO-27	4.0		15												
GEO-27	7.0		15												
GEO-27	10.0		14												
GEO-27	12.0		15												
GEO-28	1.0		15												
GEO-28	4.0		20												
GEO-28	7.0		22												
GEO-28	10.0		20												
GEO-28	12.0		7												
GEO-29	1.0		19												
GEO-29	4.0		21												
GEO-29	10.0		19												
GEO-29	12.0		20												
GEO-31	1.0		7												
GEO-31	4.0		7												
GEO-31	7.0		7												
GEO-31	10.0		15												
GEO-33	1.0		14												
GEO-33	2.0	CH	17		98	61	19	42							
GEO-33	4.0		25												
GEO-33	7.0		21												
GEO-33	10.0		23												
GEO-33	12.0		19												
GEO-33	17.0		17	111					9.45	2.9	0.0				
GEO-34	1.0		15												
GEO-34	4.0		12												

ND Not Detected; **D** Diluted;
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810 Hesters Crossing Rd, Suite 120
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Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-34	7.0		32												
GEO-34	10.0		22												
GEO-34	12.0		24												
GEO-35	1.0		30												
GEO-35	4.0		24												
GEO-35	7.0		51												
GEO-35	10.0		26												
GEO-35	12.0		23												
GEO-36	1.0		14												
GEO-36	4.0		16												
GEO-36	7.0		21												
GEO-36	10.0		6												
GEO-36	12.0		10												
GEO-36	17.0	CH	30	93	100	63	26	37	0.93	4.1	0.0				
GEO-37	1.0		21												
GEO-37	4.0		22												
GEO-37	7.0		24												
GEO-37	10.0		97												
GEO-37	12.0		47	65					2.66	3.5	0.0				
GEO-38	1.0		12												
GEO-38	4.0		15												
GEO-38	7.0		23												
GEO-38	12.0	CL	21		85	38	17	21							
GEO-39	1.0		19												
GEO-39	4.0		20												
GEO-39	7.0		20												
GEO-39	10.0		21												
GEO-40	1.0		9												
GEO-40	4.0		15												
GEO-40	7.0		17												
GEO-40	9.0		16												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-42	1.0		18												
GEO-42	4.0		22												
GEO-42	7.0		22												
GEO-42	10.0		21												
GEO-43	1.0		13												
GEO-43	4.0		14												
GEO-43	7.0		13												
GEO-43	12.0		12												
GEO-44	1.0		15												
GEO-44	4.0		22												
GEO-44	7.0		19												
GEO-44	10.0		2												
GEO-44	12.0		21												
GEO-45	1.0		16												
GEO-45	4.0		20												
GEO-45	7.0		23												
GEO-45	10.0		18												
GEO-46	1.0		12												
GEO-46	2.0	CL	16		84	41	18	23							
GEO-46	4.0		19												
GEO-46	7.0		31												
GEO-46	10.0		19												
GEO-46	12.0	CH	23	104	82	69	18	51	6.21	10.1	10.0				
GEO-47	1.0		8												
GEO-47	4.0		7												
GEO-47	7.0		11												
GEO-47	10.0		14												
GEO-47	12.0		13												
GEO-48	1.0		20												
GEO-48	2.0	CH	23		96	71	23	48							
GEO-48	4.0		22												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-48	7.0		22												
GEO-48	9.0		17												
GEO-48	12.0		19												
GEO-49	1.0		12												
GEO-49	4.0		22												
GEO-49	7.0		21												
GEO-49	10.0		22												
GEO-49	29.0	MH	81		62	88	69	19							
GEO-50	1.0		19												
GEO-50	1.0		26									0.0079	0.4390	7.6	408
GEO-50	4.0		22												
GEO-50	7.0		37												
GEO-50	9.0		23												
GEO-50	14.0	CH	20	107	99	52	20	32							
GEO-51	1.0		12												
GEO-51	4.0		26												
GEO-51	7.0		23												
GEO-51	10.0		22												
GEO-52	1.0		16												
GEO-52	4.0		17												
GEO-52	7.0		20												
GEO-52	10.0		48												
GEO-52	12.0		19												
GEO-53	1.0		16												
GEO-53	2.0	CH	17		93	54	19	35							
GEO-53	4.0		22												
GEO-53	7.0		23												
GEO-53	12.0	ML	98	34	66	NP	NP	NP							
GEO-53	22.0		26	94											
GEO-54	1.0		22												
GEO-54	4.0		22												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-54	7.0		18												
GEO-54	9.0		21												
GEO-54	12.0		56												
GEO-56	1.0		16												
GEO-56	4.0		19												
GEO-56	7.0		26												
GEO-56	9.0		42												
GEO-57	1.0		11												
GEO-57	4.0		14												
GEO-57	7.0		20												
GEO-57	10.0		20												
GEO-57	12.0		19												
GEO-58	1.0		21												
GEO-58	4.0		24												
GEO-58	7.0		13												
GEO-58	9.0		10												
GEO-58	12.0		24												
GEO-59	1.0		17												
GEO-59	2.0	CH	21		98	54	20	34							
GEO-59	4.0		20												
GEO-59	7.0		22												
GEO-59	9.0		13												
GEO-60	1.0		9												
GEO-60	4.0		21												
GEO-60	7.0		25												
GEO-60	9.0		25												
GEO-61	1.0		19												
GEO-61	4.0		15												
GEO-61	7.0		14												
GEO-61	9.0		27												
GEO-62	1.0		13												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-62	2.0	SC	8		49	26	18	8							
GEO-62	4.0		12												
GEO-62	7.0		27												
GEO-62	10.0		22												
GEO-62	12.0	CH	21	105	91	56	23	33	4.51	6.6	10.0				
GEO-62	24.0		25	101											
GEO-63	1.0		9												
GEO-63	4.0		28												
GEO-63	7.0		21												
GEO-63	10.0		20												
GEO-63	12.0		23												
GEO-64	1.0		17												
GEO-64	1.0		22									0.0076	0.2740	7.3	294
GEO-64	4.0		21												
GEO-64	7.0		23												
GEO-64	9.0		23												
GEO-64	12.0		26												
GEO-65	1.0		11												
GEO-65	4.0		27												
GEO-65	7.0		33												
GEO-65	10.0		25												
GEO-65	12.0		25												
GEO-66	1.0		15												
GEO-66	4.0		20												
GEO-66	7.0		17												
GEO-66	9.0		28												
GEO-66	12.0	CH	22	104	100	52	22	30	6.24	5.8	10.0				
GEO-67	1.0		14												
GEO-67	2.0	CL	14		97	43	21	22							
GEO-67	4.0		20												
GEO-67	7.0		20												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
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Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-67	9.0		18												
GEO-68	1.0		15												
GEO-68	4.0		20												
GEO-68	7.0		20												
GEO-68	9.0		19												
GEO-68	12.0		22												
GEO-69	1.0		24												
GEO-69	4.0		17												
GEO-69	7.0		23												
GEO-69	9.0		25												
GEO-69	12.0		25	95					4.60	3.5	0.0				
GEO-70	1.0		14												
GEO-70	2.0	CH	16		99	61	20	41							
GEO-70	4.0		19												
GEO-70	7.0		11												
GEO-70	9.0		15												
GEO-70	12.0		26												
GEO-71	1.0		14												
GEO-71	4.0		11												
GEO-71	7.0		12												
GEO-71	10.0		14												
SUB-1	1.0		11												
SUB-1	4.0		14												
SUB-2	1.0		7												
SUB-2	2.0	CL	14		51	37	14	23							
SUB-2	4.0	SM	14		20	NP	NP	NP							
SUB-3	1.0											0.0305	0.0240	9.1	805
SUB-3	4.0	SC-SM	15	108	20	21	16	5	1.62	14.3	3.0				
SUB-6	4.0	SM	6	101	27	NP	NP	NP							
SUB-9	1.0		6												
SUB-9	4.0	SC	6		23	24	16	8							

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
810 Hesters Crossing Rd, Suite 120
Round Rock, TX 78681
Telephone: (512) 992-2087

SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.
PROJECT: Longspur Wind Project
LOCATION: Morton County, ND
NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
PMM-2	4.0	CH	25		100	77	22	55							
O&M-1	1.0		17												
O&M-1	4.0		10												
O&M-1	7.0		19	100					0.32	1.8	5.5				

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

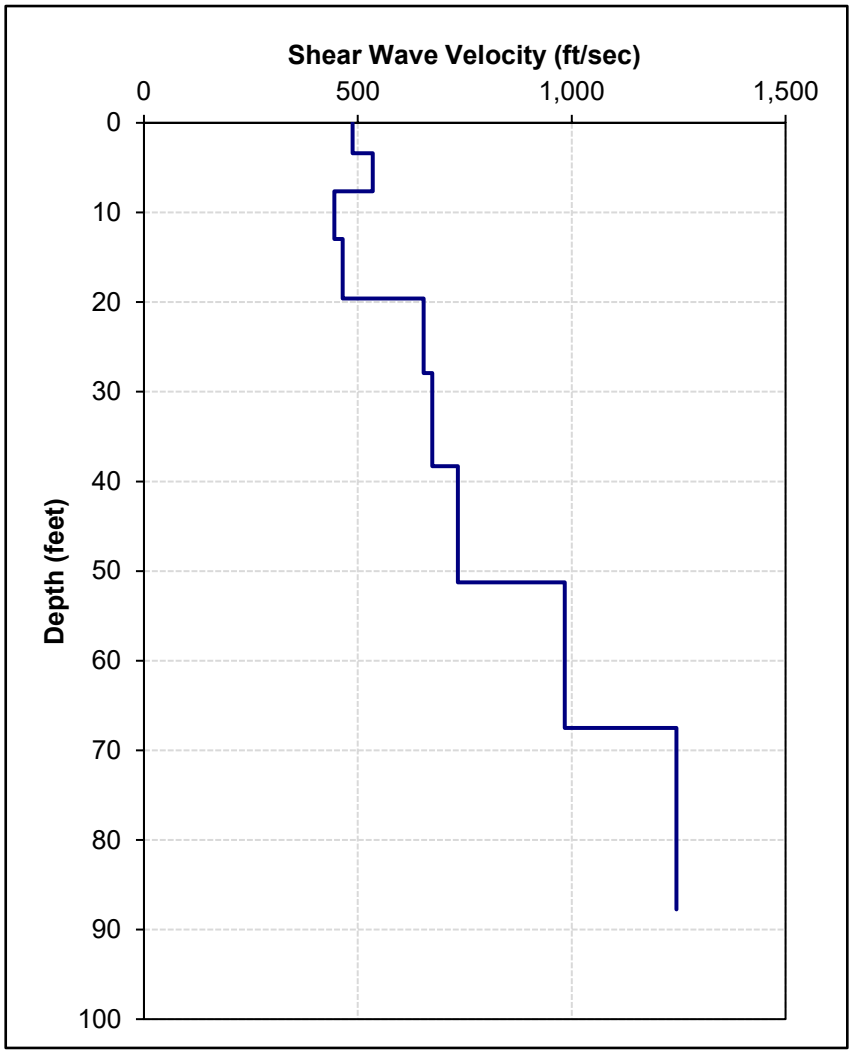
www.RRCcompanies.com

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Round Rock, TX 78661
512.992.2087

APPENDIX C

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-004

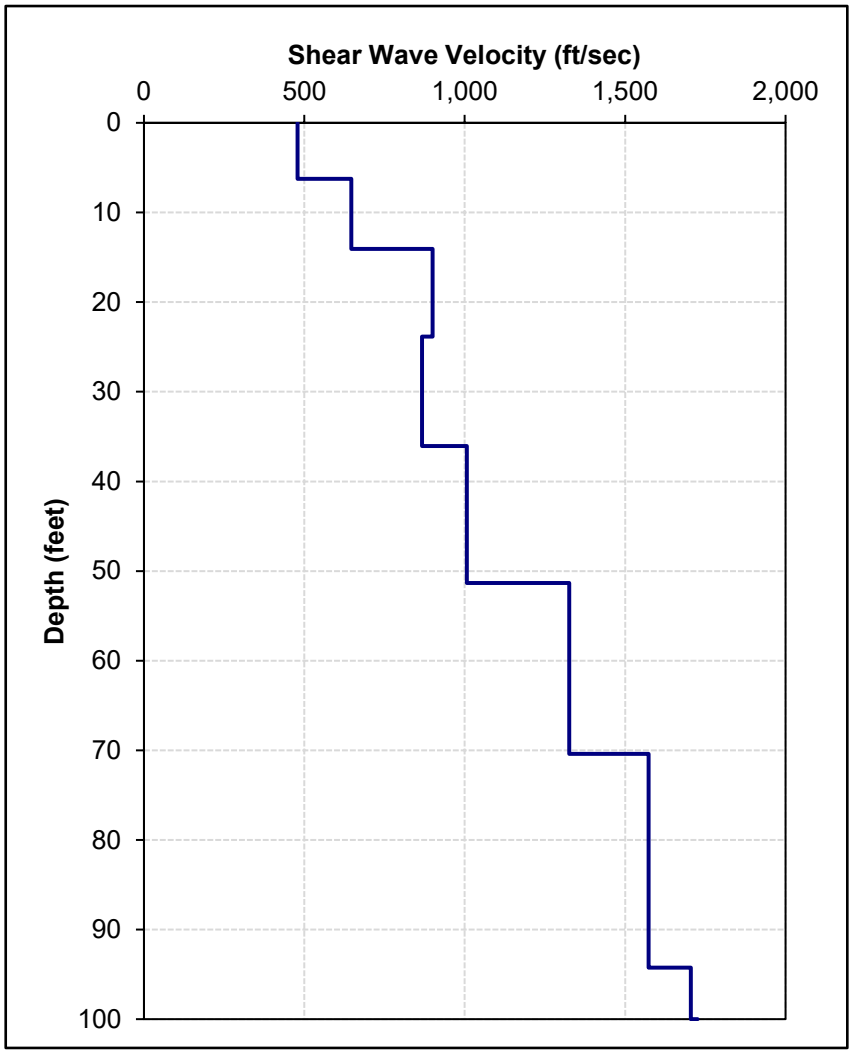
Depth (ft)	Shear Wave Velocity (ft/sec)
3.4	488
7.7	535
13.0	445
19.6	465
27.9	654
38.3	674
51.3	734
67.5	984
87.8	1,245



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-014

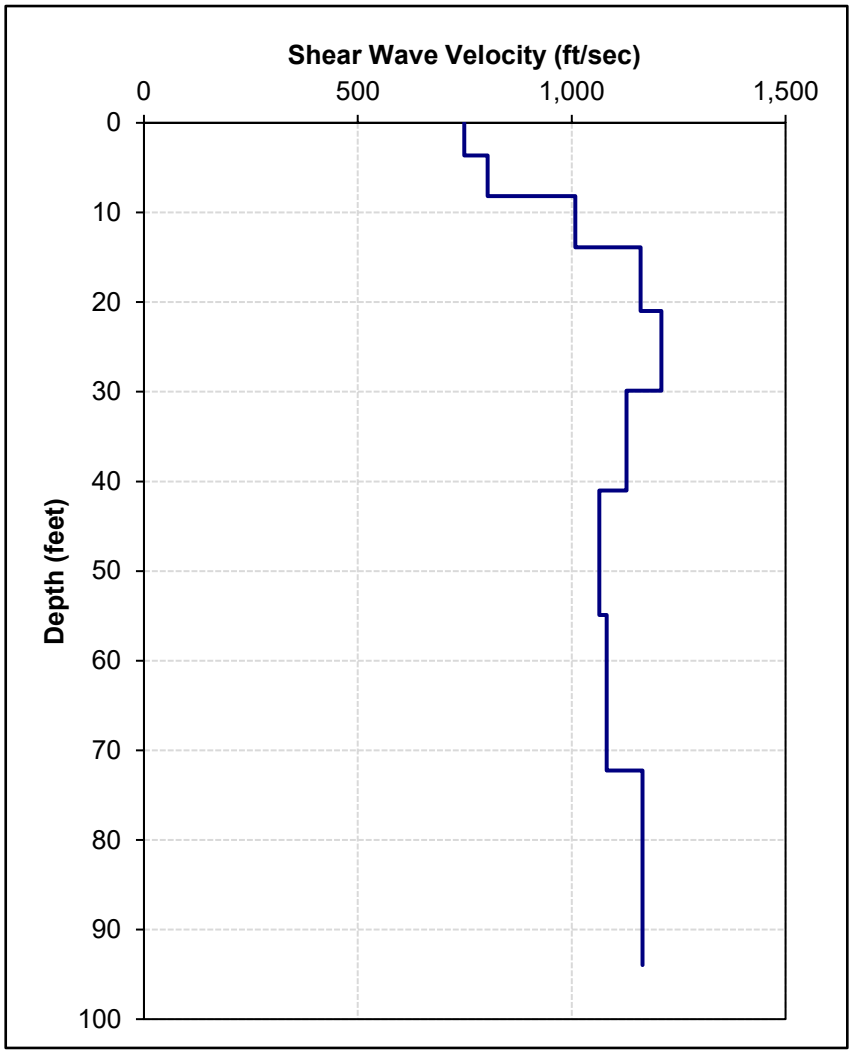
Depth (ft)	Shear Wave Velocity (ft/sec)
6.3	479
14.1	646
23.8	900
36.1	867
51.3	1,007
70.4	1,326
94.3	1,573
100.0	1,705



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-018

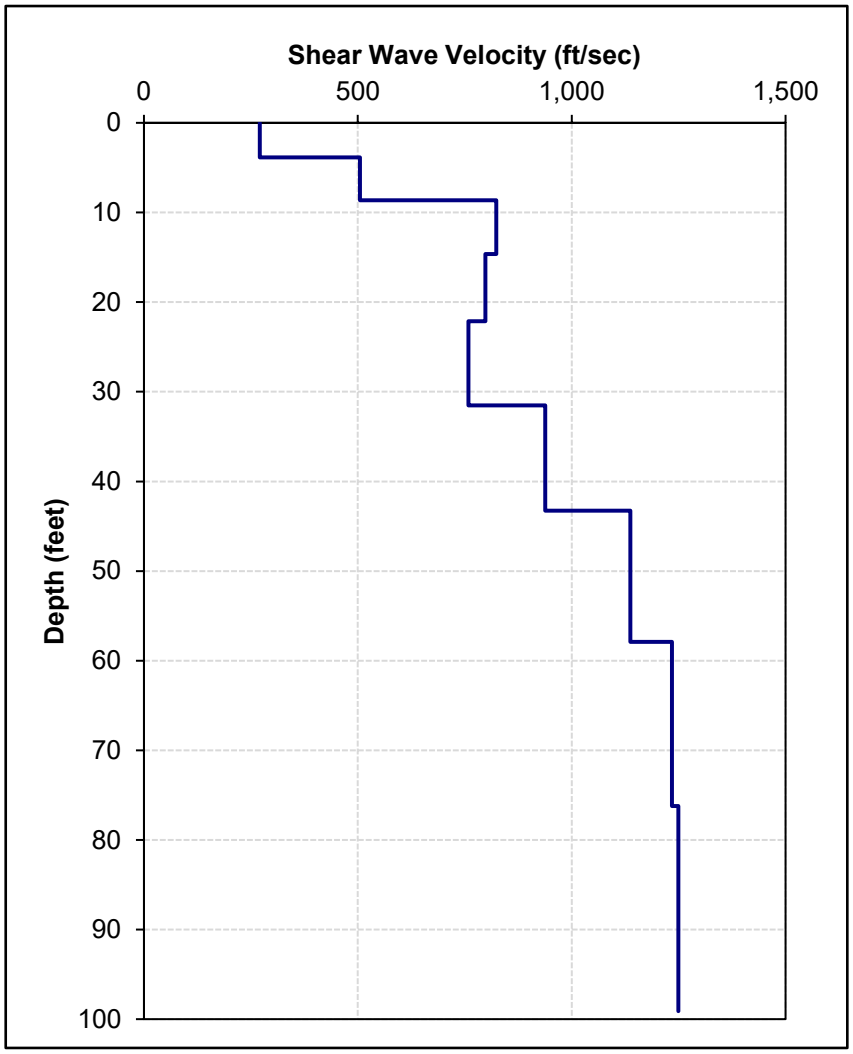
Depth (ft)	Shear Wave Velocity (ft/sec)
3.6	749
8.2	803
13.9	1,009
21.0	1,161
29.9	1,210
41.0	1,128
54.9	1,064
72.3	1,082
94.0	1,166



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-029

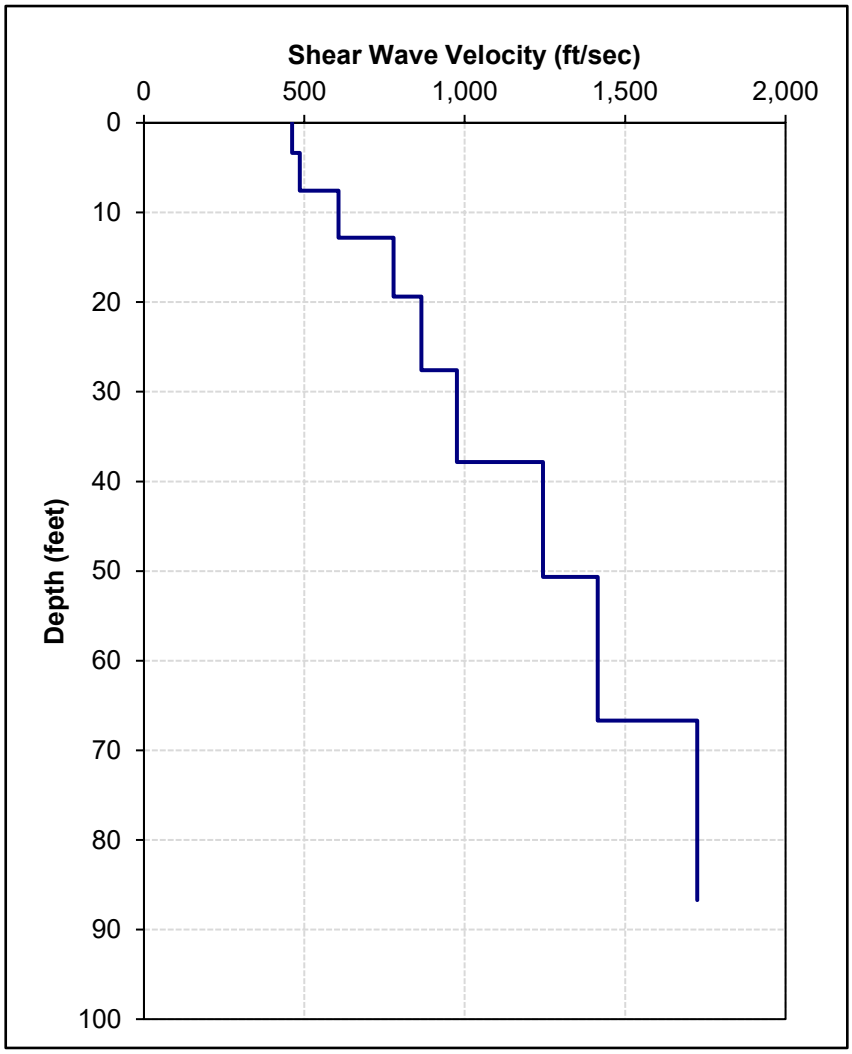
Depth (ft)	Shear Wave Velocity (ft/sec)
3.8	271
8.6	505
14.7	824
22.2	798
31.5	759
43.3	938
57.9	1,137
76.2	1,234
99.1	1,250



