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## Technical Memorandum

### Review of Draft Environmental Impact Statement, Proposed PennEast Pipeline, Docket No. CP15-558-000, FERC\EIS: 0271D

Prepared for: Delaware Riverkeeper Network

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## 1.0 INTRODUCTION

PennEast Pipeline Company, LLC (PennEast) proposes to construct a pipeline to transport natural gas from the Marcellus Shale production region in northern Pennsylvania to portions of southern New Jersey and southeastern Pennsylvania. PennEast submitted applications to the Delaware River Basin Commission (DRBC), State of Pennsylvania (PA), and the Federal Energy Regulation Commission (FERC) for approval. FERC prepared a draft environmental impact statement (DEIS) analyzing the impacts of the project. This technical memorandum (memo) reviews hydrogeologic aspects of that DEIS. This memo also reviews or references other documents prepared for the proposed project if they relate to the DEIS. Primary groundwater issues vary depending on the aquifer crossed by the pipeline. The aquifer delineation depends on the underlying bedrock and the surficial deposits at the site. Documents occasionally referenced, other than the DEIS, include various reports associated with the Section 401 certification reports because they include better descriptions of the resources than provided in the DEIS. The review included Resource Report 2 (RR2)<sup>1</sup>, which discusses the aquifers the pipeline would cross, specifies the recharge areas and rates, and discusses contamination, and the general project description, Resource Report 1<sup>2</sup>, geology report, Resource Report 6<sup>3</sup>, soils report, Resource Report 7<sup>4</sup>, the vegetation report, Resource Report 3<sup>5</sup>, and the wetland delineations reports and maps, Appendix D, USFWS Wetland Delineation Maps.

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<sup>1</sup> PennEast Pipeline, Resource Report 2, Water Use and Quality, September 2015. Hereinafter referred to as RR2.

<sup>2</sup> PennEast Pipeline, Resource Report 1, General Project Description, September 2015. Hereinafter referred to as RR1.

<sup>3</sup> Penn East Pipeline, Resource Report 6, Geological Resources, September 2015. Hereinafter referred to as RR6.

<sup>4</sup> Penn East Pipeline, Resource Report 7, Soils, September 2015. Hereinafter referred to as RR7.

<sup>5</sup> PennEast Pipeline, Resource Report 3, Fisheries, Vegetation, and Wildlife, September 2015. Hereinafter referred to as RR3.

## 2.0 SUMMARY OF WATER RESOURCES ASPECTS OF DEIS

The DEIS is insufficient as a disclosure for many reasons. With respect to water resources, the DEIS failed to present complete inventories or analyses of at least the following factors.

- design of horizontal directional drilling (HDD) crossings
- details about proposed water sources for hydrostatic testing
  - standard for how flow rates adequate for downstream uses would be maintained during diversions
- the effects of discharge from hydrostatic testing on the receiving stream
- disclose impacts to surface water resources due to pipeline construction
- failure to analyze of effects of crossing methods at each crossing and attempt to minimize impacts
- effect of blasting on stream crossing and runoff from the pipeline to streams
  - includes nitrogen contamination
- failure to complete an inventory of wetlands
  - failure to consider construction and environmental impacts of highly saturated soils at wetlands

The following subsection discusses how the DEIS fails to analyze effects of the proposed pipeline on groundwater resources.

### 2.1 Summary of Groundwater Impacts

The DEIS fails to consider how pipeline construction could affect groundwater by changing recharge rates and locations, cause drawdown both temporarily, during construction, and permanently due to changed hydrogeologic properties along the pipeline, cause pathways for contaminants to enter the subsurface, create preferential flow pathways for shallow groundwater flow, and change drainage patterns which would affect where recharge occurs. Pipeline construction and its ongoing presence could also provide additional pathways for methane and higher chain gases to reach portions of shallow aquifers where they have not previously reached. A methane leak from the pipeline would be directly into shallow groundwater if the pipeline is below the water table (which would be the case in areas with a shallow water table such as wetlands and stream crossings). The following summarizes impacts not considered in the DEIS and sections 5.0 and 7.0 provide additional details.

- Pipeline construction changes recharge by changing properties of the soils within the right of way (ROW) due to compaction and scraping, properties of the aquifer where it is excavated and backfilled, and by changing surface drainage patterns which could affect the recharge of runoff.
- Pipeline construction lowers the water table temporarily by dewatering the trench. It lowers the water table permanently by changing the aquifer properties within the trench; for example, increased conductivity in the backfill could create a pathway with lower resistance and change the water table level within the trench.
- Pipeline construction creates preferential pathways by changing the properties of the aquifer due to differing properties of the backfill.

- If the backfill has higher conductivity than the surrounding aquifer, groundwater will flow preferentially within the backfilled trench.
- If the backfill has lower conductivity, which is possible with substantial compaction of the backfill in a till or alluvial aquifer, it could block flow across the pipeline. The extreme case would be for the pipeline to cause water to surface upgradient from the trench.
- Pipeline construction through bedrock aquifers would change the properties as described in the previous bullet.
  - If the bedrock is highly fractured, such as in parts of the Catskill formation, backfill with silty till could easily have lower conductivity than the surrounding fractured bedrock.
  - Backfill with alluvium through intact bedrock would cause a high conductivity pathway.
- A leak in a pipeline would enter the groundwater in the trench, and its disposition would depend on properties of the backfill and probably even the rate.
  - A large leak would probably bubble to the surface and volatilize.
  - A small leak would probably dissolve into the groundwater, which can hold methane up to 28 mg/l at atmospheric pressure, and transport along with the groundwater flow as described in previous bullets.
  - Interestingly, because of the gas dissolving into the groundwater and because a small leak could be less detectable, a small leak could cause longer term groundwater problems.
- Pipeline construction can also change surface drainage patterns which could change the location where runoff becomes recharge.

### 3.0 FAILURE TO AVOID OR MINIMIZE ENVIRONMENTAL IMPACTS WITH RESPECT TO WATER RESOURCES

The purpose and scope of the DEIS includes a discussion of “reasonable alternatives to the proposed project that would avoid or minimize adverse environmental impacts” (DEIS, p 1-4). Additionally, Pennsylvania regulations require the applicant to complete a “detailed analysis of alternatives to the proposed action, **including alternative locations, routings or designs** to avoid or minimize adverse environmental impacts” (25 Pa. Code § 105.13(e)(1)(viii), emphasis added). The DEIS fails completely to adequately consider changes to the pipeline route or design that could avoid or minimize adverse impacts.

The following section first considers alternatives presented in the DEIS showing that the DEIS fails to adequately consider the benefits of the alternative. Second, this section considers specific route changes that could avoid or minimize impacts that were not considered.

#### 3.1 Comparison of DEIS Alternatives

DEIS Section 3.3 considers alternative projects that would meet the purpose and need of the project, but would fail to avoid and/or minimize environmental impacts. The DEIS compared alternative routings

based on the length and amount of wetland and forest impacts and on the number of various features either crossed or closely approached, without analyzing the value of those features; for example there is no comparison of water crossings beyond the number crossed. Also, there is an apparent preference for utilizing existing rights of way (ROWs), a seemingly reasonable preference only until one realizes that construction would be adjacent to existing ROWs rather than within them (DEIS, p 3-8). An existing 50 to 100 foot wide treeless swath through a forest could be doubled as the result of the preference to following existing ROWs within a forest area. Such a width doubling could have foreseeable (but unanticipated by the DEIS) effects especially in valuable forest regions such as in Hickory Run State Park (Photo 5, p 17). In a wetland, such as in Photo 5, the area exposed to solar insolation could significantly increase which would both warm the water and increase evapotranspiration. The DEIS does not consider such factors in its comparison of alternatives.

The overall impact analysis presented in DEIS Section 4.0 considers impacts due only to the chosen alternative, not due to the range of alternative routes considered in DEIS Section 3.3. This failure to fully compare among alternative routes prevents a fair comparison of the options and could lead to reasonable, economic and least environmentally damaging alternative not being chosen.

The following subsections consider The Luzerne-Carbon Counties and the Bucks County alternative with respect to water resources factors (specifically stream crossings, affected wetland area) and affected forest land to the level presented in tables in DEIS Section 3.3. The discussed alternatives are those which have obvious potential advantages from a water resources perspective. From at least the perspective of water resources, detailed consideration of the Luzerne-Carbon and Bucks County alternatives should have been carried through into DEIS Section 4.0 for comparison with the proposed preferred alternative.

### 3.11 Luzerne and Carbon Counties Route Alternative (Luzerne-Carbon Alternative)

This alternative route (DEIS, p 3-8) would replace the proposed pipeline route between MP 8.4 and 37.5. This is a critical area because of the amount of forest land. The Luzerne-Carbon alternative would be about 1.7 miles, or 6% shorter than the proposed route. While very little of the Luzerne-Carbon alternative would be adjacent to an existing pipeline route but much of proposed preferred route along an existing pipeline is within forest land so pipeline construction would increase the width of the existing pipeline corridor through the forest (see discussion above, this page). The Luzerne-Carbon alternative would avoid creating larger corridors. However, overall there would also be a 15 acre increase in the clearing of forested land for the alternative, or a 4% increase, as well as 28 stream crossings for the Luzerne-Carbon alternative as opposed to 21 stream crossings for the proposed preferred route. However it is necessary to consider the specifics of the crossings to adequately consider whether one would be more impactful.

The most obvious advantage of the Luzerne-Carbon alternative is that just 1.5 acres of wetland would be affected by construction while for the proposed preferred route, 12 acres would be affected. The DEIS does not compare wetland type or value, but the much smaller area for the alternative suggests it could be much less impactful. Also, the Luzerne-Carbon reach also includes the extremely saturated wetland

area just south of I-80 on the proposed route, which the DEIS describes as a difficult area for construction (DEIS, p 4-69 and discussion below in Section 3.33). The DEIS alternatives comparison fails to consider the advantages of not constructing the pipeline through this wetland.

The DEIS notes the increase in stream crossings and small increase in forest area clearing in its rejection of the alternative (DEIS, p 3-11). The increases are not discussed regarding the quality of the streams or forest affected, nor does it consider the value of the wetlands not impacted, so the DEIS does not provide adequate evidence in support of the choice of the proposed route.

Another factor not considered by FERC in any comparison among alternatives is the temporary work spaces. In forests areas and wetlands, the additional space needed for construction activities could increase the impacts beyond that considered in the alternatives. This would be most apparent with respect to forests, where trees may be removed to provide construction space. The DEIS must disclose if forests could be cut to provide additional work space.

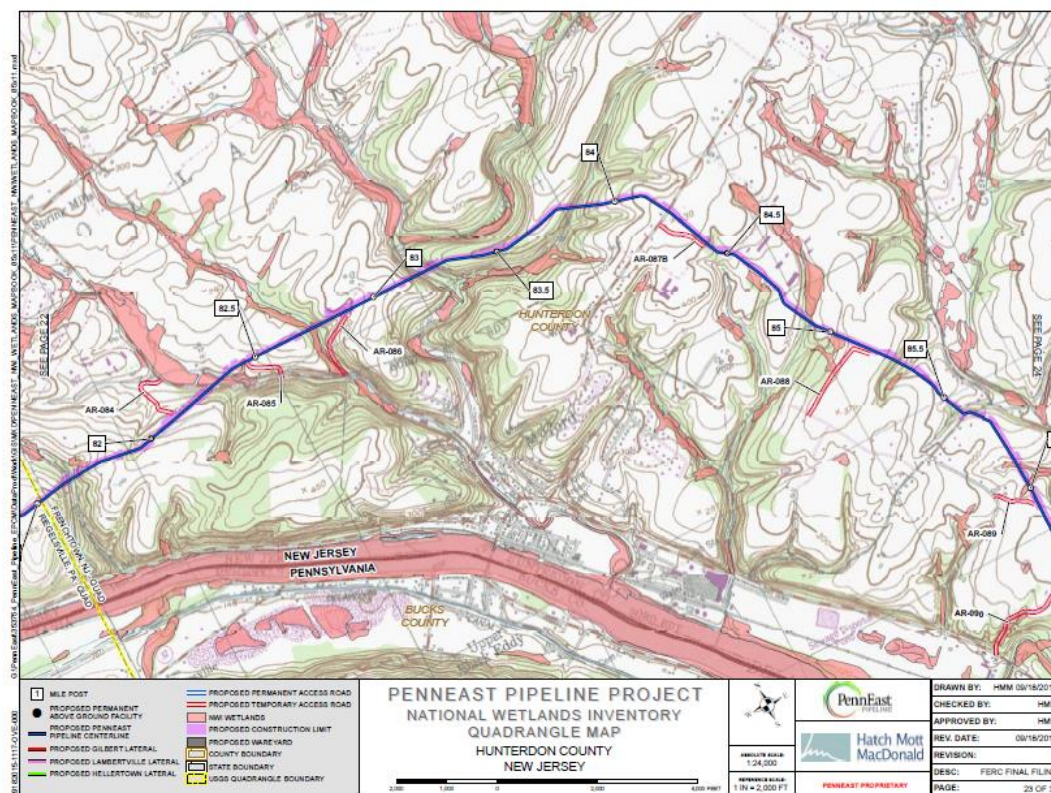
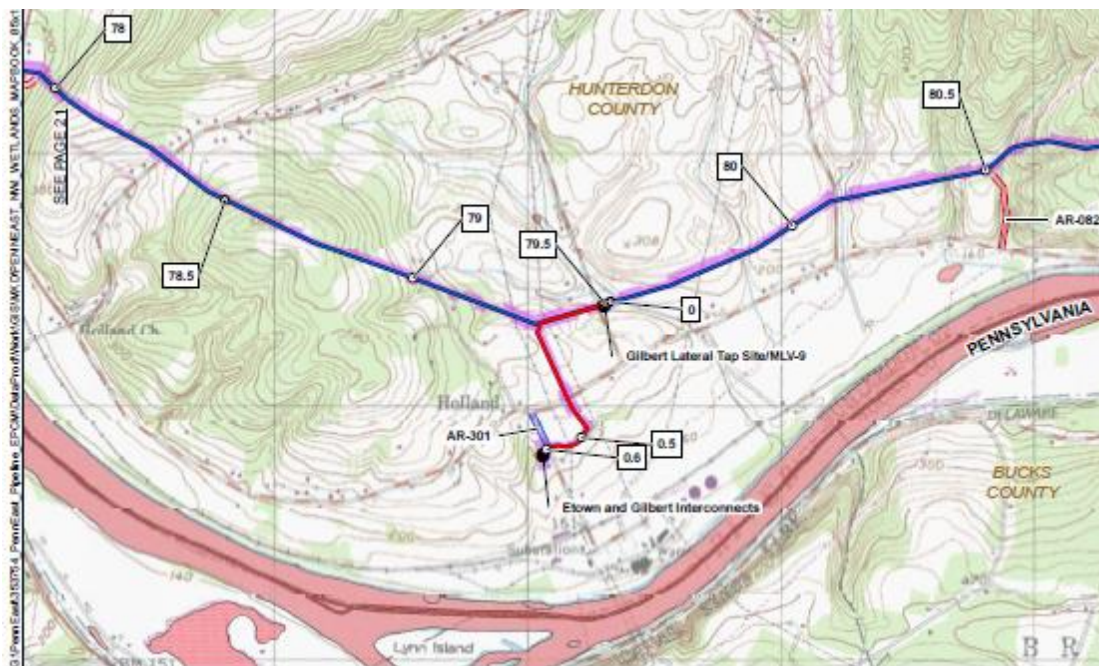
### 3.12 Bucks County Alternative

