NEXUS GAS TRANSMISSION PROJECT

RESOURCE REPORT 6

Geological Resources

FERC Docket No. CP16-__-000

November 2015

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Filing Requirement	**Location in Environmental Report**
☐ For underground storage facilities, how drilling activity by others within or adjacent to the facilities would be monitored, and how old wells would be located and monitored within the facility boundaries.	N/A
☒ Discuss the need for and locations where blasting may be necessary in order to construct the proposed facilities.	Section 6.3
☒ Identify the location (by milepost) of mineral resources and any planned or active surface mines crossed by the proposed facilities.	Section 6.4
☒ Identify any geologic hazards to the proposed facilities.	Section 6.5
☐ For LNG projects in seismic areas, the materials required by "Data Requirements for the Seismic River of LNG Facilities," NBSIR84-2833	N/A

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON
NEXUS RESOURCE REPORT 6 – GEOLOGICAL RESOURCES

FERC COMMENTS ON RESOURCE REPORT 6	LOCATION OR RESPONSE TO COMMENT
67.[1] RR 6 should include a table that identifies, by milepost, all locations where blasting is anticipated due to shallow bedrock and identify any sensitive resources at each location (e.g., wells, septic systems, structures, wetlands, waterbodies and aquatic resources, power lines).	Table 6.3-1 was added to Resource Report 6 (see Tables Section) identifying by milepost the areas where blasting may be required based on shallow to bedrock soils. The last column of the table identifies the listed constraints in the vicinity of these shallow to bedrock areas.
68. Include information in section 6.2.1 on elevation range within each physiographic province.	Elevation ranges for physiographic provinces are provided in Section 6.2.1.
69. Some of the geologic formation abbreviations listed in the text of section 6.2.2.1 do not correlate to the abbreviations in figure 6.2-1b, likely due to different abbreviations used in the state-specific GIS data. Additionally, Antrim Shale (Da) is present in figure 6.2-1b but is not included in the text. Resolve these discrepancies.	Section 6.2.2 was corrected to include the appropriate abbreviations and to match abbreviations used in Figures.
70. Include a discussion in section 6.3 of blasting as a mechanism for triggering sinkhole development (karstic or mine subsidence) and any measures NEXUS would implement to minimize this impact. Also include a description of how impacts would be assessed and mitigated. Confirm that table 6.4-2 includes mine subsidence features identified in scoping comment letters.	Additional discussion of blasting procedures has been added to Section 6.3.
71. Tables 6.4-1, 6.4-2, and 6.4-3 identify numerous non-fuel (gravel/sand) and fuel (coal) mineral resource areas that would be located within 0.25 mile of the Project. Update these tables as necessary by:	
a. clarifying what is meant by abandoned, inactive, and active;	The terms abandoned, active, and inactive used in the tables are based on the status of the permit maintained by the surface (strip) mine operators. The exact difference between abandoned and inactive surface mines cannot be discerned from the available data and may have more to do with the governing permit law (A-Law, B-Law, C-Law, or D-Law) that was in effect when the permit was acquired.
b. indicating the status of gravel/sand operations;	The title of Table 6.4-1 has been changed to indicate that those operations are active.

[1] Numbering of comments is based on letter from Federal Energy Regulatory Commission to Nexus Gas Transmission, LLC dated July 30, 2015 and posted to Docket Number PF15-10-000 regarding *Comments on Draft Resource Reports 1 through 8 and 10*.

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON NEXUS RESOURCE REPORT 6 – GEOLOGICAL RESOURCES

FERC COMMENTS ON RESOURCE REPORT 6	LOCATION OR RESPONSE TO COMMENT
c. clarifying that no active underground coal mines are thought to be located within 0.25 mile of the Project's footprint; and	Additional clarification has been provided in Section 6.4.2.1.
d. adding a table of active and inactive natural gas and oil wells, by county, located within 0.25 mile of the Project's planned footprint.	Tables 6.4-4 and 6.4-5 have been created and added to RR6.
72. NEXUS provided little discussion of Project impacts on active mineral resources. Include discussion with accompanying conclusions on the Project's potential impact on the fuel and non-fuel mineral resource activities located within 0.25 mile mentioned above from construction and operation of the Project, including from NEXUS's planned access roads.	Section 6.4 has been updated to include a brief summary that adverse impacts are not anticipated to mineral resources.
73. Given that NEXUS estimates there may be extensive underground coal mines that are unmapped and unknown, provide the following information concerning surface and/or underground coal mining:	As a point of clarification, based on the long history of coal mining in southeast Ohio, there are numerous unmapped or unknown underground coal mines. However, these old mines would not be extensive but rather small, given the difficulty of extraction with limited technology.
a. clarification, in NEXUS's discussion in section 6.4.2.1 Coal, of the distinction between room-and-pillar mining's "long-term risk of collapse and surface subsidence hazards" and longwall mining being "susceptible to more immediate collapse than room and pillar mining";	Section 6.4.2.1 has be updated to clarify the distinction between room and pillar mining's long term risk of collapse and surface mining subsidence hazards.
b. additional discussion in section 6.5.6.1 on what mitigation measures NEXUS would use to minimize damage to pipelines and subsurface structure should underground coal mines be discovered during construction;	Section 6.5.6.1 has been updated to include more discussion of mitigation measures
c. discussion of the potential for any type of future coal mining at the compressor station locations and what NEXUS would do to prevent impacts on its planned facilities should future mining occur nearby; and	Potential future coal mining at planned compressor station sites is mitigated through acquisition and/or lease agreements for the properties.
d. a discussion of any efforts NEXUS is currently engaged in, or plans it is developing, with mining companies to avoid, minimize, and mitigate potential subsidence impacts to and by the Project regarding active or future coal mining operations along the planned pipelines' paths.	Section 6.4.2.1 has been updated to indicate that, in addition to current mines, there are no mapped proposed or permitted mines within 0.25 mile of the Project.

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FERC COMMENTS ON RESOURCE REPORT 6	LOCATION OR RESPONSE TO COMMENT
74. Provide in section 6.5.1:	
a. results from karst feature identification field surveys as referenced in the final paragraph on page 6-8; and	Section 6.5.1 has be updated to address this comment
b. results of "ongoing" investigations to evaluate whether buoyancy control measures should be implemented on the pipeline in closed depressions within the Bellevue-Castalia Karst Plain (page 6-9).	Section 6.5.1 has be updated to address this comment
75. Provide in section 6.5.1.3 more discussion on karst avoidance measures and measures to remediate disturbed karst features and protect pipeline and aboveground facilities potentially impacted by discovered karst features.	Section 6.5.1.3 has been updated to address this comment.
76. Provide in section 6.5.1.3:	
a. discussion of how HDD may affect or trigger sinkhole development and describe measures that would be implemented to evaluate the potential for this to occur	Section 6.5.1.3 has been updated to address this comment.
b. an analysis of the distance an unsupported pipeline could safely span for each class of pipe that would be installed and compare this to the typical width of sinkholes likely to be encountered based on sinkhole database data and field investigations; and	Section 6.5.1.3 has been updated to address this comment.
c. description of any additional long-term (operational) monitoring of the pipeline (e.g., surface displacement surveys, manual or automated strain gauge monitoring) that would be utilized in areas of potential karst subsidence.	Based on the information provided in 6.5.1, particularly the practical experience of local/regional engineers, additional long-term monitoring, outside of standard monitoring and maintenance practices are not anticipated.
77. State in section 6.5.4 how much of the pipeline area lies on soils susceptible to liquefaction.	Soils with of high liquefaction potential/susceptibility have not been identified or mapped along the Project. NEXUS has added some additional discussion of the soils along the Project that may be likeliest to be saturated and non-cohesive (i.e., two of the three conditions required to produce soil liquefaction); however, without a significant component of ground motion due to seismic activity, the risk of liquefaction along the Project remains very low.
78. Expand the discussion in section 6.5.6 on potential presence of unmapped/unknown underground mines to address scoping comments.	Section 6.5.6 has been updated to address this comment.
79. Provide in section 6.5.6.1 more discussion on what mitigation measures NEXUS would use to minimize damage to pipelines and subsurface structure/hydrology should mines be discovered during construction, given	Section 6.5.6.1 has been updated to address this comment.

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FERC COMMENTS ON RESOURCE REPORT 6	LOCATION OR RESPONSE TO COMMENT
that many unmapped underground coal mines may exist in the Project area.	
80. Provide in section 6.5.6.1 a description of any additional long-term (operational) monitoring of the pipeline (e.g., surface displacement surveys, manual or automated strain gauge monitoring) that would be utilized in areas of potential mine subsidence.	Section 6.5.6.1 was updated to address this comment.
81. Provide in section 6.6 a discussion and reference to absence of Mesozoic Era rock formations and fossils in Ohio and Michigan to address a scoping comment regarding presence of dinosaur fossils at an unnamed river crossing.	Section 6.6 has been updated to include a discussion and reference to the absence of Mesozoic Era rock formations and fossils in Ohio and Michigan and potential for presence of dinosaur fossils.
82. Resolve the following discrepancies in section 7 between reference and text:	
a. O'Rourke and Palmer, 1994. Referenced in section 6.5.2 but not included in reference section.	Reference has been added to the References Section of this report.
b. Baranoski, 2013. Referenced in section 6.5.3 but not included in reference section.	Reference has been added to the References Section of this report.
c. Radbruch-Hall et. al., 1978. Reference in section 6.5.5 is Radbruch-Hall et. al., 1982.	This reference has been corrected in the report.
d. USEPA, 1989. This reference is not cited in the text.	Citation has been added in Section 6.5.1 of this report.

ACRONYMS AND ABBREVIATIONS

DTE or DTE Energy	DTE Energy Company
FERC or Commission	Federal Energy Regulatory Commission
MP	milepost
NEXUS	NEXUS Gas Transmission, LLC
Project	NEXUS Gas Transmission Project or Project, NEXUS Transmission, LLC
ROW	right-of-way
Spectra Energy	Spectra Energy Partners, LP
U.S.	United States
USGS	United States Geological Survey

6.0 RESOURCE REPORT 6 – GEOLOGICAL RESOURCES

6.1 Introduction

NEXUS Gas Transmission, LLC ("NEXUS") is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission ("FERC") pursuant to Section 7(c) of the Natural Gas Act authorizing the construction and operation of the NEXUS Gas Transmission Project ("NEXUS Project" or "Project"). NEXUS is owned by affiliates of Spectra Energy Partners, LP ("Spectra" or "Spectra Energy") and DTE Energy Company ("DTE" or "DTE Energy"). The NEXUS Project will utilize greenfield pipeline construction and capacity of third party pipelines to provide for the seamless transportation of 1.5 million dekatherms per day ("Dth/d") of Appalachian Basin shale gas, including Utica and Marcellus shale gas production, directly to consuming markets in northern Ohio and southeastern Michigan, and to the Dawn Hub in Ontario, Canada. Through interconnections with existing pipelines, supply from the NEXUS Project will also be able to reach the Chicago Hub in Illinois and other Midwestern markets. The United States ("U.S.") portion of the NEXUS Project includes new greenfield pipeline in Ohio and Michigan and capacity leased from others in Pennsylvania, West Virginia, Ohio and Michigan, terminating at the U.S./Canada international boundary between Michigan and Ontario. The Canadian portion of the Project will extend from the U.S./Canada international boundary to the Dawn Hub.

A more detailed description of the Project is set forth in Resource Report 1.

This Resource Report 6 describes the geologic setting and resources of the Project area for the pipeline facilities and the new aboveground facilities (Section 6.2) and addresses the potential for blasting (Section 6.3), use of mineral resources (Section 6.4), and geological hazards that may affect the construction and operations of these new facilities (Section 6.5). Where appropriate, mitigation measures intended to reduce the impact of the Project on geological resources and/or reduce the impact of geological hazards on Project facilities are identified. A checklist showing the status of the FERC filing requirements for Resource Report 6 is included after the table of contents. A table showing the location of responses to the FERC's July 30, 2015 comments on draft Resource Report 6 follows the FERC filing requirements checklist. Tables and figures for this Resource Report are provided in the Tables and Figures Sections at the end of this report.

Project mapping including aerial photo based alignment sheets and U.S. Geological Survey ("USGS") topographic maps excerpts showing Project facilities are provided in Appendix 1A of Resource Report 1.

6.2 Geologic Setting

The Project pipeline facilities will cross from the Appalachian plateaus through the Great Lakes plains. The underlying geology of the Project includes relatively flat-lying Paleozoic (geologic era spanning 542 million years ago to 251 million years ago) sedimentary strata overlain by varying amounts of unconsolidated Pleistocene (1.65 million years ago to 10,000 years ago) deposits. The landscape of the Project is a result of the inundation of the area by seas in the Paleozoic era, the advance and retreat of continental ice sheets in the Pleistocene era, and fluvial erosion in the Holocene era (10,000 years ago to present).

6.2.1 Physiography and Topography

The U.S. is categorized into divisions, provinces, and sections (listed in decreasing scale) based on geologic structure, climate, and geomorphic history. The resultant topography of the various categories often vary noticeably from those adjacent. In 1928, Fenneman defined physiographic designations across the United States on a map titled "Physical Divisions of the United States," and these designations are still in use today. Using these designations, the Project is set in the Appalachian Highlands and Interior Plains divisions, with further description, as follows.

NEXUS Pipeline Segments	Physiographic Region		
MP (to nearest tenth)	Division	Province	Section
0 – 15.0	Appalachian Highlands	Appalachian Plateaus	Kanawha
15.0 – 79.0	Appalachian Highlands	Appalachian Plateaus	Southern New York
79.0 – 109.3	Interior Plains	Central Lowland	Till Plains
109.3 – 255.0	Interior Plains	Central Lowland	Eastern Lake

Appalachian Highland Division – area characterized by altitude but does include related lowlands in places.

Appalachian Plateaus Province – elevated, flat-lying sedimentary rocks with varying degrees of stream dissection.

Kanawha Section – dissected plateau comprised of fine sedimentary strata showing moderate to high relief. Elevations of the Project in the Kanawha Section range from approximately 1,140 to 1,310 feet above mean sea level (amsl).

Southern New York Section – mature, dissected plateau showing moderate relief that was covered by continental glaciers in the Pleistocene. Elevations of the Project in the Southern New York Section range from approximately 950 to 1,300 feet amsl.

Interior Plains Division – the vast middle of the continent with low relief locally.

Central Lowland Province – the low eastern portion of the interior plains.

Eastern Lake Section – the area around the Great Lakes that is characterized by the prevalence of glacial features (e.g., moraines, lakes, lacustrine plains). Elevations of the Project in the Eastern Lake Section range from approximately 750 to 970 feet amsl.

Till Plains Section – flat areas with very little stream dissection, no natural lakes, and covered by glacial drift deposits. Elevations of the Project in the Till Plains Section range from approximately 575 to 1,300 feet amsl.

6.2.2 Bedrock Geologic Materials of the Project Area

Figures 6.2-1a and 6.2-1b present bedrock geologic materials along the Project pipeline and aboveground facilities. Table 6.2-1 summarizes the bedrock geologic materials along the Project pipeline facilities and aboveground facilities by milepost. Those materials are further described below. Ohio descriptions were taken from Nicholson *et. al.,* 2005. Michigan descriptions were taken from Milstein, 1987.

