Grover Hill Wind, LLC Case No. 20-417-EL-BGN

Exhibit G Desktop Geotechnical Assessment Westwood March 9, 2021



DESKTOP GEOHAZARD ASSESSMENT

Grover Hill Wind Project Paulding County, OH

MARCH 09, 2021

PREPARED FOR:



PREPARED BY:



Westwood

Desktop Geohazard Assessment

Grover Hill Wind Project Paulding County, OH

Prepared For:

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Project Number: R0015695.00 Date: March 09, 2021

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- Exhibit 1: Overview Map
- Exhibit 2: Soils Map
- Exhibit 3: Geological Map
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- Exhibit 6: Depth to Bedrock Map
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1.0 Executive Summary

Westwood Professional Services (Westwood) is pleased to present this Desktop Geohazard Assessment Report to Starwood Energy Group, for the proposed Grover Hill Wind Project (Project) located in Paulding County, Ohio. This desktop geohazard assessment has revealed no subsurface conditions that would preclude development of the proposed wind project. The following table summarizes the geologic hazards that were evaluated, the associated risk level, and a recommendation of additional evaluation, if applicable. This executive summary table should be viewed in the context of the entire report for a full understanding of the geohazard risk potential and anticipated subsurface conditions.

Geohazard	Risk Level	Additional Evaluation Recommendation	
Expansive Soil	Moderate	Confirm soil classifications and test volume change of soil during geotechnical investigation.	
Collapsible Soil	Low	Confirm soil classifications and test volume change of soil during geotechnical investigation.	
Corrosive Soil	Low-High	Perform lab testing and corrosion evaluation.	
Earthquakes, Seismicity, Liquefaction	Low-Moderate	Include seismic design parameters in the geotechnical report.	
Shallow Bedrock	Moderate-High	Perform soil borings during geotechnical investigation, including rock coring.	
Shallow Groundwater	Moderate-High	Record depth to water in borings and install piezometers at turbine locations during geotechnical investigation.	
Karst Features	Low-Moderate	Perform additional evaluation during geotechnical investigation.	
Mining	Low	None.	
Flooding	Low-Moderate	Perform a detailed hydrologic study.	
Frost	Low-Moderate	Include frost considerations in geotechnical report recommendations.	
Soft/organic soils Moderate		Test soil strength during geotechnical investigation.	

Table 1: Executive summary of geohazard assessment findings.

2.0 Introduction

This report presents the findings of the Desktop Geohazard Assessment conducted by Westwood Professional Services (Westwood) for the proposed Grover Hill Wind Project (Project). The project involves the construction of an array of wind turbine generators (WTGs) and associated infrastructure located on approximately 9,700 acres of land in Paulding County, Ohio. The primary focus of this report is to present the findings of the desktop geohazard assessment and discuss the risk level each hazard poses to the Project. Recommendations are provided for additional evaluations to assess risk that are beyond the scope of this work.

This report is intended for the exclusive use of Starwood Energy Group, to support the development of the proposed Grover Hill Wind Project. Subsequent investigations and studies will be necessary to more accurately characterize the subsurface conditions and geologic hazards across the project site.

2.1 Project Location and Description

The proposed Project site is located around the town of Grover Hill, Ohio. The site is approximately 15 miles east of the Ohio/Indiana border. Refer to Exhibit 1 for a map of the project site and surrounding area. The Project is located in the Eastern Lake Section of the Central Lowland Province of the Interior Plains Physiographic Region (USGS, 2013). The Project is approximately 5 to 10 miles north of the Till Plains Section of the same Province and Physiographic Region. Based on aerial imagery, the present land use is predominately agriculture and woodland. Several creeks cross within the project boundary (Exhibit 1).

2.2 Local Geology

The Central Lowlands Province is the largest physiographic region in the continuous United States at approximately 585,000 square miles. This region is characterized by its glaciated history, and is generally geologically composed of glacial sediment above largely horizontal Paleozoic sandstones, shales, limestones, conglomerates, and coals. Many minerals are mined in the Central Lowlands, including sandstone and limestone in Ohio and Indiana (NPS, 2019).

Based on Web Soil Survey data available through the United States Department of Agriculture (USDA, 2020), many soil units have been mapped within the project boundary, as shown on Exhibit 2. The three most prominent soil units are Paulding clay (approximately 53% coverage within the project boundary), Latty silty clay (22%) and Nappanee silty clay loam (9%). Paulding clay is mapped as fat clay (United Soil Classification System: CH) and described as a clayey glaciolacustrine deposit. Latty silty clay is mapped as lean or fat clay (CL, CH) and is described as clayey glaciolacustrine deposits over clayey till. Nappanee silty clay loam, primarily located in river floodplains on site, is mapped as lean or fat clay (CL, CH), and is described as reprised as a clayey glaciolacustrine deposits over clayey till. Nappanee silty clay loam, primarily located in river floodplains on site, is mapped as lean or fat clay (CL, CH), and is described as reprised as glacial till. Other soil units within the project boundaries primarily classify as lean clay (CL), fat clay (CH), silt (ML), and elastic silt (MH), and are primarily described as clayey glaciolacustrine deposits, glacial till, and alluvium.

According to the Geologic Map of Ohio, the project site is mapped within the Salina Group (Ohio Geological Survey, 2005; Exhibit 3), which primarily consists of Silurian Dolostone with occasional thin beds of shale and evaporite rock. North of the Project, three Devonian geologic units are mapped within 10 miles of the project site. The Detroit River Group is composed dolostone and limestone, with

some sandstone at the base of the unit. The Dundee Limestone is primarily thin-bedded fossiliferous limestone with some cherty dolostone in the lower portion of the unit. The Traverse Group is split into an upper unit composed of dolostone and a lower unit composed of shale interbedded with limestone. The depth to bedrock across the project site is generally expected to be between 10 and 50 ft bgs based on public records of water well logs (Exhibit 6; ODNR, 2020a).

3.0 Geologic Hazards

3.1 Expansive Soil

Expansive or swelling soils have the potential to undergo volume expansion upon wetting or drying. Swell potential depends strongly on physicochemical interactions between particles, and swelling soils predominantly occur in arid and semiarid areas where the soil contains large amounts of lightly weathered clay minerals. The majority of surficial soils on site are classified as fat clay (USDA, 2020; Exhibit 2), and are mapped with a low to moderate linear extensibility (USDA, 2020; Exhibit 4), which is a laboratory measured soil property that describes the difference in soil volume between dry and moist state. The United States Army Corps of Engineers technical manual for foundations in expansive soils (USACE, 1983) maps the project area as an area of generally low expansive character and/or low frequency of occurrence.

Volume increase may cause uplift forces that can create foundation instability and localized tension zones where cracking may occur. Soil shrinkage may also occur with drying of these clays and can cause differential settlement. The potential for expansive soils to impact the project is considered moderate due to the presence of fat clay, and should be investigation further in a geotechnical investigation. During the geotechnical investigation, expansion potential of soils at key infrastructure locations should be quantified through in situ and laboratory testing.

3.2 Collapsible Soil

Collapsible soils are found throughout the world in soil deposits that are eolian, subaerial, colluvial, mudflow, alluvial, residual, or manmade fills. They are defined as any unsaturated soil that undergoes a radical rearrangement of particles and greatly decreases in volume upon wetting, additional loading, or both. Collapsible soils are typically found in arid or semiarid regions with a loose soil structure, and a water content far less than saturation. Typically the structure of these low-unit weight, unconsolidated sediments consists of coarser particles bonded at their contact points by the finer silt and/or clay fraction, or possibly by surface tension in the water at the air-water interfaces. Collapse is unlikely to occur in soils which lie below the water table.