The Bucks County Alternative would replace the proposed preferred route between MP 75.8 and 99.3. It would be 3.8 miles, or almost 16% shorter, than the proposed route. It would affect just 2.4 acres of wetlands while the proposed preferred route would affect 6.3 acres and the Bucks Count Alternative would have 37 rather than 40 stream crossings. The Bucks County Alternative would affect 38 more acres of forest for a 24% increase. This alternative would include a “lateral pipeline to the proposed Gilbert Interconnect” (DEIS, p 3-14) which would require a crossing of the Delaware River. DEIS Figure 3.3.1-3 which shows the layout of the proposed preferred route for the pipeline and the Bucks County Alternative does not show the lateral. However, the wetland mapping does show the lateral (Figure 1).

The DEIS does not compare in any detail the quality of the wetlands or stream crossings affected by either alternative. However, the wetlands and topographic mapping (RR1, Appendix D) provides a sense of the proposed route. Figure 2 shows that the proposed preferred route would cross several relatively incised streams with substantial floodplain wetlands, which from mapping appear to be valuable areas. Based on the crossings and wetlands, the Bucks County Alternative route appears less environmentally damaging from a water resources perspective, contrary to the simple comparison made by FERC (DEIS, p 3-17).

A primary argument against the alternative is the second crossing of the Delaware River (DEIS, p 3-17). However, with respect to environmental impacts, a horizontal direction drill (HDD) crossing could be less impactful, especially if the platform staging areas for HDD were not in sensitive habitats, a factor the DEIS failed to consider.







## 3.2 Small Variations in Pipeline Route

The DEIS considered small variations in the proposed preferred pipeline route, accepting some and rejecting some. Additionally, several sections of the proposed preferred pipeline route were visited and new proposals made below in section 3.22.

### 3.21 Small Routing Changes

DEIS Table 3.3.2-1 lists various small changes in the proposed preferred route that were supposedly evaluated and Appendix F provides maps. Some were incorporated into the proposed preferred route and others dismissed, with brief reasons indicated for incorporation or rejection. The longest proposals, variations numbered 7 and 9, appear to have been proposed for watershed protection reasons by the Bethlehem Authority watershed district but were rejected. These proposals are both longer than ten miles but the DEIS does not provide reasons for their rejection. Route deviation 7 (DEIS App F, p F-5) would run the pipeline east and upstream of Beltzville Reservoir and avoid a crossing of that reservoir which would seem to be desirable.

The reason listed for rejection of No. 9 is engineering constraints associated with crossing Beltzville Lake. An HDD crossing should be possible at most any point under that lake, albeit longer than at the upstream end. Environmental benefits could outweigh cost issues and should be better discussed in the DEIS. Additional evaluation of DEIS variations 7 and 9 (DEIS, Section 3.3.2), given their watershed protection benefits, is a significant failing of the DEIS analysis.

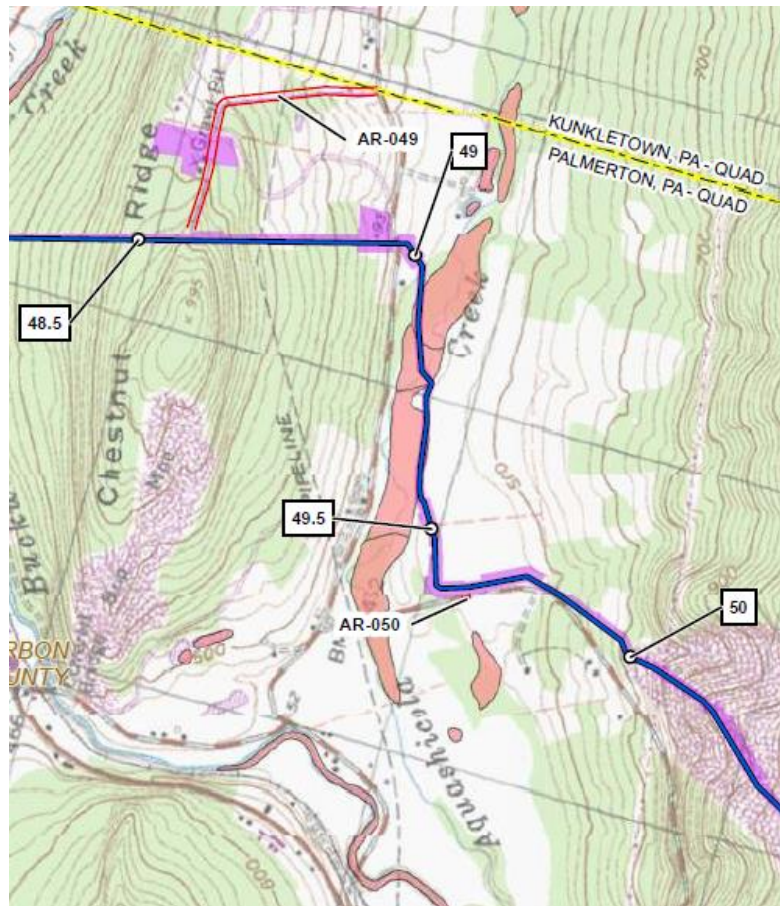
### 3.22 Alternative Routings

In some reaches, the proposed pipeline would be in an existing right-of-way. As part of my review of the 401 certification application, I visited many proposed pipeline sites. This section outlines a number of deficiencies identified during those site visits.

**Aquashicola Creek Crossing (MP 49 to 49.7):** The proposed preferred route crosses an extensive wetland and parallels Aquashicola Creek for more than half a mile (Figure 3). The proposed preferred route appears to almost maximize the amount of wetlands and floodplain affected by the pipeline. The pipeline crossing the floodplain could significantly divert groundwater flow and affect wetland water balances and baseflow in the creek. Direct impacts due to construction on the creek are also obvious. The values of the wetlands on the floodplain are obvious from a site visit, with Aquashicola Creek meandering through dense shrub/herbaceous vegetation (Photo 1).

- Penn East should consider extending the straight reach from MP48.5 to 49.0 another approximate 0.2 miles across the stream, floodplain, and wetlands prior to diverting southward. An obvious location for the new layout to intersect the pipeline would be at about MP 49.75 where the proposed pipeline changes direction to go southeast. This proposal would require negotiating a route through some Blue Mountain Ski Area facilities but this would be less environmentally damaging than the proposed layout. There would also be less potential for

construction to disturb polluted groundwater or aerially deposited sediments due to the Palmerton Zinc Pile Superfund Site (EPA 2011). There would be much less impact on wetlands and less direct stream crossing.



*Figure 3: National Wetlands Inventory map of the proposed PennEast Pipeline along the Aquashicola Creek.*



*Photo 1: Floodplain and stream along Aquashicola Creek near Little Gap, PA.*

**Monocacy Creek, MP 60.0 to 60.5:** The pipeline in this vicinity would border on a steep slope southwest of Klein Hill (Figure 4) and crosses a broad floodplain with a small stream providing groundwater discharge to Monocacy Creek (Photo 2). The route avoids the White Tail golf course but in so doing it impacts the floodplain (Photo 2) thereby affecting groundwater discharge to Monocacy Creek. Its route along the steep slopes may also cause erosion or intercept groundwater flowing from Klein Hill to the Monocacy Creek tributary (Figure 4). The crossing of East Branch Monocacy Creek near MP 61.5 (Figure 4) also involves the pipeline cutting vertically down a steeper slope.

- Penn East should consider an alternative route through this area to improve the crossing of both creeks just mentioned. Directing the proposed route east across Klein Hill would miss wetlands. All potential routings in this vicinity are in need of greater consideration.



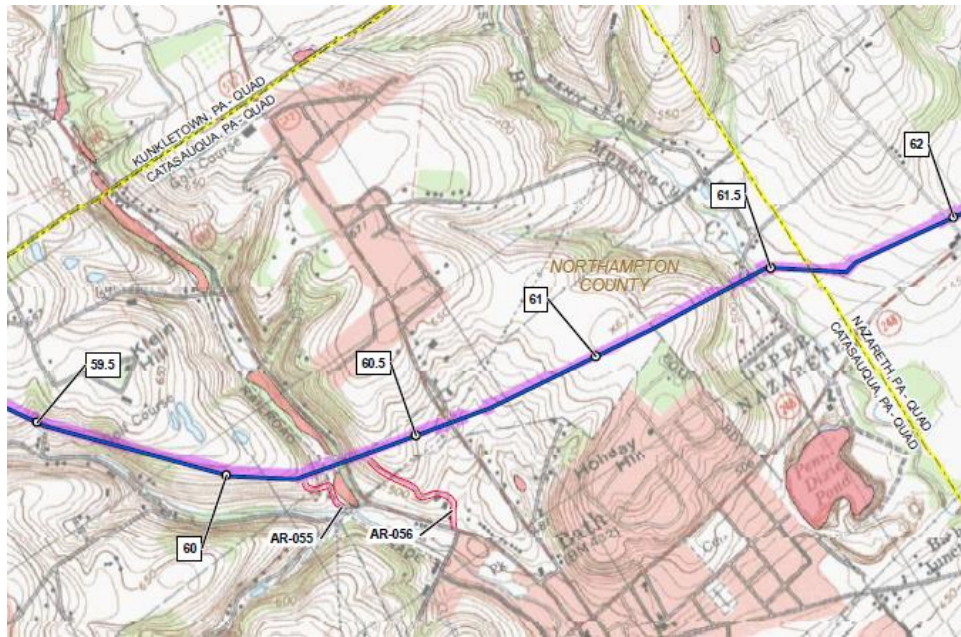
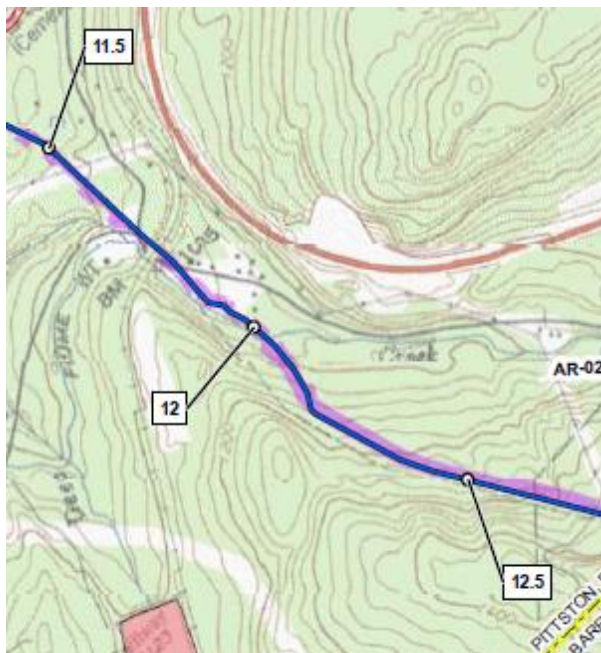


Figure 4: Snapshot of proposed pipeline near Monocacy and East Branch Monocacy Creek, near Bath, PA. MP 59.5 to 62.



Photo 2: Floodplain and small groundwater fed stream just above confluence with Monocacy Creek near MP 60.25.

