

Attachment 2.11
Desktop Geohazard Report

DESKTOP GEOHAZARD REPORT

Overland Pass Energy East Project

Sedgwick County, Colorado

May 24, 2024

PREPARED FOR:



PREPARED BY:

Westwood

Westwood

Desktop Geohazard Report

Overland Pass Energy East Project

Sedgwick County, Colorado



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Executive Summary

Westwood Professional Services (Westwood) is pleased to present this Desktop Geohazard Report to National Renewable Solutions for the proposed Overland Pass Energy East Project (Project) located in Sedgwick County, Colorado. This desktop geohazard assessment has revealed no subsurface conditions that would preclude development of the proposed wind project, although special consideration should be given to further evaluating the collapse potential of the shallow silt on site. The following table summarizes the geologic hazards that were evaluated, the associated risk level, and a recommendation for 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.

Table 1: Executive summary of geohazard assessment findings.

Geohazard	Risk Level	Additional Evaluation Recommendations
Soft/loose/organic soil	Low to Moderate	Evaluate with field and laboratory tests during geotechnical investigation
Collapsible soil	Moderate	Collect relatively undisturbed samples and evaluate with lab testing during geotechnical investigation
Expansive soil	Low	Evaluate plasticity of shallow soil with field and laboratory tests during geotechnical investigation.
Corrosive soil	Low (concrete) Moderate (steel)	Collect soil samples and evaluate with lab testing and electrical resistivity tests during geotechnical investigation
Frost action	Low	Confirm soil profiles and evaluate static groundwater level during geotechnical investigation
Shallow bedrock and obstructions	Moderate	Perform soil borings and rock coring (if required) during geotechnical investigation
Karst features	Low	Evaluate karst features during geotechnical investigation through rock coring and field observations
Mining	Low	None
Seismicity and liquefaction	Low	Design structures to resist seismic shaking, in accordance with applicable Codes.
Landslides and rock falls	Low	Perform observations of existing slope condition and avoid locating infrastructure on or near steep slopes.

Table 2: Executive summary of select geotechnical risks.

Project Element	Geotechnical Risk	Risk Level
Wind Turbine Spread Footing Foundations	Weak or problematic subgrade soil, or shallow groundwater, requiring ground improvement, buoyant foundation, or alternative foundation design.	Low
Deep Foundations	Deep drilled pier embedment depths due to weak soil capacity.	Low
Shallow Foundations	Weak or problematic subgrade soil requiring ground improvement or alternative foundation design.	Low to Moderate
Foundation Corrosion	Sacrificial steel and/or galvanization of steel and/or sulfate-resistant cement for slab-on-grade foundations.	Low to Moderate
Access Roads	Weak or problematic subgrade soil requiring thicker aggregate section, chemical stabilization (e.g., cement), or geosynthetic reinforcement.	Low to Moderate
Underground Cable	High thermal resistivity causing the need for increased cable sizing.	Moderate
Grading/Trenching	Shallow rock/cemented soil may require ripping/blasting and increase grading costs.	Low to Moderate
Fill Placement	Native soil is sensitive to moisture but may require moisture conditioning for adequate compaction.	Moderate
Groundwater	Shallow groundwater in excavations requiring dewatering.	Low
Erodibility	Moderate erosion potential of shallow soils requiring minimal ground disturbance and/or potential for additional ground stabilization and erosion control measures.	Low to Moderate

1.0 Introduction

This report presents the findings of the desktop geohazard assessment conducted by Westwood Professional Services (Westwood) for the proposed Overland Pass Energy East Project. Westwood understands that the Project is located in **Sedgwick County**, Colorado. 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 studies or investigations that are beyond the scope of this work but may be performed to further evaluate risk.

This report is intended for the exclusive use of National Renewable Solutions, to support the development of the proposed Overland Pass Energy East Project. Data was gathered from publicly available sources. Subsequent investigations and studies will be necessary to characterize the subsurface conditions and geologic hazards more accurately across the project site.

The proposed project site is located approximately 5 miles south of **Sedgwick**, Colorado. Refer to Exhibit 1 and 2 for a map of the project site and topography of the surrounding area.

1.1 Regional Geology

The project site is located in the High Plains Section of the Great Plains Province within the Interior Plains Physiographic Region (USGS, 2013). The High Plains section encompasses the majority of Nebraska west of Lincoln, and stretches into eastern Wyoming and Colorado, and south through the Panhandle of Texas. This physiographic section is characterized by relatively flat lying horizontal sedimentary bedrock deposited during periods of shallow inland seas of the continent, and then overlaid by fluvial deposited sedimentary rock of the Ogallala formation during uplift of the Rocky Mountains (Trimble, 1980). Sand dunes and windblown silt/clay deposits (loess) now cover the High Plains of eastern Colorado and buries the underlying Ogallala formation.

According to a geologic map of Colorado, the project is mapped within the Peoria Loess, Ogallala, and Eolian Sands geologic formations (USGS, 1978). Peoria Loess is composed of wind-blown silt with variable clay and sand content. The Peoria Loess forms in vertical cuts or columnar structures and overlies the Ogallala formation where present. The Ogallala has predominantly fine-to coarse-grained poorly sorted fluvial deposits of calcareously cemented silt and sand from the Miocene age (Exhibit 4). Eolian deposits are also mapped within the southwestern corner of the project site and are mainly composed of unconsolidated dune sand and silt (Exhibit 4). Eolian deposits form dunes that may be over 100 ft high (USGS, 1978).

1.2 Soil Profile and Groundwater

Based on Web Soil survey data available through the United States Department of Agriculture (USDA, 2023), there are a couple of primary soil units mapped on site:

- **Rago and Kuma Silt loam** (approximately 36% of the site): Classified as silt (ML) and lean clay (CL) in the upper 4 feet, composed of silty eolian deposits, with silty gravel and sand (GM, SM) below 4 feet,
- **Richfield Loam** (~24%): Classified as lean clay (CL), and silt (ML), composed of silty eolian deposits, with higher potential for clayey-silty sand below 2 feet.
- **Keith-Kuma Silt Loams** (~6%): Classified as lean clay (CL) and silt (ML), composed of silty eolian deposits.
- **Valent Sandy Loams** (7%): Classified as poorly graded sand with clay (SP-SC), composed of eolian sands.
- **Wages Gravelly Loam** (5%): Classified as silty clay (CL-ML), clayey sand (SC), silty sand (SM), and clayey gravel (GC), composed of gravelly and loamy silty eolian deposits.
- **Eckley-Chappell complex** (2%): Classified as poorly graded gravel (GP) and silty sand (SM), composed of thin mantle gravelly alluvium.

