August 16, 2017

Commissioners
Delaware River Basin Commission
P.O. Box 7360, 25 Police Drive
West Trenton, NJ 08628-0360

Re: DTE Midstream Appalachia, LLC Birdsboro Pipeline Project
Natural Gas Pipeline
Borough of Birdsboro and Union, Amity, Oley and Rockland Townships, Berks County, Pennsylvania
DOCKET NO. D-2016-008-1

Dear Commissioners,

The Delaware Riverkeeper Network (DRN), a private non-profit organization, champions the rights of our communities to a Delaware River and tributary streams that are free-flowing, clean, healthy, and abundant with a diversity of life. DRN has nearly 20,000 members throughout the Delaware River Watershed including residents of the Borough of Birdsboro, Union, Amity, Oley and Rockland Townships, and Berks County.

DTE Midstream Appalachia, LLC (DTE), an applicant before the Delaware River Basin Commission (DRBC), seeks approval for the Birdsboro Pipeline Project (BPP), including: approximately 13.2 miles of new 12-inch diameter natural gas pipeline; installation of a new pig receiver at the Birdsboro Power Facility; installation of one new meter site adjacent to Texas Eastern Transmission Company (TETCO) right-of-way (ROW); one new pig launcher at the TETCO interconnect; two new taps on the TETCO pipeline; and four mainline valves (MLV) along the pipeline route in the Borough of Birdsboro and Union, Amity, Oley and Rockland Townships, Berks County, Pennsylvania; and a special use permit in accordance with Section 6.3.4 of the Commission's Flood Plain Regulations.

DRN has reviewed the proposed docket for DTE's BPP and we submit these comments:

Lack of Independent Utility

DRBC acknowledges that DTE's BPP is a required component of the 485 megawatt (MW) electric generation facility proposed to be built in Birdsboro, Pennsylvania, by Birdsboro Power, LLC (DRBC Docket No. D-2016-004-1). Other required components of the power plant include a 2-mile, 16-inch water

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line, an interconnection with Reading Area Water Authority's (RAWA's) water distribution system, a 4-mile long, 230 kilovolt (kV) electric transmission line, and a 230 kV ring bus substation that ties into the existing power grid.

The power plant and these required components constitute a single and complete project. None of these components have independent utility. None of these components would be constructed without the construction of the other components. This lack of independent utility was expressly stated in correspondence to the Pennsylvania Department of Environmental Protection (PADEP) regarding RAWA's water line.

> Response: Your understanding is correct; the project will not be undertaken without the Birdsboro Power project.[1]

DTE's BPP, RAWA's water line interconnection, and the 4-mile long, 230 kV transmission line and substation may all be linear projects, but none of these projects would be built independently of the power plant. Therefore, DRBC should consider the power plant and all its required components as a single and complete project. These components may be docketed separately, but they should be considered together to determine the total land requirements, wetland disturbance, waterbody crossings, water consumption, water quality impacts, and floodplain impacts. Taken together, this power plant and its required components will have substantial adverse impacts on the water resources of the Basin. By not considering the power plant and its required components together, DRBC is inappropriately segmenting this single and complete project.

Conflict with the DRBC's Floodplain Regulations

DRN also maintains that DRBC erred when it approved the docket for Birdsboro Power. That docket constituted a special use permit in accordance with section 6.3.4 of the Commission's Flood Plain Regulations (18 CFR 415.33). Section 6.3.4 of the Commission's *Flood Plain Regulations* requires that:

> "[p]ublic utility facilities, roads, railroad tracks and bridges shall be designed to minimize increases in flood elevations and shall be compatible with local comprehensive flood plain development plans to the extent applicable."

However, DRBC approved filling of the floodplain at the proposed power plant site with compacted fill to raise the land surface by 4 feet. The final grade is intended to be at least 1 foot above the regulatory flood elevation. Given the footprint of the proposed power plant facilities (estimated to be in the range of 200,000 to 400,000 square feet), this floodplain filling would displace at minimum of 600,000 cubic feet of floodwaters when inundated by the regulatory flood. By allowing this filling of the 100-year regulatory floodplain, flooding in the vicinity of the power plant site as well as downstream will be exacerbated. Past flooding in Birdsboro has been attributed to backup of the Hay Creek from high stages of the Schuylkill River. The proposed fill on the power plant site will only exacerbate the issue of Hay Creek backup during high Schuylkill flows. DRBC should have required analysis of the displaced floodwaters prior to approval of Birdsboro Power's docket.

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[1] Weld, T.L. 24 Feb 2017. Letter to Nicholas T. Pyo, PADEP Southcentral Regional Office, *Ref: 18th Ward Water Booster Pump Station Upgrade and Water Main installation*

Apparent Omission from Docket No. D-2016-004-1

In DRBC Docket No. D-2016-004-1, DRBC notes that construction of the water, sewer, and natural gas fuel utilities required to serve the proposed power "will be located below grade and as such, will be protected from damage as a result flood fringe inundation." Even though 7 transmission line monopoles would be located in the floodway and 12 transmission line monopoles would be located in the flood fringe, DRBC considered the potential impact on flood elevations to be negligible and suggested that it was not expected to exacerbate flooding.

The proposed 4-mile long 230 kV transmission line will terminate at a 230 kV ring bus substation that ties into the existing power grid. However, it is unclear whether the proposed substation and its environmental impacts, which will likely include floodplain filling, were adequately considered by DRBC. It is also unclear if the construction of the substation should be considered to be included in DRBC Docket No. D-2016-004-1. The power plant docket mentions the substation only three times and primarily in the context of the point at which the transmission line ends.

The land required for the substation appears to be included in the total area to be disturbed by the transmission, but no mention of floodplain impacts associated with the substation site is included in DRBC Docket No. D-2016-004-1. The proposed substation will be built in the floodplain. The site of the proposed substation is located in both the flood fringe and the flood way (see Attachment A).

> The areas within the Robeson Township adjacent to the Schuylkill River are particularly low lying areas and are subject to minor flooding even after moderate rain or thaw conditions.[2]

Furthermore, the developer of the substation appears to be planning to undertake floodplain filling to secure local zoning approval:

> [T]he current [substation] design is, or can readily be made, generally consistent with the Robeson Township Floodplain Management and Stormwater Management Ordinances.[3]

This need to for floodplain filling is underscored in the Assumptions listed in the *Generation Interconnection Facility Study Report* (emphasis added):

> Initial surveys indicate portions of the AA2-115 interconnection substation site are in the 100-year flood plain of the Schuylkill River. Due to geology/topography and environmental impacts of the proposed substation site, the Developer must work through Transmission Owner on design details relative to the civil site development design requirements for raised elevation of the substation site and access road and associated environmental mitigation requirements.[4]

The apparent omission, in DRBC Docket No. D-2016-004-1, of reference to the floodplain filling for the substation suggest that any floodplain filling for this purpose is not expressly authorized by special permit

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[2] Dawood Engineering, Inc. (December 2016). Hydrologic and Hydraulic Report for Birdsboro Power, LLC Electric Transmission Line

[3] Kraft, G.D. 4 Feb 2017. Letter to Toby R. Stutzman, Dawood Engineering, Inc., *Re: Birdsboro Power, LLC, KE File - A278c*

[4] PJM Interconnection. (December 2016). Generation Interconnection Facility Study Report For PJM Generation Interconnection Request Queue Position AA2-115 S. Reading-Boyertown 230 kV

under 6.3.4 of the Commission's *Flood Plain Regulations*. No work should be allowed to proceed on the substation until it is fully and properly permitted.

This apparent omission also underscores the importance of considering a project like the proposed Birdsboro power plant and all its required connections as a single and complete project, a step that would help to ensure that the full scope of all impacts are considered together. DRN also requests that DRBC reopen DRBC Docket No. D-2016-004-1 for comment so that the full impacts of the proposed 230 kV transmission line, substation, and any required floodplain filling can be considered in the full context the proposed power plant project.

Need for the DTE BPP

DRBC should consider the need proposed natural gas pipeline in the context of the need for the proposed power plant. Without the power plant, there is no need for the proposed pipeline. The sole customer for this pipeline is Birdsboro Power. Pennsylvania is already the largest exporter of electricity in the nation, so the electricity to be generated at the proposed power plant Birdsboro is not needed in Pennsylvania, yet Pennsylvanians and Pennsylvania's environment will bear the harm from these impacts. Moreover, given that the costs of shipping electricity make it impractical to move long distances, building the power plant and constructing these appurtenant structures in Berks County, where the electricity is not needed, does not make sense.

Cumulative Impact of New Natural Gas Power Plants

Production of fracked shale gas and its liquids in central and western Pennsylvania has resulted in a push by the natural gas industry and their pipeline partners to construct new and expanded processing, transport, and end use infrastructure. PADEP has approved more than 47 natural gas power plants since January 2014. In the past six years, 13 new pipeline projects/expansions have been built in just the Delaware River watershed, and at least 12 more pipelines are proposed for this region. The likely result will be increased consumption of natural gas (in both foreign and domestic markets) which in turn means pressure for increased shale gas production in Pennsylvania and increased impacts in the Delaware River Watershed.

The development of so many new natural gas power plants will have substantial effects and will continue to have substantial effects on the water resources of the Basin through consumptive use. Conserving and protecting the water resources of the Delaware River Basin is central to the mission of the DRBC. DRN notes that the Schuylkill River watershed and the middle Schuylkill region in particular have experienced growth and continues to see increasing water demand, particularly with respect to thermoelectric generation. In its 2010 report, *Schuylkill River Hydrology and Consumptive Use Report*, the Philadelphia Water Department (PWD) noted that Pennsylvania "defines watersheds with a consumptive use above 50% of the 7Q10 as having stressed water resources." PWD goes on to note that:

> *The Schuylkill River is approaching water stress conditions.* Combined upstream consumptive use and downstream consumptive use total 42% of the 1 in 25 year annual average baseflow, which implies the Schuylkill River is approaching a water stress situation. The upstream consumptive use is 22% and the downstream consumptive use is 20% of the predevelopment 1 in 25 year annual average baseflow.[5]

[5] Philadelphia Water Department. (2010). Schuylkill River Hydrology and Consumptive Use Report.

Given the potential consumptive demand of new natural gas power plants coupled with concerns that the Schuylkill River is approaching water stress conditions, DRN recommends DRBC undertake a study of the need to extend the Southeastern Pennsylvania Ground Water Protected Area (GWPA) regulations to the full Schuylkill River watershed.

In addition, the DRBC could conserve and protect the water resources of the Delaware River Basin by adopting a resolution encouraging the use of dry cooling technology for power generation similar to that adopted by the Susquehanna River Basin Commission.[6]

Preferred Route

DRN questions the applicant's selection of a preferred route that requires the crossing of a hazardous liquids pipeline (see Attachment B).

The DTE BPP will also cross Karst geology and carbonate rocks (see Attachment C). The ramifications for this geology include increased potential for sinkholes during and after construction as well as the increased potential for a pipeline break.

DTE's preferred route impacts more wetlands than any alternatives considered as well as the most forested/shrub-scrub wetlands. It also impacts the largest extent of forested land.[7] If DRBC does docket this pipeline, it should require route variations to further reduced impacts to wetlands, waterbodies, and forested areas.

DTE's preferred route also crosses land on which a quarry is now active. The Lehigh Cement Company LLC (Lehigh) quarry site will be crossed by 6,734 feet of pipeline. DTE indicates it has a ROW easement in place the does not allow Lehigh to blast in the vicinity of the pipeline. However, DTE leaves the door open for Lehigh to request permission to blast in the vicinity of the pipeline in the future.

> It is recommended that if Lehigh ever comes to DTE and requests permission to blast anywhere in the area of the pipeline, that a new analysis be performed.[8]

DRBC should not docket DTE's BPP unless Lehigh signs an easement agreeing never to blast within 200 feet of the proposed pipeline. DTE should also be required to commit to never allowing Lehigh to blast within 200 feet of the pipeline.

Wetland Disturbance

DRN believes that the applicant's delineated wetland boundaries deserve scrutiny. We have seen that applicants have failed to identify and delineate wetlands along with other proposed pipeline routes. For example, data collected by DRN volunteer monitors along a ½ mile section of the proposed PennEast Pipeline route found at least 12 vernal pool complexes or groundwater seeps where the PennEast

[6] Susquehanna River Basin Commission. (2015). Resolution No. 2015-02: Use of Dry Cooling Technology for Power Generation and other Facilities.

[7] GAI Consultants, Inc. (February 2017). Federal Energy Regulatory Commission Draft Resource Report 10, DTE Midstream Appalachia, LLC, Docket No. PF17-1-000 Birdsboro Pipeline Project, Berks County, Pennsylvania

[8] Peterson Engineering. (June 2017). Study of the Effects of Blasting near a Pipeline.

Company identified just two vernal pool habitats and no groundwater seeps. DTE has identified just 3 vernal pools along the path of the BPP.[9]

DTE proposes to affect 2.48 acres of wetlands during the construction of the BPP, including approximately 1.35 acres of palustrine emergent wetland (PEM), 0.06 acres of palustrine scrub-shrub (PSS) wetlands and 1.07 acres of palustrine forested wetlands (PFO). Following construction, applicant proposes to restore disturbed wetland areas to preexisting contours and allowed them naturally revegetate. Approximately 0.06 acres of PSS and 1.07 acres of PFO wetlands, located in the permanently maintained corridor, will be permanently converted to PEM wetlands. Likely more extensive alterations than described here will occur in these wetlands. DRN has attached a report by Schmidt Associates (Attachment D) documenting the adverse impacts associated with the conversion of forested wetlands to emergent wetlands.

The Little Manatawny Creek is on the Pennsylvania Fish and Boat Commission's Wild Trout List due to the presence of naturally reproducing brown trout. As such, all wetlands in an along the floodplains of the Little Manatawny and its tributaries are classified as Exceptional Value (EV) and cannot be degraded. The applicant does not indicate whether any of the wetlands to be permanently converted are EV wetlands. Conversion of EV wetlands should not be allowed. If any EV wetlands are being permanently converted from a PFO to a PEM, they are being altered in direct conflict with Pennsylvania state law.

The extent of the wetland impacts associated with this pipeline suggests that impact avoidance and minimization does not appear to have been attempted aggressively. A review of the pipeline route suggests that impacts to roads or structures may have been avoided by diverting the route through wetlands.

Instead of making every effort to avoid wetlands, the applicant has opted for a program of compensatory mitigation. The applicant proposes to offset permanent wetland conversion impacts to PSS and PFO wetlands with a PEM wetland enhancement totaling 3.72 acres. Given that replacement and enhancement may both be ineffective, compensatory mitigation should be a last resort. When proposed, it should strive toward functional replacement of lost wetlands, rather than just areal replacement. The applicant proposes wetland enhancement rather than replacement. As such, it appears this project will result in a net loss of wetland acreage as well as a loss of wetland functions and values.

Wetlands provide various ecosystems services such as carbon storage, flood abatement, water quality maintenance, and biodiversity support. Wetland mitigation and other "offset" policies rely on restoration as a form of compensation for the loss of ecosystem function and structure, with the assumption that the entire suite of ecosystem services that have been lost will be replaced.[10] Research over the past decade indicates that there are many cases where wetland restoration, including compensatory mitigation, leads to the creation of wetlands that are not ecologically equivalent to naturally occurring wetlands, which calls into question the level to which ecosystem services can be replaced. [11] It is unlikely that any mitigation will fully restore each ecosystem service equally.

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[9] Dawood Engineering, Inc. (February 2017). Wetland and Stream Delineation Report, Birdsboro Pipeline Project 216097.01, Union, Amity, Oley, and Rockland Township; Borough of Birdsboro, Berks County, Pennsylvania.

[10] Jessop, J., et al. (2015). Tradeoffs among ecosystem services in restored wetlands. Biological Conservation, 191, 341-348. http://ward.nres.illinois.edu/pubs/Jessop%20et%20al%20Bio%20Conservation%20(2015).pdf

[11] Jessop, J., et al. (2015). Tradeoffs among ecosystem services in restored wetlands. Biological Conservation, 191, 341-348. http://ward.nres.illinois.edu/pubs/Jessop%20et%20al%20Bio%20Conservation%20(2015).pdf

Tradeoffs occur when one service is changed at the expense of another. For example, studies have shown that optimizing restored wetlands for nutrient cycling and removal comes at the expense of less biodiversity. [12] There are currently no standard requirements for measuring ecosystem functions at impacted wetlands prior to impact or after mitigation or restoration. The performance standards used to evaluate mitigation wetlands are based on vegetation and provide little indication of whether other ecosystem functions are being replaced in any capacity. Therefore, it is unknown which ecosystems services are being provided through wetland mitigation and their level of effectiveness. [13] It is likely that many ecosystem services will be impaired compared to what the natural wetland provided.

After construction, the applicant proposes to restore preconstruction contours, vegetation, and hydrology. However, compaction of soil along pipeline routes ultimately leads to differences in hydrology of impacted wetlands and waterbodies. Soil samples were taken along the existing the Tennessee Gas Pipeline Company's 300 Line on November 29, 2012 and simply attempting to dig along the right of way (ROW), in comparison to digging in the nearby adjacent intact forest, indicated that severe compaction had occurred along the existing ROW. This soil compaction is further illustrated by the lack of vegetation that continues to persist adjacent and near wetlands and elsewhere along the TGP 300 Line.

