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May 6, 2024

Via Hand Delivery & Electronic Mail

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

In re: Oliver Wind IV, LLC
Oliver Wind IV Wind Energy Center - Oliver County
Siting Application
Case No. PU-23-317
Our File No. 035218-000083

Dear Mr. Kahl:

I am writing on behalf of my client Oliver Wind IV, LLC ("Oliver Wind IV"). On April 29, 2024, the Commission issued an order approving the construction and operation of the Oliver Wind IV Energy Center to be located in Oliver County, North Dakota. Order Paragraph No. 8 states Oliver Wind IV shall provide the results of field verifications of the three areas Oliver Wind IV identified as being potentially geologically unstable where collection lines were proposed to be routed. Case No. PU-23-317, Docket No. 69, Order pg. 20. Order Paragraph No. 8 further provides that if Oliver Wind IV elects to bore these areas, it shall provide the Commission with geotechnical reports. In accordance with this requirement, enclosed for filing are eight copies of Barr Engineering's geotechnical report dated April 30, 2024 (the "Report").

The two locations where collection routing appeared to intersect areas of potential landslides are west of Turbine No. 65 ("Area No. 1") and west of Turbine No. 63 ("Area No. 2").[1] With respect to Area No. 1, the Report states that some evidence exists suggesting a landslide is not located in the area. Report pg. 5. For Area No. 2, the Report goes on to state it does not appear a historic landslide is present at this location. Report pg. 6. The Report ultimately concludes that "[i]f the collection line is bored beneath the potential shear zones at the mapped landslides (17 to 18.5 feet for Area No. 1, 15 to 17.5 feet for Area No. 2), the geotechnical risk to the collection line is considered low, and boring below the potential landslides would not impact slope stability." Oliver Wind IV intends to install collection lines via boring at Area Nos. 1 and 2 and will adhere to the Report's recommendations of boring below the potential shear zone depths referenced above for each area.

[1] *See* Docket No. 1, Application, Figure 16, Bates Nos. Oliver IV Wind 000117 and 000116, respectively.

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Compliance Filing - Geotechnical Reports
Oliver Wind IV, LLC
Casey Furey, Crowley Fleck, PLLP

The remaining location identified by Oliver Wind IV as an area of potential geologic instability was located between Turbine Nos. 3 and 4 (Docket No. 1, Application, Figure 16, Bates No. Oliver IV Wind 000109). For this location, the Report concludes "[t]he proposed collection line route is near mapped landslides between Turbines 3 and 4; however, the mapped landslides do not overlap the proposed collection line route, as shown in the inset of Figure 5." Report pg. 2 (emphasis added). Thus, construction of collection line routing in this area will avoid mapped landslide deposits.

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

Sincerely,

/s/ Casey A. Furey

Casey A. Furey

CAF/lh
Enc.

cc: Brian Johnson (via email)
Erik Edison (via email)
Tracy Davis (via email)
Robert Frank (via email)

resourceful. naturally.
engineering and environmental consultants

BARR

Technical Memorandum

To: Aatir Fayyaz
From: Joe Chilson, Jed Greenwood, PE
Subject: FINAL, Revision 0 – Mapped Landslides – Collection Line Routes
Date: April 30, 2024
Project: Oliver Wind IV Project

Barr Engineering Co. (Barr), under authorization and contract with Oliver Wind IV, LLC (Oliver Wind IV), has completed a geotechnical investigation for the proposed Oliver Wind IV Project in Oliver and Mercer County, North Dakota. The Oliver IV Wind Project is a proposed wind project consisting of approximately 76 primary and alternate wind turbine generator locations and other project infrastructure. As part of the project, Oliver Wind IV requested that Barr evaluate two locations where the proposed collection line route crosses mapped historic landslides. To perform an evaluation, a review of available data was carried out and one geotechnical boring was completed at each of the two locations. The purpose of this memorandum is to present the conclusions from the potential landslides evaluation.

1.0 Background

The Oliver Wind IV Project is located in northwest Oliver County, North Dakota, west of the town of Center and south of the of the town of Hazen, as shown on Figure 1. Limited site reconnaissance, a geotechnical field investigation, laboratory testing, and review of available data have been completed by Barr to assess the mapped landslides.

1.1 Site Geology

Bedrock that outcrops or is near the surface in Oliver County is sedimentary in origin. The predominant formation is the Sentinel Butte Formation (Figure 2). This formation was deposited by fluvial, alluvial, or lacustrine processes during the Paleocene epoch (66 to 56 million years ago).

The surficial soils at the site consist of loess, glacial till, and alluvial deposits derived from glaciers (Figure 3), in addition to residual soils derived from the underlying bedrock. The project site is mapped as having 0.5 to 2.5 meters (approximately 2 to 8 feet) of loess (Kohfield and Muhs, 2001; Figure 4). Underlying the thin mantle of loess, mapped geologic units within the project site consist primarily of clayey to sandy till from the Wisconsinan glaciation. Also present in large portions of the site are loamy residuum, sheetwash alluvium, and glacial deposits from the Holocene and late Wisconsin time. Alluvial deposits are mapped in stream drainages, but proposed wind turbines are largely sited away from these areas except in isolated instances (Figure 3). Residual soils are common across the project site and are likely derived from the Sentinel Butte Formation).

2.0 Mapping of Landslides

The topography of the proposed turbine layout generally consists of low to moderate relief areas divided by drainage features. Although the site is not located in generally steep terrain, due to the weak nature of some of the subsurface clays, landslides occur in the area. The North Dakota Geological Survey (NDGS) has several areas within the project site mapped as Quaternary landslide deposits, including some locations near proposed wind turbines and proposed collection line routes (Figure 5). The topography at the mapped landslides is typically moderate relief with some local areas of steep relief.

The NDGS identified these landslide deposits based on remote sensing datasets. The first dataset consisted of stereopairs generated from aerial photography collected in the 1950s and 1960s. Stereopairs are sets of two-dimensional, overlapping, vertical aerial images. When viewed through a stereoscope, the images create a quasi-three-dimensional image which can be effective in helping to identify landslide deposits. While stereopairs were once common analytical tools, they have largely fallen out of use due to more advanced imaging and computer processing techniques.

Other datasets used to identify landslide deposits include more recent digital orthophotography and light detection and ranging (LiDAR) data collected in the 2010s. Digital orthophotography is aerial photography which has been corrected for distortions due to imaging techniques and geographic relief. LiDAR data originates from a laser scanner mounted on an aircraft which transmits and receives pulses of light aimed at the ground surface. This creates a high-density, high-resolution ground elevation model.

All datasets used to generate the NDGS mapped landslide deposits are the result of interpretations from aerial imaging techniques. Based on Barr's understanding of the data sources, these landslides were not reviewed by the NDGS in the field. It is possible that some of the mapped areas do not include landslide deposits based on the above and apparent lack of physical evaluation of the potential landslides.

Mapped landslides (Figure 5) overlap with the proposed collection line route west of Turbine 65 (herein termed as "Area No. 1") and the proposed collection line route west of Turbine 63 (herein termed as "Area No. 2"). The proposed collection line route is near mapped landslides between Turbines 3 and 4; however, the mapped landslides do not overlap the proposed collection line route, as shown in the inset of Figure 5.

3.0 Review of Aerial Imagery and Topography

Aerial imagery and topography (Figure 3; Attachment 1) was reviewed for any indications of landslides. It appears a landslide may have occurred at Area No. 1 (surrounding boring LSD-1) based on the possible presence of a headscarp and somewhat hummocky topography. However, some evidence exists suggesting that it is not a landslide such as no discernable toe bulge, relatively weak hummocks, and a non-obvious headscarp. There are no indications that a landslide has occurred at Area No. 2 (surrounding

boring LSD-2) due to a lack of a headscarp, smooth contours (no hummocky topography), and no discernable toe bulge.

4.0 Geotechnical Investigation and Subsurface Conditions

4.1 Geotechnical Investigation

The two areas to investigate were indicated by Oliver Wind IV. One geotechnical boring was performed within each of the two mapped landslides areas (Figure 6). The borings were located based on the mapped landslides and the alignment of the proposed collection line routes. It was required to move boring LSD-1 approximately 30 feet due to the presence of snow at the time of the investigation; however, the boring was still within the footprint of the mapped landslide.

The geotechnical borings were performed by Interstate Drilling Services, LLP of Grand Forks, North Dakota. The borings were advanced with a track-mounted drill rig using the hollow-stem auger drilling method. The drill rig was equipped with an automatic drop hammer to collect split-spoon samples.

Prior to drilling, Barr reviewed the topography to estimate likely depths of the potential historic shear zones. Continuous standard penetration test (SPT) sampling was conducted within the estimated depth range for the potential historic shear zone while 2.5-foot intervals were sampled above this zone. For boring LSD-1 (associated with Area No. 1), SPTs were conducted at 2.5-foot intervals from 10 to 20 feet and continuous SPT sampling was conducted from 20 to 50 feet. For boring LSD-2 (associated with Area No. 2), SPTs were conducted at 2.5-foot intervals from 5 to 15 feet and continuous SPT sampling was conducted from 15 to 30 feet.

SPT was generally performed in accordance with ASTM D1586 "Standard Methods for Penetration Test and Split-Barrel Sampling of Soils". The notable deviation from ASTM D1586 is the sampler used during continuous sampling was a 2.5-foot sampler and not the standard 1.5-foot sampler. Blow counts necessary to advance the split-spoon sampler were recorded in the field and are included on the boring logs. In the boring logs (Attachment 2), N-values are uncorrected, and the N-values shown where the 2.5-foot sampler was used are based on the increments from 6 to 12 inches and from 12 to 18 inches. All soil samples were classified in general accordance with the Unified Soil Classification System (USCS) ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" and sealed in the field to preserve the in-situ moisture content.

Soil samples were delivered to Soil Engineering Testing, Inc. (SET) of Bloomington, Minnesota, for laboratory testing. The geotechnical boring logs are provided in Attachment 2.

At the time of the drilling, site reconnaissance was completed. The site reconnaissance was performed to look for indications of a historic landslide in the areas of the two mapped landslides.

