MOTT MACDONALD

PennEast PIPELINE

APPENDIX B

INADVERTENT RETURN RISK ASSESSMENT

HDD ID	Potential Contributing Factors to an Inadvertent Return	Mitigation/Discussion
Pennsylvania/New Jersey		
Delaware River	Changing lithology - Changing geotechnical strata between western side (dolomite) and eastern side of the river (gneiss). Soils containing high percentage of gravels and cobbles - During the geotechnical Investigation, layers of gravel and isolated boulders were observed extending to various depths on both sides of the Delaware River. These soils represent a risk to the overall bore stability, raveling of gravel into the bore, potential damage to the pipe string, and increased pullback loads/stresses. Karst Features & Fault Transitioning - Mapped Karst features include 4 surface depressions within 0.5 miles of the borings on the Pennsylvania side of the river. Controlling and maintaining fluid flow within the bore	Developing grouting plans and loss of circulation plans - This will be a Contractor workplan requirement. Implementation of casing -To support these soils and mitigate the risks associated with such deposits, a temporary conductor casing is recommended on the both sides of the HDD installation. Locating the drill outside of areas of known Karst features - HDD designed to avoid known locations of Karst features. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Drill and intersect methodology - The drill and intersect method was chosen to mitigate risks associated with the geotechnical data provided during the investigation, such as drilling through cobbles and gravel at the entry and exit points, and hydraulic fracture through the overburden materials above the alignment. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required drilling fluid pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
New Jersey		
Milford Warren Glenn Rd.	Controlling and maintaining fluid flow within the bore	Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required drilling fluid pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore

HDD ID	Potential Contributing Factors to an Inadvertent Return	Mitigation/Discussion
Nishisakawick Creek	Controlling and maintaining fluid flow within the bore	Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required drilling fluid pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Lockatong Creek	Length of Drill – Longer HDD drill lengths require higher drilling fluid pressures to facilitate drilling fluid flow back to the drill rig. Controlling and maintaining fluid flow within the bore	Drill and intersect methodology - The drill and intersect method was chosen to mitigate risks associated with the designed length of the drill, as this strategy helps to the lower drilling fluid pressures. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Featherbed Lane	No detailed bedrock information for south side – Borings could not be completed due to site access restrictions, and quality of bedrock unable to be determined. Controlling and maintaining fluid flow within the bore	Geophysical investigation completed in lieu of borings – A seismic refraction survey was completed to determine the depth to bedrock along the northern portion of the crossing. Bedrock conditions and materials assumed to be similar to those identified in completed borings on the south side of the crossing. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required drilling fluid pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore

HDD ID	Potential Contributing Factors to an Inadvertent Return	Mitigation/Discussion
Wickecheoke Creek Tributary	Soils containing high percentage of gravels and cobbles - During the geotechnical Investigation, some gravels were noted in the upper soil layer. These soils could represent a risk to the overall bore stability, raveling of gravel into the bore, potential damage to the pipe string, and increased pullback loads/stresses. Low RQD zones (<40%) - the rock quality is low for the first 40 feet of depth in the vicinity of Boring B-68. Controlling and maintaining fluid flow within the bore	Implementation of casing - During the geotechnical investigation, gravel was noted in the upper soil layer. Given the shallow depth and relatively low anticipated percentage of gravel, temporary conductor casing is not deemed necessary for the proposed crossing. However, the HDD Contractor should be prepared to install temporary conductor casing if actual soil conditions warrant its use. Developing grouting plans and loss of circulation plans for implementation if preferential drilling fluid flow pathways are encountered - This will be a Contractor workplan requirement. Refer to Schedule A-10 HDD Construction Specification. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Wickecheoke Creek	Controlling and maintaining fluid flow within the bore	Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Brookville Hollow Rd.	No detailed bedrock information for south side – Borings could not be completed due to site access restrictions, and quality of bedrock unable to be determined. Controlling and maintaining fluid flow within the bore	Geophysical investigation completed in lieu of borings – A seismic refraction survey was completed to determine the depth to bedrock along the southern portion of the crossing. Bedrock conditions and materials assumed to be similar to those identified in completed borings on the north side of the crossing. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore

HDD ID	Potential Contributing Factors to an Inadvertent Return	Mitigation/Discussion
Alexauken Creek	Soils containing high percentage of gravels and cobbles - During the geotechnical Investigation, some soils containing decomposed rock fragments were encountered. These soils could represent a risk to the overall bore stability, raveling of gravel into the bore, potential damage to the pipe string, and increased pullback loads/stresses. Length of Drill – Longer HDD drill lengths require higher drilling fluid pressures to facilitate drilling fluid flow back to the drill rig. Controlling and maintaining fluid flow within the bore	Implementation of casing - During the geotechnical investigation, gravel was noted in the upper soil layer. Given the shallow depth and relatively low anticipated percentage of gravel, temporary conductor casing is not deemed necessary for the proposed crossing. However, the HDD Contractor should be prepared to install temporary conductor casing if actual soil conditions warrant its use. Drill and intersect methodology - The drill and intersect method was chosen to mitigate risks associated with drilling through decomposed rock fragments and gravel at the entry and exit locations. This strategy allows for both sides of the installation to be temporarily cased during drilling operations. The drill and intersect method can also mitigates risk associated with the designed length, as this strategy helps to the lower drilling fluid pressures. Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Pleasant Valley Rd.	Controlling and maintaining fluid flow within the bore	Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore
Washington Crossing Pennington Rd.	Controlling and maintaining fluid flow within the bore	Locating the drill within favourable geotechnical materials at a sufficient installation depth – A stable flow pathway can be created between the drill bit and the HDD entry/exit locations when properly drilled by the HDD contractor. Hydrofracture/hydraulic fracture evaluations completed to define allowable drilling fluid pressures and required drilling fluid pressures - The results will be verified by the Contractor as part of their workplan and used during construction to limit downhole drilling fluid pressures. Contractor required by contract documents to monitor downhole annular drilling fluid pressures during entire pilot bore