DRN has learned that appears that some pipeline companies considers temporary work spaces (TWS) or additional temporary work spaces (ATWS) to have no impact on wetlands located there. TGP considers this to be "no impact" and as a result no acreages are included for wetlands in these areas. Since TWS and ATWS are often located in very close to streams and wetlands, or in forest areas, soils in these work spaces will be compacted by heavy equipment. Removal of adjacent trees eliminates shading for nearby waterbodies. Forests will take generations to recover and grow back. ATWS and TWS areas should be avoided and minimized and the footprint of the ROW should be reduced to the greatest extent possible.

Waterbody Crossings

DTE BPP proposes to directly cross 17 waterbodies: 11crossings will use open cut dry crossing methods, 5 crossings will use horizontal directional drilling (HDD), and 1 crossed will use conventional bore. In addition to the 5 waterbody crossings, it appears that 7 wetlands will also be crossed using HDD, a process that results in cuttings or spoils. The wetland and waterbody HDD crossings total approximately 4,500 feet, nearly a mile, with approximately1,400 feet of that total associated with the HDD crossing of the Schuylkill River.[14] This volume of HDD will undoubtedly produce large amounts of spoils.

The applicant states that "All HDD fluids and cuttings recovered from the bore pits will be hauled off-site to a state approved facility." No mention is made regarding the potential for some of the spoils to be contaminated. The power plant site where the HDD crossing of the Schuylkill River will exit has seen industrial use since 1740. The level of contamination of the soils on this brownfield site has prompted DTE to make the recommendation that:

[12] Jessop, J., et al. (2015). Tradeoffs among ecosystem services in restored wetlands. Biological Conservation, 191, 341-348. http://ward.nres.illinois.edu/pubs/Jessop%20et%20al%20Bio%20Conservation%20(2015).pdf

[13] Jessop, J., et al. (2015). Tradeoffs among ecosystem services in restored wetlands. Biological Conservation, 191, 341-348. http://ward.nres.illinois.edu/pubs/Jessop%20et%20al%20Bio%20Conservation%20(2015).pdf

[14] GAI Consultants, Inc. (February 2017). Federal Energy Regulatory Commission Draft Resource Report 1, DTE Midstream Appalachia, LLC, Docket No. PF17-1-000, Birdsboro Pipeline Project, Berks County, Pennsylvania.

> Fill containing surface soils located in the proposed pipeline right-of-way should be removed prior to performing pipeline work. The fill containing surface soil should be disposed at properly regulated waste facility. [15]

Despite the agricultural nature of the region the DTE BPP will cross, this area has a long history of development, including industrial uses that may have passed from memory. Amity Township is the oldest incorporated township in Berks County with settlement dating to the early 1700s. HDD spoils from the Schuylkill River crossing and the other waterbody and wetland crossings may include harmful constituents which may require special handling and disposal. This docket should include special conditions requiring special handling of spoils.

Furthermore, this docket does not address the threat of inadvertent returns, or inadvertent spills of drilling fluids. Inadvertent returns are considered to be a common occurrence with HDD crossings.[16]

> An analysis by FracTracker and the Clean Air Council finds that approximately 202,000 gallons of drilling fluids have been accidentally released in 90 different spill events while constructing the Mariner East 2 pipeline in Pennsylvania. In a more recent update, FracTracker estimates these occurred at 42 distinct locations.[17]

Among the Mariner East 2 spills was one not far from the path of the DTE BPP in Cumru Township where approximately 500 gallons of fluids surfaced in retention pond on May 31, 2017. The drinking water intake for the Borough of Pottstown's is located just a short distance downstream from the site of the proposed HDD crossing of the Schuylkill River. Given problems that have resulted with inadvertent returns during construction of other pipelines such as the Mariner East 2, DRBC should require special conditions in the docket regarding notification, containment, cleanup, and restoration activities.

Water Supply

The applicant estimates needing approximately 0.420 million gallons of water for hydrostatic testing, 0.05 million gallons of water for HDD operations, and 0.03 million gallons of water for dust control. DTE proposes purchasing the needed water from RAWA. DRN questions how this will be accomplished given that the municipalities along the path of the proposed pipeline (Borough of Birdsboro and Union, Amity, Oley and Rockland Townships) are not within RAWA's current service area.

> **3. Area Served.** The RAWA service area currently includes the City of Reading; Bern, Grill, Greenfield, Kenhorst, Lower Alsace, and Ontelaunee Townships; and portions of Muhlenberg and Cumru Townships. Each of the areas served are located in Berks County, Pennsylvania. Additionally, RAWA sells water wholesale to the Boroughs of Wyomissing, West Reading, Shillington and Mount Penn; and Muhlenberg Township, all in Berks County, Pennsylvania. RAWA also has interconnections with Bern Township Municipal Authority (0.9 mgd), Ontelaunee Township Municipal Authority (1.6 mgd), and Reading Regional Airport Authority (0.2 mgd). This docket approves the interconnection with the

[15] Dawood Engineering, Inc. (May 2017). Limited Geoprobe Investigation Report: HDD Pit and Pipeline, Former Armorcast Site for: Birdsboro Pipeline, Berks County, Pennsylvania.

[16] Tetra Tech, Inc. (December 2016). HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan: Pennsylvania Pipeline Project.

[17] Jalbert, K. (2 August 2017).Mariner East 2 Drilling Fluid Spills – Updated Map and Analysis. FracTracker Alliance. Retrieved from https://www.fractracker.org/2017/07/me2-drilling-fluid-spills/

Pennsylvania American Water Company (PAWC) Glen Alsace District water distribution system. For the purpose of defining Area Served, the Application is incorporated herein by reference consistent with conditions contained in the Decisions section of this docket. [18]

DRBC did approve a water supply interconnection between RAWA and the proposed power plant through a water pipeline that proposed to run approximately 2.5 miles northwest from the Birdsboro Power facility along Route 724 through Robeson Township and Kenhorst Borough to RAWA's water distribution system.

The interconnection approved in this docket will be acknowledged and D-2016-004-1 (Emberclear Corporation – Birdsboro Power, LLC Consumptive 4 Use incorporated into RAWA's Area Served and list of interconnections in the next renewal of or modification to Docket No. D-2000-059 CP-2 (RAWA Surface Water Withdrawal and Interconnection Project) in the future.[19]

The docket approved by DRBC for the Birdsboro Power facility did not approve use of the new interconnection for the DTE pipeline water needs. DRN reiterates its request that DRBC reopen RAWA's docket now to ensure interested members of the public are fully apprised of what appears to be yet another expansion of the RAWA service area in which approval is requested after the fact. The public should be given opportunity to submit informed comment on RAWA's practices before this docket is approved.

DRN is also concerned that the applicant proposes piping the needed water from existing unmetered RAWA water hydrants. With no metering in place to verify the amounts of water used, how can RAWA verify that the applicant is taking no more that the proposed amounts? DRBC should require metering to ensure that the applicant is only allowed to take the approved volume of water.

DRN also notes that use of water from hydrants for construction purposes is considered by RAW to be a nonessential uses of water. If RAWA is experiencing a short term supply shortage, it may request general conservation of inside water uses and may impose mandatory conservation measures to reduce or eliminate nonessential uses of water.[20]

Given dry conditions that persisted throughout the Delaware River Basin in 2016, DRBC should require to the applicant identify an alternative water supply. Should dry conditions return during construction of the BPP, the applicant should have a reliable source of water the provision of which does not put drinking water supplies at risk. On November 3, 2016, PADEP declared a drought warning for Carbon, Lehigh, Monroe, and Northampton Counties.[21] Berks County, with rainfall at just 82% of normal, was one of 30 counties under drought watch. [22] In October 2016, Berks County received just 27 percent of its normal rainfall for the month. [23]

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[18] Delaware River Basin Commission. (2012). DOCKET NO. D-2012-023-1.

[19] Delaware River Basin Commission. (2016). DOCKET NO. D-2016-004-1.

[20] Reading Area Water Authority. (1994). Water Service Resolution Governing the Furnishing of Water Service Within the City of Reading and in portions of the Townships of Muhlenberg, Lower Alsace, Bern, Ontelaunee, and Cumru and Borough of Kenhorst, Berks County.

[21] Yoder, M. (3 November 2016). Pennsylvania extends drought warning and watches. Reading Eagle. Retrieved from http://www.readingeagle.com/news/article/pennsylvania-extends-drought-warning-and-watches

[22] Pennsylvania Department of Environmental Protection (7 November 2016). Drought Information: Current Drought Information Status. Retrieved from

Wastewater Treatment

Given compliance issues of local sewage treatment plants, DRBC should ensure that the selected treatment facility has adequate capacity to treat and dispose of the water used for hydrostatic testing for this project. The City of Reading entered into a consent agreement with the U.S. Environmental Protection Agency in 1997 for longstanding discharge violations at the City's Fritz Island wastewater treatment facility.[24] As plant upgrades are not expected to be completed until 2019, this facility should not be allowed to accept DTE's hydrostatic testing wastewater. The February 2016 minutes for the Birdsboro Municipal Authority state that:

> Discussion was had on the moratoriums on connections to the wastewater treatment plant. There needs to be two years of good data for the moratorium to be lifted. That should happen after this year. [25]

If a moratorium on connections to the Birdsboro wastewater treatment plant is currently in place, it should not be allowed to receive the DTE's hydrostatic testing wastewater. DRBC should also DTE provide the list of the wastewater treatment plant facilities proposed to treat and dispose of the hydrostatic testing wastewater be provided 90 days in advance and provide opportunity for public comment on the treatment facility to be selected.

DRBC should also require that DTE secure an Industrial discharge permit with the wastewater treatment facility. The hydrostatic testing water should also be required to meet pretreatment limits before being accepted at the selected treatment facility.

Earthquake Risk

DTE should be required to show how it will respond to earthquake risk. Peak horizontal ground acceleration (PHGA) is the rate in change of motion of the earth's surface during an earthquake as a percent of the established rate of acceleration due to gravity. PHGA values for the path of the proposed water line range are approximately 14-percent, values that correspond to earthquakes that can cause significant building damage.[26] Earthquakes can and have occurred in the vicinity of the proposed pipeline, including in the Flying Hills area, as well as the vicinity of the proposed power plant (see images below).[27]

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http://www.dep.pa.gov/Business/Water/PlanningConservation/Drought/Pages/default.aspx; Yoder, M. (3 November 2016). Pennsylvania extends drought warning and watches. Reading Eagle. Retrieved from http://www.readingeagle.com/news/article/pennsylvania-extends-drought-warning-and-watches

[23] Yoder, M. (3 November 2016). Pennsylvania extends drought warning and watches. Reading Eagle. Retrieved from http://www.readingeagle.com/news/article/pennsylvania-extends-drought-warning-and-watches

[24] City of Reading. (2017). Wastewater Conveyance And Treatment, https://www.readingpa.gov/content/waste-water-treatment-plant

[25] Birdsboro Municipal Authority (9 February 2016). Birdsboro Municipal Authority Meeting 2/9/16.

[26] Pennsylvania Emergency Management Agency. 2013. Pennsylvania 2013 Standard State All-Hazard Mitigation Plan.

[27] https://earthquaketrack.com/

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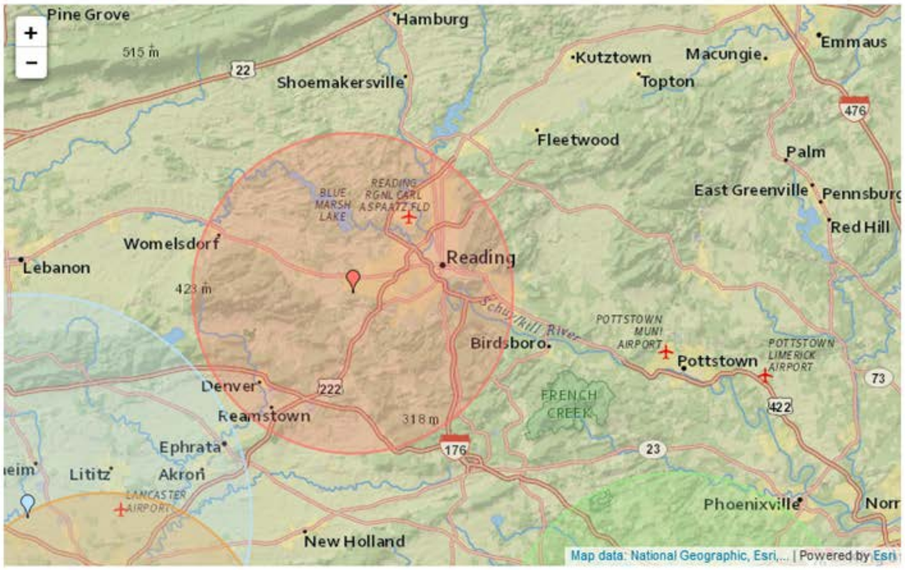

- 3 months ago 2.3 magnitude, 5 km depth
  Willow Street, Pennsylvania, United States
- 2 years ago 1.5 magnitude, 1 km depth
  Conestoga, Pennsylvania, United States
- 2 years ago 2.7 magnitude, 2 km depth
  Downingtown, Pennsylvania, United States
- 4 years ago 1.8 magnitude, 5 km depth
  Conestoga, Pennsylvania, United States
- 6 years ago 5.8 magnitude, 6 km depth
  Louisa, Virginia, United States
- 8 years ago 2.3 magnitude, 3 km depth
  Raubsville, Pennsylvania, United States
- 8 years ago 2.8 magnitude, 5 km depth
  Pennsville, New Jersey, United States
- 9 years ago 3.4 magnitude, 4 km depth
  Landisville, Pennsylvania, United States
- 9 years ago 2.1 magnitude, 1 km depth
  Milford, New Jersey, United States
- 10 years ago 2.1 magnitude, 7 km depth
  Sinking Spring, Pennsylvania, United States

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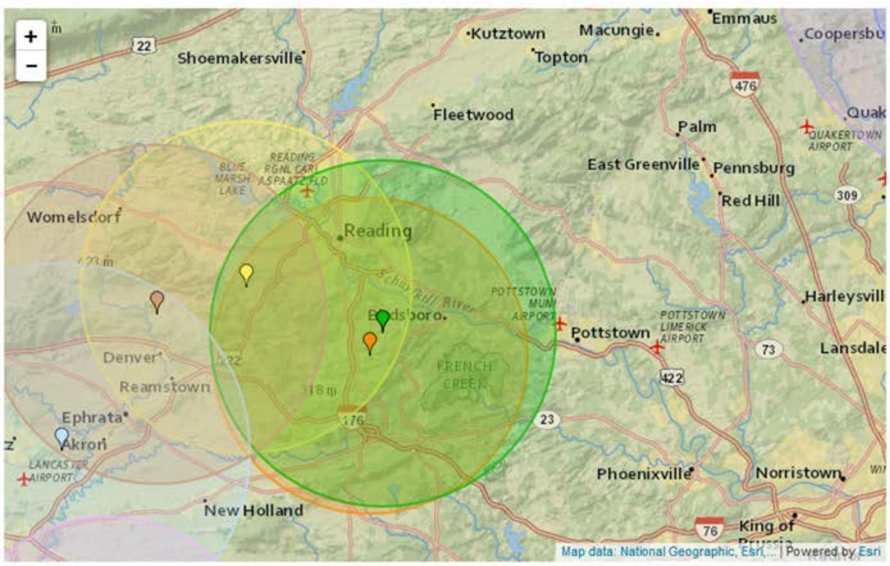
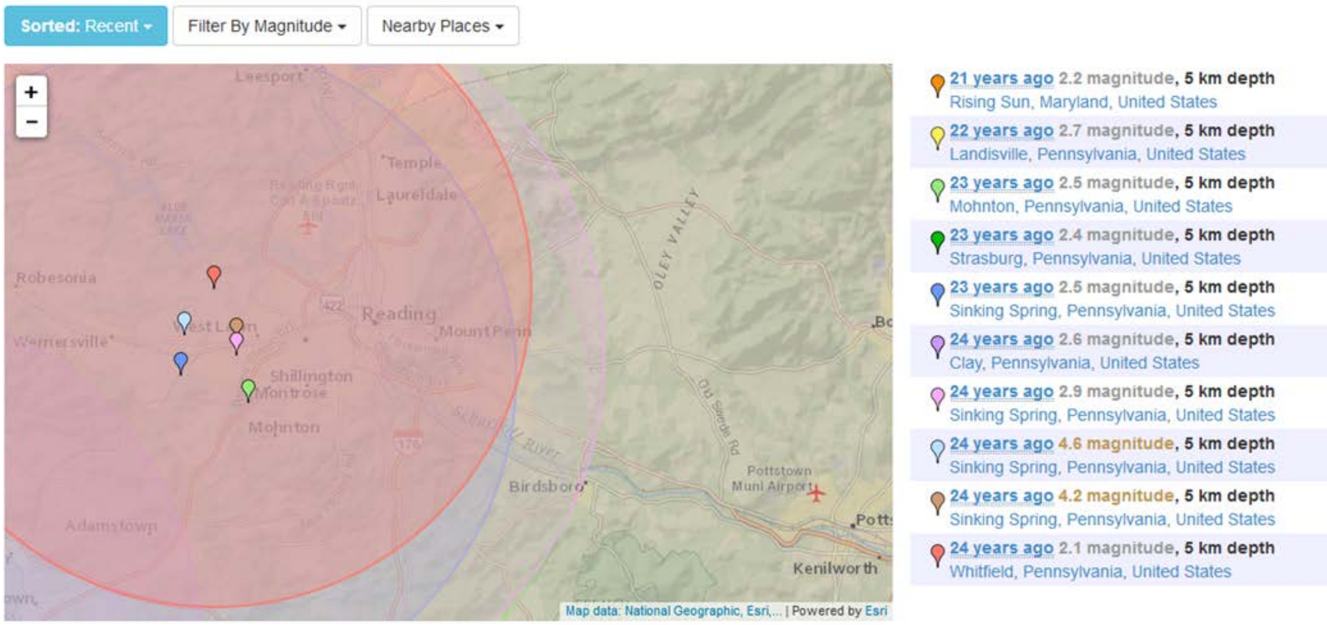


