ROVER PIPELINE
An ENERGY TRANSFER Company

ROVER PIPELINE LLC

Rover Pipeline Project

RESOURCE REPORT 6
Geological Resources

FERC Docket No. CP15-___-000

February 2015

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LIST OF ACRONYMS

ATWS	additional temporary workspace
FERC or Commission	Federal Energy Regulatory Commission
DCNR	Pennsylvania Department of Conservation and Natural Resources
HDD	horizontal directional drill
hp	horsepower
MP	milepost
ODGS	Division of Geological Survey
ODNR	Ohio Department of Natural Resources
Rover Plan	Rover's Upland Erosion Control, Revegetation, and Maintenance Plan
Project	Rover Pipeline Project
Rover	Rover Pipeline LLC
U.S.	United States
USGS	United States Geological Survey

RESOURCE REPORT 6--GEOLOGICAL RESOURCES	
Filing Requirement	**Location in Environmental Report**
• Describe, by milepost, mineral resources that are currently or potentially exploitable. (§ 380.12 (h) (1))	Section 6.2
• Describe, by milepost, existing and potential geological hazards and areas of nonroutine geotechnical concern, such as high seismicity areas, active faults, and areas susceptible to soil liquefaction; planned, active, and abandoned mines; karst terrain; and areas of potential ground failure, such as subsidence, slumping, and landsliding. Discuss the hazards posed to the facility from each one. (§ 380.12 (h) (2))	Section 6.4
• Describe how the project would be located or designed to avoid or minimize adverse effects to the resources or risk to itself, including geotechnical investigations and monitoring that would be conducted before, during, and after construction. Discuss also the potential for blasting to affect structures, and the measures to be taken to remedy such effects. (§ 380.12 (h) (3))	Sections 6.1.3, 6.2, and 6.3
• Specify methods to be used to prevent project-induced contamination from surface mines or from mine tailings along the right-of-way and whether the project would hinder mine reclamation or expansion efforts. (§ 380.12 (h) (4))	Sections 6.1.3 and 6.2
• If the application involves an LNG facility located in zones 2, 3, or 4 of the Uniform Building Code's Seismic Risk Map, or where there is potential for surface faulting or liquefaction, prepare a report on earthquake hazards and engineering in conformance with "Data Requirements for the Seismic Review of LNG Facilities," NBSIR 84-2833. This document may be obtained from the Commission staff. (§ 380.12 (h) (5))	Not Applicable
• If the application is for underground storage facilities: (§ 380.12 (h) (6)) (i) Describe how the applicant would control and monitor the drilling activity of others within the field and buffer zone; (ii) Describe how the applicant would monitor potential effects of the operation of adjacent storage or production facilities on the proposed facility, and vice versa; (iii) Describe measures taken to locate and determine the condition of old wells within the field and buffer zone and how the applicant would reduce risk from failure of known and undiscovered wells; and (iv) Identify and discuss safety and environmental safeguards required by state and Federal drilling regulations.	Not Applicable

6.0 GEOLOGICAL RESOURCES

Rover Pipeline LLC (Rover) is seeking authorization from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act to construct, own, and operate the proposed Rover Pipeline Project (Project). The Rover Pipeline Project is a new natural gas pipeline system that will consist of approximately 711.2 miles of Supply Laterals and Mainlines, 10 compressor stations, and associated meter stations and other aboveground facilities that will be located in parts of West Virginia, Pennsylvania, Ohio, and Michigan. The Project will include approximately 509.1 miles of proposed right-of-way, extending from the vicinity of New Milton, Doddridge County, West Virginia to the vicinity of Howell, Livingston County, Michigan, and will include approximately 202.1 miles of dual pipelines.

The Project will consist of the following components and facilities:

- Supply Laterals:
  - eight supply laterals consisting of approximately 199.7 miles of 24-, 30-, 36-, and 42-inch-diameter pipeline in West Virginia, Pennsylvania, and Ohio,
  - two parallel supply laterals, each consisting of approximately 18.8 miles (for a total of approximately 37.6 miles) of 42-inch-diameter pipeline (Supply Connector Lateral Line A and Line B) in Ohio,
  - approximately 72,645 horsepower (hp) at six new compressor stations to be located in Doddridge and Marshall counties, West Virginia; Washington County, Pennsylvania; and Noble, Monroe, and Harrison counties, Ohio, and
  - two new delivery, 11 new receipt, and two bidirectional meter stations on the Supply Laterals.

- Mainlines A and B:
  - approximately 190.6 miles of 42-inch-diameter pipeline (Mainline A) in Ohio,
  - approximately 183.3 miles of parallel 42-inch-diameter pipeline (Mainline B) in Ohio,
  - approximately 114,945 hp at three new compressor stations to be located in Carroll, Wayne, and Crawford counties, Ohio, and
  - two new delivery meter stations in Defiance County, Ohio.

- Market Segment:
  - approximately 100.0 miles of 42-inch diameter pipeline in Ohio and Michigan,
  - approximately 25,830 hp at one new compressor station to be located in Defiance County, Ohio, and
  - two new delivery meter stations in Washtenaw and Livingston counties, Michigan.

This Resource Report describes the geologic setting in the Project area, identifies potential mineral resources within the areas, discusses geologic hazards that may impact the Project, and details measures to avoid or mitigate the impact to resources and from potential hazards. Section 6.1 describes the geologic setting of the Project area. Section 6.2 discusses the mineral resources within the Project area and potential impacts to those resources. Section 6.3 addresses blasting issues. Section 6.4 discusses geologic hazards that may affect construction and operation of the Project. Section 6.5 describes paleontological resources. Section 6.6 provides a list of references.

6.1 GEOLOGICAL SETTING

The Supply Laterals are located within the Appalachian Plateau Province in West Virginia, Pennsylvania and Eastern Ohio, as well as the un-glaciated Kanawha section and a short portion of the Glaciated Allegheny Plateau section. This area is a dissected plateau that has been severely eroded by creeks and rivers with well-developed steep relief. Topographic relief can range from 200-750 feet, decreasing from east to west.