4.2 Laboratory Testing – Moisture Content

Moisture content testing was completed on all SPT samples. Changes in moisture content, especially if the material is homogeneous, may indicate the presence of a landslide.

A total of 24 moisture contents tests were completed. The two tests on sand samples resulted in moisture contents of 12 and 16 percent. The remaining tests were completed on clay samples. The tests on clay samples resulted in moisture contents ranging from 20 to 43 percent, with an average of 24 percent. The sand was logged as a poorly graded sand with silt. The clay was primarily logged as a fat clay, with lesser amounts for lean clay. Given the above and the field logging, the soil is generally in a moist condition.

The moisture content testing is provided in Attachment 3.

4.3 Soil Stratigraphy

Results from the geotechnical soil borings were used to obtain an understanding of the stratigraphy at the mapped landslides. As determined from field data, the stratigraphy at the two borings primarily consisted of Sentinel Butte clay in both borings, and a lesser amount of sand in boring LSD-1. The borings utilized continuous samples to look for potential shear planes (often shown as a "slickensides" in clay soils), which should be present at the depth of the shear zone.

Boring LSD-1:
The boring was blind drilled (i.e., no sampling) from 0 to 10 feet. From a depth of 10 to 16 feet, a layer of poorly graded sand with silt was observed. The sand was olive brown to tan, fine-grained, and moist. Two SPT N-values in the sand layer were 25 and 33 blows per foot (bpf), indicating medium dense to dense relative density.

From a depth of 16 to 50 feet (termination depth), fat clay was observed. The fat clay was dark gray, moist, included lignite fragments, occasionally included silt laminations, and often included oxidized fractures. The fractures were typically vertical or horizontal, though a small number of angled fractures (approximately 30 degrees from horizontal) were observed in the 17- to 18.5-foot and 25- to 27.5-foot samples and one of the fractures (in the 17- to 18.5- foot sample) appeared to potentially be slickensided but it was not definitive. SPT N-values from 17 to 47.5 feet ranged from 29 to 43 bpf, with an average of 36 bpf. The SPT N-value at a depth of 48 to 49 feet was 87 bpf. The SPT N-values have low variability at depths of 17 to 47.5 feet. The SPT N-values within the clay indicates a very stiff to hard consistency from 16 to 47.5 feet, and hard consistency from 47.5 to 50 feet.

The two sand samples had moisture contents of 12 and 16 percent. Excluding the 20- to 22.5-foot sample, the moisture content of the other 12 samples that were clay ranged from 22 to 24 percent. The 20- to 22.5-foot sample was observed to have silt laminations and resulted in a moisture content of 20 percent. The results indicate very consistent moisture content for the conditions observed, primarily within the clay.

Boring LSD-2:
The boring was blind drilled from 0 to 5 feet. From a depth of 5 to 11 feet, a layer of lean clay was observed. The lean clay was olive brown, moist, with sand, and included trace lignite and claystone fragments. From a depth of 11 to 50 feet (termination depth), fat clay was observed. The fat clay was reddish brown to dark gray, moist, included trace lignite fragments, and included a few oxidized fractures that were vertically aligned. No slickensides were observed.

The moisture content of the clay samples was relatively consistent. Excluding the 12- to 13.5-foot and the 15- to 17.5-foot samples, the moisture content ranged from 20 to 25 percent with an average of 23 percent. The moisture contents of the 12- to 13.5-foot and 15- to 17.5-foot samples were 31 and 43 percent, respectively. The higher moisture content of the two samples may be a result of higher plasticity in the material. Also, it could be indicative of a shear zone as the stiff clays become closer to normally consolidated due to shearing (dilation) and the moisture content often increases due to the higher porosity.

SPT N-values at depths of 5 to 17.5 feet ranged from 7 to 10 bpf, indicating medium stiff to stiff consistency. SPT N-values at depths 17.5 to 30 feet ranged from 24 to 45 bpf, indicating very stiff to hard consistency.

4.4 Field Observations

During the drilling on February 16 and 17, 2024, a limited site reconnaissance campaign was performed. The two mapped landslide areas were visually inspected at the surface. The site reconnaissance was performed to inspect for indications of a landslide, including tension cracking, scarps, appearance of unnatural benching, hummocks, seeps, toe bulging, etc. A thin layer of snow was present during the reconnaissance, therefore potential minor indicators could have been obscured. No indications of landslides were observed at or near Area No. 1 or Area No. 2.

5.0 Conclusions

Based on the information presented above, Barr's opinion is as follows:

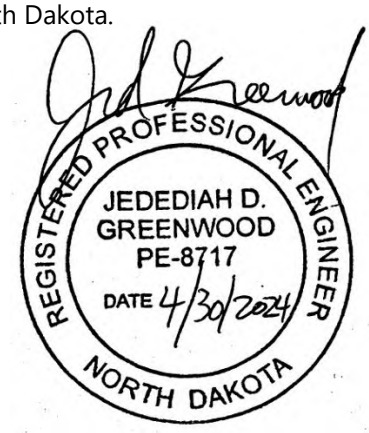
- It is possible that some of the areas mapped as landslides (NDGS, 2023) do not have actual landslides. In general, physical data (i.e., geotechnical borings) is believed to be more reliable to identify landslides than the mapping provided by NDGS, which is based on remote sensing.
- A historic landslide may exist at Area No. 1 (boring LSD-1). The potential of an existing landslide is based on the possible presence of a headscarp and somewhat hummocky topography. However, some evidence exists suggesting that it is not a landslide such as no discernable toe bulge, relatively weak hummocks, and a non-obvious headscarp. It should be noted that the possible slickensided discontinuity observed in the SPT sample collected at a depth of 17 to 18.5 feet could indicate the presence of a landslide and the depth of the shear zone, though the evidence

is not definitive especially with the lack of increase in moisture content at this depth, which often indicates the presence of a shear zone. **If the landslide is present, the shear zone (bottom of the sliding mass) is likely at a depth range of 17 to 18.5 feet at the location of boring LSD-1.**

- Based on the information presented above, it does not appear a historic landslide is present at Area No. 2 (boring LSD-2). There are no indications that a landslide has occurred in this area due to a lack of a headscarp, smooth contours (no hummocky topography), and no discernable toe bulge. However, the moisture contents of the 12- to 13.5-foot and 15- to 17.5-foot samples were 31 and 43 percent, respectively. The higher moisture content of the two samples could be indicative of a shear zone as the stiff clays become closer to normally consolidated due to shearing (dilation) and the moisture content often increases due to the higher porosity. **If the landslide is present, the shear zone (bottom of the sliding mass) is likely at a depth range of 15 to 17.5 feet at the location of boring LSD-2.**
- If the collection line is bored beneath the potential shear zones at the mapped landslides (17 to 18.5 feet for Area No. 1, 15 to 17.5 feet for Area No. 2), the geotechnical risk to the collection line is considered low, and boring below the potential landslides would not impact slope stability. Construction of the collection line by trenching from the surface is unlikely to impact slope stability provided the trench backfill is compacted to a minimum of 92 percent of the material's standard Proctor maximum dry density and the alignment of the collection line is not parallel to the topographic contours at the toe of the mapped landslide.

6.0 Certifications

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of North Dakota.



Jedediah D. Greenwood, PE
PE #: PE8717

4/30/2024
Date

References

Kohfeld, K. E. and Muhs, D. R., 2001, Mid-continental USA Gridded Maps of Loess Thickness, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2001-049. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

North Dakota Geological Survey (NDGS). 1:24,000 and 1:100,000 Scale Maps. Landslides. https://www.dmr.nd.gov/ndgs/SurfaceMap/SurfaceMap.asp?source=landslide24k%20Accessed%202/15/2023. Accessed September, 2023.

Tables

Figures

Attachments

Tables

Table 1

Investigation Coordinates and Testing Summary

Geotech ID	Structure	UTM Coordinates, Zone 14S, WGS84 [m]		Geographic Coordinate System [Degrees]		Geotechnical Boring
		Northing	Easting	Latitude	Longitude	
LSD-1	Collecition Line, Near Turbines T-60/T-65	5227529.1	312342.3	47.17448	-101.47648	X
LSD-2	Collecition Line, Near Turbine T-63	5225582.9	312259.4	47.15696	-101.47676	X