Refer to Exhibit 3 for a map of the surficial soils on site. The primary soil units' shallow soils on site have low to moderate erodibility factors (k), ranging from 0.02 to 0.55 (out of 0.7 maximum) (USDA, 2023).

Publicly available water well logs were reviewed for estimations of water table depth. Well logs found within the project site were recorded prior to 1980 and showed groundwater 180 ft below ground

surface or deeper (CWCB, 2023). Water well logs also showed a mixture of eolian deposits and occasional gravelly clays in the upper 20 ft.

2.0 Geologic Hazards

2.1 Soft/Loose/Organic Soil

Foundations located in areas of soft/loose/organic soil may have reduced bearing capacity and increased compressibility that can present challenges to the design of shallow and deep foundations. Access roads may also require a thicker gravel cross section and subgrade stabilization/reinforcement. Low density silt also tends to have a high thermal resistivity, which may increase the size of underground electrical cables.

The Web Soil Survey (USDA, 2023) maps most of the site as silt or clay derived eolian sands and loess with low organic content below the topsoil. The overall risk of soft/loose/organic soils on site is considered low to moderate, with greater potential for loose wind blown deposits in the upper 5 feet of the subsurface. Field and laboratory tests performed during the geotechnical investigation should evaluate and confirm the strength and compressibility of the soil on site.

2.2 Collapsible Soil

Soil collapse occurs when a relatively loose, dry, low-density material is inundated with water and subjected to a load. Eolian deposits such as loess are particularly prone to collapse, as their depositional environment facilitates a loose, low-density profile. The risk of collapse occurring beneath shallow foundations is generally considered low if proper subgrade preparation measures are taken. The shallow soil mapped on site is expected to be silt and lean clay or gravelly alluvium or eolian deposits, which indicates moderate potential for soil collapse. Spread footing turbine foundations are anticipated to bear between 8 and 12 feet below grade, which is typically below the anticipated depth of collapse potential. Collapse potential and consolidation tests may be performed during the geotechnical investigation to better quantify collapse potential, especially in areas with shallow foundations such as the substation.

2.3 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. 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 shallow soils on site are primarily mapped as low to moderate plasticity silt and clay, which is expected to have a low potential for expansion. The USDA classifies the soil on site as generally having low to moderate potential for soil expansion based on Web Soil Survey's linear extensibility rating (USDA, 2023). According to a US Army Corp Expansive Soil Map of the United States, the site is mapped

within an area of low swelling potential (USACE, 1977). The risk for expansive soils on site is low. Atterberg limits and swell potential tests are recommended during the geotechnical investigation to better quantify expansive soil potential.

2.4 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 USDA Web Soil Survey pertaining to soils considered corrosive to concrete and corrosive to steel. The potential for concrete corrosion was characterized as low across the site with consideration to sulfate and sodium content, texture, moisture content, and acidity (pH) of the soil (USDA, 2023). The potential for corrosion of (uncoated) steel is considered moderate with consideration to soil moisture, particle-size distribution, acidity (pH) and electrical conductivity of the soil (USDA, 2023). Maps of where these corrosion hazard levels occur in relation to the Project site are provided in Exhibits 6 and 7.

Corrosivity tests, including sulfate content, chloride content, pH, and electrical resistivity, should be performed on shallow soil samples collected within the project site during the geotechnical investigation to better characterize the potential for corrosion of buried steel and concrete structures. A detailed corrosion evaluation should also be performed as part of the design phase.

2.5 Frost Action

Frost heave can occur when frozen soil below shallow foundations expands due to the formation of ice lenses. Shallow ground water and silty soils create optimal conditions for the formation of shallow ice lenses that can cause heave (FHWA, 2006). The Naval Facilities Engineering Command Design Manual 7.01 (1986) maps the extreme frost depth at the Project as 4.0 feet. Critical foundations should be placed below the extreme frost depth or designed to accommodate the effects of frost.

The USDA Web Soil Survey (2023) shows the majority of the project site as having low to moderate frost susceptibility. Conventional drilled pier foundations could heave along with the ground surface if not designed to resist frost uplift forces. Access roads may require additional maintenance and gravel placement during the spring thaw. The potential for frost action on site is generally considered low to moderate due to the high fraction of fine-grained soil on site and frost depth, but lack of water source to develop significant ice lenses.

2.6 Shallow Bedrock and Obstructions

Shallow bedrock and subsurface obstructions, such as gravel, cobbles, boulders, and cemented soils are an important consideration when evaluating project constructability because it can inhibit trenching, drilled pier construction, and conventional excavations. Based on review of local geology and soil conditions, gravel and/or calcareously cemented soils may be encountered on portions of the site, especially at depths below 14 ft bgs. The Ogallala formation (Exhibit 3) has the highest potential for gravel and cemented soil. The potential for shallow obstructions is considered moderate.

2.7 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.

According to the USGS Karst Hazard Potential in the United States (2014), the project area does not lie in an area of karst potential. The nearest potential for carbonate rocks at or near the surface in a dry climate are shown 50 miles south of the project site, as seen in Exhibit 8. As this formation is not mapped within the project area, dissolution karst features are not expected to impact the project infrastructure.

2.8 Mining

According to the Colorado Division of Natural Resources (CODNR, 2023), no active underground mines are mapped within or near the project site. There are no sand and gravel pits located within **Sedgwick** County. The potential for ground subsidence due to the collapse of an underground mines is considered low at the Project site.

2.9 Seismicity and Liquefaction

The USGS Quaternary Fault and Fold Database shows the closest fault to the project site is the Valmont fault, located approximately 150 miles southeast of the site. The Valmont fault is a late Quaternary fault with a southern dipping direction and slip rate of less than 0.2 mm/yr (USGS, 2023a). The fault does not cross through the project boundary, and the risk of ground rupture from existing faults on site is considered low.