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-033

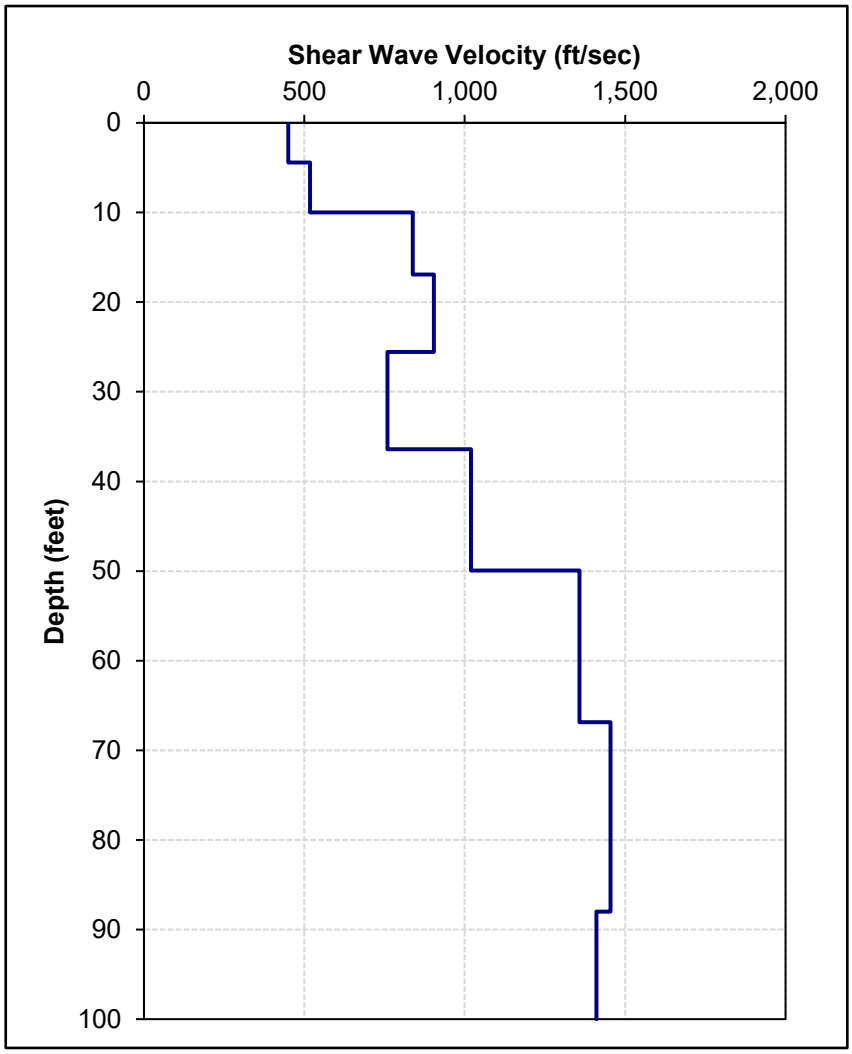
Depth (ft)	Shear Wave Velocity (ft/sec)
3.4	462
7.6	486
12.8	607
19.4	778
27.6	865
37.8	976
50.7	1,244
66.7	1,414
86.7	1,725



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-064

Depth (ft)	Shear Wave Velocity (ft/sec)
4.4	450
10.0	518
16.9	838
25.6	904
36.4	760
49.9	1,020
66.9	1,357
88.0	1,455
100.0	1,411



Note:
1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955518, -101.761945)
Date:	5/12/2025
Measurement No. & Orientation:	DSR-1 / NE-SW
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 84° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: 1. Fence Lines is at approximately 500 feet East running N-S and 350 feet South running E-W.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	2	1.5	0.5		0.5	1.5			9.996	0.2	126.6	242.33
2	2	2	3	1		1	3			135.9	0.1	27.75	106.23
3	4	2	4.5	1.5		1.5	4.5			158.3	0.2	10.83	62.19
6	6	4	9	3		3	9			134.6	0	3.401	39.06
10	6	4	15	5		5	15			147.0	0	1.809	34.63
20	12	6	30	10		10	30			186.3	0.1	0.832	31.85
30	12	6	45	15		15	45			135.0	0.2	0.553	31.76
60	12	12	90	30		30	90			169.0	0.2	0.214	24.58
100	12	12	150	50		50	150			213.2	0	0.0979	18.74
200	12	12	300	100		100	300			280.2	0.1	0.038	14.55
300	12	12	450	150		150	450			125.8	0.1	0.0219	12.58

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955518, -101.761945)
Date:	5/12/2025
Measurement No. & Orientation:	DSR-1 NW-SE
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 88° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 500 feet East running N-S and 350 feet South running E-W.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			9.979	0	112.5	215.34
2	2	2	3	1		1	3			102.1	0.1	30.88	118.22
3	4	4	4.5	1.5		1.5	4.5			100.4	0.1	9.618	55.23
6	6	6	9	3		3	9			115.9	0	3.383	38.85
10	6	6	15	5		5	15			163.5	0.1	1.812	34.68
20	12	12	30	10		10	30			148.2	0.1	0.908	34.76
30	12	12	45	15		15	45			144.5	0.1	0.574	32.96
60	12	12	90	30		30	90			135.7	0.1	0.206	23.66
100	12	12	150	50		50	150			175.6	0.1	0.095	18.18
200	12	12	300	100		100	300			210	0	0.037	14.16
300	12	12	450	150		150	450			135.2	0.1	0.022	12.63

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.957200, -101.763272)
Date:	5/12/2025
Measurement No. & Orientation:	DSR-2 NE-SW
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 89° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 150 feet East running NE-SW.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			15.2	0	39.61	75.82
2	2	2	3	1		1	3			132.5	0	13.94	53.37
3	4	4	4.5	1.5		1.5	4.5			135.9	0.1	4.626	26.56
6	6	6	9	3		3	9			183.1	0	2.136	24.53
10	6	6	15	5		5	15			160.5	0.1	1.524	29.17
20	12	12	30	10		10	30			190.0	0.1	0.92	35.22
30	12	12	45	15		15	45			177.1	0.1	0.607	34.86
60	12	12	90	30		30	90			176.2	0.3	0.221	25.38
100	12	12	150	50		50	150			221.7	0.1	0.104	19.91
200	12	12	300	100		100	300			208.5	0.1	0.037	14.16
300	12	12	450	150		150	450			163.3	0.1	0.0225	12.92
600	12	12	900	300		300	900			115.4	0	0.0092	10.57

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.954955, -101.762062)
Date:	5/13/2025
Measurement No. & Orientation:	TSR-1 E-W
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 91° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 150 feet South running E-W and 500 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			21.3	0	62.18	119.02
2	2	2	3	1		1	3			23.2	0	36.14	138.35
3	4	4	4.5	1.5		1.5	4.5			108.6	0.1	19.43	111.58
6	6	6	9	3		3	9			201.7	0	7.044	80.90
10	6	6	15	5		5	15			193.8	0	2.964	56.74
20	12	12	30	10		10	30			218.7	0.1	1.075	41.15
30	12	12	45	15		15	45			215.4	0.1	0.553	31.76

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.954955, -101.762062)
Date:	5/13/2025
Measurement No. & Orientation:	TSR-1 N-S
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 90 ° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 150 feet South running E-W and 500 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			19.3	0	58.45	111.88
2	2	2	3	1		1	3			26.2	0.1	34.48	132.00
3	4	4	4.5	1.5		1.5	4.5			131.8	0.1	20.53	117.89
6	6	6	9	3		3	9			192.3	0	6.835	78.50
10	6	6	15	5		5	15			181.6	0	2.754	52.72
20	12	12	30	10		10	30			201.3	0	0.954	36.52
30	12	12	45	15		15	45			191.2	0.1	0.494	28.37

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955010, -101.760918)
Date:	5/13/2025
Measurement No. & Orientation:	TSR-2 NE-SW
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 88 ° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 150 feet South running E-W and 225 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			21.5	0	46.63	89.26
2	2	2	3	1		1	3			20.4	0	31.86	121.97
3	4	3	4.5	1.5		1.5	4.5			19.7	0	22.31	128.11
6	6	5	9	3		3	9			243.2	0.1	7.38	84.76
10	6	6	15	5		5	15			238.2	0.1	3.189	61.04
20	12	10	30	10		10	30			209.8	0.1	1.053	40.31
30	12	12	45	15		15	45			135.1	0.1	0.559	32.10

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955010, -101.760918)
Date:	5/13/2025
Measurement No. & Orientation:	TSR-2 NW-SE
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 88 ° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 150 feet South running E-W and 225 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			18.6	0	48.33	92.51
2	2	2	3	1		1	3			16.2	0.1	32.62	124.88
3	4	4	4.5	1.5		1.5	4.5			81.3	0	21.38	122.77
6	6	6	9	3		3	9			221.8	0	6.332	72.72
10	6	6	15	5		5	15			196.3	0.1	3.018	57.77
20	12	12	30	10		10	30			201.4	0.1	0.958	36.67
30	12	12	45	15		15	45			162.3	0.1	0.545	31.30

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955574, -101.760990)
Date:	5/12/2025
Measurement No. & Orientation:	TSR-3 E-W
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 87 ° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 350 feet South running E-W and 250 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			9.6	0	81.62	156.23
2	2	2	3	1		1	3			9.8	0	42.57	162.97
3	4	4	4.5	1.5		1.5	4.5			103.8	0	21.94	125.99
6	6	6	9	3		3	9			163.4	0.1	6.88	79.02
10	6	6	15	5		5	15			124.9	0	2.963	56.72
20	12	12	30	10		10	30			83.9	0.2	0.897	34.34
30	12	12	45	15		15	45			95.9	0.3	0.433	24.86

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0

Wenner Array

Project Name:	Minnesota Power - Longspur
Black & Veatch Project No.:	
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava
Project Location:	West Morton, ND (46.955574, -101.760990)
Date:	5/12/2025
Measurement No. & Orientation:	TSR-3 N-S
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force
Weather (Present and Recent):	Sunny, 91 ° F
Meter Model Type:	Supersting; R8
Serial No. & Calibration Date:	SS2106234, 1/28/26

Notes: Fence Line is at approximately 350 feet South running E-W and 250 feet East running N-S.

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V_{M-N} (mV) [1]	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	1	1.5	0.5		0.5	1.5			4.8	0	78.86	150.95
2	2	2	3	1		1	3			9.6	0	45.07	172.54
3	4	4	4.5	1.5		1.5	4.5			83.9	0.1	18.06	103.71
6	6	6	9	3		3	9			137.8	0	5.179	59.48
10	6	6	15	5		5	15			91.6	0.1	2.185	41.82
20	12	12	30	10		10	30			103.5	0	0.947	36.25
30	12	12	45	15		15	45			123.9	0.1	0.545	31.30

[1] Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of “a” spacing.

Project Name: Longspur Wind Project
Black & Veatch Project No.:
Supplier Name: RRC Power & Energy LLC

In Situ Electrical Soil Resistivity Summary Data Form

Revision 0

Instructions:
1. Enter resistance and resistivity values of all traverse locations listed below.
2. Submit this completed spreadsheet with the final report.

Apparent Resistance (ohm)

Electrode "a" spacing (ft)	DSR-1 NE-SW	DSR-1 NW-SE	TSR-1 N-S	TSR-1 E-W	TSR-2 NE-SW	TSR-2 NW-SE	TSR-3 N-S	TSR-3 E-W	DSR-2 NE-SW
1	126.600	112.500	58.450	62.180	46.630	48.330	78.860	81.620	39.610
2	27.750	30.880	34.480	36.140	31.860	32.620	45.070	42.570	13.940
3	10.830	9.618	20.530	19.430	22.310	21.380	18.060	21.940	4.626
6	3.401	3.383	6.835	7.044	7.380	6.332	5.179	6.880	2.136
10	1.809	1.812	2.754	2.964	3.189	3.018	2.185	2.963	1.524
20	0.832	0.908	0.954	1.075	1.053	0.958	0.947	0.897	0.920
30	0.553	0.574	0.494	0.553	0.559	0.545	0.545	0.433	0.607
60	0.214	0.206							0.221
100	0.098	0.095							0.104
200	0.038	0.037							0.037
300	0.022	0.022							0.023
600									0.009

Apparent Resistivity (ohm-m)

Electrode "a" spacing (ft)	DSR-1 NE-SW	DSR-1 NW-SE	TSR-1 N-S	TSR-1 E-W	TSR-2 NE-SW	TSR-2 NW-SE	TSR-3 N-S	TSR-3 E-W	DSR-2 NE-SW
1	242.331	215.341	111.882	119.021	89.257	92.511	150.949	156.232	75.82
2	106.235	118.218	131.999	138.354	121.969	124.879	172.541	162.970	53.37
3	62.191	55.231	117.892	111.575	128.114	122.773	103.708	125.989	26.56
6	39.060	38.853	78.499	80.899	84.758	72.722	59.480	79.016	24.53
10	34.627	34.684	52.716	56.735	61.042	57.769	41.824	56.716	29.17
20	31.851	34.761	36.522	41.154	40.312	36.675	36.254	34.340	35.22
30	31.756	32.962	28.368	31.756	32.100	31.296	31.296	24.865	34.86
60	24.578	23.659							25.38
100	18.739	18.184							19.91
200	14.547	14.165							14.16
300	12.576	12.633							12.92

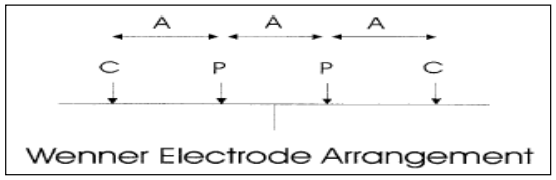
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-001
DATE 5/14/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.928622
LONGITUDE : -101.860048
WEATHER: Sunny
Temp. (°F) 69°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

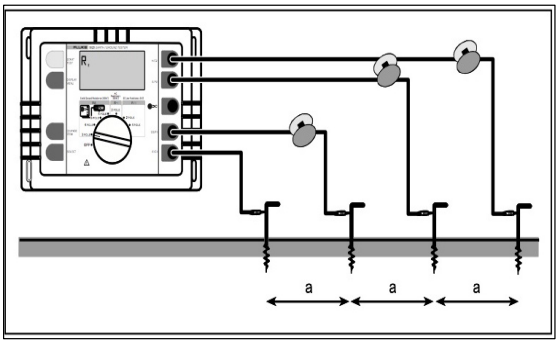
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

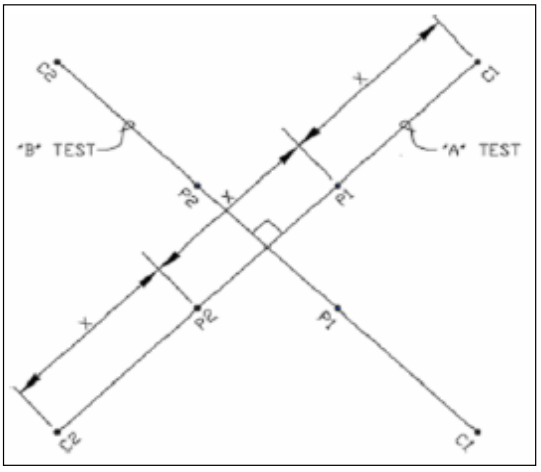
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	4.452	4.26	4.628	4.43			4.35
1	4	2	3.531	6.76	3.318	6.35			6.55
1.5	4	2	2.343	6.73	2.331	6.69			6.71
2.5	4	2	1.297	6.21	1.362	6.52			6.36
3	4	2	0.824	4.73	0.816	4.69			4.71
5	4	2	0.384	3.68	0.399	3.81			3.75
7	4	2	0.201	2.70	0.194	2.60			2.65
10	12	6	0.113	2.17	0.121	2.32			2.24
15	12	6	0.068	1.95	0.067	1.92			1.93
20	12	6	0.054	2.06	0.052	1.99			2.03
30	12	6	0.044	2.54	0.043	2.49			2.51
45	12+	6+	0.037	3.16	0.037	3.20			3.18
70	12+	6+	0.029	3.86	0.030	4.05			3.96
100	12+	6+	0.021	4.01	0.020	3.76			3.88

Notes: Fence line at ~300 ft south of the profile center, going E-W.



Wenner Electrode Arrangement



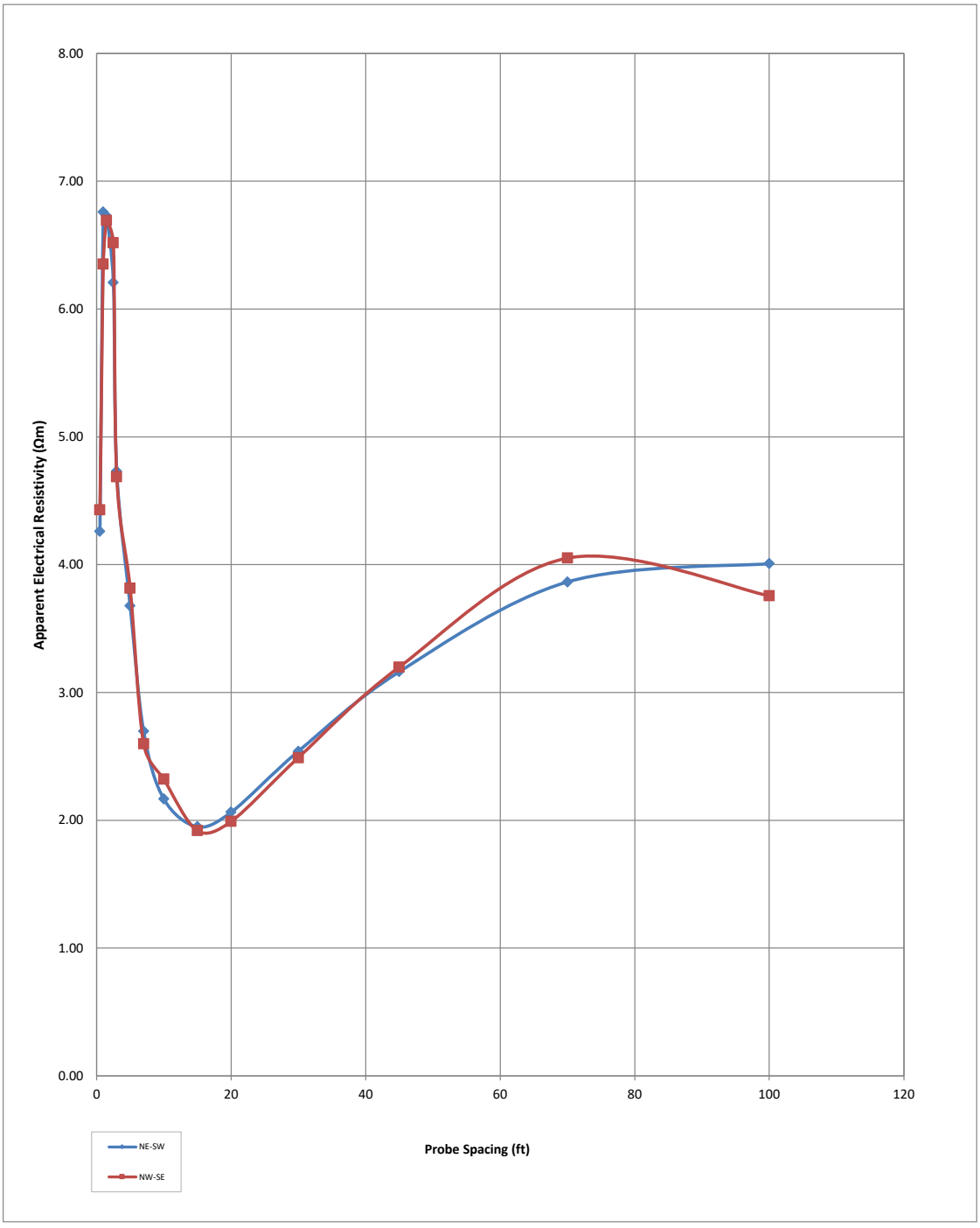


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-001



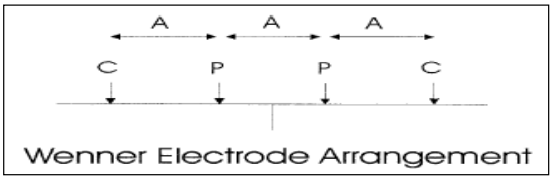
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-008
DATE 5/14/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.916389
LONGITUDE : -101.834616
WEATHER: Sunny
Temp. (°F) 72°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

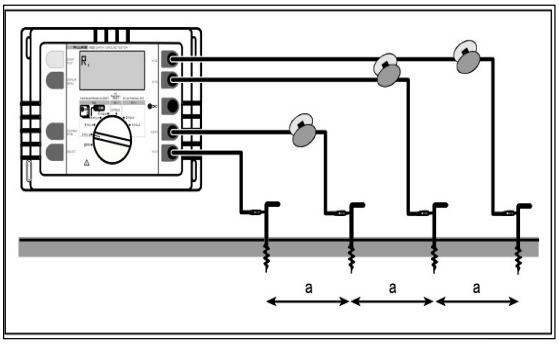
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

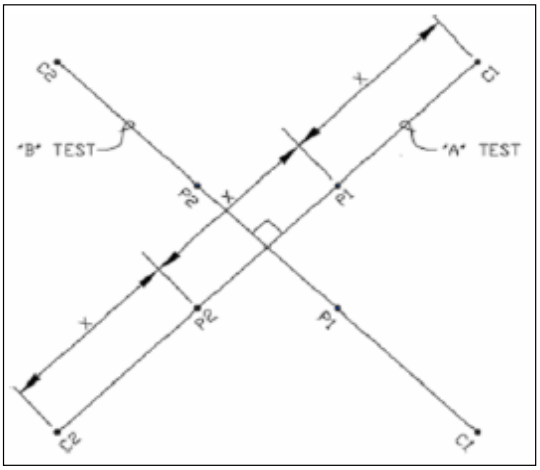
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	9.113	8.72	8.884	8.50			8.61
1	4	2	7.573	14.50	7.424	14.21			14.35
1.5	4	2	5.115	14.69	5.230	15.02			14.85
2.5	4	2	3.235	15.48	3.122	14.94			15.21
3	4	2	2.342	13.45	2.456	14.10			13.78
5	4	2	1.265	12.11	1.315	12.59			12.35
7	4	2	0.858	11.50	0.856	11.47			11.49
10	12	6	0.497	9.50	0.504	9.65			9.58
15	12	6	0.295	8.48	0.310	8.89			8.69
20	12	6	0.203	7.78	0.202	7.72			7.75
30	12	6	0.142	8.15	0.141	8.11			8.13
45	12+	6+	0.097	8.32	0.093	7.97			8.14
70	12+	6+	0.063	8.47	0.064	8.58			8.53
100	12+	6+	0.048	9.10	0.048	9.14			9.12

Notes:



Wenner Electrode Arrangement



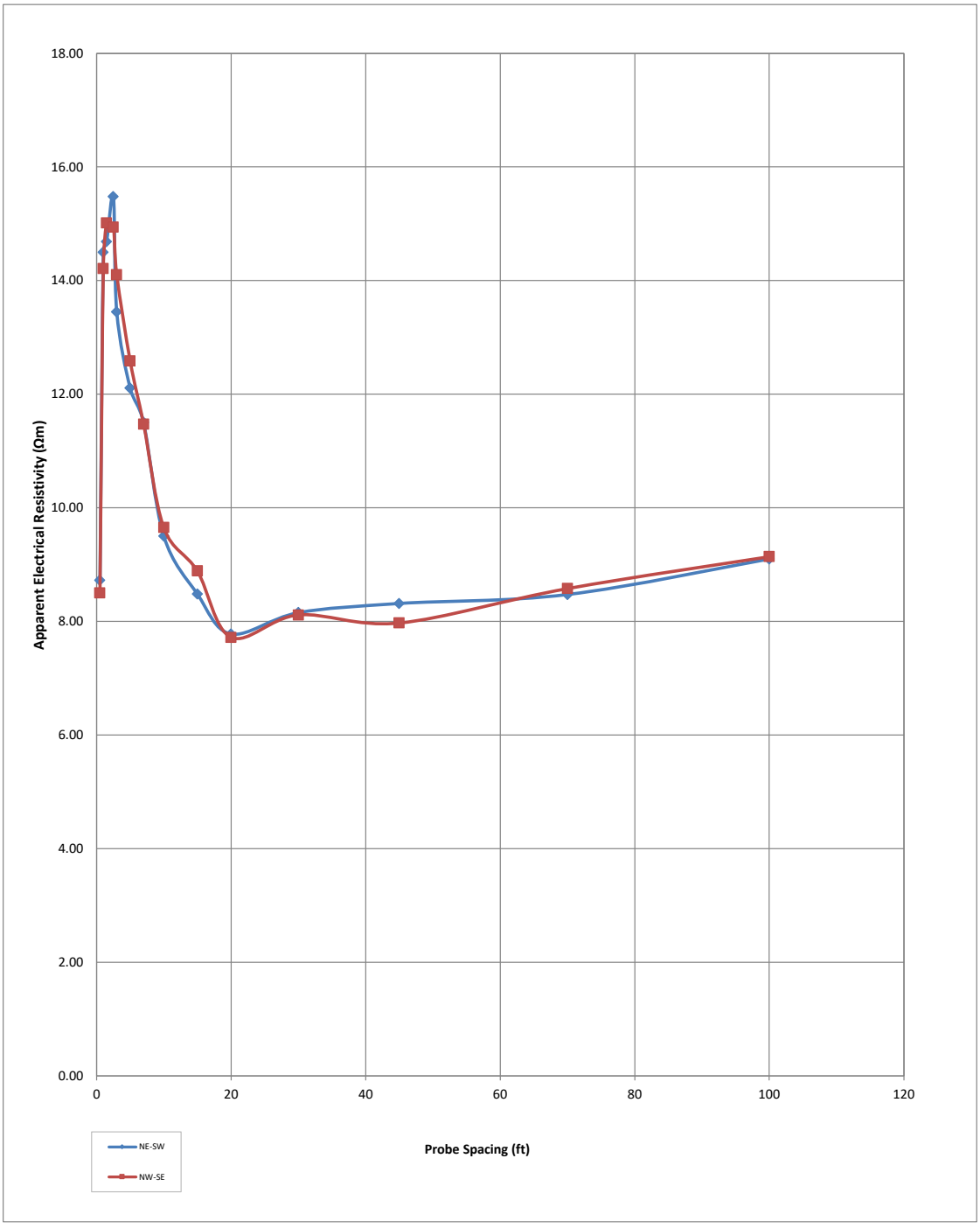


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-008



SOIL RESISTIVITY MEASURMENT DATA SHEET

0 GEO-010

DATE 5/14/2025

CLIENT ALLETE Renewable Resources, Inc.

PROJECT Longspur Wind **Project No.** GE2503026

LOCATION: Morton County, ND

LATITUDE : 46.921177

LONGITUDE : -101.821968

WEATHER: Partly Cloudy **Temp. (°F)** 69°F

TOP SOIL: Silt (ML), Brown, Dry

TYPE OF TEST : Wenner 4-Pin Method

EQUIPMENT: SuperSting

SERIAL NO. SS2106234

MODEL: R8

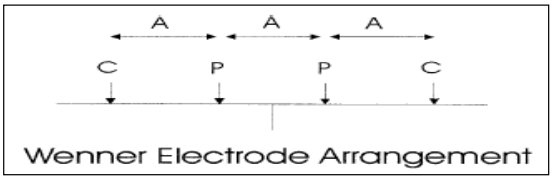
CALIBRATION DUE DATE: 1/28/2026

TEST PERFORMED BY : RRC

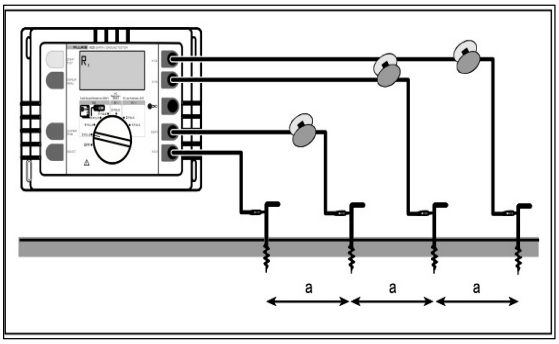
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhom

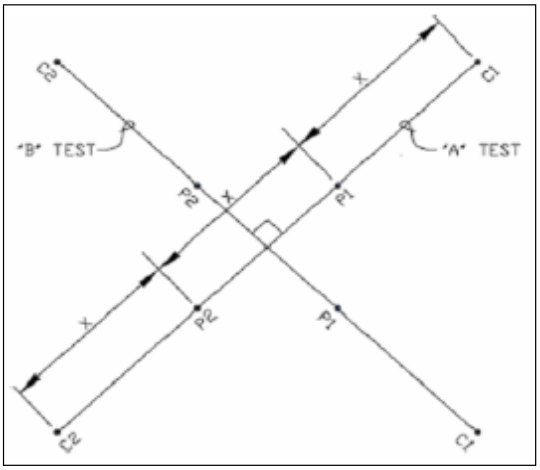
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	
0.5	4	2	12.540	12.00	13.430	12.85			12.43
1	4	2	9.440	18.07	9.272	17.75			17.91
1.5	4	2	7.432	21.34	7.343	21.08			21.21
2.5	4	2	5.435	26.01	5.453	26.09			26.05
3	4	2	4.692	26.94	4.529	26.01			26.48
5	4	2	3.356	32.12	3.524	33.73			32.92
7	4	2	2.536	33.98	2.426	32.51			33.24
10	12	6	1.675	32.06	1.623	31.07			31.56
15	12	6	1.056	30.32	1.032	29.63			29.98
20	12	6	0.743	28.44	0.734	28.11			28.28
30	12	6	0.455	26.11	0.452	25.95			26.03
45	12+	6+	0.279	24.06	0.297	25.62			24.84
70	12+	6+	0.159	21.26	0.153	20.45			20.86
100	12+	6+	0.103	19.75	0.092	17.69			18.72

Notes: Fence line at ~300 ft west of the profile center, going N-S.



Wenner Electrode Arrangement



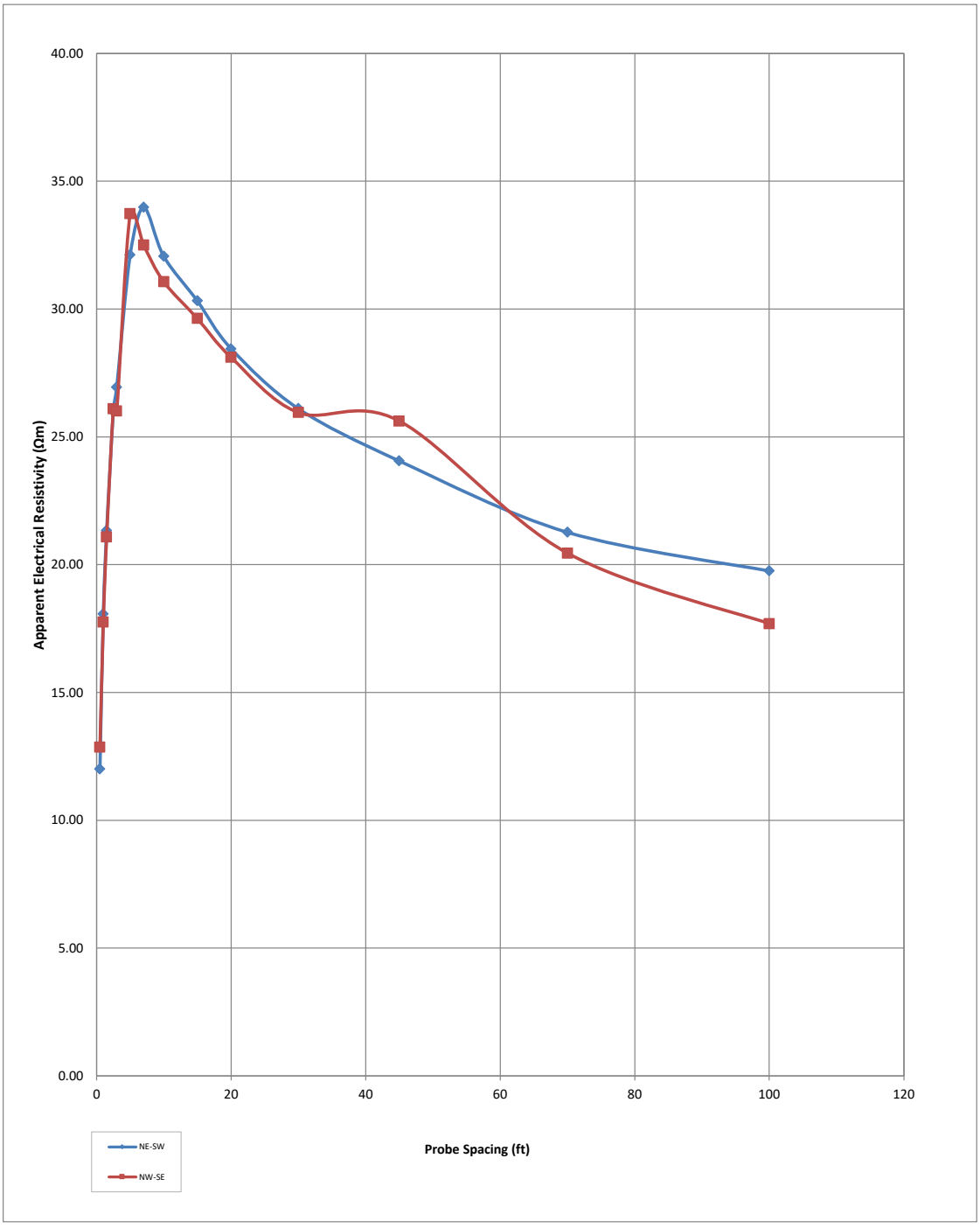


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-010



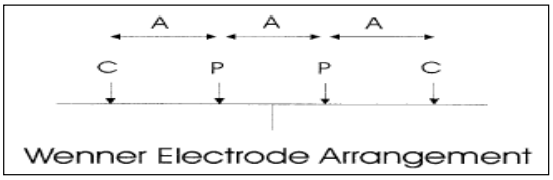
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-019
DATE 5/17/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.886393
LONGITUDE : -101.800325
WEATHER: Sunny
Temp. (°F) 49°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

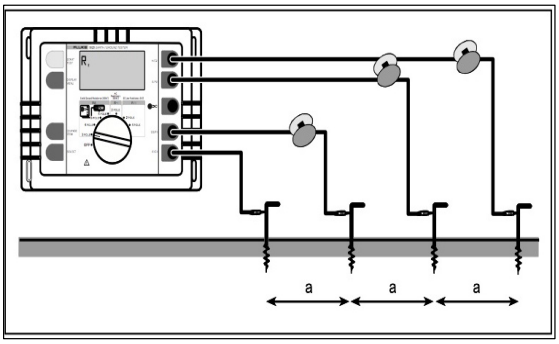
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhom

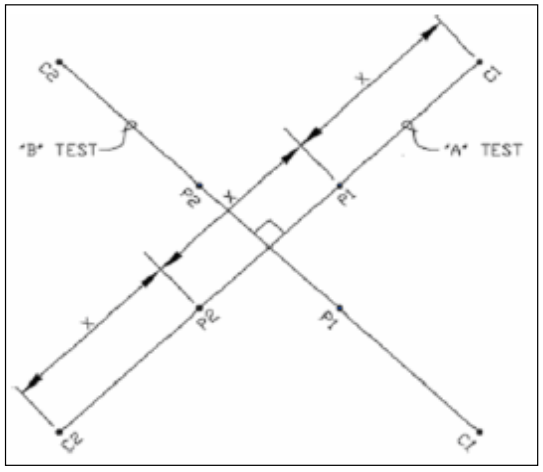
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	15.320	14.66	17.250	16.51			15.59
1	4	2	8.679	16.61	9.245	17.70			17.15
1.5	4	2	6.246	17.93	6.645	19.08			18.51
2.5	4	2	5.136	24.58	5.235	25.05			24.81
3	4	2	4.964	28.51	4.883	28.04			28.27
5	4	2	4.053	38.79	3.769	36.07			37.43
7	4	2	2.735	36.65	2.756	36.93			36.79
10	12	6	1.618	30.97	1.542	29.52			30.24
15	12	6	0.854	24.53	0.853	24.48			24.50
20	12	6	0.525	20.08	0.572	21.91			20.99
30	12	6	0.301	17.31	0.299	17.16			17.24
45	12+	6+	0.125	10.80	0.117	10.11			10.46
70	12+	6+	0.060	7.99	0.058	7.75			7.87
100	12+	6+	0.039	7.56	0.041	7.91			7.73

Notes: Powerlines at ~1800 ft north of the profile center, going E-W.



Wenner Electrode Arrangement



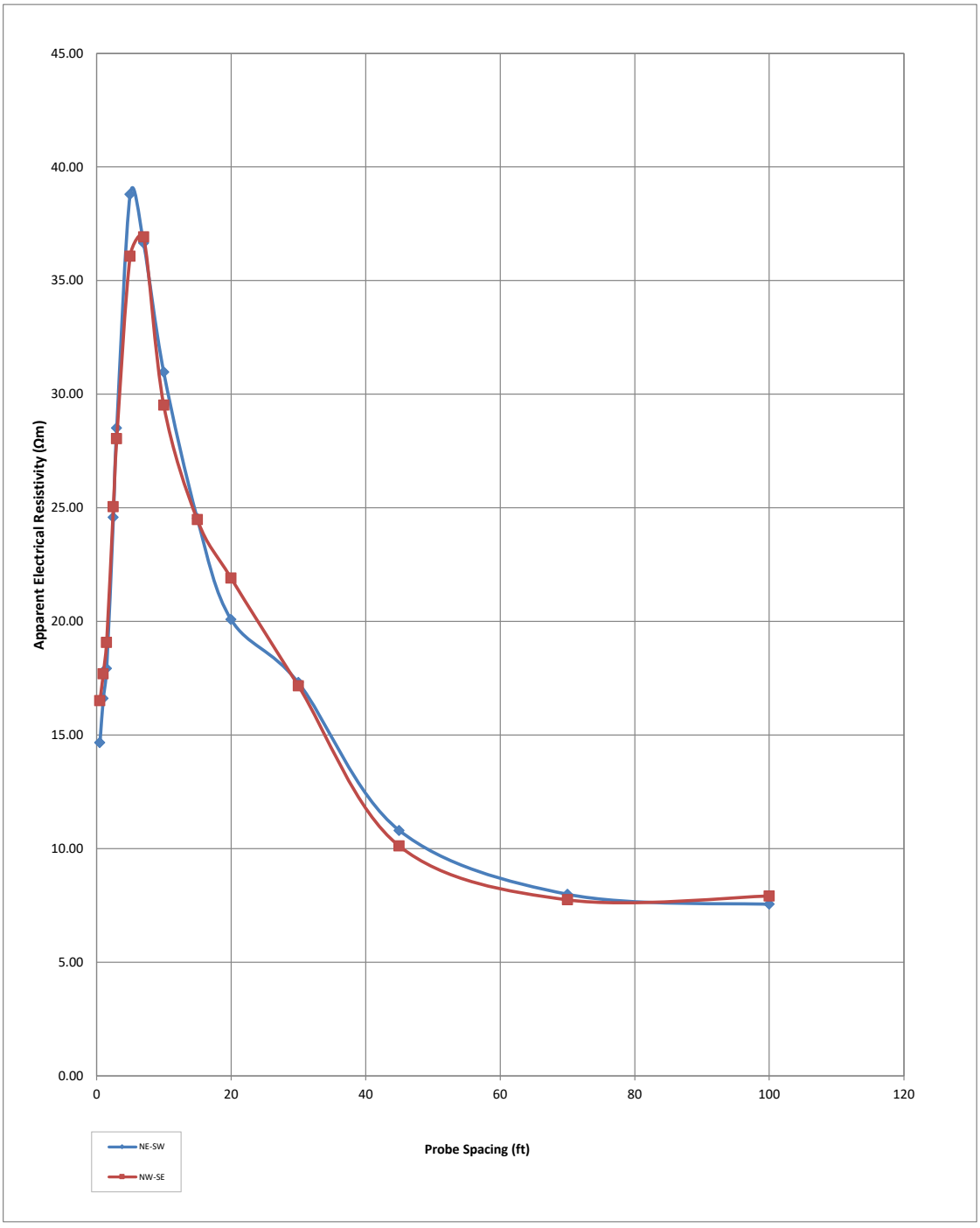


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-019



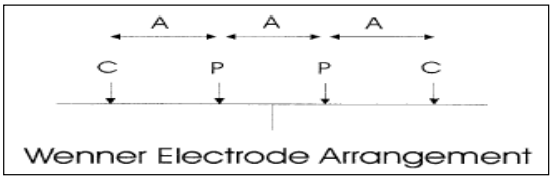
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-022
DATE 5/6/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.973121
LONGITUDE : -101.745487
WEATHER: Sunny
Temp. (°F) 65°F
TOP SOIL: Silty Clay, Brown, Dry-Moist
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

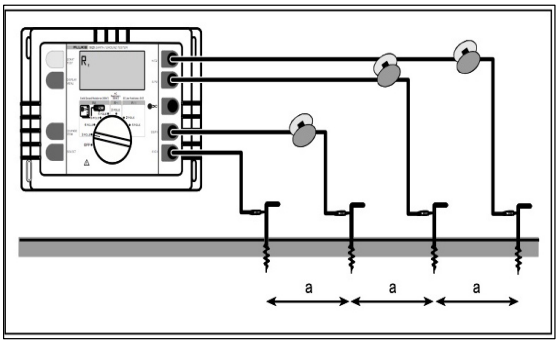
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

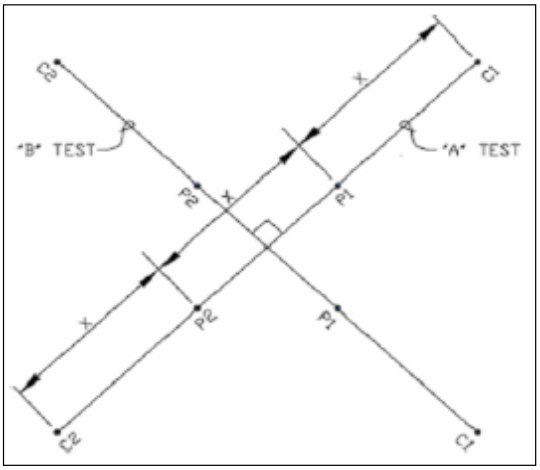
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	35.280	33.77	38.660	37.00			35.38
1	4	2	26.240	50.23	27.740	53.10			51.66
1.5	4	2	21.300	61.16	20.910	60.04			60.60
2.5	4	2	12.010	57.47	11.440	54.74			56.11
3	4	2	9.882	56.75	10.330	59.32			58.03
5	4	2	4.090	39.14	4.210	40.29			39.72
7	4	2	1.980	26.53	1.998	26.77			26.65
10	12	6	0.938	17.95	0.922	17.65			17.80
15	12	6	0.502	14.40	0.489	14.05			14.23
20	12	6	0.331	12.69	0.326	12.49			12.59
30	12	6	0.219	12.55	0.210	12.07			12.31
45	12+	6+	0.135	11.62	0.139	11.95			11.78
70	12+	6+	0.088	11.83	0.088	11.77			11.80
100	12+	6+	0.063	12.02	0.062	11.80			11.91

Notes: Fence line at ~300 ft east of the profile center, going N-S.