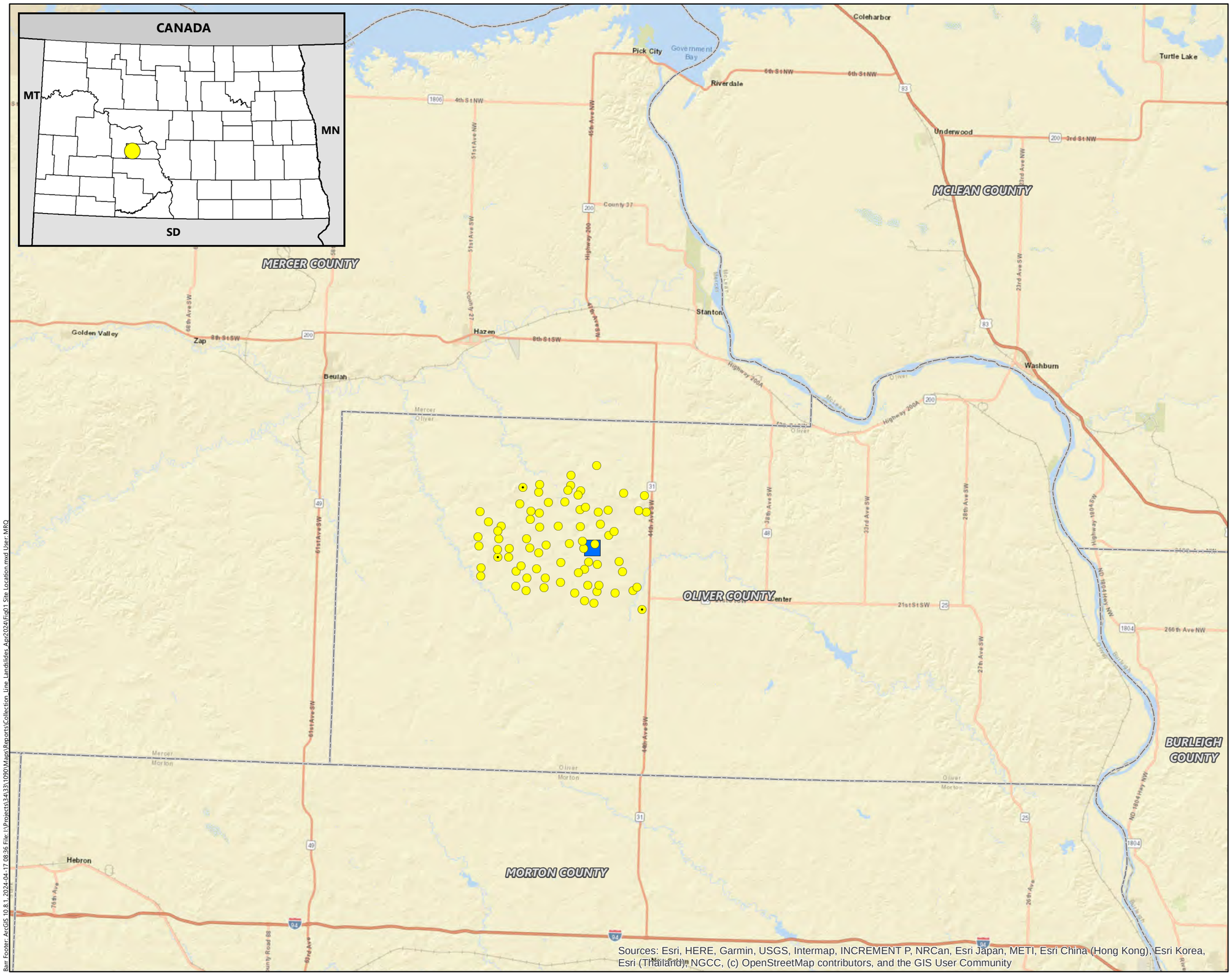
Table 2
Laboratory Moisture Content Testing Summary

Sample Location		Approx Material Type[1]	Moisture Content [%]
Geotech ID	Depth [ft]		
LSD-1	10 - 11.5	SM/SP-SM	12.3
	13.5 - 17	SM/SP-SM	15.7
	17 - 18.5	CH	22.2
	20 - 22.5	CH/ML	19.7
	22.5 - 25	CH	23.5
	25 - 27.5	CH	22.8
	27.5 - 30	CH	24.0
	30 - 32.5	CH	21.9
	32.5 - 35	CH	23.2
	35 - 37.5	CH	21.9
	37.5 - 40	CH	23.0
	40 - 42.5	CH	22.9
	42.5 - 45	CH	22.6
	45.0 - 47.5	CH	21.5
	47.5 - 50	CH	23.7
LSD-2	5 - 6.5	CL/CH	22.2
	8.5 - 10	CL/CH	20.1
	12 - 13.5	CH	31.2
	15 - 17.5	CH	43.0
	17.5 - 20	CH	25.3
	20.0 - 22.5	CH	24.0
	22.5 - 25	CH	21.9
	25.0 - 27.5	CH	22.8
	27.5 - 30	CH	22.3

Number of Tests	24
Minimum	12.3
Maximum	43.0
Average	23.1
Standard Deviation	5.4

[1] Approximate Soil Types - see boring logs for full description

Figures



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

County Boundary

Miles

5 0 5

Kilometers

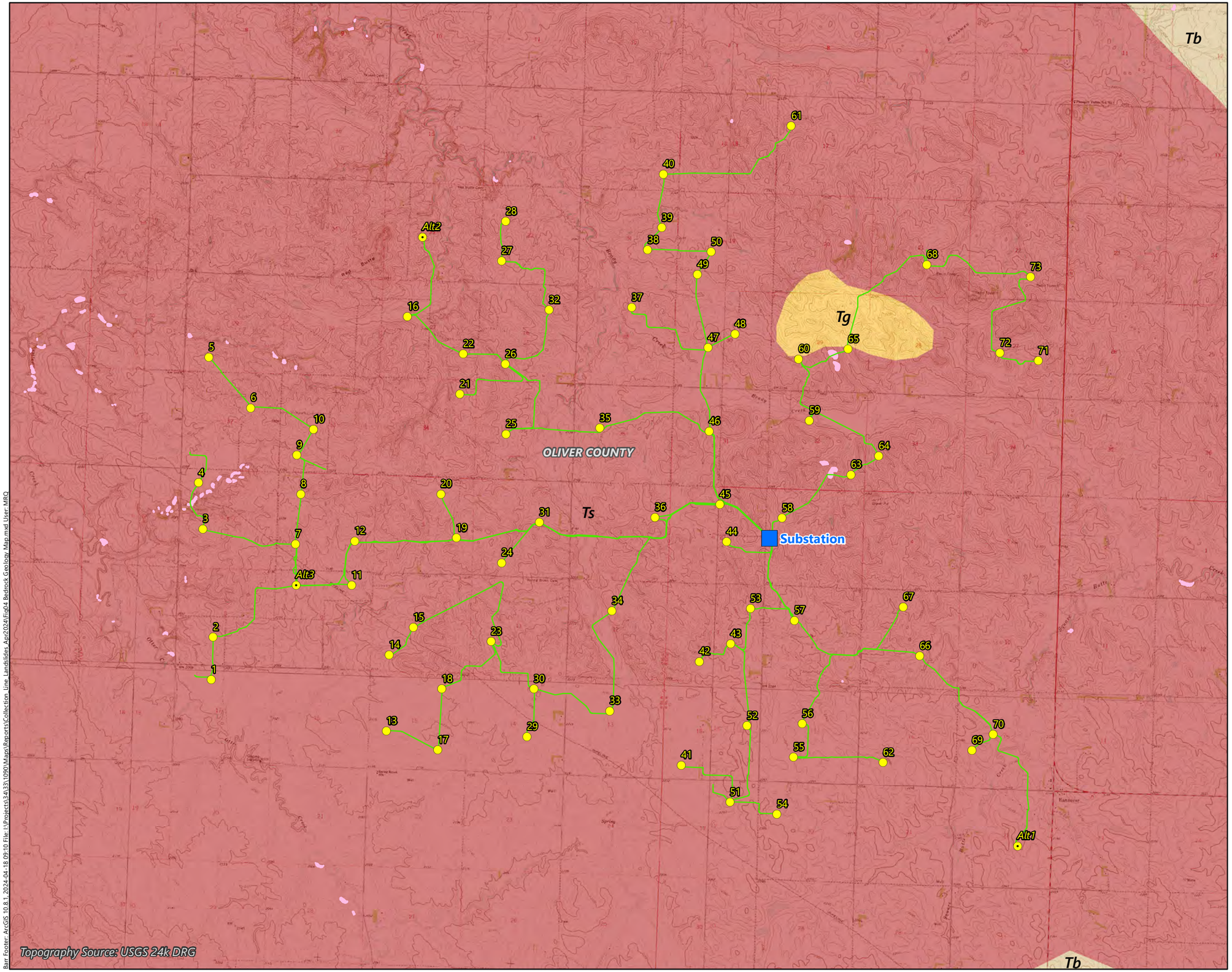
10 0

Figure 1

SITE LOCATION

Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-04-17 08:36 File: I:\Projects\34331090\Maps\Reports\Collection_Line_Landslides_Apr2024\Fig01 Site Location.mxd User: MRQ



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

Collection Line Route: Revision M, Scenario A (1/24/2024)

Landslide Deposit Extent (NDGS)

Bedrock Geology

Tb - Bullion Creek Formation

Tg - Golden Valley Formation

Ts - Sentinel Butte Formation

Landslide Data Source:
North Dakota Geological Survey
Available online at https://www.dmr.nd.gov/ndgs/SurfaceMap/
Accessed 2/15/2023

Geology Data Source:
Based on Bluemle, John P., 1983, Geologic and Topographic Bedrock Map of North Dakota, NDGS Miscellaneous Map 25, 1:670,000 scale. Digitized by North Dakota Geological Survey.
Annotated by North Dakota Dept. of Health-Divison of Water Quality