According to the Web Soil Survey (USDA, 2020), most soils at the project site have a significant finegrained particle fraction. In the presence of moisture, the fine-grained particles will act as binder and counteract soil collapse. The potential for collapsible soil is considered low for this site, although consolidation tests may be warranted during the geotechnical investigation to assess soil compressibility.

3.3 Corrosive Soil

Corrosive soils have the potential to create electrochemical or chemical reactions that may corrode or weaken buried concrete and steel foundations over time. To assess this hazard, soil composition data was analyzed from the NRCS Web Soil Survey pertaining to soils considered corrosive to concrete and corrosive to steel (USDA, 2020). The potential for concrete corrosion was characterized as low across the Project site by the USDA with consideration to sulfate and sodium content, texture, moisture content, and acidity (pH) of the soil. The potential for corrosion of (uncoated) steel is considered high by the NRCS Web Soil Survey with consideration to soil moisture, particle-size distribution, acidity (pH) and electrical conductivity of the soil (USDA, 2020).

Corrosivity tests should be performed on shallow soil samples collected within the Project site as part of the geotechnical investigation to better characterize corrosion potential to buried steel and concrete foundations. A detailed corrosion evaluation may be performed based on the results of corrosivity tests performed during the geotechnical investigation.

3.4 Earthquakes, Seismicity, and Liquefaction

According to the USGS fault database (USGS, 2020), there are no active faults within or near the project site, and there is very little potential for surface fault rupture to occur. Although faults do not exist near the project site, seismicity can still be a hazard in the form of ground shaking from earthquake events at greater distances from the project site. At least 200 earthquakes above magnitude 2.0 have been recorded in Ohio since the earliest recording in 1776. Although the majority of these events have had a magnitude of 3.0 or less, at least 15 earthquakes have caused surficial damage. These earthquakes have primarily occurred in two distinct zones. The Northeastern Ohio Seismic Zone in Lake and Ashtabula Counties was most active in the late 1980's, which may have been induced by deep well fluid injection. The Western Ohio Seismic Zone, 30 to 50 miles south of the Project site was most active in the 1930's and generally has earthquakes that occur 3 miles below the surface along faults associated with a Precambrian failed rift zone (USGS 2019a; Exhibit 5).

Two of the largest earthquakes events in Ohio history, magnitudes 5.4 and 5.0, occurred in early March, 1937, approximately 40 miles south of the Project site. The shake map from a magnitude 4.5 earthquake located 32 miles south of the Project site recorded weak to not-felt ground shaking at the Project site, which would have not caused surficial damage. There are no shake maps associated with the 5.0+ events in the USGS database, however, the magnitude of these events at the distance to the Project site can generally be assumed to have caused weak to light perceived ground shaking. The project site is outside of the primary influence zone of the Western Ohio Seismic Zone (Exhibit 5). Structural design of project infrastructure should account for seismic shaking, in accordance with applicable codes and standards. Hazard from earthquakes and associated seismicity is considered low to moderate.

Liquefaction is the loss of soil strength from a rapid change in stress condition (most commonly earthquake seismicity), causing the soil to lose shear strength and behave like a liquid. Soils that are coarse-grained, loose, saturated, and poorly-graded are most susceptible to densification under cyclic seismic loading. Cyclic softening may also occur as a result of seismicity in fine-grained soils, particularly where less than 15% of fines are clay sized particles (Boulanger and Idriss, 2006). Other factors that are more difficult to identify such as fabric, confining pressure, and initial stress state may also affect a soil's propensity to liquefy. The shallow lean and fat clays (CL, CH) mapped on site (USDA, 2020; Exhibit 2) are

not considered susceptible to liquefaction or cyclic softening, and liquefaction is considered a negligible hazard.

3.5 Shallow Bedrock

The bedrock beneath the Project site is expected to be dolostone with occasional thin beds of shale and evaporite rock, designated as the Salina Group (Ohio Geological Survey, 2005; Exhibit 3). According to bedrock topography mapping by the Ohio Geological Survey, the surface of bedrock at the Project site ranges from approximately 680 to 720 feet above mean sea level (Ohio Geological Survey, 2003; Exhibit 6). Ground surface elevation varies from approximately 700 to 735 feet above mean seal level (USGS, 2019b), which suggests bedrock may be present at depths less than 50 feet across the Project site. Historic water well log logs in Paulding and Van Wert County (ODNR, 2020a; Exhibit 6) confirm that bedrock was generally encountered between 10 and 50 ft bgs. Exhibit 6 provides a spatial representation of the bedrock topography contours and historic water well log bedrock depths near the Project site.

If the depth to bedrock at turbine locations is less than 12 feet then rock excavations may be required. The rock may be excavated with a ripper if weathered, but could require blasting if competent. During the geotechnical investigation, the depth to rock at key infrastructure locations (e.g. wind turbines) and the strength of the rock should be analyzed with rocking coring, laboratory testing, and seismic surveys. The potential for shallow bedrock to affect the Project is considered moderate to high.

3.6 Shallow Groundwater

Due to glacial depositional environment and seasonal variation in precipitation and meltwater, the Project site may have fluctuations in groundwater levels and perched shallow groundwater for extended periods. The USDA Web Soil Survey (USDA, 2020) estimates that perched groundwater can be as shallow as 2 ft below the ground surface. Historic water well logs (ODNR, 2020a; Exhibit 7) suggest that the static groundwater level is generally within 25 feet of the ground surface at the Project site, and less than 5 feet below ground surface in some areas (Exhibit 7).

If conventional shallow spread (gravity) foundations are used for wind turbines, shallow groundwater may result in buoyant turbine foundation design. The presence of shallow or perched groundwater may also present challenges to open excavations and trenches by destabilizing sidewalls and subgrade if dewatering systems are not implemented. Shallow groundwater may soften access road subgrade and increase the chance of flooding/ponding on site. The potential for shallow groundwater to influence the Project is considered moderate to high. Depth to groundwater should be recorded during the geotechnical investigation, and piezometers should be installed at proposed turbine locations for dynamic observation of water levels.

3.7 Karst Features

Karst features generally develop in areas with wet subsurface conditions and soluble bedrock including carbonate rock (limestone and dolomite) or evaporite rock (e.g., gypsum, anhydrite, and halite minerals) that may dissolve over time to form underground caves and create ground instability. Karst geology can be particularly hazardous as caves develop slowly while failures are rapid, often causing several feet of

subsidence and sinkholes at the surface. Risk to wind turbines ranges from slight tilting to catastrophic failure.

Western Ohio has shallow groundwater and shallow carbonate bedrock, a prime combination for the creation of karst features. The Ohio Department of Natural Resources Department of Geologic Survey (ODNR, 2020b; Exhibit 8) maps the project site in an area of with karst potential due to "Silurian- and Devonian-age carbonate bedrock overlain by more or less than 20 feet of glacial drift and/or alluvium. According to the USGS Karst Hazard Potential in the United States map (USGS, 2014), the project area is classified as a kart potential zone with "carbonate rocks buried under <50 ft of glacially derived insoluble sediments in a humid climate". The Ohio Department of Natural Resources Department of Geologic Survey (ODNR, 2020b) maps the majority of Ohio suspected and field verified karst features in the southwestern corner of the state and near the Lake Eerie coastline in Sandusky, Seneca, Huron, Erie Counties. There are no mapped suspected or field verified karst features in Paulding or the surrounding counties; however, the Silurian Group bedrock at the Project site has been associated with suspected and field verified karst features in other parts of the state (ODNR, 2006).

Due to the mapped karst potential, shallow carbonate bedrock, and shallow groundwater, the karst hazard at this project is considered low to moderate. Karst potential should be further evaluated during the geotechnical investigation with rock coring, observing for water loss or tool drop while drilling, surveying the site for surficial karst topography such as depressions, and a visual inspection of voids in rock at nearby limestone quarries, if accessible. Geophysical surveys such as GPR, seismic refraction, electrical resistivity imaging are additional options to quantify the extent of karst features if they are identified during the geotechnical investigation.