Wenner Electrode Arrangement



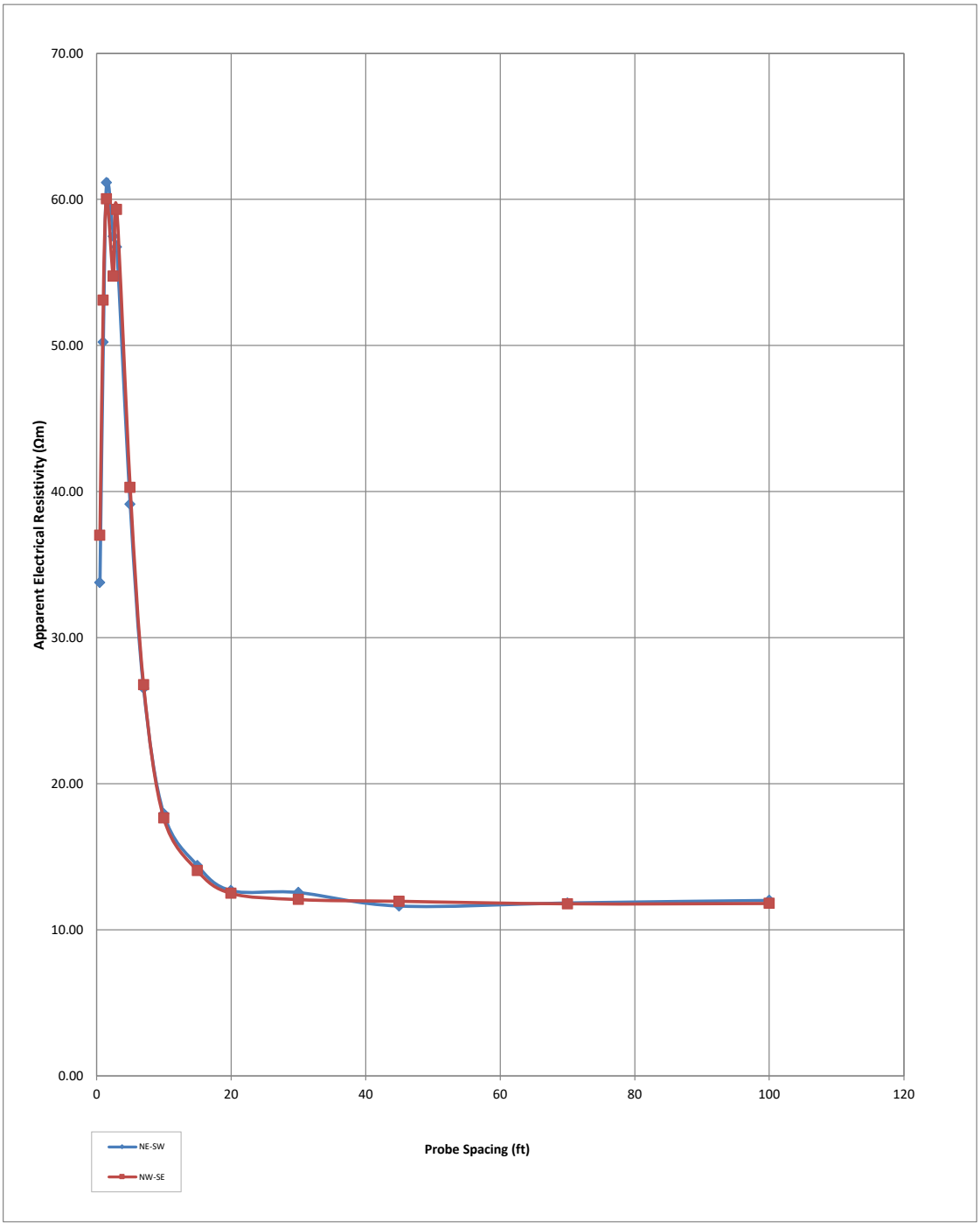


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-022



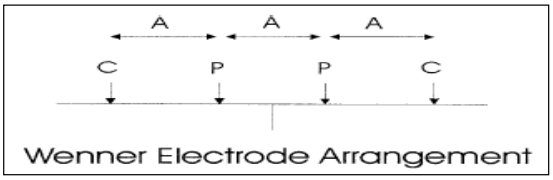
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-033
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.95389
LONGITUDE : -101.730973
WEATHER: Partly Cloudy
Temp. (°F) 42°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

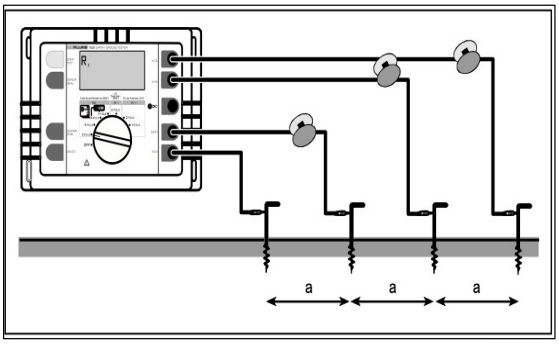
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

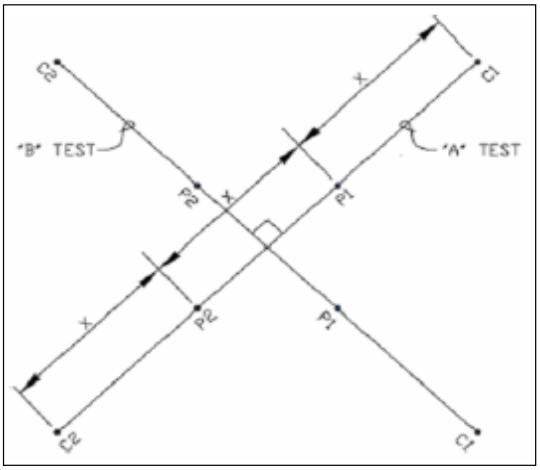
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	28.530	27.31	31.560	30.21			28.76
1	4	2	19.530	37.38	20.380	39.01			38.20
1.5	4	2	14.270	40.97	15.240	43.76			42.36
2.5	4	2	8.028	38.42	8.383	40.12			39.27
3	4	2	6.249	35.88	6.862	39.40			37.64
5	4	2	2.749	26.31	2.934	28.08			27.20
7	4	2	1.592	21.33	1.574	21.09			21.21
10	12	6	0.876	16.78	0.902	17.27			17.02
15	12	6	0.498	14.30	0.501	14.40			14.35
20	12	6	0.297	11.39	0.297	11.35			11.37
30	12	6	0.172	9.90	0.177	10.19			10.04
45	12+	6+	0.104	8.98	0.118	10.12			9.55
70	12+	6+	0.063	8.49	0.065	8.74			8.61
100	12+	6+	0.041	7.83	0.044	8.39			8.11

Notes:



Wenner Electrode Arrangement



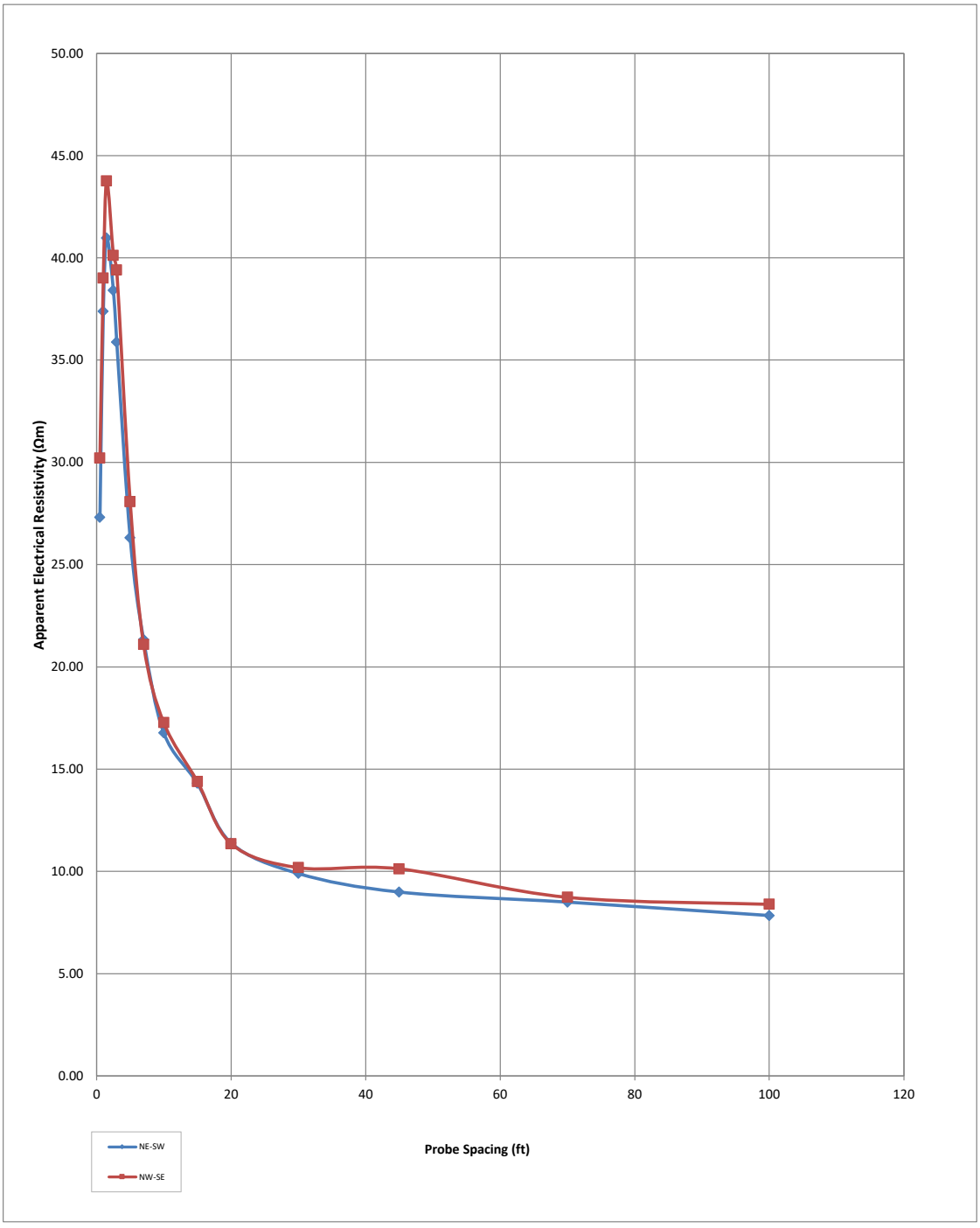


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-033



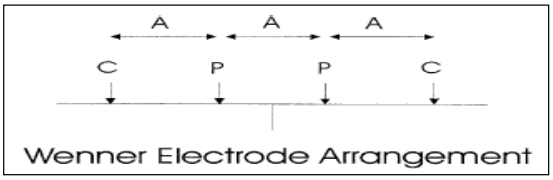
SOIL RESISTIVITY MEASURMENT DATA SHEET

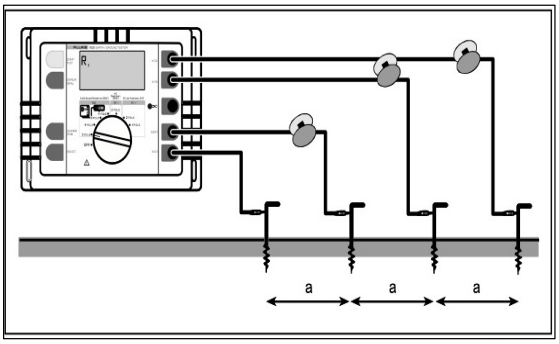
Survey ID GEO-046
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.932595
LONGITUDE : -101.787575
WEATHER: Sunny
Temp. (°F) 82°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

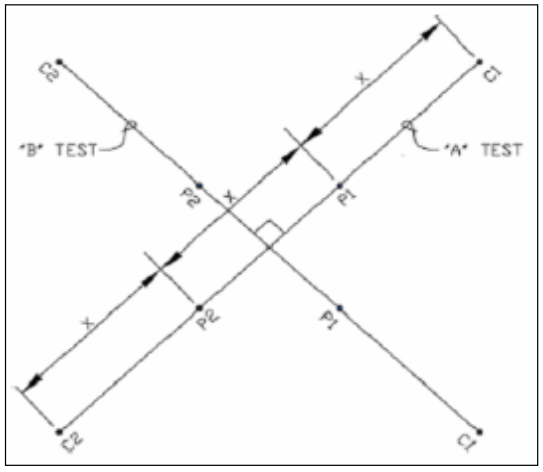
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	18.890	18.08	19.150	18.33			18.20
1	4	2	17.440	33.38	17.530	33.55			33.47
1.5	4	2	15.840	45.48	15.620	44.85			45.16
2.5	4	2	11.160	53.40	11.280	53.98			53.69
3	4	2	8.551	49.10	8.769	50.36			49.73
5	4	2	4.140	39.62	4.261	40.78			40.20
7	4	2	2.556	34.25	2.433	32.60			33.42
10	12	6	1.345	25.75	1.421	27.20			26.47
15	12	6	0.581	16.69	0.559	16.05			16.37
20	12	6	0.314	12.01	0.325	12.43			12.22
30	12	6	0.191	10.99	0.178	10.23			10.61
45	12+	6+	0.123	10.61	0.130	11.23			10.92
70	12+	6+	0.091	12.14	0.095	12.77			12.46
100	12+	6+	0.076	14.46	0.073	13.88			14.17

Notes:





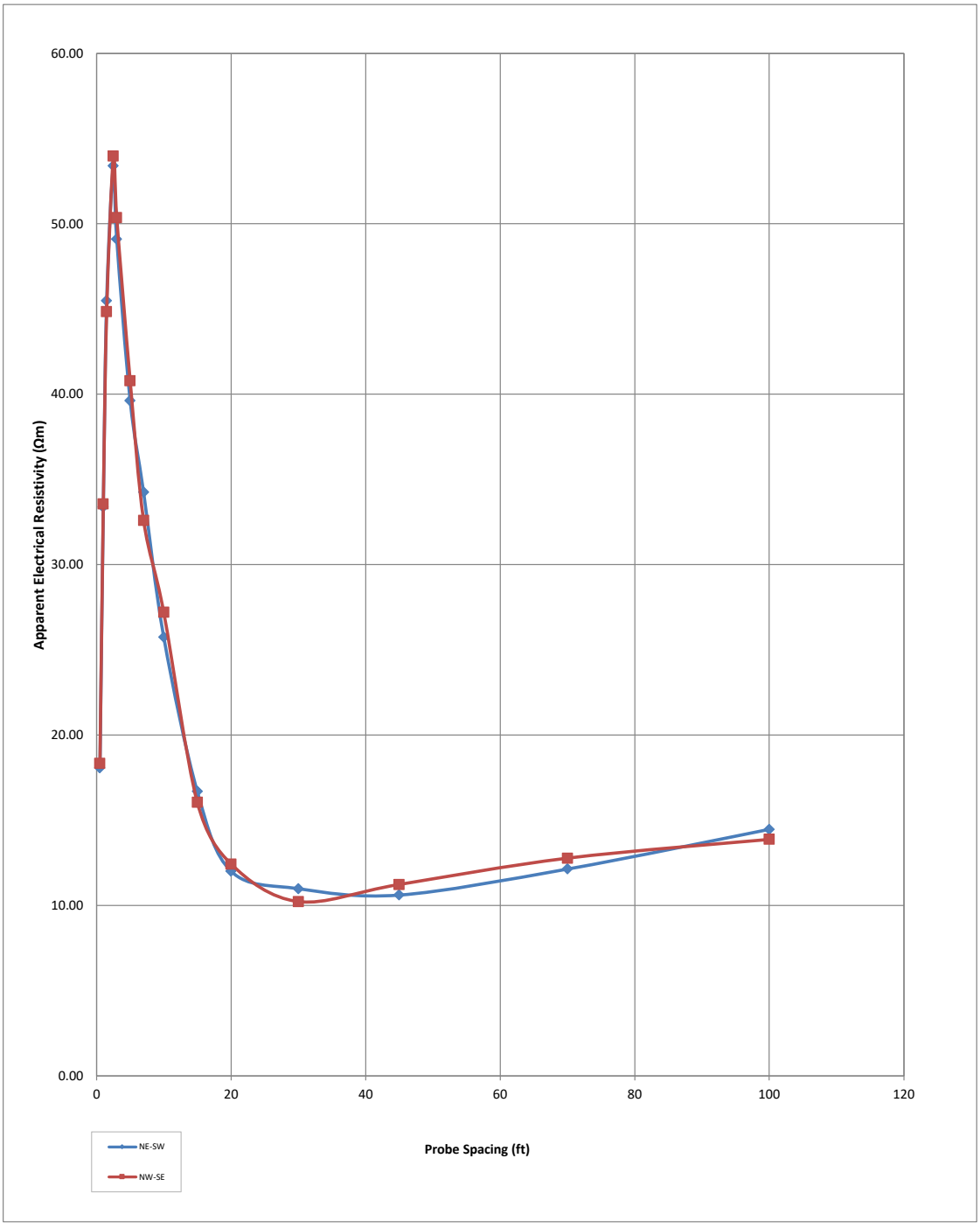


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-046



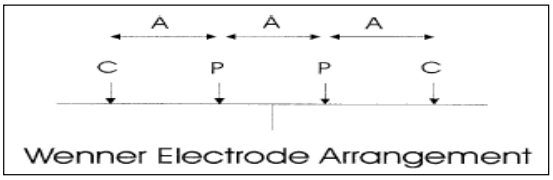
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-048
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.932595
LONGITUDE : -101.787575
WEATHER: Partly Cloudy
Temp. (°F) 82°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

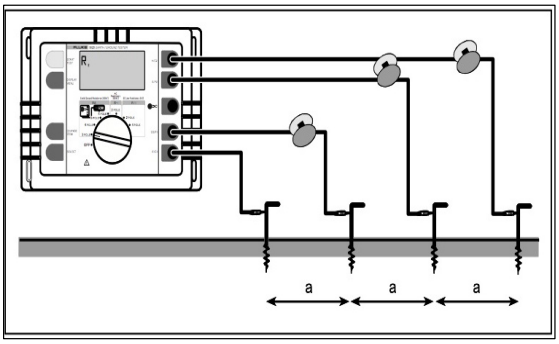
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

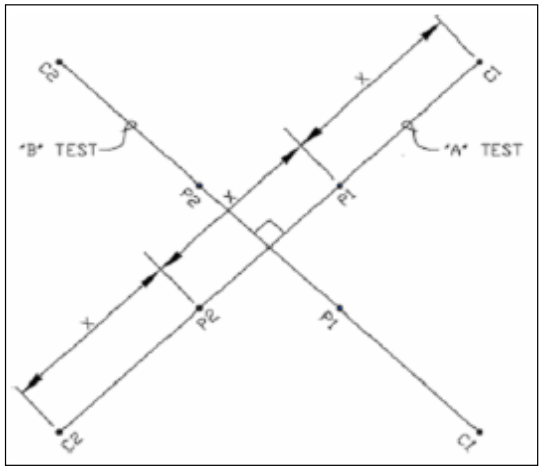
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	29.850	28.57	33.930	32.47			30.52
1	4	2	20.640	39.51	22.710	43.47			41.49
1.5	4	2	16.060	46.11	16.390	47.06			46.59
2.5	4	2	12.670	60.63	12.320	58.96			59.79
3	4	2	9.053	51.99	10.050	57.71			54.85
5	4	2	4.188	40.08	4.260	40.77			40.43
7	4	2	2.257	30.24	2.292	30.71			30.48
10	12	6	1.253	23.98	1.347	25.78			24.88
15	12	6	0.592	17.01	0.605	17.36			17.18
20	12	6	0.364	13.92	0.404	15.45			14.69
30	12	6	0.176	10.08	0.194	11.16			10.62
45	12+	6+	0.102	8.82	0.119	10.28			9.55
70	12+	6+	0.075	10.09	0.078	10.46			10.27
100	12+	6+	0.055	10.60	0.057	10.97			10.78

Notes:



Wenner Electrode Arrangement



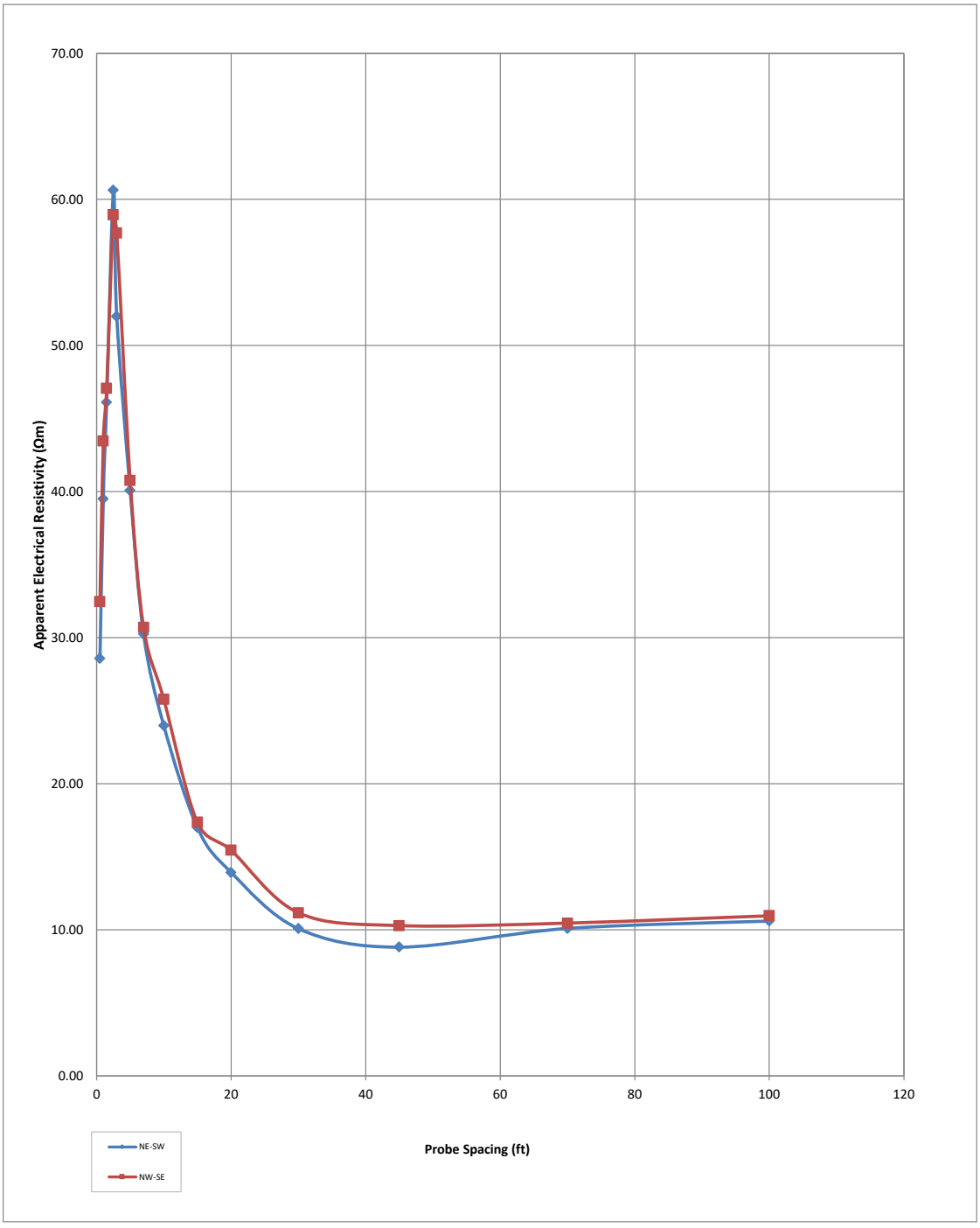


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-048



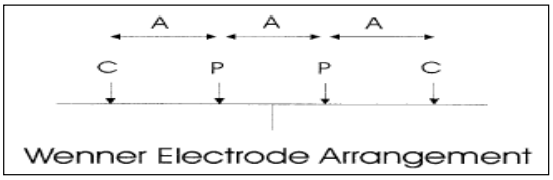
SOIL RESISTIVITY MEASURMENT DATA SHEET

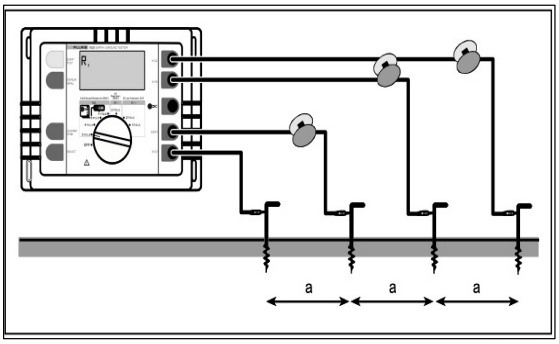
Survey ID GEO-053
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.932595
LONGITUDE : -101.787575
WEATHER: Partly Cloudy
Temp. (°F) 82°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

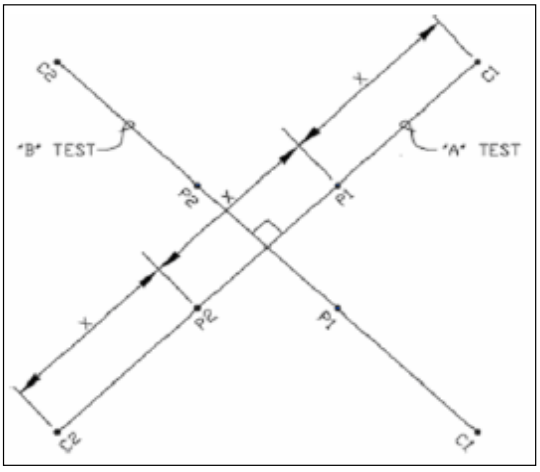
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	26.490	25.35	28.720	27.49			26.42
1	4	2	18.470	35.35	20.820	39.85			37.60
1.5	4	2	13.850	39.77	14.580	41.86			40.81
2.5	4	2	8.474	40.55	9.034	43.23			41.89
3	4	2	6.437	36.96	6.734	38.67			37.82
5	4	2	3.309	31.67	3.573	34.20			32.93
7	4	2	2.184	29.26	2.257	30.24			29.75
10	12	6	1.376	26.34	1.357	25.97			26.16
15	12	6	0.733	21.04	0.775	22.25			21.64
20	12	6	0.387	14.80	0.397	15.21			15.00
30	12	6	0.201	11.57	0.226	12.97			12.27
45	12+	6+	0.128	11.06	0.129	11.07			11.06
70	12+	6+	0.079	10.63	0.078	10.44			10.54
100	12+	6+	0.052	9.89	0.054	10.39			10.14

Notes: Powerlines at ~900 ft west of the profile center, going N-S.