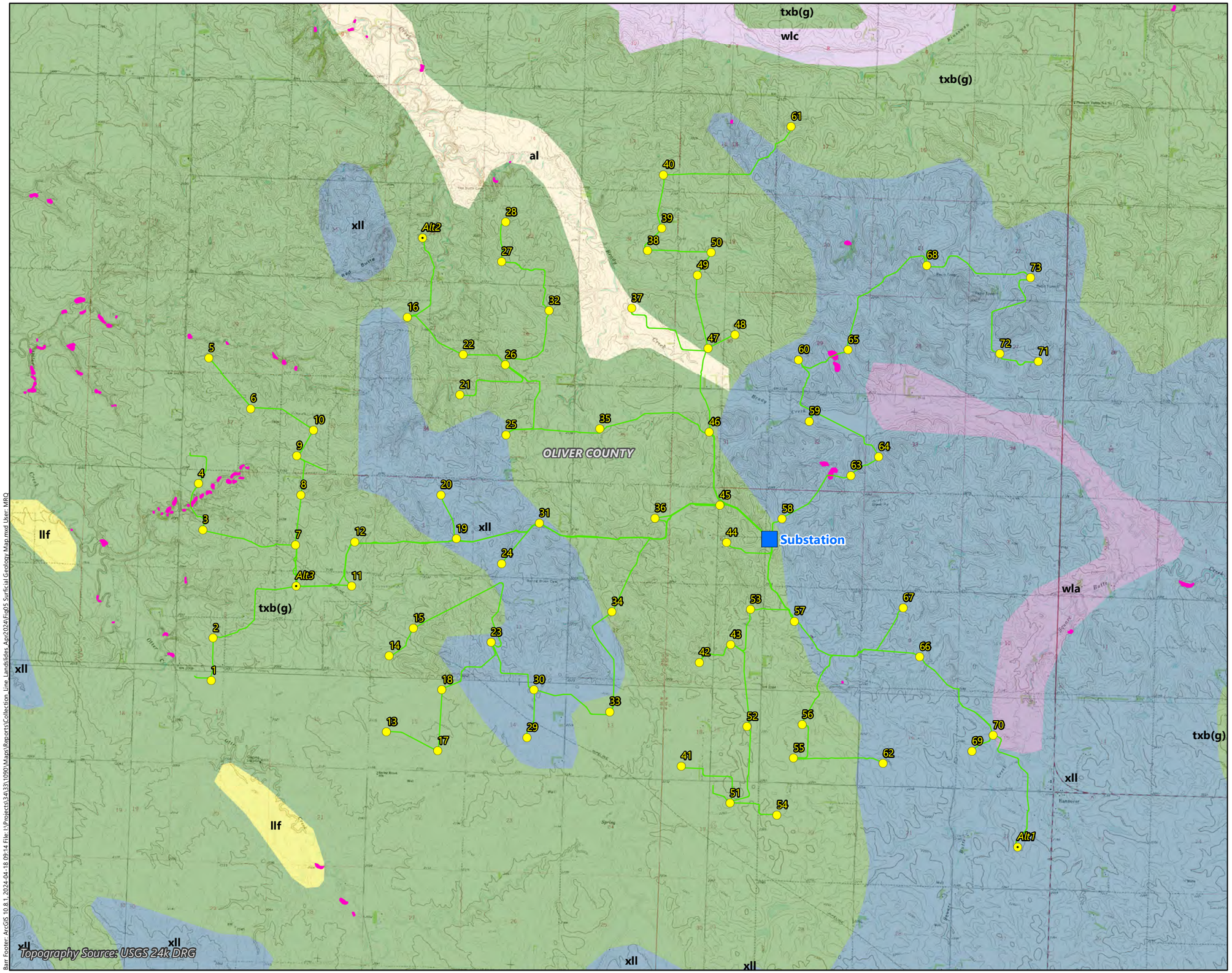
Feet
5,000 0 5,000

Meters
1,000 0 1,000

Figure 2

BEDROCK GEOLOGY MAP
Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-04-18 09:10 File: I:\Projects\34\33\1090\Maps\Reports\Collection_Line_Landslides_Apr2024\Fig04 Bedrock Geology Map.mxd User: MRQ



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

Collection Line Route: Revision M, Scenario A (1/24/2024)

Landslide Deposit Extent (NDGS)

Surficial Geology

Holocene and Late Wisconsin

al; Alluvium

wla; Loamy or Clayey Sheetwash Alluvium

wlc; Loamy or Clayey Sheetwash Alluvium and Lake Deposits

xll; Loamy Disintegration Residuum, Sheetwash Alluvium, Colluvium, and Glacial Deposits

Late Wisconsin

llf; Slackwater Lake Deposits and Outwash Sand and Gravel

txb(g); Clayey to Sandy Till --Ground moraine

Landslide Data Source:
North Dakota Geological Survey
Available online at https://www.dmr.nd.gov/ndgs/SurfaceMap/
Accessed 2/15/2023

Geology Data Source:
Source: Fullerton et al. Quaternary Geologic Atlas of the Dakotas 4x6 Quadrange Misc. Investigation Series, MAP I-1420 (NL-14). US Geological Survey. 1995.

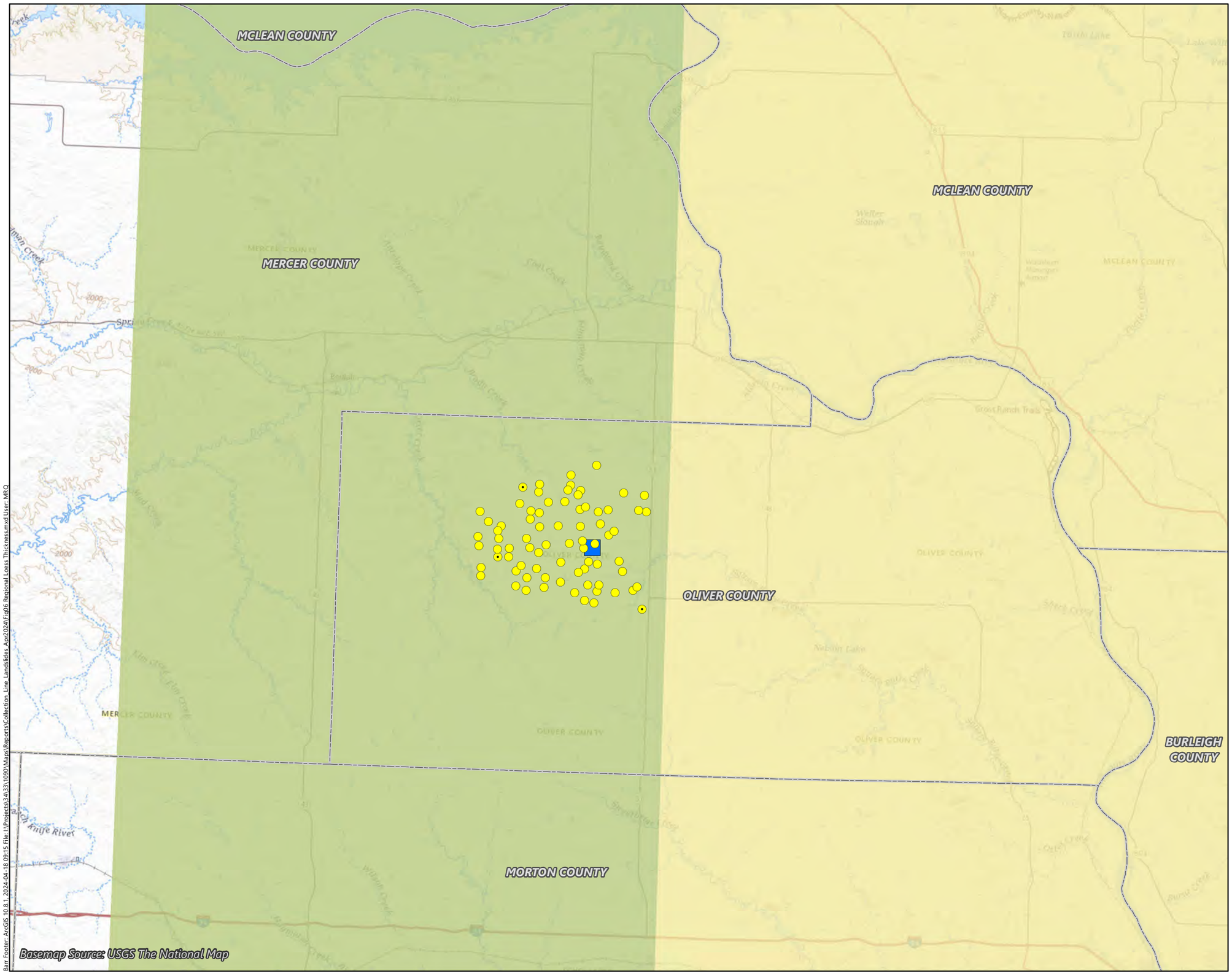
Feet
5,000 0 5,000

Meters
1,000 0 1,000

Figure 3

SURFICIAL GEOLOGY MAP
Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-04-18 09:14 File: I:\Projects\343\1090\Maps\Reports\Collection_Line_Landslides_Apr2024\Fig05 Surficial Geology Map.mxd User: MRQ



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

Thickness of Loess (meters)

0.5 - 2.5 m

2.5 - 5.5 m

Source: Kohfeld, K. E. and Muhs, D. R., 2001, Mid-continental USA Gridded Maps of Loess Thickness, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2001-049. NOAA/NGDC