- 10 years ago 2.1 magnitude, 7 km depth
  Flying Hills, Pennsylvania, United States
- 11 years ago 2.5 magnitude, 6 km depth
  Sinking Spring, Pennsylvania, United States
- 13 years ago 2.2 magnitude, 2 km depth
  Barrington, New Jersey, United States
- 14 years ago 2.7 magnitude, 1 km depth
  Flying Hills, Pennsylvania, United States
- 14 years ago 2.4 magnitude, 3 km depth
  Milford, New Jersey, United States
- 14 years ago 3.8 magnitude, 3 km depth
  Milford, New Jersey, United States
- 17 years ago 2.0 magnitude, 5 km depth
  Strasburg, Pennsylvania, United States
- 20 years ago 3.0 magnitude, 5 km depth
  Rothsville, Pennsylvania, United States
- 21 years ago 2.6 magnitude, 5 km depth
  Reinholds, Pennsylvania, United States
- 21 years ago 2.2 magnitude, 5 km depth
  Rising Sun, Maryland, United States



Docket Approval Duration

DRBC proposes a docket with no expiration date. If DRBC does not disapprove this docket, it should include a docket renewal provision to afford the opportunity to address repair or replacement needs as well as potential abandonment by the applicant. DTE's has significant maintenance obligations for its existing pipeline system. DTE has nearly 2,500 miles of cast-iron main in its pipeline system, the second-most of any utility in the U.S.[28] DTE's pipeline system is also reported to have 285 miles of unprotected, bare steel pipe in its system.[29] DRBC has a vested interest in ensuring that the applicant continues to protect the water resources of the Delaware River Basin. A docket renewal provision would give DRBC the greater ability to ensure pipeline operators don't walk away from their responsibilities in the event of financial hardship.

Summary

DRN urges the DRBC to disapprove this docket because this pipeline, the power plant it serves, and the power plant's other required components will have substantial adverse impacts on the water resources of the Basin. At a minimum, DRBC should delay taking action on this draft docket until concerns and questions raised by this application, including another possible expansion of RAWA's service area, have been fully addressed.

Thank you for the opportunity to provide these comments.

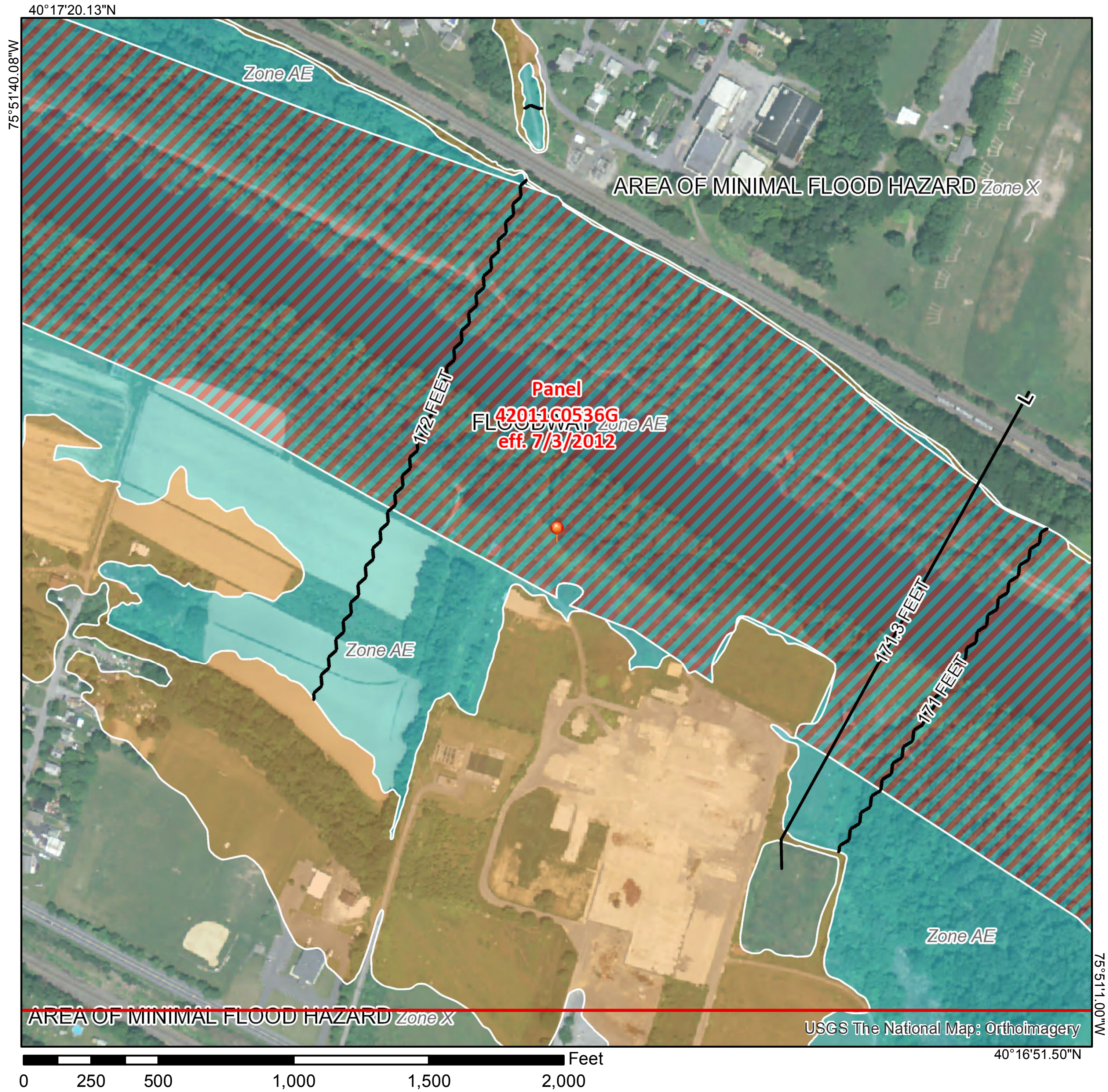
Respectfully submitted,

Maya K. van Rossum
the Delaware Riverkeeper

[28] Matheny, K. (12 October 2014). Environmental disasters lurk in energy pipelines. Detroit Free Press. Retrieved from http://www.freep.com/story/money/business/michigan/2014/10/12/energy-environmental-threats/17046063/

[29] Matheny, K. (12 October 2014). Environmental disasters lurk in energy pipelines. Detroit Free Press. Retrieved from http://www.freep.com/story/money/business/michigan/2014/10/12/energy-environmental-threats/17046063/

National Flood Hazard Layer FIRMette



Legend

- Cross-Sections
- Base Flood Elevations

Flood Hazard Zones

- 1% Annual Chance Flood
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee

LOMRs

- Effective

Map Panels

- Digital Data
- Unmodernized Maps
- Unmapped

N

This map complies with FEMA's standards for the use of digital flood maps. The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. The base map shown complies with FEMA's base map accuracy standards.

The NFHL is a living database, updated daily, and this map represents a snapshot of information at a specific time.

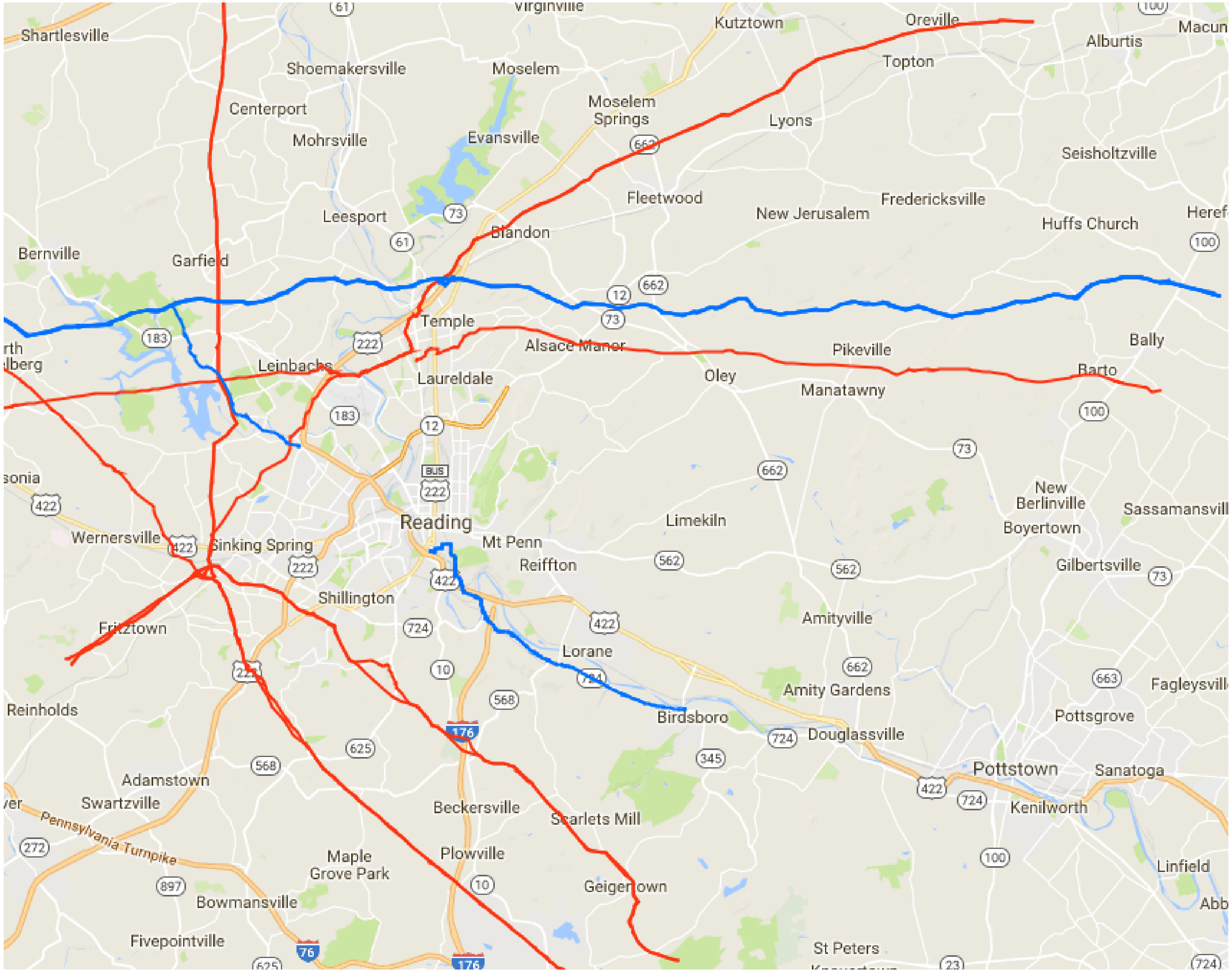
Flood risks are dynamic and can change frequently due to a variety of factors, including weather patterns, erosion, and new development. FEMA flood maps are continually updated through a variety of processes. Users should always verify through the Map Service Center (http://msc.fema.gov) or the Community Map Repository that they have the current effective information.

NFHL maps should not be created for unmapped or unmodernized areas.

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

Date: 11/18/2016 Time: 10:46:23 AM



Legend

Gas Transmission Pipelines

Hazardous Liquid Pipelines

5 km
2 mi

Pipelines depicted on this map represent gas transmission and hazardous liquid lines only. Gas gathering and gas distribution systems are not represented.

This map should never be used as a substitute for contacting a one-call center prior to excavation activities. Please call 811 before any digging occurs.

Questions regarding this map or its contents can be directed to npms@dot.gov.

Projection: Geographic

Datum: NAD83

Map produced by the Public Viewer application at www.npms.phmsa.dot.gov

Date Printed: Aug 03, 2017

SINKHOLES AND KARST-RELATED FEATURES OF BERKS COUNTY, PENNSYLVANIA

OPEN FILE REPORT: 8801

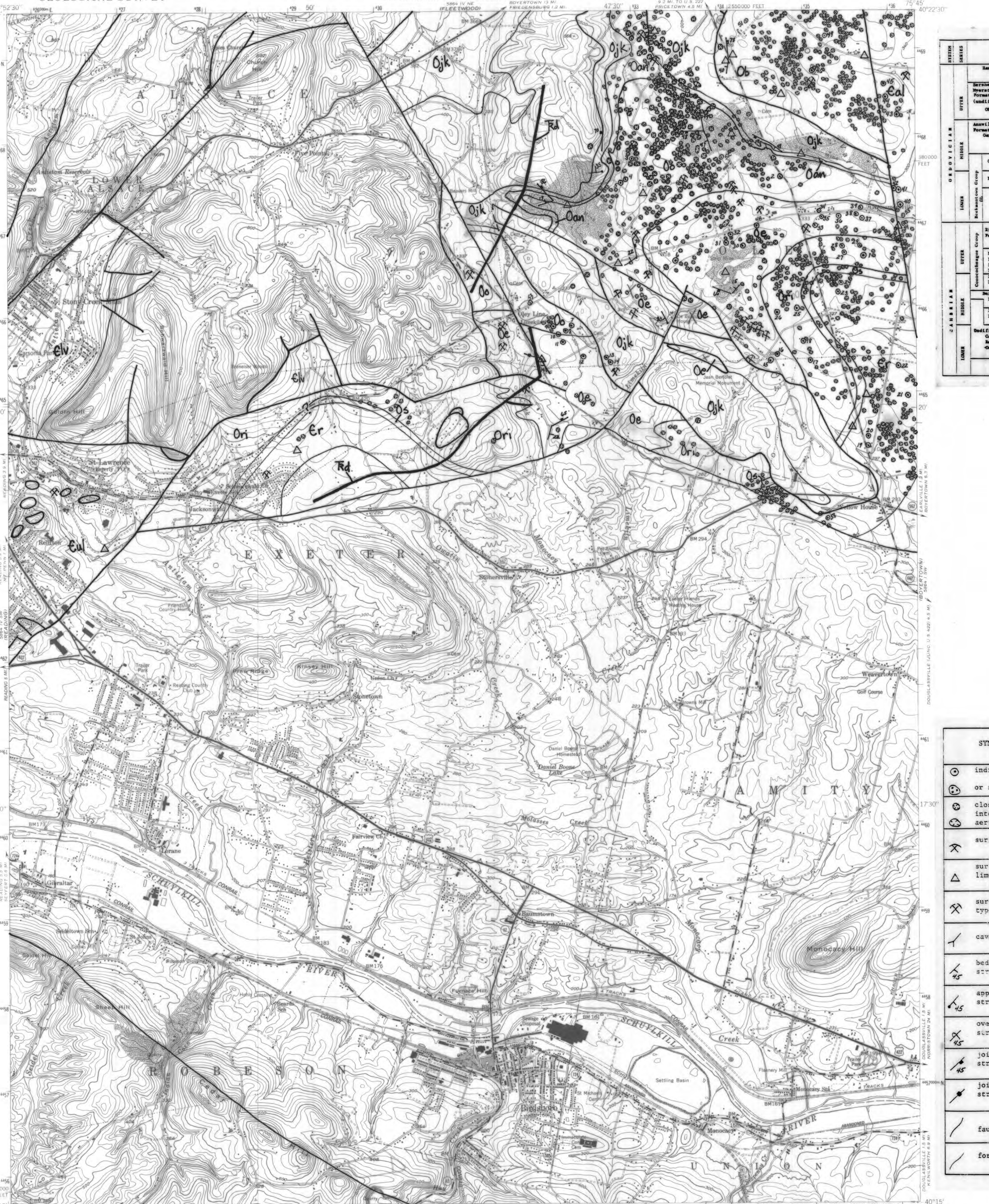
by W.E.Kochanov

1988

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY

0650
BIRDSBORO QUADRANGLE
PENNSYLVANIA-BERKS CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SYMBOLS

- individual sinkhole
- or sinkhole group
- closed depressions interpreted from aerial photographs
- surface mine, iron
- surface mine limestone/dolomite
- surface mine type unknown
- cave entrance
- bedding orientation strike and dip
- approximate strike and dip
- overturned, bed strike and dip
- joint orientation strike and dip
- joint orientation strike and 90° dip
- fault contact
- formation contact