Mainlines A and B transition out of the steeper terrain to moderate relief and then into lower topographic elevations and flatter relief of the Central Lowlands Province in north-central Ohio, and across the Ohio Till Plains section. This low-relief topographic surface was formed by deposits of glacial till, outwash plains, and glacial-lake plains. Long, low, arcuate ridges, which were formed by recessional moraines and generally are concave to the north, are common features on these plains. The glacial deposits that compose the ridges and plains have completely buried the pre-glacial topographic features of most of this area.

The Market Segment continues into the Huron-Erie Lake Plains section in Michigan to Livingston County (Pennsylvania Department of Conservation and Natural Resources [DCNR], 2000; Ohio Department of Natural Resources, Division of Geological Survey [ODGS], 1998; U.S. Geologic Survey [USGS], 1995).

A summary of the range of slopes and depth to bedrock, by milepost (MP), is presented in Resource Report 7, Table 7AA-1.

6.1.1 Surficial Geologic Materials

Surficial geologic deposits and materials in West Virginia, Pennsylvania, and eastern Ohio have undergone physical weathering and are composed primarily of clast and clastic colluvium. Except for the alluvial valleys within these areas, the surficial residual materials are thinly covered and typically range in thickness from null along ridgelines to 20 feet near colluvium near valley floors. Surficial geology is not primarily mapped in these areas as the residuum is thinly covered over the parent bedrock (see Resource Report 7, Table 7A-4 for a summary by MP, and Attachment 7B for a detailed description). In the previously glaciated areas of north-central Ohio and Michigan, the surficial deposits include various tills, recessional moraines, outwash deposits in buried valleys and various glacial lake deposits. In these areas, the thickness of the surficial materials range from 0-80 feet, with some buried valleys over 100 feet thick (Esch, J., 2012; ODGS, 2005; USGS, 1995; USGS, 2003).

Tables 6A-1 and 6A-2 in Appendix 6A list surficial deposits found along the Project pipelines and at the aboveground facilities, respectively. A summary of those surficial material types is provided below.

- Wave-Planed Ground Moraine – Ground moraine deposits subsequently eroded by wave action of post-glacial, high-level ancestral Lake Erie (ODGS, 2004).
- Lake Deposits/Lacustrine Clay and Silt – Flat-lying clay and silt deposits, this deposition often alternated seasonally between finer material in winter and coarser material in summer (varves).
- Ridge Moraine (lateral, medial, end) – Ridges comprised of till, poorly sorted material ranging in size from clay to boulders, outlining glacial extent.
- Ground Moraine – Expanse of till deposited under the glacier or during retreat, comprised of poorly sorted material ranging in size from clay to boulders.
- Kames and Eskers – Sorted and bedded sand and gravel deposits. Kames are in irregular shaped mounds and eskers are long and winding.
- Outwash (and post-glacial alluvium) – Sorted, sometimes cross-bedded flat planes of gravel and sand, grading from coarse to fine.
- Peat – Peat deposits associated with glacial lake deposits; decayed lake vegetation.
- Fine Textured Till – Poorly sorted material ranging in size from clay to boulders, with a greater percentage of fine material (sand and silt).
- Medium Textured Till – Poorly sorted material ranging in size from clay to boulders, with a greater percentage of medium grained material (sand and gravel).
- Coarse Textured Till – Poorly sorted material ranging in size from clay to boulders, with a greater percentage of coarse material (cobbles and boulders).
- Lacustrine Sand and Gravel – Glacially deposited, sorted sand and gravel.

6.1.2 Bedrock

Tables 6A-3 and 6A-4 in Appendix 6A summarize bedrock found along the Project pipelines and at the aboveground facilities, respectively. Figure 6B-1, Sheets 1 through 4, in Appendix 6B show the location of these formations with respect to the Rover pipelines. These bedrock formations are further described below.

- Antrim Shale (Da) – Devonian dark brown to black carbonaceous, thinly laminated shale. The unit is 0-230 feet thick (USGS & ODGS, 2005).
- Allegheny Formation (PAa) – Pennsylvanian cyclic sequences of sandstone, siltstone and shale, limestone and coal. Unit thickness is 150-200 feet in the northeast and 325 feet in the west (Cardwell et al, 1986).
- Allegheny and Pottsville Groups Undivided (PAap) – Pennsylvanian black, gray, greenish and olive clayey to silty, locally calcareous shale, clayey to sandy, thin to medium bedded siltstone and silty underclay. Shale and siltstone contain localized marine fossils. Underclay is often rooted in underlying coal beds. Light to medium gray, very fine to medium grained, cross-bedded sandstone is locally quartzose, conglomeratic and calcareous in the lower third of the unit. Black to light gray, micritic to medium grained limestone grading to flint with marine fossils. Contains concretions and banded bituminous coal up to 12 feet thick. The unit is up to 700 feet thick total (USGS & ODGS, 2005).