Seismicity can also be a hazard in the form of ground shaking from earthquake events at greater distances from the project site. According to the United States Geological Survey (USGS, 2023b), there have been a total of 3 earthquakes with magnitude of 2.5 or greater on the Richter scale in the last 100 years within 100 miles of the project site (Exhibit 5). The nearest earthquake event occurred 75 miles away April 2007 and was a 3.0 magnitude event. On the Mercalli scale, this event would translate to an intensity of MM III and would be felt indoors by many with slight disturbance (MDNR, 2023). Seismicity is not expected to significantly impact the design, construction, or operation of this project. Structural design of project infrastructure should account for seismic shaking in accordance with applicable codes and standards.

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. Due to the fine-grained nature of the soil at the project site, deep groundwater, and low magnitude of historic earthquakes, there is low potential for liquefaction.

2.10 Landslides and Rock Falls

Landslides and rock falls are typically associated with steep slopes composed of loose or erodible soils, weak rock formations, unfavorable loading, and a triggering mechanism such as heavy rainfall or a seismic event. Landslides are rotational or translation slides of a land mass over a well-defined slipping plane. Debris flows are similar to landslides but are typically differentiated by viscous flow of sliding material.

The Overland Pass Energy East Project site does not contain any significantly sloping terrain. According to the U.S. Landslide Inventory (USGS, 2023c), there are no potential landslides within 50 miles of the project site. Due to the relatively flat topography of the project site and the low magnitude of earthquake events near the Project, the risk of landslides and rock falls is considered low.

Soil erodibility is generally mapped as low to moderate, as discussed in Section 1.2 (USDA, 2023). The loss of natural vegetation on loess slopes can lead to progressive erosion which will increase runoff and create a higher susceptibility to slope failure. However, the relatively flat terrain contained within the project boundary presents a low risk for progressive erosion loss. Project infrastructure should not be located on or near steep slopes, which are not commonly seen within the project boundary.

3.0 Supplemental Geotechnical Investigations

Supplemental geotechnical evaluations should be performed on site to assist with development, design, and construction of the Project. Standard geotechnical investigation methods on wind projects applicable to this project site include, but are not limited to:

- Soil borings with standard penetration test (SPT)
- Rock coring where competent bedrock is encountered
- Groundwater measurements, with piezometers installed where groundwater is encountered or anticipated to be less than 15 ft below grade.
- Laboratory testing on select representative samples, including index properties, collapse potential, corrosivity, consolidation on compressible clays, and thermal resistivity
- Electrical resistivity tests performed for grounding design evaluation at representative wind turbines and the project substation
- Seismic testing for subsurface S-wave velocities to evaluate rotational stiffness

This desktop review has not revealed any anticipated subsurface conditions that require specialized investigation methods outside of the industry standard testing scope for a wind project.

4.0 Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use by National Renewable Solutions for the Overland Pass Energy East 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 will be necessary to validate conditions and more accurately characterize the geologic hazards and subsurface conditions

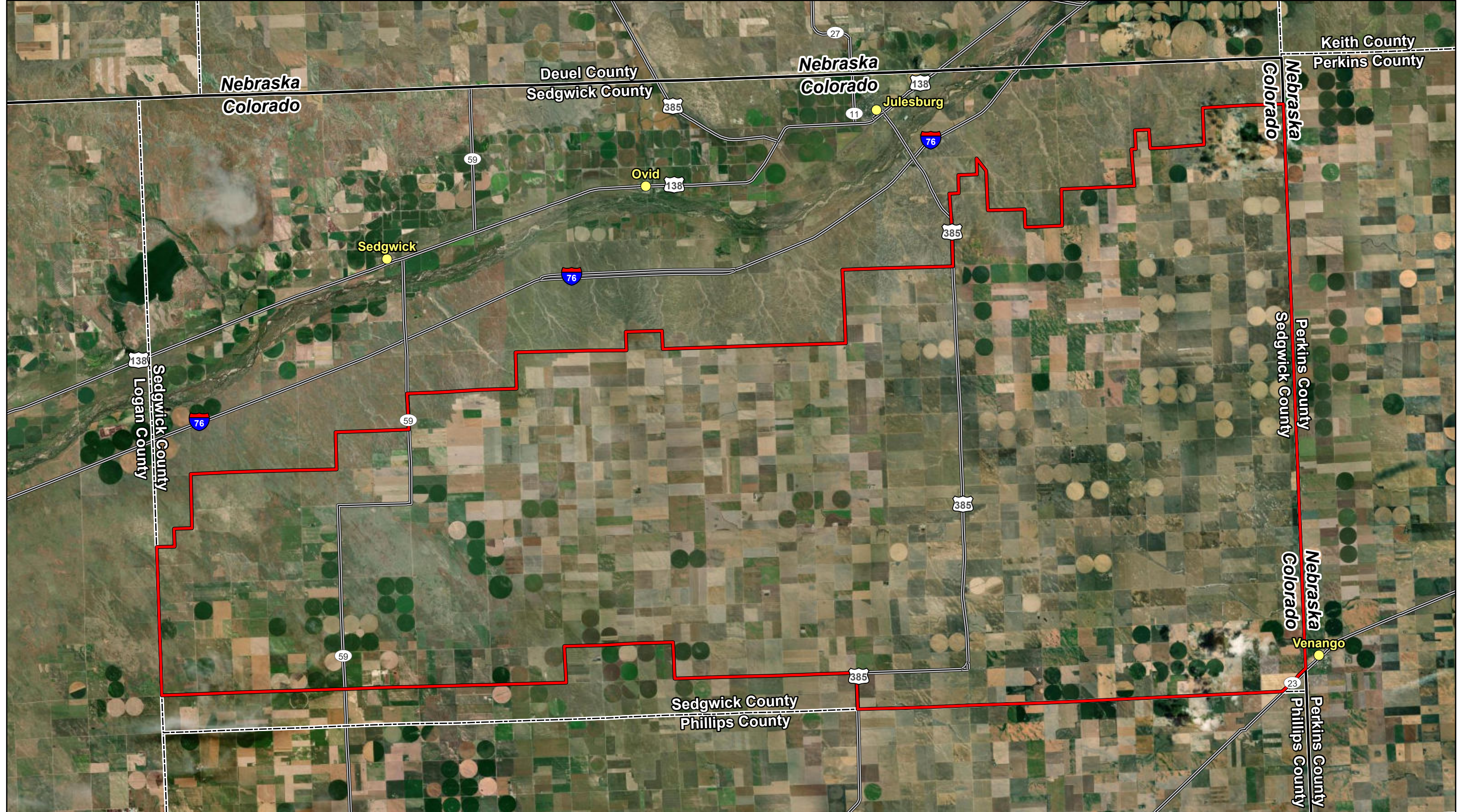
across the site. The primary focus of this report was to identify the potential risk of various geohazards and provide recommendations for additional analyses and investigations.