6.2.2.1 Ohio

Connemaugh Group (IPc) – Lithologies include shale, siltstone, and mudstone. IPc shales are black, gray, green and red; have clayey to silty textures; and contain marine fossils in places in lower half of the unit, and is partially calcareous. Siltstones are gray, green and red, locally variegated; have clayey to sandy texture; and thinly bedded to nonbedded. IPc mudstones are black, gray, green, red, and yellow, variegated in part; have clayey to silty textures; are locally calcareous; and are commonly nonbedded. IPc sandstone tends to be green-gray weathering to yellow-brown; are mostly very fine to medium grained, but locally conglomeratic; are thin to massive to cross bedded; and are locally calcareous. Limestone and coal in this group are thin and discontinuous. IPc limestones are black, gray and green, micritic to coarse grained, and thin bedded to concretionary with marine fossils common in lower half of interval and thin to medium bedded, nonmarine limestone common in upper half of unit. Coal in the unit tends to be thin, bituminous, impure and very locally thick enough for economic development. Lateral and vertical lithic variability and gradation is common. The IPC is as much as 500 feet thick.

Allegheny and Pottsville Groups, undivided (IPap) – Lithologies include shale, siltstone, and underclay. IPap shales are black, gray, and olive; clayey to silty; locally contain marine fossils; and are calcareous in part. IPap siltstones are gray, greenish and olive; clayey to sandy; thin bedded to medium bedded; and locally contain marine fossils. IPap underclay is gray and olive; generally 3 feet or less in thickness; clayey to silty; commonly rooted and underlying coal beds; nonbedded; and locally varies from flint to plastic clay. IPap sandstone is light to medium gray weathering to yellow-brown; mostly very fine to medium grained, locally quartzose and conglomeratic in lower one-third of unit; thin to massive to cross bedded; and locally calcareous. IPap limestone is black to light gray; micritic to medium grained; locally grades into flint; and thin to medium bedded with discoidal concretions containing marine fossils. Locally nonmarine, micritic limestones occur beneath coal beds in upper one third of IPap. IPap coal is mostly banded bituminous, locally cannel; thin to locally as much as 12 feet thick; generally in discrete beds but locally contain shale partings and split into multiple beds. Lateral and vertical lithic variability and gradation is common. IPap is as much as 700 feet thick.

Maxville Limestone; Rushville, Logan, and Cuyhoga Formations, undivided (Mlc) – Mlc lithologies include interbedded shale, siltstone, and sandstone of various shades of gray, yellow to brown. Mlc sandstones are silty to granular with local stringers of quartz pebbles. Mlc shale is clayey to silty and locally fossiliferous. Medium to dark gray, thin to thick bedded limestone locally preserved at top of interval where Mlc crops out in southern half of state. Lithologies percentages vary in different areas where unit crops out with lateral and vertical gradation common at a regional scale.

Berea Sandstone and Bedford Shale, undivided (Dbb) – Lithologies include sandstone and shale. The upper portion of Dbb is brown sandstone weathering to light brown to reddish brown, thinly to thickly bedded (planar to lenticular bedding) with minor shale interbeds. The sandstone is 5 to 75 feet thick, locally 100 to 125 feet thickness in Lorain, Cuyahoga, and Medina Counties. The lower portion of Dbb is gray to brown shale, locally reddish brown; thin to medium bedded (planar to lenticular bedding); interbedded siltstone and sandstone, ripple marks in siltstone beds; 80 to 180 feet thick, locally thin to absent where Berea Sandstone is thick.

Ohio Shale (Do) – Do is a brownish black to greenish gray shale, weathers brown that is carbonaceous to clayey, laminated to thin bedded (fissile parting) with carbonate and/or siderite concretions in the lowermost 50 feet, petroliferous odor, and 250 to 500+ feet thick.

Prout Limestone (Dp) – An olive gray hard, siliceous limestone, dolomitic in part with irregular bedding; pyrite, glauconite and phosphatic bone fragments at upper contact; 0 to 9 feet thick. Contains corals superficially similar to those of lower part of Jaycox Shale Member of Ludlowville Formation in NY.

Plum Brook Shale (Dpl) – Dpl lithologies include shale and argillaceous limestone; gray; thin bedded fossiliferous; 0 to 40 feet thick.

Delaware Limestone (Dd) – Dd is a gray to brown Limestone that is thin to massive bedded with argillaceous partings, nodules and layers and carbonaceous, petroliferous odor. It is as much as 45 feet thick.

Columbus Limestone (Dc) – Dc lithologies include gray to brown limestone and dolomite, weathering brown with massive bedding. The upper 2/3 of Dc are fossiliferous, gray limestone; the lower 1/3 is brown dolomite. Dc is up to 105 feet thick.

Salina Group (Ss) – Gray, yellow-gray to olive-gray dolomite; laminated to thin bedded; occasional thin beds and laminae of dark gray shale and anhydrite and/or gypsum; brecciated zones in part.

Tymochtee and Greenfield Formations, undivided (Stg) – Olive-gray to yellowish- brown dolomite that is thin to massive bedded, in which the upper two-thirds commonly contains brownish-black to gray shale laminae and locally developed brecciated zones in lower one third.

Lockport Dolomite (Sl) – Dolomite has been observed in shades of white to medium gray, is medium to massive bedded, fine to coarse crystalline; fossiliferous; and vuggy.

Detroit River Group (Ddr) – Ddr is primarily brown to gray dolomite that is medium to thick bedded, laminated, with nodules or interbeds of anhydrite and/or gypsum. The basal part of Ddr becomes sandy dolomite or fine-grained sandstone. Ddr is as much as 170 feet thick.

Dundee Limestone (Ddu) – Ddu is olive gray to brown limestone. The upper part is thin bedded, and the lower part is medium to thick bedded. Fossiliferous characteristics in upper part becomes cherty dolomite in lower part. Ddu is as much as 105 feet thick.

Traverse Group (Dts) – Dts is dolomite and shale interbedded with limestone. The upper part is gray to light brown, thin to medium bedded dolomite with abundant chert. The lower part is olive gray, thin to medium bedded shale interbedded with limestone that is very fossiliferous. Dts is as much as 170 feet thick.

Antrim Shale (Da) – Da is dark brown to black, carbonaceous, thinly laminated Shale that is 0 to 230 feet thick.

Sunbury and Bedford Formations, undivided (MDsd) – MDsd lithologies include shale and siltstone. MDsd shale is black to brownish-black, carbonaceous in upper one third of interval, gray to bluish-gray, clayey with occasional siltstone lamina and thin beds in lower two-thirds of interval.

6.2.2.1 Michigan

Bedford Shale (Dbd) – Dbd is a bluish to light gray, silty shale that becomes sandy in its upper part and has a gradational contact with the overlying Berea Sandstone. It is commonly 50 to 100 feet thick and thins and becomes fine grained to the west.

Berea Sandstone (Db) – The Berea attains a thickness of 260 feet in Huron Co. but thins northwestward, westward, and southwestward away from the thumb area and is absent in the eastern half of the Michigan basin. Unit is generally 50 to 100 feet throughout its extent. Consists predominantly of light gray sandstone that is fine grained in the lower and upper parts of the formation but medium to coarse grained in the middle. It is silty and pyritic in its lower part.

Sunbury Shale (DMs) – Sunbury shale is the youngest of the regionally extensive black gas shales. It is typically fissile black shale that weathers into small discoidal sharp-edged chips. Pyrite is common, particularly near the base where it separates a zone of small inarticulate brachiopods and SIPHONODELLA conodont fauna from the underlying Berea. The unit is present only in the western part of the basin. Crops out at many places along the eastern flank of the Cincinnati arch in Ohio and northeastern Kentucky and ranges there from 10 to 40 feet thick.

Coldwater Shale (Mc) – The Coldwater conformably overlies the Sunbury and Ellsworth Shales and conformably underlies the Marshall Sandstone. Maximum thickness is about 1,200 feet in Iosco and Arenac Cos just north of Saginaw Bay, but is generally 1,000 feet in the eastern two-thirds of the basin and thins to about 550 feet in the western third. Unit consists predominantly of gray to bluish gray shale. Its clay minerals are chiefly illite and kaolinite with minor chlorite. Other lithologies occur in the Coldwater and their distributions divide the formation into distinct eastern and western facies. In the eastern half of the basin, beds of silty and sandy shale, siltstone and fine-grained sandstone are common, and increase in abundance and coarseness to the west and up section. In the western half of the basin the Coldwater shales are more calcareous and beds of glauconitic, fossiliferous limestone and dolostone occur frequently especially in the middle and upper portions of the formation. Two marker beds can be traced over long distances: the Lime and the Red Rock beds. The Lime occurs throughout the western part of the basin and is commonly 18 to 3 feet thick. The Red Rock is more extensive and occurs in all parts of the basin except the extreme northeast. It is typically 9 to 18 feet thick and locally reaches 50 feet.

Traverse Group (Dt) – See description provided previously for Ohio.

Antrim Shale (Da) – See description provided previously for Ohio.

6.2.3 Surficial Geologic Materials of the Project Area

Surficial geology of the Project area is comprised of unconsolidated sediments deposited in the Quaternary period, which includes the Pleistocene (1.65 million years ago to 10,000 years ago) and Holocene (10,000 years ago to present) epochs. Quaternary deposits in the Project area can be broken out into three general categories, based on their depositional environment: deposits laid down by advancing Pleistocene ice sheets (moraines and most tills); glacial melt deposits (stratified deposits from glacial streams and lakes); and recent deposits (alluvium in existing floodplains and swamp deposits). Quaternary geologic materials may be categorized by their depositional environment (e.g., swamp), grain size (e.g., sand and gravel), formation type (e.g., moraine), or a combination of these (e.g., lacustrine sand).

During Pleistocene glacial periods, advancing continental ice sheets rounded uplands, widened stream valleys, laid down a layer of till atop bedrock, and mounded till near the ice margins (moraines). The deposits of advancing ice, including till-covered uplands, moraines, and ground moraine (till plain), consist of till. Till is a dense diamict deposit generally consisting of gravel and fine silt and clay. There is little to no stratification of till deposits as the ice carried virtually all particle sizes (from boulders to clay) and meanwhile ground the material plucked from the underlying bedrock into ever smaller particles (rock flour).

Material laid down by glacial melt water can be generally referred to as stratified drift. The stratification of these deposits is due to the energy of the water that deposited the material. Coarser materials indicate faster flows (e.g., deltas and outwash streams), and finer deposits are interpreted to indicate standing or slow moving water (e.g., lakes). The multiple advances and retreats of the intercontinental ice sheets in the Pleistocene created a complex fabric in which the last glacial maximum (the Wisconsin glaciation) largely erased indications of prior glacial advances but, in places, left traces of older deposits behind. Adding to the complexity are the various and dynamic depositional environments created by glacial advance and retreat. For example, an area once covered by the last ice sheet may have subsequently been a glacial lake around the margins of the receding ice that later drained when the ice dam that created the lake failed, and there may be a stream running through the area today with localized swamps. In this hypothetical circumstance the area may have till atop bedrock overlain by lacustrine silts or sands with stream alluvium and swamp deposits overlying the glacial lake deposits in some locations.

The surficial geology of the Project is generally comprised of till in the shape of ground moraine, ground moraine, and thin till overlying an upland with lesser subglacial sands and gravels in the form of kames and eskers and outwash sands and gravels in northeast to north-central Ohio (ODGS, 2005). From north central Ohio (around milepost ("MP") 112) to the northern terminus, the surficial geologic deposits are wave-planed till, fines (silt and clay) and sandy deposits all related to glacial lakes Maumee (3 stages), Arkona, Whittlesey, Warren (3 stages), and Wayne, which covered the area about 14,000 years ago to 12,000 years ago (Stierman *et. al.,* 2005). These glacial lakes preceded the formation of Lake Erie and extended further to the south and west of the current lake (Kelley and Farrand, 1967). Lacustrine clays were deposited across the area when the lakes were present, and as these ancestral lakes receded toward modern-day Lake Erie, beach and eolian sands were deposited atop the clay in places. Of particular significance is the Oak Openings region (approximate MP 186.6 to 196.3) where the beach ridge sands overlie lacustrine clays, creating a unique ecosystem of sand dunes, swamp forest and wet prairies. Additional details about the Oak Openings region are provided in Resource Reports 2 and 3.

A review of surficial geology maps provided information regarding the nature of deposits expected in the Project area. Figures 6.2-2a and 6.2-2b depict the surficial geology in the Project area, and Table 6.2-2 summarizes surficial geology in the vicinity of the proposed pipeline and aboveground facilities.

6.3 Rock Removal and Blasting

Based on NEXUS' experience, field reconnaissance and review of soils and geologic maps of the Project area, shallow bedrock (less than 5 feet from the surface) may be encountered at various locations along the Project alignment. In Resource Report 7, Table 7.2-2, the depth to bedrock is presented, where available, based on the U.S. Department of Agriculture, Natural Resources Conservation Service digital Soil Survey Geographic Database.

Rock encountered during trenching will be removed using one of the techniques identified in Section 1.7.1.8 of Resource Report 1. The technique selected is dependent on the relative hardness, fracture susceptibility, and expected volume of the material. Techniques include:

- Conventional excavation with a backhoe;
- Ripping with a dozer followed by backhoe excavation;
- Hammering with a pointed backhoe attachment followed by backhoe excavation;
- Blasting followed by backhoe excavation; or
- Blasting surface rock prior to excavation.

Blasting will only be required in areas where shallow rock is present and where the rock has high enough shear strength to require blasting to excavate it from the trench. The NEXUS Project Blasting Plan (*see* Appendix 1B3 in Resource Report 1) identifies the impact avoidance and minimization measures employed by NEXUS if blasting is determined necessary and will contain special provisions that will be taken to monitor and assess blasting within 150 feet of private or public water supply wells, should that situation arise.

If blasting is required, it will be designed and controlled to focus the energy of the blasting to the rock within the trench and to limit ground accelerations outside the trench. This should minimize fracturing of rock outside of the trench. However, if new fractures develop in the rock outside of the trench, the ground accelerations are not expected to be high enough to produce ground displacement along these fractures sufficient to open the fractures and significantly increase the permeability of the rock.

Possible karst and underground mines along the Project alignment are geologically limited to Ohio. No karst or underground mines have been identified in Michigan. Based on data from ODNR there are two segments of the alignment that will cross both (a) in an area of expected shallow rock and (b) in close proximity to either possible karst or an underground mine. The first of these segments occurs in Wayne County, where the alignment passes the Wayne No. 2 abandoned underground mine. At its closest point, the alignment is within 475 feet of the Wayne No. 2 Mine. With this offset, the ground accelerations associated with blasting in the trench are not expected to have any impact on the mine. The second of these segments occurs in Erie County, where the alignment passes through a possible karst area over an approximately 1-mile segment that spans State Route 269. However, given the design and control of the blasting (detailed in the NEXUS Project Blasting Plan in Appendix 1B3 in Resource Report 1), the impact of trenching in a karst area requiring blasting is not expected to be any greater than the impact of trenching in a karst area not requiring blasting. Therefore, no sinkhole development (karstic or mine subsidence) is expected to occur.

Large rock not suitable for use as backfill material will either be windrowed along the edge of the right-of-way ("ROW"), with permission from the landowner, used to construct ATV barriers across the ROW, or buried on the ROW. NEXUS will negotiate with landowners and will obtain permission to permanently store rock along, over, through or across the ROW. Otherwise the excess rock will be hauled off-site and disposed of in an appropriate manner. NEXUS is evaluating the need for specifying blast rock disposal areas in the Project vicinity. Any remaining rock will be used to backfill the trench to the top of the existing bedrock profiles.