- Bayport Limestone (Mb) – Typically 49-98 feet of Mississippian sandy yellow limestones, cross-bedded white sandstone and little dolomite, minor shale, bedded chert and evaporates (Milstein, 1987).
- Bedford Shale (Dbd) – Typically 49-98 feet of Devonian bluish to light gray silty shale (sandy in upper part). Unit thins and fines to the west (Milstein 1987).
- Brea Sandstone (Db) – Typically 49-98 feet of Devonian light gray mostly fine-grained sandstone, medium to coarse grained in the middle, and silty and pyritic in lower part. The unit thins in a deltaic fashion towards the northwest, west and southwest, and is absent to east (Milstein, 1987).
- Berea Sandstone and Bedford Shale Undivided (Dbb) – Devonian planar to lenticular bedded upper sandstone and lower shale. Sandstone is brown, weathering to light brown or reddish brown, with minor shale interbeds. Typical thickness is 5-75 feet, but as much as 125 feet locally. Lower shale is gray to brown, locally reddish brown, thin to medium beds with interbedded sandstone and rippled siltstone. Typically 80-180 feet thick. The unit is thin to absent where the Brea sandstone is thick (USGS & ODGS, 2005).
- Casselman Formation (PAcc) – Pennsylvanian cyclic sequences of shale, siltstone, sandstone, red-beds, thin impure limestone and thin, non-persistent coal deposits. Red-beds are known for their association with landslides (Berg et al, 1980).
- Coldwater Shale (Mc) – Mississippian gray to bluish gray, thinly bedded fossiliferous shale with some clay. Michigan’s eastern facies is silty and sandy, with siltstone, fine-grained sandstone and increasing coarseness westward. Michigan’s western facies is calcareous with fossiliferous, glauconitic limestone and dolostone. Siderite nodules are common in Ohio. “Lime” (3-20 feet thick) and Red Rock (10-20 feet thick, locally 49 feet) tracer beds are present within the unit. Unit thickness is generally 1,000 feet in Michigan, and as thick as 150 feet in Ohio (Milstein, 1987; USGS & ODGS, 2005).
- Columbus Limestone (Dc) – Up to 105 feet of Devonian gray limestone (upper two-thirds) and brown dolomite (lower third). Limestone is massively bedded and fossiliferous (USGS & ODGS, 2005).
- Conemaugh Group (PAc) – Pennsylvanian cyclic sequences of predominantly non-marine red and gray shale, siltstone and some sandstone, with thin limestone and coal. This unit includes the Casselman and Glenshaw formations (see descriptions). Unit thickness is 750-850 feet in the northeast and 530 feet in the west (Cardwell et al, 1986).
- Deleware Limestone (Dd) – Up to 45 feet of Devonian gray to brown thin to massively bedded carbonaceous, argillaceous limestone. Unit smells of petroleum (USGS & ODGS, 2005).
- Detroit River Group (Ddr) – Devonian brown to gray, medium to thickly bedded, laminated dolomite with nodules or interbeds of anhydrite or gypsum, becoming sandy dolomite or fine-grained sandstone at the bottom (USGS & ODGS, 2005).
- Dundee Limestone (Ddu) – Up to 105 feet of Devonian olive gray to brown limestone. The upper part is thinly bedded and fossiliferous. The lower part is medium to thickly bedded with cherty dolomite (USGS & ODGS, 2005).

- Dunkard Group (PPAd/Pd) – Permian to Pennsylvanian non-marine cycles of sandstone, siltstone, red and gray shale, limestone and coal containing the Greene, Washington and Waynesburg formations. Unit is greater than 450 feet in the west (Cardwell et al, 1986).
- Glenshaw Formation (PAcg) – Pennsylvanian cyclic sequences of shale, sandstone, red-beds, thin limestone coal deposits. There are four Marine limestone or shale horizons. Red-beds are known for their association with landslides (Berg et al, 1980).
- Lockport Dolomite (Sl) – Silurian white to medium gray, medium to massively bedded fine to coarse crystalline fossiliferous and vuggy dolomite. Potential stromatolite, thrombolite and coral-microbialite reef remnants found in the Lockport Dolomite (USGS & ODGS, 2005).
- Marshall Sandstone (Mm) – Consists of two Mississippian members: Marshall (131-328 feet thick thinning north and west) and Napoleon (161-200 feet thick). The Marshall, typically sparsely fossiliferous, sometimes cross-bedded and rippled, very fine to coarse buff, tan and gray sand, is finer and fossiliferous lower in the unit. The Napoleon consists of medium-grained sandstone with some cross-bedded coarse sand intervals (Milstein, 1987).
- Maxville Limestone, Rushville, Logan and Cuyhoga Formations Undivided (Mlc) – Mississippian interbedded fossiliferous clayey to silty shale, siltstone, and gray and yellow to brown, silty to granular sandstone. Minor limestone is medium to dark gray, thin to thickly bedded and mostly preserved at the top of the interval where it crops out in the southern half of the state (USGS & ODGS, 2005).
- Michigan Formation (Mmi) – Typically 299-400 feet of Mississippian greenish gray and dark gray shale, discontinuous sandstone, limestone, dolostone, gypsum and anhydrite. A dolomite tracer bed called “Brown Lime” is 10-20 feet thick (Milstein, 1987).
- Monongahela Group (PAm) – 170-350 feet of Pennsylvanian non-marine cyclic sequences of gray, nonbedded to thinly bedded, micritic clayey to silty limestone, red and gray shale, greenish-gray to yellow-brown silty to locally conglomeriatic and calcareous, cross-bedded sandstone, siltstone, mudstone and coal in northern and central Ohio. The unit is black, red, gray, green to red and yellow in southeast Ohio. The unit contains the Uniontown and Pittsburg formations. Commercially viable coal is present (Berg et al, 1980; USGS, 2005; ODGS, 2005).
- Ohio Shale (Do) – 250 to over 500 feet of Devonian brownish black to greenish gray carbonaceous to clayey, laminated to thinly bedded shale with petroleum odor. Carbonate and siderite concretions are in the lower 50 feet (USGS & ODGS, 2005).
- Olentangy Shale (Dol) – 20-55 feet of Devonian greenish to gray clayey laminated to thinly bedded shale with thin beds of brownish-gray shale in the upper two-thirds and limestone nodules in the lower third (USGS & ODGS, 2005).
- Quaternary Alluvium (Qal) – Quaternary alluvial sand, gravel, silt and clay deposits (Cardwell et al, 1986).
- Saginaw Formation (PAs) – Approximately 400 feet of Pennsylvanian fresh to marine sandstone, shale, coal and limestone (Milstein, 1987).
- Salina Group (Ss) – Silurian gray, yellow-gray to olive-gray laminated to thinly bedded dolomite with occasional laminae of dark gray shale and anhydrite or gypsum with some brecciated zones (USGS & ODGS, 2005).