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.

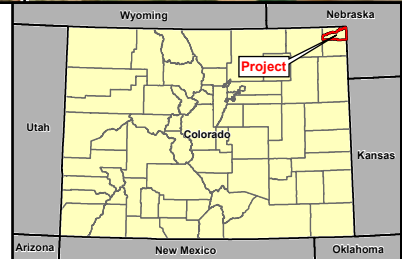
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Exhibits



Data Source(s): Westwood (2024); ESRI WMS World Imagery Basemap (Accessed 2024); Census Bureau (2023).



Legend

- Studied Area
- Major Road
- County Boundary
- State Boundary
- Town/Village

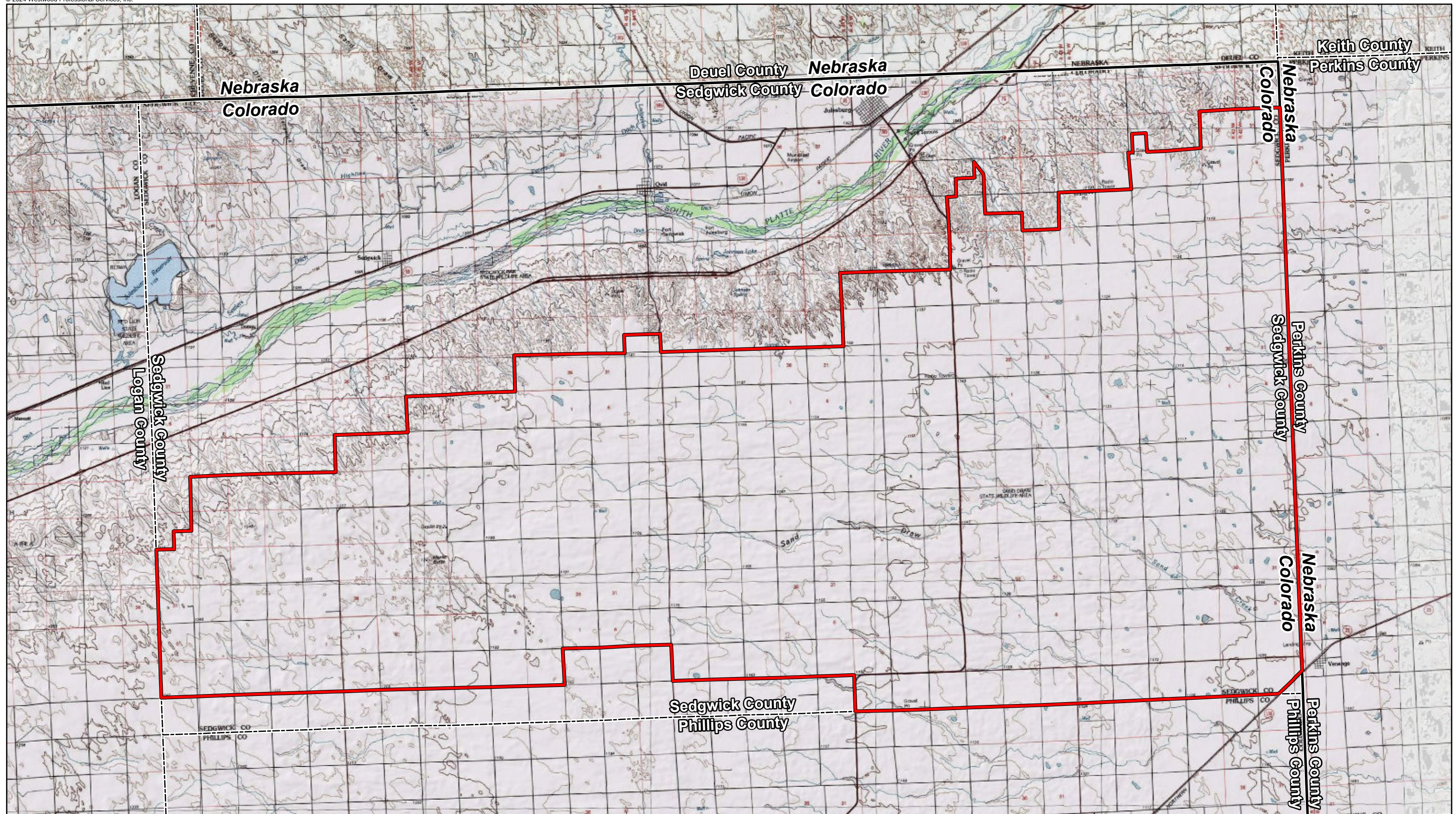


Overland Pass Energy East Wind Project
Sedgwick County, Colorado

Project Overview Map

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Data Source(s): Westwood (2024); ESRI WMS USA Topo Basemap (Accessed 2024).

