TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC

Resource Report No. 6
Geologic Resources and Hazards

Transcontinental Gas Pipe Line Company
Northeast Supply Link Project

December 2011

SUMMARY OF FILING INFORMATION		
INFORMATION	**Data Sources[1]**	**Found in**
1. Identify the location (by milepost) of mineral resources and any planned or active surface mines crossed by the proposed facilities. (§380.12 (h) (1 & 2)). Describe hazards to the facilities from mining activities, including subsidence, blasting, slumping or landsliding or other ground failure.	II, S, LL	Section 6.4
2. Identify any geologic hazards to the proposed facilities. (§380.12 (h) (2))	II, LL, S	Section 6.5 and Table 6.5-1
3. Discuss the need for and locations where blasting may be necessary in order to construct the proposed facilities. (§380.12 (h) (3))	D, II	Section 6.3
4. For LNG Projects in seismic areas, the materials required by "Data Requirements for the Seismic Review of LNG Facilities," NBSIR84-2833. (§380.12 (h) (5))	---	Not Applicable
5. 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. (§380.12 (h) (6))	---	Not Applicable
• Identify any sensitive paleontological resource areas crossed by the proposed facilities. (Usually only if raised in scoping or required by land-managing agency.)	P, II, LL	Section 6.7
• Briefly summarize the physiographic and bedrock geology of the project area.	II, LL	Section 6.2 and Table 6.2-1 and Table 6.2-2
• If the application is for underground storage facilities:	D	
– Describe monitoring of potential effects of the operation of adjacent storage or production facilities on the proposed facility, and vice versa;	D	Not Applicable
– Describe measures taken to locate and determine the condition of old wells within the field and buffer zone and how the applicant would reduce risk from failure of known and undiscovered wells; and	--	Not Applicable
• Identify and discuss safety and environmental safeguards required by state and Federal drilling regulations.	--	Not Applicable

1
A Aerial Photographs
B Agency Consultation
D Applicant
H Comprehensive Plans, County or Land Management Agencies
L Field Surveys
P Geologic Survey Personnel, Federal, State, and Local
S Mineral Resource Maps, Federal and State
X NRCS Soil Surveys
II Surficial Geology and Bedrock Geology Maps
LL USGS Topographic Maps

Response to FERC Comments on September 28, 2011	
Comment:	**Found in:**
1. Describe the Walcksville Member of Catskill Formation in section 6.2.3.	6.2.3
2. Revise section 6.2.5 to include a discussion on anticipated depth to bedrock at the Caldwell B Replacement.	6.2.5
3. Revise table 6.2-2 to include the estimated depth to bedrock for the proposed aboveground facilities.	6.2.5 and Table 7.2-5
4. Provide a draft Blasting Plan that details how blasting would be conducted, including within residential areas if necessary.	Appendix 6B
5. Discuss historical mining operations in the Project area and determine whether the Project crosses former underground mines or tailings.	6.4.1 and 6.4.2
6. In section 6.5.1, identify faults by name and location crossed by or located near each Project facility. Also address whether the faults crossed by or located near the Project have been active in the recent geologic past and whether they resulted in ground surface displacement.	6.5.1.1 and 6.5.1.2
7. Discuss the potential for sinkhole development for the Stanton Loop and the aboveground facilities.	6.5.4
8. Discuss whether the Project would cross any historic landslide features.	6.5.3.1 and 6.5.3.2
9. Discuss the potential to encounter paleontological resources at the proposed aboveground facilities.	6.7.1 and 6.7.2
10. Confirm the citations for the "Pennsylvania Bureau of Topographic and Geologic Survey, 2000" and "USGS, 2003" are used in the text.	Not applicable

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List of Acronyms

bgs	below ground surface
dt/d	decatherms per day
CFR	Code of Federal Regulations
DxC	Dekalb extremely stony loam, 8 to 25 percent slopes
DxE	Dekalb extremely stony loam, 25 to 80 percent slopes
E&SCP	Erosion and Sediment Control Plan
FERC	Federal Energy Regulatory Commission
hp	horsepower
KkoC	Klinesville channery loam, 6 to 12 percent slopes
KkoD	Klinesville channery loam, 12 to 18 percent slopes
M&R	meter and regulator
MLV	mainline valve
MP	milepost
MSL	mean sea level
NGA	Natural Gas Act
NJDEP	New Jersey Department of Environmental Protection
NJGS	New Jersey Geological Survey
NSL	Northeast Supply Link
PADEP	Pennsylvania Department of Environmental Protection
ROW	right-of-way
RR	resource report
Transco	Transcontinental Gas Pipe Line Company, LLC
USGS	United States Geological Survey
WeB	Weikert shaly silt loam, 3 to 8 percent slopes

WeD	Weikert shaly silt loam, 15 to 25 percent slopes
WkE	Weikert and Klinesville shaly silt loams, 25 to 80 percent slopes

6. GEOLOGIC RESOURCES AND HAZARDS

6.1 INTRODUCTION

Transcontinental Gas Pipe Line Company, LLC (Transco) is proposing to expand its pipeline systems in the Pennsylvania-New Jersey-New York region to meet the immediate and future demand for natural gas in the Northeast. To accomplish this, Transco will file an application for a Certificate of Public Convenience and Necessity (Certificate) from the Federal Energy Regulatory Commission (FERC). Transco is requesting authorization to construct and operate the Northeast Supply Link Project (NSL Project or Project) to expand its existing pipeline systems located in Pennsylvania, New Jersey, and New York under Section 7(c) of the Natural Gas Act (NGA); and to abandon certain facilities under Section 7(b) of the NGA. The NSL Project will create a new transportation path for 250,000 decatherms per day (dt/d) of natural gas from various receipt points on Transco's Leidy Line in Pennsylvania to various delivery points along Transco's mainline and Leidy systems in Pennsylvania, New Jersey, and New York.

The Project will consist of 12.03 miles of 42-inch diameter pipeline looping extension, 26.95 miles of pipeline uprate, 0.46 miles of 36-inch diameter pipeline replacement, construction of a new compressor station and new electrical substation, and modification of several aboveground facilities. The proposed facilities are located in Pennsylvania, New Jersey, and New York. An overview of the proposed facilities is provided below. Refer to Figure 1.1-1 in Resource Report (RR) 1, "General Project Description," for a Project overview map that shows the location of all proposed facilities and their association with Transco's existing pipeline facilities.

Proposed Pipeline Facilities

- **Muncy Loop (Lycoming County, Pennsylvania):** Approximately 2.22 miles of 42-inch diameter pipeline, extending the existing Leidy Line "D" loop between mileposts (MPs) 128.97 and 131.19.

- **Palmerton Loop (Monroe County, Pennsylvania):** Approximately 3.17 miles of 42-inch diameter pipeline, extending the existing Leidy Line "D" loop between MPs 40.50 and 43.67.

- **Stanton Loop (Hunterdon County, New Jersey):** Approximately 6.64 miles of 42-inch diameter pipeline, extending the existing Leidy Line "C" loop between MPs 6.90 and 13.54.

- **Caldwell B Replacement (Essex County, New Jersey):** Approximately 0.46-mile replacement of the existing 36-inch diameter Caldwell B Loop.

Preliminary alignment sheet mapping for the proposed pipeline facilities is included in the Mapping Supplement in Volume 3.

Proposed Pipeline Uprates

- **Caldwell Uprate (Essex, Passaic, Bergen, and Hudson counties, New Jersey):** Pressure uprate along approximately 25.55 miles of the existing 36-inch Caldwell B Loop, Mainline B, and 72nd Street Lateral.

- **Long Island Extension Uprate (Richmond County, New York):** Pressure uprate along approximately 1.40 miles of the existing 26-inch diameter Long Island Extension pipeline.

The pipeline uprates will not include any ground disturbance and are, therefore, not discussed further in this RR. All work related to the uprates will be at aboveground facilities as described below.

New Compressor Station: New Jersey

- **Compressor Station 303 (Essex County, New Jersey):** A new single-unit 25,000 hp electric-drive compressor station.

New Electrical Substation: New Jersey

- **Electrical Substation (Essex County, New Jersey):** A new high voltage electric substation to be constructed on an existing PSE&G transmission right of way (ROW) to transmit power from the PSE&G grid to Compressor Station 303.

Site plans for the new compressor station and electrical substation are provided in the Mapping Supplement in Volume 3.

Compressor Station Modification: Pennsylvania

- **Compressor Station 515 (Luzerne County, Pennsylvania):** An additional 16,000 horsepower (hp) compressor unit at Transco's existing Compressor Station 515.

Compressor Station Modification: New Jersey

- **Compressor Station 505 (Somerset County, New Jersey):** Facility modifications at Transco's existing Compressor Station 505.

Site plans for the compressor station modifications are provided in the Mapping Supplement in Volume 3.

Other Aboveground Facility Modifications: Pennsylvania

- **Leidy Interchange Hub (Clinton County, Pennsylvania):** Facility modification associated with upgrading the odorization system due to increased flow volumes.

- **Mainline Valves (MLVs) (Lycoming and Monroe Counties, Pennsylvania):** Relocation and modification of MLVs along the Muncy and Palmerton pipeline loops.

Other Aboveground Facility Modifications: New Jersey

- **Roseland Meter and Regulator (M&R) Station (Essex County, New Jersey):** Facility modification due to the Caldwell Uprate including valve and piping replacement and regulation installation. It may also include modification related to the proposed Compressor Station 303.
- **Montclair State University M&R Station (Passaic County, New Jersey):** Facility modification due to the Caldwell Uprate including valve replacement and isolation of the station during testing of the Caldwell Loop.
- **East Rutherford M&R Station (Bergen County, New Jersey):** Isolation of the scrubbers and heaters during testing of the Caldwell Loop. Facility modification due to the Caldwell Uprate including additional regulation installation.
- **Regulator Station 240 (Bergen County, New Jersey):** Isolation of Regulator Station 240 piping during testing of the Caldwell Loop; pressure testing of Meadows Regulator No. 2 and installation of valves and other equipment.
- **Meadows Heaters (Bergen County, New Jersey):** Modification of existing heaters and installation of a new heater to accommodate increased flow volumes.
- **MLV 505B60 (Essex County, New Jersey):** Modifications and testing to accommodate increased pressure.
- **Paterson Lateral Take-off (Bergen County, New Jersey):** Installation of overpressure protection from Mainline B.
- **MLVs (Hunterdon County, New Jersey):** Relocation and modification of MLVs along the Stanton Loop.