**Mill Creek, MP 12.0:** Mill Creek near MP 12.0 likely should have a different layout (Figure 5). The proposed pipeline would parallel the stream next to a hillslope for about 0.3 mile (Figure 5). However, most of the alluvium forming the base of the valley lies north of the proposed pipeline. The pipeline trench could likely divert much of the groundwater discharge from the alluvium away from the stream during low flow conditions. A preferred alternative would have the pipeline cut directly across the floodplain at about MP 12.1 and merge with the current layout at MP 11.5.



*Figure 5: Snapshot of the wetlands map for MP11.5 to 12.5.*

### 3.3 Alternative Designs and Construction Practices

#### 3.31 Trench Plugs

Trench plugs are a factor in the design that are poorly analyzed. As described in the DEIS:

Permanent trench plugs are intended to slow subsurface water flow and erosion along the trench and around the pipe in sloping terrain. Permanent trench plugs will be constructed with sand bags or an equivalent as identified in the permit requirements. On severe slopes greater than 30 percent, "Sakrete" may be used at the discretion of the Chief Inspector. Topsoil shall not be used to construct trench plugs. Permanent trench plugs, which are used in conjunction with waterbars (slope breakers), shall be installed at the locations shown on the construction drawings or as determined by the EI. Trench plugs shall be installed at the base of slopes adjacent to waterbodies and wetlands, and where needed to avoid draining of a resource. (DEIS, Appendix D, section 9.5.8.1)

Trench plugs are used to interrupt flow along a trench, which could be considered preferential flow as discussed elsewhere in this memo. However, Penn East does not analyze how trench plugs would



operate or whether they would do as claimed. A plug presumably with lower conductivity than the rest of the trench backfill would interrupt flow through the trench and potentially cause water to discharge to the ground surface. FERC does not provide for accommodating this surface flow or consider how it changes groundwater flow.

- The alternative design that must be considered would include a drain through the plug to lower the hydrostatic pressure in the trench caused by the plug and a plan for discharge of trench flow that may discharge to the surface.

### *3.32 Stream Crossing Methods*

There would be 165 and 90 stream crossings in Pennsylvania and New Jersey, respectively (DEIS, p 2-9). All dry stream crossing construction methods would involve development of a trench across the stream with subsequent backfill. Dry stream crossing techniques involve temporarily diverting the stream from the streambed so that trenching occurs without flowing water, using either a flume or a dam and pump method (RR2, p 2-28; RR1, p 1-84, -85). The method used to trench and install the proposed pipeline would not influence the effect that trench and streambed crossing could have on groundwater/surface water relations near the crossing.

Trench backfill would have different conductivity than the surrounding alluvium, usually lower if the trench backfill is compacted and the surrounding is alluvium. The trench therefore would hydraulically impede groundwater flowing parallel to the stream and force it to surface into the stream. Depending on conditions downstream of the trench, the surface water would either percolate back into the alluvium or continue flowing as surface water, leaving less water stored in the alluvium than would otherwise be stored there. This could result in lower baseflow downstream of the trench because the trench effectively dams the groundwater flow so that groundwater discharges to the stream at times when the aquifer should be filling with percolating surface water. Each crossing is a different circumstance, but the DEIS has not analyzed the groundwater hydrology near any of the crossings.

- The DEIS should present an analysis of the hydrogeology at each crossing to assure that the design impacts groundwater flow the least and preserves surface baseflow.

Horizontal borings would affect the groundwater flow and groundwater/surface water interactions much less than trenches with backfill. This is simply because the bores have less effect on the overburden above the pipeline and do not interrupt the groundwater flow.

- The DEIS should present, on a site-by-site basis for each waterbody crossing, whether a horizontal boring would be less impactful to groundwater and cause less decrease to baseflow than would a trench. The DEIS should present environmental benefits of boring in each instance.

- Alternatively, PennEast should consider an alternative backfill design which would allow flow through the backfill with less impedance than would otherwise occur.<sup>6</sup>

Some of the crossings discussed in section 3.32 are obviously better suited for horizontal borings rather than dry trenches. These include Aquashicola Creek and Monacacy Creek, and Hokendauqua Creek. Streams with potentially contaminated sediments, such as East Monacacy Creek, are also better suited for boring rather than trenching.

- All crossings listed in DEIS Table G-5 (for Pennsylvania) and G-6 (for New Jersey) should be considered with respect to whether a boring would be preferable. The most obvious candidates are those proposed to have a dry crossing but are also FERC class intermediate (for 10 to 100 feet wide) or major. Large crossing widths with small watersheds are more likely to have streams dependent on groundwater, because large width indicates higher flow and a larger floodplain and small watershed suggests less surface water runoff in the stream.

The crossing of Mud Run at MP 33.1 (Photos 3 and 4) presents several challenges. It is a FERC intermediate crossing with a very large watershed and proposed dry crossing. However, it has a bedrock channel, as shown in Photo 3. There is also a groundwater dependent tributary running on floodplain (Photo 4). A trench would intercept much of the groundwater flow in the alluvium which would support baseflow in this channel. This crossing should be done with an HDD which would have the added advantage of not trenching along a steep side canyon on the north side of the stream that likely is highly erodable.

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<sup>6</sup> Such a design could include high conductivity zones in the backfill, such as created by bedding the pipeline with gravel or topping the trench with gravel. An obvious problem with this alternative design is that trench backfill with higher conductivity may just create preferential flow paths and allow the trench to fill with water. The recommendation is for PennEast to consider the alternative, including feasibility issues discussed here.



*Photo 3: Bedrock stream bottom in Mud Creek near MP 33.1*



*Photo 4: Spring flow on floodplain near MP 33.1.*



### 3.33 Wetland Crossing Methods

Open trenching is the primary means of crossing wetlands, regardless of wetland type or value (RR2, p 2-55). PennEast has done no analysis of the impacts of trenching across wetlands nor does the DEIS present any analysis. That analysis specifically should be of groundwater flows through the wetland. Most of the wetlands are at least partly groundwater dependent with the wetland being supported by lateral groundwater flow into the wetland area. The trench would intercept some of that groundwater flow causing it to surface, as described in section 3.32.

A good example occurs at about MP 29.6 where the pipeline crosses an existing wetland that depends on groundwater for support (Figure 6, Photo 5). There is no obvious surface water inflow, other than storm runoff (Figure 6). The wetland straddles a minor topographic divide, so the area supporting the south end of the wetland is limited. A trench that causes groundwater to surface could significantly change the water balance in the south end of the wetland thereby causing it to be lost due to indirect impacts - indirect being not direct construction but a loss of water.

- At wetlands like this, PennEast should consider whether a deeper boring could prevent indirect losses of wetlands. They should do this for all significant wetlands crossed by the proposed pipeline.

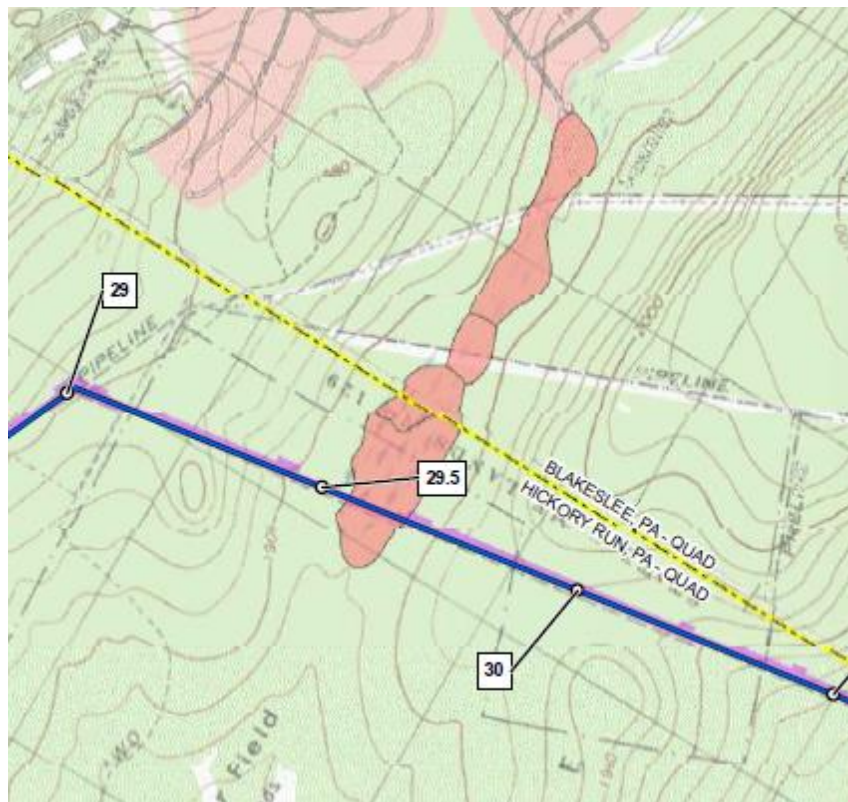


Figure 6: Map of wetland and topography near MP 29.6.



*Photo 5: Groundwater dependent wetland, MP 29.6. Shows vehicle damage.*

The existing pipeline corridor provided access to many areas for inspection, but it was also obvious that the pipeline corridor allowed 4WD access to water features along the pipeline. At MP 29.5 in Hickory Run State Park, vehicles using the pipeline for access had damaged a wetland the proposed preferred route for PennEast would cross (Photo 6). This access allows repeated and continual damage to water resources near the pipeline.

- Penn East should limit vehicular access to any pipeline ROW. The DEIS should assess the potential for ancillary damages to water resources (and other features) caused by the pipeline, such as due to enhanced access. The DEIS should also discuss how to prevent and mitigate these damages, including closing areas to vehicular access and providing enhanced enforcement strategies (gates alone do not work ATVs go around them).





*Photo 6: Vehicular damage to wetlands near MP 29.5 in Hickory Run State Park.*

## 4.0 IMPROPER DISCLOSURE: SECTIONS OF THE PROJECT NOT ANALYZED FOR THE DEIS

The DEIS lists means by which various resources will be affected by the project. However, the DEIS fails to present a full inventory of these resources or to fully survey the potential, known and foreseeable impacts. It is not proper for the DEIS to suggest that essential construction, data gathering or analyses simply be completed “prior to construction” or even “during the DEIS comment period”.

PennEast proposed to use HDD for eleven crossings, including five waterbody crossings, but would present site specific plans at a later date (DEIS, p 4.51). Aspects of the plans that could be critical at those crossings were not made available for public review as part of this DEIS. Such plans would include the “location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction” (Id.). These areas all have potential impacts far exceeding general pipeline construction. The DEIS should also justify that the crossing areas and methods are “the minimum needed to construct the crossing” (Id.), and that the public to be able to review this aspect of the design. The containment plans for spills of drilling mud and other contingency plans should also be included as important elements in the DEIS for discussion and review.

The DEIS fails to disclose sufficient details about proposed water sources for hydrostatic testing. PennEast anticipates using 18 million gallons for hydrostatic testing, but have proposed only preliminary water source locations and volumes (DEIS, p 4-52 and Table 4.3.2-7). The proposed locations differ from

the locations presented in Table 2.4-1 of RR2. The most obvious difference is that in the RR2 table, most sources are from streams and/or lake whereas the DEIS table lists hydrants. Hydrants presumably means they will draw water from a municipal source or that for some sections they will use water from other sections where the “Potential Source” is a “Jumper from Section \*” where \* is one of the pipeline section numbers.

The DEIS indicates that PennEast would commit to maintaining flow rates adequate for downstream uses including aquatic life, water body designated use or withdrawals (DEIS, p 4.52). However, the DEIS does not indicate any standard for determining the adequate amount of water, therefore there is no way for the public to review the analysis or have confidence in the DEIS statements. With respect to municipal withdrawals, the DEIS does not address how to prevent the withdrawal from having deleterious effects on the municipal water supply, including the ability to fight fires. It is not appropriate to assume the water purveyor contracted with will have sufficient control to actually prevent a withdrawal when it would overtax their system.

DEIS Table 4.3.2-7 lists discharge locations simply as coordinates without listing the receiving stream. This is insufficient disclosure because it is not an analysis of the effects of the discharge on the receiving stream, including limits on the potential flow rate which could be important if the stream is small and the discharge of hundreds of thousands of gallons of water could cause erosion or upset ongoing biologic processes (for example, discharge near a redd<sup>7</sup> could cause localized sedimentation or erode the streambed). It is also important to assess the effects of discharging treated water, with potential chlorine or byproducts, into the surface water because those chemicals could affect aquatic biota.

Alternatively, if the plan is to actually use discharge water from one section to test another, the DEIS should disclose the details of those plans. Details on capturing water discharge from the pipeline section being tested are necessary so that the potential for spills can be assessed. If near a stream crossing, the potential chemicals in any spilled water should be disclosed.

The DEIS acknowledges that PennEast has not provided details of its water withdrawal plan by recommending that PennEast file a final plan prior to construction (DEIS, p 4-52). The DEIS indicates that some of the factors noted above in this memorandum should be provided prior to construction, but that is not public disclosure as required by NEPA. Specifically, the DEIS notes that PennEast should provide a “plan detailing the decision process for determining when an alternative water source would be used during exceptional dry periods” (DEIS, p 5-5).

- The DEIS should include and analyze the plan for water withdrawal for hydrostatic testing and its discharge.