Legend

- Studied Area
- County Boundary
- State Boundary



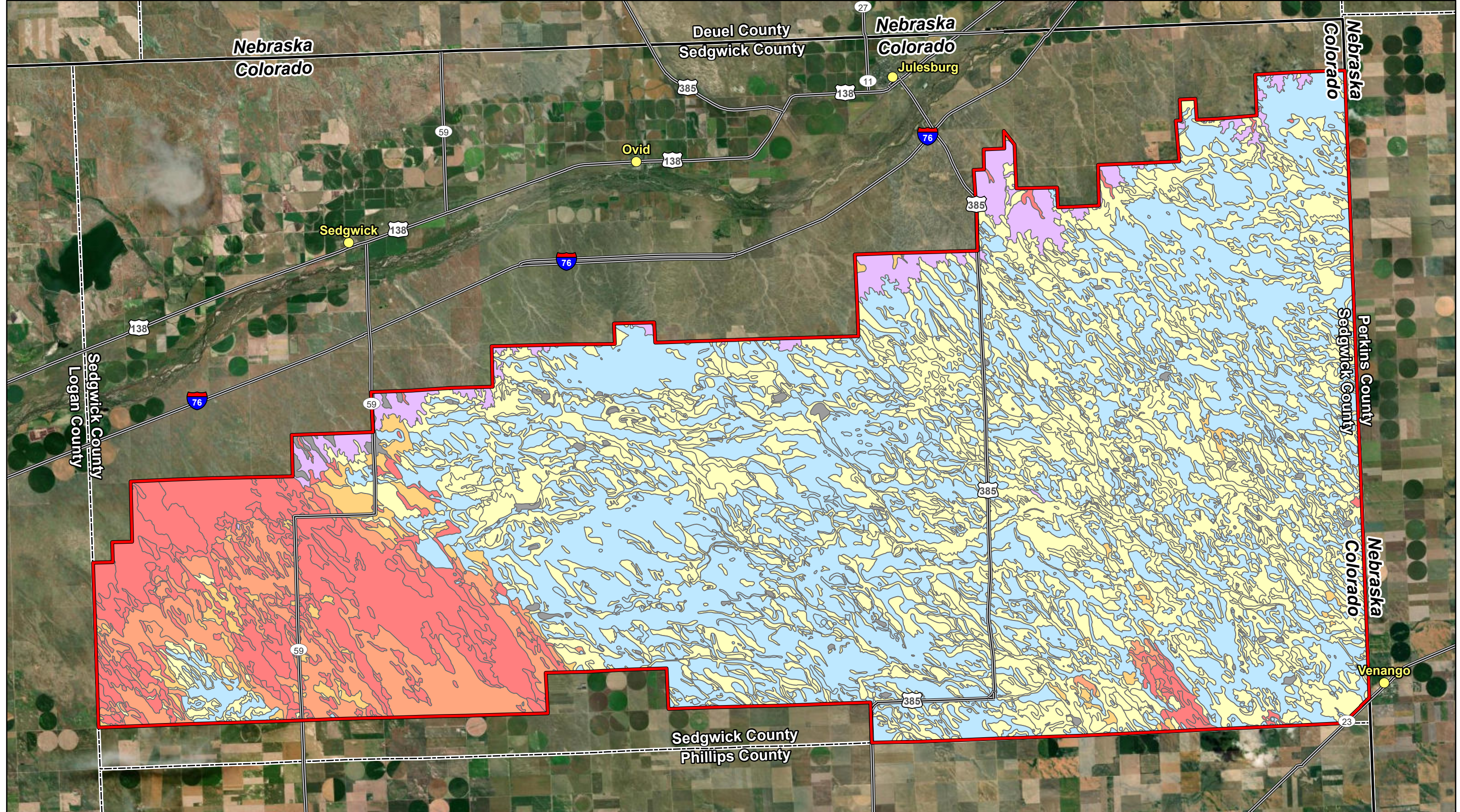
Overland Pass Energy East Wind Project

Sedgwick County, Colorado

USGS Topography Map

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Data Source(s): Westwood (2024); ESRI WMS World Imagery Basemap (Accessed 2024); Census Bureau (2023); NRCS (2024).

Legend

- Studied Area
- Major Road
- Town/Village
- County Boundary
- State Boundary

Unified Soil Classifications

- SM
- SC-SM
- SC
- CL

- CL-ML
- ML
- GC
- No Classification Available



Overland Pass Energy East Wind Project

Sedgwick County, Colorado

Surficial Soils Map

EXHIBIT 3a

Westwood

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Map Unit Symbol | Unified Soil Classification | Map Unit Name

114 | No Classification Available | Valent sand, hilly
 115 | No Classification Available | Valent loamy sand, 3 to 9 percent slopes
 1650 | CL | Kuma loam, 0 to 1 percent slopes
 1652 | CL | Kuma silt loam, 0 to 1 percent slopes
 1653 | CL | Kuma silt loam, 1 to 3 percent slopes
 1726 | CL | Rosebud loam, 1 to 3 percent slopes
 1739 | ML | Rosebud-Canyon loams, 1 to 3 percent slopes
 1740 | ML | Rosebud-Canyon loams, 3 to 6 percent slopes
 1810 | CL | Satanta loam, 0 to 1 percent slopes
 1811 | CL | Satanta loam, 1 to 3 percent slopes
 1819 | CL-ML | Satanta very fine sandy loam, 3 to 6 percent slopes
 45 | No Classification Available | Julesburg loamy sand, 3 to 9 percent slopes
 5934 | No Classification Available | Creighton very fine sandy loam, 1 to 3 percent slopes
 BaE | No Classification Available | Bayard-Ascalon-Manter sandy loams, 5 to 12 percent slopes
 BcE | SC | Bayard-Canyon complex, 5 to 12 percent slopes
 CaB | CL | Campus-Richfield loams, 0 to 3 percent slopes
 CaC | CL | Campus-Richfield loams, 3 to 5 percent slopes
 CcD | CL | Canyon complex, 3 to 9 percent slopes
 EcE | GC | Eckley-Chappell complex, 9 to 20 percent slopes
 GrA | No Classification Available | Gravel pits
 HtB | SC-SM | Haxtun loamy sand, 0 to 3 percent slopes
 HtC | SM | Haxtun loamy sand, 3 to 5 percent slopes
 HxA | SC-SM | Haxtun sandy loam, 0 to 1 percent slope
 HxB | SC | Haxtun sandy loam, 0 to 3 percent slopes