Other Aboveground Facility Modifications: New York

- **Narrows M&R Station (Richmond County, New York):** Modification to accommodate proposed increased delivery volumes.
- **Brooklyn Regulating Vault (Kings County, New York):** Addition of below-grade, downstream regulation facility adjacent to an existing facility to accommodate proposed increased delivery volumes.
- **134th Street Manhattan M&R Station (New York County, New York):** Facility modification due to the proposed increased delivery volumes, including piping replacement, building replacement, and ancillary modifications.

Site plans for all aboveground facility modifications are provided in the Mapping Supplement in Volume 3.

6.2 GEOLOGY AND PHYSIOGRAPHY

Geologic maps prepared by the United States Geological Survey (USGS), Pennsylvania Geological Survey, Pennsylvania Bureau of Topographic and Geologic Survey, Pennsylvania

Department of Conservation and Natural Resources, New Jersey Department of Environmental Protection (NJDEP), and New Jersey Geological Survey (NJGS) were used to determine the geologic formations crossed by the proposed Project.

6.2.1 Pipeline Facilities

The following summarizes the physiography, topography, and bedrock geology of the NSL Project pipeline facilities. Table 6.2-1 summarizes bedrock formations crossed by the pipeline facilities.

6.2.2 Muncy Loop

The Muncy Loop is located in the Susquehanna Lowland Section of the Ridge and Valley Physiographic Province (PDCNR 2000). The section was formed as the rocks were compressed toward the northwest and folded into the long, linear folds. Erosion of the folded rocks created the ridges and valleys of the Susquehanna Lowland Section.

Elevations along the Muncy Loop vary from 700 to 1,010 feet above mean sea level (MSL; see the Mapping Supplement in Volume 3). Some of the gorges are at least 1,000 feet deep. In most valleys, the slope is fairly uniform from top to bottom. In some valleys, the slopes have a large-scale, stair-step appearance, which results from erosion of sandstones and shales.

Depth to bedrock along the Muncy Loop ranges from 10 to 20 inches below ground surface (bgs) to greater than 60 inches bgs (see Table 7.2-1 in Resource Report 7, “Soils”). The shallowest identified depth to bedrock (10 to 20 inches bgs) is located in Weikert and Klinesville shaly silt loams, 25 to 80 percent slopes (WkE), Weikert shaly silt loam, 3 to 8 percent slopes (WeB), and Weikert shaly silt loam, 15 to 25 percent slopes (WeD) .

The Muncy Loop crosses one bedrock formation of Devonian age. The Trimmers Rock Formation includes olive-gray siltstone and shale, characterized by graded bedding; marine fossils; some very fine-grained sandstone in the northeast; and black shale of Harrell Formation at the base in Susquehanna Valley (USGS 2005a, USGS 2006).

6.2.3 Palmerton Loop

The Palmerton Loop is located in the Blue Mountain Section of the Ridge and Valley Physiographic Province (PDCNR 2000). Elevations along the Palmerton Loop vary from 640 to 1,180 feet above MSL. The Blue Mountain Section is formed on sandstone, siltstone and shale, and some limestone and conglomerate. Very resistant sandstone occurs at the crests of the Blue Mountain. Shales and siltstones occur on the slopes and valleys.

Table 6.2-1
Summary of Bedrock Formations Crossed by Pipeline Facilities

State	County	Milepost			Geologic Formation	Primary Lithology	Secondary Lithology
Muncy Loop							
Pennsylvania	Lycoming	128.97	to	131.19	Trimmers Rock Formation	Siltstone	Shale
Palmerton Loop							
Pennsylvania	Monroe	40.50	to	40.95	Bloomsburg Formation	Shale	Siltstone
		40.95	to	41.27	Decker Formation through Poxono Island Formation, undivided	Calcareous sandstone	Limestone
		41.27	to	41.54	Ridgeley Formation through Coeymans Formation, undivided	Sandstone	Siltstone
		41.54	to	41.69	Buttermilk Falls Limestone through Esopus Formation, undivided	Siliceous sandstone	Limestone
		41.69	to	41.79	Ridgeley Formation through Coeymans Formation, undivided	Sandstone	Siltstone
		41.79	to	41.91	Buttermilk Falls Limestone through Esopus Formation, undivided	Siliceous sandstone	Limestone
		41.91	to	42.47	Marcellus Formation	Black Shale	Limestone
		42.47	to	43.06	Mahantango Formation	Shale	Siltstone
		43.06	to	43.42	Trimmers Rock Formation	Siltstone	Shale
		43.42	to	43.66	Towamensing Member of Catskill Formation	Sandstone	Siltstone
		43.66	to	43.67	Walcksville Member of Catskill Formation	Sandstone	Siltstone
Stanton Loop							
New Jersey	Hunterdon	6.90	to	7.44	Passaic Formation	Siltstone and shale	
		7.44	to	7.69	Granophyre	Granophyre, medium- to coarse-grained	
		7.69	to	7.83	Passaic Formation	Siltstone and shale	
		7.83	to	8.66	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebbly sandstone and conglomerate	
		8.66	to	8.67	Stockton Formation	Sandstone, mudstone, silty mudstone, argillaceous siltstone, and shale	
		8.67	to	8.80	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebbly sandstone and conglomerate	
		8.80	to	8.96	Stockton Formation	Sandstone, mudstone, silty mudstone, argillaceous siltstone, and shale	
		8.96	to	9.46	Stockton Formation	Sandstone, mudstone, silty mudstone, argillaceous siltstone, and shale	
		9.46	to	10.36	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebbly sandstone and conglomerate	
		10.36	to	11.26	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebble to cobble quartzite conglomerate, sandstone	

Table 6.2-1
Summary of Bedrock Formations Crossed by Pipeline Facilities

State	County	Milepost			Geologic Formation	Primary Lithology	Secondary Lithology
		11.26	to	11.49	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebbly sandstone and conglomerate	
		11.49	to	12.57	Stockton Formation Cobble Conglomerate and Sandstone facies	Pebble to cobble quartzite conglomerate, sandstone	
		12.57	to	13.18	Jutland Klippe Sequence Unit A	Shale, sandstone, limestone, siltstone, and quartz-pebble conglomerate	
		13.18	to	13.18	Jutland Klippe Sequence Unit B	Shale, dolomite, siltstone, sandstone, quartzite, and limestone	
		13.18	to	13.39	Jutland Klippe Sequence Unit A	Shale, sandstone, limestone, siltstone, and quartz-pebble conglomerate	
		13.39	to	13.54	Jutland Klippe Sequence Unit B	Shale, dolomite, siltstone, sandstone, quartzite, and limestone	
Caldwell B Replacement							
New Jersey	Essex	1821.10	to	1821.57	Towaco Formation	Sandstone	Siltstone

Sources: USGS 2005a, USGS 2006; Pennsylvania Bureau of Topographic and Geologic Survey 2001
Notes:
[a] PDCNR 2000. Map 13, Physiographic Provinces of Pennsylvania. Compiled by W. D. Sevon, Fourth Edition.
[b] NJGS 2006. Physiographic Provinces of New Jersey. Prepared by Richard Dalton 2003.

Depth to bedrock along the Palmerton Loop ranges from 20 to 40 inches bgs to greater than 60 inches bgs (see Table 7.2-1 in RR 7, "Soils"). The shallowest identified depth to bedrock (20 to 40 inches bgs) is located in Dekalb extremely stony loam, 25 to 80 percent slopes (DxE), and Dekalb extremely stony loam, 8 to 25 percent slopes (DxC) (see the Mapping Supplement in Volume 3).

Bedrock in the vicinity of the Palmerton Loop consists of rock from the Devonian age and Silurian age. The Palmerton Loop crosses eight bedrock formations:

- The Bloomsburg Formation consists of grayish-red siltstone, shale, and sandstone arranged in fining-upward cycles (USGS 2005a, USGS 2006).
- The Decker Formation through Poxono Island Formation, undivided consists of the Decker Formation-gray calcareous sandstone having lenses of calcareous conglomerate, siltstone, and shale, and lenses of limestone and dolomite. The Poxono Island Formation consists of thin-bedded dolomite, limestone, and shale; and red shale in lower part (USGS 2005a, USGS 2006).
- The Ridgeley Formation through Coeymans Formation, undivided consists of the Ridgeley Formation-white siliceous sandstone; Shriver Chert--gray siltstone and shale and dark-gray chert; and the Coeymans Formation--gray, clayey to sandy limestone (USGS 2005a, USGS 2006).
- The Buttermilk Falls Limestone through Esopus Formation, undivided consists of the Buttermilk Falls Limestone-gray fossiliferous limestone and black chert; and the Esopus Formation--gray silty shale and sandy siltstone (USGS 2005a, USGS 2006).
- The Marcellus Formation consists for the most part of sooty black shale and a few beds of medium-gray shale and limestone nodules or beds of dark gray to black limestone (USGS 2005a, USGS 2006).
- The Mahantango Formation consists of thickly laminated marine shale, siltstone, very fine sandstone, and some limestone, with an occasional coral reef or biostrome. It also contains the Clearville and Chaneysville Siltstone Members of Pennsylvania (USGS 2005a, USGS 2006).
- The Trimmers Rock Formation consists of olive-gray siltstone and shale, characterized by graded bedding; marine fossils; some very fine grained sandstone in northeast; and black shale of Harrell Formation at the base in Susquehanna Valley (USGS 2005a, USGS 2006).
- The Towamensing Member of Catskill Formation consists of dominantly gray sandstone and some siltstone and shale; and freshwater fossils (USGS 2005a, USGS 2006).
- The Walcksville Member of Catskill Formation consists of greenish-gray sandstone and red siltstone and mudstone in fining-upward cycles (USGS 2005a, USGS 2006).