The DEIS also fails to disclose impacts to surface water resources due to pipeline construction. It acknowledges that “clearing and grading of streambanks, in-stream trenching, blasting, trench dewatering, inadvertent returns from HDD operations, and potential spills or leaks of hazardous

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<sup>7</sup> A redd is a spawning area or nest made by salmonids.

materials” (DEIS, p 4-55, p 5-6) could affect surface waters. It lists several potential impacts including (DEIS, p 4-55):

- Modification of aquatic habitat
- Increased runoff and in-stream sediment loading
- Decreased dissolved oxygen
- Releases of pollutants from sediments
- Modification of riparian areas
- Introduction of chemical contaminants to waterways

The DEIS essentially repeats this noting that the “extent of the impact would depend on sediment loads, stream velocity, turbidity, bank composition, and sediment particle size” (DEIS, p 4-55). It does not quantify either the existing conditions or describe how the pipeline would affect the existing conditions. For each water crossing, the DEIS could easily describe the stream velocities, expected range of flows, bank composition, bed sediment sizes and contaminants present on those sediments, riparian conditions, and stream type (Rosgen and Silvey 1996). Using this information the DEIS could make at least semi-quantitative descriptions of the impacts pipeline construction will cause to the stream. HDD crossings would cause substantially fewer impacts to the stream, especially concerning changes in sediment transport and riparian vegetation (outlined at DEIS p 5-6).

- The DEIS should present detailed analyses for each stream crossing of the potential for the crossing to change flow velocities, sediment transport, and stream type. The DEIS should discuss alternative crossings including underground borings.

The DEIS similarly fails to prescribe crossing methods. As discussed above, the default crossing method should be with HDD, as PennEast will do at some crossings (DEIS, p 4-68). Justification for other crossing methods should be included in the DEIS. As part of an analysis of the impacts, the DEIS must consider the potential for the trench to affect groundwater flow as analyzed in section 7.2 of these comments. It is not proper to conclude there will be no permanent loss of wetland area without analyzing whether the trench causes a change in groundwater level which would affect wetlands right at the trench. Additionally, a change in groundwater level could cause a lasting change in wetland vegetation contrary to DEIS claims (DEIS, p 4-70).

- The default plan should be to construct stream and wetland crossings using HDD. To use a different crossing method, PennEast should be required to justify the change and that justification should be part of the DEIS.

Pipeline construction would require blasting in places (DEIS, p 4-13, -55), especially where depth to bedrock is shallow or where there are significant very large boulders that could need breaking prior to removal. Mud Run at MP 33.1 (p 14) is a good example of such a location. Blasting leaves nitrogen which can run off with stormflow and enter streams as nitrate or ammonia. The DEIS does not even mention this possibility, although EISs for other types of projects, such as mines, that would use

substantial explosive, often discuss the potential addition of nitrogen loading extensively. The discussion on blasting (DEIS, p 4-58) concerns worker safety, not environmental impacts.

- The DEIS should analyze and discuss the potential for blasting along the pipeline route to cause nitrogen pollution.

The DEIS also fails to present a complete inventory of delineated wetlands. The proposed preferred project route would cross 106 and 104 wetlands in Pennsylvania and New Jersey, respectively. PennEast could not do field delineations for 23% of the proposed preferred route within Pennsylvania (DEIS, p 4-65). PennEast completed field delineations at just 31 locations in New Jersey, or just 11 miles of the 36 miles of pipeline within New Jersey (DEIS, p 4-66); that calculates as only 31% of the project in New Jersey. Remote sensing methods used to “approximate the locations and boundaries of wetlands” (DEIS, p 4-65) have a large margin of error. Cumulatively the likely inaccuracies of mapping numerous small wetland areas along a pipeline ROW could be very high, rendering the estimates of wetland area (DEIS, p 4-66) very suspect and highly deficient. Simply requiring PennEast to file a delineation report prior to construction (Id.) is not appropriate disclosure as required for a DEIS. The DEIS has a similar failing to disclose the presence of vernal pools (DEIS, p 4-68).

- The DEIS should contain a complete inventory of delineated wetlands and vernal pools. The inventory should be based on field survey.

The DEIS particularly highlights one wetland area that is very saturated and at which PennEast will have a great many problems with construction (DEIS, p 4-69). Contractors in the past have been unable to contain the wetland soils within a 75-foot construction corridor (Id.). The requirement that PennEast file “special construction methods that it would implement during construction in extremely saturated wetlands” by the end of the DEIS comment period (Id.) is insufficient disclosure because it does not provide the public with time to review it. The DEIS must include an analysis of the impacts that the proposed crossing method would have on the wetlands at issues. A specific, wetland by wetland analysis, of potential impacts associated with each crossing needs to be provided as part of any DEIS.

- A proper “Project-specific Wetland Restoration Plan” (DEIS, p 4-73) should be made available for public review as part of the DEIS rather than simply prior to construction (Id.).

DEIS Section 5.2 is a list of FERC-recommended mitigations. However, most of the recommended mitigation is actually necessary studies or analysis that should be completed for public review as part of the DEIS. Recommendations 15 through 27 concern water resource related issues. The need for some of these has been discussed above. Specifically, recommendation 22 is to identify the water sources and discharge locations for the hydrostatic test plan. Recommendation 24 requires a complete wetland delineation report and recommendation 25 does the same for vernal pools. Recommendation 26 is for a plan for crossing “extremely saturated wetlands”. Recommendation 27 is for a wetland restoration plan.

- The effects of FERC mitigations, and all others in DEIS Section 5.2, should be analyzed and disclosed in the DEIS; after the fact preparation and release is inappropriate given the significant impacts of each and every one of these items individually and cumulatively.

## 5.0 IMPROPER DISCLOSURE: FAILURE TO DESCRIBE OR INVENTORY FEATURES OF GROUNDWATER HYDROLOGY IMPACTS

Construction and operations of the proposed pipeline affects groundwater in numerous ways that can then affect surface waters and wetlands. If the proposed project decreases groundwater recharge, it will decrease the groundwater discharge as well. That discharge controls baseflow and maintains the water level in wetlands during dry periods. Trench construction and backfill changes the conductivity of the formations which either causes preferential flow or blocks flow. Higher conductivity leads to preferential flow which can cause an aquifer to drain more quickly and ease the pathway for contaminants to reach wetland and streams. Lower conductivity backfill would restrict groundwater flow that intersects the trench and possibly divert from its natural discharge point or even cause it to surface. All of these factors can decrease surface baseflow, cause wetlands to dry more quickly, and cause more contaminants to reach streams and aquifers. The DEIS considers hydrogeology only in a cursory fashion, not analyzing these specific impacts at all.

In broad terms, the subsections that follow address the inventory and descriptions of recharge, aquifers, soils and special features.

### 5.1 Recharge

The DEIS does not describe groundwater recharge, and therefore fails to describe one of the most important factors of the hydrogeology of the area. Because many aspects of the project could affect recharge, failing to describe the process in the project is a serious deficiency. The following discussion of recharge is from a review of RR2.

The recharge map (RR2, Figure 2.2.4-1 for Pennsylvania) shows broad areas of equally distributed recharge. Distributed recharge means the recharge estimate is based on recharge being spread over a broad area. The rate is simply a streamflow, assumed to emanate from recharge over the entire area, divided by area expressed in length/time, usually inches/year. It does not account for heterogeneities in the geology, such as those caused by faults or anticlines (the folding away from the crest of an anticline causes tension cracks in the bedrock which allows more meteoric water to enter the aquifer at the crest than elsewhere) or topography, which causes the location of recharge to be highly variable across the area.

Recharge in RR2 (Figure 2.2.4-1) was estimated using Wolock (2003), a nationwide digital data set of recharge estimates on a nationwide grid of 1 km grid cells. The abstract for Wolock (2003) noted: "This 1-kilometer resolution raster (grid) dataset is an index of mean annual natural ground-water recharge. The dataset was created by multiplying a grid of base-flow index (BFI) values by a grid of mean annual



runoff values derived from a 1951-80 mean annual runoff contour map. Mean annual runoff is long-term average streamflow expressed on a per-unit-area basis". Reese and Risser (2010) noted that Wolock emphasized that recharge values "are strictly for the long term, and qualifies the use of the results and method" (Reese and Risser 2010, p 9) and that "site-specific recharge values are not expected to be accurate because of the generalization of data over time and space" (Id.). Therefore, the values in RR2 should not be considered to represent the specific recharge at a point, such as the pipeline route.

Reese and Risser (2010) presented a different recharge estimate methodology for the state of Pennsylvania based on estimates for HUC10 watershed scales, which in Pennsylvania range from about 50 to 400 square miles. Comparison of Reese and Riser (2010) Plate 3 and RR2 Figure 2.2.4-1 does not suggest substantial differences between the estimated rates determined with the two methods. Reese and Risser (2010) Plate 5 indicates the estimation errors in the area of the pipeline (in PA) range from 2.0 to 3.83 inches. The regression equation used to develop the statewide estimates (Risser et al. 2008) had the following significant independent variables, which are factors that explain recharge.

- Mean annual precipitation – more precipitation leads to more recharge, all else being equal. Factors that concentrate precipitation in an area should also increase the recharge.
- Average daily maximum temperature – this would be a surrogate variable for evapotranspiration and recharge likely decreases as this variable increases.
- Percent carbonate rock – carbonate rock is very conductive and this variable is a surrogate for the control that geology exerts on recharge. A larger percentage of carbonate rock means more recharge.
- Percent sand in soil – this relates to the infiltration capacity of the soil, so that more sand means more recharge.
- Average stream channel slope – this would be a surrogate for more relief which would probably relate to relief and steepness, with more runoff and less recharge occurring where the slope is steeper.

Although these factors were developed at a watershed scale, they could represent factors at a point. Pipeline construction can significantly affect soils and vegetation (Pierre et al. 2015), which would primarily be represented as percent sand in the Risser et al regression equation. Effects on soils would primarily be compaction and lost vegetation.

Based on information available in scientific literature, and including the discussion already found in RR2, the DEIS could and should assess how pipeline construction would affect the factors discussed above and use the Risser et al regression to describe how pipeline construction would affect recharge. Failure to assess, discuss and evaluate the impacts of the proposed pipeline project on recharge is a significant failing that must be remedied and subject to public review and comment along with the other corrections this expert and others are recommending.

Section 7.1 of this report provides additional details and quantifies the effects of the proposed pipeline on recharge.

## 5.2 Aquifers

The DEIS only briefly discusses aquifers, primarily regarding surficial aquifers as till or alluvial aquifers. It discusses bedrock aquifers at two levels, first as four principal aquifers along the route (DEIS, p 4-26 and Table 4.3.1-1) and second based on the 40 bedrock formations that underlie the pipeline (DEIS, Appendix G-4). Therefore, there are up to 40 different sets of average transmissivity and groundwater storage properties along the pipeline which means up to 40 different average responses to stresses on the aquifer; I note “average” because each of the bedrock formations are heterogeneous so there is variability both within a bedrock formation and among formations. The DEIS does not provide maps of the aquifers nor any information on the hydraulic properties of the formations; the listing of bedrock in Appendix G-4 is limited to the formation name and Appendix G-2 provides detailed geologic descriptions but no hydrogeologic properties. The description of bedrock aquifers as “composed of unbroken solid rock ...” (DEIS, p 4-28) is incorrect because it is primarily through fractures that any groundwater can flow. If the bedrock was truly unbroken, there would be no flow.

Bedrock beneath the shallow aquifers controls whether recharge circulates deeply or flows a short distance and discharges to a surface channel; at a small scale such as on ridge tops or slopes the channels are probably small. Fractures control where recharge enters the bedrock as well as how contaminants circulate through the aquifers. Fractures allow a higher proportion of the recharge to enter the bedrock whereas areas with no fractures will force most of the recharge to flow elsewhere and possibly recharge at points away from where the precipitation falls. Two factors, the formation type and topographic position, control bedrock fractures, and therefore conductivity, specific yield, and the ability for recharge to enter the bedrock and how deeply it circulates.

The failure to describe aquifer properties is a severe shortcoming of the DEIS. There is some data available which should have been used along with further exploration to discuss aquifer properties and assess the implications for groundwater, recharge and water quality issues. Taylor (1984) describes the properties of bedrock aquifers that underlie the pipeline from MP 0.0 to about 62.8. Low et al (2002) describes the properties of underlying bedrock formations from MP 62.8 to about 77.6, through Northhampton and Bucks County. Herman (2001) describes in detail the properties of bedrock aquifers through the Newark Basin of New Jersey. Poth (1972) discusses the Martinsburg Formation. Rather than relying just on broad generalizations, the DEIS needs to discuss details of the bedrock underlying the pipeline by milepost, as it does for soils and wetlands.

Table 1 shows relevant properties for bedrock types underlying the preferred pipeline route proposed. The table emphasizes the variability between minimum and maximum yield as an example of the heterogeneity of the formations. The DEIS should include a much expanded but similar table of bedrock properties. As discussed below, these properties considered with soil properties and the topographic location along the pipeline can be used to assess the effect the pipeline will have on recharge.