I-W | No Classification Available | Intermittent water
 JuB | SM | Julesburg loamy sand, 0 to 3 percent slopes
 JuC | SM | Julesburg loamy sand, 3 to 5 percent slopes
 KgB | ML | Keith, goshen, and kuma silt loams, 0 to 3 percent slopes
 KkB | CL | Keith-Kuma silt loams, 0 to 3 percent slopes
 KwE | CL | Keith and wages soils, 5 to 12 percent slopes
 PaC | CL | Platner loam, 3 to 5 percent slopes
 PeC | CL-ML | Platner-Eckley association, 3 to 5 percent slopes
 Ra | ML | Rago and Kuma loams
 RaB | ML | Rago and kuma silt loams, 0 to 3 percent slopes
 RaC | ML | Rago and kuma silt loams, 3 to 5 percent slopes
 RcB | CL | Richfield loam, 0 to 3 percent slopes
 RcC | CL | Richfield loam, 3 to 5 percent slopes
 Sa | SM | Sandy alluvial land
 Sc | ML | Scott silt loam
 VaD | SM | Valent fine sand, rolling
 VaE | SM | Valent fine sand, hilly
 VdC | SM | Valent-Dailey fine sands, 0 to 3 percent slopes
 W | No Classification Available | Water
 WaC | CL | Wages gravelly loam, 3 to 5 percent slopes
 WaD | CL | Wages gravelly loam, 5 to 9 percent slopes
 WcB | CL | Wages-Campus-Weld loams, 0 to 3 percent slopes
 Wt | No Classification Available | Wet alluvial land

Data Source(s): Westwood (2024); NRCS (2024).



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Overland Pass Energy East Wind Project

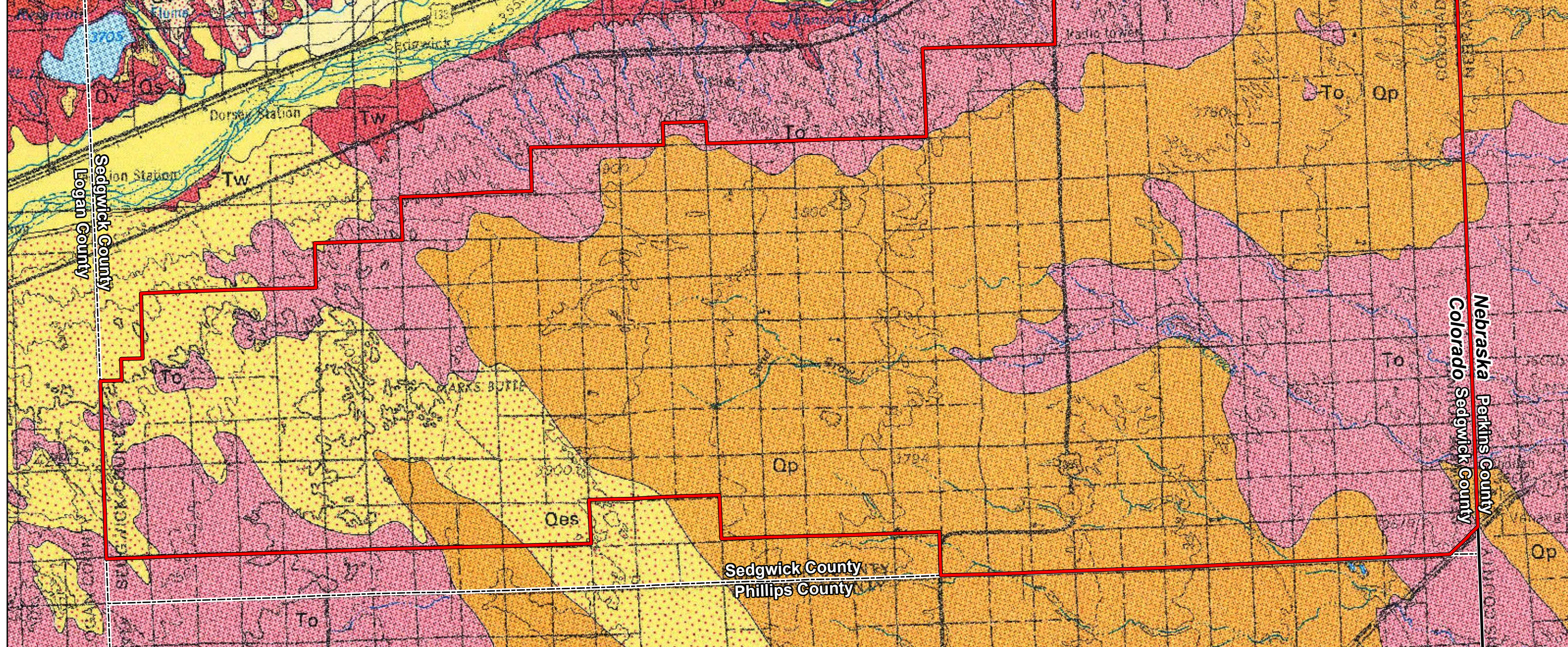
Sedgwick County, Colorado

Surficial Soils Table

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CORRELATION OF MAP UNITS

Qal	Qes	Pinedale Glaciation	Holocene	
Qb	Qp			
Qil		Bull Lake Glaciation	QUATERNARY	
Qs		Sangamon Interglaciation		
Qv		Sangamon Interglaciation or Illinoian Glaciation		
Qrl		Yarmouth Interglaciation or Kansan Glaciation		
Qn		Aftonian Interglaciation or Nebraskan Glaciation		
Tou				TERTIARY
To				
Ta				
Kl				CRETACEOUS
Kp				



Data Source(s): Westwood (2024); ESRI WMS USA Topo Basemap (Accessed 2024); USGS (2018).