6.2.4 Stanton Loop

The Stanton Loop is located both in the Highlands physiographic province and the Piedmont physiographic province (NJGS 2006). Elevations along the Stanton Loop vary from 180 to 440 feet above MSL. The Highlands province consists of rugged topography with a series of discontinuous rounded ridges separated by deep narrow valleys. The Piedmont province is chiefly a low rolling plain divided by a series of higher ridges (NJGS 2006).

Depth to bedrock along the Stanton Loop ranges from 10 to 20 inches bgs to 60 to 120 inches bgs (see Table 7.2-1 in RR 7, "Soils"). The shallowest identified depth to bedrock (10 to 20 inches bgs) is located in Klinesville channery loam, 12 to 18 percent slopes (KkoD) and Klinesville channery loam, 6 to 12 percent slopes (KkoC) (see the Mapping Supplement in Volume 3).

Bedrock in the vicinity of the Stanton Loop consists of rocks of Lower Jurassic and Upper Triassic, Early Jurassic, Lower Middle Ordovician to Upper Cambrian, and Middle Ordovician age. The Stanton Loop crosses six bedrock formations:

- The Passaic Formation is composed of predominantly red beds consisting of argillaceous siltstone; silty mudstone; argillaceous, very fine-grained sandstone; and shale; mostly reddish-brown to brownish-purple, and grayish-red (USGS 2005a, USGS 2006).

- The Granophyre consists of fine-grained to aphanitic dikes; medium- to coarse grained, subophitic discordant stock-like intrusions of dark-greenish-gray to black diabase; and plugs of dark gray, concordant to discordant sheetlike, medium- to coarse-grained, quartz-rich to albite-rich granophyre (USGS 2005a, USGS 2006).

- The Stockton Formation Cobble Conglomerate and Sandstone facies consists of predominantly medium- to coarse-grained, light-gray, light-grayish-brown, or yellowish- to pinkish-gray arkosic sandstone and medium- to fine-grained, violet-gray to reddish-brown arkosic sandstone; with lesser, reddish to purplish-brown, silty mudstone, argillaceous siltstone, and shale (USGS 2005a, USGS 2006).

- The Stockton Formation consists of predominantly medium- to coarse-grained, light-gray, light-grayish-brown, or yellowish- to pinkish-gray arkosic sandstone and medium- to fine-grained, violet-gray to reddish-brown arkosic sandstone; with lesser, reddish to purplish-brown, silty mudstone, argillaceous siltstone, and shale (USGS 2005a, USGS 2006).

- The Jutland Klippe Sequence Unit A consists of interbedded red, green, and tan shale, sandstone, and dark-gray, aphanitic to fine-grained limestone, which contains floating quartz-sand grains. Grades downward through interbedded sequence of red, green and brown shale to medium-gray to brown, fine- to coarse-grained sandstone and quartz-pebble conglomerate. Lower beds are dark-gray shale and siltstone containing minor dark-gray, aphanitic to fine-grained, medium-bedded limestone (USGS 2005a, USGS 2006).

- The Jutland Klippe Sequence Unit B consists of heterogeneous sequence of interbedded red, green, tan and gray shale; interlaminated dolomite and shale; interbedded fine-grained graywacke siltstone and beds or lenses of sandstone; light-gray to pale-pinkish-gray quartzite; and interbedded fine-grained, thin-bedded limestone and red and green shale. Limestone locally resembles an intraformational conglomerate because it is disrupted, boudinaged, and surrounded by shale beds. Lower contact gradational and within interbedded sequence of thin- to medium-bedded sandstone, siltstone, and limestone (USGS 2005a, USGS 2006).

6.2.5 36-Inch Caldwell B Replacement

The Caldwell B Replacement is located entirely within the Piedmont physiographic province of New Jersey (NJGS 2006). Ground elevations along the Caldwell B Replacement are approximately 170 feet above MSL.

The Piedmont physiographic province consists of varied topography, ranging from lowlands to peaks and ridges of moderate altitude and relief. The Piedmont Province is comprised of intrusive, sedimentary, and volcanic rocks associated with the Newark Basin that range in age from Late Triassic to Early Jurassic (NJGS 2000). The Newark Basin is one of a series of rift basins located along the eastern seaboard of North America that was formed during the opening of the Atlantic Ocean. Rock within the Newark Basin is considered part of a larger area known as the Newark Super Group and typically includes basalt, diabase, siltstone, mudstone, sandstone, and conglomerate. Predominant depositional environments within the Newark Super Group are lacustrine, fluvial, and volcanic.

The Caldwell B Replacement crosses one bedrock formation:

- The Towaco Formation consists of reddish-brown to brownish-purple, fine- to medium-grained micaceous sandstone, siltstone, and silty mudstone. Distributed throughout the formation are eight or more sequences of gray to greenish- or brownish-gray, fine-grained sandstone, siltstone and calcareous siltstone and black, microlaminated calcareous siltstone and mudstone containing diagnostic pollen, fish, and dinosaur tracks (USGS 2010). Depth to bedrock is more than 5 feet (see Resource Report 7, Table 7.2-4).

Aboveground Facilities

Geologic formations underlying the aboveground facilities are listed in Table 6.2-2. Depth to bedrock ranges from 10 to 90 inches (see Resource Report 7, Table 7.2-5).

Table 6.2-2
Geologic Formations Underlying Aboveground Facilities

Facility Name	Location	Geologic Formation
Compressor Station 505	Somerset County, New Jersey	Passaic Formation and Passaic Formation Gray Bed
Compressor Station 515	Luzeme County, Pennsylvania	Pocono Formation
Compressor Station 303	Essex County, New Jersey	Towaco Formation
Electrical Substation	Essex County, New Jersey	Towaco Formation
Regulator Station 240 – Facility Modifications	Bergen County, New Jersey	Passaic Formation Mudstone facies
Roseland M&R	Essex County, New Jersey	Towaco Formation
Montclair State University M&R Station	Passaic County, New Jersey	Orange Mountain Basalt
E. Rutherford M&R Station (PSE&G)	Bergen County, New Jersey	Passaic Formation Mudstone facies
Manhattan M&R Station – 134th Street	New York County, New York	Not Applicable
Narrows M&R Station	Richmond County, New York	Till moraine
Brooklyn Regulating Vault	Kings County	Glacial and Alluvial deposits
Paterson Lateral Take-off	Bergen County, New Jersey	Passaic Formation Mudstone facies
Meadows Heaters	Bergen County, New Jersey	Passaic Formation Mudstone facies
Leidy Interchange Hub	Clinton County, Pennsylvania	Catskill Formation
MLV 505B60	Essex County, New Jersey	Preakness basalt

6.3 BLASTING

Shallow bedrock is anticipated to be encountered near the Muncy Loop, Palmerton Loop and Stanton Loop. The shallowest depth to bedrock is approximately 10 to 20 inches bgs along the Muncy Loop (see Section 6.2.2), approximately 20 to 40 inches bgs along the Palmerton Loop (see Section 6.2.3), and approximately 10 to 20 inches bgs along the Stanton Loop (see Section 6.2.4). However, based on existing information about subsurface geologic formations present along the Project construction area and other recent construction experience in the vicinity of these loops, the lithologic units associated with these loops are generally softer and can be ripped with construction equipment. For these reasons, Transco does not anticipate blasting will be required along these loops. However, if conditions are encountered that warrant the use of controlled blasting, the appropriate permits and regulatory requirements will be met prior to blasting.

If bedrock is encountered during construction, and blasting is required, Transco's construction contractor will use seismically controlled blasting techniques in compliance with state and federal regulations governing the use of explosives to assist in the removal of rock from the pipeline trench. Details of how blasting would be conducted and measures to avoid and minimize impacts related to blasting are included in Transco's draft Blasting Plan for the Project (see Appendix 6B). A site-specific blasting plan would be developed prior to any blasting.

Blasting will be controlled to impact only near-surface materials and will be limited in intensity to fragment shallow bedrock only. Transco will procure required permits from the Pennsylvania Department of Environmental Protection (PADEP) and/or the NJDEP. To avoid damage, the blasting contractor will conduct appropriate pre-blasting geotechnical investigations, where needed, and develop specific blasting operations and monitoring plans to address site variables, such as location, terrain, soil and rock types, type of explosives, charge weight and configuration, depth of charge, spacing between charges, simultaneous detonation or microsecond delays, horizontal and slant distance to the nearest structure, and placement of blasting mats over the area. Seismic control of blasting will limit stresses on existing pipelines, nearby domestic structures, water supply wells, or electrical transmission tower footings that are located near the Project area.

Specific measures for avoiding or minimizing potential impacts as listed in the draft Blasting Plan include the following:

- Pre and post-blast surveys of water supply wells within 150 feet of the blasting area;
- Pre- and post-blast condition surveys on nearby structures or utilities;

- Use of warning signs, site access control, and audible warning signals before and after a blast;
- Procedures for safe blasting materials handling, storage, and use;
- Performance of blasting in accordance with applicable guidelines and regulations;
- Location of buried utilities in the work area;
- Seismograph vibration monitoring during blasting to assess vibrations generated by a blast;
- Optimization of blast charge size and delay timing to minimize vibration; and
- Use of matting to contain the potential for airborne debris.

If evidence of damage to structures or utilities is detected after blasting, repairs will be made to restore the structure or utility to pre-blast conditions, including repair or replacement of water supply wells.

Transco does not anticipate blasting will be required within 100 feet of residences. Transco's typical construction blasting specifications contain mitigation procedures for residential areas within proximity to projects and will be incorporated into Transco's contract with the construction contractor. In the event that blasting is required in unanticipated areas, Transco's construction contractor is required to retain a state-licensed blasting specialist to design and implement site-specific addenda to the blasting plan.