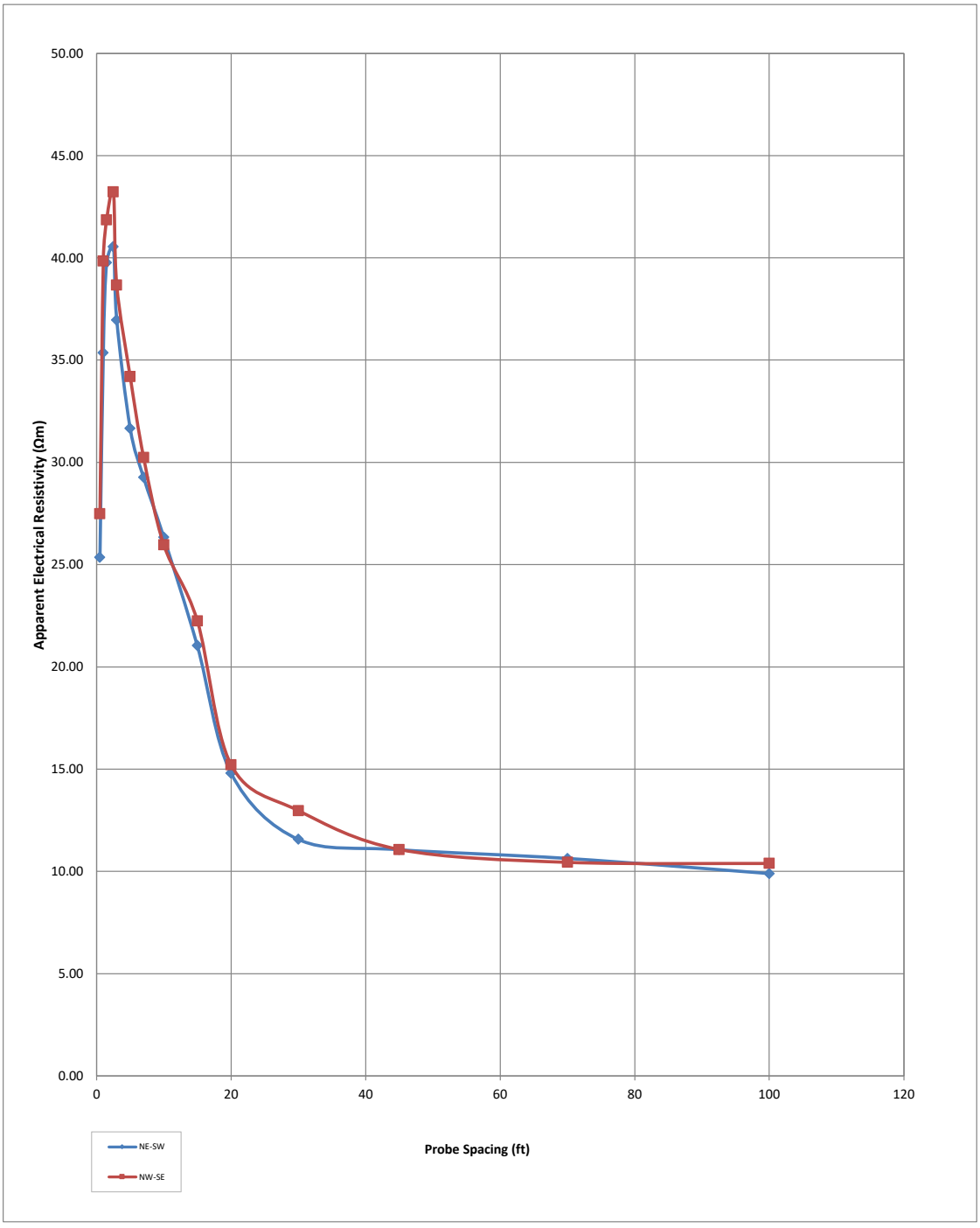


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-053



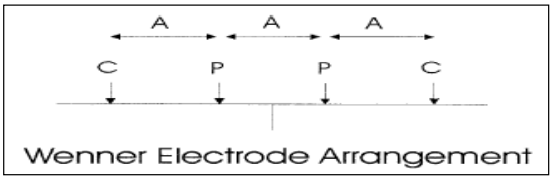
SOIL RESISTIVITY MEASURMENT DATA SHEET

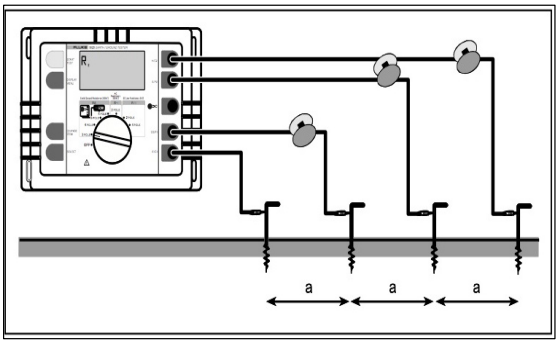
Survey ID GEO-059
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.911622
LONGITUDE : -101.695731
WEATHER: Sunny
Temp. (°F) 61°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

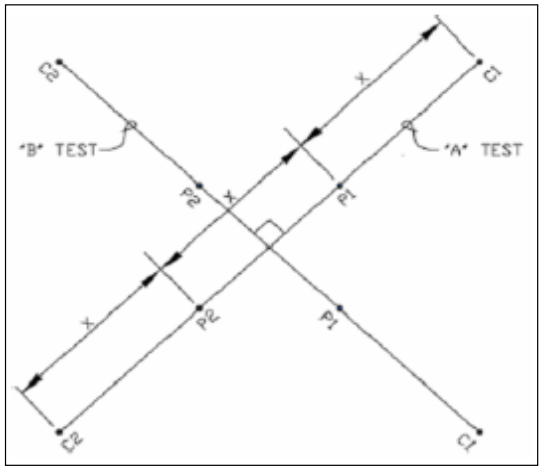
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	44.240	42.34	41.830	40.03			41.19
1	4	2	29.240	55.97	27.810	53.23			54.60
1.5	4	2	20.530	58.95	19.770	56.76			57.86
2.5	4	2	15.570	74.51	15.730	75.27			74.89
3	4	2	9.345	53.66	10.030	57.60			55.63
5	4	2	4.532	43.37	5.024	48.08			45.73
7	4	2	2.935	39.33	2.738	36.69			38.01
10	12	6	1.635	31.30	1.536	29.40			30.35
15	12	6	0.835	23.98	0.853	24.50			24.24
20	12	6	0.413	15.82	0.473	18.12			16.97
30	12	6	0.194	11.15	0.208	11.92			11.54
45	12+	6+	0.093	8.05	0.114	9.81			8.93
70	12+	6+	0.065	8.77	0.068	9.14			8.96
100	12+	6+	0.041	7.92	0.047	9.05			8.49

Notes:





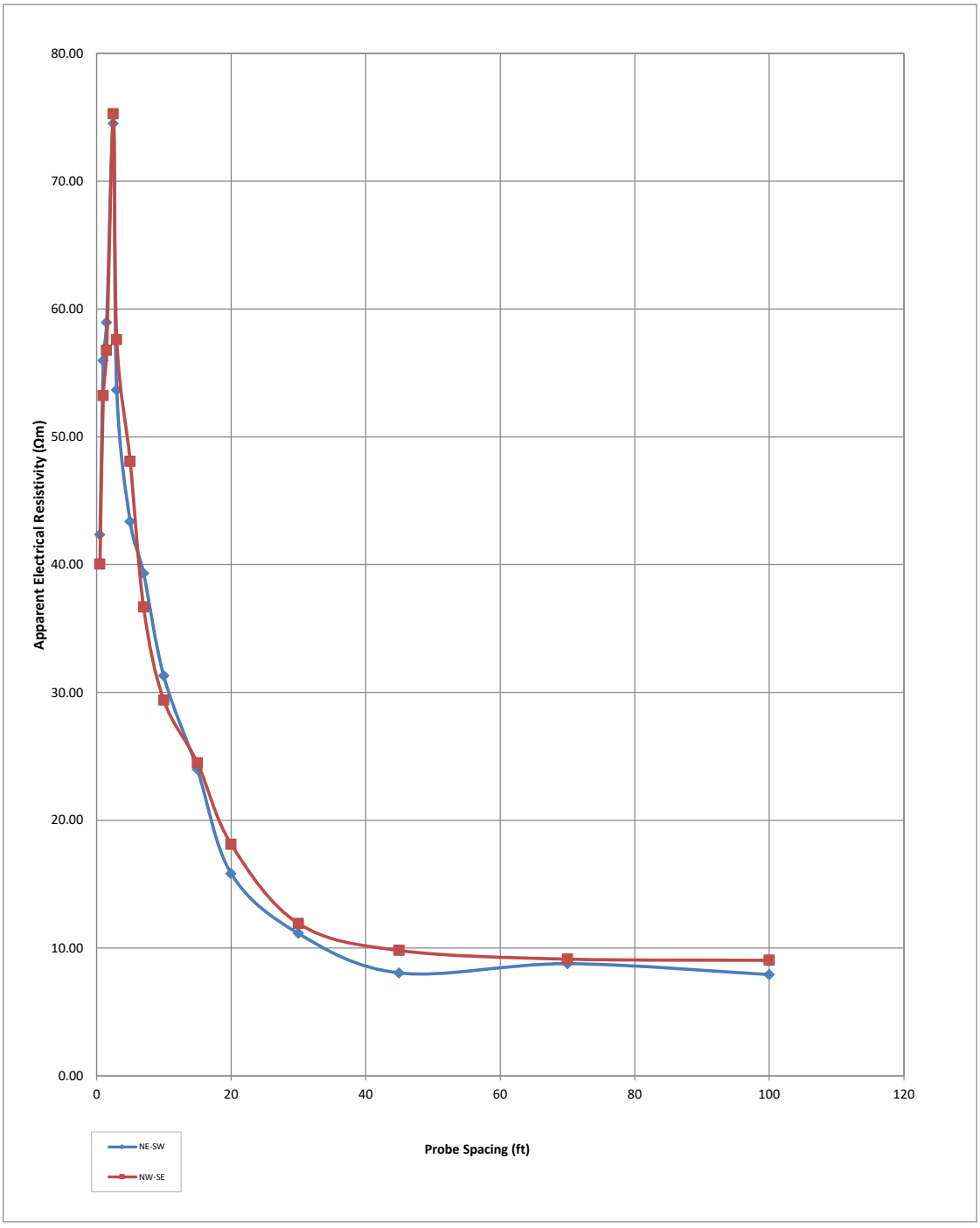


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-059



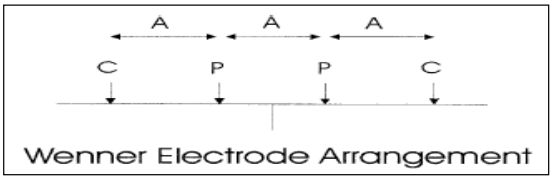
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID GEO-062
DATE 5/13/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.908306
LONGITUDE : -101.677064
WEATHER: Sunny
Temp. (°F) 59°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

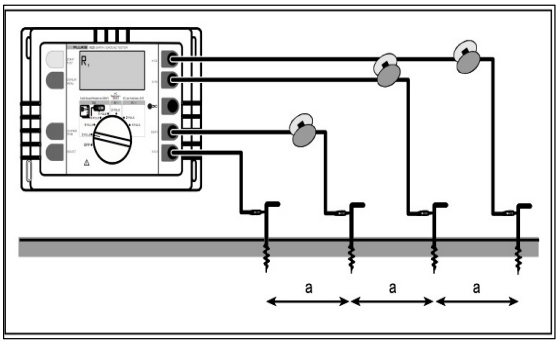
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

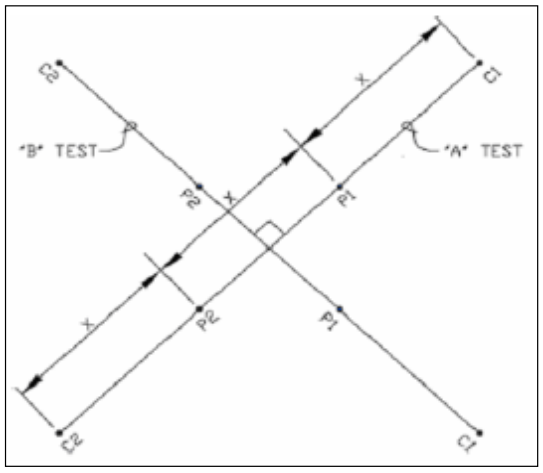
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	28.230	27.02	27.420	26.24			26.63
1	4	2	19.110	36.58	21.530	41.21			38.90
1.5	4	2	13.720	39.39	14.560	41.80			40.60
2.5	4	2	8.244	39.45	8.424	40.31			39.88
3	4	2	5.124	29.42	5.066	29.09			29.26
5	4	2	2.734	26.17	2.623	25.10			25.64
7	4	2	1.582	21.20	1.613	21.61			21.40
10	12	6	1.042	19.95	0.957	18.33			19.14
15	12	6	0.614	17.63	0.592	17.01			17.32
20	12	6	0.413	15.81	0.422	16.17			15.99
30	12	6	0.201	11.51	0.213	12.20			11.86
45	12+	6+	0.109	9.41	0.114	9.81			9.61
70	12+	6+	0.065	8.68	0.068	9.14			8.91
100	12+	6+	0.048	9.23	0.044	8.48			8.85

Notes: Powerlines at ~950 ft south of the profile center, going E-W.



Wenner Electrode Arrangement



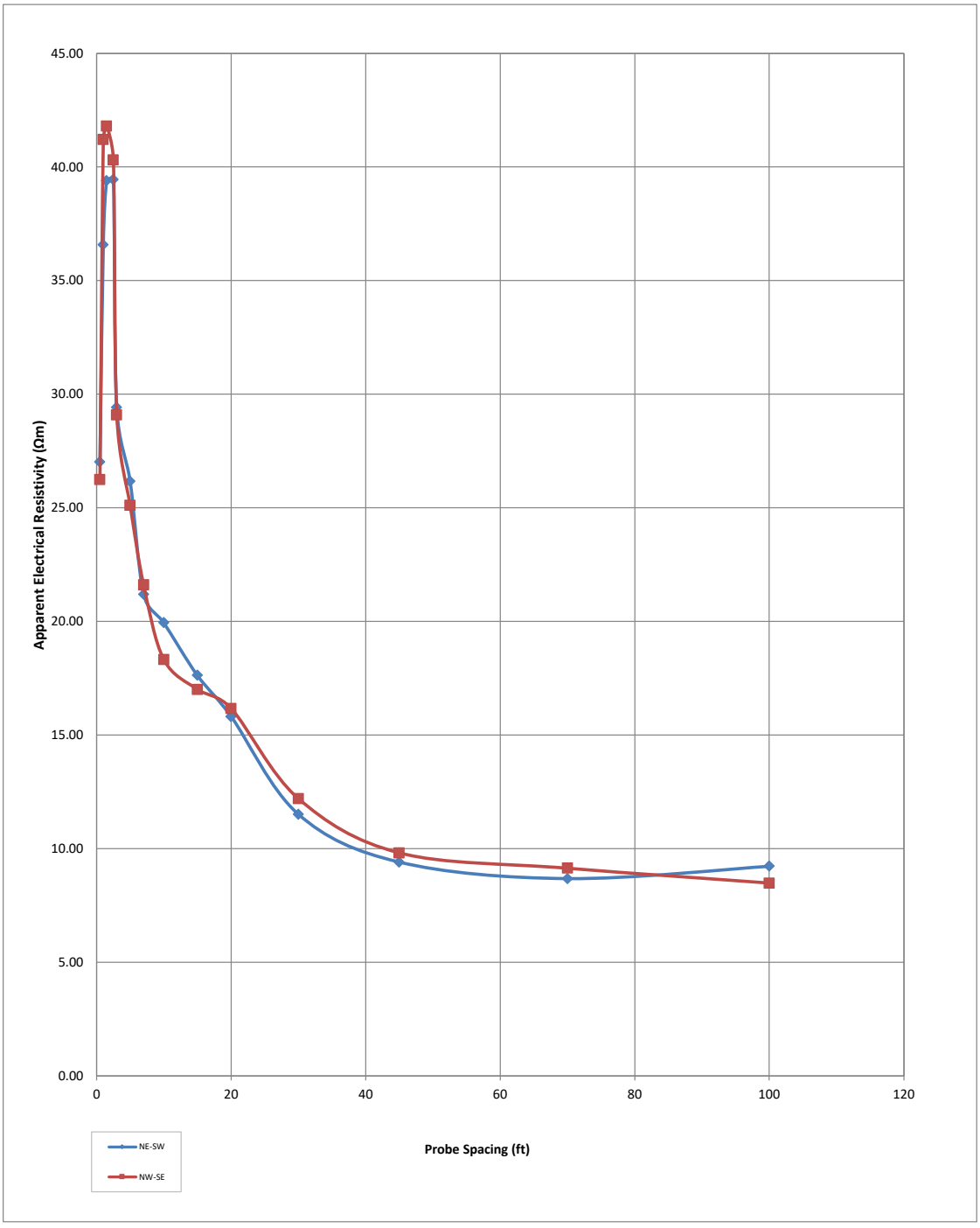


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-062



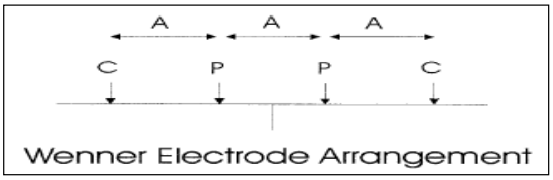
SOIL RESISTIVITY MEASURMENT DATA SHEET

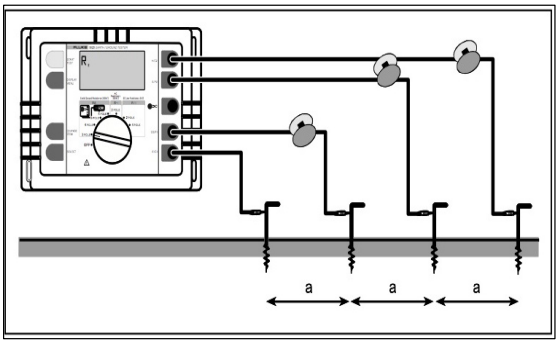
Survey ID GEO-067
DATE 5/17/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.897545
LONGITUDE : -101.664921
WEATHER: Sunny
Temp. (°F) 55°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

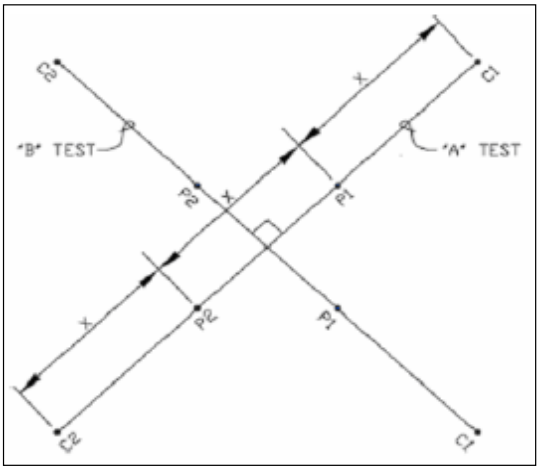
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	38.270	36.63	41.030	39.27			37.95
1	4	2	27.540	52.72	26.580	50.88			51.80
1.5	4	2	21.570	61.93	20.230	58.08			60.01
2.5	4	2	16.730	80.06	15.340	73.41			76.73
3	4	2	10.000	57.42	10.850	62.31			59.86
5	4	2	5.253	50.27	5.248	50.23			50.25
7	4	2	3.475	46.56	3.549	47.55			47.06
10	12	6	1.815	34.74	1.793	34.32			34.53
15	12	6	0.923	26.51	1.063	30.52			28.52
20	12	6	0.514	19.69	0.542	20.76			20.22
30	12	6	0.214	12.30	0.205	11.75			12.02
45	12+	6+	0.111	9.59	0.103	8.91			9.25
70	12+	6+	0.064	8.55	0.062	8.37			8.46
100	12+	6+	0.047	8.94	0.044	8.34			8.64

Notes: Fence line at ~350 ft north of the profile center, going E-W.