Miles

5 0 5

Kilometers

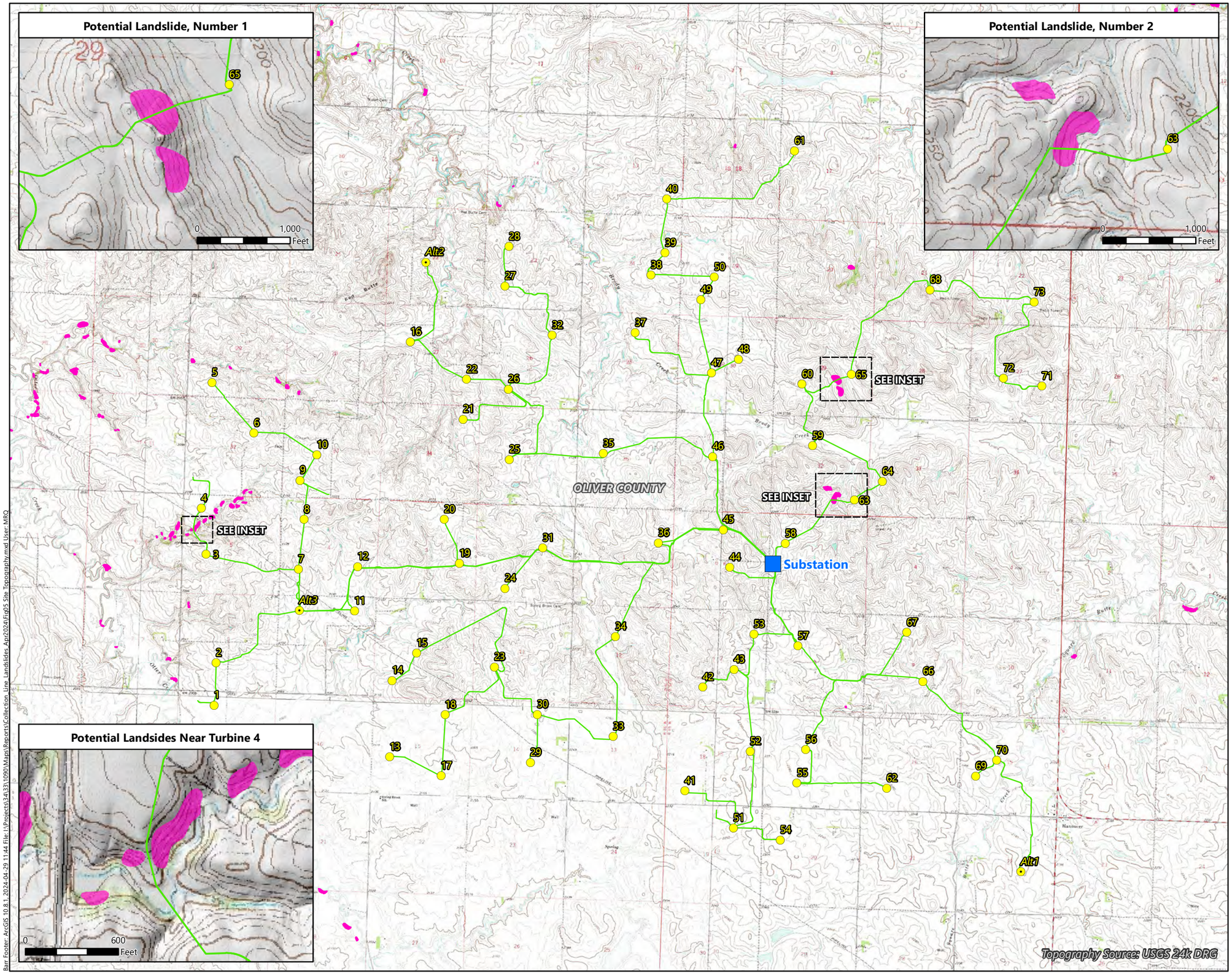
10 0

Figure 4

REGIONAL LOESS THICKNESS

Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1 2024-04-18 09:15 File: I:\Projects\343\1090\Maps\Reports\Collection_Line_Landslides_Apr2024\Fig06 Regional Loess Thickness.mxd User: MRQ



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

Collection Line Route: Revision M, Scenario A (1/24/2024)

Landslide Deposit Extent (NDGS)

Landslide Data Source:
North Dakota Geological Survey
Available online at https://www.dmr.nd.gov/ndgs/SurfaceMap/
Accessed 2/15/2023

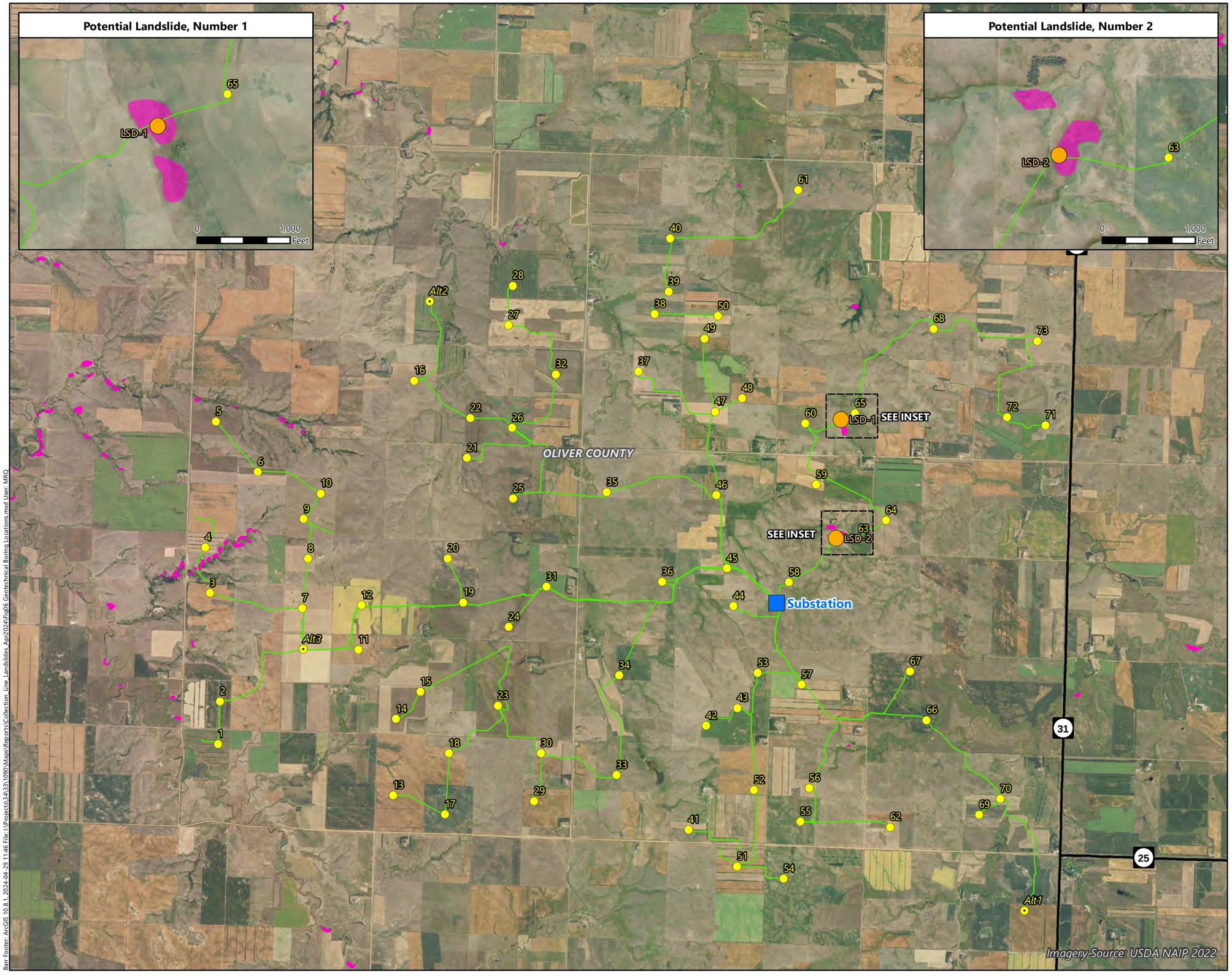
Feet
5,000 0 5,000

Meters
1,000 0 1,000

Figure 5

SITE TOPOGRAPHY
Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-04-29 11:44 File: I:\Projects\341331\1090\Maps\Reports\Collection_Line_Landslides_Apx2\2024\Fig05 Site Topography.mxd User: MRQ



Turbine Location (Layout 16)

Alternate Turbine (Layout 16)

Substation Location

Geotechnical Boring Location

Collection Line Route: Revision M, Scenario A (1/24/2024)

Landslide Deposit Extent (NDGS)

Landslide Data Source:
North Dakota Geological Survey
Available online at https://www.dmr.nd.gov/ndgs/SurfaceMap/
Accessed 2/15/2023

Feet
5,000 0 5,000

Meters
1,000 0 1,000

Figure 6

GEOTECHNICAL BORING LOCATIONS
Collection Line Landslides Memorandum
Oliver Wind IV Project
Oliver Wind IV, LLC
Mercer and Oliver Counties,
North Dakota

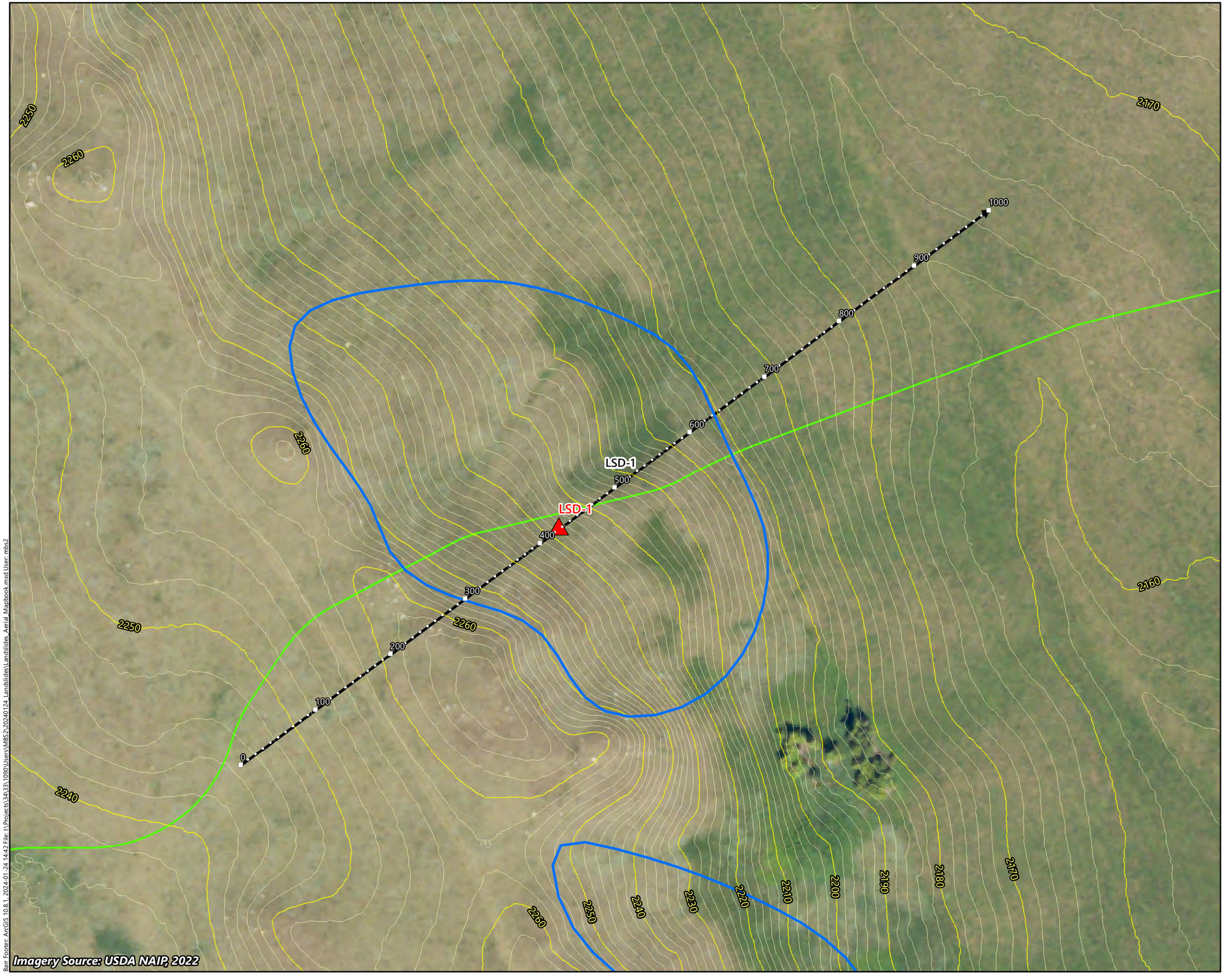
Barr Footer: ArcGIS 10.8.1, 2024-04-29 11:46 File: I:\Projects\343\1090\Maps\Reports\Collection_Line_Landslides_App2024\Fig06_Geotechnical_Boring_Locations.mxd User: MRQ