Rock and rock debris produced by blasting (and other excavation activities) will not be windrowed along the ROW unless permission is secured from the landowner or land managing agency. Disposal of rock debris will be in an appropriate area on or off the ROW approved by the individual landowners and in accordance with Transco's *Plan and Procedures* (adapted from the FERC Plan and Procedures; Appendix 7B and 2E, respectively) and applicable regulatory requirements.

6.4 MINERAL RESOURCES

An assessment of mineral resources within approximately 0.25 miles of the construction ROW was conducted using USGS topographic maps and publicly available mineral resource information. Historical mining operations were conducted for coal, copper, graphite, limonite, magnetite, and manganese in Pennsylvania and New Jersey. No abandoned mines are located in Monroe County, Pennsylvania. Abandoned coal mines are located in Lycoming County, Pennsylvania. Abandoned copper mines are located in Essex County, New Jersey. Abandoned copper, graphite, limonite, magnetite, iron, and manganese mines are located in

Hunterdon County, New Jersey. However, none of the proposed Project facilities cross former underground mines or tailings (NJGS 1994; PASDA 2008).

Active mines and mineral processing plants located in the Project vicinity include crushed stone, sand, gravel, silica, peat, iron oxide pigments, common clay and shale, and sulfur.

6.4.1 Pennsylvania

No mining operations are located within 0.25 miles of the proposed pipeline and aboveground facilities in Pennsylvania. Oil and gas fields historically have been concentrated in the western half of Pennsylvania. However, recent advances in drilling techniques have allowed for economically feasible extraction of natural gas from gas-rich shales, which are plentiful in Pennsylvania. Drilling activity for extraction of natural gas from the Marcellus Shale formation has increased over the past two years in Pennsylvania. Based on the most current data, the nearest gas wells to the NSL Project area are located in Clinton County, approximately 0.5 miles from the Leidy Interchange Hub, and in Lycoming County, approximately 2 miles west of the proposed Muncy Loop (PADEP 2011). Based on the separation distance, none of these wells would affect, or be affected by, construction activities associated with the Leidy Interchange Hub and Muncy Loop. Furthermore, the Project will not prevent access to any subterraneous gas resources.

Historical mining operations were conducted for coal, copper, graphite, limonite, magnetite, and manganese in Pennsylvania. Abandoned coal mines are located in Lycoming County, Pennsylvania. However, the Muncy Loop does not cross former underground mines or tailings. No abandoned mines are located in Monroe County, Pennsylvania (PASDA 2008).

6.4.2 New Jersey

No mining operations are located within 0.25 miles of the proposed pipeline and aboveground facilities in New Jersey. The Marcellus Shale formation does not extend into New Jersey, so there is no conflict with natural gas extraction (EIA 2010). New Jersey has no fossil fuel reserves (EIA 2010).

Historical mining operations were conducted for coal, copper, graphite, limonite, magnetite, and manganese in New Jersey. Abandoned copper mines are located in Essex County, New Jersey. Abandoned copper, graphite, limonite, magnetite, iron, and manganese mines are located in Hunterdon County, New Jersey. However, none of the Project facilities in New Jersey cross former underground mines or tailings (NJGS 1994).

6.4.3 Impacts and Mitigation

Based on the information available at the time of this report, no mine or oil and gas field hazards have been identified for the NSL Project area. Therefore, mine and oil and gas hazard mitigation for the Project is not necessary.

6.5 GEOLOGIC HAZARDS

Geologic hazards are conditions or phenomena that present a risk or are potentially dangerous to life and/or property, and are either naturally occurring or man-made (AGI 1984). Geologic hazards of potential concern in the Project area include earthquakes, faults, soil liquefaction, landslide susceptibility, and karst topography. All geologic hazards identified along the proposed pipeline loops and replacement are presented in Table 6.5-1.

Table 6.5-1
Potential Geologic Hazards for the NSL Project

Facility	Mileposts (MP)	Approximate Percent of Facility Area	Hazard
Muncy Loop	129.96 to 131.19	90	Geologic conditions present for potential sinkholes (karst terrain)
	Entire Loop	100	Moderate landslide incidence (1.5 to 15 percent of the area is involved in landsliding)
	Entire loop	100	Seismic potential / peak horizontal acceleration (1 to 2 percent g) with 10 percent probability of exceedance in 50 years
Palmerton Loop	41.47 to 43.67	70	Geologic conditions present for potential sinkholes (karst terrain)
	Entire Loop	100	High susceptibility to landsliding and moderate incidence
	Entire loop	100	Seismic potential / peak horizontal acceleration (3 to 4 percent g) with 10 percent probability of exceedance in 50 years
Stanton Loop	13.13 to 13.54	5	Geologic conditions present for potential sinkholes (karst terrain)
	Entire Loop	100	Low landslide incidence (less than 1.5 percent of the area is involved in landsliding)
	Entire Loop	100	Seismic potential/peak horizontal acceleration (4 to 5 percent g) with 10 percent probability of exceedance in 50 years
Caldwell B Replacement	Entire Replacement	100	Moderate susceptibility to landsliding and low incidence
	Entire Replacement	100	Seismic potential / peak horizontal acceleration (5 to 6 percent g) with 10 percent probability of exceedance in 50 years

Sources:
USGS Open-File Report 2004-1352, 1984; ESRI 2010 (Karst Areas).
USGS Open-File Report Issue Identification: 97-289, 2001; ESRI 2010 (Regional Landslide Incidence and Susceptibility).
USGS 2002; ESRI 2010 (Regional Seismic Zones).

6.5.1 Seismic Hazards

The majority of earthquakes occur along boundaries of tectonic plates. Eastern North America (including Pennsylvania and New Jersey) is far from the nearest plate boundary, the Mid-Atlantic Ridge, some 2,000 miles to the east. Nevertheless, the eastern United States does experience a moderate level of earthquake activity (Sharnburger 2003).

Earthquake intensity is a measure of the extent to which man-made structures are damaged by a seismic event and generally depends on distance from the epicenter of that event. The Modified Mercalli Intensity Scale ranges from an earthquake intensity value of I, in which the earthquake is not felt, to a maximum intensity value of XII, in which damage is nearly total, large rock masses are displaced, and objects are thrown into the air (Cargo and Mallory 1977).

In general, the proposed Project area is located in a region of the United States where a low to moderate earthquake hazard may be expected as shown on the United States Geological Survey national seismic-hazard map (USGS 2003). Intensity V or greater earthquakes have been reported in Pennsylvania in 1884, 1889, 1908, 1934, 1938, 1954, 1961, 1964, 1968, and 1972. In New Jersey earthquakes of intensity V or higher have been reported in 1895, 1921, 1927, 1933, 1938, 1939, 1957, 1961, 1968, and 1973 (USGS 2009). The largest earthquake in New Jersey occurred June 1, 1927, and was intensity VII (USGS 2009). In New York earthquakes of intensity V or higher have been reported in 1737, 1857, 1877, 1884, 1897, 1925, 1929, 1931, 1944, and 1966 (USGS 2009).

The USGS-National Earthquake Hazard Reduction Program has developed a series of maps that depict the estimated probability that certain levels of ground shaking from an earthquake will occur within a given area over a period of time. To make such estimations, USGS takes into account the past seismic history of an area and the expected decrease in intensity relative to the distance from the epicenter. These maps are used to create and update design provisions of building codes in the United States. The codes provide design standards for buildings, bridges, highways, and utilities, such as natural gas pipelines. Values on these seismic hazard maps are called peak acceleration values and are expressed as a percentage of gravitational acceleration (acceleration of a falling object due to gravity); the higher the value, the greater the potential hazard.

6.5.1.1 Pennsylvania

Historically, seismic events in Pennsylvania are generally concentrated in the southeastern portion of the state, specifically Berks, Lehigh, and Lancaster counties (USGS 2005b). The proposed Muncy Loop is not located near any known fault locations. The peak acceleration in the proposed Muncy Loop area is not expected to be more than 1 to 2 percent of gravity, with a 10 percent chance of being exceeded in 50 years based on USGS mapping.

The proposed Palmerton Loop crosses an approximate fault location near MP 41.75 at longitude -75°20′30″, latitude 40°51′48″ (name unknown). An approximate fault location is determined on the best information available. However, specific fault features have not been identified at the mapped location. The closest known fault locations are located 1.25 miles west (longitude -75°22′22 ″, latitude 40°52′07″; name unknown) and approximately 1 mile south (longitude -75°19′38 ″, latitude 40°50′52″; name unknown) of the Palmerton Loop. Known fault locations are based on specific fault features at the mapped location. No information could be found to determine if these faults have been active in the recent geologic past or whether they resulted in ground surface displacement. The peak acceleration in the proposed Palmerton Loop area is not expected to be more than 3 to 4 percent of gravity, with a 10 percent chance of being exceeded in 50 years based on USGS mapping. At 3 to 4 percent gravity, the perceived shaking would be moderate and there would be very light potential damage.

No faults are located near Compressor Station 515 or Leidy Interchange Hub.

Based on the above information, the seismic activity in the area of the Pennsylvania Project facilities is not considered substantial; therefore, the potential seismic risk to construction or operation of the Muncy Loop, Palmerton Loop, and aboveground facilities is considered low.

6.5.1.2 New Jersey

Seismic events in New Jersey are generally concentrated in the far northeastern portion of the state and are of low intensity. The proposed Stanton Loop crosses the Flemington Fault, which is part of the Ramapo Fault system. The most recent earthquake activity of the Ramapo Fault system was in February 2009 with a magnitude of 3.0, which is considered a minor earthquake (NJGS 2011). An unknown amount of strike/dip displacement may have occurred on the Flemington Fault. The peak acceleration in the proposed Stanton Loop area is not expected to be more than 4 to 5 percent of gravity, with a 10 percent chance of being exceeded in 50 years based on USGS mapping. At 4 to 5 percent gravity, the perceived shaking would be moderate and there would be very light potential damage.