6.4 Mineral Resources

Mineral Resources in the Project area include non-fuel resources (limestone, sand and gravel, clay, *etc.*) along the entire Project route and fuel resources (coal and oil and gas) in the Allegheny Plateau portion of the Project in Ohio.

6.4.1 Non-fuel Mineral Resources

Non-fuel mineral resources were assessed in the Project area by a review of government mine databases and a review of aerial photographs (2011-2014). Table 6.4-1 presents non-fuel surface mines located within ¼ mile of the Project pipeline. No non-fuel mine or mine leases were identified as being crossed by the current route. Avoidance was the primary method to prevent an impact to mines. There were no non-fuel surface mines identified within ¼ mile of the aboveground facilities.

The types of minerals commercially mined in the general geographic area of the proposed Project are summarized below.

Ohio (USGS, 2013b and ODNR, 2013)

- Columbiana County – sand and gravel, clay
- Stark County – sand and gravel, crushed stone
- Summit County – sand and gravel, salt
- Wayne County – sand and gravel, salt
- Medina County – sand and gravel
- Lorain County – sandstone
- Erie County – crushed stone, sandstone, sand and gravel, limestone
- Sandusky County – crushed stone, limestone
- Wood County – crushed stone, limestone
- Henry County –limestone
- Lucas County – crushed stone, limestone
- Fulton County – sand and gravel

Michigan (USGS, 2013a)

- Lenawee County – sand and gravel
- Monroe County – limestone, clay
- Washtenaw County – sand and gravel

6.4.2 Fuel Resources

6.4.2.1 Coal

Southeast Ohio has been involved in the commercial production of coal since as early as 1800. Since that time, approximately 2.35 billion tons of coal have been produced in Ohio. Early mining operations were largely underground mines. Technological advances in the mid-20th century made the extraction of coal from strip mines an economically viable option, and surface mining was predominant. In the last approximately 20 years, coal extraction in Ohio has switched back toward underground mines as surficial coal deposits have been exhausted (ODGS, 2012). Based on the information provided below and in Tables 6.4-2 and 6.4-3, no impact to coal resources is anticipated.

Underground mining may be room-and-pillar mining or longwall mining. Since room-and-pillar mining has been used for much longer, it is the most common method historically used in Ohio. Room-and-pillar mining leaves pillars of mineable material to support the room. Roof rock can also be supported by timbers in some instances. This method results in long-term risk of collapse and surface subsidence hazards as the pillars lose their integrity with time and the roof rock eventually collapses. Longwall mining is in greater practice in modern coal mines because it yields a much greater percentage of the minable resource. The longwall method uses temporary hydraulic roof support that is removed as the coal bed is mined away and the roof rock is left unsupported and allowed to collapse. As a result, longwall mining is susceptible to more immediate collapse than room and pillar mining (Gordon, 2009). Mapped active and abandoned underground mines within ¼ mile of the Project are summarized in Table 6.4-2. No current, proposed, or permitted underground mines were identified in Table 6.4-2. There are no mapped underground abandoned or active mines within ¼ mile of aboveground facilities.

Mapped surface coal mines within ¼ mile of the Project are summarized in Table 6.4-3. There are no mapped current or proposed surface coal mines within ¼ mile of the Project. The Project does not intersect mapped former surface coal mines.

6.4.2.2 Oil and Gas

The Appalachian Basin has a history of drilling for oil and natural gas resources that dates back to 1859. From 1895 to 1903 Ohio produced more oil than any other state in the United States. Oil and gas in those days was produced from conventional wells drilled vertically into a reservoir rock (typically sandstone) where liquid and gas hydrocarbons occupied the pore spaces in the rock. In recent years the Appalachian Basin has seen extensive drilling for unconventional oil and gas resources. The Marcellus and Utica Shales are Devonian and Ordovician (respectively) formations that underlie eastern Ohio. Both formations contain hydrocarbons (natural gas and liquids), but they cannot be extracted economically through conventional drilling and extraction methods. Multi-directional drilling and hydraulic fracturing have quickly expanded oil and gas production in the Marcellus and Utica Shales. These methods require a larger footprint during exploration and development than conventional drilling methods due to the need for retention ponds and/or tanker trucks for the high volume of production and flowback water generated during completion of these wells.

There are known oil and gas wells within 0.25 mile of the Project area, and production and gathering facilities are currently being permitted and installed on an ever changing basis in Eastern Ohio. Active and inactive oil and gas wells within 0.25 mile of the Project are summarized in Tables 6.4-4 and 6.4-5, respectively. NEXUS is aligning the Project pipeline and facilities to avoid conflicting with locations mapped within the workspace. The most viable mitigation is to route around the active well sites or provide an offset from the well as agreed upon with the producers. Construction of the Project will require shallow excavation and as a result, no impact will occur to the relatively deep oil and gas resources or the associated wells. Accordingly, no additional mitigation measures are deemed necessary beyond the avoidance measures that are being developed for the two wells identified along the Project corridor.

6.5 Geologic Hazards

Geologic hazards are natural physical conditions that, when active, can impact environmental features and man-made structures. Utilization of collocating the pipeline alignment with existing infrastructure such as power lines and other pipelines where practical, the flat to gently rolling terrain of the majority of the pipeline alignment and geological investigation performed by the Project's engineers during the design phase, allow geological hazard areas to be mitigated using modern construction techniques and ROW restoration techniques. Geologic hazards assessed and methods for mitigating these potential hazards are presented below.

6.5.1 Karst

According to USGS, the Project traverses a karst area between MP 124.3and 190.2 and then again from MP 224.5 to 247.7 (Weary and Doctor, 2014). Mapped karst terrain data are presented as Figure 6.5-1 and illustrate karst terrain identified along the Project route.

Karst topography is 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.

Karst terrains have surface drainage systems that are established by sinkholes, springs, caves, disappearing streams, and underground drainage channels and caverns. The collapse of a cavern over a large area can create a solution valley or basin. Downstream of a karst drainage system is typically a spring where the system reaches the surface. These springs typically discharge in a valley and are commonly near the valley bottom, but can occur anywhere (USEPA 1989).

Dissolution sinkholes result from rainfall and surface water flowing through fractures in the soluble bedrock. In these instances a small depression gradually forms. The topographic expression of this feature is gently rolling hills and shallow depressions.

Cover-subsidence sinkholes result when overlying unconsolidated granular materials (sands) settle into void spaces in the underlying soluble bedrock. Dissolution of the soluble bedrock and the filling with the overlying material continues, forming a noticeable depression at the ground surface. In areas where the unconsolidated material is thick or the material contains more clay, the process is slow and relatively uncommon.

Cover-collapse sinkholes occur in areas where the unconsolidated material is clay-rich. In these cases, the void spaces are filled but a depression is not formed, rather the clay acts like a “bridge” and the cavity migrates toward the surface as the underlying clay fills the void. Eventually the bridge fails, forming a sinkhole.

Sinkholes can be a combination of these types or may form in phases with various karst features.

The type and thickness of the unconsolidated material over soluble rock is related to the frequency and type of sinkhole that can form. USGS states that surface expression of sinkholes is unlikely in areas where bedrock is covered by greater than 50 feet of unconsolidated glacial material (Weary and Doctor, 2014). A study conducted in the vicinity of a portion of the Project found that areas with 25 feet or more of glacial drift overlying soluble bedrock showed little to no surface expression of sinkholes (Aden, 2013). Figure 6.5-1 shows the karst areas of the Project where carbonate bedrock is covered by more or less than 50 feet of glacial drift. All of the carbonate bedrock in Michigan is covered by more than 50 feet of glacial sediment.

Aden, 2013 identified and mapped karst features in the area known as the Bellevue-Castalia Karst Plain. Those identified within 1,500 feet of the Project pipeline and aboveground facilities are summarized in Table 6.5-1. Field surveys by staff trained in karst feature identification and mitigation measures are on-going to identify karst features along the Project Route.

An electromagnetic (EM) geophysical survey (Geonics EM-31) was conducted in April and May 2015 to investigate those segments of the alignment underlain by possible shallow rock. This survey provided near-continuous coverage (gaps where landowners denied access) on the alignment through the probable karst areas, including Bellevue-Castalia Karst Plain. The data was acquired by a team of geologists and geophysicists, and photographs were acquired of geological anomalies encountered along the survey line (the alignment at the time of survey) as part of the data acquisition. These EM data and field photographs are currently being analyzed to identify possible karst features along the alignment that might warrant further field investigation.

These surveys included conversations with engineers working for Erie County, Sandusky County, Ohio Department of Transportation, and the Ohio Turnpike Authority. None of the engineers contacted were aware of pavement distress as a result of karst impacts within the Bellevue-Castalia Karst Plain. The Erie County Engineer, Sandusky County Engineer and Ohio Turnpike Authority reported no experience of pavement distress as a result of karst impacts anywhere within their systems. Ohio Department of

Transportation District 2 reported karst impacts in gypsum north of the Project area along the shore of Lake Erie in Sandusky County, and Ohio Department of Transportation District 3 reported karst impacts south of the Project in Ashland County.

According to the County Engineers in both Erie and Sandusky Counties, the only karst-related issue in the vicinity of the Project was surface flooding due to groundwater rising and flowing from karst springs. This phenomenon is well described in the Ohio Department of Natural Resources map "Karst Flooding in Bellevue, Ohio, and Vicinity - 2008" (Pavey *et. al.*, 2012). The concentration of flooding in 2008 was located south of the proposed alignment of the NEXUS pipeline. Investigations of this event are on-going to evaluate whether buoyancy control measures should be implemented on the pipeline in closed depressions within the Bellevue-Castalia Karst Plain. Buoyancy control analyses performed to date indicates control measures will only be required in those instances where the trench is fully or partially water-filled during construction and will not be required as mitigation for flood events after construction.

6.5.1.1 Karst Sensitive Areas – Ohio

According to Weary and Doctor (2014) the Project is underlain by carbonate bedrock and less than 50 feet of glacial drift from: MP 124.3 to 133.8, MP 138.1 to 139.4, MP 147.8 to 148.5, MP 149.1 to 176.2, MP 177.5 to 178.1, and MP 181.1 to 185.7. The Waterville Compressor Station is the only compressor station in the Project that is underlain by carbonate bedrock and less than 50 feet of glacial drift. The primary identified karst sensitive area in the vicinity of the Project is the Bellevue-Castalia Karst Plain, as described above.

6.5.1.2 Karst Sensitive Areas – Michigan

Portions of the Project in Michigan in mapped karst areas are underlain by greater than 50 feet of unconsolidated glacial drift. The presence of this thick layer of glacial sediment means that there is little to no surface expression of karst features in Michigan.

6.5.1.3 Karst Mitigation

NEXUS will conduct awareness training for karst-like features during Supervisor Staff environmental training, including buffer zone requirements for known karst features. The Chief Inspector, Craft Inspectors, Safety Inspector, Lead Environmental Inspector and Environmental Inspectors will be aware of the potential for sinkhole formation during construction and trained to identify the signs of sinkhole formation.

In addition, as required by 49 Code of Federal Regulations, Part 192.613, NEXUS will conduct route surveillance during construction and operation of the facilities, along with training of surveillance personnel, to monitor the pipeline ROW for evidence of subsidence, surface cracks, or depressions which could indicate sinkhole formation. Should either be identified, the Project geotechnical engineer will be notified. In extreme instances, the affected pipeline segment will be excavated, repositioned, or replaced to a stress-free state, and properly bedded and backfilled to pre-construction contours.

Where practical, the pipeline has been routed around evolving sinkholes or any filled sinkholes. If a sinkhole or solution cavity is discovered during trenching, the pipeline will either be routed around this feature or the feature will be mitigated by cleaning and backfilling the feature to fill the void and prevent future erosion.

During field reconnaissance in the Bellevue-Castalia Karst Plain area, the largest filled sinkholes observed had maximum plan dimensions of 30 to 35 feet. For comparison, the allowable span length for a simply-supported segment of 36-inch pipe (Grade X70 with a 0.5-inch wall thickness) loaded with the weight of three feet of compacted backfill (140 pcf) would be approximately 125 feet. This analysis would indicate that even if an unmapped sinkhole is identified or develops below the pipeline, the pipeline will be able to safely span the sinkhole.

HDD drilling near the entry and exit points, where the drill path is in soil and where the cover over the drill path is shallow (e.g., less than 40 feet), there is a potential for soil erosion that could lead to sinkhole development. This sinkhole development is only likely to occur in loose, erodible soils (e.g., loose silts and sands). As part of the geotechnical investigation for an HDD, boreholes were drilled near the entry and exit points to characterize the soil and rock along the drill path. Where the risk of soil erosion is considered excessive, the entry and/or exit tangent could be cased prior to HDD drilling to mitigate this risk. This type of construction-related sinkhole development is not karst-related and can occur in any terrain where the conducive geotechnical conditions exist.

6.5.2 Seismic Environment and Risk

Seismic risk is associated with large earthquake events. The Project is located in an area of very little seismic activity.

The USGS produces hazard probability peak ground acceleration maps. Peak ground acceleration values are represented as factors of “g”, the acceleration of a falling object due to gravity. The USGS Seismic Hazard Maps (USGS, 2008) indicate that there is a 2 percent probability of reaching 5-7 percent “g” in 50 years. From this, it is noted that earthquakes and seismic hazards are unlikely to interfere with the Project.

It should be noted that O’Rourke and Palmer (1994) performed a review of the seismic performance of gas transmission lines in southern California. The authors found that electric arc-welded pipelines constructed post-World War II in good repair have never experienced a break or leak as a result of either traveling ground waves or permanent ground deformation during a southern California earthquake. The authors further concluded that modern electric arc welded gas pipelines in good repair are generally highly resistant to traveling ground wave effects and moderate amounts of permanent deformation.

6.5.3 Active Faults

The USGS Quaternary Fold and Fault Database was searched to identify any Quaternary faults that would be crossed by the proposed pipeline. None were identified (USGS, 2006). The Project crosses the Bowling Green Fault System near MP 180.8, near the horizontal directional drilling crossing of the Maumee River. This fault system has been identified in basement rock. The surface of the basement rock in these areas ranges from approximately 2,200 to 2,300 feet below ground surface (Baranoski, 2013).

Underground injection wells are used as a means of disposing of waste water in Ohio. In late 2011 waste water injection along a dormant fault zone in northern Ohio may have caused a magnitude 4.0 earthquake. The buildup of hydrostatic pressure along the faults could have triggered fault slip and the resulting release of energy, though this cannot be conclusively shown. The Ohio Division of Natural Resources has since prohibited the drilling of injection wells into Precambrian basement rock, where old fault zones are located. Based on the actions of the Ohio Division of Natural Resources and the depth of ancient fault zones, enhanced seismicity from fluid injection wells is not anticipated to be a significant concern.