3.8 Mining

Ohio has been an active mining state since the mid-19th century, with primarily surficial mineral mining in the west and underground coal mining in the east (ODNR, 1988). There are no abandoned underground mines mapped near the Project site and there are three active limestone surface mines within 10 miles of the Project (ODNR, 2020c; Exhibit 9). These mines are not considered a hazard to the Project, but may be useful for observing the quality and karst susceptibility of carbonate bedrock at the Project site.

3.9 Flooding

Floods are among the most frequent and damaging of natural hazards. Flooding can occur from sustained precipitation, meltwater, overflows of dam or water systems, or some combination of these factors. Ohio has had several damaging floods in its history (NOAA, 2020), and three flood-related deaths in 2019 (OCSWA, 2020). Exhibit 10 shows the Federal Emergency Management Agency (FEMA) mapping for 100-year floodplains near the Project site (FEMA, 1989). The FEMA floodplains follow the main natural waterways that intersect the Project site, including Prairie Creek, West Branch Prairie Creek, and Middle Creek. Building Project infrastructure within the floodplains is not recommended. The flooding hazard for this Project is considered low to moderate. A detailed hydrologic study should be performed to fully quantify the flood-related risks to this project.

3.10 Frost

The shallow clay expected at the Project site (Section 2.2; Exhibit 2) are considered frost susceptible soils in cold climate regions, such as Northern Ohio. Frost heave can occur when frozen soil below shallow foundations heaves due to the formation of ice lenses. The USDA Web Soil Survey (2020) maps nearly the entire project site as an area of high frost susceptibility. The Naval Facilities Engineering Command Design Manual 7.01 (1986) maps the extreme frost depth at the Project as 3 feet.

Critical foundations and pipes should be placed below extreme frost depth or designed to accommodate the effects of frost. Conventional turbine foundations typically bear beneath the extreme frost depth. Access roads may require additional maintenance and gravel placement during the spring thaw. Due to the high frost-susceptibility of soils on site but the relatively low expected impact on the Project, frost hazard is considered low to moderate.

3.11 Soft/Organic Soils

Soft organic soil can sometimes be found in topographically low and agricultural areas, exhibiting low strength and high compressibility. Foundations located in areas of soft/organic soil may have reduced bearing capacity and increased compressibility which may present challenges to the design of shallow foundations. Access roads may also require a thicker gravel cross section and subgrade stabilization/reinforcement.

Web Soil Survey (USDA, 2020) maps Paulding clay and Latty silty clay, which cover approximately 75% of the Project area, with organic contents of approximately 5%. Both of these soil units are classified as fat clay, which can be soft and compressible, especially when wet. The other soil units on site are expected to have organic contents generally varying between 2% and 4%. Based on the published organic contents, prevalence of fat clay, and predominate agricultural land use, the potential for soft and organic soils to affect the Project is considered moderate.

4.0 Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use by Starwood Energy Group for the Grover Hill Wind Project. The desktop geohazard assessment in this report was based on a review of available resources and is dependent on the accuracy of data compiled by others. Careful consideration and judgment was used to choose reliable sources; however, a subsequent detailed geotechnical investigation and other work recommended in this report will be necessary to validate conditions and more accurately characterize the geologic hazards and subsurface conditions across the site. The primary focus of this report was to identify the potential risk of various geohazards and provide recommendations for additional analyses and investigations.

In the event that any changes in the nature, design, or location of the project site are made, the conclusions and recommendations contained in this desktop report should not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing by

Westwood. Westwood is not responsible for any claims, damages, or liability associated with the interpretation of this data by others.

5.0 References

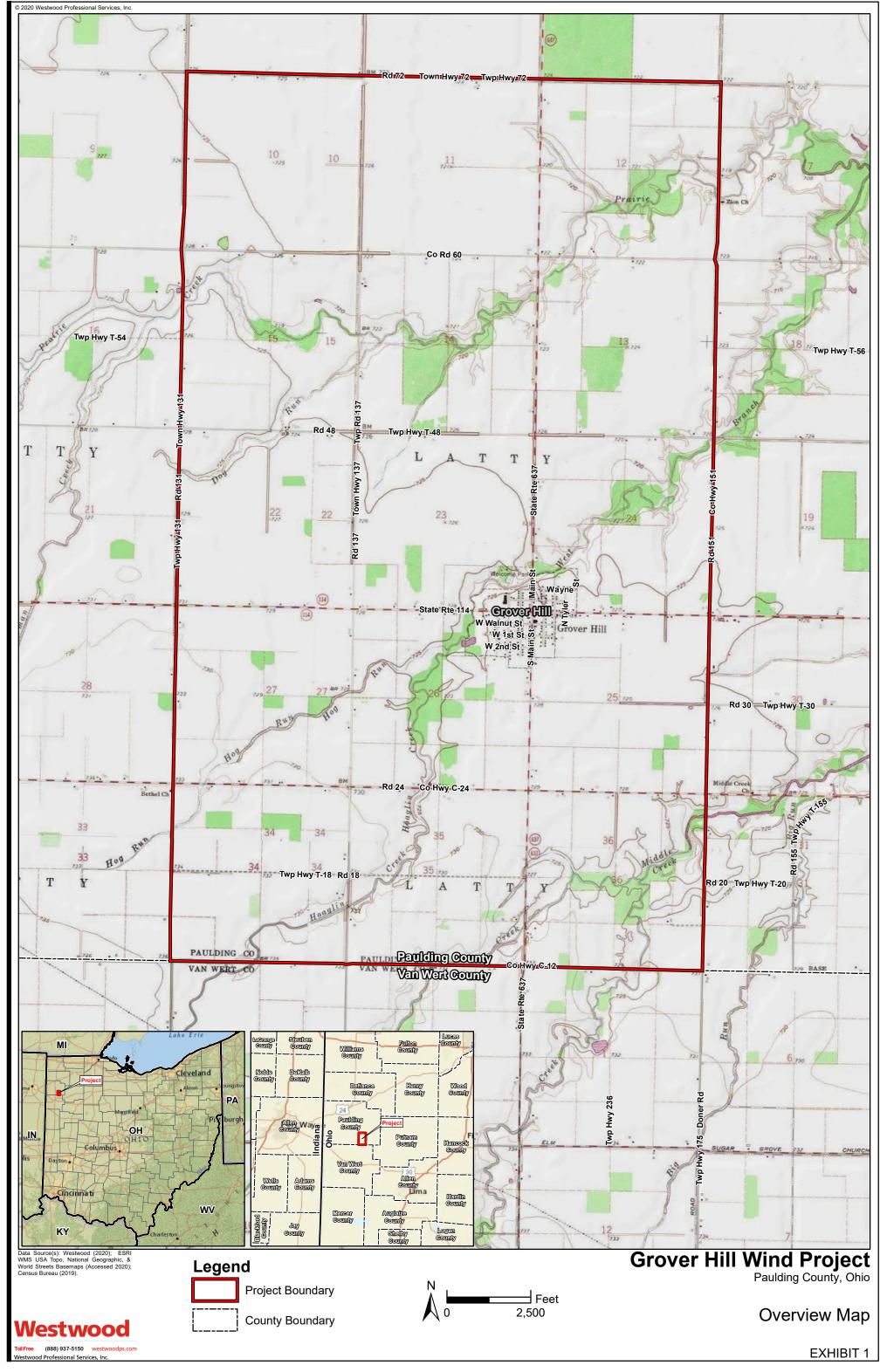
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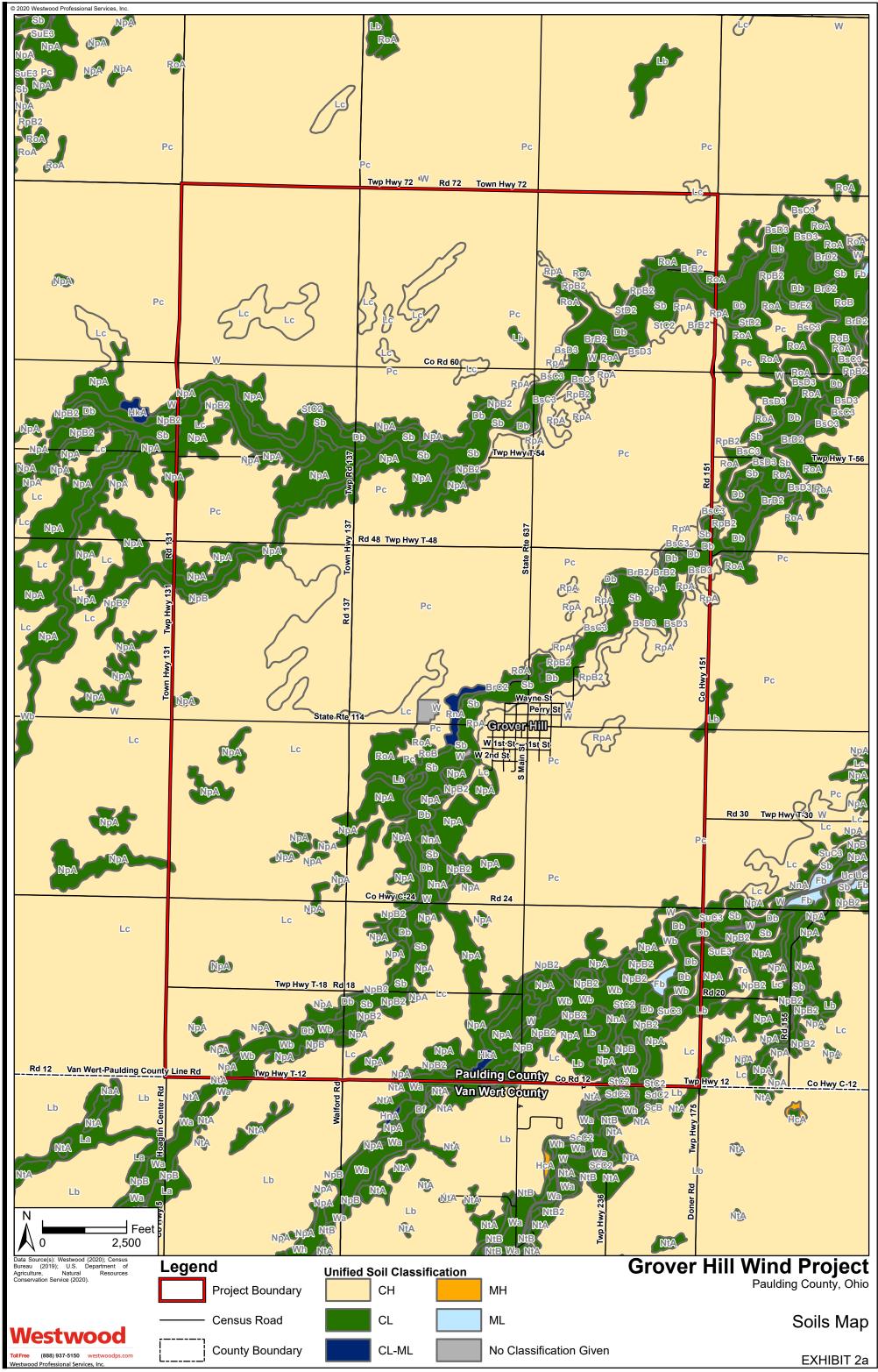
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Map Unit Symbol | Map Unit Name