Attachments

Attachment 1

Aerial Imagery and Topography of Area Nos. 1 and 2

Attachment 1 Aerial Imagery and Topography of Area Nos. 1 and 2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

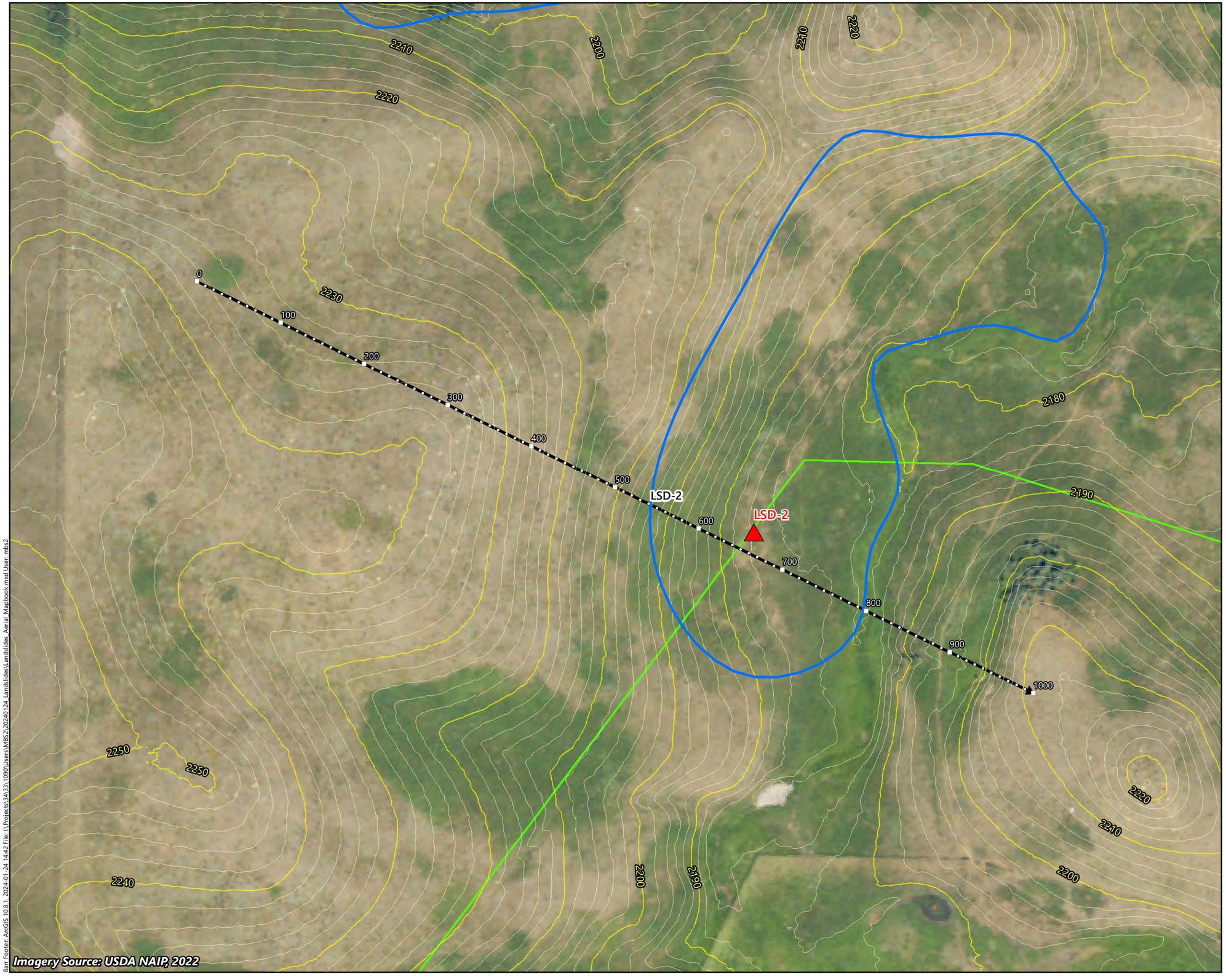
Feet
100 0 100

Meters
30 0 30

Figure 1

PROFILE LSD-1
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-01-24 14:42 File: I:\Projects\34\33\1090\Users\MBS2\20240124_Landslides\Landslides_Aerial_Mapbook.mxd User: mbs2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

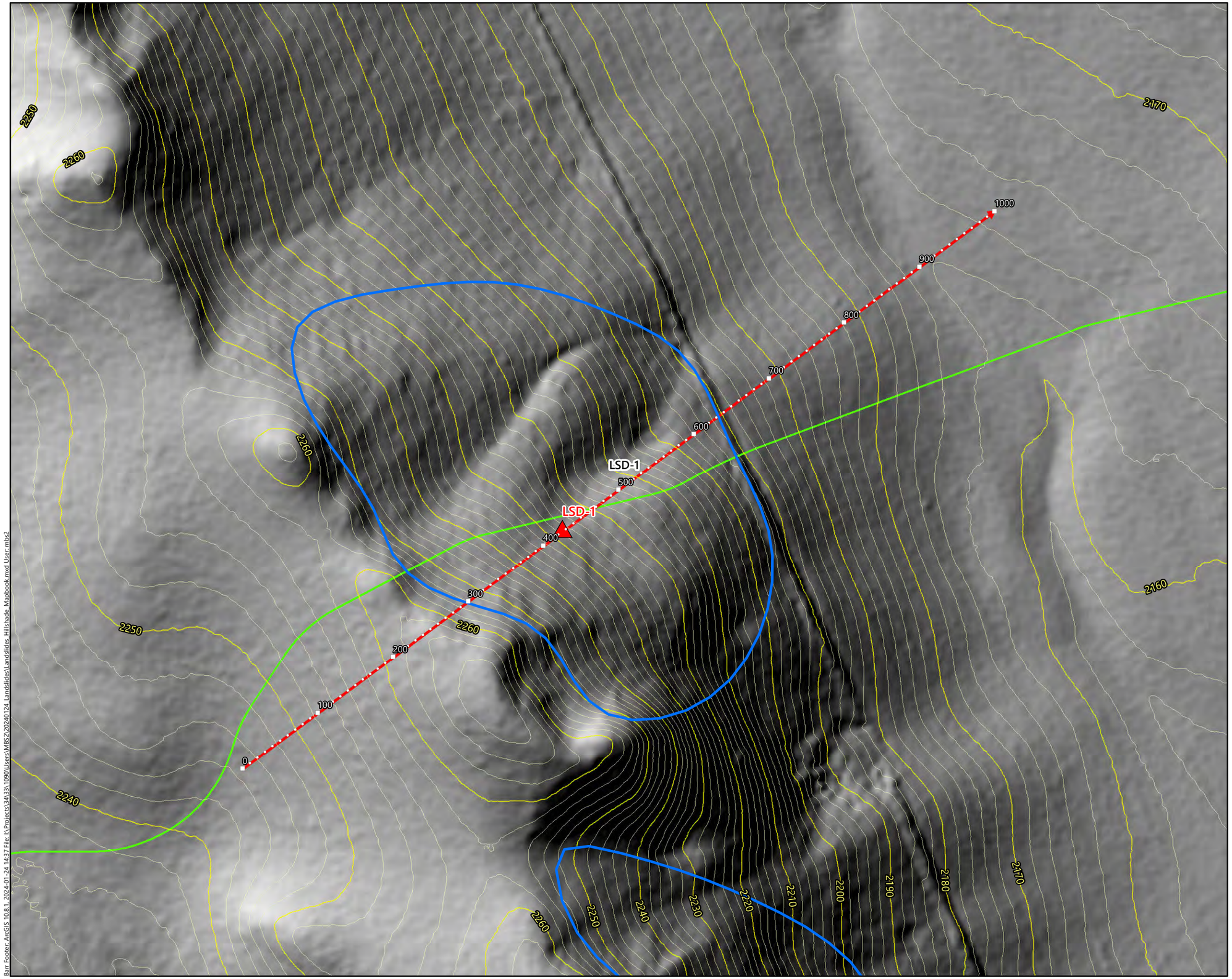
Feet
100 0 100

Meters
30 0 30

Figure 2

PROFILE LSD-2
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-01-24 14:42 File: I:\Projects\343\33\1090\Users\MBS2\20240124_Landslides\Landslides_Aerial_Mapbook.mxd User: mbx2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