6.5.4 Areas Susceptible to Soil Liquefaction

Soil liquefaction is the process by which stress exerted on soil during an earthquake can cause it to flow like a liquid, even down very gradual slopes, and lose load-bearing capability. For liquefaction to occur three factors must be present: non-cohesive soils, a relatively shallow water table, and rapid strong ground motion (University of Washington, 2000). Examples of non-cohesive soils can be loose fluvial, alluvial, or colluvial deposits where a high degree of sorting keeps soil grains from interlocking. Artificial fill can also be non-cohesive in nature. Historically, wet areas that were filled, as in many coastal cities, can be particularly susceptible to soil liquefaction. Mapping of soil liquefaction potential has, up to now, largely been limited to areas of the greatest likelihood and risk (e.g., the San Francisco Bay area of California). No maps of liquefaction potential have been identified for areas surrounding the Project.

Along the Project route, areas potentially satisfying the first two of the above-described conditions necessary for soil liquefaction (e.g., non-cohesive soils and a shallow water table) are most likely to be found in alluvial sediments located in the floodplains immediately around medium to large sized streams or rivers; however, the likelihood of rapid ground motion from earthquakes is low, and no modern occurrences of soil liquefaction due to earthquake shaking in the Project area have been documented. Furthermore, pipelines are installed below ground, reducing their susceptibility to any potential damage caused by liquefaction.

6.5.5 Areas Susceptible to Landslides

Landslides occur when rock, sediments, soils, and debris move down steep slopes. Landslides are often triggered by heavy rains, erosion by rivers, earthquakes, or human activities (e.g., man-made structures or pilings of rock). The Landslide Overview Map of the Conterminous United States (Radbruch-Hall *et. al.*, 1982) indicates that the first approximately 8.7 miles of the Project (including the Hanoverton Compressor Station) are located in an area of high landslide susceptibility but moderate landslide occurrence. Moderate landslide incidence indicates that 1.5 percent to 15 percent of the area showing evidence of landslides.

Underlying geology and high relief make eastern Ohio prone to landslides, particularly in the form of rotational slumps and earthflows (Hansen, 1995). Fine-grained clastic bedrocks (e.g., shale and mudstone) are prone to slide along exposed slopes. Red mudstones known as "red beds," which are identified in the Conemaugh Group, weaken when wet and may result in landslides.

A buildup of hydrostatic pressure in colluvium may also result in debris avalanches. Hillside seeps can be an indication of potentially enhanced landslide susceptibility, due to the presence of a shallow water table in these locations. North-facing slopes are generally at higher risk for landslides due to greater moisture retention (Hansen, 1995). Prior to construction of the Project, Project personnel will be trained for the management of potential landslides. During the Project's Environmental Training Program, the Contractor's field supervisory personnel and the Company's supervisory personnel including the Chief Inspector, Craft Inspectors, and the Environmental Inspectors, will be trained on the potential for landslides to occur during construction. The training will also provide the appropriate protocol for work stoppage if a landslide occurs and a communication plan to alert the appropriate Company and Contractor Supervisors.

6.5.5.1 Landslides Mitigation

Geotechnical investigations will be conducted during the design phase to identify (or further delineate) areas of landslide risk to allow for site specific measures to be developed. Mitigative and remedial measures will be implemented, as needed, to ensure slope stabilization and minimize the risk of landslides. For example, slope breakers constructed of materials such as sand bags may be installed on slopes with elevated erosion potential. In areas of side hill cuts, the right-of-way will be restored to preconstruction topography and erosion and sediment control measures will be installed to control surface water run-off, prevent scouring, and ensure slope stability.

The NEXUS Project Erosion and Sediment Control Plan in Appendix 1B1 of Resource Report 1 provides field procedures associated with use of slope breakers, temporary and permanent trench plugs, matting, rip rap, and other erosion control measures.

In the areas the Project traverses where the potential landslide hazards may exist, the NEXUS Project team will coordinate with the construction contractor in regard to the site-specific conditions involved. The NEXUS Project will mitigate the potential risks using best construction practices to limit impacts. Prior to entering these areas, the Contractor's field supervisory personnel and the Company's supervisory personnel including the Chief Inspector, Craft Inspectors, and the Environmental Inspectors, will be trained on recognizing these conditions. In areas where geologic hazards have been identified, the same staff will be trained on the implementation and monitoring of the mitigation plans for these hazards. As conditions are identified, this team, based on the type of condition witnessed, will notify the Project Geotechnical Engineer for support, and reduce the amount of equipment in the area, or shutdown work in the area until additional measures can be implemented as directed by the Project Geotechnical Engineer.

During construction, measures will be implemented to minimize potential risks from landslides and soil erosion, especially in the areas of steep slopes. Where steep side slopes are encountered along the pipeline alignment, the upslope side of the construction ROW will be cut during grading and used to fill the downslope side of the ROW, thereby providing a safe and level surface on which to operate heavy equipment. Construction along hillsides may require additional temporary workspace downslope to accommodate the storage of excavated material. During grade restoration, the spoil will be placed back in the cut, compacted to restore original contours, and reseeded. Once grade and drainage patterns have been reestablished, permanent erosion controls (e.g., slope breakers) will be installed as needed. These activities will minimize the potential for man-induced landslides and erosion in the Project area. The Project Alignment Sheets located in Appendix 1A of Resource Report 1, Volume II-B show each additional temporary workspace proposed for the Project and include contour information depicting the existing topography.

6.5.6 Surface Subsidence – Underground Mines

Underground mining poses risks to engineered structures because of the potential for the overlying strata to collapse into the void formed by the extraction of minerals. As discussed in Section 6.4, a portion of the Project area has a significant history of underground coal mining that dates back to the beginning of the 19th century. Several mapped abandoned underground mines are present near the first approximately 52 miles of the proposed Project route, but no mapped abandoned underground mines underlie the Project. Based on the long history of coal mining in eastern Ohio, there are expected to be mines that are unmapped and unknown near the eastern portion of the Project, as they predate accurate records. Old abandoned mines are expected to be generally small and of the room-and-pillar type, and many of these unmapped mines have likely already collapsed. The amount of surface subsidence potentially caused by collapse of these mines is dependent upon the size of the collapsed void space and the thickness and composition of the materials overlying the mine. According to the ODGS, there are no active underground mines beneath the proposed Project route.

6.5.6.1 Underground Mine Mitigation

If the final alignment traverses an abandoned mine location, a geophysical survey will be performed prior to the construction phase of the Project to determine the depth to the top of the mine. Depending on results of the analysis performed by NEXUS Geological Engineers, construction methodology can be altered to accommodate the subsurface conditions. These alterations may include, but are not limited to, reducing the amount of equipment that is allowed on the ROW in this area, changing the pipe lay direction, i.e., switching the working and spoil sides of the ROW, and/or dragging pipe sections into place using rollers.

The pipeline alignment has been sited to avoid known abandoned underground coal mines identified by ODNR and by County Engineers in those Ohio counties with any history of underground coal mining. However, if an undocumented abandoned underground coal mine is discovered during construction, the following process would be implemented:

- Use geophysical survey methods (possibly combined with limited geotechnical boreholes) to map the footprint of the mine, the depth of the mine roof below existing grade (cover), and the depth of the mine floor below existing grade;
- Re-route the horizontal alignment to avoid the mapped footprint or bore/HDD under the mine. If above is not practical, re-route the alignment to avoid areas where the cover is thick enough that the increase in vertical stress on the roof during construction would not exceed 10% of current vertical stress;

- If above is not practical, perform more detailed characterization and assessment of the mine and implement remediation in accordance with the *Manual for Abandoned Underground Mine Inventory and Risk Assessment* (FHWA IF-99-007), which was authored by Ohio Department of Transportation (ODOT).

The primary risk of an abandoned underground mine is during pipeline construction and not operation, as the roof loads will be at their maximum during construction.

6.5.7 Flash Flooding

Streams that are typically prone to flash floods tend to have narrow river valleys, steep slopes, and rock-bottoms. Flash floods can also significantly increase the likelihood of landslides along the Project by weakening the bedrock material and undercutting already steep slopes.

Anthropogenic impacts on flooding potential include over-steepened slopes and reduced overburden from past strip mining in the area. These conditions exist only at the eastern end of the Project, mainly in Columbiana County, Ohio. As required, aboveground facilities and pipeline stream crossings will be designed to preclude impacts from high velocity flows, largely by controlling erosion, per the NEXUS Project Erosion and Sediment Control Plan. 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. After construction is completed, each crossing will be periodically inspected for signs of erosion and remediated, as necessary.

Designated Federal Emergency Management Agency flood plains along the Project route are discussed in Resource Report 2.

6.6 Paleontological Resources

Paleontological resources potentially encountered along the Project include invertebrate fossils in Paleozoic sedimentary bedrock and Pleistocene bones in glacial sediments. Since there are no Mesozoic sedimentary strata along the Project route, large vertebrate fossils of that era (e.g., dinosaurs) are not present. Bedrock invertebrate fossils are common in Paleozoic Era strata and are not considered significant. Recorded findings of vertebrate fossil bones from the Pleistocene epoch that have been identified in counties along the Project route include: mastodons, wooly mammoths, horses, birds, reptiles, deer, caribou, bison, elk, and flat-headed peccaries (Hansen, 1992). Some of the remains that have been found coincide with the identification of anthropological resources such as flint tools and arrowheads. No specific locations of these fossils are documented along the Project route.

Given the small footprint of the proposed trench excavation of the Project, it is unlikely that paleontological resources will be encountered by the Project. Should fossilized remains (e.g., animal bones potentially belonging to prehistoric creatures) be discovered during construction, NEXUS personnel will respond according to the Unanticipated Discoveries Plan included in Appendix 4C of Resource Report 4.

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TABLES

TABLE 6.2-1

Bedrock Geology of the NEXUS Project

Project Feature	MP Start	MP End	Map Symbol	Unit Age	Lithology1	Lithology2	State
TGP Interconnect	0.0	0.9	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	0.0	1.9	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	1.9	2.3	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	2.3	4.7	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	4.7	5.3	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	5.3	5.5	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	5.5	5.7	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	5.7	6.4	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	6.4	6.5	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	6.5	7.3	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	7.3	7.7	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	7.7	8.0	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	8.0	8.3	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	8.3	9.6	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	9.6	12.0	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	12.0	12.2	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	12.2	12.5	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	12.5	13.1	IPc	Pennsylvanian	siltstone	shale	OH
Nexus Mainline Pipeline	13.1	39.6	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	39.6	39.7	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	39.7	40.1	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	40.1	41.2	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	41.2	45.3	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	45.3	45.5	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	45.5	47.9	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	47.9	48.3	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	48.3	48.9	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	48.9	49.2	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	49.2	51.5	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	51.5	51.9	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	51.9	51.9	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	51.9	52.0	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	52.0	52.2	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	52.2	52.4	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	52.4	54.9	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	54.9	55.6	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	55.6	56.0	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	56.0	56.0	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	56.0	56.5	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	56.5	56.6	Mlc	Mississippian	shale	siltstone	OH

TABLE 6.2-1

Bedrock Geology of the NEXUS Project

Project Feature	MP Start	MP End	Map Symbol	Unit Age	Lithology1	Lithology2	State
Nexus Mainline Pipeline	56.6	56.6	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	56.6	59.5	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	59.5	59.8	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	59.8	60.1	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	60.1	60.5	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	60.5	61.8	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	61.8	64.6	IPap	Pennsylvanian	shale	siltstone	OH
Nexus Mainline Pipeline	64.6	89.9	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	89.9	90.7	Dbb	Devonian	sandstone	shale	OH
Nexus Mainline Pipeline	90.7	91.6	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	91.6	95.3	Dbb	Devonian	sandstone	shale	OH
Nexus Mainline Pipeline	95.3	96.1	Mlc	Mississippian	shale	siltstone	OH
Nexus Mainline Pipeline	96.1	100.3	Dbb	Devonian	sandstone	shale	OH
Nexus Mainline Pipeline	100.3	100.7	Do	Devonian	black shale	shale	OH
Nexus Mainline Pipeline	100.7	109.8	Dbb	Devonian	sandstone	shale	OH
Nexus Mainline Pipeline	109.8	110.1	Do	Devonian	black shale	shale	OH
Nexus Mainline Pipeline	110.1	112.1	Dbb	Devonian	sandstone	shale	OH
Nexus Mainline Pipeline	112.1	124.2	Do	Devonian	black shale	shale	OH
Nexus Mainline Pipeline	124.2	125.0	Dp	Devonian	limestone	dolostone (dolomite)	OH
Nexus Mainline Pipeline	125.0	125.6	Dpl	Devonian	shale	limestone	OH
Nexus Mainline Pipeline	125.6	126.1	Dd	Devonian	limestone		OH
Nexus Mainline Pipeline	126.1	126.5	Dpl	Devonian	shale	limestone	OH
Nexus Mainline Pipeline	126.5	128.8	Dd	Devonian	limestone		OH
Nexus Mainline Pipeline	128.8	132.1	Dc	Devonian	limestone	dolostone (dolomite)	OH
Nexus Mainline Pipeline	132.1	140.1	Ss	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	140.1	148.2	Stg	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	148.2	150.2	Sl	Silurian	dolostone (dolomite)		OH
Nexus Mainline Pipeline	150.2	151.2	Stg	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	151.2	163.4	Sl	Silurian	dolostone (dolomite)		OH
Nexus Mainline Pipeline	163.4	163.6	Stg	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	163.6	168.7	Sl	Silurian	dolostone (dolomite)		OH
Nexus Mainline Pipeline	168.7	170.5	Stg	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	170.5	173.0	Sl	Silurian	dolostone (dolomite)		OH
Nexus Mainline Pipeline	173.0	174.1	Stg	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	174.1	178.1	Sl	Silurian	dolostone (dolomite)		OH
Nexus Mainline Pipeline	178.1	180.8	Stg	Silurian	dolostone (dolomite)	shale	OH