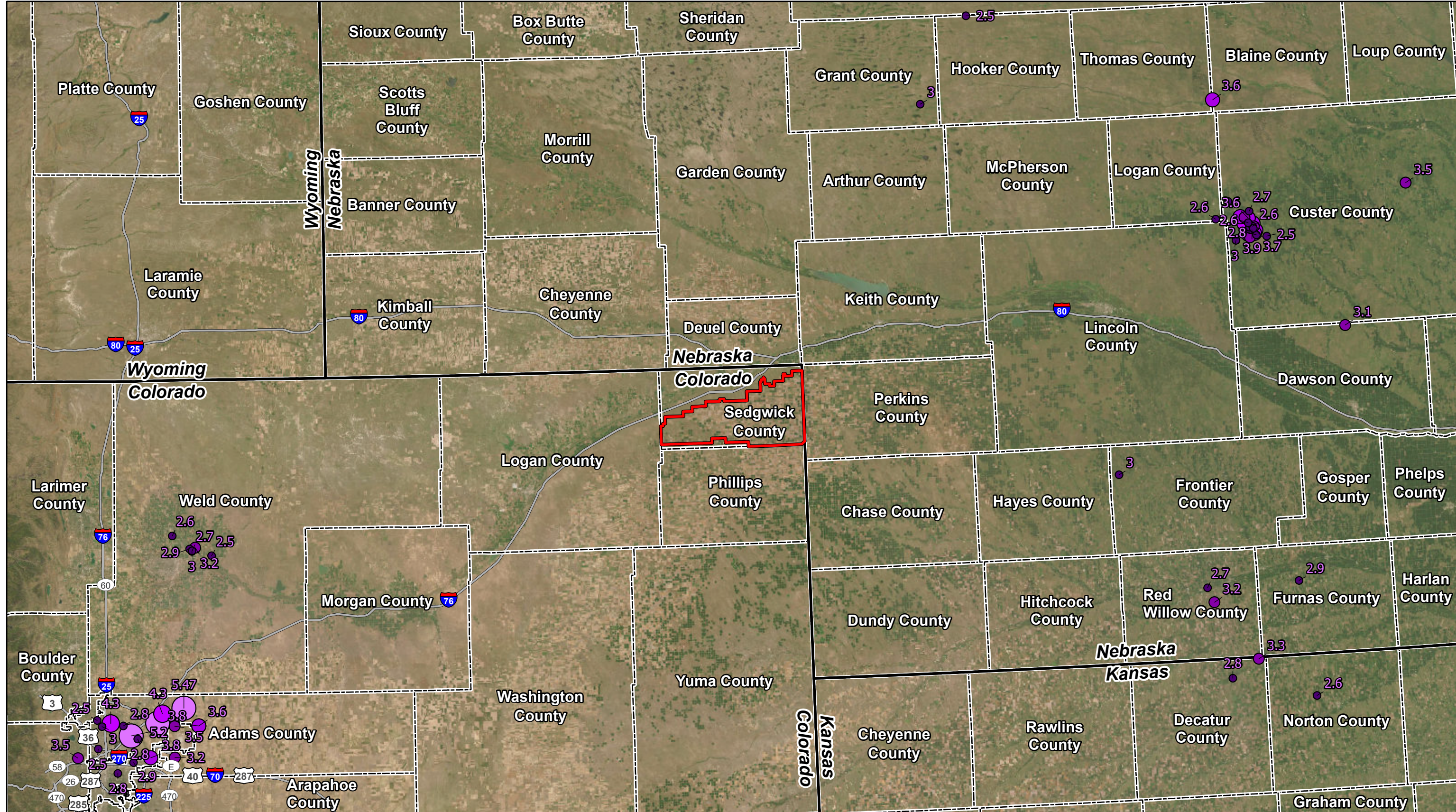
- Legend**
- Studied Area
 - County Boundary
 - State Boundary



Overland Pass Energy East Wind Project
Sedgwick County, Colorado

Local Geology Map

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Data Source(s): Westwood (2024); ESRI WMS World Imagery Basemap (Accessed 2024); Census Bureau (2023); USGS (2020).