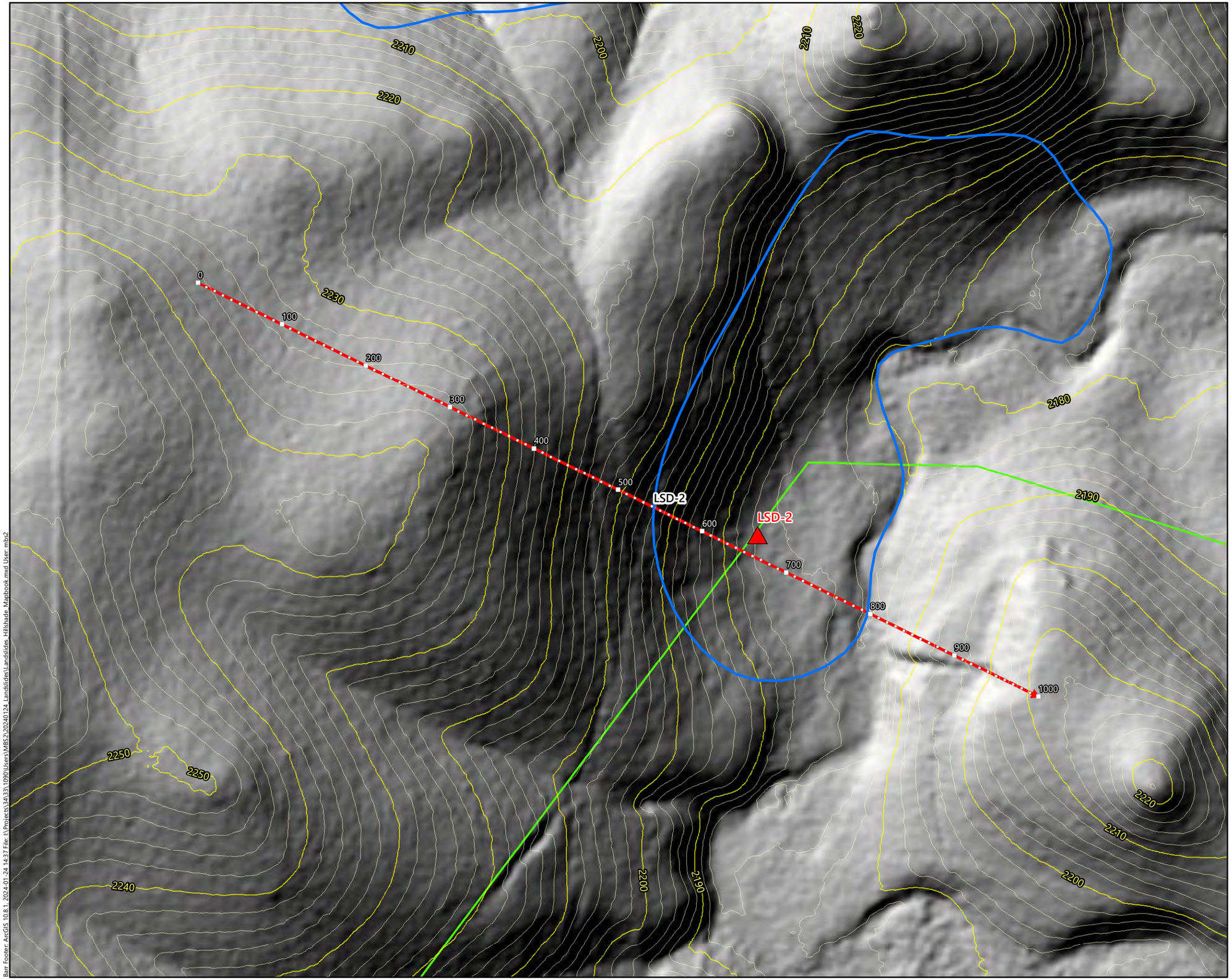
Feet
100 0 100

Meters
30 0 30

Figure 1

PROFILE LSD-1
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Bar Footer: ArcGIS 10.8.1, 2024-01-24 14:37 File: I:\Projects\3A\33\1090\Users\MBS2\20240124_Landslides\Landslides_HIlshade_Mapbook.mxd User: mbs2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

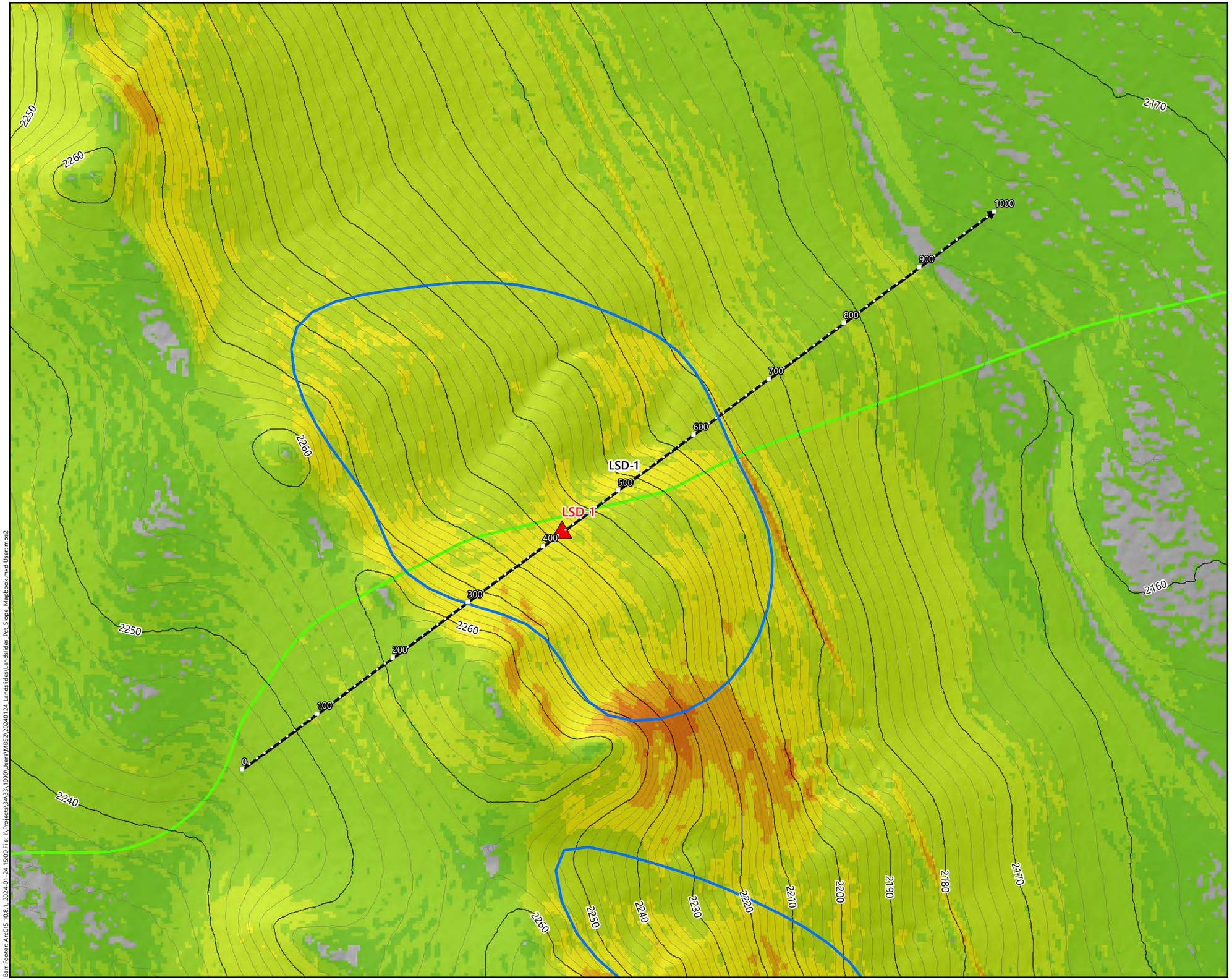
Feet
100 0 100

Meters
30 0 30

Figure 2

PROFILE LSD-2
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Bar Footer: ArcGIS 10.8.1, 2024-01-24 14:37 File: I:\Projects\343\1090\Users\MBS2\20240124_Landslides\Landslides_Hillshade_Mapbook.mxd User: mbs2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

Percent Slope

0 - 2 (not shown)

2 - 5

5 - 10

10 - 20

20 - 30

30 - 40

40 - 50

50 - 60

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

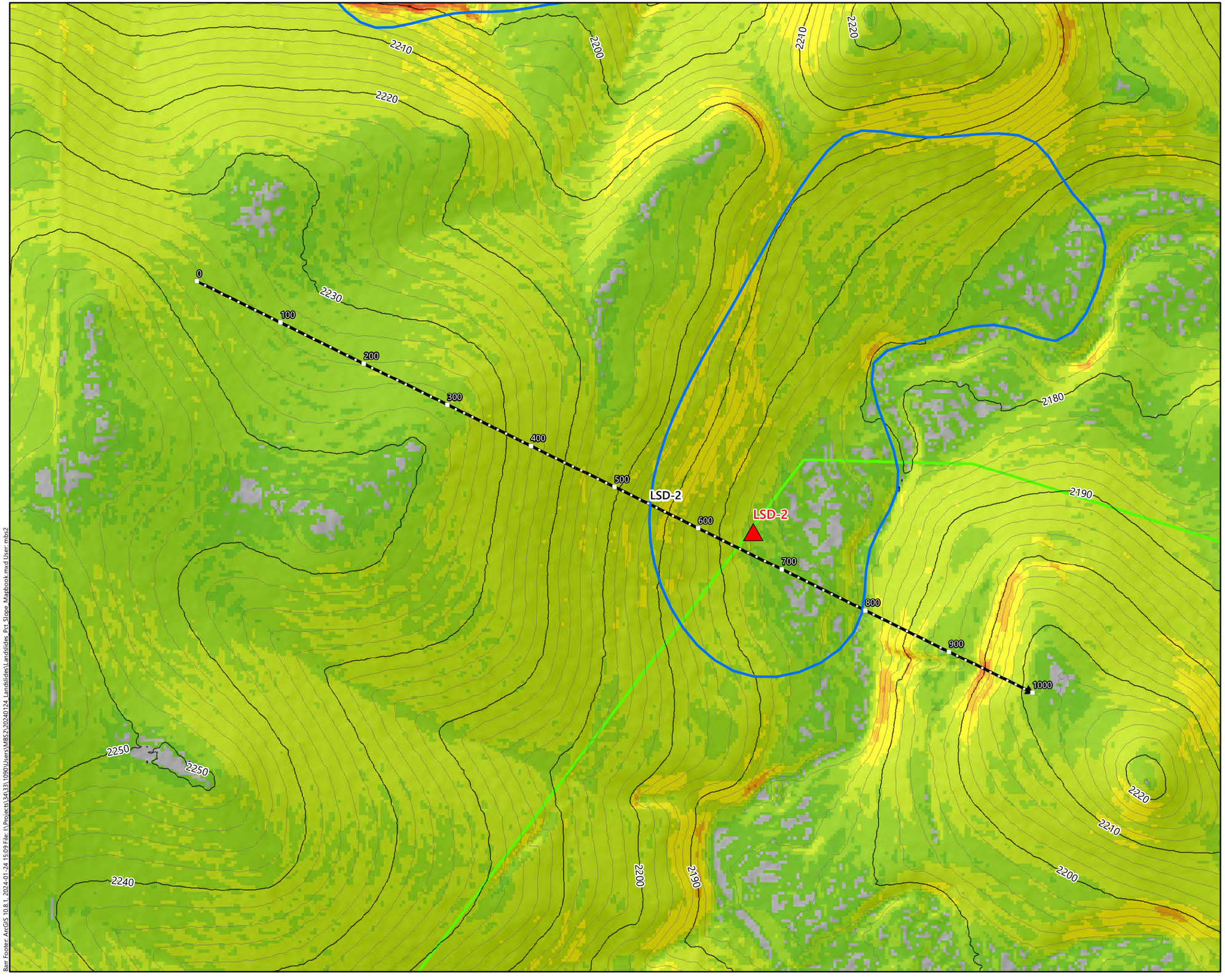
Feet
100 0 100

Meters
30 0 30

Figure 1

PROFILE LSD-1
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-01-24 15:09 File: I:\Projects\343\33\1090\Users\MBS2\20240124_Landslides\Landslides_Pct_Slope_Mapbook.mxd User: mbs2