TABLE 6.2-1

Bedrock Geology of the NEXUS Project

Project Feature	MP Start	MP End	Map Symbol	Unit Age	Lithology1	Lithology2	State
Nexus Mainline Pipeline	180.8	182.5	Ss	Silurian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	182.5	186.2	Ddr	Devonian	dolostone (dolomite)	evaporite	OH
Nexus Mainline Pipeline	186.2	187.2	Ddu	Devonian	limestone	dolostone (dolomite)	OH
Nexus Mainline Pipeline	187.2	187.8	Ddr	Devonian	dolostone (dolomite)	evaporite	OH
Nexus Mainline Pipeline	187.8	188.5	Ddu	Devonian	limestone	dolostone (dolomite)	OH
Nexus Mainline Pipeline	188.5	190.2	Dts	Devonian	dolostone (dolomite)	shale	OH
Nexus Mainline Pipeline	190.2	203.2	Da	Devonian	shale	black shale	OH
Nexus Mainline Pipeline	203.2	208.3	MDsd	Devonian and/or Mississippian	shale	black shale	OH
Nexus Mainline Pipeline	208.3	210.5	Dbd	Late Devonian	shale	sandstone	MI
Nexus Mainline Pipeline	210.5	211.8	Db	Late Devonian	sandstone	siltstone	MI
Nexus Mainline Pipeline	211.8	212.8	DMs	Mississippian-Devonian	black shale		MI
Nexus Mainline Pipeline	212.8	217.1	Mc	Mississippian	shale	limestone	MI
Nexus Mainline Pipeline	217.1	217.6	DMs	Mississippian-Devonian	black shale		MI
Nexus Mainline Pipeline	217.6	220.4	Mc	Mississippian	shale	limestone	MI
Nexus Mainline Pipeline	220.4	221.2	DMs	Mississippian-Devonian	black shale		MI
Nexus Mainline Pipeline	221.2	224.5	Db	Late Devonian	sandstone	siltstone	MI
Nexus Mainline Pipeline	224.5	225.7	Dbd	Late Devonian	shale	sandstone	MI
Nexus Mainline Pipeline	225.7	227.2	Da	Late Devonian	black shale	limestone	MI
Nexus Mainline Pipeline	227.2	230.9	Dt	Middle Devonian	limestone	shale	MI
Nexus Mainline Pipeline	230.9	233.8	Dd	Middle Devonian	limestone	dolostone (dolomite)	MI
Nexus Mainline Pipeline	233.8	235.7	Dt	Middle Devonian	limestone	shale	MI
Nexus Mainline Pipeline	235.7	235.8	Dd	Middle Devonian	limestone	dolostone (dolomite)	MI
Nexus Mainline Pipeline	235.8	247.7	Dt	Middle Devonian	limestone	shale	MI
Nexus Mainline Pipeline	247.7	255.2	Da	Late Devonian	black shale	limestone	MI
Project Feature	**Permanent ROW Area (ac)**	**Permanent ROW Area (sf)**	**Map Symbol**	**Unit Age**	**Lithology1**	**Lithology2**	**State**
Clyde Compressor Station (CS-3)	48.12	2,096,098	Ss	Silurian	dolostone (dolomite)	shale	OH
Hanoverton Compressor Station (CS-1)	4.24	184,698	IPap	Pennsylvanian	shale	siltstone	OH
Hanoverton Compressor Station (CS-1)	19.69	857,602	IPc	Pennsylvanian	siltstone	shale	OH
Wadsworth Compressor Station (CS-2)	19.79	862,035	IPap	Pennsylvanian	shale	siltstone	OH
Waterville Compressor Station (CS-4)	34.14	1,487,289	Ddr	Devonian	dolostone (dolomite)	evaporite	OH
MR01 (TGP)	2.04	88,804	IPc	Pennsylvanian	siltstone	shale	OH
MR02&3 (Kensington/OPEN)	4.27	186,001	IPc	Pennsylvanian	siltstone	shale	OH

TABLE 6.2-1

Bedrock Geology of the NEXUS Project

Project Feature	MP Start	MP End	Map Symbol	Unit Age	Lithology1	Lithology2	State
MR05 (Dominion East Ohio)	0.00	0	Dc	Devonian	limestone	dolostone	OH
MR05 (Dominion East Ohio)	1.88	81,939	Dd	Devonian	limestone		OH
MR04 (DTE / WillowRun)	0.68	29,806	Da	Late Devonian	black shale	limestone	MI

Sources: Milstein, 1987 and Nicholson et al., 2005

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
TGP Interconnect	0.0	0.9	NA	NA	NA	OH
Nexus Mainline Pipeline	0.0	0.2	NA	NA	NA	OH
Nexus Mainline Pipeline	0.2	1.9	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	1.9	2.4	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	2.4	4.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	4.8	5.0	T	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	5.0	6.4	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	6.4	6.4	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	6.4	8.0	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	8.0	8.1	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	8.1	9.7	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	9.7	9.8	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	9.8	11.0	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	11.0	11.3	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	11.3	11.6	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	11.6	15.7	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	15.7	17.3	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	17.3	18.0	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	18.0	21.2	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	21.2	25.0	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	25.0	25.2	NA	NA	NA	OH
Nexus Mainline Pipeline	25.2	26.4	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	26.4	26.6	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	26.6	27.0	SGf	Buried Valley	> 100	OH
Nexus Mainline Pipeline	27.0	27.4	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	27.4	27.9	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	27.9	28.9	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	28.9	29.9	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	29.9	30.7	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	30.7	30.9	Fsg	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	30.9	31.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	31.2	32.4	Fsg	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	32.4	33.3	Tsg	Outwash/Kame	25 - 100	OH
Nexus Mainline Pipeline	33.3	33.5	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	33.5	34.7	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	34.7	35.3	Tsg	Outwash/Kame	25 - 100	OH
Nexus Mainline Pipeline	35.3	36.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	36.2	37.1	Tsg	Outwash/Kame	25 - 100	OH
Nexus Mainline Pipeline	37.1	37.6	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	37.6	38.3	Tsg	Outwash/Kame	25 - 100	OH

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
Nexus Mainline Pipeline	38.3	41.2	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	41.2	42.0	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	42.0	42.4	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	42.4	42.6	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	42.6	43.9	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	43.9	44.3	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	44.3	44.5	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	44.5	45.1	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	45.1	45.3	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	45.3	45.5	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	45.5	46.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	46.2	46.2	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	46.2	46.3	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	46.3	46.5	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	46.5	46.9	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	46.9	47.9	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	47.9	48.2	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	48.2	49.2	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	49.2	50.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	50.2	50.9	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	50.9	51.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	51.2	52.5	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	52.5	52.7	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	52.7	54.7	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	54.7	55.6	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	55.6	55.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	55.8	56.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	56.2	56.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	56.8	57.1	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	57.1	58.6	SGf	Buried Valley	> 100	OH
Nexus Mainline Pipeline	58.6	59.1	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	59.1	59.4	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	59.4	60.7	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	60.7	61.0	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	61.0	63.6	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	63.6	64.4	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	64.4	64.8	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	64.8	65.0	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	65.0	65.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	65.2	65.6	Tsg	Buried Valley	> 100	OH

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
Nexus Mainline Pipeline	65.6	67.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	67.2	68.1	Tsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	68.1	68.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	68.2	70.5	Tsg	End Moraine	25 - 100	OH
Nexus Mainline Pipeline	70.5	70.9	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	70.9	71.7	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	71.7	76.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	76.2	76.4	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	76.4	76.6	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	76.6	76.9	Tsg	End Moraine	25 - 100	OH
Nexus Mainline Pipeline	76.9	79.2	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	79.2	85.5	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	85.5	86.4	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	86.4	86.7	Fsg	Alluvial	< 25	OH
Nexus Mainline Pipeline	86.7	86.9	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	86.9	89.3	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	89.3	90.7	T	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	90.7	91.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	91.8	92.3	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	92.3	92.4	Fsg	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	92.4	92.7	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	92.7	94.2	Tsg	Complex	> 100	OH
Nexus Mainline Pipeline	94.2	94.7	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	94.7	97.2	T	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	97.2	97.9	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	97.9	99.0	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	99.0	99.3	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	99.3	99.6	Tsg	Complex	> 100	OH
Nexus Mainline Pipeline	99.6	100.2	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	100.2	100.8	Tsg	Complex	> 100	OH
Nexus Mainline Pipeline	100.8	103.1	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	103.1	103.5	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	103.5	104.3	Tsg	Ground Moraine	25 - 100	OH
Nexus Mainline Pipeline	104.3	104.5	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	104.5	105.9	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	105.9	106.1	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	106.1	108.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	108.8	108.9	Tsg	Thin Upland	25 - 100	OH

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
Nexus Mainline Pipeline	108.9	109.7	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	109.7	110.0	Tsg	Thin Upland	25 - 100	OH
Nexus Mainline Pipeline	110.0	111.8	T	Thin Upland	< 25	OH
Nexus Mainline Pipeline	111.8	112.9	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	112.9	113.8	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	113.8	113.9	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	113.9	114.2	Tsg	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	114.2	114.5	Fsg	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	114.5	116.3	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	116.3	116.7	Fsg	Buried Valley	25 - 100	OH
Nexus Mainline Pipeline	116.7	117.0	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	117.0	119.2	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	119.2	126.9	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	126.9	127.0	SGt	Beach Ridge	< 25	OH
Nexus Mainline Pipeline	127.0	131.8	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	131.8	132.6	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	132.6	132.7	SGt	Beach Ridge	< 25	OH
Nexus Mainline Pipeline	132.7	132.8	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	132.8	133.0	SGt	Beach Ridge	< 25	OH
Nexus Mainline Pipeline	133.0	133.4	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	133.4	133.6	SGt	Beach Ridge	25 - 100	OH
Nexus Mainline Pipeline	133.6	136.9	Tsg	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	136.9	141.5	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	141.5	141.6	F	Buried Valley	> 100	OH
Nexus Mainline Pipeline	141.6	141.8	Fsg	Buried Valley	> 100	OH
Nexus Mainline Pipeline	141.8	143.0	F	Buried Valley	> 100	OH
Nexus Mainline Pipeline	143.0	144.6	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	144.6	145.3	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	145.3	145.8	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	145.8	146.0	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	146.0	146.1	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	146.1	146.7	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	146.7	149.4	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	149.4	153.3	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	153.3	153.5	Fsg	Alluvial	< 25	OH
Nexus Mainline Pipeline	153.5	161.4	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	161.4	162.2	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	162.2	162.5	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	162.5	162.6	Fsg	Alluvial	< 25	OH
Nexus Mainline Pipeline	162.6	163.6	T	Lacustrine	< 25	OH

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
Nexus Mainline Pipeline	163.6	164.0	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	164.0	167.8	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	167.8	169.3	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	169.3	170.1	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	170.1	171.8	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	171.8	172.3	Tsg	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	172.3	173.1	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	173.1	174.0	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	174.0	180.5	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	180.5	181.4	Tsg	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	181.4	181.8	Fsg	Alluvial	25 - 100	OH
Nexus Mainline Pipeline	181.8	183.2	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	183.2	184.0	T	Lacustrine	< 25	OH
Nexus Mainline Pipeline	184.0	185.5	T	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	185.5	186.6	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	186.6	186.8	SGf	Beach Ridge	25 - 100	OH
Nexus Mainline Pipeline	186.8	196.3	SGf	Beach Ridge	25 - 100	OH
Nexus Mainline Pipeline	196.3	199.3	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	199.3	199.7	F	Lacustrine	> 100	OH
Nexus Mainline Pipeline	199.7	200.9	F	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	200.9	201.0	Tsg	Lacustrine	25 - 100	OH
Nexus Mainline Pipeline	201.0	208.3	Tsg	Lacustrine	> 100	OH
Nexus Mainline Pipeline	208.3	214.4	Lacustrine clay and silt	No Data	No Data	MI
Nexus Mainline Pipeline	214.4	220.5	Lacustrine sand and gravel	No Data	No Data	MI
Nexus Mainline Pipeline	220.5	249.5	Lacustrine clay and silt	No Data	No Data	MI
Nexus Mainline Pipeline	249.5	255.2	Lacustrine sand and gravel	No Data	No Data	MI
Project Feature	**Permanent ROW Area (ac)**	**Permanent ROW Area (sf)**	**Lithology**	**Setting**	**Thickness**	**State**
Clyde Compressor Station (CS-3)	0.00	128	SGt	Beach Ridge	25 - 100	OH
Clyde Compressor Station (CS-3)	48.12	2,095,970	Tsg	Lacustrine	25 - 100	OH
Hanoverton Compressor Station (CS-1)	2.52	109,715	Fsg	Alluvial	25 - 100	OH
Hanoverton Compressor Station (CS-1)	21.41	932,585	T	Thin Upland	< 25	OH
Wadsworth Compressor Station (CS-2)	11.87	517,259	T	Thin Upland	< 25	OH

TABLE 6.2-2

Surficial Geology of the NEXUS Project

Project Feature	MP Start	MP End	Lithology	Setting	Thickness (ft)	State
Wadsworth Compressor Station (CS-2)	7.91	344,776	Tsg	Thin Upland	25 - 100	OH
Waterville Compressor Station (CS-4)	34.14	1,487,289	T	Lacustrine	< 25	OH
MR01 (TGP)	2.04	88,804	NA	NA	NA	OH
MR02&3 (Kensington/OPEN)	0.00	0	NA	NA	NA	OH
MR05 (Dominion East Ohio)	1.88	81,939	T	Lacustrine	< 25	OH
MR04 (DTE / WillowRun)	0.68	29,806	Lacustrine sand and gravel	No Data	No Data	MI

NOTES:

F - fines; Fsg - fines over sand and gravel; SGf - sand and gravel over fines; SGt - sand and gravel over till; T - till; Tsg - till over sand and gravel

TABLE 6.4-1

Active Industrial Mines within 0.25 mile of the NEXUS Project

MP	Distance (mi)	Direction	Resource	Producer
127.5	0.21	S	Limestone	Hanson Aggregate Midwest, Inc.
160.0	0.00	On Top Of	Limestone	Olen Corporation
248.9	0.04	E	Sand & Gravel	J+T Aggregate, LLC

Sources:
ODNR Industrial Minerals Mining Operation GIS layer. Last update: 3/11/2014
Mining and Minerals layer on Michigan DEQ GeoWebFace
http://ww2.deq.state.mi.us/GeoWebFace/#

TABLE 6.4-2

Mapped Underground Mines within 0.25-mile of the NEXUS Project

Milepost	Distance (mi)	Direction	Mine Type	Status	API Number	Operator
7.7	0.2	SSW	Coal	Abandoned	340298000602/ 340298010802	King & Perian / J.S. Stone Coal Co
35.5	0.2	N	Coal	Abandoned	341538003502	R & T Coal Company
35.7	0.2	N	Coal	Abandoned	341538003402	Overholt Coal Company
42.6	0.2	N	Coal	Abandoned	341538003202	Massilon - Akron Coal Company
44.4	0.2	NE	Coal	Abandoned	341538002702	Akron - Massilon Coal Company
45.7	0.2	E	Coal	Abandoned	341538001102	Massilon Coal Mining Companay
50.9	0.2	N	Coal	Abandoned	341698001702	J.D. Jones Coal Co
52.1	0.2	NE	Coal	Abandoned	341698000702	H.E Loomis
53.7	0.1	N	Coal	Abandoned	341698000202	Ohio Salt Co.

Sources:

ODNR's Mines of Ohio Interactive Map, last updated 3/8/2013, https://gis.ohiodnr.gov/website/mrm/OhioMines/

Crowell, D.L., DeLong, R.M., Banks, C.E., Hoeffler, P.D., Gordon, C.P., McDonald, James, Wells, J.G., Powers, D.M., Slucher, E.R., with cartography by Powers, D.M., 2011, Known Abandoned Underground Mines of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map EG-3, version 2.0, scale 1:500,000.