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**Table 1: Hydrogeologic properties of bedrock formations near the PennEast pipeline. SC is specific capacity. All data from Taylor (1984) and Low et al. (2002), unless otherwise specified.**

<b>Formation</b>	<b>Min Yield</b>	<b>Max Yield</b>	<b>Domestic Median yield</b>	<b>Nondomestic median yield</b>	<b>Comments</b>
Catskill	0	300	12	35	1146 well analyzed
Pocono	3	350	12	18	
Mauch Chunk	0	710	25	50	
Llewellyn	2	50	10		limited data, just seven domestic wells
Pottsville	5	300	25	48	
Spechty Kopf	-				a thin formation between the Catskill and Pocono
Trimmers Rock	1	60	6	15	
Mahantango	-				Hamilton Group
Marcellus	1	900	10	65	Hamilton Group
Buttermilk Falls Limestone	-				
Ridgeley	2	650	10	122	part of Onondaga and Old Port Formatin
Decker	-				
Bloomsburg	2	500	6	66	
Shawangunk	-				
Jacksonburg	1	1200	17	75	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)
Allentown	5	1500	30	150	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)

<b>Leithsville</b>	2	1000	25	250	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)	
	<b>Min SC</b>	<b>Max SC</b>	<b>Median SC</b>	<b>Yield (gpm)</b>	<b>Median K (ft/d)</b>	<b>Comments</b>
Hardyston	0.04	18	0.57	31	0.24	
Felsic to mafic gneiss	-					
Hornblende gneiss	-					
Trenton gravel	0.01	80	6.6	105	430	very shallow
Igneous and metamorphic rocks	-					
Brunswick conglomerate	-					Conglomerate for other formations, but not Brunswick
Brunswick	0.07	140	1.5	60	1.3	
Lockatong	0.05	40	0.4	10	0.78	
Stockton	0.07	75	1.3	60	1.2	
Diabase	0.01	5	0.12	7.5		very few, very shallow fractures
Martinsburg	0.06	10	0.61	1	1.3	Northhampton County only, K from model calibration (Sloto et al. 1991)
Jacksonburg	0.01	34	1.2		3.1	properties from Lehigh County, K from model calibration (Sloto et al. 1991)
Allentown	0.03	125	4.3		47	properties from Lehigh County, K from model calibration (Sloto et al. 1991)
Leithsville	0.18	375	2.4		125	properties from Lehigh County, K from model calibration (Sloto et al. 1991)

Taylor further describes the variability in yield as a function of topography:

Wells in higher topographic positions (hilltops and hillsides) have smaller yields than those in lower topographic positions (valley, gullies, and draws). Valleys and draws often form where the rocks are most susceptible to physical or chemical weathering. Hilltops are generally underlain by more resistant rocks. Lithologic variations and weaknesses in rocks caused by bedding partings, joints, cleavage, and faults promote rapid weathering and can produce low areas in the topography. These types of geologic features often occur in high-permeability zones which yield significant amounts of water to wells. (Taylor 1984, p 29).

Specific capacity provides guidance regarding the yield throughout the depth of the wells, whereas shallow fractures would allow recharge to enter the bedrock and deep fractures control how deep the recharge circulates (Taylor 1984). Most bedrock formations have the maximum fractures between 100 and 150 feet bgs with the Catskill Formation having the most fractures from 150 to 250 feet bgs (Taylor 1984, Table 7). Hamilton group bedrock has relatively more fractures near the ground surface, between 0 and 50 feet bgs than other formations (Id.). The topographic position therefore better describes the tendency for surface fractures and describes locations where bedrock is most receptive to recharge. Lower specific capacity on ridges means that recharge will remain in the shallow till or alluvial aquifers mantling the bedrock. As noted, the depth to bedrock in many areas is only a few feet so recharge flows as shallow groundwater. The shallow groundwater flow from ridgetops reaches drainages, usually high elevation first order drainages, where the bedrock has higher yields and some of the shallow groundwater enters it. Details of the impacts are further discussed in section 7.1.

- The DEIS should provide a table of bedrock aquifers that includes relevant properties, including specific capacity statistics or well yields, and conductivity where available. If properties for a given bedrock aquifer have not been published, it is reasonable for PennEast to complete the analyses for existing wells.
- The DEIS should discuss the roll of topography in controlling conductivity and how fractures control conductivity and how deep recharge may reach in the bedrock
- The DEIS should assess the implications for the water resources that will be impacted by the proposed preferred route and alternative routes considered.

## 5.3 Soils

### 5.31 Contaminated Soils

DEIS Section 4.2 describes soils to be crossed by the proposed preferred pipeline route and RR7 is the PennEast soils report which provides more detailed maps showing soil types along the proposed preferred route (RR7 Figure 7.1-1) and tables listing characteristics of the soils along the pipeline (RR7, Tables 7.1-1, -2). DEIS Table 4.2.1-1 summarized critical soil characteristics including poorly or very poorly drained, excessively drained, poor revegetation potential, high compaction, severe erosion potential, prime farmland crossed, and slope by percent of proposed route length affected but is not specific as to location. In addition to lacking this specific location information, these tables fail to



consider characteristics which are collocated and as a result could lead to more critical conditions. The DEIS is generally insufficient for consideration of the soil conditions on water resources impacted by the proposed preferred route.

DEIS Table 4.2.1-2 shows potential groundwater or soils contamination along the pipeline route. However, the table does not show the type of contamination at those sites. At no point in the DEIS is there a discussion as to the effect the proposed pipeline could have on contaminated soils or, more accurately, the potential for, and ways in which, the proposed pipeline could release contamination from the contaminated soils thereby affecting the environment and natural resources.

- The DEIS needs to provide a detailed assessment of soil conditions and potentials and the likely ramifications for groundwater flows and contamination; this assessment must include the presence and potential release of contaminated soils.
- The DEIS must present mitigation plans to prevent currently contaminated soils from degrading nearby groundwater due to construction disturbance and the enduring presence of the pipeline.

### 5.32 Soil Runoff and Recharge

Neither the DEIS nor RR7 discuss NRCS (1986) hydrologic soil groups, commonly known as A, B, C, or D groups, considered the most important soils classification for hydrology (Pierre et al. 2015). Using the NRCS methods, soils would be assigned a curve number which describes their runoff potential and their sensitivity to disturbance. Disturbance of some soils would increase their curve number which represents increased runoff and decreased recharge.

Pipeline disturbance to soils includes the removal of vegetation which when present shelters the soil from raindrop erosion and protects/increase its capacity for rainfall recharge; and includes soil compaction and furrowing caused by construction traffic on the soils which reduces the soil's ability to infiltrate and recharge rainfall and impacts the ability of the soil to support/encourage vegetation regrowth. Highly compacted soils inhibit vegetation regrowth. Even when shrubs and trees are allowed to regrow on compacted soils as part of a pipeline maintenance plan, and are able to regrow, their ability to protect soils from erosion due to a healthy canopy and healthy root growth, as well as their ability to encourage rainfall infiltration and recharge requires years and often decades to reestablish. After construction, ongoing maintenance activities and inspection with heavy equipment can re-inflict compaction impacts.

The impacts of construction of the proposed pipeline on soils, can have significant and enduring ramifications for runoff, erosion, groundwater, stream baseflows and for supporting healthy habitats required by wildlife.

- It is important to understand and assess the quality of the soils that will be impacted by pipeline construction, operation and maintenance. The DEIS needs to provide this needed analysis and assessment.

Table 2 shows the mileage for soils that have high compaction potential and poor drainage along the pipeline developed from RR7 Table 7.1-2; the DEIS does not provide similar data. Approximately 9.25 miles or 7.8% of the total length of the proposed preferred route in both states, including laterals, have high compaction potential and poor drainage. The slopes are moderate, with the steepest being 6%, which is steep enough to generate significant runoff from disturbed slopes. Silt and clay make soil easier to compact so pipeline reaches with high silt/clay could be most compacted which reduces recharge and increases runoff.

*Table 2: Soils subject to a high potential of compaction, by mile post. From RR7 Table 7.1-2.*

Begin MP	End MP	Length (miles)	Drainage	Slope (%)	Soil series
0	0	0.05	Poorly	6	Chippewa silt loam
3.1	3.1	0.05	Very poorly	2	Wayland silt loam
5.5	5.5	0.05	Poorly	6	Rexford loam
6.2	6.3	0.1	Poorly	2	Holly Silt Loam
6.5	6.5	0.05	Poorly	2	Holly Silt Loam
13.1	13.3	0.2	Poorly	6	Rexford loam
16.8	16.9	0.1	Very poorly	4	Chippewa very stony silt loam
17.7	17.7	0.05	Very poorly	4	Chippewa very stony silt loam
17.7	17.8	0.1	Very poorly	1	muck
24.5	24.5	0.05	Very poorly	3	Lickdale and Tughill very stony loams
26.5	26.6	0.1	Very poorly	4	Norwich very stony loam
27	27.3	0.3	Very poorly	1	muck and peat
29.5	29.6	0.1	Very poorly	1	muck and peat
30.1	30.9	0.8	Poorly	4	Shelmadine very stony silt loam
30.9	31.1	0.2	Very poorly	3	Lickdale and Tughill very stony loams
31.1	31.2	0.1	Poorly	2	Shelmadine silt loam

32.4	32.6	0.2	Very poorly	3	Lickdale and Tughill very stony loams
33.1	33.1	0.05	Poorly	2	Holly Silt Loam
34.5	34.8	0.3	Very poorly	1	Papakating silty clay loam
35.1	35.4	0.3	Poorly	4	Shelmadine very stony silt loam
35.4	35.4	0.05	Poorly	4	Shelmadine very stony silt loam
36	36	0.05	Poorly	4	Shelmadine very stony silt loam
36	36.1	0.1	Very poorly	3	Lickdale and Tughill very stony loams
36.1	36.2	0.1	Poorly	4	Shelmadine very stony silt loam
36.1	36.1	0.05	Poorly	2	Holly Silt Loam
36.5	36.6	0.1	Poorly	4	Shelmadine very stony silt loam
36.6	36.8	0.2	Very poorly	3	Lickdale and Tughill very stony loams
36.8	36.9	0.1	Poorly	4	Alvira and Shalmdine very stony silt loams
36.9	37.2	0.3	Poorly	2	Alvira and Shalmdine very stony silt loams
41.1	41.2	0.1	Poorly	2	Alvira and Shalmdine very stony silt loams
41.2	41.5	0.3	Poorly	4	Alvira and Shalmdine very stony silt loams
41.6	41.6	0.05	Poorly	2	Holly Silt Loam
45	45.1	0.1	Poorly	2	Holly Silt Loam
49	49.4	0.4	Very poorly	1	Papakating silty clay loam
53.5	53.5	0.05	Poorly	4	Andover-Buchanan gravelly loams
53.5	53.5	0.05	Poorly	4	Andover-Buchanan gravelly loams

53.7	53.7	0.05	Poorly	2	Andover-Buchanan gravelly loams
54.2	54.3	0.1	Poorly	2	Andover-Buchanan gravelly loams
54.3	54.4	0.1	Poorly	2	Andover-Buchanan gravelly loams
54.3	54.3	0.05	Poorly	4	Andover-Buchanan gravelly loams
55.9	56	0.1	Poorly	2	Brinkerton-Comly silt loams
56.7	56.7	0.05	Poorly	6	Brinkerton-Comly silt loams
58.5	58.5	0.05	Poorly	2	Brinkerton-Comly silt loams
59.2	59.2	0.05	Poorly	6	Brinkerton-Comly silt loams
60.3	60.3	0.05	Poorly	2	Holly Silt Loam
61.4	61.5	0.1	Poorly	2	Brinkerton-Comly silt loams
63.5	63.6	0.1	Poorly	2	Holly Silt Loam
70.9	71	0.1	Poorly	1	Fluvaquents
72.5	72.8	0.3	Poorly	4	Cokesbury-Califon channery silt loams
72.9	73	0.1	Poorly	5	Cokesbury silt loam
73.1	73.4	0.3	Poorly	4	Cokesbury-Califon channery silt loams
73.4	73.6	0.2	Poorly	5	Cokesbury silt loam
1.3	1.4	0.1	Poorly	5	Cokesbury silt loam
92.5	92.7	0.2	Poorly	1	Croton silt load
92.7	92.8	0.1	Poorly	1	Bowmansville silt loam
92.8	93	0.2	Poorly	1	Croton silt load
93	93.5	0.5	Poorly	1	Croton silt load
93.3	93.3	0.05	Poorly	4	Croton silt load

94	94.1	0.1	Poorly	4	Croton silt load
94.3	94.3	0.05	Poorly	3	Croton silt load
94.5	94.6	0.1	Poorly	3	Croton silt load
94.5	94.6	0.1	Poorly	1	Croton silt load
95	95.1	0.1	Poorly	4	Croton silt load
97.4	97.5	0.1	Poorly	4	Reaville wet variant silt loam
104.8	104.8	0.05	Poorly	1	Bowmansville silt loam
105.9	106	0.1	Poorly	1	Bowmansville silt loam
108.3	108.3	0.05	Poorly	1	Doylestown and Reaville variant silt loams
112.7	112.9	0.2	Poorly	1	Doylestown and Reaville variant silt loams

Individual reaches shown in Table 2 are mostly less than 0.3 miles in length, with a 0.8 mile reach at MP 30.1 being an exception.

- The DEIS needs to provide detailed information on soils that have high compaction potential and poor drainage along the pipeline along with pipeline mile posts.