- Sunbury Shale (DMs/Ms) – Mississippian to Devonian, black to brownish black gas shale, with pyrite, especially at the base where it is fossiliferous. Shale is fissile, weathering into small discoidal sharp-edged chips. Unit is 10-40 feet thick, thinning eastward in Michigan and 30-120 feet thick in Ohio (Milstein, 1987; USGS & ODGS, 2005).
- Sunbury and Bedford Formations Undivided (MDsd) – Devonian to Mississippian shale. Shale is black to brownish and carbonaceous in the upper third of the unit and gray to bluish gray in the lower two-thirds with some siltstone lamina (USGS & ODGS, 2005).
- Traverse Group (Dts) – Up to 170 feet of Devonian gray to light brown, thinly bedded dolomite with abundant chert and olive gray, thin to medium bedded, very fossiliferous shale with interbedded limestone (USGS & ODGS, 2005).
- Tymochtee and Greenfield Formations Undivided (Stg) – Silurian olive-gray to yellowish brown thin to massively bedded dolomite. The upper two-thirds commonly has brownish-black to gray shale laminae. The lower third is locally brecciated. Potential stromatolite, thrombolite and coral-microbialite reef remnants found in the Greenfield Dolomite (USGS & ODGS, 2005).

6.1.3 Construction and Operation Impacts and Mitigation

6.1.3.1 Pipeline Facilities

Construction activities and storage of construction materials and equipment will be confined to the temporary and permanent rights-of-way, the additional temporary workspace (ATWS), or one of the approved staging/pipe yards. Trench depths will typically range from 5 to 10 feet depending on soil conditions and land use and to maintain a minimum of 3 feet of cover over the top of the pipe. The trench width at the ground surface will typically range between 14 and 25 feet to maintain stable trench walls and accommodate deeper trenches in the various soil conditions.

Storage for trench spoil and topsoil will require between 30 and 60 feet (depending on the width and depth of the trench and topsoil stripping) to prevent sloughing of the spoil back into the trench and maintain safe work areas for construction workers. Following construction of the Project, the areas disturbed by construction will be restored to their original condition and use, to the greatest extent practicable. All aboveground facilities will be fenced and converted to industrial use.

Upon completion of the pipeline installation, the surface of the right-of-way disturbed by construction activities will be graded to match original contours and to be compatible with surrounding drainage patterns, except at those locations where permanent changes in drainage will be required to prevent erosion, scour, and possible exposure of the pipeline. Horizontal directional drilling (HDD) entry and exit pits will be backfilled and the disturbed ground surface similarly graded. Rover's *Horizontal Directional Drill Contingency Plan* is included in Resource Report 1, Appendix 1B.

Segregated topsoil will be replaced, and soils that have been compacted by construction equipment traffic will be disked. Areas will be seeded and mulched where required. Temporary and permanent erosion control measures will be installed in accordance with *Rover's Upland Erosion Control, Revegetation and Maintenance Plan* (Rover Plan) (see Resource Report 1, Appendix 1B).

No impacts to geologic materials are anticipated as a result of construction and operation of the pipeline facilities.

6.1.3.2 Aboveground Facilities

Excavation will be performed as necessary to accommodate the reinforced concrete foundations for the new compressors, launching and receiving facilities, metering equipment, and buildings. Backfill will be compacted in place, and excess soil will be used elsewhere or distributed around the site to improve grade. The geologic materials present will support standard construction techniques.

The areas inside the fence at the aboveground facilities will be permanently converted to industrial use. Most areas in and around the buildings, meters, and associated piping and equipment will be covered with crushed rock (or equivalent) to minimize the amount of maintenance required. Roads and parking areas may be of crushed rock, concrete, or asphalt. Other ground surfaces will be seeded with a grass that is compatible with the climate and easily maintained. This will prevent the erosion of surficial geologic materials.

No impacts to geologic materials are anticipated as a result of construction and operation of the aboveground facilities. No impacts to construction from the existing geologic materials are anticipated.

6.1.3.3 Additional Temporary Workspace

ATWS will be required where an obstacle prevents the normal placement of spoil and the placement of pipe sections immediately adjacent to the pipe trench (for example, at a waterbody crossing or road crossings), where additional volumes of spoil will be generated in areas where a reduced right-of-way is being used (for example, at wetland crossings), or where additional construction operations will be performed (for example, at HDDs).

No impacts to geologic materials are anticipated as a result of the use of ATWS.

6.1.3.4 Access Roads

Access roads are used to transport construction workers and materials to the construction right-of-way from public interstate, state, and county highways/roads. These access roads include private roads and/or two-tracks that may require modifications or improvements to safely support the expected loads associated with the movement of construction equipment and materials to and from the public roadways to the construction right-of-way.

Modifications or improvements to these access roads may include grading or other minor maintenance to prevent rutting and erosion during use, placement of additional gravel or crushed stone on the existing surface, enlargement to accommodate the pipe stringing trucks, and/or installation of board mats that will be removed upon completion of construction. By stabilizing the road base, erosion will be controlled, preventing impacts to the existing geologic materials.

Temporary access roads constructed specifically for the Project will be removed, the surface graded to original contours, and the land restored to its original use with the goal to stabilize the surficial materials and prevent erosion. Permanent access roads will be constructed and maintained as required to facilitate access to the aboveground facilities and in compliance with any landowner and federal and state requirements.

No impacts to geologic materials are anticipated as a result of the construction and use of Project access roads.

6.1.3.5 Contractor Yards

Contractor yards will be used during construction of the Project to store pipe, equipment, and other contractor materials.

Upon completion of construction, all temporary facilities (e.g., trailers, sheds, latrines, pipe racks, fencing, and gates) will be removed from the contractor yards. Unless otherwise requested by the landowner, each site will be graded to original contours and seeded if appropriate, so that the land is restored to its pre-construction conditions. No impacts to geologic resources are anticipated.