Mapped, edited, and published by the Geological Survey

Control by USGS, NOS/NOAA, and USCE

Topography by photogrammetric methods from aerial photographs taken 1942. Field checked 1947

Polyconic projection. 10,000-foot grid ticks based on Pennsylvania coordinate system, south zone. 1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 6 meters south and 30 meters west as shown by dashed corner ticks

Revisions shown in purple and woodland compiled in cooperation with Commonwealth of Pennsylvania agencies from aerial photographs taken 1981 and other sources. This information not field checked. Map edited 1983

Purple tint indicates extension of urban areas

11° 196 MILS
0°32' 9 MILS

UTM GRID AND 1983 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, hard surface
Light-duty road, hard or improved surface
Secondary highway, hard surface
Unimproved road
Interstate Route U. S. Route State Route

QUADRANGLE LOCATION

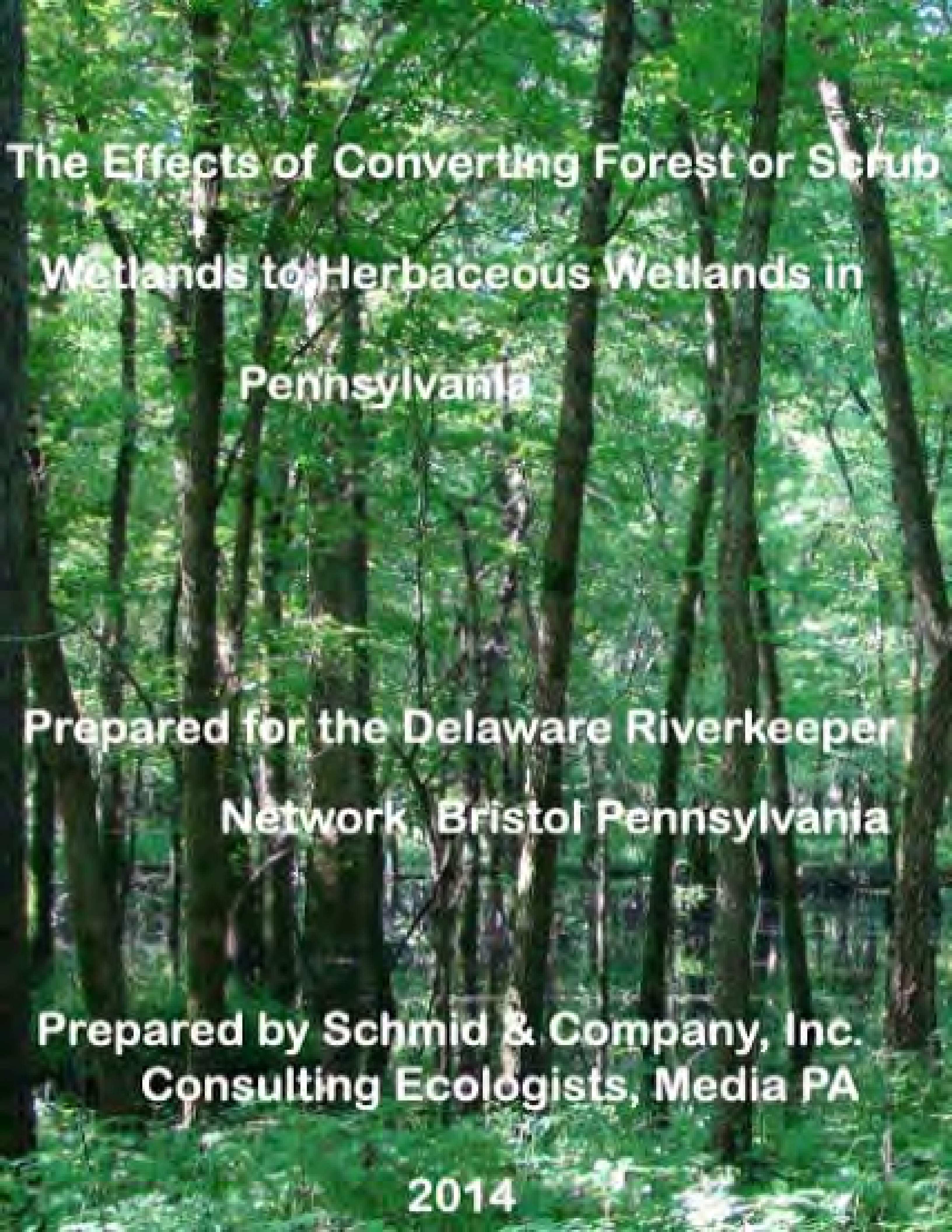
0650
BIRDSBORO, PA.
40075-C7-TF-024
1947
PHOTOREVISED 1983
DMA 5864 IV SE–SERIES V831

The work presented here has not been reviewed for formal publication.

Bureau of Topographic and Geologic Survey
P.O. Box 8453, Harrisburg, PA 17105-8453

Compiled by W.E.Kochanov 6/87-12/87

TOPOGRAPHIC & GEOLOGIC SURVEY
P. O. BOX 2357, EXECUTIVE HOUSE
HARRISBURG, PA 17120



The Effects of Converting Forest or Scrub Wetlands to Herbaceous Wetlands in Pennsylvania

Prepared for the Delaware Riverkeeper Network, Bristol Pennsylvania

Prepared by Schmid & Company, Inc.
Consulting Ecologists, Media PA

2014

Table of Contents

The Effects of Converting Forest or Scrub Wetlands to Herbaceous Wetlands in Pennsylvania

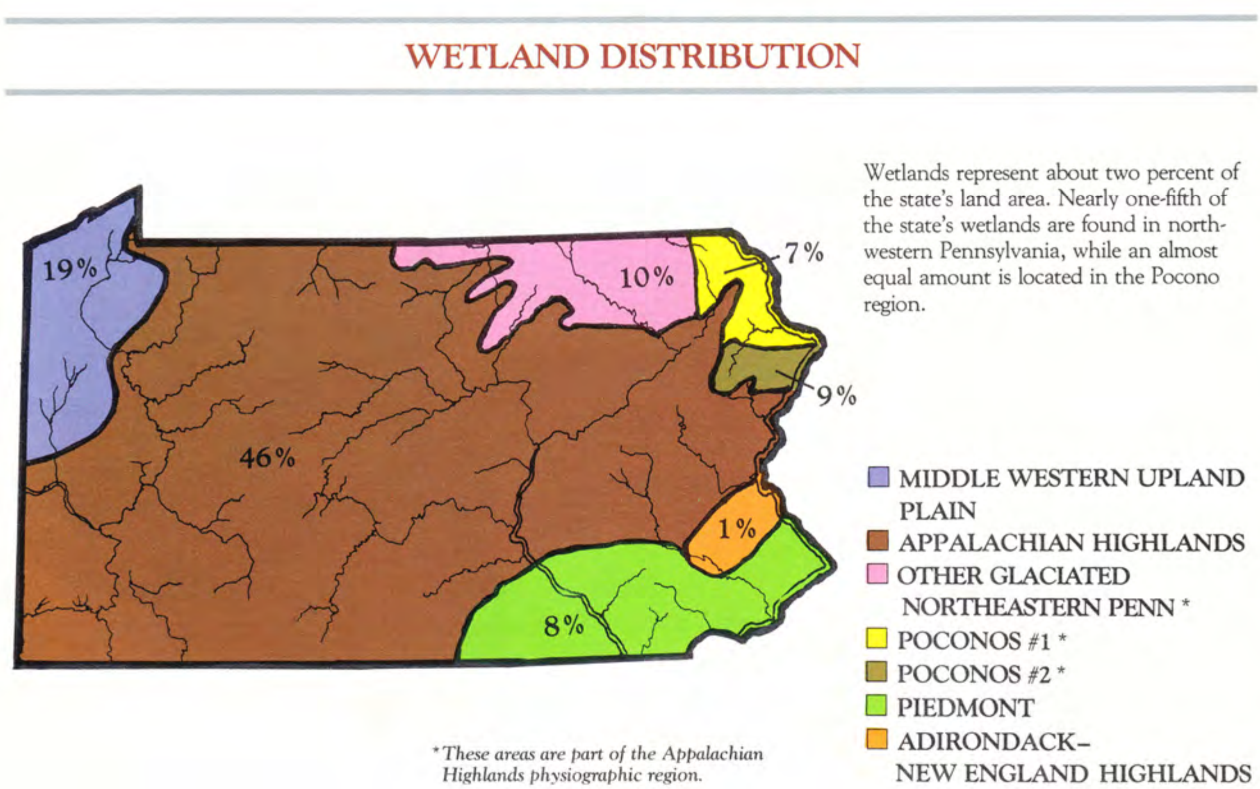
Wetlands are tracts of land characterized by the recurrent and prolonged presence of surface water and/or near-surface groundwater. Their vegetation, wildlife, and soil properties are greatly influenced by wetness, that is, by their hydrology. Wetness has a profound effect on the biogeochemical reactions that occur in the top foot of wetland soil, allowing bacteria to render such soils anaerobic (oxygen-free) and thereby affecting the chemistry of the soil particles as observed in soil color and organic matter, determining the kinds of microorganisms present, selecting the kinds of rooted plants able to survive and compete, and in turn affecting the quality of habitat for animals including humans. Like streams, ponds, lakes, rivers, and oceans, wetlands today are deemed to be bodies of surface water, peculiar places transitional between (1) permanent open waters and (2) dry lands wet only during precipitation events. Some wetlands are associated with areas where surface waters and groundwater interconnect.

For many years wetlands were regarded as wastelands, and public policy encouraged their physical conversion to accommodate more highly valued land uses of many kinds (farms, cities, roads, residential and commercial development). In response, millions of acres of wetlands were destroyed across the United States, including more than half of Pennsylvania's wetlands (more than 600,000 acres). Not until the latter half of the twentieth century were the environmental and societal values of suddenly scarce wetlands broadly appreciated and subjected to legal protection against unnecessary alteration in the United States (Schmid 2000). Today most construction activities in wetlands are regulated by public agencies concerned with environmental protection. Regulators at the federal, State, and/or municipal level may be involved in permit review and approval. Most construction activities that would affect wetlands are unlawful, unless previously authorized by permit, but the applicable laws vary greatly from place to place in their scope and stringency.

Wetness (above-ground inundation or in-ground saturation within the uppermost foot of topsoil) for periods of two weeks or more, at least seasonally recurrent, is the primary characteristic that locally distinguishes individual wetlands from non-wetland areas that may display similar climate, exposure (aspect), slope, geology (rock type), soils, and biota (plants, animals, bacteria, fungi). The prolonged presence of surface water at relatively shallow depth (< 6 feet) and the presence of emergent vegetation distinguish wetlands from the deep, open waters of lakes and the flowing channels (some with submerged or floating plants) of streams---other bodies of surface water with which wetlands often are closely associated. Wetlands often occupy a landscape zone transitional between open waters and the seldom-wet uplands found at higher elevations. Along with groundwater, surface streams, rivers, lakes, ponds, and wetlands are regulated Waters of the Commonwealth of Pennsylvania. Many, but not all, of the wetlands and other surface water bodies in Pennsylvania are also Waters of the United States (USEPA and USACE 2014).

In the large and diverse Commonwealth of Pennsylvania there are many kinds of wetlands. Pennsylvania wetlands in the aggregate occupy a small proportion of the land surface, and are most extensive in formerly glaciated areas such as the plateaus of the northeastern and northwestern counties, as shown below in a National Wetland Inventory drawing (from Tiner 1987). Individual wetlands can range in size from a few square feet to many acres. Wetlands today are recognized as contributing to water quality, wildlife habitat, endangered species protection, and the human landscape far out of proportion to their percentage share of the Pennsylvania land surface, and thus warrant stringent protection from human modifications to the extent practicable. These values increase as human population and population density increase. At the same time, the economic value of property where the destruction of wetlands has been authorized can greatly exceed the cash value of that property in its natural condition. Hence the extent to which public agencies can protect wetland resources often conflicts with the desire of private landowners to alter the property which they own.

Pennsylvania Wetlands Are Geographically Concentrated.



Agencies tasked with implementing the federal Clean Water Act (P.L. 92-500, 86 Stat. 816) and the Pennsylvania Dam Safety and Encroachments Act (32 P.S. 693) and Clean Streams Law (35 P.S. 691), long have defined wetlands as

> Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas (25 *Pa. Code* 105.1.)

Accurate wetland identification and delineation depend upon a careful analysis of plants, soils, and hydrology using the best available scientific guidance to apply the official definition in each real situation on the surface of the earth. In the central sections of most wetlands the general public can readily ascertain the distinctive conditions that characterize tree-filled swamps and herb-dominated marshes. Precisely locating the boundaries of a wetland, however, in gently sloping transitional areas where the requisite field indicators gradually drop out, typically requires specialized training in the visual appearance of vegetation, soils, and hydrology as they occur outdoors in all seasons, along with thorough knowledge of relevant agency rules for consistent decisionmaking. The details of scientific knowledge of wetland functions and regulatory adjustments in setting regulatory boundaries and analyzing impacts have changed over recent decades as our understanding of wetlands has increased.

To apply the regulatory definition of wetlands in the field, federal and Pennsylvania regulators (25 *Pa. Code* 105.451) employ the Army Corps of Engineers *Wetland Identification and Delineation Manual* (ERL 1987) in conjunction with its recent regional supplements (for example, USACE 2012) and other technical support documents (including Lichvar *et al*. 2014, Vasilas *et al*. 2010, USACE 2014). These official documents provide the guidance necessary for recognizing the current extent of regulated wetlands under various conditions of season, wetness, and human disturbance, using field indicators of vegetation, soil, and hydrology.

In Pennsylvania the Army Corps of Engineers provides, in response to landowner requests, formal written Jurisdictional Determinations (JDs) that confirm the accurately mapped extent of wetlands and bodies of surface water eligible for regulation at the federal, State, and municipal level on specific tracts of land. Absent the issuance of a valid JD, there is no way for a landowner or the public to ascertain accurately the limits of a regulated wetland. Topographic maps, National Wetland Inventory maps, floodplain maps, soil survey maps, and planning maps of many kinds can provide useful technical information, but do not identify in detail the limits of regulated wetlands (or streams) that need to be considered by the sponsors of construction projects. Consultants typically document sites on behalf of landowners and prepare paperwork for agency review. Careful documentation of wetlands whose proffered boundaries are superimposed onto a land ownership survey is required as part of a request for a

JD, and Corps staff typically inspect each property in the field prior to approving a JD. JDs remain valid for five years, in recognition of the fact that wetland boundaries can change over time as a result of natural changes as well as unregulated human activities nearby. Only the Natural Resources Conservation Service (NRCS), an arm of the US Department of Agriculture, issues permanent wetland identifications for purposes of eligibility for federal programs that support crop production. Such NRCS determinations apply only to farming, not to general construction activities.

Delineated wetlands are best avoided when new construction projects are proposed, and permit applicants are expected to minimize unavoidable impacts insofar as practicable. The JD forms the informational basis for permit calculations and for designing compensatory mitigation to offset agency-approved impacts to the extent practicable.

Recent experience confirms that applicant-proffered wetland boundaries continue to warrant detailed scrutiny by the Army Corps of Engineers and other regulators. In one 2010 mining application in Greene County, National Wetland Inventory maps disclosed 4 wetlands on a 642-acre site. The applicant's consultant submitted a proposed delineation to PADEP showing 10 wetlands. After field inspection by the Corps, the JD drawing of the same tract of land showed 27 wetlands (Schmid & Co., Inc. 2013). In Sullivan County a gas company consultant delineated streams and wetlands in a 50-foot wide right-of-way along some 4,000 feet of unpaved township road. After the adjoining landowners secured Corps JDs, the square footage of regulated streams and wetlands increased to 700% of that flagged for the gas company within the same 4-acre strip of land (Schmid & Co., Inc. 2011b). The Corps field representative commented that significant under-identification of wetlands had occurred at several recent gas well installations where he had been involved with enforcement actions. None of those permittees had secured a Corps JD, and PADEP as usual had approved their permits without questioning the accuracy of information in the applications. It is not possible to overemphasize the necessity for JD applications followed by field-checking by Corps staff of proffered delineations as critical to the identification of wetlands in Pennsylvania prior to permit approval. Unidentified wetlands are not protected at all.