- BrB2 | Broughton silty clay loam, 2 to 6 percent slopes, eroded
- BrC2 | Broughton silty clay loam, 6 to 12 percent slopes, eroded
- BrD2 | Broughton silty clay loam, 12 to 18 percent slopes, eroded
- BrE2 | Broughton silty clay loam, 18 to 35 percent slopes, eroded
- BsC3 | Broughton silty clay, 6 to 12 percent slopes, severely eroded
- BsD3 | Broughton silty clay, 12 to 18 percent slopes, severely eroded
- Db | Defiance silty clay loam, occasionally flooded
- De | Defiance silt loam
- Df | Defiance silty clay loam
- Fb | Flatrock silt loam, occasionally flooded
- FtA | Fulton loam, 0 to 2 percent slopes
- HcA | Hoytville silty clay loam, 0 to 1 percent slopes
- HkA | Haskins loam, 0 to 2 percent slopes
- HnA | Haskins loam, 0 to 2 percent slopes
- HtA | Hoytville silty clay, 0 to 1 percent slopes
- La | Latty silty clay loam
- Lb | Latty silty clay loam
- Lb | Latty silty clay, till substratum, 0 to 1 percent slopes
- Lc | Latty silty clay, till substratum, 0 to 1 percent slopes
- LuB2 | Lucas silty clay loam, loamy substratum, 2 to 6 percent slopes, eroded
- Md | Mermill silt loam
- Mg | Millgrove silty clay loam
- NaA | Nappanee loam, 0 to 2 percent slopes
- NnA | Nappanee loam, 0 to 2 percent slopes
- NpA | Nappanee silt loam, 0 to 2 percent slopes
- NpA | Nappanee silty clay loam, 0 to 2 percent slopes
- NpB | Nappanee silt loam, 2 to 6 percent slopes
- NpB | Nappanee silty clay loam, 2 to 6 percent slopes
- NpB2 | Nappanee silty clay loam, 2 to 6 percent slopes, eroded
- NtA | Nappanee silty clay loam, 0 to 2 percent slopes
- NtB | Nappanee silty clay loam, 2 to 6 percent slopes
- NtB2 | Nappanee silty clay loam, 2 to 6 percent slopes, moderately eroded
- Pc | Paulding clay, 0 to 1 percent slopes
- RnA | Roselms loam, 0 to 2 percent slopes
- RoA | Roselms silty clay loam, 0 to 2 percent slopes
- RoB | Roselms silty clay loam, 2 to 6 percent slopes
- RpA | Roselms silty clay, 0 to 2 percent slopes
- RpB2 | Roselms silty clay, 2 to 6 percent slopes, eroded
- Sb | Saranac silty clay loam, occasionally flooded
- ScB | St. Clair silt loam, 2 to 6 percent slopes
- ScC2 | St. Clair silt loam, 6 to 12 percent slopes, moderately eroded
- SdC2 | St. Clair silty clay loam, 6 to 12 percent slopes, eroded
- Sh | Shoals silt loam occasionally flooded