6.2 MINERAL RESOURCES

6.2.1 Mining

A summary of the fuel and non-fuel mineral surface and subsurface mined resources found throughout the Project area were assessed by a review of government mine databases (USGS, 2005). Table 6A-5 in Appendix 6A lists mines located within 0.25 mile of the Project pipelines. Coal mining areas are crossed on the Cadiz, Seneca, Clarington, Majorsville, and Burgettstown Laterals, the Supply Connector Lines A and B, and the first 39 miles of Mainlines A and B. Table 6.2-1 summarizes other surface mining areas crossed.

TABLE 6.2-1
Types of Surface Mines within 0.25 Mile of Project Pipelines

Pipeline Segment	County	State	Surface Mine
Sherwood and CGT Laterals	Doddridge	WV	None nearby
Sherwood Lateral	Tyler	WV	None nearby
	Wetzel	WV	Construction sand and gravel
Majorsville Lateral	Marshall	WV	None nearby
Burgettstown Lateral	Hancock	WV	Clay
	Washington	PA	None nearby
Sherwood, Seneca, Berne, and Clarington Laterals	Monroe	OH	Crushed/broken stone, general limestone
Seneca and Berne Laterals	Noble	OH	None nearby
Majorsville Lateral	Belmont	OH	Construction sand and gravel
Cadiz Lateral, Supply Connector Lines A and B, Mainlines A and B	Harrison	OH	Clay
Burgettstown Lateral	Jefferson	OH	Clay

TABLE 6.2-1
Types of Surface Mines within 0.25 Mile of Project Pipelines

Pipeline Segment	County	State	Surface Mine
Mainlines A and B	Tuscarawas	OH	Clay, crushed/broken stone, coal
	Stark	OH	None nearby
	Wayne	**OH**	**None nearby**
	Ashland	OH	None nearby
	Richland	OH	Clay, crushed/broken stone, coal
	Crawford	OH	None nearby
	Seneca	OH	Clay
	Hancock	OH	Clay
	Wood	OH	None nearby
Mainlines A and B, Market Segment	Henry	OH	None nearby
	Defiance	OH	None nearby
Market Segment	Fulton	OH	None
	Lenawee	MI	Clay, fire clay, construction sand and gravel
	Washtenaw	MI	Construction sand and gravel, emery, fire clay
	Livingston	MI	Construction sand and gravel
	Livingston	MI	Construction sand and gravel
Sources: ODNR, 2014; PASDA, 2014; USGS, 2014e; WVGS, 2014.			

The Project area has undergone coal mining dating back to the early 1800s. Coal mining initially was conducted below ground with manual labor. Access to the coal seams were from the sides of hillsides with mine shafts, horizontal mine entries, or sloping tunnels angling downward from the surface. Many of the early mines were poorly mapped and used room and pillar mining. This subsurface mining technique could lead to mine collapse and surface subsidence. With the depletion of surface coal sources and the advancement of automated mining equipment, subsurface mining again became economically viable via longwall mining, where large blocks of coal are removed and the overburden is allowed to collapse or subside in a controlled manner (Ohio Department of Natural Resources [ODNR], 2011).

Active and inactive surface coal mines are encountered at multiple locations along the Project pipelines. However, there is a potential to encounter smaller unmapped surface mines or mine entrances during construction. If unmapped mines are encountered, Rover will notify the state agency governing mines of the geographic location.

The Rover pipelines will cross active coal mines. In these areas, Rover will work with each operator in advance of construction to review forecasted mining operations in the vicinity of the proposed pipeline, any controlled land subsidence that is planned as part of mine operations, and the Rover construction schedule. This includes consultations with mining operators who have obtained the legal right to subside properties in the vicinity of the Seneca and Clarington Laterals (Pre-Filing Comment C-858). To support operation of the pipeline, Rover will develop a communications plan for each active mine being crossed, with an action item to include prior notification by the operator of any planned blasting and/or any land subsidence events in the vicinity of the pipeline. Mine operators will be provided details within their respective easement agreement concerning:

- where they can excavate within their respective easements,
- what the requirements are to cross over the pipeline easement area with heavy equipment,
- notice required to be made to Rover's gas control/engineering department and an engineered blasting plan is required to be submitted to Rover and approved by company, and
- any blasting activity occurring within 300 ft of a high pressure line will require seismological surveillance (peak particle velocity and frequency) for every blast.

Mine operators are required to control blasting impacts at each facility. Rover geotechnical personnel will review each notification and assess any potential impacts to the pipeline on a case-by-case basis. This communication plan will be part of pipeline operations. Pipeline warning signs will be installed within line-of-sight over the pipeline with contact numbers of Rover Gas Control and the One Call system.

Methods to prevent impacts to geological resources will also prevent Project induced contamination from surface mines or from mine tailings (see Section 6.1.3). Rover will work with mining operators to ensure the pipeline will not impact existing or planned future operations.

6.2.2 Organic Fuel - Wells

Conventional oil and natural gas resources are present in the Project area. Along the eastern portion of the Supply Laterals in West Virginia, Pennsylvania and portions of Ohio, coalbed gas, shale gas and tight gas is present. Shale gas is also present in northwestern Ohio and Michigan. (USGS, 2014a).

A list of known oil and gas wells located within 0.25 mile of the Project pipelines is provided in Table 6A-6 in Appendix 6A. The well locations were searched by geographic coordinates in state databases. No oil and gas wells were identified within 0.25 miles of an aboveground facility. However, if a previously unidentified well is encountered during construction, the location of the well will be reviewed to see if it affects the easement of the pipeline. If it is a water well, Rover will cap the abandoned the well. If this is a fuel producer's well, the appropriate state agency will be notified to locate the owner. A shift in the pipeline route may be required if the well owner cannot be found and the well cannot be capped or abandoned in accordance with state requirements.