Wetland Permits

Regulated activities in Pennsylvania wetlands and other bodies of water cannot legally be initiated prior to permit approval by the Department of Environmental Protection (PADEP), except for waivered activities (25 *Pa. Code* 105.12) and registered activities that conform to the requirements of pre-approved general permits (25 *Pa. Code* 105.441 *et seq.*). Above established minimum thresholds of impact, regulated activities in federally regulated wetlands and waters also require approval from the Army Corps of Engineers. Except for those areas and activities excluded from regulation by waiver or authorized via general permits, wetland functions by regulation must be identified by an applicant when permit approval is sought for activities that will encroach upon wetlands and other bodies of water in Pennsylvania (25 *Pa. Code* 105.13). Permit applications for relatively small encroachments may be reviewed only by State agencies; larger or more damaging activities must be considered independently also by federal agencies. Few of the more than 2,500 Pennsylvania municipalities have adopted any ordinances protective of wetlands, but some have included wetlands as among resources to be reviewed at the local level, and their wetlands may be protected over and above what State and federal agencies require. Like PADEP, local agencies generally lack the staff resources to identify jurisdictional boundaries for wetlands.

After wetlands have been identified, permit applicants are expected to avoid impacts, and where unavoidable, to make every practicable effort to minimize impacts when planning their construction projects; PADEP is to review such efforts to avoid and minimize impacts [25 *Pa. Code* 105.14(b)(7)]. Where encroachments are proposed into wetlands, it is the responsibility of the permit applicant to identify onsite conditions in every affected wetland as a basis for ascertaining the probable alteration of functions when analyzing unavoidable adverse impacts and providing appropriate compensatory mitigation (25 *Pa. Code* 105.14, .15, and .18a). Impacts are to be analyzed in an Environmental Assessment (§105.15). The extent and nature of unavoidable impacts become the basis for developing the applicant's proposal for site restoration and compensatory mitigation. The quality of wetland assessment depends on the thoroughness and accuracy of underlying wetland inventory as well as the professional competence of the delineator and agency reviewer. Wetland functions form a principal aspect of the environmental assessment.

PADEP and district offices of the Army Corps of Engineers have adopted a joint permit application (Form 3150-PM-BWEW0036A, March 2013) and related forms that solicit the minimum information needed for agency decisionmaking regarding affected wetlands and other bodies of water on properties where construction is planned that may damage these resources. Public notice is required for individual joint permit applications, but not for waivered activities or for registrations of applicant intent to rely upon general permits. PADEP staffers are charged with reviewing each application to insure its completeness, its accuracy, and the applicant's proposed compliance with applicable regulations. Permit files, application data, and related correspondence are public records and can be examined by persons concerned about wetland protection through the procedures of Pennsylvania's Right to Know Law (Act 3 of 2008) and the federal Freedom of Information Act (5 USC 552 *et seq.*). Upon approval of a PADEP permit, the window for filing appeals to the Pennsylvania Environmental Hearing Board by any aggrieved party remains open for thirty days. Applicants are required to conform to the conditions and limitations set forth in general and individual permits. All recipients of individual permits by regulation are required to file a statement of compliance with permit requirements within 30 days of work completion and to file final as-built plans within 90 days showing any changes from original plans and specifications (25 *Pa. Code* 105.107).

In Pennsylvania some wetlands are deemed more valuable than others. Exceptional Value wetlands deserve *specia*l protection. Such wetlands exhibit one or more of the following characteristics (25 *Pa. Code* 105.17):

1. Serve as habitat for fauna or flora listed as threatened or endangered under federal or Pennsylvania law.
2. Are hydrologically connected to or located within 0.5 mile of the above and maintain the habitat of the endangered species.
3. Are located in or along the floodplain of the reach of a wild trout stream or waters listed as having Exceptional Value and the floodplain of their tributary streams, or within the corridor of a federal or Pennsylvaia designated Wild or Scenic River.
4. Are located along an existing public or private drinking water supply and maintain the quantity or quality of that surface water or groundwater supply.
5. Are located in State-designated natural or wild areas within State parks or forests, in federally designated Wilderness Areas or National Natural Landmarks.

Wetlands that qualify as having Exceptional Value are defined as surface waters of Exceptional Ecological Significance (25 *Pa. Code* 93.1), and thus (like Pennsylvania streams that have been designated or have attained Exceptional Value uses) are to be treated as Tier 3 Outstanding National Resource Waters in the language of the Clean Water Act of 1972 (as amended, 33 *USC* §1251 *et seq*.; *US Environmental Protection Agency Water Quality Handbook* - Chapter 4: Antidegradation [40 *CFR* 131.12]). These highest-quality resources are to be protected from degradation. Wetlands that do not exhibit any of the above-listed characteristics are deemed “Other” wetlands.

Permits for structures and activities in Exceptional Value wetlands are not to be approved unless PADEP finds that: the dam, water obstruction, or encroachment will not have an adverse impact on the wetland, as determined in accordance with §§ 105.14(b) and 105.15; the project is water dependent, requiring access to, proximity to, or siting within the wetland to fulfill its basic purpose; there is no practicable alternative that would not involve a wetland or that would have less adverse effect on the wetland and not have other significant adverse effects on the environment; the project will not cause or contribute to a violation of an applicable State water quality standard; the project will not cause or contribute to pollution of groundwater or surface water resources or diminution of resources sufficient to interfere with their uses; and the applicant replaces the affected wetland in accordance with criteria at § 105.20a [25 *Pa. Code* 105.18a(a)]. Yet Corps Jurisdictional Determinations are not required for Exceptional Value wetlands in Pennsylvania, so these wetlands are equally likely to be overlooked as those lacking exceptional value.

“Other” wetlands also are deemed “a valuable public natural resource” (25 *Pa. Code* 105.17) that is to be protected from significant impacts in similar fashion to

Exceptional Value wetlands. Permits are to be granted to dams, water obstructions, or encroachments affecting Other wetlands only when PADEP finds that: the project will not have a significant adverse impact considering the areal extent of the impacts, values, and functions of the wetlands, the uniqueness of the wetland functions and values in the area or region; comments from environmental agencies have been addressed; adverse impacts on the wetland are to be avoided or reduced to the maximum extent possible; there is no practicable non-wetland impacting alternative; the applicant has convincingly demonstrated that non water-dependent projects have no practicable alternative, overcoming the rebuttable presumption that such alternatives exist; the project will not cause or contribute to violation of an applicable State water quality standard; the project will not cause or contribute to pollution of groundwater or surface water resources or diminution of resources sufficient to interfere with their uses; the cumulative effect of this project and other projects will not result in a major impairment of the Commonwealth's wetland resources; and the applicant replaces the affected wetland in accordance with criteria at § 105.20a [25 *Pa. Code* 18a(b)]. On paper, Pennsylvania offers stringent protection to its wetlands.

Wetland Functions

Nine wetland functions are specifically identified in the definitions section of Pennsylvania's Dam Safety and Encroachments regulations (25 *Pa. Code* 25.1). By regulation, these functions are the minimum that require consideration as PADEP evaluates every encroachment permit affecting 1 acre or less of wetlands. Larger wetlands, as well as Exceptional Value wetlands smaller than 1 acre may require more complex assessment of additional functions and values in addition to these [25 *Pa. Code* 105.13(d)(3)]:

Wetland Functions Requiring Analysis in PADEP Permits

1. Serving natural biological functions, including food chain production; general habitat; and nesting, spawning, rearing and resting sites for aquatic or land species.
2. Providing areas for study of the environment or as sanctuaries or refuges.
3. Maintaining natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, natural water filtration processes, current patterns or other environmental characteristics.
4. Shielding other areas from wave action, erosion, or storm damage.
5. Serving as a storage area for storm and flood waters.
6. Providing a groundwater discharge area that maintains minimum baseflows.
7. Serving as a prime natural recharge area where surface water and groundwater are directly interconnected.
8. Preventing pollution.
9. Providing recreation.

Different wetlands exhibit different combinations of functions. Some mutually exclusive functions (for example, groundwater recharge and groundwater discharge) can alternate over time within a single wetland. The functions performed by a wetland may vary over seasons and from year to year. The functions that any given wetland is capable of performing result from both the internal characteristics of the wetland itself and the surrounding context in which that wetland exists, including its connection with other natural areas and with watercourses. Corridors for wildlife movement, for example, are important to allow populations of animals to move between areas of wetland habitat, and many streams function as wildlife corridors. Similarly, only a wetland located on the shore of an open water body can shield other areas from wave action. The success of a wetland in performing functions can be affected greatly by past or ongoing human activity. Most wetland functions are disrupted permanently or temporarily by construction activities that impinge upon the wetland vegetation, soils, or hydrology directly. Human activities that increase performance of one function can accompany decreasing performance of other functions by that wetland.

Wetland functions also can be affected by construction outside the wetland itself out to a distance of 1,500 feet or more (Houlahan *et al*. 2006). For example, wildlife that breed in wetlands, such as reptiles and amphibians including frogs and salamanders, normally range into the adjoining uplands for distances of many hundreds of feet in eastern North America during the course of an annual cycle. If the adjacent lands are deforested or paved, or the wetland isolated by an intervening road or fence, the wetland habitat can be rendered useless to such creatures. By way of further example, altering the light and wind by removing the surrounding forest can cause a major change in the plants and animals that can survive in a wetland. Surface disturbances outside a wetland also can have major impact on the hydrology of the wetland, profoundly altering its ecosystem by draining or flooding it.

There is no State-regulated wetland buffer in Pennsylvania, such as exists in New Jersey or New York. Those States have expressed concern for the variable boundaries of wetlands that result from differing weather conditions year to year. They wisely recognize that the associated transitional areas adjacent to wetlands comprise essential parts of the functioning ecosystem of each wetland. Hence they long have considered the preservation of ecosystems adjacent to a wetland to be an essential part of protecting that wetland's functions and values. The absence of regulated buffers around wetlands in Pennsylvania renders its wetlands at risk of unavoidable degradation, especially in areas of concentrated human populations. A few Pennsylvania municipalities have recognized or sought to remedy this environmental risk through local ordinances that provide for maintenance of some amount of undeveloped protective buffer outside the wetland.

.

Wetland Classification

The functions and values of a wetland differ according to the placement of the wetland in the landscape and the manner in which it gains its wetness.

Functional analysis logically addresses different classes of wetlands differently when addressing their potential for damage or rehabilitation. Wetlands and shallow water bodies are usefully categorized at the most basic level by general hydrogeomorphic system. Across most of the Pennsylvania landscape, wetlands and small ponds are assigned to the Palustrine (P) system, which is distinguished from tidal estuarine and marine classes, lakes, and large rivers. Wetlands along the boundaries of water bodies are assigned to the Riverine (R) or Lacustrine (L) systems, although many floodplain wetlands are labeled as Palustrine. Marine (M) and Estuarine (E) classes are of limited extent in Pennsylvania.

The following table identifies the most recent hydrogeomorphic classifications under development by the PADEP (draft Technical Guidance Document 310-2137-002, 7 March 2014, p. 27). The classification is significant as it affects the functional analysis of all water bodies including wetlands.

Mid-Atlantic HGM Wetland Classification:

- Classes
  - Subclasses
    - Modifiers
- Marine
  - subtidal
  - intertidal
- Estuarine
  - subtidal
  - lunar intertidal
  - wind intertidal
  - impounded
- Riverine
  - lower perennial
  - floodplain complex
  - upper perennial
  - headwater complex
  - intermittent
    - beaver impounded
    - human impounded
- Lacustrine (fringe)
  - permanently flooded
  - semipermanently flooded
  - intermittently flooded
  - artificially flooded
- Palustrine
  - Flat
    - Flat mineral soil
    - Flat organic soil
  - Slope
    - Stratigraphic
    - Topographic
      - mineral soil
      - organic soil
  - Depression
    - perennial
    - seasonal
    - temporary
      - human impounded
      - human excavated
      - beaver impounded

PADEP goes on to offer additional detail on the principal kinds of wetlands in Pennsylvania classed by location associated with hydrology that require consideration during functional assessments. The modifiers give an idea of the variability of the basic types (draft Technical Guidance Document 310-2137-002, 7 March 2014, p. 24-25). Once these distinctions have been formally adopted by PADEP for consideration in each permit application, the precision and quality of data provided by applicants' consultants should improve, along with the quality of impact analysis.

Pennsylvania Hydrogeomorphic Wetland Classification Key.

1.	Wetland found along tidal fringe of a marine ecosystem (ocean, beach, rocky shore)	**2**
1.	Wetland not associated with marine ecosystem	**3**
2.	Continuously submerged littoral zone	**Marine subtidal** (MF1)
2.	Alternately flooded and exposed to air	**Marine intertidal** (MF2)
3.	Wetland associated with shallow estuarine ecosystem (Mixture of saline and freshwater)	**4**
3.	Wetland not associated with shallow estuarine ecosystem	**7**
4.	Wetland not impounded	**5**
4.	Wetland impounded	**Estuarine impounded** (EFh)
5.	Wetland continuously submerged	**Estuarine subtidal** (EF1)
5.	Wetland alternately flooded and exposed to air	**6**
6.	Wetland regularly or irregularly flooded by semidiurnal, storm, or spring tides	**Estuarine lunar intertidal** (EF2l)
6.	Wetland flooding induced by wind	**Estuarine wind intertidal** (EF2w)
7.	Wetland associated with freshwater stream or river	**8**
7.	Wetland not associated with freshwater stream or river	**11**
8.	Wetland associated with permanent flowing water from surface sources	**9**
8.	Wetland dominated by ground water or intermittent flows	**10**
9.	Wetland associated with low gradient tidal creek (see Estuarine types 3)	
9.	Wetland associated with low gradient and low velocities, within a well-developed floodplain (typically >3rd order)	**Riverine lower perennial** (R2)
9.	Wetland part of a mosaic dominated by floodplain features (former channels, depressions) that may include slope wetlands supported by ground water (see Slope 17)	**Riverine floodplain complex** (R2c)
9.	Wetland associated with high gradient and high velocities with relatively straight channel, with or without a floodplain (typically 1st - 3rd order)	**Riverine upper perennial** (R3)
10.	Wetland part of a mosaic of small streams, depressions, and slope wetlands generally supported by ground water	**Riverine headwater complex** (R3c)
10.	Wetland associated with intermittent hydroperiod	**Riverine intermittent** (R4)

Note:	For any riverine type that is impounded, distinguish between:	
	Wetland impounded by beaver activity	**Riverine...beaver impounded** (R...b)
	Wetland impounded by human activity	**Riverine...human impounded** (R...h)
11.	Wetland fringing on a lake or reservoir	**12**
11.	Wetland not fringing on lake or reservoir	**14**
12.	Wetland inundation controlled by relatively natural hydroperiod	**13**
13.	Wetland inundation is permanent with minor fluctuations (year round)	**Lacustrine permanently flooded** (LFH)
13.	Wetland inundation is semipermanent (growing season)	**Lacustrine semipermanently flooded** (LFF)
13.	Wetland inundation is intermittent (substrate exposed often)	**Lacustrine intermittently flooded** (LFJ)
12.	Wetland inundation controlled by dam releases	**Lacustrine artificially flooded** (LFK)
14.	Wetland water source dominated by precipitation and vertical fluctuations of the water table due to low topographic relief	**15**
14.	Wetland differs from above	**16**
15.	Wetland substrate is primarily of mineral origin	**Flat mineral soil** (FLn)
15.	Wetland substrate is primarily of organic origin	**Flat organic soil** (FLg)
16.	Wetland water source is primarily ground water and has unidirectional and horizontal flows	**17**
16.	Wetland forms a depression	**18**
17.	Water source for wetland derived from structural geologic discontinuities resulting in discharge of groundwater from distinct point(s) on slope	**Stratigraphic slope** (SLs)
17.	Water source for wetland accumulates at toe-of-slope before discharging	**Topographic slope** (SLt)
Note:	For any slope type, distinguish between: Wetland substrate is primarily of mineral origin	**...slope mineral soil** (SL...n)
	Wetland substrate is primarily of organic origin	**...slope organic soil** (SL...g)
18.	Wetland with frequent surface connections conveying channelized flow	**Depression perennial** (DFH)
18.	Wetland with infrequent surface water connections conveying channelized flow	**Depression seasonal** (DFC)
18.	Wetland with no surface outlet, often perched above water table	**Depression temporary** (DFA)
Note:	For any depression type that is impounded or excavated distinguish between:	
	Wetland is impounded by human activities	**Depression...human impounded** (DPh)
	Wetland is excavated by human activities	**Depression...human excavated** (DPx)
	Wetland is impounded by beaver activities	**Depression...beaver impounded** (DPb)

Another of the basic classifications of wetlands derived from their appearance and germane to assessing their functions is their vegetation type. The descriptive framework for vegetation structure was devised by the US Fish and Wildlife Service (Cowardin *et al*. 1979) and is used for small-scale mapping by the National Wetlands Inventory. Vegetation and hydrogeomorphic location are combined to identify the principal habitat types identified by PADEP in Pennsylvania (Draft Technical Guidance Document 310-2137-001, March 2014,

p. 7). Notably, PADEP to date has not identified any nontidal Riverine wetland habitat types:

Some Pennsylvania Wetland Habitat Types.

LAB	Lacustrine Aquatic Bed
LEM	Lacustrine Emergent
LFL	Lacustrine Flat
PAB	Palustrine Aquatic Bed
PEM	Palustrine Emergent
PFL	Palustrine Flat
PFO	Palustrine Forested
PSS	Palustrine Scrub/Shrub

Lacustrine Emergent Wetland and Lacustrine Aquatic Bed.