The Caldwell B Replacement does not cross any known fault locations. The nearest known faults are located approximately 2.75 miles northwest of the Caldwell B Replacement location. The peak acceleration in the Caldwell B Replacement area is not expected to be more than 5 to 6 percent of gravity, with a 10 percent chance of being exceeded in 50 years based on USGS mapping. At 5 to 6 percent gravity, the perceived shaking would be moderate and there would be very light potential damage.

No faults are located near the proposed Compressor Station 303 and Electrical Substation, or Compressor Station 505.

Based on the above information, the seismic activity in the area of the New Jersey Project facilities and proposed new compressor station is not considered substantial; therefore, the potential seismic risk to construction or operation of the Stanton Loop, Caldwell B Replacement, Compressor Station 303, Electrical Substation, and Compressor 505 is considered low.

6.5.2 Soil Liquefaction

Soil liquefaction is a phenomenon that occurs when the strength and stiffness of a soil is reduced causing the soil to "flow" like a liquid and is commonly associated with strong earthquakes. As discussed in Section 6.5.1, the potential for severe seismic ground acceleration (large earthquakes) is considered low for the entire Project area; therefore, the potential for soil liquefaction is considered to be a low risk.

6.5.3 Landslides

A landslide, a form of ground failure, involves the down-slope movement of earth materials under the force of gravity due to natural or artificial causes. Table 6.5-2 provides a summary of landslide prone areas along the proposed pipeline facilities.

Table 6.5-2
Landslide Prone Areas along NSL Project Pipeline Facilities

Pipeline Facility	Landslide Incidence and Susceptibility	Milepost Affected
Muncy Loop	Low landslide incidence (less than 1.5% of the area is involved in landsliding) to moderate landsliding incidence (1.5 to 15% of the area is involved in landsliding)	Entire Loop in Lycoming County
Palmerton Loop	High susceptibility to landsliding and moderate incidence	Entire Loop in Monroe County
Stanton Loop	Low landslide incidence (less than 1.5% of the area is involved in landsliding)	Entire Loop in Hunterdon County
Caldwell B Replacement	Moderate susceptibility to landsliding and low incidence	Entire replacement in Essex County
Source: USGS Open-File Report Issue Identification: 97-289, 2001; ESRI 2010.		

6.5.3.1 Pennsylvania

Pennsylvania has a long history of significant landslide activity. This has resulted from a combination of humid temperature climate, locally steep and rugged topography, and great diversity in the erosion and weathering characteristics of relatively near surface sedimentary rocks. Landslides have occurred in many parts of Pennsylvania but are most abundant in much of the Appalachian Plateaus physiographic province of western and north-central Pennsylvania (PGS and Pittsburgh Geological Survey 1999). No specific historic landslide information is available for Lycoming County or Monroe County in Pennsylvania. However, no evidence of past landslide activity was apparent during environmental field surveys conducted along the pipeline ROWs.

The southern portion of Lycoming County, Pennsylvania, in which the Muncy Loop is located, contains folded sedimentary rocks and colluvial soil on slopes. Types of landslides in this area include rock slides, debris slides, and debris avalanches; with slumps on lower slopes and stream banks (PDCNR 2001). The Muncy Loop is located in an area considered to have low landslide incidence (less than 1.5% of the area is involved in landsliding) to moderate landslide incidence (1.5 to 15% of the area is involved in landsliding).

The southern half of Monroe County, Pennsylvania, in which the Palmerton Loop is located, contains folded sedimentary rocks and colluvial soil on slopes. Types of landslides in this area include rock slides, debris slides, and debris avalanches; with slumps on lower slopes and stream banks (PDCNR 2001). The Palmerton Loop is located in an area considered to be highly susceptible to landslides and moderate incidence.

6.5.3.2 New Jersey

In the state of New Jersey, landslides have occurred in the northern and central part of the state and include slumps, debris flows, rockfalls, and rockslides. Although landslides are not as common in New Jersey as in other areas of the United States, they are a geologic hazard in areas with steep to moderate slopes or geologic units prone to failure. The landslides are caused by heavy rains, weathering, ocean waves, quarrying and construction activities (NJGS 2010).

Types of landslides in Hunterdon County, in which the Stanton Loop is located, include rock fall, rock slides, and debris flow (NJGS 2009). The Stanton Loop is located in an area considered to have low landslide incidence (less than 1.5% of the area is involved in landsliding). There have been two historical landslides (rock slide and debris flow) located approximately 2.5 and 2 miles north, respectively, of the Stanton Loop (NJDEP 2011). Project facilities in New Jersey do not cross any historic landslides (NJDEP 2011).

Types of landslides in Essex County, in which the Caldwell B Replacement is located, include rock fall and debris flow (NJGS 2009). The Caldwell B Replacement is located in an area with moderate susceptibility to landsliding and low incidence. There have been four historical landslides (rockfall and debris flow) located east/southeast approximately 3 to 3.5 miles of the proposed Caldwell B Replacement (NJDEP 2011). No historic landslides have occurred at the Caldwell B Replacement area (NJDEP 2011).

6.5.4 Karst Topography/Ground Subsidence (Sinkhole)

Karst topography is created from the dissolution of soluble rocks, principally limestone and dolomite. Generally, karst forms by the movement of water through rocks containing 50 percent or more carbonate minerals. Karst is characterized by closed depressions (i.e., sinkholes), caves, cave systems, and underground drainage. As described below, each of the proposed pipeline loops intersects geologic formations in which karst terrain typically occurs.

Based on review of a USGS national-scale database, it appears that karst terrain could exist in the Project area. Specifically, the mapped extent of karst terrain appears to overlap with the Muncy Loop and Palmerton Loop, with a small area near the Stanton Loop. No karst areas are located in proximity to the Caldwell B Replacement or any of the aboveground facilities, so the potential for sinkhole development in these areas is low.

Although karst terrain could exist along the Palmerton and Muncy Loops, review of the Pennsylvania Department of Conservation and Natural Resources (PDCNR) sinkhole inventory data indicates no occurrences of sinkholes in Lycoming or Monroe counties, where the Muncy Loop and Palmerton Loop are located, respectively (PDCNR 2007). New Jersey does not maintain a database of historic sinkholes, so similar information for the Stanton Loop is not available.

Karst is known to occur primarily in association with limestone and dolomite formations. Review of bedrock formations crossed by the pipeline facilities indicates that the Muncy Loop crosses siltstone and shale, which would minimize the likelihood of karst terrain. The Palmerton Loop crosses sandstone, siltstone, shale, black shale, calcareous sandstone, and siliceous sandstone. However, some of the secondary lithology for the Palmerton Loop does contain limestone. The Stanton Loop crosses shale, sandstone, siltstone, quartz-pebble conglomerate, dolomite, quartzite, and limestone. Previous Transco pipeline construction and maintenance in the area of the pipeline loops have not encountered karst terrain. Consequently, the hazard associated with karst terrain along the loops is considered minimal.

6.6 DESIGN, CONSTRUCTION, AND MITIGATION

Natural gas pipelines are designed and installed in accordance with federal regulations, as presented in 49 Code of Federal Regulations (CFR) Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards. Every pipeline is designed and constructed to provide adequate protection from washouts, floods, unstable soils, landslides, or other hazards that may cause the pipe to move or to sustain abnormal loads. Standards presented in these regulations are normally adequate to avoid or minimize issues related to geologic hazards. No areas requiring special design or construction considerations as a result of geological hazards have been identified for any component of the Project.

6.6.1 Seismic Hazards

Transco has not identified specific problems associated with seismic hazards in the vicinity of its existing pipelines in the region since they were originally constructed in the 1950s and does not expect new problems along the pipeline loops proposed for this Project. The intensity, frequency, and duration of potential impacts resulting from the potential hazard of minor earthquakes are anticipated to be minor, given the geographic location. Well-maintained pipelines constructed using modern arc-welding techniques have performed well in seismically active areas of the United States (O'Rourke and Palmer 1996). Consequently, only large, abrupt ground displacements have caused serious impacts on those facilities. Due to the limited potential for large, seismically induced ground movements in the Project area (USGS 1996), there is only minimal risk of earthquake-related impacts on the proposed facilities. Consequently, no special design or construction mitigation measures to address seismic hazards are planned for the proposed pipeline facilities.

6.6.2 Soil Liquefaction

The potential for severe seismic ground acceleration (large earthquakes) is considered low for the entire Project area; therefore, the potential for soil liquefaction is not considered a significant hazard in the vicinity of the proposed Project and no special design or construction mitigation measures are planned to address this hazard.

6.6.3 Landslides

The Project component most susceptible to landslides is the proposed Palmerton Loop, which has a high susceptibility to landsliding and moderate incidence. Transco has not encountered landslide activity along the existing pipeline ROW in this area, or in the areas of the other proposed pipeline loops. Therefore, Transco estimates a low potential for landslide occurrence for the proposed pipeline facilities. In addition, construction techniques described in Transco's Project-specific Plan and Procedures and Project-specific Erosion and Sediment Control Plan (E&SCP) will minimize the potential for slope failure and erosion. As specified in Transco's Plan (see Appendix 7B), permanent trench breakers and permanent slope breakers will be installed in areas of steep slopes. Trench breakers are designed to prevent preferential water flow along the pipeline trench by diverting subsurface water flow to the land surface. Groundwater discharging at the land surface is then redirected off the ROW by the slope breakers. Used in combination, these structures prevent subsurface piping of soils that can lead to slope instability and failure.

6.6.4 Karst Topography/Ground Subsidence

As described in Section 6.5.4, there is the potential to encounter karst terrain on the Muncy, Palmerton, and Stanton loops. However, based a detailed review of local geology and previous pipeline construction in the immediate area, the likelihood of encountering karst terrain is minimal. The following construction measures will mitigate the potential for surface water to infiltrate into subsoils exposed during open-cut trench construction and cause sinkholes that could impact groundwater and other resources.