Natural gas is stored throughout the U.S. in deep underground reservoirs. There are three primary types of storage, in depleted gas reservoirs, aquifer reservoirs, and salt cavern reservoirs. Underground natural gas storage facilities are located within one-mile of the Project pipelines and include the locations listed on Table 6.2-2. Depleted gas reservoirs found nearby the Project facilities are the most common form of underground storage. The depleted natural gas reservoir formation is capable of storing injected natural gas. These reservoirs are utilized to support supply needs along pipeline systems as demand changes seasonally. These deep formations will not be impacted by the propose Pipeline construction.

TABLE 6.2-2
Natural Gas Storage Facilities within 1 Mile of Project Pipelines

Location	Milepost	Distance (mile)	Type	Name	Status
CGT Lateral	5.7	0.33	Depleted Gas Reservoir	Equitrans LP	Active
Source: EIA, 2008.					

6.3 BLASTING

In some portions of the Project, near surface and exposed bedrock is present. Based on the presence of this weathered and un-weathered shallow sedimentary bedrock (see Table 6A-3), Rover anticipates mechanical methods such as conventional excavation with a backhoe, ripping with a dozer followed by backhoe excavation, or hammering with a pointed backhoe attachment followed by backhoe excavation will sufficiently support construction activities, and that no blasting will be required.

A summary of shallow bedrock conditions likely to be encountered, by pipeline segment, is provided below. A detailed summary by MP is presented in Volume II-B, Attachment 7A-1, to Resource Report 7.

TABLE 6.3-1
Summary of Shallow Bedrock along the Project Pipelines

Pipeline Segment	Bedrock	Weathered Bedrock	Total (miles)
Supply Laterals			
Berne Lateral	2.59	0.78	3.37
Burgettstown Lateral	20.61	8.69	29.3
Cadiz Lateral	0.0	0.13	0.13
CGT Lateral	4.52	0.91	5.43
Clarington Lateral	19.28	1.87	21.15
Majorsville Lateral	20.87	0.61	21.48
Seneca Lateral	22.09	1.35	23.44
Sherwood Lateral	22.44	22.58	45.02
Supply Connector Lines A and B	4.49	6.96	11.45
Mainlines			
Mainlines A and B	6.72	4.48	11.2
Market Segment	0.0	0.0	0.0
Total	**123.61**	**48.36**	171.97
Source: USDA, 2014			

Large rock not suitable for use as backfill material may be windrowed along the edge of the right-of-way in upland areas where the landowner has authorized placement or recycled off-site.

In the unlikely event blasting is required, Rover will implement the procedures outlined in the Blasting Plan in Resource Report 1, Appendix 1B.

6.4 GEOLOGIC HAZARDS

6.4.1 Seismic Risk

The Project area is not within a tectonic plate boundary where frequent high energy earthquakes are typically common (USGS, 2014a).

During an earthquake, seismic waves travel out from an earthquake epicenter through the surrounding rock. Ground motion is higher closer to the location of the event. In general, ground motion decreases away from the epicenter, though the amount of ground motion at the surface is related to more than just distance from the epicenter. Some natural materials can amplify ground motion; that is, ground motion is typically less on solid bedrock and greater on thick deposits of clay, sand, or artificial fill.

Seismic hazards defined in building codes are typically based on peak ground acceleration. During an earthquake, a particle attached to the earth will move back and forth irregularly. The horizontal force a structure must withstand during an earthquake is related to ground acceleration. Peak ground acceleration is the maximum acceleration experienced by a particle during an earthquake.

The USGS produces probabilistic Seismic Hazard Maps for the U.S. with peak horizontal acceleration values represented as a factor of “g”. The factor “g” is equal to the acceleration of a falling object due to gravity. Figure 6B-2 and Figure 6B-3 in Appendix 6B provide the seismic hazard maps for the region. A review of these USGS Seismic Hazard Maps (USGS, 2014b) for the Project area indicates the Project is located in a relatively low seismic hazard area, with primarily a two percent probability of a 4-10 percent “g” exceedance in 50 years for the Project facilities. Notable on Figure 6B-2 is an elevated area south of Mainline MP 200. This is the location of an actual point value from a known earthquake and the location of several historical earthquakes (see Figure 6B-4 in Appendix 6B and Table 6A-7 in Appendix 6A).

The USGS fault database was searched for faults in the Project area believed to be a source of greater than magnitude 6 earthquakes. None were identified. The mapped fault database was also searched. One mapped fault is crossed near Mainline MP 170, the Bowling Green Thrust Fault. The fault is Silurian Age, 443 – 416 million years ago (see Figure 6B-5) (USGS, 2006).

Specific site conditions, including earthquakes, are considered in the design of the pipeline and aboveground facilities. The magnitude of earthquakes in the Project area is relatively low and the ground vibration would not pose a problem for a modern welded-steel pipeline. Modern electric arc-welded gas pipelines are generally highly resistant to traveling ground wave effects and moderate amounts of permanent deformation (O’Rourke and Palmer, 1994).

Based on the low seismic risk and occurrence assigned to the Project area, the risk of damage to pipeline facilities by earthquakes is anticipated to be low.

6.4.2 Soil Liquefaction

Earthquake waves cause water pressures to increase in loose sand and silt, causing the sand grains to lose contact with each other, decreasing the strength of the material, transforming it into a liquid state. Soil liquefaction is a process whereby the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. The result is a transformation of soil to a liquid state. Three factors must be present for liquefaction to occur (USGS, 2014d):

- loose, granular sediment consisting of man-made land and beach, stream and windblown deposits that are young (Pleistocene);
- soils must be saturated, where water fills the spaces between sand and silt grains; and
- strong shaking by a large earthquake.

The Project area is within a zone of low seismic hazard (see Section 6.4.1), thus the likelihood of soil liquefaction to occur in the Project area is low.