Palustrine wetlands are the most numerous and widespread kinds in Pennsylvania, accounting for 97% of the wetlands mapped in the Commonwealth by the National Wetland Inventory from high-elevation aerial photos taken during the late1970s and early 1980s (Tiner 1990). National Wetland Inventory mapping is a useful tool whose results are valuable for regional wildlife resource management, but it significantly omits many forested wetlands in Pennsylvania and is not a reliable guide to regulated wetland locations or boundaries.

Nevertheless, its incomplete and approximate data are readily available online and often are displayed on maps generated by geographical information systems. Hydric soil map units in county soil maps and wetland patterns on US Geological Survey topographic quadrangles also offer clues to wetland locations. But the actual extent of wetlands and streams can be determined only by field delineation of specific properties when construction activities are proposed.

The principal kinds of vegetation found in Palustrine wetlands are classed as forest (PFO), scrub (PSS), and herbland (PEM) based on visual observation and/or aerial photographs. Available statistics probably underestimate the proportion of forested wetlands in Pennsylvania, inasmuch as they are based on aerial photographs rather than field investigation and omit forested wetlands not distinguishable remotely. Palustrine flats (FL) devoid of vegetation are not common. The focus of vegetation classification is on the size and structure of the general mass of vegetation present in the landscape. An individual plant, depending on species, can pass through the structural stages of herb, shrub, and tree as it grows in wetlands or uplands. The US Fish and Wildlife Service has reported their estimate of cover types of National Wetland Inventory wetlands in Pennsylvania based on 1975-1985 aerial photographs (Tiner 1990):

Palustrine Forests.

Delhaas Woods, Bucks County. Photograph by Roger Earl Latham.

Columbus Bog, State Game Lands 197, Warren County. Photograph by Paul Wiegman.

Acres of National Wetland Inventory Wetlands in Pennsylvania, 1975-1985.

Palustrine Wetlands	
Emergent	*52,338 a*
Deciduous Forested	*146,715 a*
Evergreen Forested	*31,204 a*
Deciduous Scrub-Shrub	*47,539 a*
Evergreen Scrub-Shrub	*1,849 a*
Mixed Deciduous Shrub-Emergent	*25,000 a*
Open Water	*61,841 a*
Other Mixed Types	*26,242 a*
Total Palustrine Wetlands	*392,728 a*
Lacustrine Wetlands	*8,521 a*
Riverine Wetlands	*2,675 a*
PENNSYLVANIA WETLANDS	*403,924 a*

Forest vegetation (FO) is dominated by trees at least 3 inches in minimum trunk diameter measured 4.5 feet above the ground and at least 20 feet tall. Shrubs and herbs can grow beneath the canopy trees, or the forest floor can be essentially bare. Scrub (SS) is dominated by shrubs with multiple stems less than 3 inches in diameter and rarely taller than 20 feet. Herbs can be abundant beneath the shrubs but trees are few; light tends to reach the land surface to a much greater degree than in forests. Herblands (EM) are generally devoid of woody plants but instead support various kinds of non-woody, herbaceous higher plants that emerge from the soil surface. Their plant cover can be sparse or dense. Tracts of land that qualify as forest, scrub, or herbland may intergrade and are mapped as mixed types (for example, FO/SS). The forest, scrub, and herbland categories each can be subdivided into numerous subtypes, depending on the purpose of such classification and appropriate level of detail. For example, Palustrine forest and scrub polygons on maps can be broadleaf deciduous (assigned the modifier “1” by the National Wetland Inventory, as in “PFO1”) or needleaf evergreen (“PFO4”); emergent herbs can be persistent year-round (“1” as in “PEM1”) or nonpersistent (“PEM2”), and any of these modifiers can be further supplemented by codes for dominant plant genus or species or for other ecosystem attributes where more precise distinctions are needed.

In Pennsylvania Palustrine ecosystems, forested wetlands are more extensive than scrub and herbaceous wetlands. Natural plant succession generally trends toward forest conditions in eastern North America (Braun 1950, Küchler 1964), and thus herbaceous and scrub wetlands tend to reflect earlier stages of natural post-disturbance succession than forested wetlands. The first-approximation airphoto mapping of Pennsylvania wetlands by the US Fish and Wildlife Service reported deciduous forests making up 37% of Palustrine wetlands; evergreen forest, 8%; deciduous scrub, 12%; evergreen scrub, <0.1%; mixed deciduous scrub-herbland, 6%; herbland, 13%; open water (including farm ponds), 16%; and other mixed types, 7% based on 1975-1985 aerial photographs (Tiner 1990). Under natural conditions the forest community is disrupted occasionally by storms, fire, and beaver activity. Human activities today are a much more common source of forest removal. Not all herblands, however, are rapidly changing categories of plant succession on their way to becoming forests; some can persist naturally for long periods of time as viewed by humans. The plants found in particular wetland communities can range from diverse species to almost monotypic where invasives have become established.

State and federal agencies that keep records of wetlands and wetland modifications use these vegetation types for data collection and analysis. Each distinctive vegetation type also is associated with characteristic functions. Herbaceous wetland vegetation is capable of being reestablished relatively quickly following temporary disturbance, within only a few growing seasons, if soil and hydrologic conditions are favorable. Shrubs require additional years to reach full size, and forest trees require decades for canopy closure, even where soil disturbance has not been severe. Diverse populations of desirable native species can require long periods of time to become established in disturbed or newly created wetlands.

Functions of Pennsylvania Wetlands

This section discusses the functions listed above (as set forth in 25 *Pa. Code* 105.1) that are typically associated with Palustrine forested (PFO) wetlands and compares them with similar functions in scrub (PSS) and herbaceous (PEM) wetlands. These functions are subject to disruption by human activities as well as by catastrophic occurrences of weather (hurricanes, tornadoes), ice storms, landslides, floods, and fires. Reductions in some functions may accompany increases in others.

The PADEP list of nine wetland functions in Chapter 105 regulations is reasonably comprehensive and suited to project-scale analysis based on the specific acreage of wetlands affected by an individual permittee. Current regulations do not focus on quantitative annual productivity of timber or wildlife, removal of air pollutants, carbon sequestration, or less tangible functions such as aesthetic or historic/cultural appreciation. Nor do they require measurement of the values of any identified functions to individuals or groups. They do not specify how to compare the relative values of different functions, how to index current, past, or future functions of specific wetlands to generally accepted "reference" natural wetlands, call attention to the context of land surrounding a wetland, address the scarcity of a vegetation type, or provide for actual consideration of cumulative wetland impacts beyond an individual permit. PADEP long has found it virtually impossible to consider cumulative impacts, even for a single large project, because of its longstanding willingness to consider permits for fragments of a project on a piecemeal basis independently. PADEP does not expect an applicant to address its entire single project in a joint permit submission, much less analyze its proposed impacts cumulatively with those of other permittees over large areas. PADEP also does not focus on the uniqueness or heritage value of specific wetlands (aside from their potential for classing a wetland as having Exceptional Value) or a wetland's actual replaceability or irreplaceability, should damage be authorized.

1. Natural Biological Functions and General Habitat

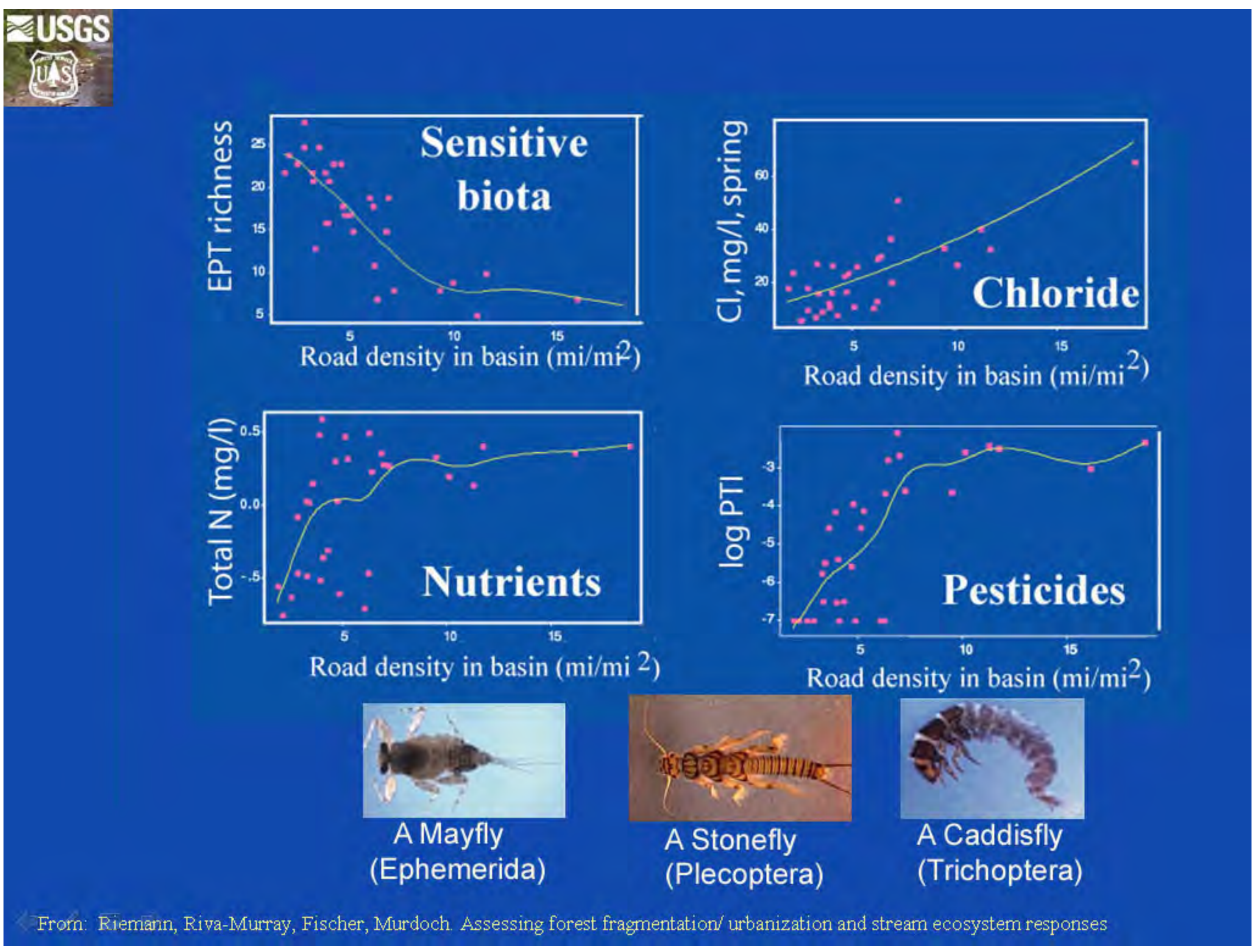
Natural biological functions of all wetlands include food chain production, general habitat, and resting-nesting-spawning-rearing sites for animals and fish. Many rare species of plants and animals are directly dependent on wetland habitats. Trees are the largest kinds of plants and have the greatest ability to modify the environmental effects of solar radiation, precipitation, temperature, humidity, and air quality as a result of their above-ground biomass. These natural, localized environmental modifications are of vital importance to the other plants and to the animals that live within and beneath forest cover. Tree leaves produce more tons of biomass per acre than shrubs for consumption by grazers and accumulate larger standing crops of organic material above ground. Tree trunks and limbs provide food for some animals and homes for many, with more complex structure than scrubs or herblands.

Pennsylvania forests consist of a wide variety of broadleaf deciduous trees, each species of which provides a somewhat different diet to the consumers that depend on it (Zimmerman *et al*. 2012; McShea & Healy 2002). Oaks, maples, ashes, elms, cherries, birches, and beech reflect the ancient geological history of Appalachia, and they returned to glaciated regions when the Pleistocene ice sheets melted. Pennsylvania forests also support many needleaf evergreen trees such as pines, hemlocks, and spruces. Very few stands of unharvested primeval forest remain in Pennsylvania; most of its forests have regrown following two or more episodes of intensive logging, burning, and other human disturbance during the past four centuries---episodes that have greatly affected the streams of the Commonwealth. Closed canopy forest consisting of mature trees requires about a century to recover to a recognizable mature forest structure after fire or clearcutting. About one third of Pennsylvania's forest stands are 80 years old or more; only 7%, 100 years old or more (McCaskill *et al*.

2013). Regenerated forest stands may or may not resemble their predecessors in their species composition when examined in detail, and the largest regrown individual trees are significantly smaller than historic records document as inherited by European colonists. Selective harvesting can remove key forest constituents, thereby reducing habitat value, and the forest canopy is further disrupted by logging roads, well pads, pipeline rights-of-way, borrow areas, and spills of fuel, brine, and other pollutants. Various kinds of shrubs and herbs grow only beneath a mature forest canopy. Wood ducks (*Aix sponsa*), a particularly handsome native species of waterfowl, require tree cavities for nesting as well as nearby water.

Trees growing in adjacent wetlands and streambanks are the major source of food for aquatic organisms in small, headwater streams. The intensity of ongoing human disturbance on the streams of forested areas can be estimated by the linear extent of roads per unit area. As summarized graphically by the United States Forest Service and US Geological Survey, human activity as approximated by road density has a dramatic effect on the quality of streams for sensitive aquatic insects that form the base of the aquatic food chain:

Road Density and Aquatic Parameters.



Both broadleaf and evergreen trees can dominate Pennsylvania wetlands, although broadleaf trees remain much more abundant (McCaskill *et al*. 2013). The value of forested wetlands to wildlife and to landowners is affected by the number of kinds of trees and other plants present (species diversity), their density and biomass (timber volume), the amount of dead timber standing and on the ground, the amount of grazing by domestic livestock and browsing by white-tailed deer, and the proportion of non-natives present. Diverse, high-quality vegetation is at greatest risk of human degradation and is the most difficult to restore (Olson and Doherty 2011). Wetland forests provide nesting, rearing, resting, and feeding sites for birds and mammals. One third of the bird species in the United States depend on wetlands (230 of 636; Welsch *et al*. 1995). Bears spend 60% of their time in forested wetlands during spring and summer (Newton 1988).

Unfragmented wetland forests are of great importance to many declining species of migratory songbirds. Wet forest floors are attractive wintering areas in which endangered bog turtles hibernate, and thick stands of evergreens shelter wintering deer and other animals. As already noted, the nutrients derived from tree leaves and twigs are vital to the macroinvertebrates and fish of Pennsylvania streams. Forest ecosystems are limited in their growth capability and affected in species composition by the availability of nutrients provided by the weathering of rock and transported in by air masses. The carbon from tree litter in turn can make up 99% of the total dissolved organic carbon at the base of the aquatic food web in forested streams (Stoler and Relyea 2011). Isolated vernal pools free of predatory fish are critically important to many uncommon reptiles and amphibians whose populations are dwindling. Discharges of stormwater, waste chemicals, and rubbish can degrade general habitat functions in forest and other wetlands.

Permanent forest disruption across Pennsylvania wetlands and uplands.

Scrub wetlands accumulate less standing biomass than mature forests. Hence any of the functions that derive from quantity of biomass are reduced in scrub as compared with forest wetlands, such as influence on microclimate, the amount of organic matter available for consumers of plant biomass, or the protection offered to soil from erosion. Some herbaceous wetlands can produce biomass in quantities rivaling forests above and below ground, but they lack the structural diversification of above-ground biomass of the woody wetlands. For animals adapted to herbaceous wetlands, such ecosystems provide important general habitat, nesting, resting, and rearing sites. The microtopography of hummocks provides habitat diversity critical to many species. Temporarily or permanently inundated herbaceous wetlands linked to streams and lakes have key importance as spawning and nursery grounds for fish, and inundated scrub wetlands are more common than inundated forests in Pennsylvania. The scrubs and sedge meadows with deep organic deposits associated with very wet herbaceous wetlands are prime spring and summer areas for various reptiles including the endangered bog turtle (*Glyptemys muehlenbergii*). Bog turtles prefer to overwinter in mats of tree roots where emerging groundwater warms near-surface temperatures. Herbaceous wetlands are of special importance to migrating waterfowl.

2. Environmental Study Areas and Refuges

Forested wetlands can serve as environmental study areas, particularly when located near schools, in public parks, and on other sites available to the public. Because natural plant succession in Pennsylvania normally trends toward forest vegetation, forests usually characterize refuges and sanctuaries relatively undisturbed by people, and forested wetlands typically provide high quality habitat to wildlife. The significance of forest cover to wetland wildlife increases as the size of wetlands decreases, particularly in landscapes with intensive human activity.

Scrub and herbaceous wetlands also can serve as study areas and biological refuges. They are less screened visually and aurally from adjacent human activities by their relatively lower quantities of biomass. They provide key habitat for wetland plants and animals that require open sun reaching the soil surface. Herbaceous wetlands are prime locations for birders.