- During construction Transco will install surface water diversion berms adjacent to the pipeline trench to divert surface water run-off away from the trench toward an appropriate discharge point.
- Transco will limit the potential for direct precipitation to pond within open trenches by minimizing the dimensions of the trench and duration of construction.
- Backfilling will be controlled to restore surface water infiltration characteristics of soils to the extent possible. During backfilling, the compacted backfill surface will be crowned and sealed to compensate for slumping, prevent channeling down the backfilled pipe ditch, and restore contours (after settling) for surface water run-off.
- Final grading and contouring of the ROW will restore appropriate run-off.
- Disturbed areas will be restored with vegetation.

During operation, routine ROW monitoring inspections will be completed as described in RR 1, “General Project Description.” This monitoring will include visual ground surface inspection to confirm there are no new karst-related surface features which potentially could impact pipeline operations.

6.7 PALEONTOLOGY

Due to the age and depositional environments of the geologic units in and around the Project area, there is the potential to uncover rare or unique fossils.

6.7.1 Pennsylvania

Communication with a Pennsylvania Department of Conservation and Natural Resources Bureau of Topographic and Geological Survey Senior Geologist indicated that there are no known significant paleontological resources in the bedrock beneath the proposed Project area (Kochanov 2011). The probability of encountering any significant paleontological resources is low and only common fossils would be expected. Rare amphibian and reptile bones have been found in Clinton County (west of Lycoming County), where the proposed modification to the aboveground Leidy Interchange Hub is located. The town of Leidy is underlain by the fossiliferous Lock Haven Formation. While most of the invertebrate fossils in this formation would be considered fairly generic, there is still a possibility of uncovering a rare species or unique locality. Preserved Holoptychius (fish) spines were found in abundance near the town of Laporte in Sullivan County (east of Lycoming County) (Kochanov 2011).

The proposed Muncy Loop will be located in Wolf and Penn townships in Lycoming County, which contain fossils within the Catskill Formation which are typically plants and the bony plates, spines, and teeth of a variety of fish.

The proposed Palmerton Loop will be located in Ross Township in Monroe County, which contains generic invertebrate fossils associated with the Devonian Mahantango Formation; no rare/unique fossils are expected to be encountered (Kochanov 2011).

6.7.2 New Jersey

Communication with the New Jersey State Museum's Curator of Natural History indicated that some rare finds may be present near the proposed Project area (Parris 2011).

The proposed Stanton Loop will be located in Hunterdon County in Clinton, Franklin and Union townships. Much of Hunterdon County is underlain by Piedmont rocks of Triassic Age and the New Jersey State Museum's Curator of Natural History requested that any excavations should be monitored by Transco for possible new discoveries (all vertebrate fossils are generally considered to be rarities). The Jutland Klippe, which is a remarkable Ordovician structural outlier, has produced graptolite fossils of very great interest, primarily in Union Township, Hunterdon County. The New Jersey State Museum and the New Jersey Geological Survey have conducted recent research on the Jutland Klippe, and any new localities there would be considered very important finds.

The proposed Caldwell B Replacement will be located in the Borough of Roseland in Essex County which contains many dinosaur tracks which have been found in rocks of Triassic age (Parris 2011).

The aboveground facilities are located in Essex County, Passaic County, and Bergen County, New Jersey. No paleontological discoveries specific to these municipalities have been documented (Parris 2011). Therefore, the probability of encountering any significant paleontological resources is low and only common fossils would be expected in these areas.

6.7.3 Impacts and Mitigation

Geologic units crossed by the pipeline in Pennsylvania and New Jersey contain fossil materials. Paleontological occurrences are not predictable. Based on the estimated depth of disturbance, the proposed pipeline construction activity is not anticipated to disturb paleontological resources in Pennsylvania or New Jersey. However, Transco will include in the operating procedures for their environmental inspectors a requirement to notify the Pennsylvania Geological Survey or New Jersey State Museum of paleontological materials or fossil materials encountered during trenching operations.

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TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC

Resource Report No. 6
Geologic Resources and Hazards

Transcontinental Gas Pipe Line Company
Northeast Supply Link Project

APPENDICES

December 2011

Appendix 6A

Agency Correspondence

From: Parris, David [David.Parris@sos.state.nj.us]
Sent: Wednesday, April 13, 2011 10:50 AM
To: Werth, Marcy
Cc: 'Richard Dalton'; David C. Parris
Subject: RE: Question regarding paleontological resources

The Roseland area is an area where many Dinosaur tracks have been found in rocks of Triassic Age. Much of Hunterdon County is underlain by Piedmont rocks of Triassic Age also, and any excavations should be monitored for possible new discoveries. (All vertebrate fossils are generally considered to be rarities.)

The Jutland Klippe, which is a remarkable Ordovician structural outlier, has produced graptolite fossils of very great interest, primarily in Union Township, Hunterdon County. Much of the recent research on this subject has been performed by the New Jersey State Museum and the New Jersey Geological Survey, and any new localities there would be very important finds.

I will be pleased to provide more details and copies of publications regarding these paleontological resources.

David C. Parris
Curator of Natural History
New Jersey State Museum

From: Werth, Marcy [mailto:MWerth@ene.com]
Sent: Tuesday, April 12, 2011 12:02 PM
To: Parris, David
Subject: Question regarding paleontological resources

Would there be any known significant paleontological resources in the bedrock in Hunterdon County (Clinton, Franklin and Union municipalities) or Essex County (Roseland municipality)? Trying to determine the probability of encountering any significant paleontological resources (rare or unique fossils) in those areas other than common fossils. I'm doing research for possible construction in those areas.

Thank you.

Marcy Werth
Ecology and Environment, Inc.
368 Pleasant View Drive, Lancaster, NY 14086
Phone: 716-684-8060 Ext: 2626 | Fax: 716-684-0844
mwerth@ene.com | www.ene.com

Celebrating 40 Years of Green Solutions

From: Don Monteverde [Don.Monteverde@dep.state.nj.us]
Sent: Tuesday, April 19, 2011 12:06 PM
To: Werth, Marcy
Cc: Suhas Ghatge
Subject: Paleontology Hunterdon County, NJ
Dear Ms. Werth,

Your request has filtered down to me. The three townships that you mentioned in your re quest are covered by metamorphic units of Proterozoic age which are devoid of fossils as well as various sedimentary rocks of lower Paleozic and Mesozoic age. Paleozoic sediments rarely have fossils. Those that are known from the area are graptolites and conodonts. Graptolites are present in some shales while the conodonts are microfossils that occur in carbonate and limited sandstone units. Neither group would I consider "significant for the collector but are very useful in age determinations for people studying the geologic history of the region. Mesozoic sediments which cover the largest are within the three municipalities rarely have fossils to the best of my knowledge. There is the potential for some dinosaur tracks as they have been found in similar aged units elsewhere but I do not know of any examples in your requested region. Other fossils might include plant remains but those to are few and far between. I don't know of any localities in your region off hand.

I hope this answers your question. If you have any further questions please feel free to contact me.

Regards,
Don

Don Monteverde
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New Jersey Geological Survey
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>>> "Werth, Marcy" <MWerth@ene.com> 04/11/2011 4:36 PM >>>
Are there any known significant paleontological resources in the bedrock in Hunterdon County (Clinton, Franklin and Union municipalities)? Just checking to see if the probability of encountering any significant paleontological resources is very low and only common fossils would be expected in those areas.

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From: Kochanov, William [wkochanov@state.pa.us]
Sent: Tuesday, April 12, 2011 11:24 AM
To: Werth, Marcy
Subject: RE: Feedback Form Response

There is always the chance in finding rare or unique fossils associated with a particular stratigraphic unit. In general, the probability is rather low. I am not aware of any unique fossils in the broad areas you have defined.

1. Ross Township, Monroe County; generic invertebrate fossils associated with the Devonian Mahantango Formation; no rare/unique fossils 2. Wolf and Penn Townships, Lycoming County; fossils within the Catskill Formation are typically plants and the bony plates, spines, teeth of a variety of fish; rare amphibian and reptile bones have been found in Clinton County; preserved Holoptychius (fish) spines were found in abundance near the town of Laporte, Sullivan County.

Bill K.

William E. Kochanov|Senior Geologist
PA Department of Conservation and Natural Resources Bueau of Topographic and Geological Survey 3240 Schoolhouse Road|Middletown, PA 17057-3534
Phone: 717.702.2033|Fax: 717.702.2065
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www.dcnr.state.pa.us/topogeo
Hours: M-F, 8:00-4:00

-----Original Message-----
From: Werth, Marcy [mailto:MWerth@ene.com]
Sent: Tuesday, April 12, 2011 8:40 AM
To: Kochanov, William
Subject: RE: Feedback Form Response

I'm just interested to find out if there are any rare or unique fossils in that area. Doing research for possible construction.

-----Original Message-----
From: Kochanov, William [mailto:wkochanov@state.pa.us]
Sent: Tuesday, April 12, 2011 8:23 AM
To: Werth, Marcy
Subject: RE: Feedback Form Response

Marcy,

There are a number of fossil localities in these counties. Are you requesting information on the presence of unique fossils or are you requesting information on fossil collecting localities of a more generic nature?

Sincerely,

Bill K.

William E. Kochanov|Senior Geologist
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Hours: M-F, 8:00-4:00

-----Original Message-----
From: mwerth@ene.com [mailto:mwerth@ene.com]
Sent: Monday, April 11, 2011 4:15 PM
To: Kochanov, William
Subject: Feedback Form Response

Would there be any known significant paleontological resources in the bedrock in Lycoming County (Wolf and Penn municipalities) or Monroe County (Ross municipality)? Trying to deterimine the probability of encountering any significant paleontological resources in those areas other than common fossils that would be expected.