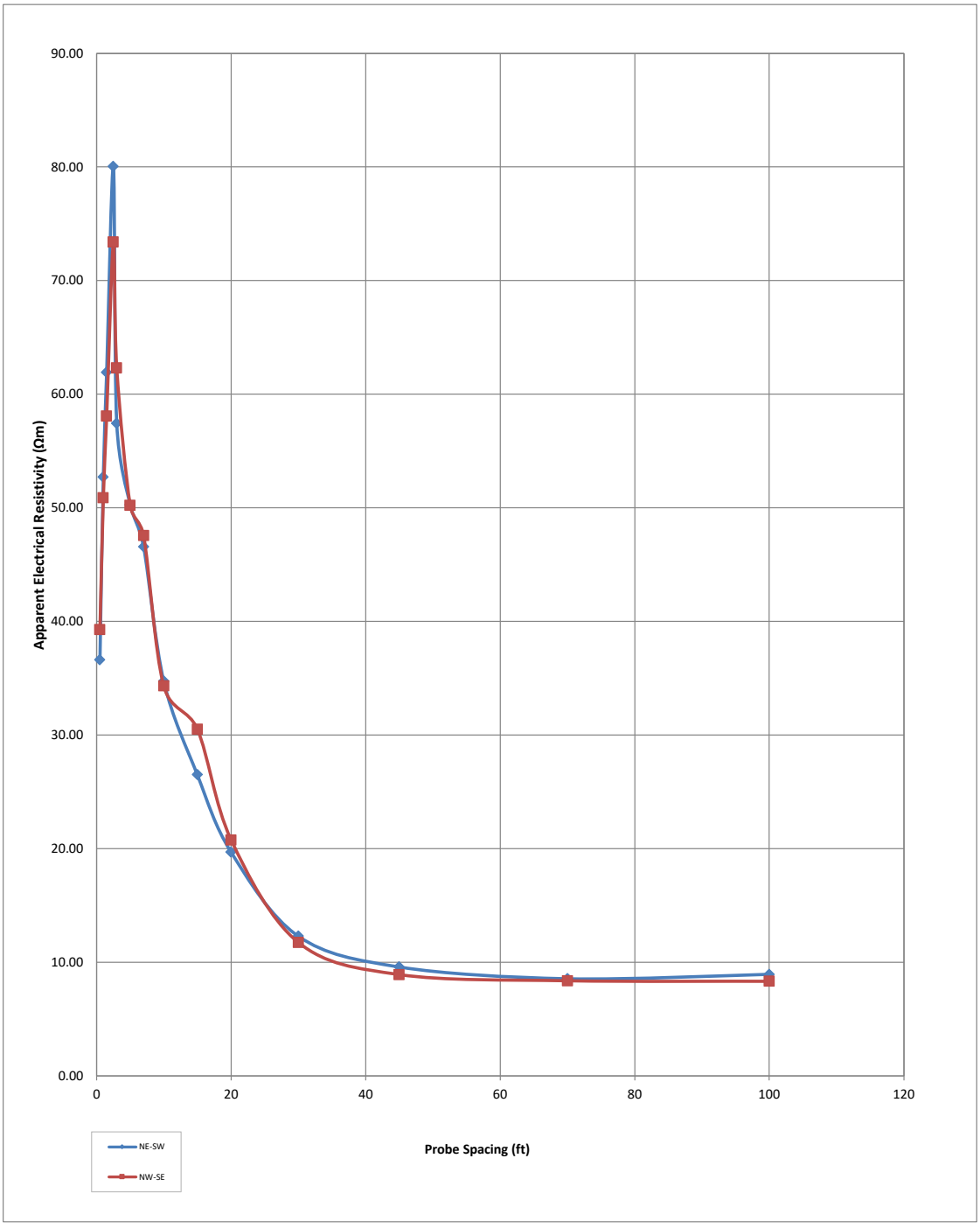


General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation: r=2*p*R*spacing*0.3048, where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind

Electrical Resistivity Survey at GEO-067



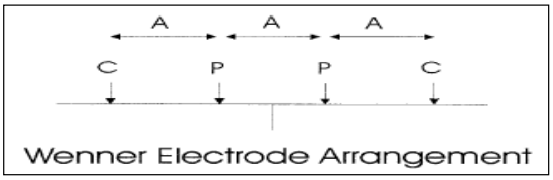
SOIL RESISTIVITY MEASURMENT DATA SHEET

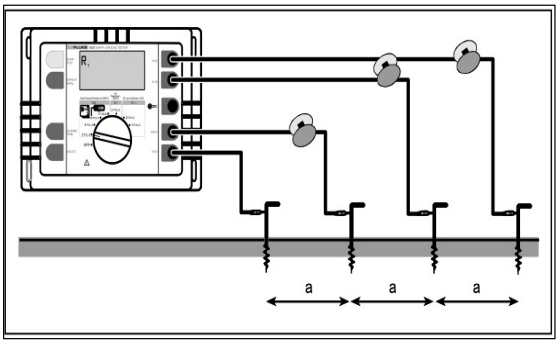
Survey ID GEO-070
DATE 5/11/2025
CLIENT ALLETE Renewable Resources, Inc.
PROJECT Longspur Wind
Project No. GE2503026
LOCATION: Morton County, ND
LATITUDE : 46.881276
LONGITUDE : -101.690209
WEATHER: Sunny
Temp. (°F) 97°F
TOP SOIL: Silt (ML), Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: SuperSting
SERIAL NO. SS2106234
MODEL: R8
CALIBRATION DUE DATE: 1/28/2026
TEST PERFORMED BY : RRC

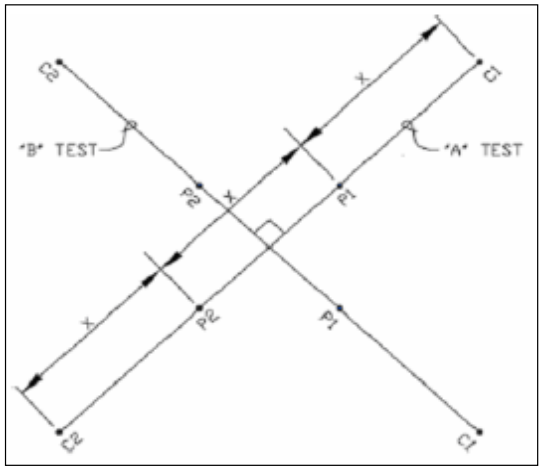
TEST SET RANGE
Meter Current: 1mA - 2000mA
Meter Resistance: 0.01Ohm - 19.99kOhom

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	8.899	8.52	9.018	8.63			8.57
1	4	2	7.183	13.75	7.281	13.94			13.84
1.5	4	2	5.038	14.47	5.162	14.82			14.64
2.5	4	2	2.963	14.18	3.010	14.40			14.29
3	4	2	2.246	12.90	2.307	13.25			13.07
5	4	2	1.250	11.96	1.382	13.23			12.60
7	4	2	0.843	11.29	0.812	10.87			11.08
10	12	6	0.537	10.28	0.544	10.42			10.35
15	12	6	0.337	9.66	0.311	8.93			9.30
20	12	6	0.215	8.25	0.211	8.09			8.17
30	12	6	0.135	7.76	0.138	7.94			7.85
45	12+	6+	0.093	8.03	0.095	8.20			8.12
70	12+	6+	0.060	8.06	0.059	7.91			7.98
100	12+	6+	0.042	8.11	0.042	7.97			8.04

Notes: Powerlines at ~2500 ft south of the profile center, going E-W.





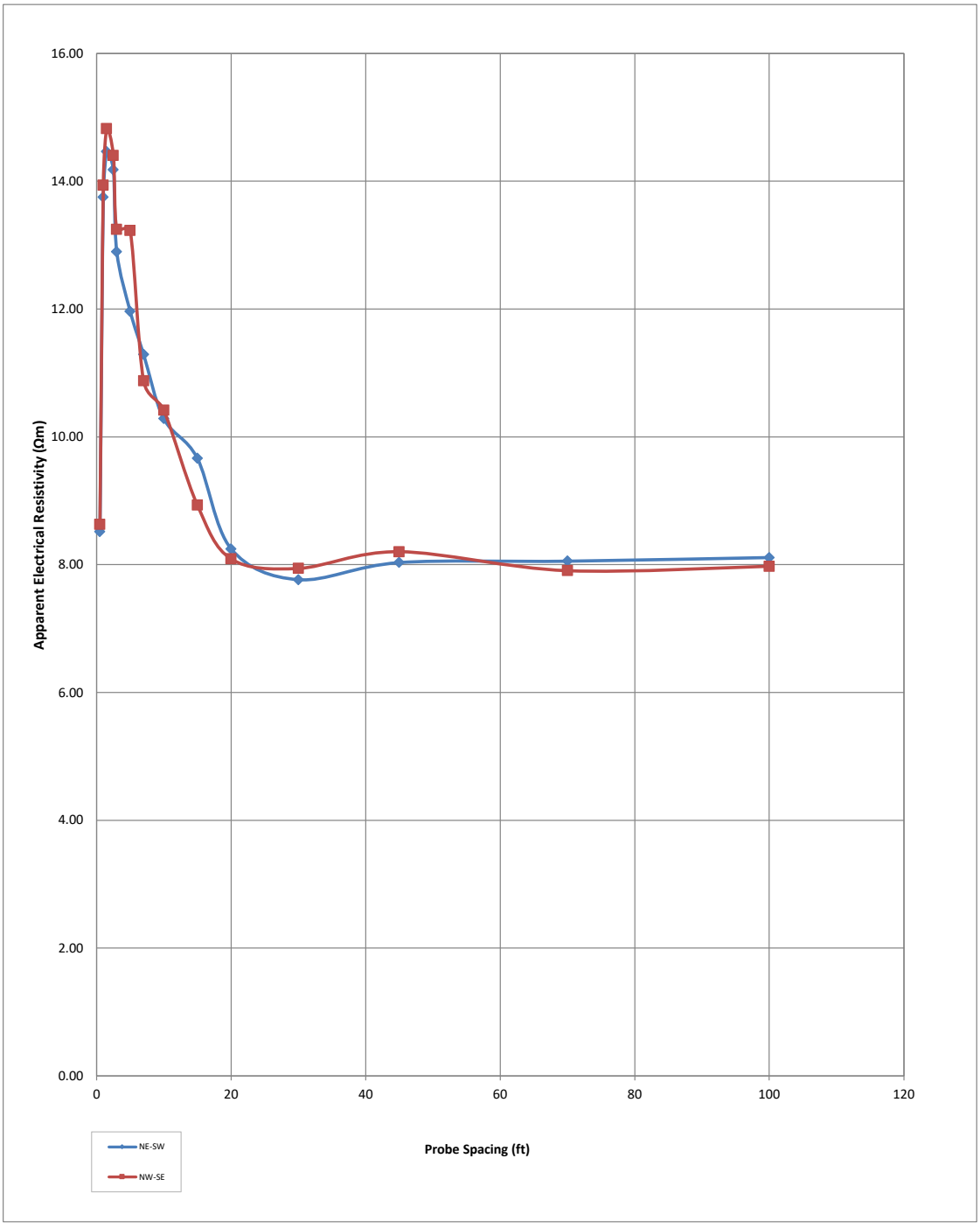


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Longspur Wind

Electrical Resistivity Survey at GEO-070



Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Soil Thermal Resistivity Sample & Testing Summary
Longspur Wind Project (PN: GE2503026)

Boring	*Depth*	*Percent Passing #200 Sieve*	*Maximum Dry Density (ASTM D698)*	*Optimum Water Content (ASTM D698)*	*LL*	*PL*	*PI*
	ft	*%*	*pcf*	*%*			
GEO-001	2-4	99.5	99.5	22.2	63	22	41
GEO-008	2-4	98.8	107.0	18.2	57	19	38
GEO-010	2-4	90.7	92.4	27.6	71	24	47
GEO-019	2-4	96.5	111.8	16.3	30	18	12
GEO-022	2-4	36.8	115.6	12.7	22	16	6
GEO-033	2-4	97.7	100.4	20.8	61	19	42
GEO-046	2-4	84.0	112.1	15.4	41	18	23
GEO-048	2-4	96.2	99.1	20.7	71	23	48
GEO-053	2-4	93.2	103.1	19.5	54	19	35
GEO-059	2-4	97.9	104.8	20.2	54	20	34
GEO-062	2-4	49.0	113.9	12.3	26	18	8
GEO-067	2-4	97.4	105.9	18.1	43	21	22
GEO-070	2-4	98.7	100.6	20.8	61	20	41
SUB-2	2-4	51.2	116.1	13.7	37	14	23

Boring	*Depth*	*Soil Type (USCS)*
GEO-001	2-4	Fat Clay (CH)
GEO-008	2-4	Fat Clay (CH)
GEO-010	2-4	Fat Clay (CH)
GEO-019	2-4	Lean Clay (CL)
GEO-022	2-4	Silty, Clayey Sand (SC-SM)
GEO-033	2-4	Fat Clay (CH)
GEO-046	2-4	Lean Clay with Sand (CL)
GEO-048	2-4	Fat Clay (CH)
GEO-053	2-4	Fat Clay (CH)
GEO-059	2-4	Fat Clay (CH)
GEO-062	2-4	Clayey Sand (SC)
GEO-067	2-4	Lean Clay (CL)
GEO-070	2-4	Fat Clay (CH)
SUB-2	2-4	Sandy Lean Clay (CL)

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Round Rock, TX 78664
(512) 358-6048

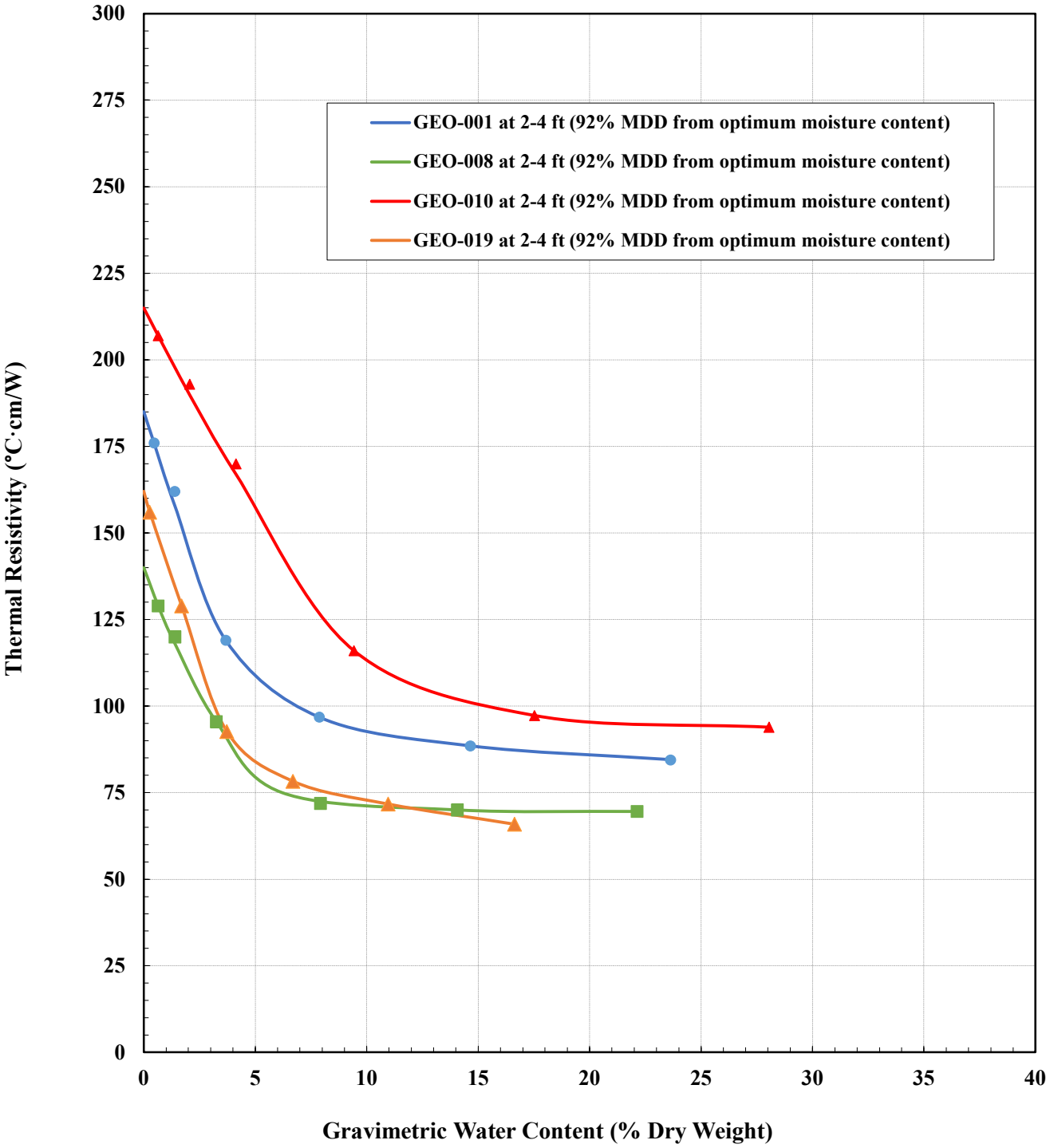
Soil Thermal Resistivity Sample & Testing Summary
Longspur Wind Project (PN: GE2503026)

Remolded Samples						
Boring	*Remold Water Content*	*Percent Compaction*	*Target Remold Dry Density*	*Actual Remold Dry Density*	*Thermal Resistivity at Wet (IEEE 442)*	*Thermal Resistivity at Dry (IEEE 442)*
	%	*%*	*pcf*	*pcf*	*°C-cm/W*	*°C-cm/W*
GEO-001	23.6	92	91.5	92.2	85	185
GEO-008	22.1		98.4	100.0	70	140
GEO-010	28.1		85.0	85.2	94	215
GEO-019	16.6		102.9	103.2	66	162
GEO-022	16.6		106.4	106.9	48	126
GEO-033	20.3		92.4	93.3	83	165
GEO-046	15.8		103.1	103.8	64	136
GEO-048	22.4		91.2	92.2	84	172
GEO-053	19.7		94.9	95.6	85	168
GEO-059	21.0		96.4	97.1	76	145
GEO-062	12.7		104.8	105.0	62	162
GEO-067	18.1		97.4	98.1	73	158
GEO-070	20.6		92.6	93.9	79	169
SUB-2	14.0		106.8	107.5	58	125

HuaMiao Cao, P.E., 6/3/25
Analysis & Quality Review/Date

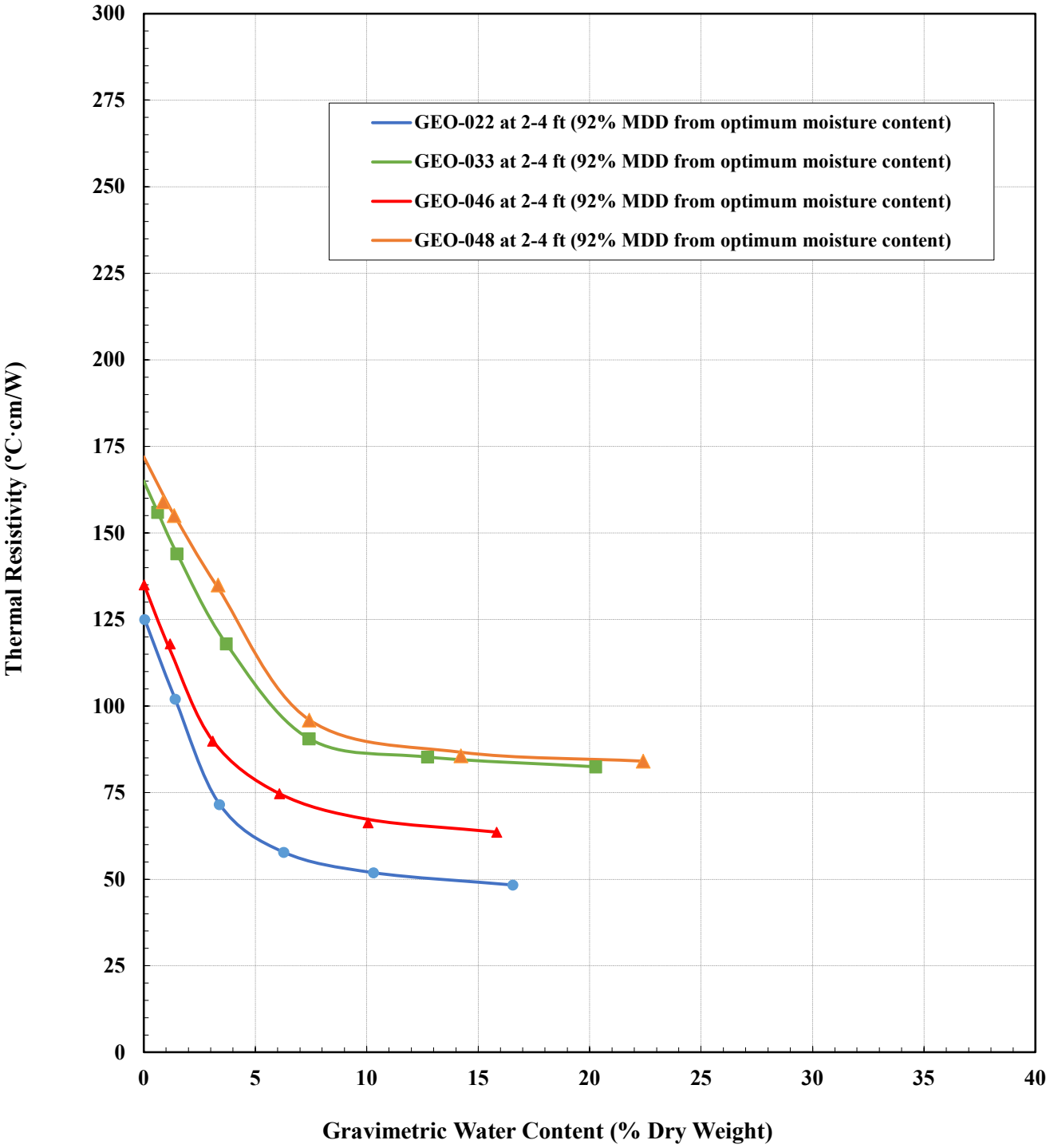
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Soil Thermal Resistivity Testing Dryout Curves
Longspur Wind Project (PN: GE2503026)



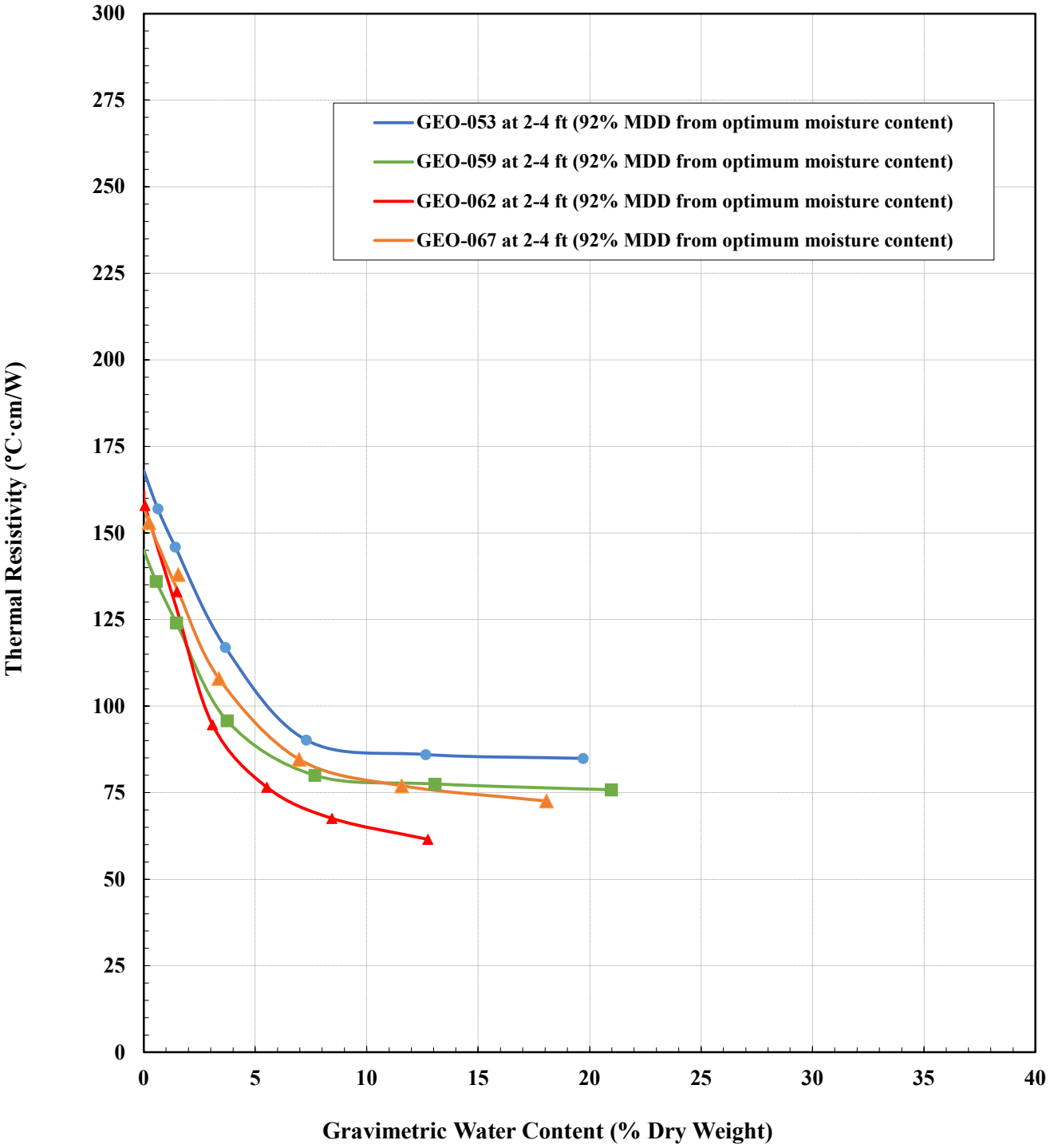
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Soil Thermal Resistivity Testing Dryout Curves
Longspur Wind Project (PN: GE2503026)