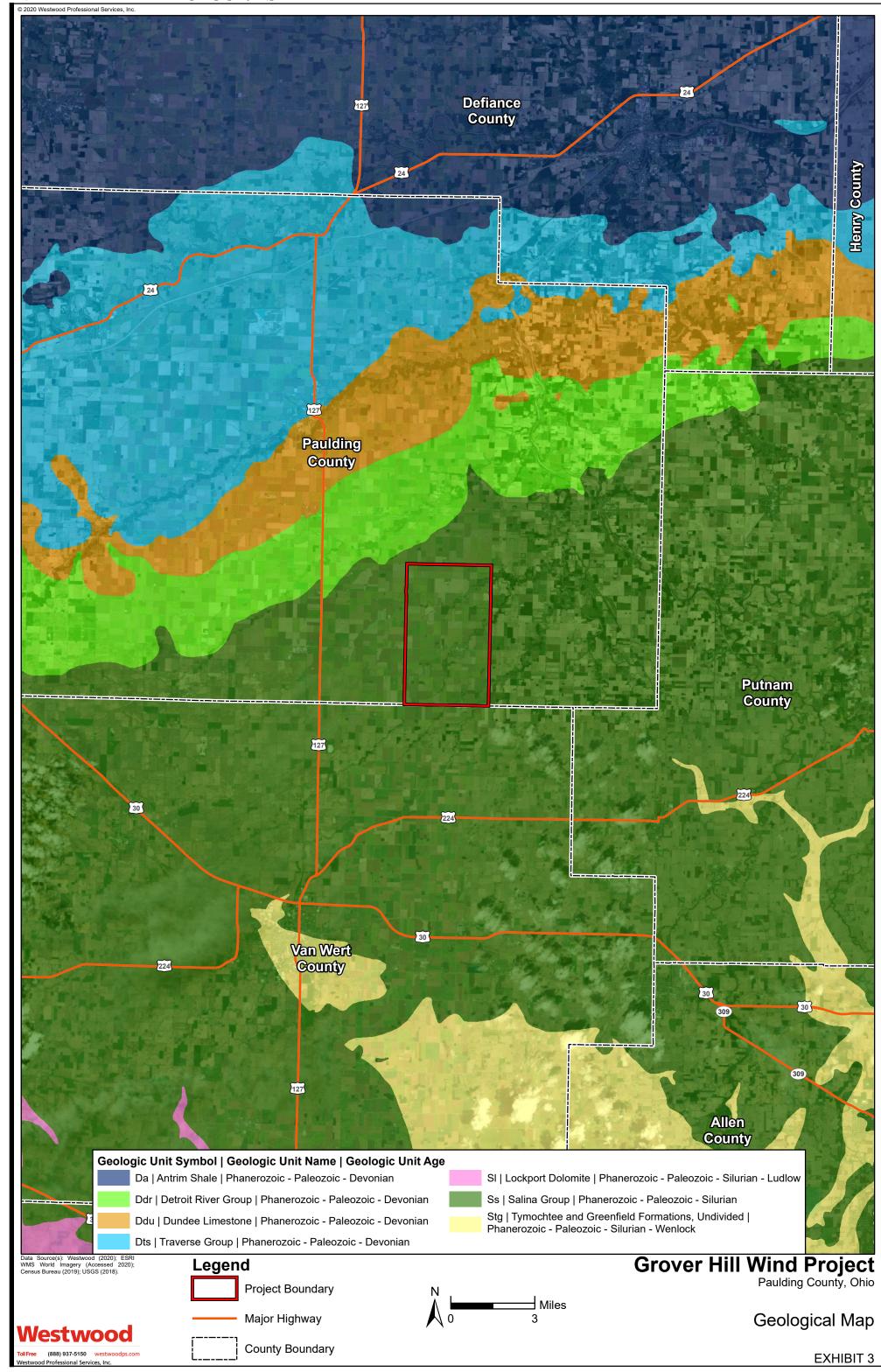
Data Source(s): Westwood (2020): U.S. Department of Agriculture, Natural Resources Conservation Service (2020).	G	rover Hill Wind Project Paulding County, Ohio
	Wh Wabasha silty clay	
	Wb Wabasha silty clay loam, frequently flooded	
	Wa Wabasha silty clay loam	
	W Water	
	Uc Udorthents, clayey, hilly	
	To Toledo silty clay, 0 to 1 percent slopes	
	SuE3 St. Clair silty clay, 12 to 25 percent slopes, severely eroded	
	SuC3 St. Clair silty clay, 6 to 12 percent slopes, severely eroded	
	StD2 St. Clair silty clay loam, 12 to 18 percent slopes, eroded	
	StC2 St. Clair silty clay loam, 6 to 12 percent slopes, eroded	
	Sh Shoals silt loam, occasionally flooded	