3. Water Quality and Quantity Protection and Drainage Patterns

Forest wetland vegetation has maximal effect on processes affecting water movement and interaction with the land. By their mass, trees are able to slow the energy of falling raindrops and thereby limit soil erosion. Similarly, their mass and shade render the affected ground beneath the trees moister and cooler than nearby areas open to the sun. Decaying leaves provide a surface that readily accepts precipitation and allows it to infiltrate soil rather than quickly running off the surface.

The interflow through soils in turn contributes to natural extended flow of streams, minimizing both flooding and stream dryup. Nutrients can be bound up in tree trunks for centuries, and thereby kept out of waterways. The complex chemical reactions in wetland soils allow bacterial denitrification fostered by the carbon from leaves and vital to preventing excess nitrate-nitrogen from reaching streams. Wetland tree roots also can help anchor banks of streams against erosion. Forest loss to other land uses in Pennsylvania occurs at the rate of about 150 acres per day (McCaskill *et al*. 2013). Presumably most of these converted lands are not wetland forests, inasmuch as PADEP acknowledges the loss of less than 100 acres of all wetlands annually via individual permits, including forested wetlands.

Scrub and nonpersistent herbaceous wetlands stockpile less biomass on the land surface year-round than forested wetlands. They may offer less protection to the soil than forested wetlands, and their smaller roots may provide less resistance to physical erosion of streambanks.

Discharges of wastewater can contain pollutants at sufficient concentrations to overwhelm the ability of natural wetland systems to accommodate the pollutants, resulting in severe damage to the wetland ecosystems by manure, sewage, spilled brine, oil, and other chemicals. Rubbish also can degrade general habitat functions in forest and other wetlands.

4. Shoreline Protection and Stormwater Shielding

Aside from those on the banks of lakes and large rivers, forested wetlands in Pennsylvania generally have limited opportunity to shield other areas from wave and storm damage. Tree roots can stabilize streambanks large and small against stormwater erosion. To a lesser degree scrub wetlands can function similarly. Shrub willows often are planted to stabilize shorelines.

Some herbaceous wetlands occupy the shallow fringes of large water bodies, where they serve to reduce wave action and encourage sedimentation (thereby protecting water quality).

5. Flood Storage

Forested wetlands often serve as temporary storage areas for storm and flood waters. The economic value of such storage increases annually as flood damages rise in response to increased runoff from a growing human population, impervious surfaces from ever-expanding land development, and storm events of increasing severity driven by global warming in response to the burning of fossil fuels. Many forest ecosystems are adjusted to and dependent upon seasonal flooding, unlike most human structures that are easily damaged even by short-term inundation during flood peaks. Scrub and herbaceous wetlands, provided that they are suitably located, can function equally as well as forested wetlands for temporary stormwater storage, although they may not shade the stored water so effectively and therefore not keep its temperature so low as a dense forest cover.

6. Groundwater Discharge

Spring seep areas are characteristic along the base of slopes in Pennsylvania forested wetlands. The forest shade keeps summer temperatures low as groundwater travels over the land surface toward headwater streams. Trout are a major feature of Pennsylvania streams and much sought-after by anglers. Many Pennsylvania streams have water near the limit of summer warmth that trout can tolerate. Forested wetlands along watercourses are essential to maintaining temperatures low enough for trout to survive and reproduce as global warming continues in response primarily to the burning of fossil fuels. Conversely, because of the warmth of groundwater, spring seeps may become snow-free earlier than dry uplands, and thereby attract feeding turkeys and other wildlife.

Shrub and herbaceous wetlands also can be associated with seeps flowing toward small streams. They are less able to keep surface water temperatures low than forests because of their lesser shade, but they may transpire fewer gallons of water during the course of a hot day. As mentioned previously, groundwater seeps closely associated with masses of tree roots are especially attractive areas for overwintering bog turtles.

Forested Wetland with Seeping Groundwater Discharge.

7. Groundwater Recharge

Countless local topographic depressions in forested wetlands store precipitation, slow its movement toward streams during periods of flood, and enable it to recharge local groundwater during wet seasons. Recharged groundwater, in turn, typically finds outlets to local streams. Recharge can be greater in scrub and herbaceous wetland depressions, because their plant cover transpires less water into the atmosphere than large trees.

8. Pollution Prevention and Sediment Control

Forested wetlands prevent pollution of water bodies by reducing the erosive force of rainstorms. Their trees break the fall of droplets hitting leaves and branches; they anchor the soil with roots and cover it with absorptive leaf litter; their roots bind streambank soils against erosion. Forested wetland soils enable sedimentation, denitrification, and other biogeochemical processing as surface waters pass through. Scrub and herbaceous wetlands can function comparably, but provide less physical protection against soil erosion by precipitation. Forested buffers surrounding wetlands can provide the most effective long-term protection of wetlands from sediment influx originating in disturbed lands.

9. Human Recreation

Wetland forests provide recreational opportunities for Pennsylvania citizens and visitors, calling forth significant contributions to the economy of the Commonwealth on a sustainable basis by those who use the outdoors. Great numbers of people find the seasonally changing display of blooms and colored leaves highly attractive and a sharp contrast to landscapes in urban centers. Recreational hunters seek the game animals---deer, bear, squirrels, waterfowl, and other game birds---that depend on wetland as well as upland forests. Anglers depend on riparian forests to keep the Pennsylvania streams cool enough and to supply food for salmonids. Forested wetlands are especially effective in providing humans with natural landscapes contrasting sharply with urban commercial and industrial environments.

Scrub and herbaceous wetlands also provide recreational opportunities for hiking and for game habitat. Herbaceous wetlands often attract spectacular flocks of migratory waterfowl.

Palustrine Deciduous Scrub Opening in Needleaf-Dominated Bog on Peat.

Rosencrans Bog Natural Area, Clinton County. Photograph by Staff of The Western Pennsylvania Conservancy.

Through its recent draft technical guidance documents PADEP appears to be seeking to expand from a strictly acreage-based evaluation of wetland impacts and working instead toward a weighting of functions, indexing to reference ecosystems, and consideration of conditions adjacent to the affected wetland. State methodology also is just beginning to consider cumulative effects on a watershed basis, which is essential for rationally offsetting the negative side effects (externalities) of construction in wetlands. The proposed technical guidance draws conceptually on federally sponsored work on wetland functions that has been underway for twenty years (Smith *et al*., 1995) as well as the more recent work by Robert Brooks and his coworkers at Riparia, the Cooperative Wetlands Research Center at Pennsylvania State University. PADEP's current list of functions is displayed below.

Table 2
Wetland Functions and Their Value

Functions Related to Hydrologic Processes	Benefits, Products, and Services Resulting from the Wetland Function
Short-Term Storage of Surface Water: the temporary storage of surface water for short periods.	Onsite: Replenish soil moisture, import/export materials, conduit for organisms. Offsite: Reduce downstream peak discharge and volume and help maintain and improve water quality.
Long-Term Storage of Surface Water: the temporary storage of surface water for long periods.	Onsite: Provide habitat and maintain physical and biogeochemical processes. Offsite: Reduce dissolved and particulate loading and help maintain and improve surface water quality.
Storage of Subsurface Water: the storage of subsurface water.	Onsite: Maintain biogeochemical processes. Offsite: Recharge surficial aquifers and maintain baseflow and seasonal flow in streams.
Moderation of Groundwater Flow or Discharge: the moderation of groundwater flow or groundwater discharge.	Onsite: Maintain habitat. Offsite: Maintain groundwater storage, baseflow, seasonal flows, and surface water temperatures.
Dissipation of Energy: the reduction of energy in moving water at the land/water interface.	Onsite: Contribute to nutrient capital of ecosystem Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality
Functions Related to Biogeochemical Processes	**Benefits, Products, and Services Resulting from the Wetland Function**
Cycling of Nutrients: the conversion of elements from one form to another through abiotic and biotic processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Removal of Elements and Compounds: the removal of nutrients, contaminants, or other elements and compounds on a short-term or long-term basis through burial, incorporation into biomass, or biochemical reactions.	Onsite: Contributes to nutrients capital of ecosystem. Contaminants are removed, or rendered innocuous. Offsite: Reduced downstream loading helps to maintain or improve surface water quality.
Retention of Particulates: the retention of organic and inorganic particulates on a short-term or long-term basis through physical processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Export of Organic Carbon: the export of dissolved or particulate organic carbon.	Onsite: Enhances decomposition and mobilization of metals. Offsite: Supports aquatic food webs and downstream biogeochemical processes.
Functions Related to Habitat	**Benefits, Goods and Services Resulting from the Wetland Function**
Maintenance of Plant and Animal Communities: the maintenance of plant and animal community that is characteristic with respect to species composition, abundance, and age structure.	Onsite: Maintain habitat for plants and animals (e.g., endangered species and critical habitats), for rest and agriculture products, and aesthetic, recreational, and educational opportunities. Offsite: Maintain corridors between habitat islands and landscape/regional biodiversity.

Stressors

The functional values of wetlands can be reduced by many stressors, most of which are directly or indirectly the result of human activity and also are more intense and persistent than natural disruptive forces. The evolving PADEP list of stressors lists 37 kinds that are readily observable in the field, grouped into five categories (Draft Technical Guidance Document 310-2137-002, March 2014, p. 33). They prudently have left a blank for other, unlisted stressors in each of the five categories, for less commonly encountered conditions.

PADEP-listed Wetland Stressors.

Vegetation Alteration
Mowing
Moderate livestock grazing (within one year)
Crops (annual row crops, within one year)
Selective tree harvesting/cutting (>50% removal, within 5 years)
Right-of-way clearing (mechanical or chemical)
Clear cutting or Brush cutting (mechanized removal of shrubs and saplings)
Removal of woody debris
Aquatic weed control (mechanical or herbicide)
Excessive herbivory (deer, muskrat, nutria, carp, insects, etc.)
Plantation (conversion from typical natural tree species, including orchards)
Other:
Total Number:
Hydrologic Modification
Ditching, tile draining, or other dewatering methods
Dike/weir/dam
Filling/grading
Dredging/excavation
Stormwater inputs (culvert or similar concentrated urban runoff)
Microtopographic alterations (e.g., plowing, forestry bedding, skidder/ATV tracks)
Dead or dying trees (trunks still standing)
Thermal alteration (power plant or industrial discharges with evidence of high temperatures)
Stream alteration (channelization or incision)
Other:
Total Number:
Sedimentation
Sediment deposits/plumes
Eroding banks/slopes
Active construction (earth disturbance for development)
Active plowing (plowing for crop planting in past year)
Intensive livestock grazing (in one year, ground is >50% bare)
Active selective forestry harvesting (within one year)
Active forest harvesting (within two years, includes roads, borrow areas, pads, etc.)
Turbidity (moderate concentration of suspended solids in the water column, obvious sediment discharges)
Other:
Total Number:

Eutrophication
Direct discharges from agricultural feedlots, manure pits, etc.
Direct discharges from septic or sewage treatment plants, fish hatcheries, etc.
Heavy or moderately heavy formation of algal mats
Other:
Total Number:
Contaminant/Toxicity
Severe vegetation stress (source unknown or suspected)
Obvious spills, discharges, plumes, odors, etc.
Acidic drainages (mined sites, quarries, road cuts)
Point discharges from adjacent industrial facilities, landfills, railroad yards, or comparable sites
Chemical defoliation (majority of herbaceous and woody plants affected, within one year)
Fish or wildlife kills or obvious disease or abnormalities observed
Excessive garbage/dumping
Other:
Total Number:

The more numerous the stressors affecting a wetland, the lower its value. When rating the value of wetland conditions, the proposed PADEP scoring also assigns higher value to wetlands surrounded by forests than to those surrounded by scrub, and assigns higher value to those wetlands surrounded by scrub than to those surrounded by herblands or ponds. Managed wetland buffers are scored lower than wild, unmanaged buffers (Draft Technical Guidance Document 310-2137-002, March 2014, p. 33).

In 2006 PADEP sampled 204 wetlands and used their evolving protocols to rank the condition of those wetlands (PADEP 2014c). How representative the sampled wetlands might be of Pennsylvania wetlands as a whole was not stated, but the rankings from their protocol testing were reported as follows:

Condition Category	Number of Wetlands	Total Acreage	Percent of Resource
Highest	13	127.74	6.10%
High	59	556.19	26.70%
Medium	41	468.89	22.50%
Low	91	930.07	44.70%
Totals	**204**	**2082.88**	**100.00%**

Conversion of Woody Wetlands to Herbaceous Wetlands

Forest and scrub wetlands can be converted to herbaceous wetlands in various ways with effects more or less catastrophic, even if wetland conditions are not intentionally obliterated permanently to enable the construction of roads, buildings, or farm fields. Woody stems can be cut at the ground surface and merely the aboveground trees and shrubs removed, if the goal is to reduce disruption of the soil. More invasively, tree stumps and shrub roots can be grubbed. Biologically active soils can be removed entirely. Hydrology can be diverted or impounded. The amounts and kinds of functions lost and gained will be determined by what conditions previously existed in the wetland as well as the nature and extent of disturbance. If any one of the three major wetland characteristics (hydrophytic vegetation, hydric soils, or hydrology) is not or cannot be restored to natural conditions, then the conversion of wetland to non-wetland will be permanent. The conversion of forested wetlands to scrub or herbaceous wetlands is not readily reversible, inasmuch as forest regrowth at best requires many decades, and may be intentionally prevented by repeated cutting or by spraying herbicides.

When wetland vegetation is changed by people from forest or scrub to herbaceous, many of the wetland's functions can be altered. Detailed study is necessary in order to predict accurately the probable changes and compose plans for appropriate mitigation, because the affected functions will vary at each location supporting a natural wetland.

Where naturally variable wetland hydrology has been restored, some generalist wetland plants usually will follow quickly unless toxic substances also have been introduced, and hydric soils eventually will become recognizable after many years of weathering have elapsed. Pennsylvania wetlands evolved after the retreat of glacial ice, and their biota retains the ability to recover following natural disturbances that are less drastic than those of current technology. Unless artificial plantings are made to accelerate the establishment of desirable species, however, invasives that thrive in human-disturbed wetlands are likely to invade and crowd out preferred species of native plants. Construction activities usually provide ample opportunities for invasive plants and animals to arrive at construction sites. Various online sources provide links to information on invasive species, including those of the Governor's Invasive Species Council of Pennsylvania (www.invasivespeciescouncil.com), the Pennsylvania Department of Conservation and Natural Resources (www.dcnr.state.pa.us/conservationscience/), and the US Forest Service (www.fs.fed.us/invasivespecies).

If the objective is to restore pre-disturbance native wetland vegetation, then near-replacement of pre-disturbance hydrology and soils is most likely to yield the desired plant community. Such replacement only succeeds where careful investigation of plants, soils, and hydrology preceded the wetland disturbance, so that mitigation site modification effectively can mimic the structure of the lost wetland. Light-tolerant herbaceous and scrub wetland plants can be restored more rapidly than forest vegetation, which takes many years for trees to reach mature size and natural diversity even where maximally successful. Protection of new plantings of native woody species from browsing deer and rabbits often is critical for the survival of the plants during the early years after wetland creation or restoration, and supplemental watering may be necessary during unusually dry years while root systems are being formed. Plantings of herbaceous wetlands can be devastated by migrating waterfowl. Moreover, the early-succession trees which will thrive in an open wetland only slowly are replaced by shade-tolerant species of late forest succession. Late-succession native herbs characteristic of mature Pennsylvania forested wetlands would not be expected to grow until the forest canopy has become reestablished and soil formation has proceeded to approximate natural conditions.

Compensatory mitigation in the form of replacement wetland creation or degraded wetland restoration is intended to result in functioning wetlands that do not require ongoing human intervention. Pennsylvania permit conditions long have required five years of monitoring for wetland restoration and creation projects along with written reports to PADEP, but post-construction monitoring has been sporadic at best and approved wetland restoration plans often have been unsuccessful in execution. Ponds are much easier and quicker to build than forested wetlands, but do not provide mitigation for various wetland functions. Similarly, basins engineered to detain stormwater flows from developed areas seldom result in high-value wetlands.

As one illustrative example of the conversion of woody wetlands to herbaceous cover, pipelines can be considered. The excavation of trenches for miles uphill, downhill, and across streams and wetlands is a catastrophic event followed by some measure of soil cover replacement on top of the pipes. But few pipeline operators

Pipeline construction through Pennsylvania wetlands. The corridor will be maintained free of woody vegetation after the pipe is buried.

Herbaceous Wetland 40 Years after Pipeline Installation.

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are prepared to allow reforestation to obscure right-of-way conditions. Thus pipelines are likely to involve vegetation stressors such as right-of-way clearing, clear-cutting of brush, and removal of woody debris both prior to and for the long term subsequent to pipeline installation. Mechanical clearing using equipment occurs, as does spraying with non-selective chemical herbicides to prevent the reestablishment of trees and shrubs so that rights-of-way can be quickly inspected on the ground and from the air.