Furthermore additional details are needed that are critical to determine the significance of the impact of the pipeline construction and the enduring footprint of its ROW for runoff, recharge, erosion, and water quality impacts. Among the additional factors needed is the depth to bedrock. Depth to bedrock is essential because it defines the soil and shallow aquifer thickness through which groundwater interflow would occur. RR6 presents depth to bedrock only as related to soil types and without mile posts (RR6, Table 6.3-4). The DEIS presents depth to bedrock only as a consideration regarding introduction of subsoil rock in topsoil (DEIS, p 4-25).

- The DEIS should include maps and tables showing depth to bedrock along the proposed pipeline route.
- The DEIS needs to include map, analysis and evaluation of the recharge, runoff, pollution, vegetation, habitat, soil and erosion impacts resulting from the combination of soil type, slope,

compaction potential and depth to bedrock for each section of pipeline along the proposed preferred route as well as alternatives.

## 5.4 Springs and Seeps

The DEIS acknowledges that surveys for springs and seeps have not been completed. The inventory as presented is only for springs/seeps within 150 feet of the pipeline (DEIS, Table 4.3.1-5). It is not possible for the public to review the impacts of the proposed preferred route and alternative routes on water resources if the inventory of resources is not complete. Additionally, as discussed below in section 7.0 regarding the analysis of impacts, various pipeline-induced impacts could affect resources much further than 150 feet from the pipeline. For that reason, the DEIS as presented is incomplete.

- The DEIS should include a complete inventory of springs and seeps within a quarter mile of the pipeline to adequately consider the changes which could occur due to pipeline construction.

## 5.5 Karst

Karst occurs where shallow bedrock is limestone which has had significant dissolution which caused caverns and caves to form within in it. The DEIS notes that karst can lead to sinkholes, but fails to note that karst can be a significant preferential flow pathway for contaminants and therefore could exacerbate contamination issues or incidents caused by pipeline construction or operation.

The DEIS fails to provide full mapping of the location of karst. The DEIS states that PennEast is developing a Karst Mitigation Plan (DEIS, p 5-2) but has not completed it which means the potential for encountering karst and the impacts of the pipeline doing so are not known.

- The DEIS should present the result of a final karst study for the area and present plans for mitigating problems caused by constructing through karst or caused by rapid contaminant transport within karst.

# 6.0 IMPROPER DISCLOSURE OF POTENTIAL CONTAMINATION TO WATERS AND SOILS

Construction and operations of the proposed pipeline will encounter areas of contamination, including areas with industrial sites such as mines and areas with naturally high levels of contaminants. Construction through these areas can release contaminants. The DEIS fails to adequately inventory these areas or discuss the potential for pipeline construction to release contaminants.

## 6.1 Mine-Impacted Soils

There are numerous mines near the centerline of the proposed pipeline, beginning at about MP 5.1 and continuing to MP 11.2, as noted in DEIS Table 4.1.4-1. None apparently are operating. The soils table in RR7 (Table 7.1-1) lists various soils in this reach as “mine dump” or strip mine, burned”. Partially shown



on Figure 7, mine-affected soils cover substantial areas on the east side of the Susquehanna River crossing. Excavating or otherwise disturbing mine spoil can release contaminants, including acid mine drainage (AMD) if sulfides are present. However, the DEIS does not present any discussion of minerals that could be present in these soils or discuss whether minerals or other contaminants including AMD could result from meteoric water leaching through or running off of these soils. The mine spoil identified in RR7 is considered to have high conductivity (RR7, Table 7.1-1 for Luzerne County), which means the potential for contaminants to be released by construction disturbance is relatively high. It also has the potential for high erosion when disturbed (RR7, p 7-16). But the DEIS fails to discuss the pollution potential that will result.

- The DEIS should include data or information regarding the mineral content of the soils to be crossed by the proposed pipeline and the results of leaching tests that should be required.
- The DEIS should assess the potential for pipeline construction to generate acid generation or leach metals in all areas where it crosses mine spoil.
- The DEIS should present avoidance and mitigation discussions focused on preventing the leaching and transport of acid and metals from the site.

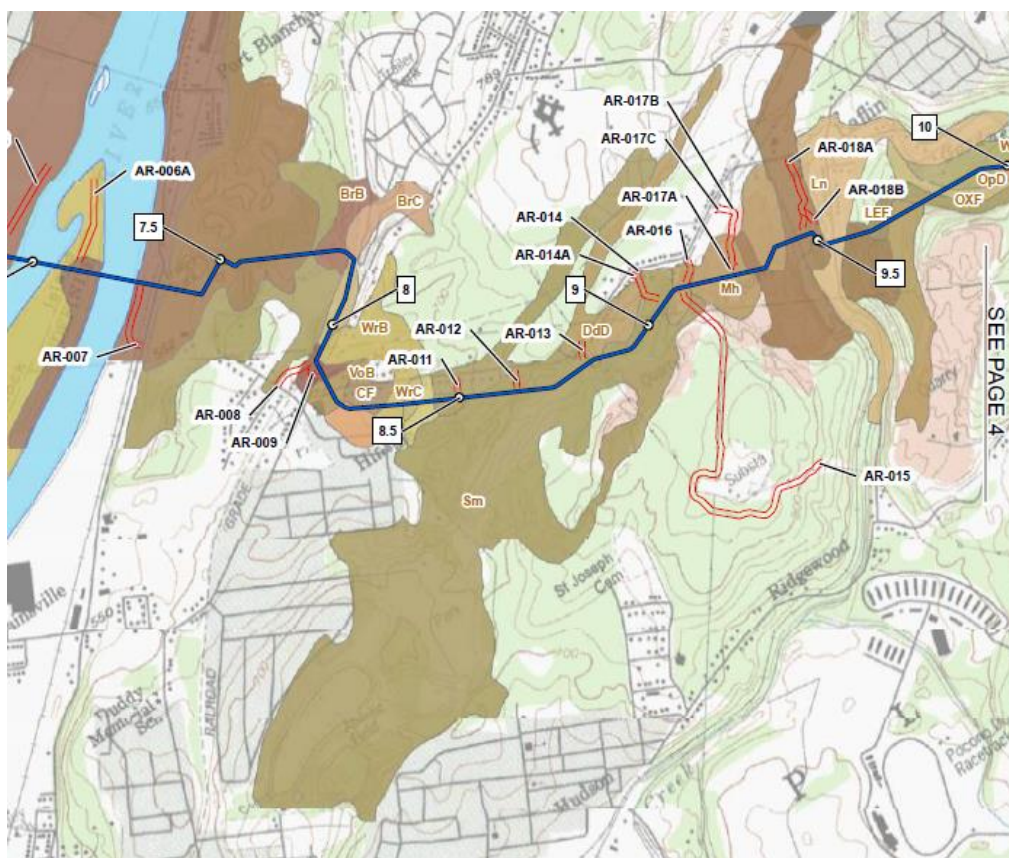


Figure 7: Snapshot of soils map (RR7, Figure 2.1-1) showing MP 7.0 to 10.0. Soil SM is strip mine.

## 6.2 Arsenic Leaching from Bedrock along the Pipeline Route

Arsenic occurs naturally in the bedrock of the Newark Basin portion of the proposed preferred pipeline route and alternatives (DEIS, p 4-11). The DEIS notes that the primary source is the mineral pyrite. This assertion that the primary source of arsenic is the mineral pyrite is incorrect because pyrite consists simply of iron and sulfur, as  $\text{FeS}_2$ , and is a major AMD source.

The mineral arsenopyrite, in which As (i.e. arsenic) substitutes for one of the sulfur atoms, can be a source. The DEIS' explanation of the source of As is insufficient and a serious deficiency in the analysis because the source controls the potential for the As to leach from the mineral due to construction disturbance. The presence of As in wells near the proposed pipeline (Id.) is evidence that there is a source from which As could leach into groundwater.

The DEIS states that "shallow groundwater ... generally have (sic) low arsenic concentrations and that high arsenic concentrations ... are the result of more mature groundwater interacting with geochemically susceptible and arsenic-enriched water bearing zones, which are often deeper wells" (DEIS, p 4-12). However, the statement is unreferenced and the DEIS provides no data to support the statement. The DEIS recognizes that the potential to mobilize arsenic is uncertain but then claims they have "no indication that common construction activities that involve shallow excavation, such as home construction, has resulted in increased arsenic concentrations in water supply wells" (Id.). That statement is also unsupported by references or data although its implication is that they have performed substantive analysis of the potential for leaching from shallow construction. The analysis which supports these claims and assertions needs to be provided in the EIS documentation so it can be reviewed by the public and commented upon – as it stands this claim is unsupported and likely false and therefore fails to support the conclusions based upon it.

The DEIS relies on the Serfes (2016) analysis which involved leach testing samples of Lockatong and Passaic Formation to conclude that the potential for arsenic leaching from soils disturbed by trench construction is less than significant. The Lockatong lies near the ground surface and is representative of rock that will be disturbed by trench construction. Serfes' evidence and descriptions do not fully support his conclusions so the DEIS inappropriately minimizes the potential contamination.

- The samples for the Lockatong Formation were "obtained by compositing approximately 100 pounds each of competent unweathered boulders randomly selected adjacent to roadside outcrops" (Serfes 2016, p 3). Boulders may not be representative either structurally or geochemically of the standard fractured bedrock of the formation. Samples should have been drawn from the outcrop but deep enough that weathering would have been minimal.
- The EPA 1627 method calls for leaching with  $\text{CO}_2$ -saturated, deionized reagent water whereas Serfes (2016) states the saturation occurred with deionized water without mentioning  $\text{CO}_2$ . Without  $\text{CO}_2$  saturation, Serfes' samples could leach oxidation products more quickly than the method would otherwise call for. This would change the results.

- Serfes claims that hydrous ferric oxides (HFO) that form on pyrite surfaces (observed during the test) would sequester arsenic from reaching groundwater. This could result from the HFO crusting process (Serfes 2016, p 5) occurring faster than arsenic release due to pyrite oxidation in the test. This could be due to the sample particle size distribution (PSD) not being representative of the particles in the field. It may not represent field conditions.
- Pyrite oxidation and arsenic mobilization in the field could occur through preferential flow zones that have a much smaller proportion of ferrous products with which to form HFOs that will sequester arsenic.
- Results of leach tests for sample ML-2, ML-DUP-2, and ML-6 exceed 10 ug/l for the first four weeks, and some for the first seven weeks, and this could represent some of the first contaminant flushes from the project. There is no appropriate reason given for why this is not representative of the leaching that will occur initially after pipeline construction.
- Serfes (2016) Figure 13 shows graphs of arsenic, sulfate and iron with time. Serfes suggests the sulfate figure shows that pyrite oxidation decreased after week 9. “Note sulfide (sic) concentration increase in (b) indicates aggressive pyrite oxidation between weeks 5 and 9” (Serfes 2016, Figure 13). The figures indicate post week 9 for ML-DUP-2 is a pyrite mostly oxidized phase. Data in Serfes (2016) Table 2 does not support his conclusion of most pyrite being oxidized by week 9. Although the sulfate concentrations are highly variable there is no consistent change that occurs at week 8. The highest sulfate concentration for ML-2 occurs in week 11. The variation shown in Serfes Table 2 demonstrates that conditions along the pipeline will be highly variable; if the roadside samples are representative, Table 2 shows simply that some areas can oxidize a great deal more than others.

The results of the arsenic leaching tests relied on by the DEIS show that arsenic leaching could be more variable than expected. It depends on how the particle size distribution compares with that occurring on the site and whether oxidation would occur faster in some than other areas. It also depends on how fast ferric ions can be mobilized to form hydrous ferric oxides. Finally, it depends on whether preferential flow zones that could release arsenic and not contact HFOs could occur along the pipeline. The highly variable arsenic concentrations in shallow wells further exemplifies how variable arsenic occurrence could be near the pipeline.

- The arsenic analysis is insufficient to indicate that arsenic leaching from pipeline construction in the Newark Basin would not be a problem for shallow groundwater. The DEIS needs to legitimately and scientifically analyze this issue and threat in order to properly inform avoidance and mitigation options.

### 6.3 Palmerton Zinc Pile Superfund Site

The DEIS also fails to consider whether pipeline construction will release contaminants from the Palmerton Zinc Pile Superfund site<sup>8</sup>, but claims it would be more than 0.25 miles to the east of the boundary (DEIS, p 4-33) without considering groundwater plumes or air born transport.

The proposed preferred pipeline route would lie within the one-mile buffer zone of the Palmerton Zinc Pile superfund site, as mapped (EPA 2011); the pipeline reach between the Aquashicola Creek floodplain and the Blue Mountain Ski Area parking lot would be within the buffer around the superfund site. The value of the buffer zone is questionable for two reasons. First, EPA states that the contaminated groundwater status is not under control

(<https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0300624>, accessed 8/12/16). Second, the Superfund site is within a mile west of the project site, which is upwind. There is no information on the final Remedial Investigation/Feasibility Study for the site, which would possibly outline the extent of existing contamination. Therefore, there is no final mapping of the potential contamination near the site. The DRAFT Restoration Plan and Environmental Assessment (Trustees of the Palmerton Zinc Pile Superfund Site 2010) notes that hazardous substances contaminated several miles of Aquashicola Creek and 40 acres of wetlands within the Aquashicola watershed through processes including aerial deposition and shallow groundwater contamination (Id., p 11). Because the Superfund site is downwind of the proposed pipeline, there is likely contamination along the proposed pipeline route. (Note that sampling shown on Exhibit 3-2 of Trustees (2010) is of sediments, contamination of which would have moved downstream, and that even upstream of the site one of four sediment samples have moderate toxicity.) Given that the Palmerton Water Company has four production wells at the foot of Blue Mountain that supply water to the towns of Palmerton and Aquashicola, an analysis of groundwater impacts and potential threats to this important drinking water supply for thousands needs to be earnestly and scientifically considered by the DEIS; as written, it is not.