6.4.3 Landslides

Figure 6B-6 in Appendix 6B provides an excerpt of the USGS Landslide Overview Map of the U.S. that was reviewed as part of this hazard analysis (USGS, 1997b). Table 6A-8 in Appendix 6A presents landslide hazards by MP.

Along the Sherwood, CGT, Seneca, Berne, Clarington, Cadiz, and Majorsville Laterals, the landslide incidence and susceptibility is high (over 15 percent of the area is involved in landsliding). The Burgettstown Lateral traverses from an area of high susceptibility (over 15 percent) in Pennsylvania, West Virginia and extreme eastern Ohio to an area of high susceptibility to landsliding and moderate incidence.

The Supply Connector Lines A and B, and Mainlines A and B, traverse areas of high susceptibility to landsliding and moderate incidence (north of the Cadiz Lateral), to areas of high susceptibility to landsliding and low incidence in Carroll and Tuscarawas counties, Ohio, to areas of low landslide incidence west of Carroll and Tuscarawas counties (less than 1.5 percent of the area is involved). The remainder of Mainlines A and B are within areas of low landslide incidence, except for two isolated areas of moderate susceptibility to landslides and low incidence in Crawford and Defiance counties, Ohio.

The ATWS locations that may be required in areas of potential landslides and/or steep slopes are presented in detail by line segment in Resource Report 1.

The Market Segment crosses areas of low landslide incidence.

In general, landslides occur more frequently on steep slopes than in level areas and in areas with surface soil with a low shear strength. Steep slopes underlain by shale bedrock or bedrock interbedded with shale are common within the southeastern Project area. Shale bedrock typically yields clay-rich soils with a low shear strength. Commonly referred to as red-beds, these shales in West Virginia, Pennsylvania, and eastern Ohio consist of clay silt, and sand size particles that weather easily and lead to landslide incidents in the area (ODGS, 1996). This area of the Project is characterized by steep slopes and local relief of several hundred feet. In Ohio, the red beds of the Conemaugh and Monongahela Groups are well-known for slumps and earthflows (ODGS, 1995).

Landslides occur when rock, soil and sediments, soils, and debris move down steep slopes. Such gravity-induced flow is usually precipitated by heavy rains, erosion by rivers, earthquakes, or human activities (e.g. man-made structures or piles of rock or ore). Areas of unstable soils that could be susceptible to landslides may be characterized by soils that shrink or swell with changes in moisture content and are located in areas with steep relief. Landslides include rotational slumps, the movement of a large mass of weak rock or sediment; earthflows, weathered mass of rock or sediment that flow downslope in an unorganized fashion, typically a slow process; and, rockfall, a rapid downslope movement of bedrock traveling downslope in a freefall.

To limit the potential for landslides, Rover will manage stormwater during construction with stormwater drainage systems; trench breakers to prevent water from draining down the trench; temporary and permanent trench plugs; and, avoid changing natural drainage patterns by implementing the construction and restoration techniques included in the Rover Plan (see Appendix 1B in Resource Report 1). Rover has employed a geoprofessional (geologist or engineer) to evaluate the pipeline routes for areas of high landslide susceptibility and identify any site-specific construction or restoration procedures that should be implemented in these high risk areas to further limit the potential for landslides.

Methods that may be used to reduce landslide susceptibility include deeper burial of the pipeline, or installation of rip-rap, shoring, jute matting and waddles, reinforced fill, compacted fill, and/or rock lined swales. Landslides can also be mitigated by installation of engineered systems to control water which may include diversion of water and drainage along the slope to relieve groundwater pressures or the installation of a drain pipe that would extend from the trench breakers to the base of the slope so water does not build up pressure or mass above the water bars. Restoration will include installation of recommended permanent erosion controls and establishment of permanent vegetation. Periodic monitoring of these landslide prone areas will be conducted during the first and second years following construction, and monitoring will be conducted as needed in relatively steep slopes and areas susceptible to slippage for any evidence of a potential problem.

6.4.4 Land Subsidence

Subsidence is a motion of the earth’s surface, a sudden sinking or gradual downward settling of land with little or no horizontal motion that can be caused by surface faults and intensified or accelerated by subsurface mining or the pumping of oil, natural gas, or groundwater. As described in Section 6.2.1, coal mines in the southwestern Project area date back to the early 1800’s and continue to the present day.

The majority of the mines found along the Project pipelines are located in West Virginia, Pennsylvania, and eastern Ohio (see Table 6A-5 in Appendix 6A). Coal mine depths can range from less than 100 feet below the surface to 1,000 feet or more. Deeper mines with solid rock strata above are less likely to collapse as compared to a near-surface mine. Not all mines are mapped and the presence of mines has not prevented the construction and operation of other natural gas infrastructure. In Ohio for example, the Ohio Department of Transportation has inventoried over 1,200 sites where abandoned underground mines underlie state highways, U.S. routes, and interstate highways (ODGS, 2014a).

Underground mining is also completed for salt, limestone, and gypsum in the Project area. Most of this mining is completed with heavy machinery. However, salt is also mined by solution mining. Each of these mining methods create voids that have the potential to lead to land subsidence. Underground salt mining under Lake Erie has not generated subsidence. The Project facilities are not located in areas where solution mining has led to subsidence (Lake, Summit, and Media counties, Ohio) (Ohio, 2011).

Compaction of soil in some aquifer systems can result from excessive groundwater pumping. Typically, these subsidence events are permanent as the soil compacts and reduces the size of the pore spaces.

No subsidence locations from groundwater withdrawals were identified along the Project route. No mine collapse locations were identified along the Project route. However, based on the extensive history of underground mining in the Project area, localized surface subsidence is a potential hazard to the Project during and after construction.

Rover will conduct environmental training sessions for all Rover construction management and contractor personnel prior to and during the pipeline installation. While this training will focus on implementation of best management practices contained in the Project plans, it will also include awareness training for subsidence. The training will include the potential for unanticipated subsidence that could be discovered during construction. The training will also include protocol for work stoppage if subsidence is discovered and notification to Supervisors.