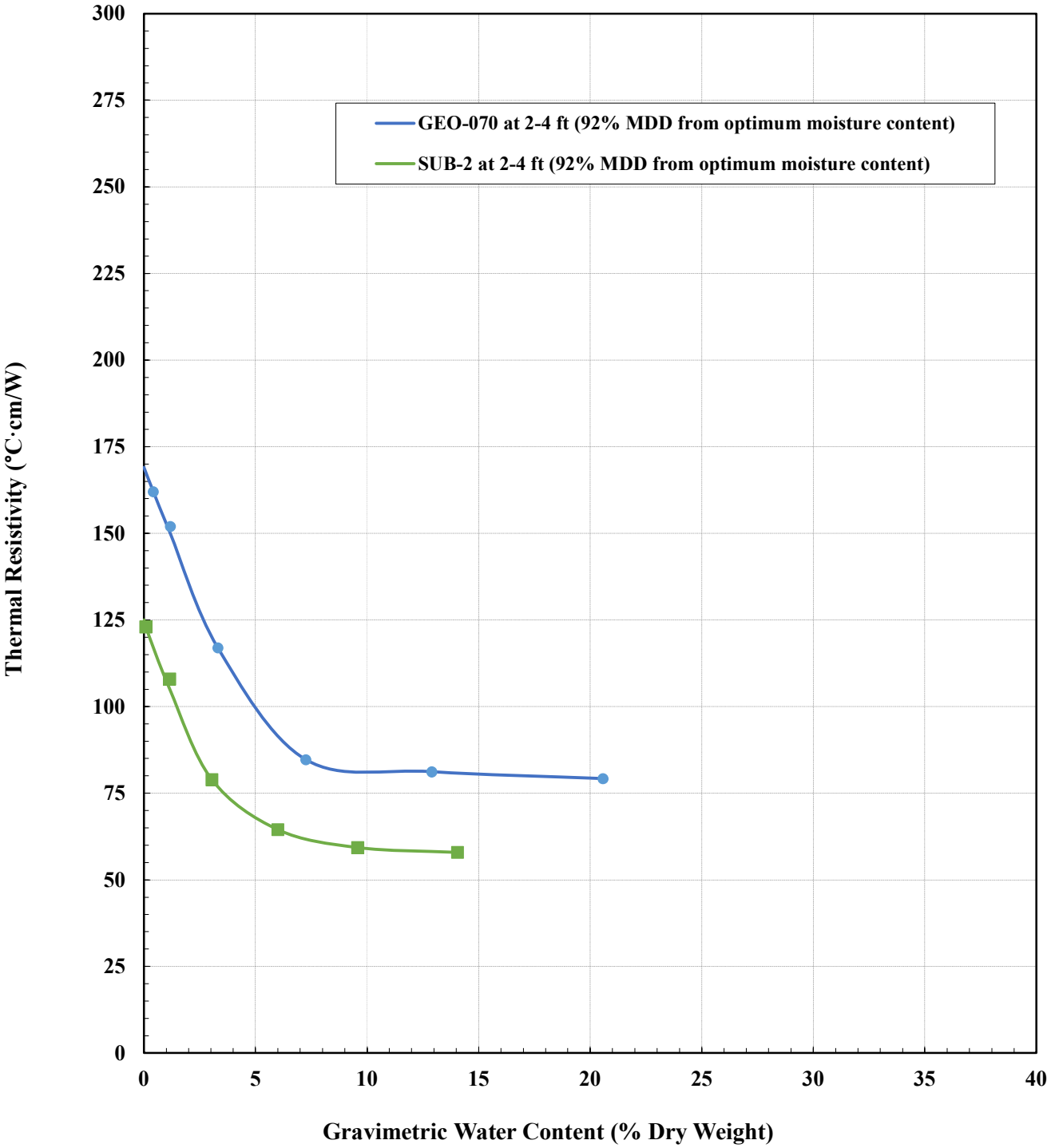
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Soil Thermal Resistivity Testing Dryout Curves
Longspur Wind Project (PN: GE2503026)



Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Soil Thermal Resistivity Testing Dryout Curves
Longspur Wind Project (PN: GE2503026)



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Round Rock, TX 78661
512.992.2087

APPENDIX D

Table D1.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-1

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 4	Sand (Reese)	25	--	110	--	31	--	--	--	--	--
3	4 to 7	Sand (Reese)	90	--	110	--	35	--	--	--	--	--
4	7 to 12	Sand (Reese)	60	--	58	--	33	--	--	--	--	--
5	12 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	67.6	3,450	--	0.005	--	--	--	--
10	34 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,050	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D1.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-1

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 4	SM	110	31	--	--	3.12	6	0.6	90	2,400
3	4 to 7	SP	110	35	--	--	3.69	30	2.9	350	6,400
4	7 to 12	SP	58	33	--	--	3.39	16	1.5	370	6,400
5	12 to 14	SC	63	35	--	--	3.69	30	2.9	590	10,300
6	14 to 19	SC	63	35	--	--	3.69	40	3.9	720	10,300
7	19 to 24	SC	63	35	--	--	3.69	38	3.7	770	10,300
8	24 to 29	CL	68	--	5,980	--	3.04	73	4.2	1,070	10,300
9	29 to 34	CL	68	--	3,450	--	3.04	26	2.2	740	10,300
10	34 to 40	CL	68	--	5,050	--	3.04	38	2.8	930	15,100

Table D1.3 – Grout Anchor Design Parameters for SUB-1

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	SM	9
3	4 to 7	SP	15
4	7 to 12	SP	12
5	12 to 14	SC	15
6	14 to 19	SC	18
7	19 to 24	SC	17
8	24 to 29	CL	21
9	29 to 34	CL	12
10	34 to 40	CL	18

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D2.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-2

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	920	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	58	--	33	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	58	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,450	--	0.005	--	--	--	--
9	34 to 39	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--
10	39 to 40	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D2.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	920	--	3.04	7	--	0	2,000
2	3 to 7	CL	120	--	920	--	3.04	7	1.0	200	2,000
3	7 to 9	SP	58	33	--	--	3.39	16	1.5	350	6,400
4	9 to 14	SC	63	35	--	--	3.69	27	2.6	550	10,800
5	14 to 19	SC	63	35	--	--	3.69	39	3.8	730	15,600
6	19 to 24	SP	58	35	--	--	3.69	40	3.9	800	16,000
7	24 to 29	SC	63	35	--	--	3.69	85	8.3	1,220	16,300
8	29 to 34	CL	68	--	5,450	--	3.04	41	2.9	980	16,300
9	34 to 39	SC	63	35	--	--	3.69	51	5.0	1,090	18,000
10	39 to 40	SC	63	35	--	--	3.69	45	4.4	1,060	18,000

Table D2.3 – Grout Anchor Design Parameters for SUB-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 9	SP	12
4	9 to 14	SC	14
5	14 to 19	SC	17
6	19 to 24	SP	18
7	24 to 29	SC	29
8	29 to 34	CL	19
9	34 to 39	SC	20
10	39 to 40	SC	19

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D3.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-3

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	790	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	33	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	3,850	--	0.005	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	4,390	--	0.005	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D3.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	CL	120	--	790	--	3.04	6	0.9	170	1,700
3	7 to 9	SC	63	33	--	--	3.39	14	1.3	330	5,600
4	9 to 14	SC	63	35	--	--	3.69	28	2.7	560	11,200
5	14 to 19	SC	63	35	--	--	3.69	33	3.2	680	11,500
6	19 to 24	SC	63	35	--	--	3.69	44	4.3	840	11,500
7	24 to 29	CL	68	--	3,850	--	3.04	29	2.4	790	11,500
8	29 to 34	CL	68	--	4,390	--	3.04	33	2.6	860	13,100
9	34 to 39	CL	68	--	5,980	--	3.04	50	3.3	1,070	17,900
10	39 to 40	CL	68	--	5,980	--	3.04	79	4.4	1,070	17,900

Table D3.3 – Grout Anchor Design Parameters for SUB-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 9	SC	11
4	9 to 14	SC	15
5	14 to 19	SC	16
6	19 to 24	SC	19
7	24 to 29	CL	13
8	29 to 34	CL	15
9	34 to 39	CL	21
10	39 to 40	CL	21

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D4.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-4

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	34	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,050	--	0.005	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	3,990	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D4.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-4

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	650	--	3.04	5	--	0	1,400
2	3 to 7	CL	125	--	650	--	3.04	5	0.8	140	1,400
3	7 to 9	SC	63	32	--	--	3.25	11	1.1	300	4,400
4	9 to 14	SC	63	34	--	--	3.54	23	2.2	500	9,200
5	14 to 19	SC	63	35	--	--	3.69	46	4.5	790	11,900
6	19 to 24	SC	63	35	--	--	3.69	33	3.2	740	11,900
7	24 to 29	SC	63	35	--	--	3.69	39	3.8	860	11,900
8	29 to 34	SC	63	35	--	--	3.69	46	4.5	990	11,900
9	34 to 39	CL	68	--	5,050	--	3.04	38	2.8	930	11,900
10	39 to 40	CL	68	--	3,990	--	3.04	30	2.4	810	11,900

Table D4.3 – Grout Anchor Design Parameters for SUB-4

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	2
3	7 to 9	SC	10
4	9 to 14	SC	13
5	14 to 19	SC	19
6	19 to 24	SC	16
7	24 to 29	SC	17
8	29 to 34	SC	19
9	34 to 39	CL	18
10	39 to 40	CL	14

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D5.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-5

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	120	650	--	0.010	--	--	--	--
3	4 to 7	Sand (Reese)	25	--	125	--	30	--	--	--	--	--
4	7 to 14	Sand (Reese)	20	--	63	--	31	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,850	--	0.004	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,450	--	0.005	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	4,650	--	0.005	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,590	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D5.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-5

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	650	--	3.04	5	--	0	1,400
2	3 to 4	CL	120	--	650	--	3.04	5	0.8	140	1,400
3	4 to 7	SC	125	30	--	--	3.00	6	0.6	150	2,400
4	7 to 14	SC	63	31	--	--	3.12	9	0.9	290	3,600
5	14 to 19	SC	63	35	--	--	3.69	36	3.5	710	12,400
6	19 to 24	SC	63	35	--	--	3.69	31	3.0	720	12,400
7	24 to 29	CL	68	--	5,850	--	3.04	44	3.1	1,050	13,900
8	29 to 34	CL	68	--	5,450	--	3.04	41	2.9	980	13,900
9	34 to 39	CL	68	--	4,650	--	3.04	35	2.7	890	13,900
10	39 to 40	CL	68	--	5,590	--	3.04	42	3.0	1,000	16,700

Table D5.3 – Grout Anchor Design Parameters for SUB-5

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	2
3	4 to 7	SC	9
4	7 to 14	SC	10
5	14 to 19	SC	17
6	19 to 24	SC	15
7	24 to 29	CL	20
8	29 to 34	CL	19
9	34 to 39	CL	16
10	39 to 40	CL	19

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D6.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-6

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,450	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 39	Sand (Reese)	60	--	62.6	--	33	--	--	--	--	--
10	39 to 40	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D6.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-6

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	1,450	--	3.04	11	--	0	3,800
2	3 to 7	SC	120	33	--	--	3.39	12	1.2	200	4,800
3	7 to 9	SC	63	32	--	--	3.25	12	1.2	300	4,800
4	9 to 14	SC	63	35	--	--	3.69	30	2.9	580	9,600
5	14 to 19	CL	68	--	5,980	--	3.04	100	5.2	1,070	9,600
6	19 to 24	SC	63	35	--	--	3.69	50	4.9	900	9,600
7	24 to 29	SC	63	35	--	--	3.69	59	5.8	1,040	9,600
8	29 to 34	SC	63	35	--	--	3.69	59	5.8	1,110	9,600
9	34 to 39	SC	63	33	--	--	3.39	24	2.3	730	9,600
10	39 to 40	SC	63	35	--	--	3.69	44	4.3	1,050	17,600

Table D6.3 – Grout Anchor Design Parameters for SUB-6

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	SC	11
3	7 to 9	SC	11
4	9 to 14	SC	15
5	14 to 19	CL	21
6	19 to 24	SC	20
7	24 to 29	SC	22
8	29 to 34	SC	22
9	34 to 39	SC	14
10	39 to 40	SC	19

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D7.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-7

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	390	--	0.02	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	115	390	--	0.020	--	--	--	--
3	4 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
4	7 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	63	5,980	--	0.004	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,850	--	0.004	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D7.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-7

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	390	--	3.04	3	--	0	800
2	3 to 4	CL	115	--	390	--	3.04	3	0.6	80	800
3	4 to 7	SC	120	33	--	--	3.39	14	1.3	240	5,600
4	7 to 14	SC	63	35	--	--	3.69	28	2.7	550	11,200
5	14 to 19	SC	63	--	5,980	--	3.04	85	4.7	1,070	17,500
6	19 to 24	SC	63	35	--	--	3.69	62	6.1	990	17,500
7	24 to 29	SC	63	35	--	--	3.69	68	6.6	1,110	17,500
8	29 to 34	CL	68	--	5,980	--	3.04	58	3.7	1,070	17,500
9	34 to 39	CL	68	--	5,850	--	3.04	44	3.1	1,050	17,500
10	39 to 40	CL	68	--	5,980	--	3.04	46	3.2	1,070	17,900

Table D7.3 – Grout Anchor Design Parameters for SUB-7

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	1
3	4 to 7	SC	11
4	7 to 14	SC	15
5	14 to 19	SC	29
6	19 to 24	SC	23
7	24 to 29	SC	25
8	29 to 34	CL	21
9	34 to 39	CL	20
10	39 to 40	CL	21

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D8.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-8

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,590	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	58	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	125	--	58	--	35	--	--	--	--	--
5	12 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 40	Stiff Clay w/o Free Water	--	--	67.6	4,790	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D8.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-8

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	1,590	--	3.04	12	--	0	4,200
2	3 to 7	SC	120	33	--	--	3.39	12	1.2	200	4,800
3	7 to 9	SP	58	35	--	--	3.69	30	2.9	510	12,000
4	9 to 12	SP	58	35	--	--	3.69	32	3.1	580	12,800
5	12 to 19	SC	63	35	--	--	3.69	35	3.4	680	14,000
6	19 to 24	SC	63	35	--	--	3.69	40	3.9	800	14,300
7	24 to 29	SC	63	35	--	--	3.69	47	4.6	930	14,300
8	29 to 34	SC	63	35	--	--	3.69	64	6.3	1,140	14,300
9	34 to 40	CL	68	--	4,790	--	3.04	36	2.7	900	14,300

Table D8.3 – Grout Anchor Design Parameters for SUB-8

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	SC	11
3	7 to 9	SP	15
4	9 to 12	SP	16
5	12 to 19	SC	16
6	19 to 24	SC	18
7	24 to 29	SC	19
8	29 to 34	SC	24
9	34 to 40	CL	17

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D9.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-1 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	3,060	--	0.005	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
3	4 to 9	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
4	9 to 14	Sand (Reese)	90	--	120	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
6	19 to 29	Stiff Clay w/o Free Water	--	--	125	4,120	--	0.005	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	125	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	125	4,650	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D9.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-1 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	3,060	--	3.04	23	--	0	9,100
2	3 to 4	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
3	4 to 9	SC	120	35	--	--	3.69	42	4.1	520	9,100
4	9 to 14	SC	120	35	--	--	3.69	29	2.8	630	9,100
5	14 to 19	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
6	19 to 29	CL	125	--	4,120	--	3.04	31	2.5	830	12,300
7	29 to 34	CL	125	--	5,980	--	3.04	48	3.3	1,070	13,900
8	34 to 39	CL	125	--	4,650	--	3.04	35	2.7	890	13,900
9	39 to 44	CL	130	--	5,980	--	3.04	75	4.3	1,070	17,900
10	44 to 50	CL	130	--	5,980	--	3.04	67	4.0	1,070	17,900

Table D9.3 – Grout Anchor Design Parameters for TL-1 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	11
3	4 to 9	SC	18
4	9 to 14	SC	15
5	14 to 19	CL	11
6	19 to 29	CL	14
7	29 to 34	CL	21
8	34 to 39	CL	16
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D10.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-2

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	3,190	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,990	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	5,450	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	29 to 30	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D10.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CH	105	--	650	--	3.04	5	--	0	1,400
2	3 to 7	CH	125	--	650	--	3.04	5	0.8	140	1,400
3	7 to 9	CL	125	--	3,190	--	3.04	24	2.1	700	8,700
4	9 to 12	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
5	12 to 14	CL	125	--	3,990	--	3.04	30	2.4	810	10,300
6	14 to 19	CL	125	--	3,450	--	3.04	26	2.2	740	10,300
7	19 to 24	CL	125	--	5,450	--	3.04	41	2.9	980	16,300
8	24 to 29	CL	130	--	5,980	--	3.04	74	4.3	1,070	17,900
9	29 to 30	CL	130	--	5,980	--	3.04	61	3.8	1,070	17,900

Table D10.3 – Grout Anchor Design Parameters for TL-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CH	--
2	3 to 7	CH	2
3	7 to 9	CL	11
4	9 to 12	CL	10
5	12 to 14	CL	14
6	14 to 19	CL	12
7	19 to 24	CL	19
8	24 to 29	CL	21
9	29 to 30	CL	21

Notes: Design depth to groundwater is 30 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D11.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-3

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,190	--	0.007	--	--	--	--
2	3 to 4	Sand (Reese)	25	--	120	--	32	--	--	--	--	--
3	4 to 7	Stiff Clay w/o Free Water	--	--	125	1,190	--	0.007	--	--	--	--
4	7 to 12	Stiff Clay w/o Free Water	--	--	130	2,650	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,990	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	125	4,390	--	0.005	--	--	--	--
9	29 to 30	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D11.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SC	105	--	1,190	--	3.04	9	--	0	3,100
2	3 to 4	SC	120	32	--	--	3.25	9	0.9	110	3,100
3	4 to 7	CH	125	--	1,190	--	3.04	9	1.1	260	3,100
4	7 to 12	CH	130	--	2,650	--	3.04	20	1.9	580	7,900
5	12 to 14	CL	125	--	3,450	--	3.04	26	2.2	740	9,100
6	14 to 19	CL	125	--	3,990	--	3.04	30	2.4	810	9,100
7	19 to 24	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
8	24 to 29	CL	125	--	4,390	--	3.04	33	2.6	860	10,300
9	29 to 30	CL	125	--	3,450	--	3.04	26	2.2	740	10,300

Table D11.3 – Grout Anchor Design Parameters for TL-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 4	SC	10
3	4 to 7	CH	4
4	7 to 12	CH	9
5	12 to 14	CL	12
6	14 to 19	CL	14
7	19 to 24	CL	11
8	24 to 29	CL	15
9	29 to 30	CL	12

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D12.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-4 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	790	--	0.010	--	--	--	--
3	7 to 12	Stiff Clay w/o Free Water	--	--	120	1,050	--	0.007	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,190	--	0.005	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	4,390	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	5,190	--	0.005	--	--	--	--
7	24 to 34	Stiff Clay w/o Free Water	--	--	125	5,850	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Sand (Reese)	225	--	125	--	34	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D12.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-4 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	CL	120	--	790	--	3.04	6	0.9	170	1,700
3	7 to 12	CL	120	--	1,050	--	3.04	8	1.1	230	2,800
4	12 to 14	CL	125	--	3,190	--	3.04	24	2.1	700	9,500
5	14 to 19	CL	125	--	4,390	--	3.04	33	2.6	860	13,100
6	19 to 24	CL	125	--	5,190	--	3.04	39	2.9	940	15,500
7	24 to 34	CL	125	--	5,850	--	3.04	44	3.1	1,050	17,500
8	34 to 39	CL	130	--	5,980	--	3.04	55	3.5	1,070	17,900
9	39 to 44	CL	130	--	5,980	--	3.04	60	3.7	1,070	17,900
10	44 to 50	SC	125	34	--	--	3.54	54	5.3	1,530	20,000

Table D12.3 – Grout Anchor Design Parameters for TL-4 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 12	CL	4
4	12 to 14	CL	11
5	14 to 19	CL	15
6	19 to 24	CL	18
7	24 to 34	CL	20
8	34 to 39	CL	21
9	39 to 44	CL	21
10	44 to 50	SC	21

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D13.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-5

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,590	--	0.007	--	--	--	--
2	3 to 9	Stiff Clay w/o Free Water	--	--	120	1,190	--	0.007	--	--	--	--
3	9 to 14	Stiff Clay w/o Free Water	--	--	125	1,720	--	0.007	--	--	--	--
4	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
5	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
7	29 to 30	Stiff Clay w/o Free Water	--	--	125	4,520	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D13.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-5

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	1,590	--	3.04	12	--	0	3,100
2	3 to 9	CL	120	--	1,190	--	3.04	9	1.1	260	3,100
3	9 to 14	CL	125	--	1,720	--	3.04	13	1.4	380	4,600
4	14 to 19	CL	125	--	3,450	--	3.04	26	2.2	740	10,300
5	19 to 24	SC	125	35	--	--	3.69	51	5.0	1,080	13,500
6	24 to 29	ML	130	--	5,980	--	3.04	78	4.4	1,070	13,500
7	29 to 30	CL	125	--	4,520	--	3.04	34	2.6	880	13,500

Table D13.3 – Grout Anchor Design Parameters for TL-5

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 9	CL	4
3	9 to 14	CL	6
4	14 to 19	CL	12
5	19 to 24	SC	20
6	24 to 29	ML	21
7	29 to 30	CL	16

Notes: Design depth to groundwater is 30 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D14.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-6 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	3,990	--	0.005	--	--	--	--
3	7 to 12	Stiff Clay w/o Free Water	--	--	125	1,050	--	0.007	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	1,850	--	0.007	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	5,190	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
7	24 to 39	Sand (Reese)	225	--	120	--	33	--	--	--	--	--
8	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,320	--	0.005	--	--	--	--
9	44 to 49	Stiff Clay w/o Free Water	--	--	130	5,450	--	0.005	--	--	--	--
10	49 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D14.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-6 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,800
2	3 to 7	SC	120	--	3,990	--	3.04	30	2.4	810	2,800
3	7 to 12	CL	125	--	1,050	--	3.04	8	1.1	230	2,800
4	12 to 14	CL	125	--	1,850	--	3.04	14	1.5	400	4,900
5	14 to 19	CL	125	--	5,190	--	3.04	39	2.9	940	9,100
6	19 to 24	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
7	24 to 39	SC	120	33	--	--	3.39	36	3.5	1,030	14,400
8	39 to 44	CL	130	--	5,320	--	3.04	40	2.9	950	15,900
9	44 to 49	CL	130	--	5,450	--	3.04	41	2.9	980	16,300
10	49 to 50	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