Marcy Werth

From: Kochanov, William <wkochanov@pa.gov>
To: Werth, Marcy
Sent: Mon Oct 17 10:15:50 2011
Subject: RE: Question regarding paleontological resources

Marcy,

Town not township... okay. The town of Leidy is underlain by the fossiliferous Lock Haven Formation. The odds favor finding invertebrate fossils that are fairly generic in scope. However, one cannot rule out the possibility of uncovering a rare species or unique locality such as the Red Hill locality near Renovo.

Bill K.

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From: Parris, David <David.Parris@sos.state.nj.us>
To: Werth, Marcy
Sent: Mon Oct 17 13:19:11 2011
Subject: RE: Question regarding paleontological resources

I don't know of any discoveries specific to those municipalities. The old Dell Quarry in Clifton/Woodland Park (=West Paterson) is a major locality for dinosaur tracks, and is now the Four Seasons of Great Notch (Hovnanian); it is very close to Little Falls. We have many specimens from that site.
Let me know if I can be of further help.

DCP

From: Werth, Marcy [mailto:MWerth@ene.com]
Sent: Wednesday, October 12, 2011 1:14 PM
To: Parris, David
Subject: Question regarding paleontological resources

Hi David,

I spoke with you back in April and you helped me find out if there were significant paleontological resources (rare or unique) other than common fossils in specific areas. I need help answering the same question for the following areas:

Essex County, NJ (North Caldwell)
Passaic County, NJ (Little Falls)
Bergen County, NJ (Carlstadt and Ridgefield)

I just need to know if there are any rare or unique fossils that could be found in these areas in case we proceed with construction. If there are some that exist, could you tell me what they are and the general location where they are located? If possible, I will need an answer before Oct 18th.

Thank you.

Marcy Werth
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Appendix 6B

Blasting Plan

Transcontinental Gas Pipe Line Company, LLC

Northeast Supply Link

Draft Blasting Plan

December 2011

Table of Contents

INTRODUCTION

Transcontinental Gas Pipe Line Company, LLC (Transco) proposes to construct and operate the Northeast Supply Link (NSL) Project (Project) in order to provide an additional 150,000 dekatherms per day (dt/day) of firm incremental transportation service from various receipt points on Transco's Leidy Line in Pennsylvania to various delivery points along Transco's Mainline and Leidy systems in Pennsylvania, New Jersey, and New York. The facilities required to provide this service include approximately 12 miles of 42-inch diameter pipeline looping extension, 27 miles of pipeline uprate, 0.4 miles of pipeline replacement, construction of a new compressor station, and modification of various aboveground facilities. Construction would begin in November 2012 with facilities in service by November 1, 2013.

Shallow bedrock is anticipated to be encountered near the Muncy Loop, Palmerton Loop, and Stanton Loop. The shallowest depth to bedrock is approximately 10 to 20 inches below ground surface (bgs) along the Muncy Loop, approximately 20 to 40 inches bgs along the Palmerton Loop, and approximately 10 to 20 inches bgs along the Stanton Loop. However, based on existing information about subsurface geologic formations present along the Project construction area and other recent construction experience in the vicinity of these loops, the lithologic units associated with these loops are generally softer and can be ripped with construction equipment. For these reasons, Transco does not anticipate blasting will be required along these loops. However, if conditions are encountered that warrant the use of controlled blasting, the appropriate permits and regulatory requirements will be met prior to blasting.

The purpose of this draft Blasting Plan is to provide guidelines for the safe use and storage of blasting materials on the Project in the event that bedrock is encountered and blasting is required. The draft Blasting Plan is intended to ensure safety of personnel and nearby facilities. **A site-specific blasting plan will be prepared prior to any blasting.**

GENERAL

Blasting-related operations including obtaining, transporting, storing, handling, loading, detonating, and disposing of blasting material, drilling, and ground-motion monitoring shall comply with applicable federal, state, and local regulations, permit conditions and the construction Contract.

Blasting for grade or trench excavation will be utilized only after all other reasonable means of excavation have been used and are unsuccessful in achieving the required results. Transco's construction contractor will be required to demonstrate that blasting is required by attempting to rip a test section (20 to 50 feet long) with a D-9 dozer (with ripper). Transco reserves the right to not require the D-9 test; such testing may be eliminated based on Transco's review of conditions. Transco may specify locations (e.g., foreign line crossings and near-by structures) where consolidated rock shall be removed by approved mechanical equipment, such as rock-trenching machines, rock saws, hydraulic rams, or jack hammers, in lieu of blasting.

Before blasting, a site-specific blasting plan will be developed. No blasting will commence until Transco's Project Engineer has analyzed the data to determine the combined stress level of each affected pipeline and will make recommendations and/or forward approval to Transco before blasting commences.

Full-scale blast tests on representative sections of rock may be conducted to prevent the need for Engineering approval prior to every blast. Blast tests would confirm that peak-particle velocities are below maximum permissible levels for a given charge per hole, hole pattern, distance from the existing mainline, and rock conditions. If any of these variables change, either new test results will be conducted or engineering calculations will be performed before blasting occurs. Transco will provide a geologist to inspect the rock and determine if previous blast tests are applicable to the proposed blasts. Transco will attempt to get long sections approved in advance by the Transco geologist. Seismograph equipment would be used to determine the peak particle velocity at the pipe (excavate to depth and record adjacent to the existing mainline) during testing. If full-scale blast tests are conducted, a complete blasting plan will be developed and approved by Transco prior to conducting tests.

Before any blasting (regardless of testing), a complete WGP-0142 (Pre-Blasting Data Sheet Form) will be reviewed by Transco. Transco will compare the completed form to full-scale tests, if completed. If there are any differences (e.g., in geology, shot pattern, and distance from the mainline), Transco will require that either: 1) new tests be conducted, or 2) calculations be performed by Transco's Project Engineer.

If no blast tests are completed, Transco will confirm that expected stresses are acceptable prior to any blasting. Seismograph equipment will be used on every blast until Transco states it is not necessary (based on similarity of rock and other conditions with previously successful blasts). Continued use of the seismograph equipment will be at Transco's discretion.

Drilling and blasting will be performed in the presence of a Transco inspector. Transco's inspector's approval is required to proceed prior to each blast.

When blasting near other in-service pipelines and other underground facilities, the requirements of the third-party operating company take precedence over Transco requirements, if third-party limitations are more strict (specifically, peak-particle velocity limits).

QUALIFICATIONS OF BLASTING CONTRACTOR

Blasting operations will be conducted by or under the direct and constant supervision of experienced personnel legally licensed and certified to perform such activity in the jurisdiction where blasting occurs.

PRE-BLASTING REQUIREMENTS

All necessary "one calls" will be placed 72 hours prior to construction or as required by one-call system(s). All property owners will be notified of impending construction before performing any right-of-way work related to blasting.

All required federal, state, and local permits relating to transportation, storage, handling, loading, and detonation of explosives will be acquired.

SITE-SPECIFIC BLASTING PLAN

The Site-Specific Blasting Plan will include the following:

- Explosive type, product name and size, weight per unit, and density;
- Delay type, sequence, and delay (ms);
- Initiation method (non-electric (shock tube) detonator is the only approved initiation system);
- Stemming material and tamping method;
- Hole depth, diameter, and pattern;
- Explosive depth, distribution, and maximum weight per delay;
- Number of holes per delay;
- Distance and orientation to nearest aboveground structure;
- Distance and orientation to nearest underground structure, including pipelines;

- Procedures for storing, handling, transporting, loading, and firing explosives, fire prevention, inspections after each blast, misfires, flyrock and noise prevention, stray current accidental-detonation prevention, signs and flagmen, warning signals prior to each blast, notification prior to blasting, and disposal of waste blasting material;
- Seismograph company, names, equipment and sensor location;
- Copies of all required federal, state, and local permits;
- Blaster's name, company, copy of license, and statement of qualifications;
- Magazine type and locations for explosives and detonating caps;
- Typical rock type and geology structure (solid, layered, or fractured);
- Pipeline location (MP and stationing); and
- Applicable alignment sheet numbers.

RESTRICTIONS ON BLASTING METHODS/TECHNIQUES (TO BE CONSIDERED WHEN DEVELOPING THE BLASTING PLAN)

- The blasting agent ammonium nitrate and fuel oil (ANFO) shall not be allowed;
- Emulsion-type explosives shall not be allowed;
- The frequency caused by the detonation of the explosive charge shall not drop below a frequency of 25 Hz;
- The minimum time delay between the detonation of charges shall not be less than 25 milliseconds; and
- There will be no more than one shot/delay

Neither electric blasting caps nor electric initiation systems will be used; only non-electric initiation systems are allowed.

MONITORING OF BLASTING

Seismograph equipment will be used to measure the peak particle velocity (PPV) of all blasts in vertical, horizontal, and longitudinal directions. Seismic monitoring will only be discontinued if: 1) the blasting schedule and blasting performance consistently produce PPVs at the pipeline that are lower than the maximum allowable limit; and 2) Transco's representative authorizes discontinuation.

The peak particle velocity will be measured at the adjacent pipeline; at any water wells, potable springs, and at any aboveground structure within 150 feet of the blasting.

The WGP Blasting Log Record (Form WGP 0143) will be completed immediately after each blast.

LIMITS ON PEAK PARTICLE VELOCITY

The peak particle velocity will not exceed 4 inches per second measured adjacent to an underground pipeline, unless Transco approves otherwise. The underground pipeline will be exposed, with measurement of peak particle velocity recorded and measured on the pipe.

For any aboveground structure (including water wells), the peak particle velocity will not exceed 2 inches per second.

For all aboveground facilities within 150 feet of the blasting, additional seismograph equipment will be used to determine the PPV at the aboveground facility. If the measured peak particle velocity at an existing pipeline or other structure exceeds the above limits, blasting activities will stop immediately and Transco will be notified. The Blasting Plan will be modified to reduce the peak particle velocity prior to any further blasting. Transco will inspect aboveground facilities within 25 feet before and after all blasting.