Rover will employ full-time Environmental Inspectors for each construction spread for the duration of Project construction. One Lead Environmental Inspector will be assigned to each spread, and one Chief Environmental Inspector will be assigned to the entire Project. All Environmental Inspectors will report to Rover’s Environmental Compliance Manager.

Post-construction right-of-way monitoring for the life of the Project will include visual assessment of subsidence and is considered a primary mitigation measure for future subsidence. Any approach to address random subsidence would be on a case-by-case basis.

6.4.5 Karst Terrain

Karst terrain develops in a landscape formed by the dissolution of soluble bedrock. Karst features form as the result of minerals dissolving out of the rock through rainwater. Slightly acidic rainwater leaches through the soil zone, becoming more acidic. This acidic groundwater slowly dissolves the soluble bedrock, a process that commonly occurs along fractures, bedding planes, and layers of rock more prone to dissolution where groundwater may be flowing through continuously. The karst terrain is characterized by the presence of sinkholes and underground drainage through joints and caves.

Karst regions in the Project area are shown on Figure 6B-7 in Appendix 6B. Areas that are primarily underlain by limestone or dolomite, and include areas of probable karst terrain along Mainlines A and B in Ohio between approximate Mainline MPs 124.0 and 209.4, and Market Segment MPs 0.0 and 4.0 in Crawford, Seneca, Hancock, Wood, Henry, and Defiance counties, Ohio. The Bellevue-Castalia Karst Plain in Ohio is not crossed by the Pipeline (ODGS, 2006). The karst area includes fissures, tubes and caves generally less than 1,000 feet long and 50 feet or less in vertical extent (ODGS, 1999; USGS, 2014c).

All excavation activities will be completed to minimize alteration of the existing grade and storm water flow to any identified karst features. Where the trench is excavated adjacent to karst features, spoils will be placed on the opposite side of the karst feature so that the soil will flow into the excavation and not toward the karst feature in the event of storm water erosion during construction. Storm water control measures will include detention, diversion, or containerization to prevent construction-influenced storm water from flowing to a karst feature drainage point (or throat). Drainage points in karst features will not be used for the disposal of water.

Hydrostatic test water discharges will be located outside of karst if at all possible. If hydrostatic test water is discharged within a karst area, it will be discharged downgradient of the karst feature. If site conditions prevent a downgradient discharge, the water will be discharged as far from the karst feature as is practicable with a filtered discharge and sediment and erosion control measures. Post-construction monitoring will ensure proper revegetation and restoration of these areas.

A Karst Mitigation Plan, which identifies mitigation measures that will be employed in karst areas, is included in Resource Report 1, Appendix 1B.

6.4.6 Flash Flooding

Flash flooding is possible in streams, rivers, and associated valleys in the Project area. Flooding is also possible during tropical events due to prolonged heavy rain and storm surges that raise surface water levels. Generally, flooding only causes a problem during pipeline construction. As required, aboveground facilities located in flood plains and pipeline stream crossings will be designed to preclude impacts from high velocity flows, largely by controlling erosion, per the Rover Procedures.

Measures will be implemented to provide the necessary equipment to handle waterbody flow increases during pipeline installation activities such as having additional pumps on stand-by for dam-and-pump crossings or appropriately sizing flumes to handle storm flows for flume crossings. In addition, equipment crossings will be designed to handle higher flow volumes that could be anticipated from storm events and flooding situations.

Post-construction monitoring will include the monitoring for washouts and erosion at each crossing and remediated, as necessary.

6.5 PALEONTOLOGICAL RESOURCES

The Project is within an area of former large, shallow, tropical seas and peri-coastal environments that occurred during the Pennsylvanian to Permian age. Marine invertebrates flourished during this era and, after dying and falling to the bottoms of these seas, some organisms became fossilized in the sedimentary rock that later formed. Other fossils were also deposited by streams. Terrestrial and plant vertebrate fossils are also found in the Project area in widespread but scattered locations. Additionally, more recent Pleistocene vertebrate remains may be encountered in Project areas covered by glacial drift.

West Virginia does not regulate paleontological findings, and overall, it is unlikely that the segments of the Supply Lateral pipelines in West Virginia would cause a material impact to known or potential paleontological findings. The Pennsylvanian to Permian age cycles of marine to non-marine deposits of shale, siltstone and sandstone contain invertebrate fossils with occasional disseminated terrestrial plant fossils and some fragmented rare vertebrate remains (fish and amphibians). The Monongahela and Dunkard groups contain invertebrate fossils, some of which may be rare (USGS, 2008). None of these fossils are deemed significant.

The units encountered along the Burgettstown Lateral in Pennsylvania contain identifiable fossils. Most fossils are of non-unique invertebrate or plant fossils. Chances of discovering a unique set of fossils based on species, abundance, preservation method or locality is remote, but possible (USGS, 2007a).

Non-glaciated areas of eastern Ohio contain Pennsylvanian to Permian units, some of which contain many marine to freshwater fossils. The Linton site in Jefferson County contains some of the oldest reptile remains known on the planet, as well as shark teeth, amphibian and fish remains. The Burgettstown Lateral does not go through the Linton site in Jefferson County (ODGS, 1996).

Within the glaciate regions of Ohio, important fossil discoveries are unlikely, but mammoth and mastodon remains may be encountered. (ODGS, 1996). Ohio does not have regulations regarding fossil protection unless encountered on federal or state land, although the Orton Geological Museum has requested to be contacted if any significant findings are uncovered.

The Michigan Geological Survey does not officially track fossils. The most likely fossils to be uncovered are those of mammals from the Pleistocene that may be uncovered in the surficial glacial drift, such as mammoths and mastodons (USGS, 2007b).

As requested by FERC staff, an Unanticipated Discoveries Plan for Paleontological Resources is provided in Appendix 1B in Resource Report 1.

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