Table D14.3 – Grout Anchor Design Parameters for TL-6 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	15
3	7 to 12	CL	4
4	12 to 14	CL	6
5	14 to 19	CL	18
6	19 to 24	CL	11
7	24 to 39	SC	17
8	39 to 44	CL	18
9	44 to 49	CL	19
10	49 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D15.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-7

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	4 to 9	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,650	--	0.005	--	--	--	--
5	12 to 19	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,450	--	0.005	--	--	--	--
8	29 to 30	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D15.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-7

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CH	105	--	650	--	3.04	5	--	0	1,400
2	3 to 4	CH	125	--	650	--	3.04	5	0.8	140	1,400
3	4 to 9	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
4	9 to 12	CL	125	--	2,650	--	3.04	20	1.9	580	7,900
5	12 to 19	SC	120	34	--	--	3.54	27	2.6	680	10,800
6	19 to 24	SC	120	35	--	--	3.69	43	4.2	1,000	14,300
7	24 to 29	CL	130	--	5,450	--	3.04	41	2.9	980	14,300
8	29 to 30	CL	130	--	4,790	--	3.04	36	2.7	900	14,300

Table D15.3 – Grout Anchor Design Parameters for TL-7

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CH	--
2	3 to 4	CH	2
3	4 to 9	CL	7
4	9 to 12	CL	9
5	12 to 19	SC	14
6	19 to 24	SC	18
7	24 to 29	CL	19
8	29 to 30	CL	17

Notes: Design depth to groundwater is 30 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D16.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-8

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	115	390	--	0.020	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	24 to 30	Stiff Clay w/o Free Water	--	--	130	5,590	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D16.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-8

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SM	105	--	920	--	3.04	7	--	0	800
2	3 to 7	SC	120	30	--	--	3.00	5	0.5	120	800
3	7 to 9	SC	125	34	--	--	3.54	21	2.0	440	800
4	9 to 12	SC	125	35	--	--	3.69	36	3.5	670	800
5	12 to 14	CL	115	--	390	--	3.04	3	0.6	80	800
6	14 to 19	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
7	19 to 24	SC	125	34	--	--	3.54	38	3.7	910	15,200
8	24 to 30	CL	130	--	5,590	--	3.04	42	3.0	1,000	16,700

Table D16.3 – Grout Anchor Design Parameters for TL-8

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SM	--
2	3 to 7	SC	9
3	7 to 9	SC	13
4	9 to 12	SC	17
5	12 to 14	CL	1
6	14 to 19	CL	7
7	19 to 24	SC	17
8	24 to 30	CL	19

Notes: Design depth to groundwater is 30 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D17.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-9

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,990	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 12	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	4,250	--	0.005	--	--	--	--
5	14 to 19	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	29 to 30	Sand (Reese)	90	--	125	--	32	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D17.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-9

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,990	--	3.04	15	--	0	5,300
2	3 to 7	SC	120	33	--	--	3.39	14	1.3	210	5,600
3	7 to 12	SC	120	34	--	--	3.54	24	2.3	510	9,600
4	12 to 14	CL	125	--	4,250	--	3.04	32	2.5	840	10,400
5	14 to 19	SC	125	34	--	--	3.54	30	2.9	720	10,400
6	19 to 24	SC	125	35	--	--	3.69	44	4.3	1,010	10,400
7	24 to 29	SC	125	34	--	--	3.54	43	4.2	1,060	10,400
8	29 to 30	SC	125	32	--	--	3.25	26	2.5	840	10,400

Table D17.3 – Grout Anchor Design Parameters for TL-9

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	11
3	7 to 12	SC	14
4	12 to 14	CL	15
5	14 to 19	SC	15
6	19 to 24	SC	19
7	24 to 29	SC	18
8	29 to 30	SC	14

Notes: Design depth to groundwater is 30 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D18.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-10

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	26	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	120	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
5	12 to 14	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
6	14 to 19	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
8	24 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D18.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-10

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	920	--	3.04	7	--	0	800
2	3 to 7	SC	115	26	--	--	2.52	2	0.2	70	800
3	7 to 9	SC	120	35	--	--	3.69	24	2.3	480	9,200
4	9 to 12	SC	120	35	--	--	3.69	32	3.1	630	9,200
5	12 to 14	SC	120	34	--	--	3.54	23	2.2	570	9,200
6	14 to 19	SC	125	34	--	--	3.54	32	3.1	740	12,800
7	19 to 24	SC	130	35	--	--	3.69	51	5.0	1,080	17,600
8	24 to 30	SC	68	35	--	--	3.69	44	4.3	1,090	17,600

Table D18.3 – Grout Anchor Design Parameters for TL-10

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	8
3	7 to 9	SC	14
4	9 to 12	SC	16
5	12 to 14	SC	13
6	14 to 19	SC	16
7	19 to 24	SC	20
8	24 to 30	SC	19

Notes: Design depth to groundwater is 24 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D19.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-11

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	2,390	--	0.005	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	31	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	12 to 19	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
7	24 to 28	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
8	28 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D19.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-11

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	2,390	--	3.04	18	--	0	3,200
2	3 to 7	SC	120	31	--	--	3.12	8	0.8	160	3,200
3	7 to 9	SC	120	33	--	--	3.39	17	1.6	380	6,800
4	9 to 12	SC	125	35	--	--	3.69	33	3.2	640	11,600
5	12 to 19	SC	125	34	--	--	3.54	29	2.8	700	11,600
6	19 to 24	SC	125	34	--	--	3.54	31	3.0	830	12,400
7	24 to 28	SC	130	35	--	--	3.69	61	6.0	1,280	20,000
8	28 to 30	SC	68	35	--	--	3.69	58	5.7	1,300	20,000

Table D19.3 – Grout Anchor Design Parameters for TL-11

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	10
3	7 to 9	SC	12
4	9 to 12	SC	16
5	12 to 19	SC	15
6	19 to 24	SC	15
7	24 to 28	SC	23
8	28 to 30	SC	22

Notes: Design depth to groundwater is 28 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D20.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-12

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	31	--	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	63	1,050	--	0.007	--	--	--	--
4	9 to 12	Sand (Reese)	60	--	63	--	33	--	--	--	--	--
5	12 to 19	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	63	1,990	--	0.007	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D20.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-12

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,400
2	3 to 7	SC	115	31	--	--	3.12	6	0.6	130	2,400
3	7 to 9	CL	63	--	1,050	--	3.04	8	1.1	230	2,800
4	9 to 12	SP	63	33	--	--	3.39	18	1.7	410	5,300
5	12 to 19	SC	68	35	--	--	3.69	33	3.2	660	5,300
6	19 to 24	SC	68	35	--	--	3.69	31	3.0	720	5,300
7	24 to 29	ML	63	--	1,990	--	3.04	15	1.6	430	5,300
8	29 to 30	SC	68	35	--	--	3.69	42	4.1	930	16,800

Table D20.3 – Grout Anchor Design Parameters for TL-12

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	9
3	7 to 9	CL	4
4	9 to 12	SP	12
5	12 to 19	SC	16
6	19 to 24	SC	15
7	24 to 29	ML	7
8	29 to 30	SC	18

Notes: Design depth to groundwater is 7 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D21.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-13 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 4	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	4 to 6	Stiff Clay w/o Free Water	--	--	120	1,320	--	0.007	--	--	--	--
3	6 to 9	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
4	9 to 14	Stiff Clay w/o Free Water	--	--	125	1,720	--	0.007	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,250	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	24 to 34	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D21.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-13 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 4	SC	105	--	1,720	--	3.04	13	--	380	3,500
2	4 to 6	CL	120	--	1,320	--	3.04	10	1.2	290	3,500
3	6 to 9	SC	120	34	--	--	3.54	22	2.1	420	4,600
4	9 to 14	CH	125	--	1,720	--	3.04	13	1.4	380	4,600
5	14 to 19	CL	125	--	2,250	--	3.04	17	1.7	490	6,700
6	19 to 24	CL	125	--	3,600	--	3.04	27	2.3	760	10,800
7	24 to 34	CL	133	--	5,980	--	3.04	68	4.0	1,070	14,300
8	34 to 39	CL	130	--	4,790	--	3.04	36	2.7	900	14,300
9	39 to 44	CL	133	--	5,980	--	3.04	77	4.4	1,070	17,900
10	44 to 50	CL	133	--	5,980	--	3.04	57	3.6	1,070	17,900

Table D21.3 – Grout Anchor Design Parameters for TL-13 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 4	SC	--
2	4 to 6	CL	5
3	6 to 9	SC	13
4	9 to 14	CH	6
5	14 to 19	CL	8
6	19 to 24	CL	13
7	24 to 34	CL	21
8	34 to 39	CL	17
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D22.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-14 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	30	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	115	--	32	--	--	--	--	--
4	9 to 14	Stiff Clay w/o Free Water	--	--	125	3,320	--	0.005	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	1,990	--	0.007	--	--	--	--
6	19 to 29	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	125	4,120	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D22.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-14 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,000
2	3 to 7	SC	115	30	--	--	3.00	5	0.5	120	2,000
3	7 to 9	SC	115	32	--	--	3.25	11	1.1	300	4,400
4	9 to 14	CL	125	--	3,320	--	3.04	25	2.2	720	5,300
5	14 to 19	CL	125	--	1,990	--	3.04	15	1.6	430	5,300
6	19 to 29	CL	125	--	3,600	--	3.04	27	2.3	760	9,100
7	29 to 34	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
8	34 to 39	CL	125	--	4,120	--	3.04	31	2.5	830	12,300
9	39 to 44	CL	130	--	5,980	--	3.04	50	3.3	1,070	17,900
10	44 to 50	CL	130	--	5,980	--	3.04	49	3.3	1,070	17,900

Table D22.3 – Grout Anchor Design Parameters for TL-14 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	9
3	7 to 9	SC	10
4	9 to 14	CL	12
5	14 to 19	CL	7
6	19 to 29	CL	13
7	29 to 34	CL	11
8	34 to 39	CL	14
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D23.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-15

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	32	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	73	--	33	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D23.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-15

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SM	105	--	1,720	--	3.04	13	--	0	3,200
2	3 to 7	SC	115	32	--	--	3.25	8	0.8	160	3,200
3	7 to 9	SC	120	32	--	--	3.25	10	1.0	290	4,000
4	9 to 14	SC	125	35	--	--	3.69	45	4.4	770	12,800
5	14 to 19	SC	125	35	--	--	3.69	53	5.2	970	12,800
6	19 to 24	SC	125	35	--	--	3.69	50	4.9	1,070	12,800
7	24 to 29	ML	68	--	5,980	--	3.04	55	3.5	1,070	12,800
8	29 to 30	SC	73	33	--	--	3.39	32	3.1	910	12,800

Table D23.3 – Grout Anchor Design Parameters for TL-15

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SM	--
2	3 to 7	SC	10
3	7 to 9	SC	10
4	9 to 14	SC	19
5	14 to 19	SC	21
6	19 to 24	SC	20
7	24 to 29	ML	21
8	29 to 30	SC	16

Notes: Design depth to groundwater is 24 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D24.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-16

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,850	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	125	--	35	--	--	--	--	--
4	9 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	19 to 25	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	25 to 29	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	63	--	35	--	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D24.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-16

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,850	--	3.04	14	--	0	4,900
2	3 to 7	SC	120	33	--	--	3.39	14	1.3	210	5,600
3	7 to 9	SC	125	35	--	--	3.69	25	2.4	500	10,000
4	9 to 14	SC	125	35	--	--	3.69	43	4.2	760	17,200
5	14 to 19	SC	125	35	--	--	3.69	45	4.4	910	18,000
6	19 to 25	SC	125	35	--	--	3.69	47	4.6	1,050	18,800
7	25 to 29	SC	68	35	--	--	3.69	50	4.9	1,170	20,000
8	29 to 30	SP	63	35	--	--	3.69	100	9.8	1,640	20,000

Table D24.3 – Grout Anchor Design Parameters for TL-16

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	11
3	7 to 9	SC	14
4	9 to 14	SC	18
5	14 to 19	SC	19
6	19 to 25	SC	19
7	25 to 29	SC	20
8	29 to 30	SP	33

Notes: Design depth to groundwater is 25 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D25.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-17

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	115	790	--	0.010	--	--	--	--
3	4 to 9	Sand (Reese)	25	--	115	--	30	--	--	--	--	--
4	9 to 12	Sand (Reese)	25	--	120	--	31	--	--	--	--	--
5	12 to 14	Sand (Reese)	60	--	68	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	60	--	68	--	34	--	--	--	--	--
7	19 to 24	Sand (Reese)	125	--	68	--	34	--	--	--	--	--
8	24 to 30	Stiff Clay w/o Free Water	--	--	71	4,650	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D25.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-17

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,600
2	3 to 4	CL	115	--	790	--	3.04	6	0.9	170	1,600
3	4 to 9	SC	115	30	--	--	3.00	4	0.4	150	1,600
4	9 to 12	SC	120	31	--	--	3.12	9	0.9	310	3,600
5	12 to 14	SC	68	35	--	--	3.69	30	2.9	660	12,000
6	14 to 19	SC	68	34	--	--	3.54	30	2.9	680	12,000
7	19 to 24	SC	68	34	--	--	3.54	33	3.2	770	13,200
8	24 to 30	CL	71	--	4,650	--	3.04	35	2.7	890	13,900

Table D25.3 – Grout Anchor Design Parameters for TL-17

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	3
3	4 to 9	SC	9
4	9 to 12	SC	10
5	12 to 14	SC	15
6	14 to 19	SC	15
7	19 to 24	SC	16
8	24 to 30	CL	16

Notes: Design depth to groundwater is 12 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total} - 62.4$ pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D26.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-18 (POI)

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	520	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	28	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 24	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
6	24 to 29	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	71	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	71	5,050	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	70.6	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	70.6	5,450	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D26.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-18 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SC	105	--	520	--	3.04	4	--	0	1,100
2	3 to 7	SC	120	28	--	--	2.77	3	0.3	90	1,200
3	7 to 9	SC	120	30	--	--	3.00	6	0.6	220	2,400
4	9 to 14	SC	63	35	--	--	3.69	27	2.6	580	10,800
5	14 to 24	SC	68	35	--	--	3.69	49	4.8	880	15,100
6	24 to 29	SC	68	35	--	--	3.69	41	4.0	910	15,100
7	29 to 34	CL	71	--	5,980	--	3.04	50	3.3	1,070	15,100
8	34 to 39	CL	71	--	5,050	--	3.04	38	2.8	930	15,100
9	39 to 44	CL	71	--	5,980	--	3.04	51	3.4	1,070	16,300
10	44 to 50	CL	71	--	5,450	--	3.04	41	2.9	980	16,300

Table D26.3 – Grout Anchor Design Parameters for TL-18 (POI)

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	8
3	7 to 9	SC	9
4	9 to 14	SC	14
5	14 to 24	SC	20
6	24 to 29	SC	18
7	29 to 34	CL	21
8	34 to 39	CL	18
9	39 to 44	CL	21
10	44 to 50	CL	19

Notes: Design depth to groundwater is 9 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D27.1 – LPILE Computer Program Parameters for Lateral Load Analysis for MET-3

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,450	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	1,450	--	0.007	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,790	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,790	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	130	5,190	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D27.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for MET-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	1,450	--	3.04	11	--	0	3,800
2	3 to 7	CL	125	--	1,450	--	3.04	11	1.3	320	3,800
3	7 to 9	ML	125	--	3,450	--	3.04	26	2.2	740	8,300
4	9 to 12	CL	125	--	2,790	--	3.04	21	1.9	610	8,300
5	12 to 14	CL	125	--	2,790	--	3.04	21	1.9	610	8,300
6	14 to 19	CL	125	--	3,600	--	3.04	27	2.3	760	10,800
7	19 to 24	CL	130	--	5,190	--	3.04	39	2.9	940	15,500
8	24 to 29	CL	130	--	5,980	--	3.04	65	3.9	1,070	17,100
9	29 to 34	CL	130	--	5,720	--	3.04	43	3.0	1,030	17,100
10	34 to 35	CL	130	--	5,980	--	3.04	50	3.3	1,070	17,900

Table D27.3 – Grout Anchor Design Parameters for MET-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	5
3	7 to 9	ML	12
4	9 to 12	CL	10
5	12 to 14	CL	10
6	14 to 19	CL	13
7	19 to 24	CL	18
8	24 to 29	CL	21
9	29 to 34	CL	20
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D28.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-1

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,850	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	1,320	--	0.007	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
5	12 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
7	19 to 24	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
8	24 to 29	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	3,600	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,050	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D28.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-1

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	1,850	--	3.04	14	--	0	3,500
2	3 to 7	CL	125	--	1,320	--	3.04	10	1.2	290	3,500
3	7 to 9	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
4	9 to 12	CL	125	--	3,060	--	3.04	23	2.0	670	8,400
5	12 to 14	SC	125	35	--	--	3.69	32	3.1	700	8,400
6	14 to 19	SC	125	33	--	--	3.39	21	2.0	600	8,400
7	19 to 24	SC	125	33	--	--	3.39	26	2.5	750	10,400
8	24 to 29	SC	125	33	--	--	3.39	29	2.8	870	10,800
9	29 to 34	CL	130	--	3,600	--	3.04	27	2.3	760	10,800
10	34 to 35	CL	130	--	5,050	--	3.04	38	2.8	930	15,100

Table D28.3 – Grout Anchor Design Parameters for PMM-1

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	5
3	7 to 9	CL	7
4	9 to 12	CL	11
5	12 to 14	SC	16
6	14 to 19	SC	13
7	19 to 24	SC	14
8	24 to 29	SC	15
9	29 to 34	CL	13
10	34 to 35	CL	18

Notes: Design depth to groundwater is 35 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D29.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-2

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	2,390	--	0.005	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	2,390	--	0.005	--	--	--	--
3	4 to 9	Stiff Clay w/o Free Water	--	--	120	1,050	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	1,850	--	0.007	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,250	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,390	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	2,650	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	4,520	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D29.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	2,390	--	3.04	18	--	0	2,800
2	3 to 4	CL	125	--	2,390	--	3.04	18	1.8	520	2,800
3	4 to 9	CL	120	--	1,050	--	3.04	8	1.1	230	2,800
4	9 to 12	CL	125	--	1,850	--	3.04	14	1.5	400	4,900
5	12 to 14	CL	125	--	2,250	--	3.04	17	1.7	490	6,700
6	14 to 19	CL	125	--	2,390	--	3.04	18	1.8	520	7,100
7	19 to 24	CL	125	--	2,650	--	3.04	20	1.9	580	7,900
8	24 to 29	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
9	29 to 34	CL	130	--	4,520	--	3.04	34	2.6	880	13,500
10	34 to 35	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

Table D29.3 – Grout Anchor Design Parameters for PMM-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	8
3	4 to 9	CL	4
4	9 to 12	CL	6
5	12 to 14	CL	8
6	14 to 19	CL	8
7	19 to 24	CL	9
8	24 to 29	CL	10
9	29 to 34	CL	16
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D30.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-3

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	2,520	--	0.005	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	2,520	--	0.005	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	4,250	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	4,520	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,320	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D30.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	CL	105	--	2,520	--	3.04	19	--	0	7,500
2	3 to 7	CL	125	--	2,520	--	3.04	19	1.8	550	7,500
3	7 to 9	CL	125	--	4,250	--	3.04	32	2.5	840	12,700
4	9 to 12	CL	125	--	4,520	--	3.04	34	2.6	880	13,500
5	12 to 14	CL	130	--	5,980	--	3.04	47	3.2	1,070	15,900
6	14 to 19	CL	130	--	5,980	--	3.04	47	3.2	1,070	15,900
7	19 to 24	CL	130	--	5,720	--	3.04	43	3.0	1,030	15,900
8	24 to 29	CL	130	--	5,320	--	3.04	40	2.9	950	15,900
9	29 to 34	CL	130	--	5,980	--	3.04	52	3.4	1,070	17,900
10	34 to 35	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

Table D30.3 – Grout Anchor Design Parameters for PMM-3

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	9
3	7 to 9	CL	15
4	9 to 12	CL	16
5	12 to 14	CL	21
6	14 to 19	CL	21
7	19 to 24	CL	20
8	24 to 29	CL	18
9	29 to 34	CL	21
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D31.1 – LPILE Computer Program Parameters for Lateral Load Analysis for ADLS-2

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	225	--	128	--	35	--	--	--	--	--
3	7 to 9	Sand (Reese)	225	--	128	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	90	--	128	--	35	--	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
6	14 to 19	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	4,920	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D31.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for ADLS-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SM	105	--	1,720	--	3.04	13	--	0	4,600
2	3 to 7	SM	128	35	--	--	3.69	32	3.1	350	8,700
3	7 to 9	SM	128	35	--	--	3.69	36	3.5	600	8,700
4	9 to 12	SM	128	35	--	--	3.69	28	2.7	600	8,700
5	12 to 14	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
6	14 to 19	SM	130	35	--	--	3.69	37	3.6	840	14,300
7	19 to 24	SC	125	34	--	--	3.54	39	3.8	940	14,300
8	24 to 29	CL	130	--	4,790	--	3.04	36	2.7	900	14,300
9	29 to 34	ML	130	--	4,920	--	3.04	37	2.8	920	14,700
10	34 to 35	CL	130	--	5,720	--	3.04	43	3.0	1,030	17,100

Table D31.3 – Grout Anchor Design Parameters for ADLS-2

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SM	--
2	3 to 7	SM	16
3	7 to 9	SM	17
4	9 to 12	SM	15
5	12 to 14	CL	10
6	14 to 19	SM	17
7	19 to 24	SC	17
8	24 to 29	CL	17
9	29 to 34	ML	17
10	34 to 35	CL	20

Notes: Design depth to groundwater is 35 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

Table D32.1 – LPILE Computer Program Parameters for Lateral Load Analysis for O&M-1 Building

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
4	9 to 12	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
5	12 to 14	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
6	14 to 18	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
7	18 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	68	2,650	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	67.6	2,790	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: *Upper 3 feet of soil should be neglected due to seasonal moisture change.

Table D32.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for O&M-1 Building

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ'	ϕ	C	C'_{Rock}	K_p	SPT N-Value	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)		(blows/ft)			
1*	0 to 3	SC	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	SC	125	34	--	--	3.54	17	1.6	250	2,000
3	7 to 9	SC	120	30	--	--	3.00	5	0.5	210	2,000
4	9 to 12	SC	125	34	--	--	3.54	23	2.2	530	7,900
5	12 to 14	SP	120	35	--	--	3.69	50	4.9	860	7,900
6	14 to 18	SC	125	34	--	--	3.54	30	2.9	720	7,900
7	18 to 24	SC	63	35	--	--	3.69	42	4.1	950	7,900
8	24 to 29	CL	68	--	2,650	--	3.04	20	1.9	580	7,900
9	29 to 34	CL	67.6	--	2,790	--	3.04	21	1.9	610	8,300
10	34 to 35	CL	67.6	--	5,980	--	3.04	100	5.2	1,070	17,900

Table D32.3 – Grout Anchor Design Parameters for O&M-1 Building

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength[2] (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	12
3	7 to 9	SC	9
4	9 to 12	SC	13
5	12 to 14	SP	20
6	14 to 18	SC	15
7	18 to 24	SC	18
8	24 to 29	CL	9
9	29 to 34	CL	10
10	34 to 35	CL	21

Notes: Design depth to groundwater is 18 feet.

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma'=\gamma_{Total}$-62.4 pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.