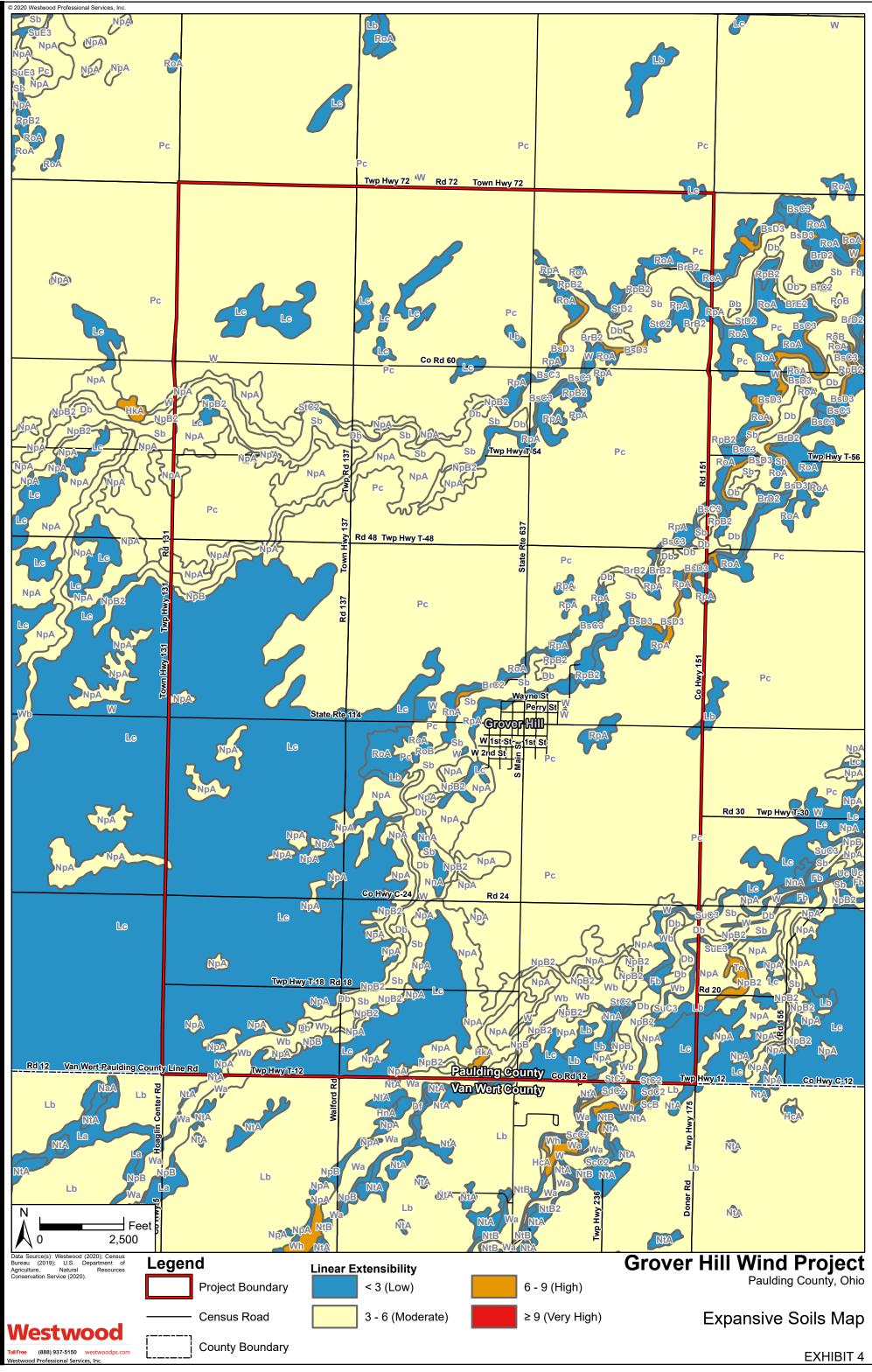
Soils Map Key

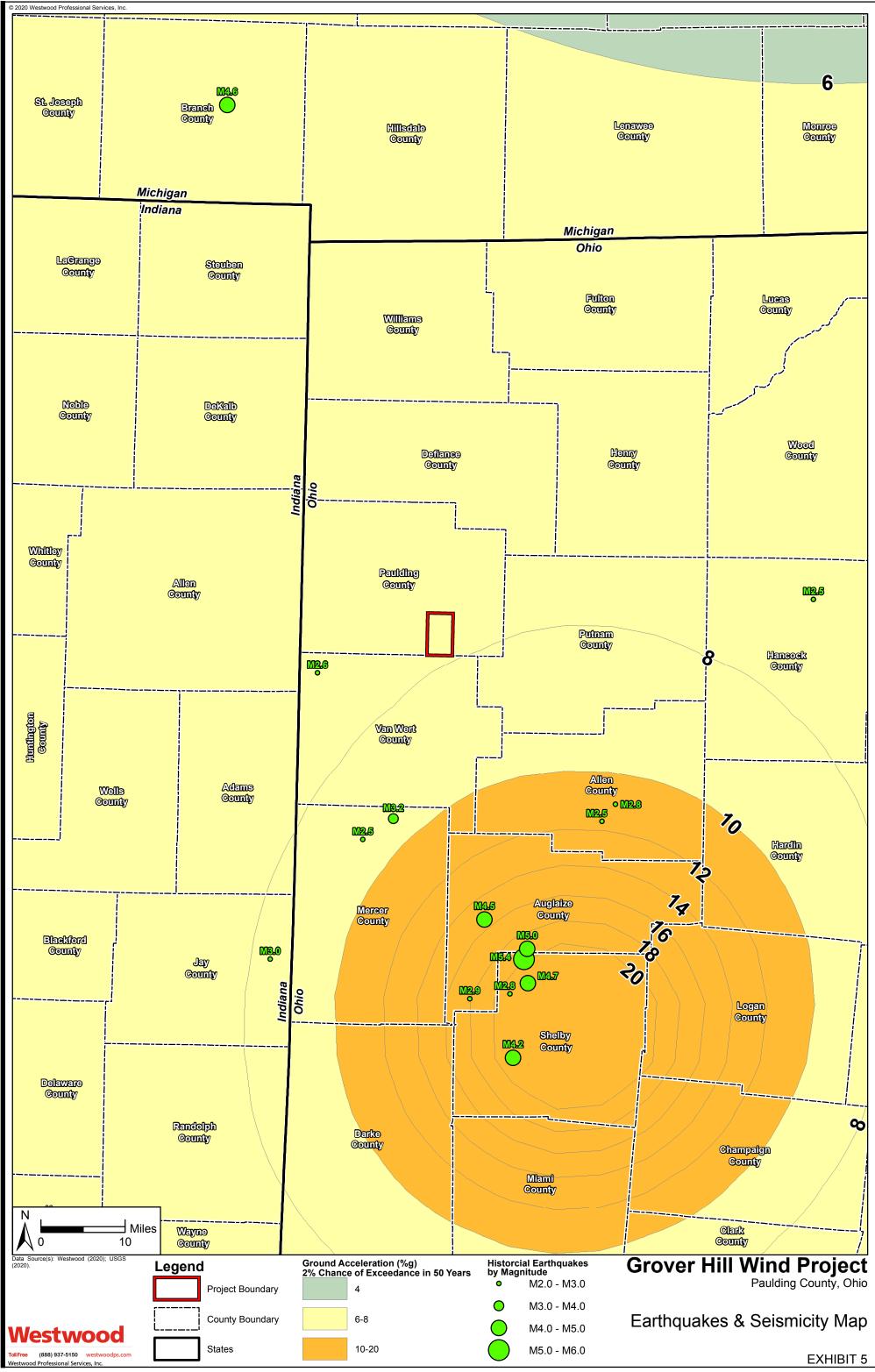
EXHIBIT 2b

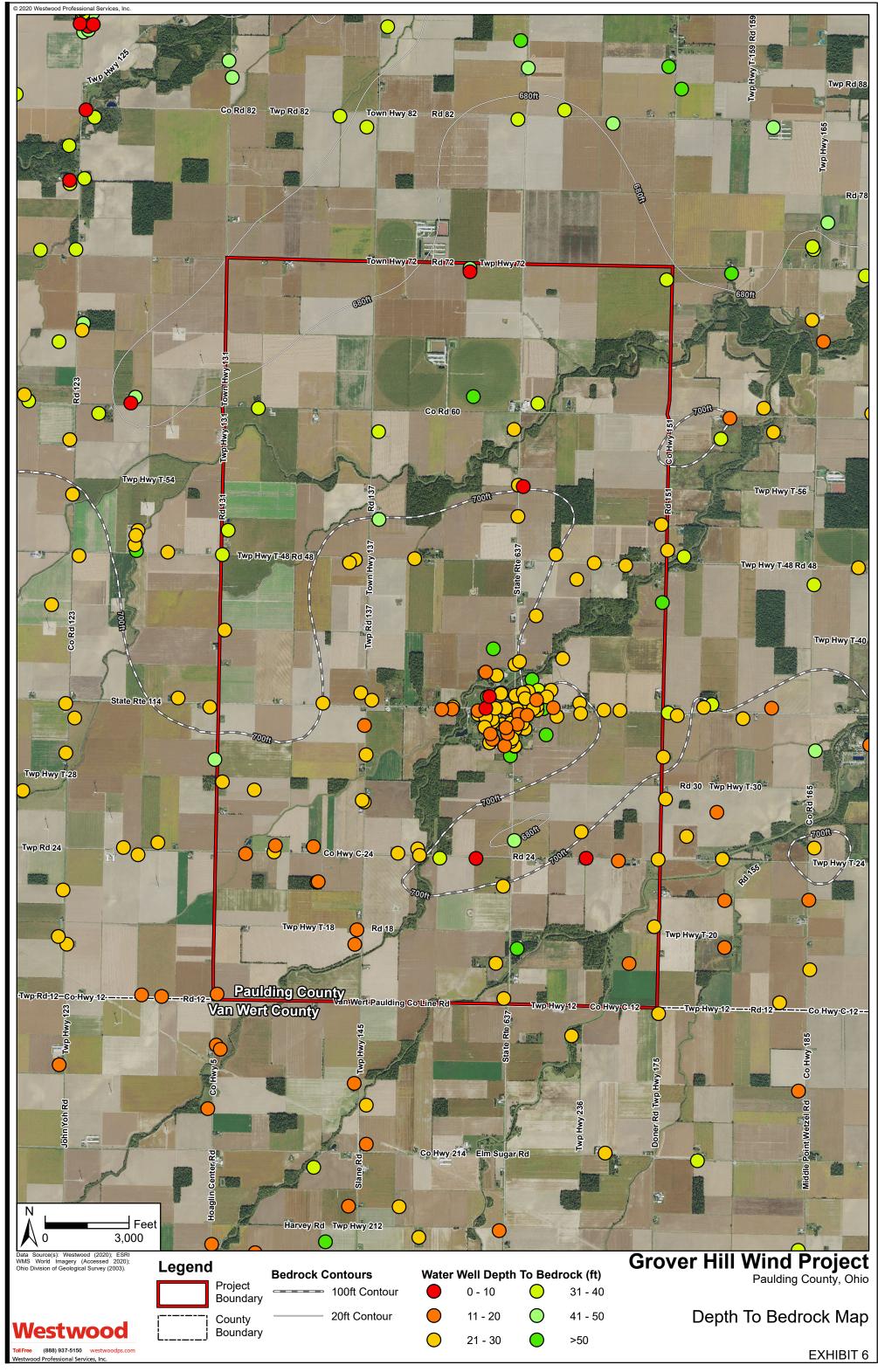


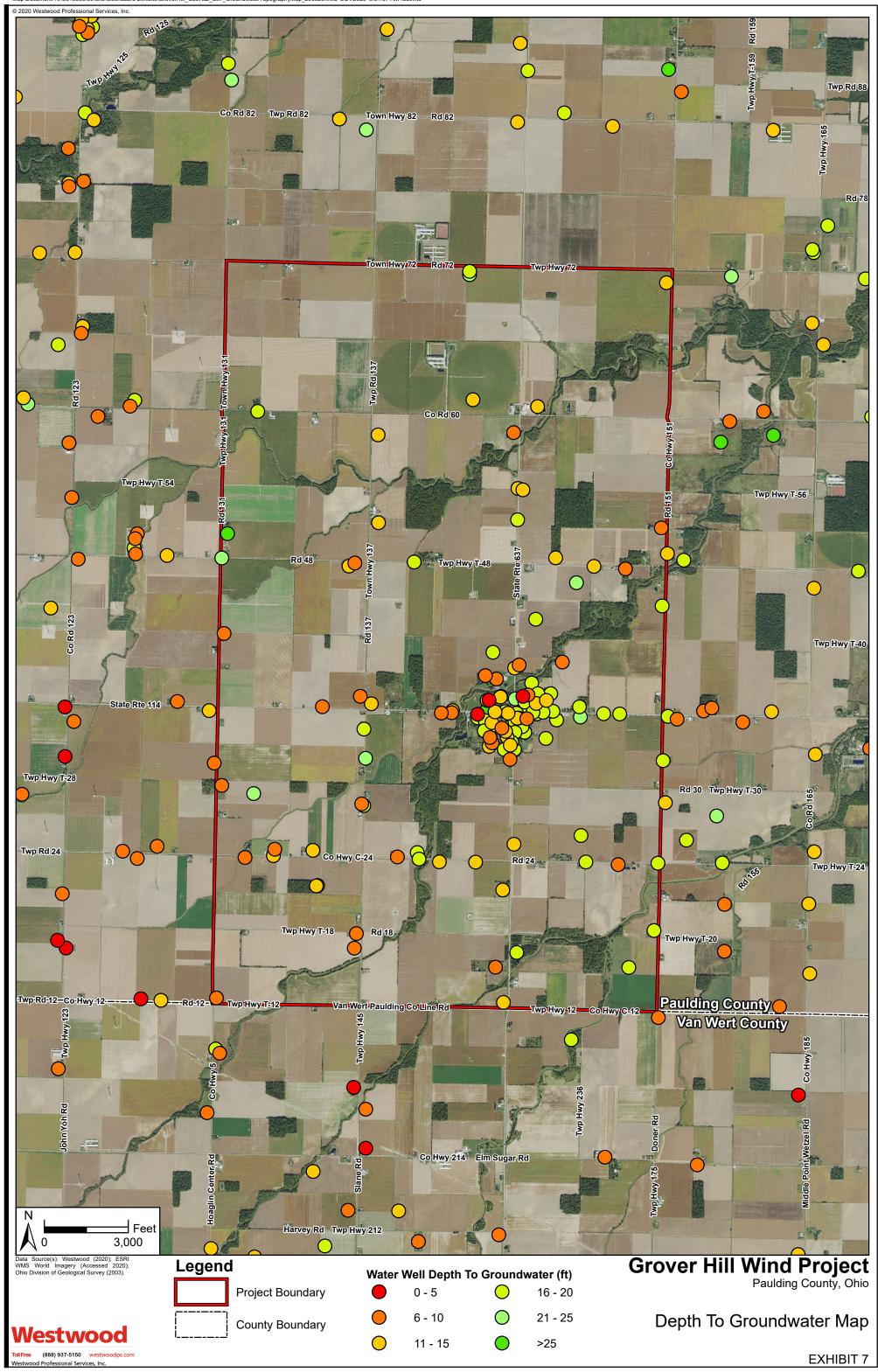