Legend

- Studied Area
- County Boundary
- State Boundary
- Major Highway

Earthquakes by Magnitude

- < 3.0
- 3.1 - 3.5
- 3.6 - 4.0
- 4.1 - 4.4
- > 4.4

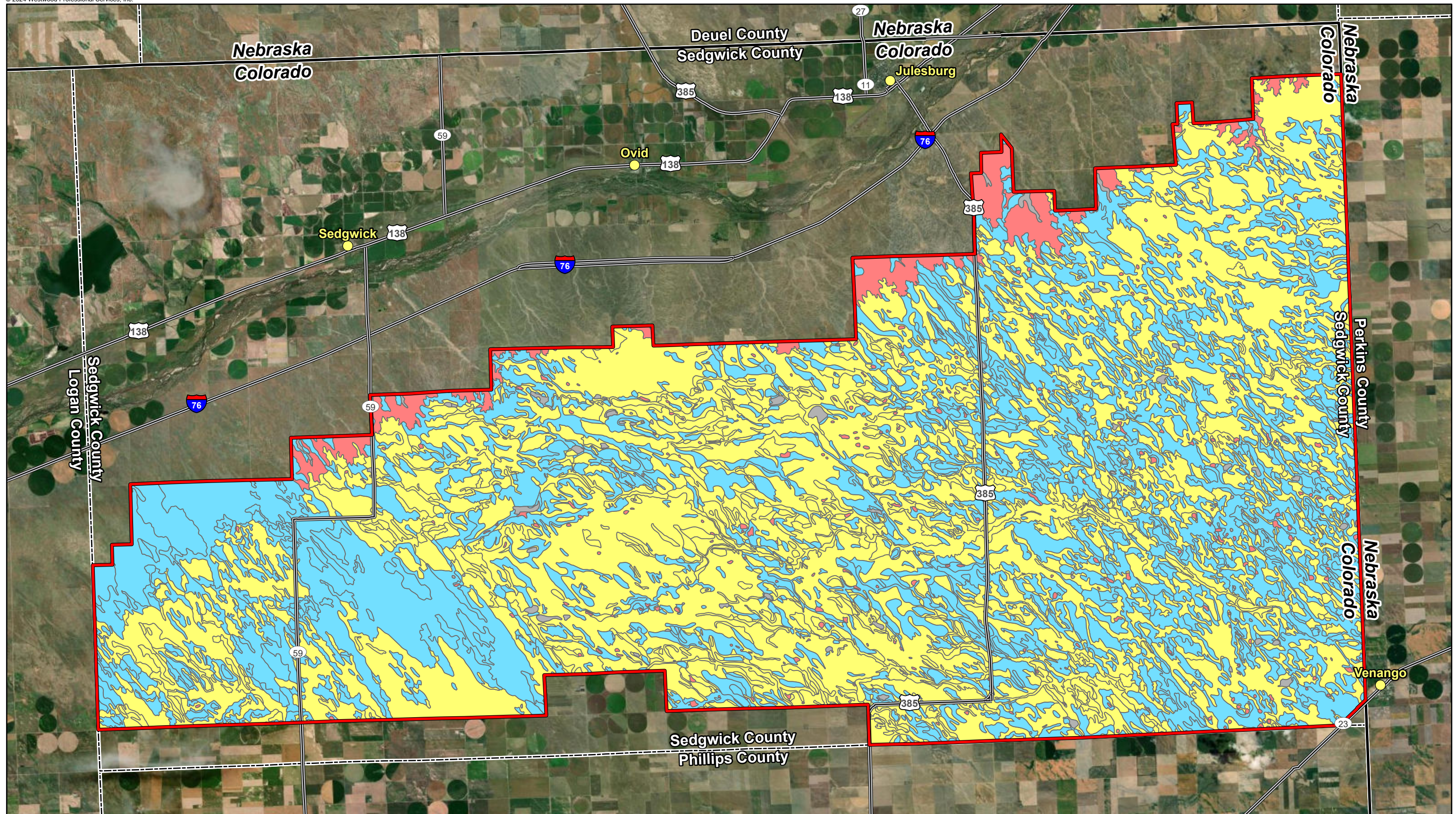


Overland Pass Energy East Wind Project

Sedgwick County, Colorado

Seismic Hazards Map

Map Document: N:\0004226_00_GIS_ArcPro\0004226_080_OverlandPass_Desktop\Geotech\Update_240209.aprx 5/30/2024 12:18 AM radevito



Data Source(s): Westwood (2024); ESRI WMS World Imagery Basemap (Accessed 2024); Census Bureau (2023); NRCS (2024).

Legend

- Studied Area
- Major Road
- Town/Village
- County Boundary
- State Boundary

Corrosion Of Steel Classifications

- High
- Moderate
- Low
- No Classification Available



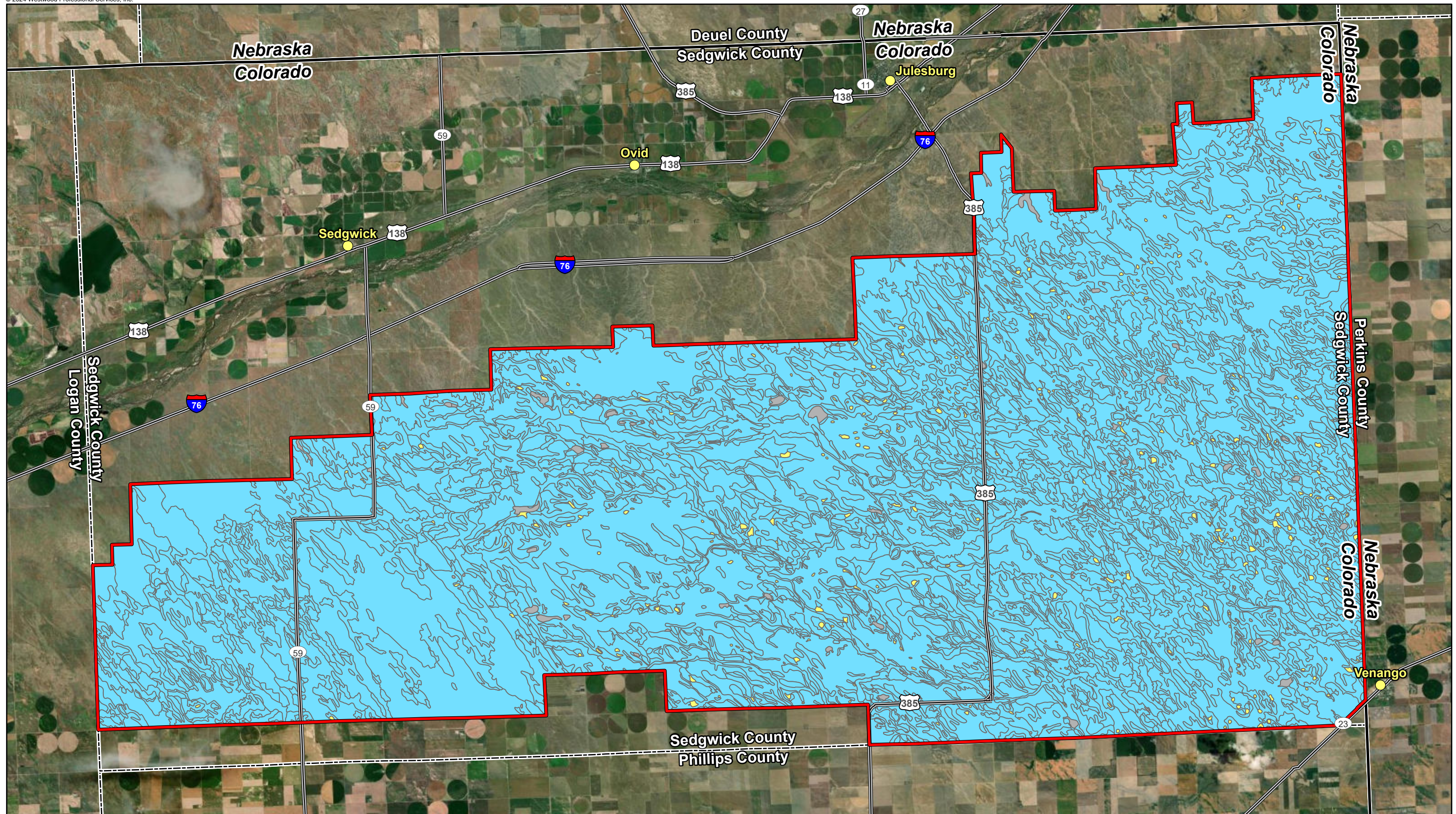
Overland Pass Energy East Wind Project
Sedgwick County, Colorado

Corrosion Of Steel Map

Westwood

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Data Source(s): Westwood (2024); ESRI WMS World Imagery Basemap (Accessed 2024); Census Bureau (2023); NRCS (2024).

Legend

- Studied Area
- Major Road
- Town/Village
- County Boundary
- State Boundary

Corrosion Of Concrete Classifications

- High
- Moderate
- Low
- No Classification Available



Overland Pass Energy East Wind Project
Sedgwick County, Colorado

Corrosion Of Concrete Map

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