TABLE 6.4-3

Surface Coal Mining Operations within 0.25 mile of the NEXUS Project Pipeline Facilities

MP	Distance (mi)	Direction	Mine Status	Premittee	Permit Application Date
HCS	0.08	W	Inactive	General Mines, Inc.	8/13/1979
2.3	0.24	W	Inactive	Blum Coal Co.	4/1/1981
2.4	0.16	W	Abandoned	John Glenn Mining Co.	12/14/1994

Note
HCS - Hanoverton Compressor
ODNR Surficial Coal Mine Operation data layer. Last updated 3/11/2014

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	**County**	**Tract a/**	**Well Type b/ c/**	**Milepost d/**	**Distance to workspace (Feet)**
Ohio					
TGP Interconnecting Pipeline					
			None		
Mainline					
	COLUMBIANA	OH-CO-013.0002	OIL & GAS	1.9	560.9
	COLUMBIANA	OH-CO-013.0002	GAS	2.0	439.9
	COLUMBIANA	OH-CO-019.0000	GAS	2.3	49.0
	COLUMBIANA	OH-CO-021.0000	GAS	2.7	109.6
	COLUMBIANA	OH-CO-026.0002	GAS	3.5	849.9
	COLUMBIANA	OH-CO-034.0000	OIL & GAS	4.2	449.1
	COLUMBIANA	OH-CO-035.0000	GAS	4.5	79.2
	COLUMBIANA	OH-CO-036.0000	GAS WITH OIL SHOW	4.6	971.0
	COLUMBIANA	OH-CO-036.0000	GAS WITH OIL SHOW	4.8	37.6
	COLUMBIANA	UNKNOWN	GAS WITH OIL SHOW	4.9	1040.2
	COLUMBIANA	OH-CO-039.0000	OIL & GAS	5.0	197.0
	COLUMBIANA	OH-CO-042.0000	GAS WITH OIL SHOW	5.1	552.6
	COLUMBIANA	OH-CO-044.0000	GAS	5.3	363.5
	COLUMBIANA	OH-CO-045.0100	OIL & GAS	5.5	750.6
	COLUMBIANA	OH-CO-051.0000	OIL & GAS	5.7	197.2
	COLUMBIANA	OH-CO-052.0100	GAS WITH OIL SHOW	6.0	953.3
	COLUMBIANA	UNKNOWN	GAS	6.0	812.0
	COLUMBIANA	OH-CO-053.0000	OIL & GAS	6.1	7.9
	COLUMBIANA	OH-CO-053.0000	GAS	6.1	19.2
	COLUMBIANA	OH-CO-054.0000	GAS	6.1	546.7
	COLUMBIANA	OH-CO-056.0000	GAS WITH OIL SHOW	6.2	1055.6

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	COLUMBIANA	UNKNOWN	OIL & GAS	6.4	962.8
	COLUMBIANA	OH-CO-059.0000	OIL & GAS	6.5	133.5
	COLUMBIANA	OH-CO-066.0030-HTAR-1	OIL & GAS	6.5	833.4
	COLUMBIANA	OH-CO-107.0000-SC	OIL & GAS	6.7	15.6
	COLUMBIANA	OH-CO-056.0000	OIL & GAS	6.7	1067.0
	COLUMBIANA	UNKNOWN	GAS	6.9	1213.1
	COLUMBIANA	OH-CO-061.0000	GAS WITH OIL SHOW	6.9	448.3
	COLUMBIANA	OH-CO-062.0000	GAS	7.3	421.0
	COLUMBIANA	OH-CO-066.0005	GAS	7.3	448.7
	COLUMBIANA	OH-CO-064.0000	OIL & GAS	7.6	68.4
	COLUMBIANA	OH-CO-064.0000	OIL	7.6	343.2
	COLUMBIANA	OH-CO-064.0000	OIL	7.6	593.9
	COLUMBIANA	OH-CO-065.0000	OIL	7.6	1076.1
	COLUMBIANA	OH-CO-065.0000	OIL	7.6	896.2
	COLUMBIANA	OH-CO-065.0000	OIL	7.6	655.3
	COLUMBIANA	OH-CO-065.0000	OIL	7.6	769.0
	COLUMBIANA	OH-CO-065.0000	OIL	7.6	614.6
	COLUMBIANA	OH-CO-105.0007-SC	OIL	7.6	795.4
	COLUMBIANA	OH-CO-105.0007-SC	OIL & GAS	7.6	807.4
	COLUMBIANA	UNKNOWN	OIL	7.7	706.6
	COLUMBIANA	OH-CO-068.0000	OIL & GAS	7.8	40.8
	COLUMBIANA	OH-CO-073.0000	OIL & GAS	8.1	501.6
	COLUMBIANA	OH-CO-074.0000	OIL & GAS	8.3	41.6
	COLUMBIANA	OH-CO-073.0000	OIL & GAS	8.4	1018.6
	COLUMBIANA	OH-CO-076.0000	OIL & GAS	8.5	0.0
	COLUMBIANA	OH-CO-078.0001	OIL & GAS	8.8	657.5
	COLUMBIANA	OH-CO-079.0000	OIL & GAS	9.1	354.4
	COLUMBIANA	OH-CO-080.0000	GAS WITH OIL SHOW	9.6	158.5
	COLUMBIANA	OH-CO-080.0000	OIL & GAS	9.9	63.2
	COLUMBIANA	OH-CO-087.0000	OIL & GAS	10.3	1082.1
	COLUMBIANA	OH-CO-086.0000	GAS WITH OIL SHOW	10.3	300.6
	COLUMBIANA	OH-CO-089.0000	OIL & GAS	10.6	0.0
	COLUMBIANA	OH-CO-106.0000	GAS	11.5	300.2
	COLUMBIANA	OH-CO-108.0000	OIL & GAS	11.9	102.6
	COLUMBIANA	OH-CO-110.0000	OIL & GAS	12.3	173.6
	STARK	OH-ST-001.0000	OIL & GAS	12.8	525.6
	STARK	OH-ST-001.0000	GAS	12.8	641.5

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	STARK	OH-ST-013.0000	OIL & GAS	14.0	132.1
	STARK	OH-ST-023.0001	GAS	15.0	152.3
	STARK	UNKNOWN	OIL & GAS	15.4	593.2
	STARK	OH-ST-029.0000	OIL & GAS	15.9	974.0
	STARK	OH-ST-030.0000	OIL & GAS	15.9	688.4
	STARK	OH-ST-030.0000	OIL & GAS	16.1	324.4
	STARK	OH-ST-030.0000	GAS WITH OIL SHOW	16.2	795.2
	STARK	OH-ST-032.0000	OIL & GAS	16.5	441.0
	STARK	OH-ST-033.0001	OIL & GAS	16.6	788.2
	STARK	OH-ST-039.0002	OIL & GAS	17.4	1116.3
	STARK	OH-ST-039.0001	OIL & GAS	17.4	115.6
	STARK	UNKNOWN	GAS WITH OIL SHOW	17.9	757.2
	STARK	OH-ST-051.0001	OIL & GAS	18.8	895.8
	STARK	OH-ST-053.0000	OIL & GAS	19.1	288.0
	STARK	OH-ST-052.0000	OIL & GAS	19.2	1023.5
	STARK	OH-ST-057.0000	OIL & GAS	19.7	599.8
	STARK	OH-ST-057.0000	OIL & GAS	19.7	543.5
	STARK	OH-ST-061.0000	OIL & GAS	20.0	327.9
	STARK	UNKNOWN	OIL & GAS	20.2	859.5
	STARK	OH-ST-067.0000	OIL & GAS	20.6	351.1
	STARK	UNKNOWN	OIL & GAS	21.5	459.8
	STARK	OH-ST-070.0000	OIL & GAS	21.8	133.2
	STARK	OH-ST-070.0000	OIL & GAS	22.0	391.7
	STARK	OH-ST-132.0000-SC	OIL & GAS	22.2	308.6
	STARK	OH-ST-075.0000	OIL & GAS	22.3	901.9
	STARK	OH-ST-075.0001	OIL & GAS	22.4	105.9
	STARK	OH-ST-076.0001	OIL & GAS	22.5	875.4
	STARK	OH-ST-075.0000	OIL & GAS	22.5	1040.3
	STARK	OH-ST-076.0000	OIL & GAS	22.6	508.0
	STARK	OH-ST-143.0000-SC	OIL & GAS	22.9	355.1
	STARK	UNKNOWN	OIL & GAS	22.9	703.0
	STARK	UNKNOWN	OIL & GAS	23.1	1020.3
	STARK	OH-ST-077.0000	OIL & GAS	23.1	331.7
	STARK	UNKNOWN	OIL & GAS	23.2	634.1
	STARK	OH-ST-079.0000	OIL & GAS	23.4	488.7
	STARK	OH-ST-081.0002	OIL & GAS	23.4	932.1
	STARK	OH-ST-081.0002	OIL	23.6	693.0
	STARK	OH-ST-079.0000	OIL & GAS	23.6	313.0

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	STARK	UNKNOWN	OIL & GAS	23.9	681.6
	STARK	OH-ST-082.0001	OIL & GAS	24.1	417.7
	STARK	OH-ST-082.0001	GAS	24.1	420.5
	STARK	OH-ST-082.0010	OIL & GAS	24.1	724.1
	STARK	OH-ST-083.0001	OIL & GAS	24.3	895.1
	STARK	OH-ST-084.0000	OIL & GAS	24.4	430.3
	STARK	OH-ST-165.0000-SC	OIL & GAS	24.5	231.0
	STARK	OH-ST-168.0000-SC	OIL & GAS	24.6	859.5
	STARK	OH-ST-084.0000	OIL & GAS	24.6	411.3
	STARK	OH-ST-085.0000	OIL	24.8	773.3
	STARK	OH-ST-085.0000	OIL & GAS	24.9	326.7
	STARK	OH-ST-085.0000	OIL & GAS	24.9	1086.3
	STARK	OH-ST-087.0000	OIL & GAS	25.1	555.8
	STARK	OH-ST-087.0000	OIL & GAS	25.1	460.2
	STARK	UNKNOWN	OIL & GAS	25.4	974.8
	STARK	OH-ST-088.0000	OIL & GAS	25.4	32.9
	STARK	OH-ST-089.0001	GAS	25.6	324.7
	STARK	OH-ST-089.0000	OIL WITH GAS SHOW	25.7	284.5
	STARK	OH-ST-180.0000-SC	GAS	25.7	206.5
	STARK	OH-ST-089.0001	OIL	25.7	775.5
	STARK	OH-ST-091.0000	OIL	25.9	644.5
	STARK	OH-ST-093.0000	OIL & GAS	26.1	669.1
	STARK	OH-ST-093.0000	OIL & GAS	26.2	41.0
	STARK	OH-ST-091.0000	OIL & GAS	26.3	1190.3
	STARK	OH-ST-190.0000-SC	OIL & GAS	26.4	871.5
	STARK	OH-ST-097.0000	OIL & GAS	26.5	57.6
	STARK	OH-ST-098.0000	OIL & GAS	26.7	113.0
	STARK	OH-ST-190.0001-SC	OIL & GAS	26.8	1138.7
	STARK	OH-ST-101.0001	OIL WITH GAS SHOW	27.0	403.4
	STARK	UNKNOWN	OIL & GAS	27.1	718.5
	STARK	UNKNOWN	OIL & GAS	27.3	1142.3
	STARK	OH-ST-104.0000	OIL & GAS	27.3	56.2
	STARK	OH-ST-105.0000	OIL & GAS	27.5	652.2
	STARK	OH-ST-203.0000-SC	OIL & GAS	28.0	376.7
	STARK	OH-ST-113.0001	OIL & GAS	28.2	510.8
	STARK	UNKNOWN	OIL & GAS	28.5	937.5
	STARK	OH-ST-113.0001	OIL & GAS	28.6	191.0

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	STARK	OH-ST-114.0000	GAS WITH OIL SHOW	28.9	374.6
	STARK	OH-ST-121.0000	GAS	29.4	451.8
	STARK	OH-ST-123.0001	GAS WITH OIL SHOW	30.1	136.2
	STARK	OH-ST-126.0000	GAS	30.5	232.2
	STARK	OH-ST-127.0002	OIL & GAS	30.7	331.1
	STARK	UNKNOWN	GAS	31.3	866.0
	STARK	OH-ST-133.0000	OIL & GAS	31.9	746.1
	STARK	OH-ST-135.0000	OIL & GAS	32.2	354.2
	STARK	OH-ST-136.0000	GAS	32.5	122.7
	STARK	OH-ST-164.0001	GAS	33.1	87.3
	STARK	OH-ST-176.0000	OIL & GAS	33.7	37.6
	SUMMIT	OH-SU-003.0001	OIL & GAS	34.4	285.9
	SUMMIT	UNKNOWN	OIL & GAS	34.7	971.4
	SUMMIT	OH-SU-009.0000	OIL & GAS	34.9	138.1
	SUMMIT	OH-SU-012.0000	OIL & GAS	35.2	93.5
	SUMMIT	OH-SU-023.0000-SC	OIL & GAS	35.2	1077.8
	SUMMIT	OH-SU-017.0000	OIL & GAS	35.5	321.3
	SUMMIT	OH-SU-024.0000	GAS	36.1	408.4
	SUMMIT	OH-SU-028.0000	OIL & GAS	36.5	735.0
	SUMMIT	OH-SU-027.0000	OIL & GAS	36.7	261.4
	SUMMIT	UNKNOWN	GAS WITH OIL SHOW	36.9	336.8
	SUMMIT	OH-SU-185.0000	OIL & GAS	48.3	58.2
	SUMMIT	UNKNOWN	GAS	48.5	824.9
	SUMMIT	OH-SU-189.0010	OIL & GAS	48.6	0.0
	SUMMIT	UNKNOWN	GAS	48.7	675.1
	SUMMIT	OH-SU-193.0000	OIL & GAS	49.0	518.3
	SUMMIT	UNKNOWN	OIL & GAS	49.2	1061.6
	SUMMIT	OH-SU-193.0000	OIL & GAS	49.3	31.7
	SUMMIT	UNKNOWN	OIL & GAS	49.3	974.9
	SUMMIT	OH-SU-200.0000	OIL & GAS	50.0	329.9
	SUMMIT	UNKNOWN	OIL & GAS	50.2	545.2
	WAYNE	OH-WA-001.0002	GAS	50.6	834.9
	WAYNE	OH-WA-002.0000	GAS	50.8	97.7
	WAYNE	OH-WA-003.0001	GAS	51.0	878.1
	WAYNE	OH-WA-010.0000	OIL & GAS	51.5	657.6
	WAYNE	OH-WA-011.0001	OIL & GAS	51.6	678.8
	WAYNE	OH-WA-036.0000-SC	GAS SHOW	52.7	1127.3

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	WAYNE	OH-WA-040.0000	OIL & GAS	54.8	985.4
	WAYNE	OH-WA-041.0000	OIL & GAS	55.2	93.4
	WAYNE	OH-WA-041.0000	OIL & GAS	55.5	342.4
	WAYNE	OH-WA-050.0000	GAS SHOW	56.2	0.0
	MEDINA	OH-ME-001.0000	OIL & GAS	56.7	174.4
	MEDINA	OH-ME-004.0000	OIL & GAS	56.9	79.8
	MEDINA	OH-ME-007.0000	OIL & GAS	57.2	332.9
	MEDINA	OH-ME-009.0000	OIL & GAS	57.9	1.6
	MEDINA	OH-ME-015.0000	OIL & GAS	58.6	134.7
	MEDINA	OH-ME-015.0000	OIL & GAS	58.8	94.4
	MEDINA	OH-ME-015.0001	OIL & GAS	59.0	955.4
	MEDINA	OH-ME-021.0000	OIL & GAS	59.5	881.1
	MEDINA	OH-ME-021.0000	OIL & GAS	59.6	113.2
	MEDINA	OH-ME-027.0000	OIL & GAS	60.0	367.3
	MEDINA	OH-ME-029.0000	OIL & GAS	60.2	35.7
	MEDINA	OH-ME-031.0000	OIL & GAS	60.3	156.9
	MEDINA	UNKNOWN	GAS	60.3	1039.2
	MEDINA	OH-ME-032.0000	OIL & GAS	60.7	115.9
	MEDINA	UNKNOWN	GAS WITH OIL SHOW	60.8	1135.5
	MEDINA	OH-ME-034.0000	OIL & GAS	61.1	653.0
	MEDINA	OH-ME-034.0000	OIL & GAS	61.2	559.6
	MEDINA	OH-ME-037.0000	OIL & GAS	61.4	264.6
	MEDINA	OH-ME-043.0000	OIL & GAS	61.6	66.1
	MEDINA	OH-ME-043.0000	OIL & GAS	61.7	956.1
	MEDINA	OH-ME-044.0000	OIL & GAS	61.8	388.1
	MEDINA	UNKNOWN	GAS WITH OIL SHOW	62.1	746.9
	MEDINA	OH-ME-046.0000	OIL & GAS	62.4	10.7
	MEDINA	OH-ME-050.0000	OIL & GAS	62.9	543.3
	MEDINA	OH-ME-054.0000	OIL & GAS	63.1	116.9
	MEDINA	OH-ME-057.0000	OIL & GAS	63.4	0.0
	MEDINA	OH-ME-057.0000	OIL & GAS	63.6	0.0
	MEDINA	OH-ME-058.0000	OIL & GAS	63.7	738.3
	MEDINA	OH-ME-098.0000-SC	GAS	63.8	392.4
	MEDINA	OH-ME-060.0000	OIL & GAS	64.0	133.0
	MEDINA	OH-ME-062.0000	GAS WITH OIL SHOW	64.3	0.0
	MEDINA	OH-ME-102.0000-SC	OIL & GAS	64.3	1015.6
	MEDINA	OH-ME-065.0000	GAS	64.6	4.9