Landslide Deposit Location

Profile Stationing

10 Foot Station

100 Foot Station

Profile Alignment

Collection Alignment

Landslide Deposit Extents (SPCS)

Elevation Contours

10-foot Contour

2-foot Contour

Percent Slope

0 - 2 (not shown)

2 - 5

5 - 10

10 - 20

20 - 30

30 - 40

40 - 50

50 - 60

> 60

LiDAR Source:
NRCS, James River, Phase 5 Lidar, 2015

Feet
100 0 100

Meters
30 0 30

Figure 2

PROFILE LSD-2
Oliver IV Wind Project
NextEra Energy Resources
Mercer and Oliver Counties,
North Dakota

Barr Footer: ArcGIS 10.8.1, 2024-01-24 15:09 File: I:\Projects\343\3\1090\Users\MBS2\20240124_Landslides\Landslides_Pct_Slope_Mapbook.mxd User: mbs2

Attachment 2

Boring Logs

Attachment 2 Boring Logs

Barr Engineering Co.
4300 MarketPointe Drive Suite 200
Minneapolis, MN 55435
Telephone: 952-832-2600

LOG OF BORING LSD-1

Project:	Oliver IV Wind Project	Surface Elevation:	Not Provided
Job No.:	34331090.01	Drilling Method:	HSA
Location:	Oliver County, North Dakota	Sampling Method:	SS
Coordinates:	Lat: 47.17448° Long: -101.47648°	Completion Depth:	50.0 ft
Datum:	NAD83		

Surface Elev.: Not Provided

Depth, feet	MATERIAL DESCRIPTION		Sample No.	% Recovery	SPT, N value or RQD %	Shear Strength, tsf (□ Qp/2)	Water Content (%) ×	Natural Dry Density (pcf) ☆
0								
5	Boring blind drilled to a depth of approximately 10 feet.							
10	POORLY GRADED SAND WITH SILT (SP-SM): fine grained; olive brown to tan; moist; medium dense to dense; with oxidation.	10.0ft	1	100	25	2.25	12.3	
			2	95	33		15.7	
15	FAT CLAY (CH): dark gray; moist; very stiff to hard; with lignite fragments.	16.0ft	3	100	40	2.25	22.2	
	17-18.5': three angled oxidized fractures (appx. 30 degrees from horizontal), one fracture is possibly slickensided.		4	100	37	2.25	19.7	
20	20': with silt laminations; trace fine sand inclusions and laminations; trace pyrite.		5	100	42	2.25	23.5	
	22.5-25': two horizontal oxidized fractures.		6	100	36	2.25	22.8	
25	25': two vertical oxidized fractures, one angled oxidized fracture (appx. 30 degrees from horizontal); horizontal laminations; trace fossils.		7	100	43	2.25	24	
			8	100	34	2.25	21.9	
30			9	100	41	2.25	23.2	
			10	100	30	2.25	21.9	
35			11	100	29	2.25	23	
			12	100	30	2.25	22.9	
40			13	100	36	2.25	22.6	
			14	100	39	2.25	21.5	
45	48': trace lignite.		15	100	87	2.25	23.7	
50	Bottom of Boring at 50.0 feet	50.0ft						

Date Boring Started:	2/16/24 2:35 pm	Water Levels (ft)	Remarks:
Date Boring Completed:	2/16/24 4:30 pm	▼ End of Drilling — Dry	
Logged By:	DJZ	▼ At Time of Drilling — Dry	
Drilling Contractor:	Interstate Drilling Services		
Drill Rig:	Diedrich D-50		Weather: 15°F, Cloudy

M:\GINT\PROJECTS\OLIVER IV WIND_34331090.01.GPJ BARRLIBRARY.GLB BOREHOLE LOG REPORT BARR TEMPLATE.GDT

Barr Engineering Co.
4300 MarketPointe Drive Suite 200
Minneapolis, MN 55435
Telephone: 952-832-2600

LOG OF BORING LSD-2

Project:	Oliver IV Wind Project	Surface Elevation:	Not Provided
Job No.:	34331090.01	Drilling Method:	HSA
Location:	Oliver County, North Dakota	Sampling Method:	SS
Coordinates:	Lat: 47.15696° Long: -101.47676°	Completion Depth:	30.0 ft
Datum:	NAD83		

Surface Elev.: Not Provided

Depth, feet	MATERIAL DESCRIPTION		Sample No.	% Recovery	SPT, N value or RQD %
0	Boring blind drilled to a depth of approximately 5 feet.				
5	LEAN CLAY (CL): olive brown; moist; medium stiff to stiff; with sand; trace oxidation, trace lignite fragments, trace claystone fragments.	5.0ft	1	95	10
10			2	95	7
	FAT CLAY (CH): reddish brown; moist; stiff; trace oxidation; trace lignite fragments.	11.0ft	3	77	11
15	FAT CLAY (CH): dark gray; moist; stiff to hard; trace lignite fragments; trace oxidation; trace silty clay laminations.	14.0ft	4	70	8
			5	100	24
20	20-27': two vertical oxidized fractures.		6	100	26
			7	100	39
25			8	90	28
			9	100	45
30	29': transitioning to organic fat clay.				
	Bottom of Boring at 30.0 feet	30.0ft			

STANDARD PENETRATION TEST DATA N in blows/ft ◎ (10 20 30 40)
REC% ▬
RQD % ◆ (20 40 60 80)
SHEAR STRENGTH, tsf □ Qp/2 (0 2,5 5)

Sample No.	Qp/2 (tsf)	N	RQD %	Natural Dry Density (pcf) ☆	Water Content (%) ×
1	1.25	10	7	80 100 120	22.2
2	0.375	7			20.1
3	1.25	11			31.2
4	2.25	8	5		43
5	2.25	24			25.3
6	2.25	26			24
7	2.25	39			21.9
8	2.25	28			22.8
9	2.25	45			22.3

Atterberg Limits: PL LL (20 40 60)

Date Boring Started:	2/17/24 8:25 am	Water Levels (ft)	Remarks:
Date Boring Completed:	2/17/24 9:05 am	▼ At Time of Drilling: Dry	
Logged By:	DJZ	▼ End of Drilling: Dry	
Drilling Contractor:	Interstate Drilling Services		
Drill Rig:	Diedrich D-50		Weather: 15°F, Sunny

M:\GINT\PROJECTS\OLIVER IV WIND_34331090.01.GPJ BARRLIBRARY.GLB BOREHOLE LOG REPORT BARR TEMPLATE.GDT

Attachment 3

Laboratory Test Results

Attachment 3 Laboratory Test Results

Water Content Test Summary (ASTM:D2216)

Project: Oliver IV Job: 14902

Client Barr Engineering Company Date: 3/5/2024

Sample Information & Classification								
Boring #	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1
Sample #								
Depth (ft)	10-11.5	13.5-17	17-18.5	20-22.5	22.5-25	25-27.5	27.5-30	30-32.5
Type	Bag	Bag	Bag	Bag	Bag	Bag	Bag	Bag
Material Classification	Silty Sand (SM/SP-SM)	Silty Sand (SM/SP-SM)	Fat Clay w/silt lenses (CH)	Alternating layers of Fat Clay (CH) and Sandy Silt (ML)	Fat Clay w/occasional silt laminations (CH)	Fat Clay (CH)	Fat Clay (CH)	Fat Clay w/laminations of silt (CH)
Water Content (%)	12.3	15.7	22.2	19.7	23.5	22.8	24.0	21.9

Sample Information & Classification								
Boring #	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-1	LSD-2
Sample #								
Depth (ft)	32.5-35	35-37.5	37.5-40	40-42.5	42.5-45	45-47.5	47.5-50	5-6.5
Type	Bag	Bag	Bag	Bag	Bag	Bag	Bag	Bag
Material Classification	Fat Clay w/laminations of silt (CH)	Fat Clay w/lenses of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/lenses of silt (CH)	Fat Clay (CH)	Lean Clay w/sand (CL/CH)
Water Content (%)	23.2	21.9	23.0	22.9	22.6	21.5	23.7	22.2

Sample Information & Classification								
Boring #	LSD-2	LSD-2	LSD-2	LSD-2	LSD-2	LSD-2	LSD-2	LSD-2
Sample #								
Depth (ft)	8.5-10	12-13.5	15-17.5	17.5-20	20-22.5	22.5-25	25-27.5	27.5-30
Type	Bag	Bag	Bag	Bag	Bag	Bag	Bag	Bag
Material Classification	Lean Clay w/sand (CL/CH)	Fat Clay (CH)	Fat Clay w/scoria (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)	Fat Clay w/laminations of silt (CH)
Water Content (%)	20.1	31.2	43.0	25.3	24.0	21.9	22.8	22.3

Sample Information & Classification								
Boring #								
Sample #								
Depth (ft)								
Type								
Material Classification								
Water Content (%)								

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431