- The DEIS should provide a plume map of groundwater contamination and a map showing soils contamination from the Palmerton Zinc Pile Superfund site and assess the implications of the various proposed pipeline routes for water, groundwater and drinking water contamination.

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<sup>8</sup> As described by EPA (<https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0300624>, accessed 8/12/16): “The Palmerton Zinc Pile Site is the area of a former primary zinc smelting operation. The site encompasses the Borough of Palmerton and surrounding areas, Blue Mountain, a large smelting residue pile called the Cinder Bank and much of the valley. For nearly 70 years, the New Jersey Zinc Company deposited 33 million tons of slag at the site, creating a cinder bank that extends for 2 1/2 miles and measures over 100 feet high and 500 to 1,000 feet wide. The smelting operations emitted huge quantities of heavy metals throughout the valley. As a result, approximately 2,000 acres on Blue Mountain, which is adjacent to the former smelters, have been defoliated, leaving a barren mountain side. Soil on the defoliated area of the mountain has contaminated the rain water flowing across it. The runoff and erosion have carried contaminants into Aquashicola (spelled correctly here) Creek and the Lehigh River. Approximately 850 people live within one mile of the site; the population of the town of Palmerton is approximately 5,000. The Palmerton Water Company has four production wells at the foot of Blue Mountain that supply water to the towns of Palmerton and Aquashicola; these wells have not been effected by contaminants from the site to date. This site was proposed to the National Priority List (NPL) on December 30, 1982 and formally added to the list on September 8, 1983.”

## 7.0 FAILURE TO ANALYZE IMPACTS TO GROUNDWATER-RELATED RESOURCES

The DEIS includes only a cursory analysis of impacts that pipeline construction will have on groundwater resources. Specifically, it failed to consider:

- How pipeline construction and operations could affect recharge and shallow groundwater flow in aquifers near the proposed pipeline.
- Preferential flow caused by trenching in the aquifer
- Potential contaminant transport enhanced by the trenching
- Groundwater drawdown caused by the trenching

This makes the DEIS demonstrably deficient and flawed.

### 7.1 Effect on Recharge

Areas where the pipeline compacts soils over critical recharge areas, especially on ridge tops and valley bottoms, will increase runoff and decrease recharge. Recharge supports baseflow to streams, therefore decreasing recharge will affect baseflow in hydrologically connected streams. Most importantly groundwater will be decreased during low flow periods and as a result impact instream habitats and water quality. The data that is provided in the DEIS suggests there will be significant losses in recharge for streams and wetlands, but the DEIS fails to provide the analysis necessary to assess the extent of this impact. This missing assessment is a fundamental failing of the DEIS that is critical for assessing water resource impacts. The following paragraphs describe losses that could occur to recharge due to pipeline construction.

Table 3 shows mile posts between which pipeline construction would compact soils in valley bottoms, not including the Susquehanna and Delaware Rivers. There are 8.1 miles of pipeline in valley bottoms with 1.9 miles overlain by compactible soils. Recharge varies significantly as discussed above, but if all of the recharge is lost over the drainage bottom area affected by the pipeline, for 10 or 22 in/year, the total lost recharge ranges from 40.9 to 90 acre-feet/year (af/y), respectively, i.e. 0.056 or 0.124 cfs. Considered as lost flow per pipeline mile, the loss would be as much as 0.007 or 0.15 cfs/mile.

*Table 3: Proposed pipeline reaches by milepost which lie in drainage bottoms. Developed from topographic mapping in RR1, Appendix D. Compactible soils is a marker showing the soil overlying the bedrock is compactible as defined in Table 1.*

Beginning MP	Ending MP	Miles	Bedrock	Compactible soils
0.5	0.8	0.3	Catskill	
4.2	4.4	0.2	Catskill	



11.5	12	0.5	Pottsville, Mauch Chunk	
16.6	16.7	0.1	Catskill	
18.2	18.4	0.2	Catskill	
19.5	19.7	0.2	Catskill	
22.6	23.2	0.6	Spechty Kopf	
33	33.2	0.2	Catskill	X
38.7	38.9	0.2	Catskill	
39.4	40.5	1.1	Catskill	
43.4	43.6	0.2	Marcellus	
45	45.1	0.1	Catskill	X
45.2	45.3	0.1	Catskill	
45.5	45.6	0.1	Catskill	
48.1	48.3	0.2	Mahantango	
49	49.7	0.7	Decker through Pocono Island	X
55.8	55.9	0.1	Graywack and shale of Martinsburg	
56.6	56.8	0.2	Graywack and shale of Martinsburg	
60.2	60.4	0.2	Martinsburg	
61.4	61.5	0.1	Jacksonburg	X
70.3	70.4	0.1	Allentown	
70.8	71.1	0.3	Leithsville	X

81.2	81.3	0.1	Brunswicke conglomerate	
81.7	81.8	0.1	Brunswicke conglomerate	
82.2	82.3	0.1	Brunswick	
82.7	82.8	0.1	Brunswick	
82.9	83.1	0.2	Brunswick	
83.8	83.9	0.1	Brunswick	
84.8	84.9	0.1	Brunswick	
86.7	86.8	0.1	Brunswick	
87.6	87.8	0.2	Brunswick	
88.3	88.4	0.1	Brunswick	
89.5	89.6	0.1	Brunswick	
89.7	89.8	0.1	Brunswick	
99.9	100	0.1	Diabase	
100.2	100.3	0.1	Diabase	
104.4	104.9	0.5	Brunswick	x

Table 4 shows mile posts between which pipeline construction would compact soils on ridge tops. Recharge on ridges has a longer path to follow to reach streams, although some shallow aquifers are very thin and may support isolated streams and springs. On ridge tops with fractured bedrock, recharge will circulate deeply into the bedrock. There are 17.1 miles of pipeline on ridge tops (Table 4) so, considering recharge at just 10 in/yr, total lost recharge due to compaction along the pipeline would be as much as 86 af/y (summing over the reaches on Table 4). Considered as flow rate per mile, the loss is 0.007 or 0.15 cfs/mile, which can be significant for small streams during baseflow.

*Table 4: Proposed pipeline reaches by milepost which lie on ridge tops. Developed from topographic mapping RR1 Appendix D.*

Beginning	Ending	Miles	Bedrock
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MP	MP		
0.8	1.1	0.3	Catskill
1.7	2	0.3	Catskill
2.3	2.5	0.2	Catskill
3.6	4.1	0.5	Catskill
12.7	12.9	0.2	Mauch Chunk
14.3	14.5	0.2	Spechty Kopf
15.3	15.6	0.3	Catskill
17.2	17.7	0.5	Spechty Kopf
20.4	21.2	0.8	Pocono
23.4	24	0.6	Catskill
29.5	30.5	1	Catskill
33.8	34.4	0.6	Spechty Kopf/Catskill
39	39.5	0.5	Catskill
45.2	47.7	2.5	Catskill
48.4	48.8	0.4	Buttermilk Falls Limestone
51	51.3	0.3	Shawangunk
59.6	61.3	1.7	Martinsburg
73.6	74.2	0.6	Hornblende gneiss
78.2	79	0.8	Jacksonburg limestone
80.6	81.2	0.6	Brunswick conglomerate
81.3	81.6	0.3	Brunswick

81.8	82.2	0.4	Brunswick
82.4	82.7	0.3	Brunswick
84.1	84.9	0.8	Brunswick
85.7	86.7	1	Brunswick
87.9	88.3	0.4	Brunswick
88.5	89.5	1	Brunswick

The analyses in Tables 3 and 4 are a representation of the type of analysis that the DEIS should have included in much more detail. The simple summary is that pipeline construction will cause precipitation to runoff and not recharge the groundwater. Because groundwater discharging to streams is the majority of streamflow during dry periods, the pipeline could cause streams to have much less flow during critical periods. This is most important for small streams.

- The DEIS fails to consider how the project construction would affect recharge rates, which are highly variable with the underlying geology, soil type and thickness, and topography controlling the actual recharge location.

The following paragraphs present a few examples of pipeline reaches that have compactible soils which the proposed pipeline could affect. The DEIS fails to assess these and similar areas in detail throughout.

For example:

→ Starting at MP 29.5 is a series of high compactable soils through MP31.2 (Table 2 and Figure 8). This reach is generally up and down the slopes of a ridge in Hickory Run State Park so runoff would be straight downhill. The bedrock is Catskill Formation which has specific capacity from 0 to 43 gpm/ft (RR2 Figure 2.2-1) and very wide ranging well yields (Taylor 1984). Recharge varies from 20 to 22.2 in/yr in this area (RR2, Figure 2.2.4-1), so pipeline construction could reduce recharge (and inflow to the wetland) by as much as 4.4 af/y (0.006 cfs or 2.8 gpm). The bedrock properties control whether the lost recharge is shallow or deep. Based on the size of the wetland (Figure 9), the area affected by the pipeline appears to be a couple percent of its tributary area, but the effect of losing this amount of recharge would depend on the connectivity of parts of the wetland. Considering that compaction could reduce recharge up to 4.4 af/y through this reach, the DEIS must provide the detail necessary to adequately assess how the lost recharge will affect hydrogeology of the area. That missing information is an irreparable deficiency that can only be remedied by providing the data and analysis necessary to assess this impact.



Figure 8: Snapshot of a portion of RR7 Figure 7.1-1 showing soils along the proposed pipeline, MP 29.5 to MP 31.8.

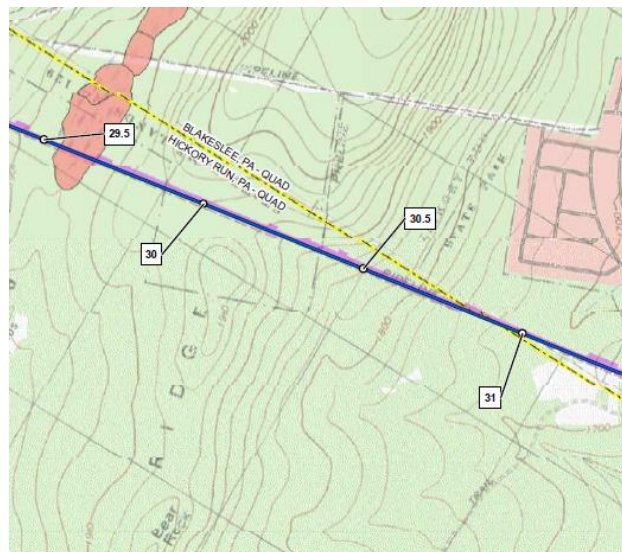


Figure 9: Snapshot of wetlands map (RR1, Appendix D, p 9 of 32).

→ At least 0.2 miles of compactible soil between MP 94.5 and MP 95.1 would reduce water flow to the wetlands located at MP 95.1 (Figure 10). The soil is Croton silt loam (Figure 11). Other wetlands cross or bound the pipeline near MP 94.5 (Figure 10). The proposed pipeline could intercept recharge either percolating at these points or flowing to the wetlands through shallow groundwater, inflicting a damaging water deficiency to the wetlands and the ecological systems it sustains.





Figure 10: Snapshot of wetlands map (RR1, Appendix D, p 26 of 32).



Figure 11: Snapshot of soils maps from MP 93.8 to 95.8 (RR7, Figure 7.1-1). CoxBb is compactible Croton silt loam.

→ Compactible soils from MP 27 to 27.3, just south of I-80 (not shown), coincide directly with wetlands between the same mile posts. This could be one of the more challenging areas for pipeline construction and will be one of the areas that will be most highly impacted without protective avoidance construction practices. Compaction will not only prevent recharge through a significant section of the wetland but compaction could also create zones across which water will not flow thereby creating segmented

aquifers within the wetland. This would render both sections more susceptible to drought and more susceptible to a contaminant spill because the dilution potential would be reduced.

→ Compactible soils from MP 34.5 through 34.8 control drainage to both sides of a wetland at MP 34.6 (Figures 12 and 13). Compaction could eliminate up to 3 af/y of recharge (0.3 miles, 50 foot wide construction corridor, 20 inches/year recharge) that supports a wetlands approximately 3.3 acres (Figure 13) in size. As a result, the water balance of the wetlands would be considerably changed and the wetland would become highly vulnerable to and/or impacted by drought. This could significantly harm the wetland even if the compaction is temporary.