TABLE 6.4-4

Active Oil and Gas Wells within 0.25 mile of the NEXUS Project

State/Facility	County	Tract a/	Well Type b/ c/	Milepost d/	Distance to workspace (Feet)
	MEDINA	OH-ME-066.0000	OIL & GAS	65.0	484.9
	MEDINA	OH-ME-069.0000	GAS	65.3	174.6
	MEDINA	OH-ME-069.0000	GAS	65.4	771.2
	MEDINA	OH-ME-077.0000	GAS WITH OIL SHOW	65.9	89.4
	MEDINA	OH-ME-082.0000	OIL & GAS	66.5	88.5
	MEDINA	OH-ME-155.0000-SC	OIL & GAS	67.0	1012.0
	MEDINA	OH-ME-085.0002	GAS	67.1	112.8
	MEDINA	OH-ME-087.0000	GAS SHOW	67.2	86.1
	MEDINA	OH-ME-090.0000	GAS	67.4	372.3
	MEDINA	OH-ME-093.0000	GAS	67.5	342.6
	MEDINA	OH-ME-099.0000	GAS WITH OIL SHOW	67.8	171.4
	MEDINA	UNKNOWN	GAS WITH OIL SHOW	67.9	996.6
	MEDINA	OH-ME-103.0000	GAS WITH OIL SHOW	68.1	24.2
	MEDINA	UNKNOWN	GAS WITH OIL SHOW	68.3	875.0
	MEDINA	OH-ME-127.0070-TAR-8-69.1	GAS WITH OIL SHOW	69.1	299.7
	MEDINA	OH-ME-129.0001	GAS	69.3	454.7
	MEDINA	OH-ME-135.0000	OIL & GAS	70.3	176.9
	MEDINA	OH-ME-139.0001	GAS	71.0	381.5
	LORAIN	OH-LO-018.0000	GAS	82.9	919.0
	LORAIN	OH-LO-022.0000	GAS	83.6	1078.0
	LORAIN	OH-LO-026.0000	UNKNOWN	84.4	119.7
	LORAIN	OH-LO-027.0000	UNKNOWN	84.4	47.4
	WOOD	UNKNOWN	OIL	165.9	1071.0
Michigan					
Mainline					
			None		

a/ Unknown tracts do not have any Project infrastructure

b/ Source: ODNR (Accessed September 2015); MDEQ (Accessed September 2015 - Michigan's MI Geographic Data Library at http://www.mcgi.state.mi.us/mgdl/)

c/ Plugged gas with oil show = gas well where oil was also observed. Plugged oil with gas show = oil well where gas was also observed.

d/ Approximate milepost along the pipeline rounded to the nearest tenth of a mile.

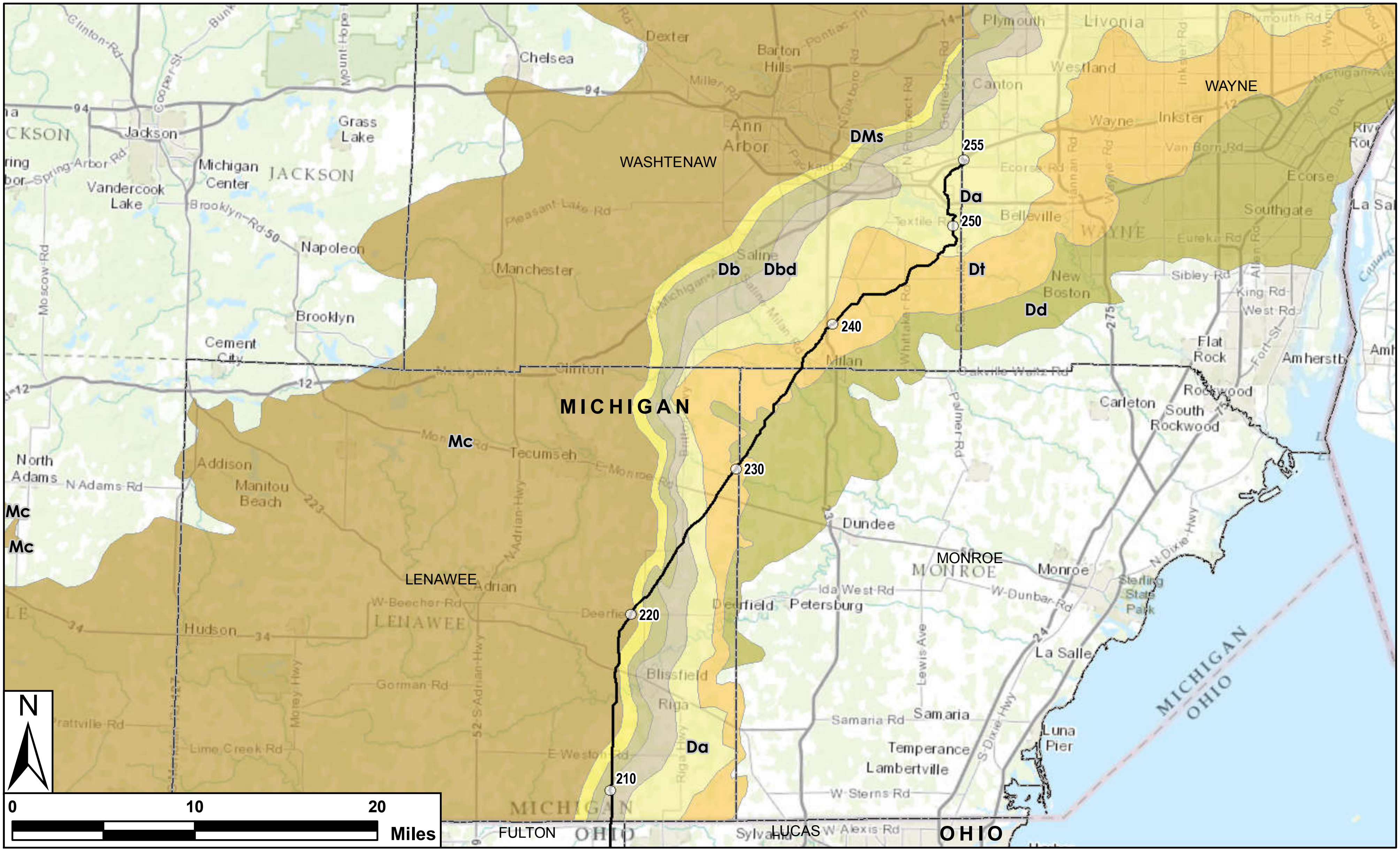
TABLE 6.5-1

Mapped Karst Features within 1,500 feet of the Project

Approximate MP	Approximate Distance (ft)	Direction from Project	Feature
126.6	255	north	Field verified sinkhole
127.9	260	south	Spring
128.6	790	north	Field verified sinkhole
130.3	800	south	Suspect sinkhole - field visited
130.4	230	south	Field verified sinkhole
130.7	1,475	north	Suspect sinkhole - field visited
130.7	1,450	north	Suspect sinkhole - field visited
130.8	980	north	Suspect sinkhole - field visited
130.9	350	northeast	Suspect sinkhole - field visited
130.9	460	south	Suspect sinkhole - field visited
131.0	830	south	Field verified sinkhole
131.0	460	south	Suspect sinkhole - field visited
131.0	1,230	south	Suspect sinkhole - field visited
131.2	990	south	Suspect sinkhole - field visited
131.5	1,475	south	Suspect sinkhole - field visited
131.5	1,175	north	Field verified sinkhole
131.6	320	south	Suspect sinkhole - field visited
131.6	1,425	north	Suspect sinkhole - field visited
131.60	1,440	north	Suspect sinkhole - field visited
132.2	75	north	Spring
133.8	1,420	south	Spring

Source: Data and feature designations from Aden, 2013.

FIGURES



Legend

- Milepost (10 miles)
- Proposed NEXUS Mainline Pipeline
- Project Counties

Bedrock Geology

- DMs
- Da
- Db
- Dbd
- Dd
- Dt
- Mc

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Source: ESRI, SPECTRA, MI GIS Open Data and TRC

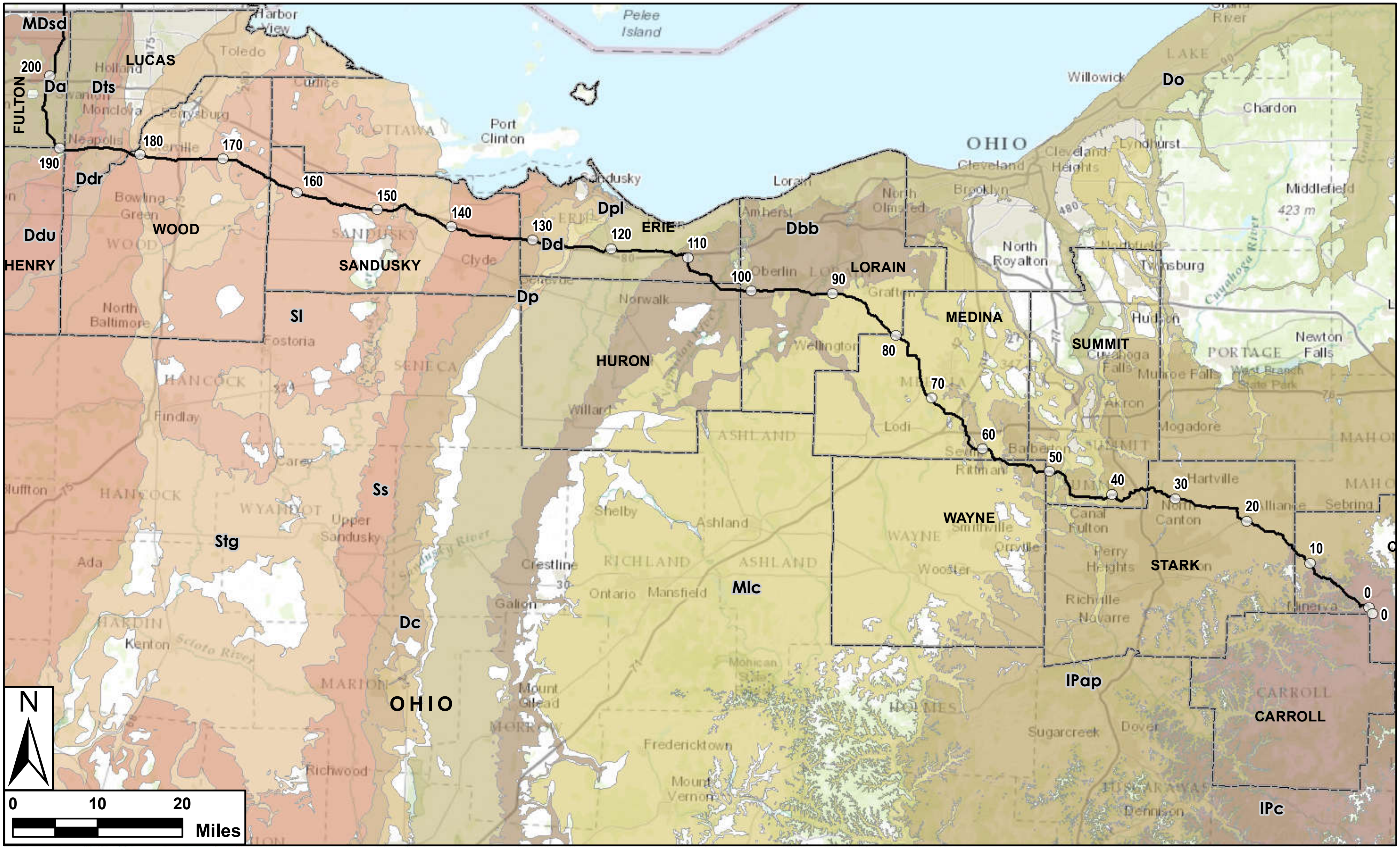
Figure 6.2-1b

Bedrock Geology Crossed by the Pipeline Facilities

Michigan

NEXUS GAS TRANSMISSION

11/12/2015



Legend

- Milepost (10 miles)
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Project Counties

Bedrock Geology

Da, Dbb, Dc, Dd, Ddr, Ddu, Do, Dp, Dpl, Dts, IPap, IPc, MDsd, Mlc, Sl, Ss, Stg

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Source: ESRI, SPECTRA, Ohio DNR and TRC.