estwood Professional Services, Inc

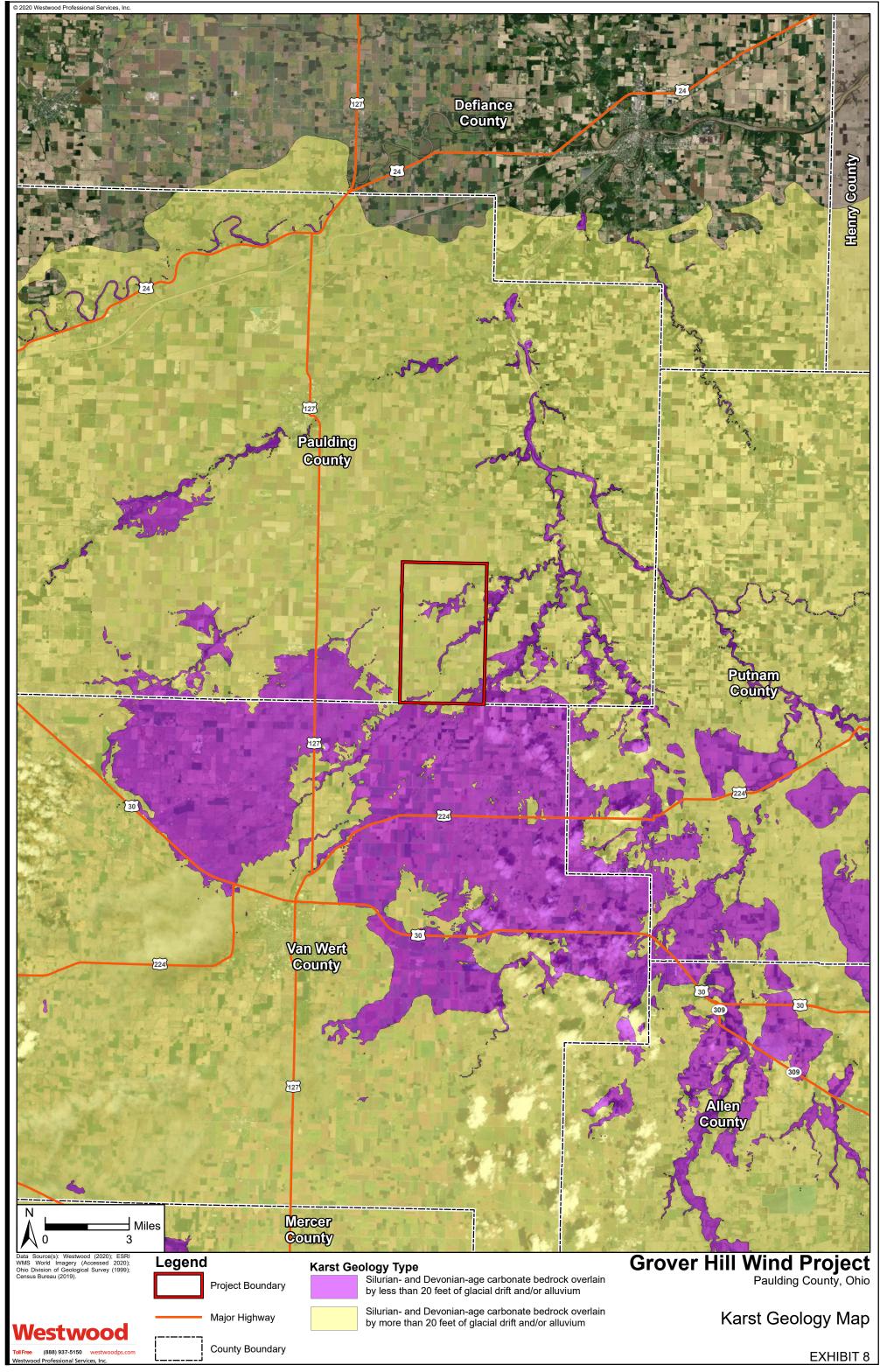


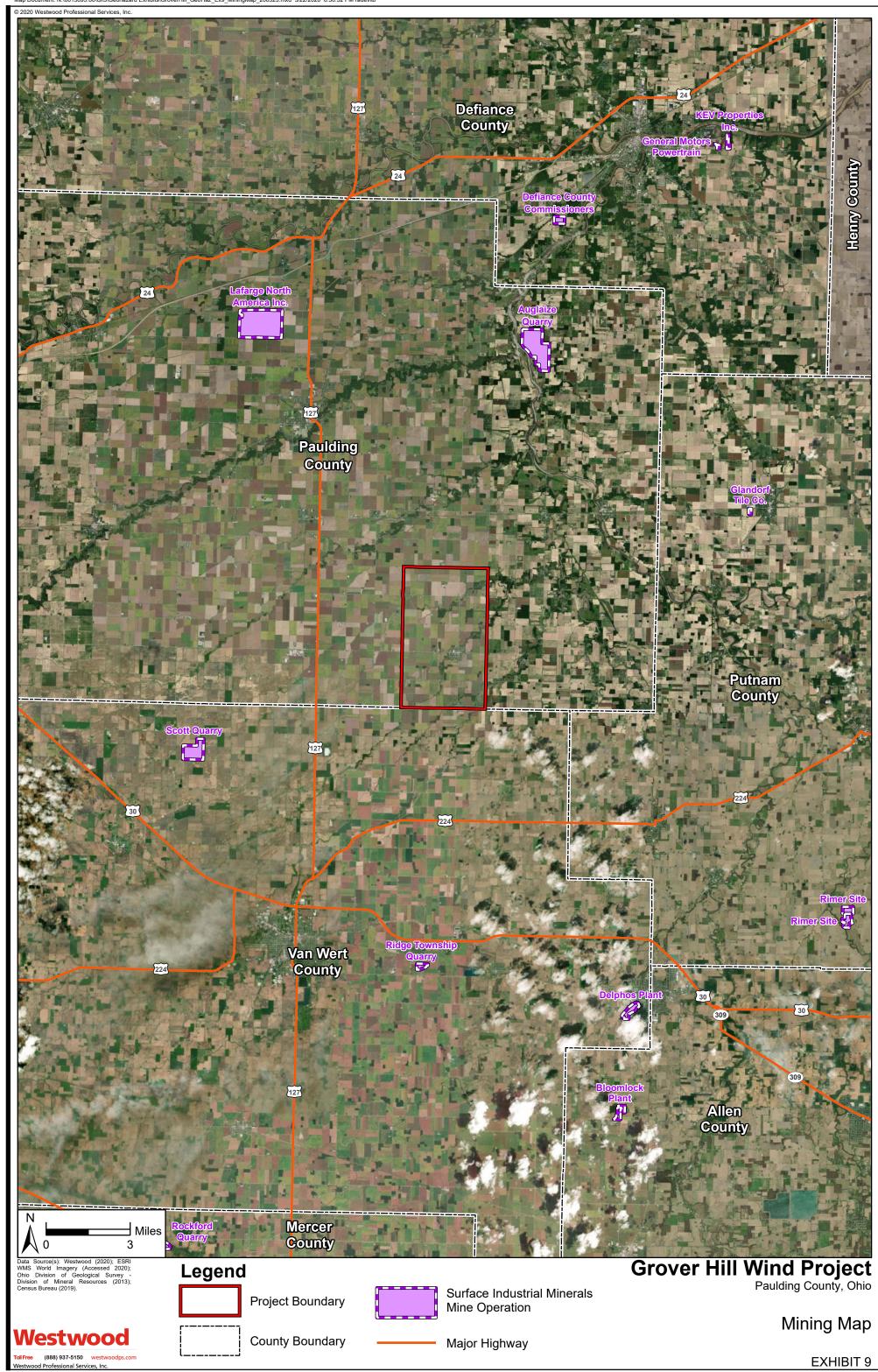


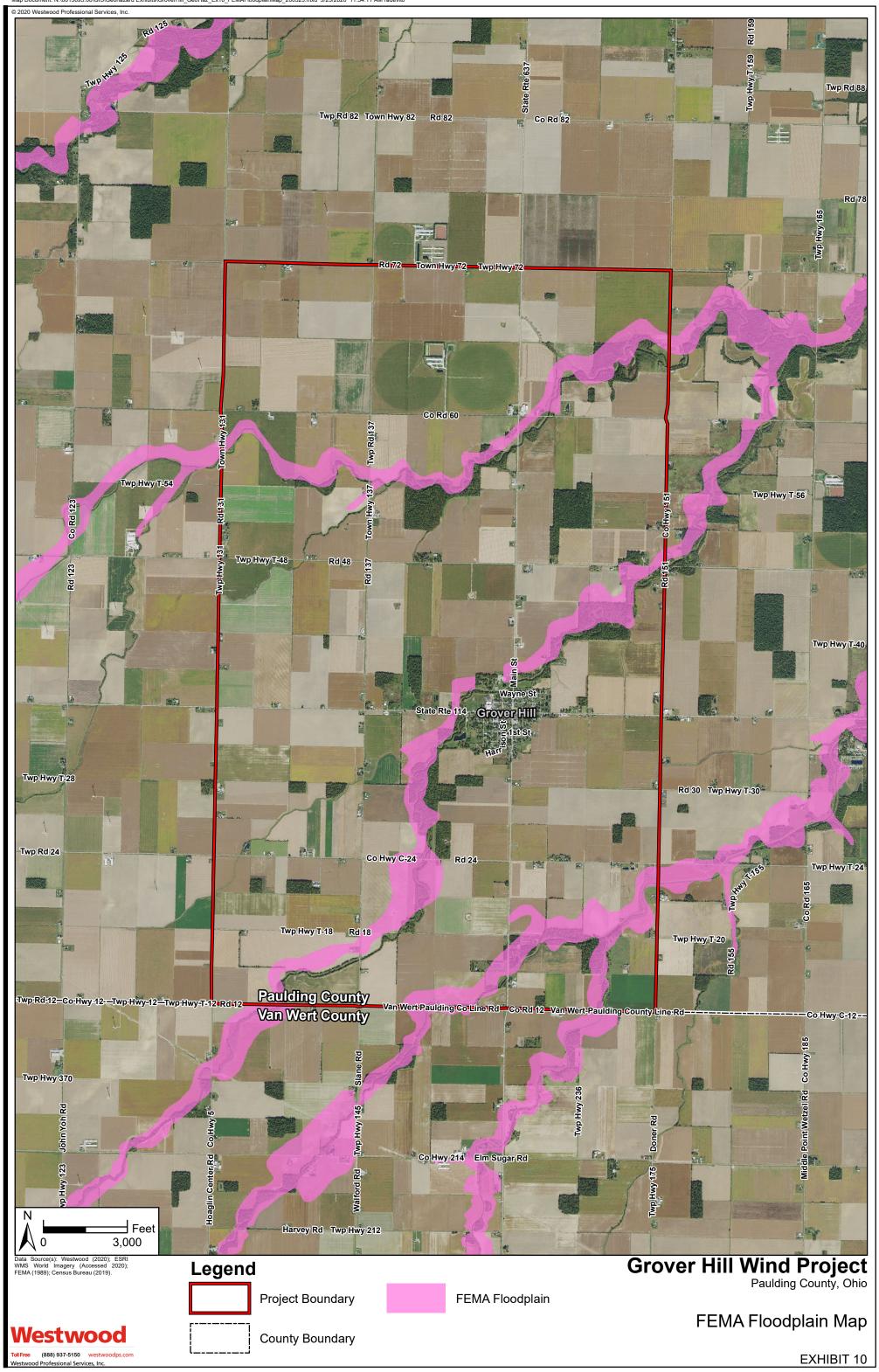












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Summary: Application - 10 of 40 (Exhibit G - Desktop Geotechnical Assessment) electronically filed by Christine M.T. Pirik on behalf of Grover Hill Wind, LLC