SAFETY

PROTECTION OF ABOVEGROUND AND UNDERGROUND STRUCTURES (RESIDENTIAL AREAS)

Control will be exercised to prevent damage to aboveground and underground structures including buildings, pipelines, utilities, springs, and water wells.

If blasting occurs within 150 feet of identified water well or potable springs, water flow performance and water quality testing will be conducted before blasting. If the water well is damaged, the well owner will either be compensated for damages or a new well will be provided.

If blasting occurs within 150 feet of any aboveground structures, the structures will be inspected before and after blasting. In the unlikely event that damage occurs to an aboveground structure, the owner will be compensated.

The size of charges will be limited in accordance with the scaled distance factor (SD) guidelines provided by the Office of Surface Mining Reclamation and Enforcement (OSMRE). For distances less than 300 feet, OSMRE states that the SD shall exceed 50. SD is equal to the distance from the blast to the aboveground structure divided by the square root of the charge (lb/delay). Listed below (for convenience) are limits on charges as a function of distance in accordance with OSMRE:

Distance from Blast to Structure, feet	Maximum Charge lb/delay
50	1.0
60	1.4
70	2.0
80	2.6
90	3.2
100	4.0
110	4.8
120	5.8
130	6.8
140	7.8
150	9.0

Blasting will not occur within 10 feet of existing pipelines unless authorized by Transco.

Holes will not be re-drilled which have contained explosive material. Holes will not be drilled where danger exists of intersecting another hole containing explosive material.

Blasting mats or padding will be used on all shots where necessary to prevent scattering of loose rock onto adjacent property and to prevent damage to nearby structures and overhead utilities.

Blasting will not begin until occupants of nearby buildings, stores, residences, places of business, places of public gathering, and farmers have been notified sufficiently in advance to protect personnel, property, and livestock. Occupants will be notified at least 72 hours prior to blasting.

Blasting in or near environmentally sensitive areas, such as streams and wildlife areas may include additional restrictions, which will be included in the site-specific blasting plans.

PROTECTION OF PERSONNEL

Only authorized, qualified, and experienced personnel will handle explosives.

Smoking, firearms, matches, open flames, and heat-and-spark-producing devices will be prohibited in or near explosive magazines or while explosives are being handled, transported, or used. No explosive material will be located where they may be exposed to flame, excessive heat, sparks, or impact.

A code of blasting signals will be established and posted in conspicuous places. Employees will learn and use this code.

Every reasonable precaution including, but not limited to, visual and audible warning signals, warning signs, flag person, and barricades will be used to ensure personnel safety.

Warning signs, with lettering a minimum of 4-inches in height on a contrasting background, will be erected and maintained at all approaches to the blast area.

Flaggers will be stationed on all roadways passing within 1,000 feet of the blast area to stop all traffic during blasting operations.

All personnel not involved in the actual detonation will stand back at least 1,000 feet and workers involved in the actual detonation will stand back at least 650 feet from the time the blast signal is given until the “ALL CLEAR” has been sounded.

An audible blasting signal (air horn or siren) will be sounded 5 minutes before and after each blast.

Blasting operations will be conducted during daylight hours.

No loaded holes will be left unattended or unprotected. No explosives will be abandoned. No loaded holes will be left overnight.

In the case of a misfire, the blaster will provide proper safeguards for personnel until the misfire has been re-blasted or safely removed.

All loading and blasting activity will cease and personnel in and around the blast area will retreat to a position of safety, during the approach and progress of an electrical storm irrespective of the type of explosives or initiation system used. This is a major safety precaution and will always be observed. All explosive materials and all non-electric initiation systems are susceptible to premature initiation by lightning.

No drilling will commence near a previous blast area until such blast area has been inspected to verify the absence of misfires. If a misfire occurs adjacent to a hole to be drilled, the misfire is cleared by the blaster using whatever techniques are called for by the situation prior to commencement of drilling. Should a misfire occur at some distance from the drilling area, drilling may be stopped while clearing preparations are underway. When the misfire is to be cleared by re-shooting, drilling will be shut down and personnel evacuated to a place of safety prior to detonation.

All transportation of explosives will be in accordance with applicable federal, state, and local laws and regulations. Any vehicle used to transport explosives will be in proper working condition and equipped with tight wooden or non-sparking metal floor and sides. If explosives are carried in an open-bodied truck, they will be covered with a waterproof and flame-resistant tarpaulin. Wiring will be fully insulated to prevent short-circuiting, and at least two fire extinguishers will be carried. The truck will be plainly marked as to its cargo so that the public may be adequately warned. Metal, flammable or corrosive substances will not be transported in the same vehicle with explosives. There will be no smoking, and unauthorized or unnecessary personnel will not be allowed in the vehicle. Loading and unloading of explosives will be done carefully by competent, qualified personnel.

Metallic slitters will be used to open fiberboard cases, provided the metallic slitter does not come in contact with the metallic fasteners of the case. There will be no smoking, no matches, no open lights, or other fire or flame nearby while handling or using explosives. Explosives will not be placed where they are subject to flame, excessive heat, sparks or impact. Partial cases or packages of explosives will be re-closed after use. No explosives will be carried in the pockets or clothing of personnel.

No blast will be fired without a positive signal from the person in charge. This person will have made certain that all surplus explosives are in a safe place; all persons, vehicles, and/or boats are at a safe distance; and adequate warning has been given. Adequate warning of a blast will consist of, but not be limited to, the following:

- Notification of day and time given to railroads, highway departments, city engineer, etc. Notification must be given at least 72 hours prior to blasting;
- Notification of homeowners nearby;
- Stopping vehicular and/or pedestrian traffic near the blast site;
- Signal given by an air horn, whistle or similar device using standard warning signals; and
- Only authorized and necessary personnel will be present where explosives are being handled or used.

The condition of the hole will be checked with a wooden tamping pole prior to loading. Surplus explosives will not be stacked near working areas during loading. Detonating fans will be cut from spool before loading the balance of charge into the hole. No explosives will be forced into a bore hole past an obstruction. Loading will be done by a blaster holding a valid license or by personnel under his direct supervision.

IN-WATER BLASTING

It is not anticipated that any underwater blasting will be required for the Project. However, in the event it is required, the following will be the minimum requirements for in-water blasting. The pipeline contractor will develop a detailed blast plan for in-water blasting. If in-water blasting is required, all applicable parts of non-water blasting will apply.

Blast holes will be held open by some device, such as wooden plugs, sleeves, casings extending above the water surface, or other suitable methods submitted to and approved by Transco. All holes to be shot at the same time will be loaded immediately prior to blasting. Loading will be by means of a non-sparking metal loading tube or similar device.

Explosives used under water will have water proof paper shells or otherwise be protected from the effects of water. The type of explosive, size of charges, and sequence of firing will be selected to minimize shock wave stresses on aquatic life adjacent to the blasting area. All appropriate resource agency notifications will be made.

STORAGE REQUIREMENTS

All explosives and initiation devices will be stored in locked magazines that have been located, constructed, approved, and licensed in accordance with local, state, and federal regulations. Magazines will be dry, well ventilated, reasonably cool (the exterior should be painted with a reflective color), bullet and fire-resistant, and kept clean.

Initiation devices will not be stored in the same box, container, or magazine with other explosives. Explosives and initiation devices will not be stored in wet or damp areas; near oil, gasoline, cleaning solvents; near sources of heat radiators, or steam pipes. No metal or metal tools will be stored in the magazine. There will be no smoking, matches, open lights, or other fire or flame inside or within 50 feet of storage magazines or explosive materials. The loading and unloading of explosive materials into or out of the magazine will be done in a business-like manner with no loitering, horseplay, or prank-playing.

Magazines will be kept locked at all times unless explosives are being delivered or removed by authorized personnel. Admittance will be restricted to the magazine keeper, blasting supervisor, or licensed blaster. Magazine construction will meet the requirements of ATF P5400.7 “Explosives Law and Regulations” (Bureau of Alcohol

Tobacco and Fire Arms) and be in accordance with local, state, or federal regulations and the Blasters Handbook.

Accurate and current records will be kept of the explosive material inventory to ensure that oldest stocks are utilized first, satisfy regulatory requirements, and for immediate notification of any loss or theft. Magazine records will reflect the quantity of explosions removed, the amount returned, and the net quantity used at the blasting site.

When explosive materials are taken from the storage magazine they will be kept in the original containers until used. Small quantities of explosive materials may be placed in day boxes, powder chests, or detonator boxes. Any explosive material not used at the blast site will be returned to the storage magazine and replaced in the original container as soon as possible.

Magazine location will be in accordance with local, state, or federal regulations. Where no regulations apply, magazines will be located in accordance with the latest edition of the 175th anniversary edition of the Blaster's Handbook and ATF P5400-7 "Explosives Law and Regulations" (Bureau of Alcohol, Tobacco and Fire Arms).

Magazines will be marked in minimum 3-inch-high letters with the words "DANGER EXPLOSIVES". Signs will be staked 10 feet away from and at a 45-degree angle to the magazine.

Placement and angle should ensure that a bullet fired perpendicular to the face of the sign does not penetrate the magazine.

GENERAL BLASTING PROCEDURE

The following list of steps will be performed in all cases. These steps represent a minimum requirement and give a general order to the blasting procedure:

- A safety meeting will be held prior to any blasting activities. Everyone who is involved with the blasting in any form must attend. Safety rules and signaling should be reviewed;
- Warning signs will be erected;
- Lightning detectors will be set up;
- Drilled holes will be measured accurately for depth and location;
- Seismic equipment will be set-up to measure velocities near the pipeline and any structures 150 feet or less from blast;

- Distances to any nearby structure (aboveground or below ground) suspected of being less than 300 feet from the blast will be measured;
- Clear the blasting affected zone;
- Give the warning signal;
- Give the blast signal;
- Detonate the blast;
- After blaster has checked for misfires and given the “ALL CLEAR” signal, inspectors will inspect any aboveground or underground facilities for damage; and
- The WGP Blasting Log Record (WGP 0143) will be completed.