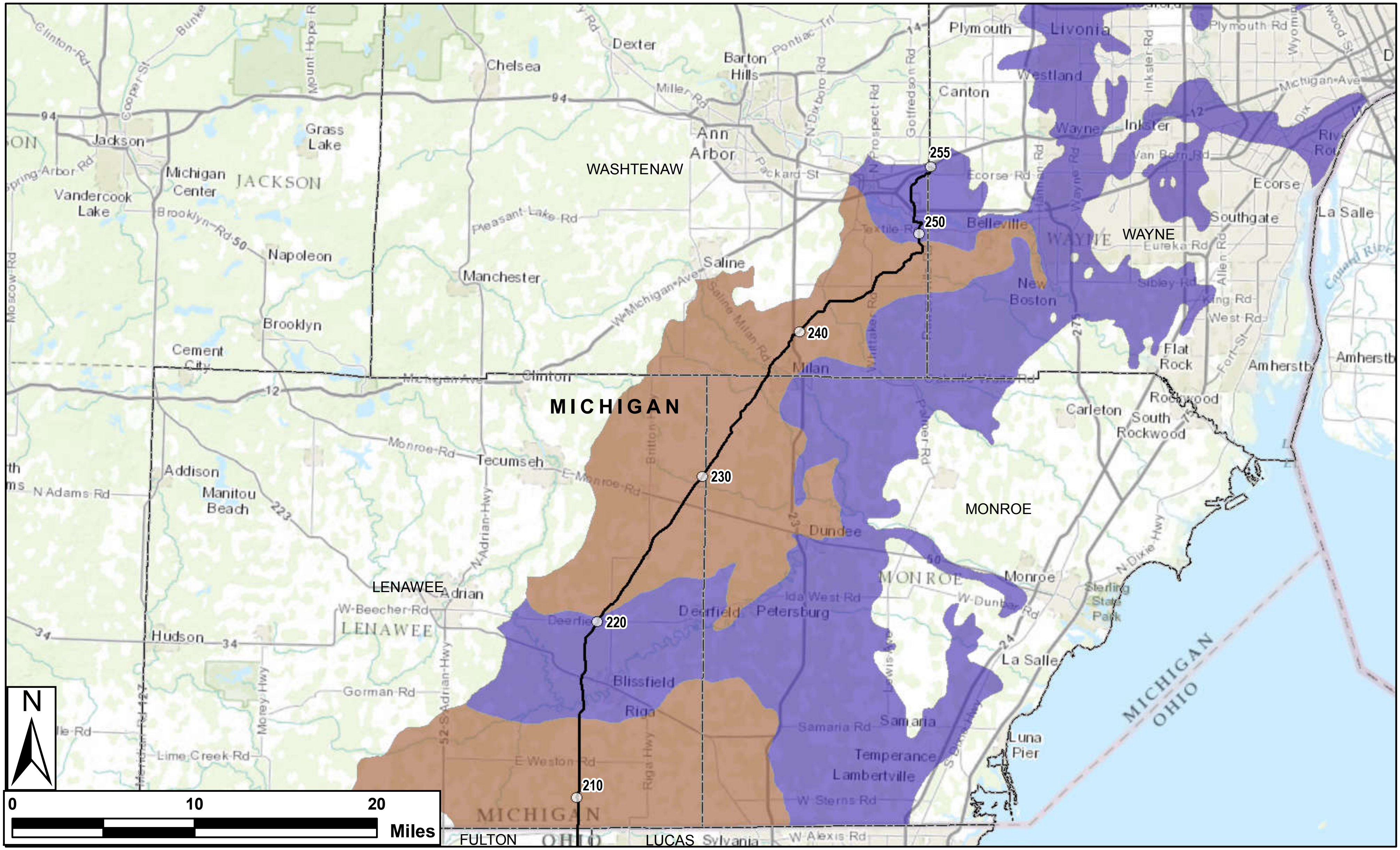
Figure 6.2-1a

Bedrock Geology Crossed by the Pipeline Facilities

Ohio

NEXUS GAS TRANSMISSION

11/12/2015



Legend

Milepost (10 miles)

Proposed NEXUS Mainline Pipeline

Project Counties

Surficial Geology

Lacustrine clay and silt

Lacustrine sand and gravel

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Source: ESRI, SPECTRA, MI GIS Open Data and TRC.

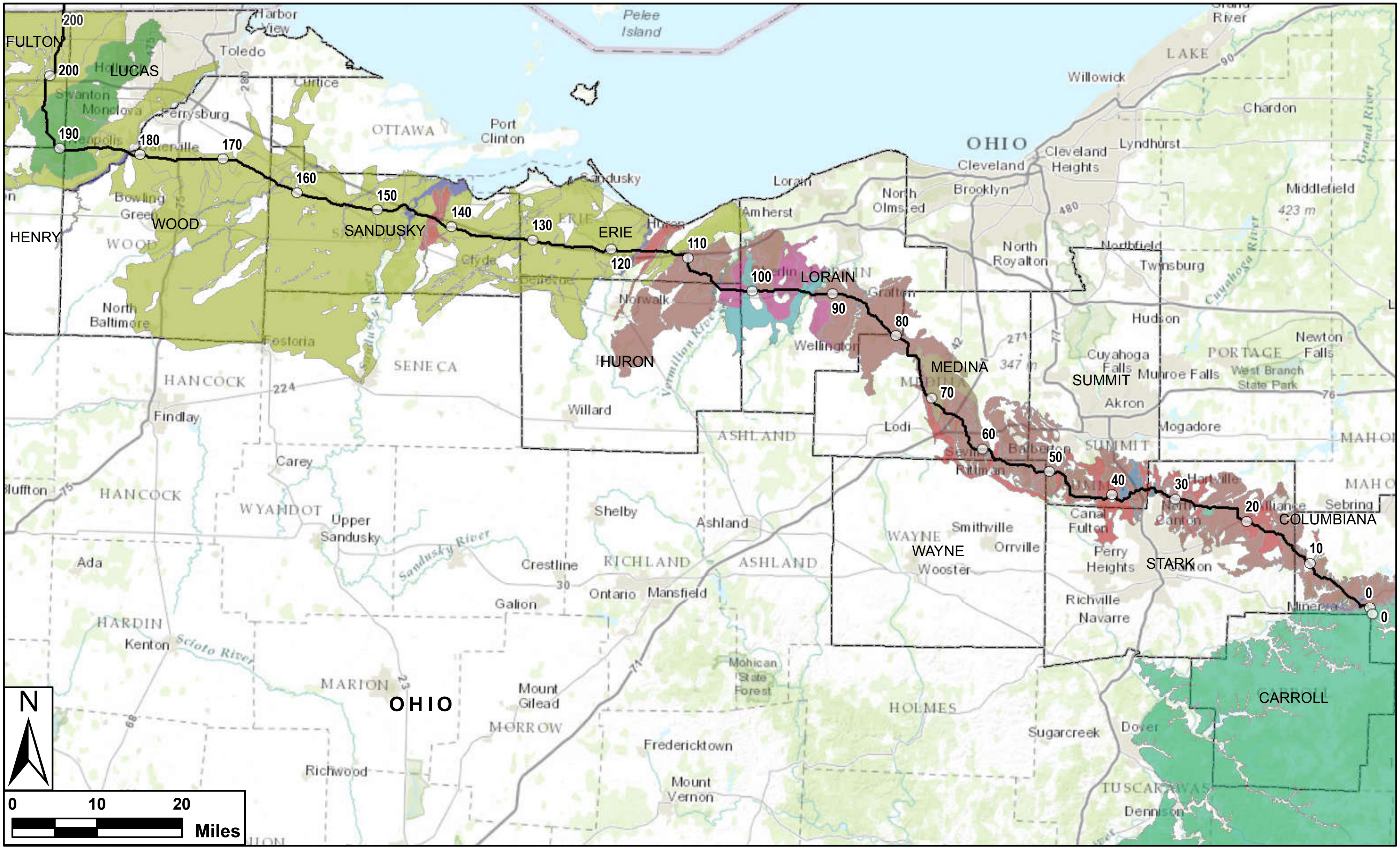
Figure 6.2-2b

Surficial Geology Crossed by the Pipeline Facilities

Michigan

NEXUS GAS TRANSMISSION

11/12/2015



Legend

○	Milepost (10 miles)	Surficial Geology			Complex		NA
	Proposed NEXUS Mainline Pipeline		Alluvial		End Moraine		Outwash/Kame
	Proposed TGP Interconnect		Beach Ridge		Ground Moraine		Thin Upland
	Project Counties		Buried Valley		Lacustrine		

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Source: ESRI, SPECTRA, Ohio DNR and TRC.

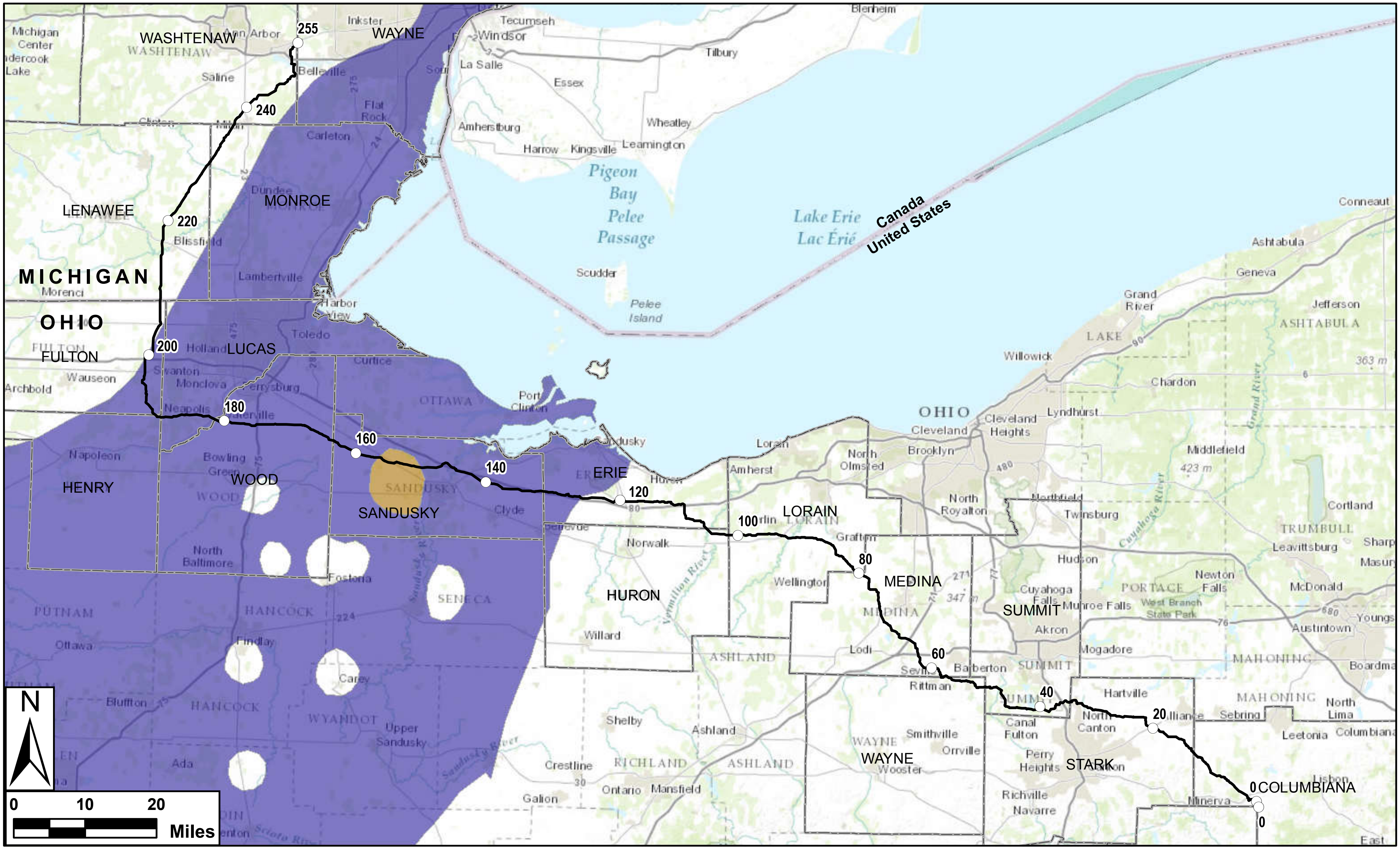
Figure 6.2-2a

Surficial Geology Crossed by the Pipeline Facilities

Ohio

NEXUS GAS TRANSMISSION

11/12/2015



Legend

- Milepost (20 miles)
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Project Counties

USGS Karst Type that Intersects Proposed Pipeline

- Short 4
- Short 5

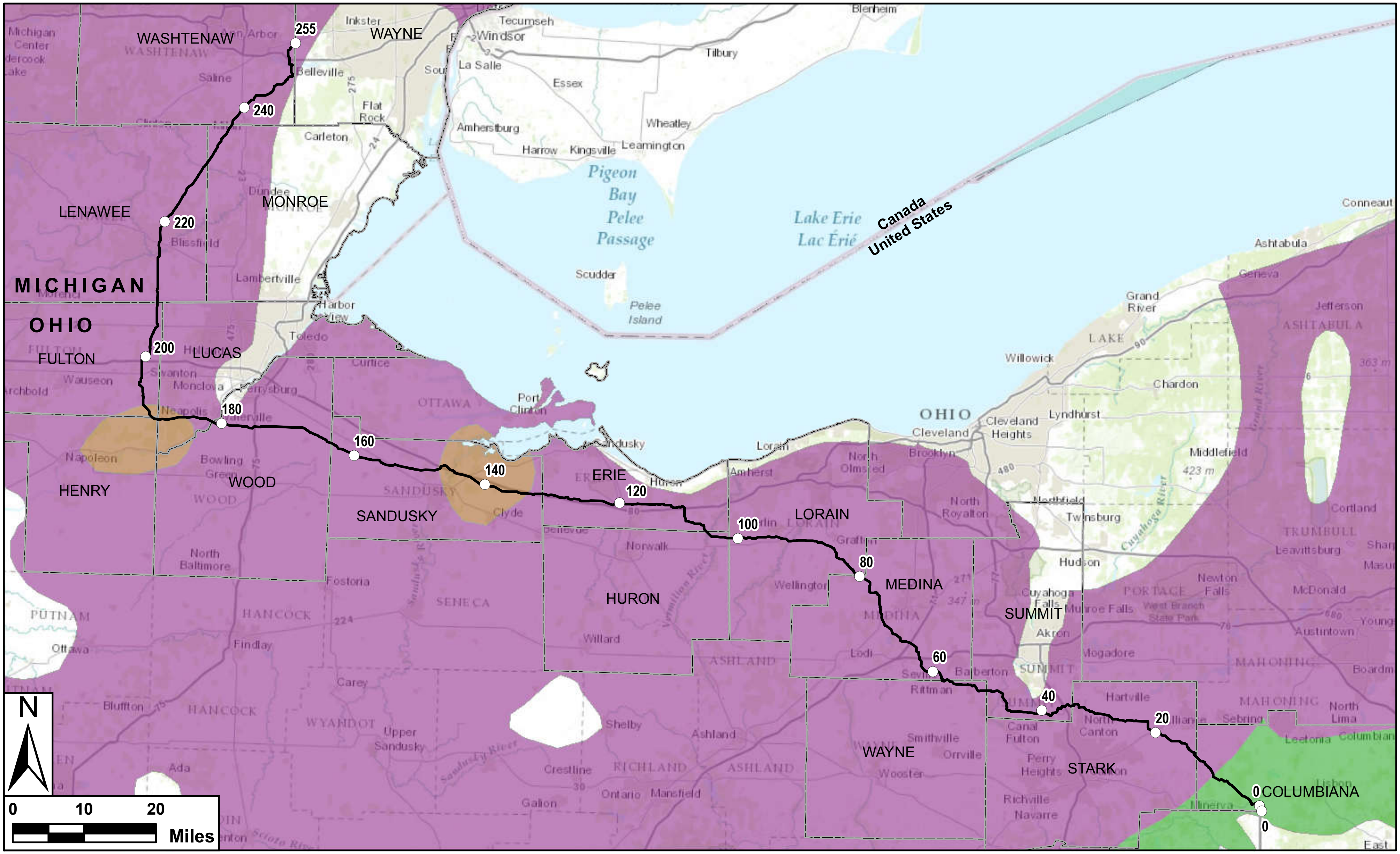
Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Sources: ESRI, TRC, Ohio DNR, MI GIS Open Data and SPECTRA

Figure 6.5-1

Karst Areas Crossed by Pipeline Facilities Michigan and Ohio

NEXUS GAS TRANSMISSION

11/12/2015



Legend

- ○ Milepost (20 miles)
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Project Counties

Landslide Susceptibility Crossed by Proposed Pipeline

- Low
- Sus-High
- Sus-Mod

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Sources: ESRI, Ohio DNR, TRC, USGS, MI GIS Open Data and SPECTRA

Figure 6.5-2

Landslide Susceptibility Crossed by Pipeline Facilities

Michigan and Ohio

NEXUS GAS TRANSMISSION

11/12/2015