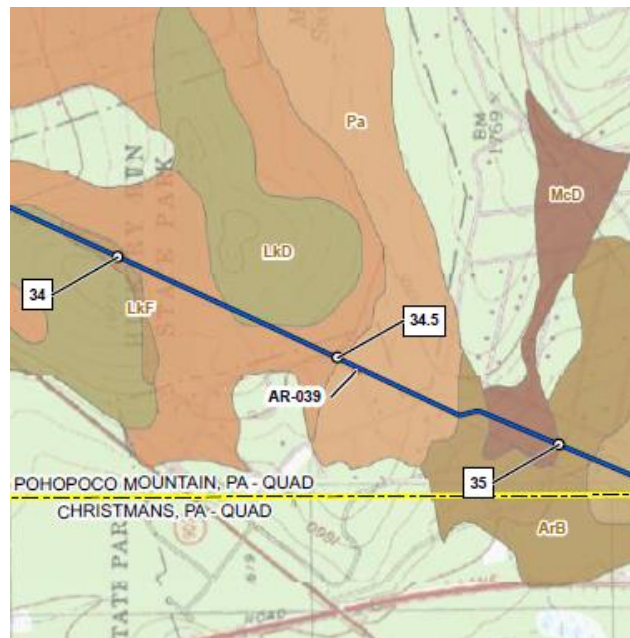


Figure 12: Snapshot of soils map from MP 33.8 to 35.2 (RR7, Figure 7.1-1).

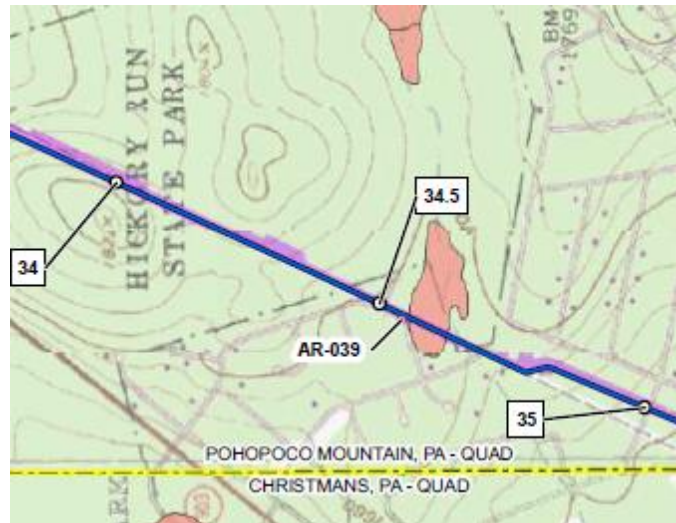


Figure 13: Snapshot of wetlands map (RR1, Appendix D, p 10 of 32).

→ Compactible soils from MP 49 to 49.4 coincide with wetlands between the same mile posts along the Aquashicola Creek. (Figure 14). This section will be in the floodplain of Aquashicola Creek in Papakating silty loam (Table 2), which is considered poorly draining. Compaction in this soil at this area may prevent recharge from the south from reaching the creek. It is foreseeable that the trench could create a barrier that segments the floodplain (see Section 5.62). Considering the width of the floodplain area with a compacted trench bisecting it, it is foreseeable that the pipeline would cause geomorphic impacts during flood events. The stream would be captured by the trench or shifted from side to side. Groundwater forced to the surface by the trench could form small channels near the pipeline.



Figure 14: Snapshot of wetlands map (RR1, Appendix D, p 14 of 32).

- The DEIS completely failed to consider how pipeline construction will affect the water balance of wetlands with groundwater inflow.
- The DEIS completely failed to consider how pipeline construction will affect recharge into bedrock by not considering how compaction will prevent water from accessing fracture zones.

## 7.2 Preferential Flow

Pipeline construction in valley bottoms affects groundwater flow in other ways. If the conductivity of the backfill is higher than that of the surrounding aquifer material, the trench could intercept flow to the stream and cause it to flow elsewhere, possibly never to reach the stream. If the conductivity is lower than that of the surrounding aquifer material, it could deflect the groundwater flow away from the stream, although it could also cause the groundwater flow to discharge to the surface away from the stream. All of these impacts are foreseeable and yet not assessed by the DEIS.

Groundwater follows the path of least resistance, which usually means the path with the highest conductivity. All but the most homogeneous formations have pathways that are much more conductive than the overall formation. The proportion of the overall flow through an aquifer that occurs through these natural pathways can be quite large. The DEIS does not discuss how the properties of the backfill would differ from those of the surrounding aquifer.

Pipeline construction would create preferential flow pathways in two ways.

One would be by creating a trench with higher conductivity than the surrounding formation. Groundwater would tend to flow into and then through the high-conductivity trench. This could occur in shallow groundwater either in low conductivity glacial till deposits or bedrock deposits. This could be most critical where the pipeline follows a steep gradient along a mountainside.

The second way is by blocking the natural flow paths with a lower conductivity backfill that diverts groundwater along the interface between the trench and the natural formation. This could occur by compacting a trench developed in high conductivity alluvium or highly fractured bedrock so that the backfill has a lower conductivity and diverts the flow along the contact. This would be most critical in areas where the pipeline follows a steep gradient along a mountainside.

Preferential flow is most probable along slopes where groundwater flows from ridges to valley bottoms, although the effects could also occur in valley bottoms and ridgetops. It could be analyzed with analytic or numerical calculations for groundwater flow along a pipeline reach from recharge to discharge and yet the DEIS fails to undertake this important analysis.

- FERC should divide the pipeline into reaches from ridge top to wetland or stream to consider the effect of changing conductivity on groundwater flow. Impact analysis should include analytic or

numerical<sup>9</sup> calculations with and without the pipeline, and include recharge estimates along the reach and different baseline (natural in-situ) parameters for the bedrock and shallow aquifers. The with-project scenario should include the trench parameterized with values representative of lower and higher conductivity backfill. FERC should estimate the changes in discharge to downgradient wetlands or streams. The results would be indicative of potential changes rather than precise predictions. FERC should identify the areas where the impacts are most likely and propose avoidance, monitoring and mitigation (see section 3.14) for the identified impacts.

## 7.21 Drawdown

Preferential flow paths, as described in the previous section, will change flow gradients and groundwater levels. This would affect areas depending on shallow groundwater tables, which would include wetlands where small differences in water levels that persist for a substantial time period could change the character of the wetland. It would also include areas that have vegetation that depends on shallow groundwater. Lowering the water table, even a small amount, for a substantial period could have long term effects on the vegetation types, whether formally delineated as a wetland or not.

A large proportion of the wetlands crossed by the proposed project depend on groundwater. Wetlands in four Pennsylvania Counties, Luzerne, Carbon, Northampton, and Bucks had as their most common primary indicators of hydrology high water table (A2), saturation (A3), and oxidized rhizospheres on living roots (C3), with second indicators including drainage patterns (B10)<sup>10</sup>.

The DEIS does not consider the importance of shallow groundwater for wetland vegetation, but RR3 discusses the importance of shallow groundwater for several vegetation types or features. The following list presents several observations from RR3 which emphasize the importance of shallow groundwater but are noticeably absent from DEIS consideration and assessment. Shallow groundwater is important for other vegetation and habitats in other areas beyond those noted below, but these are provided by way of example.

- Perhaps the most important is the leatherleaf – cranberry bog found along the pipeline route in Luzerne County (RR3, Table 3.3-4).
- There are also vernal pools which may be seasonally supported by a high groundwater table (RR3, p 3-27). Pipeline construction could affect vernal pools by preventing the groundwater table from supporting the pool as it did prior to construction. A pipeline could also divert the drainage patterns that seasonally fill the pools.
- Scrub-shrub wetlands depend on the “presence of high groundwater for extended periods” (RR3, p 3-39).

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<sup>9</sup> Numerical calculations would include the use of numerical groundwater models to make interpretative simulations. Interpretative means that the model would be parameterized according to commonly accepted field estimates of the properties. Using logical parameter changes to reflect the backfill, the model would be run with the trench. The with- and without trench results would be compared to assess potential impacts. An interpretative model is not predictive but only indicative of likely changes because it has not calibrated.

<sup>10</sup> PennEast Pipeline Project, Wetland Delineation Report – Pennsylvania, February 3, 2016, p 1-6 through 1-9.



- RR3 notes the importance of springs for creating habitat to support the endangered (in Pennsylvania and New Jersey) bog turtle. “Bog turtles inhabit distinct types of wetland habitats that include spring-fed hydrology and mucky soils. Clear groundwater with rivulets and shallow pockets of surface water typify the hydrology of bog turtle wetlands, and subterranean tunnels with flowing water are used by bog turtles both in winter for hibernation and during the hot summer months. Deep, organic, mucky soils in which bog turtles can burrow are an important component of their habitat” (RR3, p 3-65). Pipelines near enough to springs to lower the water table could decrease the flow of necessary clear groundwater. It would not just be those within 150 feet of the pipeline, but could include springs supported by groundwater flow that has been diverted by preferential flow paths in the trench or blocked by the trench.
- A species of special concern in New Jersey, the American oystercatcher, could be affected by restrictions on the groundwater flow in its habitat (RR3, Appendix 3B-2).

Pipeline construction could affect hydrology in ways that could affect vegetation, aquatic life, and wildlife in addition to the simple construction impacts. The DEIS does not analyze how the pipeline would affect any specific area with important vegetation types or aquatic species. There are broad statements about temporary impacts during construction, but there are no analyses of the change in groundwater flow patterns that will be enduring during operation of the life of the pipeline as described herein.

- The DEIS should use numerical or analytic analyses to estimate the drawdown in the groundwater along pipeline reaches.
- The DEIS should list areas with special vegetation that are near shallow aquifers that could be impacted by drawdown from the pipeline determine in the previous bullet.

## 7.22 Contaminant Transport

The preferential flow caused by higher conductivity in trench backfill discussed in section 6.2 can also enhance the movement of contaminants into wetlands or streams. Consideration of contaminants in the DEIS mostly relies on mitigation of spills and the location of the pipeline away from hazardous waste sites. As noted above, there is also a reach with potentially acid producing soils, but the DEIS does not analyze the potential transport of acid or acid-related contaminants due to pipeline construction. It does not consider the potential for the pipeline to enhance transport of contaminants from the site.

- As part of an analysis of preferential flow, the DEIS should also analyze the potential for the trench backfill to facilitate the movement of contaminants through the groundwater.

Methane leaks from the pipeline are a potential contaminant source due to the pipeline. RR2 suggests that leak detection would help to prevent this problem. The implication is that leak detection will prevent any problem, but there is no indication about the accuracy of such claims. Dissolved methane moves through the groundwater differently than other contaminants due to its buoyancy. The pipeline could be a source of methane, or higher change gases such as ethane and propane. Wetlands crossed

by the pipeline could also be a source of methane due to biogenic processes. The pipeline trench will most certainly present a pathway for contamination – to what degree, for what contaminants and along what sections of the proposed pipeline routes (preferred and alternatives) is not assessed by the DEIS.

- Contaminant transport analysis should also include the potential for the trench to allow enhanced transport of methane of any source.

Mapping wells (RR2, p 2-9) or springs and streams (RR2, p 2-11) within 150 feet of the pipeline does not protect those water features because contaminants can easily flow far beyond that distance from the pipeline. This is particularly true where the trench intersects fracture zone or higher conductivity zones.

- The DEIS must consider the transport of contaminants, including methane and spills, from the trench to and along the preferential flow pathways and assess where they would discharge. This could be into a stream or spring, or into a broader aquifer where it could affect wells.
- The DEIS needs to assess details about the pipeline leak detection PennEast asserts it will implement, including what rate of leak can be detected and what responsive actions would be triggered?
- The DEIS should analyze the extent that methane could spread from the pipeline through the groundwater due to a leak. This is probably a preferential flow issue in that the methane would disperse along the higher conductivity in the trench until it reaches a receptive fracture intersecting the pipeline or wetland or stream.

### 7.3 Summary and Recommendations

It is likely and foreseeable that pipeline construction will affect recharge distribution in the areas crossed by the pipeline, as well as runoff, pollution transport and habitats (vegetation, aquatic and onland). Compaction, vegetation removal, soil compaction, and the trench in which the pipeline will be laid are primary vehicles for these impacts. This increases runoff as well which may allow recharge to occur elsewhere downhill. Trench compaction may also prevent groundwater from flowing across floodplains and reaching streams or wetlands near their normal discharge point.

- The DEIS should complete site-specific impact analyses that considers the potential for pipeline construction effects, including compaction and vegetation removal, to change recharge and runoff patterns.
- The DEIS should complete site-specific impact analyses showing how the changed location and rates of recharge would change baseflow in streams and wetlands.
- The DEIS should propose methods to monitor these effects. Piezometers should be installed in wetlands downgradient from the pipeline to monitor changes in water levels and compare those changes to predicted changes. Piezometers should also be installed in strategic locations of the trench backfill and just outside the trench to determine whether the trench is causing drawdown or whether preferential flow is occurring (see Sections 6.1 and 6.2).
- The DEIS should propose methods to avoid first, and mitigate second, these effects. If the analysis shows changes in recharge or flow patterns, the backfill could have drains installed to

allow cross-trench flow. If necessary the surface of the pipeline could be scarified to increase infiltration through the soils.

- The DEIS should consider the water quality and habitat impacts of changed recharge and runoff patterns.

## 8.0 CONCLUSION

The DEIS proposed by FERC is demonstrably deficient and misleading because it does not include sufficient data or analysis of the water, groundwater, recharge, runoff, water quality and habitat impacts it purports to assess. Pipeline construction will affect groundwater recharge and flow, thereby affecting surface water flow and wetlands water balances. It will affect water quality by providing transport pathways for contaminants to reach wetlands or surface water and/or by changing baseflow, runoff, and watershed habitats. The DEIS does not analyze these impacts.

From the perspective of an expert review, the DEIS is demonstrably deficient and misleading and must be revisited, in its entirety, with a new and complete DEIS proposed for public and expert review.

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