In summary, the most probable, usually adverse effects of human conversion of forest or scrub to herbaceous wetlands on PADEP-listed wetland functions, the following would be expected and should be considered carefully:

1. **General Habitat and Natural Biological Functions**
   Aboveground biomass: decrease
   Forest interior habitat: loss
   Structural diversity: decrease within converted wetland
   Visual and aural screening from human activity: loss
   Local climate amelioration: decrease
   Evergreen winter cover for wildlife: loss
   Suitability for shade-loving species of plants: loss
   Production of mast (such as acorns) for wildlife: loss

Exposure to harsh wind, ice, sun: increase
Localized effects of global warming on biota: increase

2. **Study Areas and Refuges**
Structural diversity of ecosystem: decrease within converted wetland
Species diversity of plants and animals: decrease within converted wetland
Visual and aural screening from human activity: loss
Rare, ancient trees: loss

3. **Drainage Patterns, Water Quantity, and Water Quality**
Streambank anchoring against erosion: decrease
Soil stabilization: decrease
Erosion and sedimentation: increase
Nutrient storage in ecosystem: decrease
Maintenance of cold water temperature for trout: decrease

4. **Storm Damage Shielding and Shoreline Protection**
Streambank stabilization: decrease

5. **Flood Storage**
Storage volume: no significant change

6. **Groundwater Discharge**
Volume discharged: increase (reduced transpiration)

7. **Groundwater Recharge**
Volume recharged: increase (if soil not disrupted)

8. **Pollution Prevention and Sediment Control**
Erosion and sedimentation control: decrease

9. **Human Recreation**
Landscape aesthetics: disruption
Species composition, plants and animals: change
Forest interior species: loss
Maintenance of cold water temperature for trout: decrease
View and hiking corridors: increase

How much functional loss will occur as a result of authorized conversion from forest or scrub to herbland at any wetland location will depend on the functions initially present in the forested wetland, the severity of the disruption to the elements of the environment such as its soil and surface elevation, the location of the converted area in the landscape, and its connection with other wetlands, especially along stream corridors. As some functions decrease, others may increase. The degree to which impacts are negative also depends on the context of reference: “edge” species such as whitetailed deer benefit from forest fragmentation. Given the complexity of the natural world, under some sets of circumstances an anticipated negative change actually could prove beneficial. The functional loss of forested wetland is never quickly reversible, even if active maintenance were to stop, nor is it capable of offsite mitigation except, at best, until after long time delays.

Not currently identified by PADEP in its list of functions, conversion of forest to herbaceous wetland also entails a reduction in the ability of the wetland to affect human climate and to reduce air pollution. Herbaceous wetlands cannot rival forests in providing shade and screening people from wind. Likewise, they cannot promote the deposition of airborne pollutant particles or take up as much gaseous pollution as forest trees.

In principle, some of the functional losses of vegetation conversion eventually can be replaced by successful wetland mitigation onsite or offsite. But the actual substitution of lost functions by compensatory wetlands is not routine.

Wetland Compensatory Restoration and Creation

Because wetland damage and destruction routinely are authorized by permits, agencies by regulation are to require the restoration of temporary damage and the offsetting replacement of permanent loss of natural wetlands. A plan for the mitigation of unavoidable impacts by regulation is required as part of every individual joint permit application for wetland encroachments in Pennsylvania, other than "small" projects deemed by PADEP to have no significant impact on safety or protection of life, health, or the environment [25 *Pa. Code* 105.13(d)(1)(ix)]. Mitigation is defined (at 25 *Pa. Code* 105.1) as

> An action undertaken to accomplish one or more of the following:
>
> Avoid and minimize impacts by limiting the degree or magnitude of the action and its implementation.
>
> Rectify the impact by repairing, rehabilitating or restoring the impacted environment.
>
> Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
>
> If the impact cannot be eliminated by [the foregoing measures], compensate for the impact by replacing the environment impacted by the project or by providing substitute resources or environments.

PADEP records fewer than 100 acres of wetlands authorized for damage annually under individual permits during recent years, along with about 40 miles of streams (PADEP 2014c). These wetland statistics do not include losses through construction authorized by general permits. The statistics also do not include enforcement against unauthorized encroachments into streams and wetlands. (These stream statistics omit altogether about half of the land area of the Commonwealth that occupies small watersheds where stream, but not wetland, destruction is authorized automatically by waiver.)

Since the 1990s PADEP has sought 1:1 minimum replacement for wetland acreage and functions, with a preference for mitigation adjacent to the loss and on the same property. Mitigation has been designed on an acreage replacement basis, typically with no allowance for less than complete success or the time during which wetland functions are absent. Functional replacement itself has seldom if ever been mandated. For enforcement cases, PADEP policy long has sought to require 2:1 acreage mitigation (PADEP 1992, 1997a). PADEP's stated preference has been for onsite mitigation close to the allowed wetland destruction rather than for remote offsite mitigation. Such mitigation would be undertaken by the permittee, who seldom is expert in wetland mitigation.

Because less intervention is required, the restoration of wetlands previously converted to agricultural uses typically is easier and less uncertain than conversion of uplands to wetlands. Wetland hydrology, for example, sometimes can be restored simply by crushing the drainage tiles installed by farmers in order to dry fields sufficiently for commercial crops. To the extent hydrology is removed temporarily, but then restored, wetland vegetation and some semblance of a wetland ecosystem can be recovered onsite where care is taken to reconstruct natural conditions insofar as practicable. Habitat functions often can be attained more readily in rural mitigation areas than adjacent to urban development sites where the restored or created wetlands are isolated from other areas of comparable habitat. Areas amenable to wetland restoration, however, often are located offsite at considerable distance from impacted areas and affected watersheds. Wetlands in stream valleys and floodplains do not necessarily substitute functionally for wetlands along headwater streams.

Successful wetland creation from dry land, even more than restoration, depends on careful identification of water budgets pre-construction to guide attempted restoration. Abundant field experience has demonstrated that small inaccuracies in analyzing or reconstructing hydrology will result either in dry non-wetlands or in open water ponds rather than vegetated wetlands.

Hydrology normally is removed by blocking the movement of water into a wetland (1) by diking or channelizing and diverting its flow and/or (2) by expediting the removal of water from a wetland by drainage pipes or pumps. Restoration of hydrology may require detailed attention to creating almost flat slopes, and often requires design for seasonal variability in wetness. Most natural wetlands, unlike typical farm ponds and detention basins, have very gently sloping land surfaces rather than abrupt banks. Effective wetness of surface soils within a wetland can be reduced by removal of natural vegetation on and adjacent to the mitigation area, impeding the recovery of wild plants and affecting the survival of replacement plantings. Hydrology derived from channelized stormwater can be toxic to wetland plants, if the stormwater brings in road salts, oil, excessive nutrients, and other pollutants. Trees typically are less tolerant of salinity change than herbaceous plants (Adamus & Brandt 1990). Where urban runoff is the source of wetland hydrology, functional mitigation may be difficult to achieve.

Timely restoration of near-surface hydric soils that have wetland characteristics depends on the successful removal and segregation of topsoil, and then its replacement above the subsoil. By keeping holding time for stockpiled topsoil to a minimum, some of the natural seed bank can be salvaged to aid in wetland revegetation. Where the structure of the soil layers has been drastically altered, years are required for horizontal layering to become restored by natural weathering. If wetland hydrology was caused by impermeable subsurface layers such as clay lenses, and those are disrupted by excavation, capturing sufficient hydrology for wetland restoration may be impossible. If surface soil density is compacted, additional years are required for natural porosity to return along with the ability for water to penetrate (Stoler and Relyea 2011). The placement of only a few inches of soil on wetland trees and shrubs, as well as herbs, can be fatal to the disturbed plants. Mulch and short-lived cover crops can help stabilize soils without offering severe competition to desirable native wetland plants. A natural balance of groundwater recharge and discharge in constructed or restored wetlands is not easily achieved.

Given these technical considerations and the historical fact that practical humans long focused on draining and converting rather than restoring wetlands and wetland functions, the actual mitigation of wetland impacts has proved generally unsuccessful in Pennsylvania for many decades (*see*, for example, McCoy 1987, 1992; Kline 1991) and has not improved recently (Campbell *et al*. 2002, Cole & Shaffer 2002, Gebo & Brooks 2012, Hoeltje & Cole 2007, Kislinger 2008, PADEP 2014c). Seldom has mitigation created the same kind of wetlands as those damaged. Most attempted mitigation that succeeded in creating wet areas resulted in open water ponds rather than forested or scrub wetlands (Cole and Shaffer 2002). Monitoring and reporting on mitigation success on paper is required of applicants, but often not performed. PADEP staff seldom monitor wetland mitigation sites or require remedial measures of permittees.

PADEP has found that the ability of permittee-constructed mitigation

> to address the needs of a watershed is limited at best. Applicants generally do not have adequate resources to identify watershed needs, plan for and identify high value project sites, and/or secure rights to and produce significant restoration activities. (PADEP 2014c)

69 Permit Wetland Mitigations Scored by PADEP Interns, 1992-1995

Size (acres)	Success	Failure	Not Rated	% Success
0-.10	5	3	1	62.5
.10-.25	8	6	1	57.1
.25-.50	9	7	0	56.3
.50-1.0	11	3	0	78.6
1.0->	13	2	0	86.7
Total	46	21	2	68.7

Most Pennsylvania wetland impacts authorized by individual permit, after avoidance and minimization have been addressed, affect small acreages. Thus PADEP has implemented an acreage-based fee-in-lieu program to enable most permittees affecting small (0.5 acre or less) areas of wetland to substitute a one-time cash payment instead of undertaking their own construction of mitigation wetlands (PADEP 1997b). The half-acre "allowance" for cash contributions was deemed sufficient to allow any landowner enough wetland impact to build a house. Fees were set by PADEP based on its expectation that willing landowners across the Commonwealth would allow conversion of uplands to wetlands or restoration of wetlands with higher quality through voluntary cooperation with PADEP and the National Fish and Wildlife Foundation. This program has greatly assisted permittees, but it has not demonstrably resulted in compensatory wetland mitigation similar in kind or location to wetlands destroyed.

Contributions to the Washington, D.C.-based National Fish and Wildlife Foundation's Pennsylvania Wetland Replacement Project ID 95-096 became routine across the Commonwealth beginning in the 1990s. According to its web page, as of May 2014 this Foundation had sponsored 486 environmental enhancement projects of various kinds in Pennsylvania. Locational and descriptive information for these projects are displayed on an interactive map. But no data apparently exist comparing wetland acreage or functions lost to mitigation accomplished under the Pennsylvania in-lieu-fee program or identifying the geographical proximity of wetland losses versus gains on a watershed basis. Only first-time readers of PADEP regulations might expect any applicant eligible to use the Fund even to consider undertaking onsite mitigation, which is always far more expensive than scheduled contributions to the State's

Fund. The in-lieu fees long have represented a major subsidy to permittees from Pennsylvania residents and their environment (Schmid 1996a, b). Pennsylvania mitigation fees have been the same for Exceptional Value as for Other wetlands, and the acreage-based fees have been presumed to compensate for any and all wetland functions associated with the wetlands lost.

Pennsylvania Wetland Mitigation Replacement Fees (1997-2013).

De minimis impact less than or equal to .05 acre	$ 0.00
Greater than .05 acre to .10 acre	$ 500.00
Greater than .10 acre to .20 acre	$ 1,000.00
Greater than .20 acre to .30 acre	$ 2,500.00
Greater than .30 acre to .40 acre	$ 5,000.00
Greater than .40 acre to .50 acre	$ 7,500.00

Contributions to the Fund relieve permittees of any followup responsibility for mitigation monitoring or success. Between 1997 and 2013 the buying power of cash contributions to the Fund dwindled by about 30% due to inflation, while the market costs of wetland creation can be $100,000 per acre in some locations, according to the Pennsylvania Department of Transportation. Costs are less where free land and prison labor can be obtained (FHWA 2011). Moreover, the success of the wetland mitigation work done under PADEP's Replacement Project apparently has been limited and certainly has been sparsely reported. Pennsylvania's in-lieu-fee program was deemed unacceptable for use to satisfy federal wetland mitigation requirements in 2008, and its "grandfathering" expired in 2013 (33 CFR 332.8). Hence the PADEP currently is seeking federal approval for a new in-lieu-fee program (PADEP 2014c).

The generally laudable goals of the new program include (1) high quality mitigation addressing wetland functions as well as acreage, (2) ecologically based mitigation site selection, (3) efficiencies of scale in constructing, monitoring, and administering a few large mitigation projects instead of many small ones, (4) streamlined federal and State permit approvals, and (5) more effective accounting and compliance reporting (PADEP 2014c). PADEP claims that it has the expertise and staff to run an in-lieu-fee program effectively. As has been repeatedly demonstrated by PADEP staff and by independent academics, mitigation to date by permittees affecting more than the half acre of wetlands to which Fund contributions are limited typically has been of poor quality in Pennsylvania and has failed altogether in replacing the functions of wetlands lost.

The new PADEP technical guidance potentially represents an opportunity to have those who hope to benefit from damaging wetlands more effectively internalize the negative externalities of their conduct, a goal consistent with both Pennsylvania and federal law. It is not self-evident that the functions of multiple small, scattered wetlands high in the landscape can be replaced effectively by larger wetlands in floodplains, and PADEP may be asked to address this issue, as well as many other technical details, prior to gaining federal approval for its proposed in-lieu-fee program. Unquestionably, more information will need to be generated during preparation and review of each application to damage wetlands, if new PADEP technical guidance is adopted along the lines of its current draft. A significant outcome should be the more effective tailoring of compensatory mitigation to the amount and type of wetland impacts. The full costs of mitigation should include both the risk of mitigation failure and the temporal lag between impacts and restoration of functions---which, for forested wetlands can be immense.

Only if this opportunity is fully exploited will future mitigation begin to compensate for permitted impacts in Pennsylvania. The new guidance also can provide a corrective to the mitigation failures and lack of accountability long prevalent in Pennsylvania, while reducing the previous economic subsidies encouraging private destruction of wetland resources. The new information available also should allow better public understanding of the external costs of development and the benefits of successful mitigation, particularly if public access to permit records is made electronically available.

It is high time that human behaviors with harmful side effects in Pennsylvania be mitigated more effectively to enable continued prosperity for its residents and the planet's survival, as well as compliance with Article 1, Section 27, of the Pennsylvania Constitution:

> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

When completed, the new PADEP technical guidance may make possible the actual functional mitigation for conversion of forest and scrub wetlands to herbaceous wetlands. If effective, it also should help reduce so-called "natural" hazards from waters---hazards which are in fact failures of human design, construction, planning, and community development in areas subject to natural processes of stormwater movement. If the opportunity is missed, the alternative includes increased environmental plundering of remaining wetland resources, high costs for disaster survivors, especially the most vulnerable, as well as harm to communities and ever growing costs to taxpayers.

Completion of public review, PADEP revision, and implementation of the new technical guidance for wetland assessment and mitigation may take considerable time. Pennsylvania wetlands only slowly have begun to receive some attention from regulators in the context of damage by longwall (that is, high-extraction underground) bituminous coal mining, which was first allowed by Act 54 of 1994. PADEP long refused to recognize even the possibility of damage to wetlands from longwall mining, but gradually has been implementing more thorough data collection for mine applications (Schmid & Co., Inc. 2000, 2010a, 2011a, 2012, 2013).

The minimal current PADEP information and review requirements for oil and gas permits provide virtually no assurance that wetlands will be identified and protected from this extractive industry, which currently is experiencing a boom across much of the Commonwealth. Similarly, PADEP has failed to protect too many streams, particularly those streams of highest ecological value (Van Rossum *et al*. 2011; Kunz 2011; Schmid & Co., Inc. 2010b). Oil and gas permit applications generate far less environmental information than coal mining applications. Proposed regulations governing surface oil and gas activities currently are under review (25 *Pa. Code* 78, Subchapter C). PADEP and the Environmental Quality Board are preparing responses to the 24,000 comments received on their proposed oil and gas regulations. New Chapter 78 regulations could specify protection for streams and wetlands far more effectively than the regulations they are replacing.

Whether the proposed wetland analysis and mitigation technical guidance will receive similar public attention remains to be seen. Its comment period is still open and likely to be extended.

Authorship

This report was prepared by James A. Schmid, a biogeographer and plant ecologist. Dr. Schmid received his BA from Columbia College and his MA and PhD from the University of Chicago. After serving as Instructor and Assistant Professor in the Department of Biological Sciences at Columbia University and Barnard College, he joined the environmental consulting firm of Jack McCormick & Associates of Devon, Pennsylvania. Since 1980 he has headed Schmid & Company of Media, Pennsylvania.

Dr. Schmid has analyzed and secured permits for some of the largest wetland mitigation projects in the mid Atlantic States, as well as a myriad of smaller projects. He is certified as a Senior Ecologist by the Ecological Society of America, as a Professional Wetland Scientist by the Society of Wetland Scientists, and as a Wetland Delineator by the Baltimore District, Army Corps of Engineers. He has served on the professional certification committees of the Ecological Society and the Society of Wetland Scientists.

When the US Fish & Wildlife Service Pleasantville Office evaluated actual compliance with approval conditions requiring mitigation by about 100 of the Clean Water Act Section 404 fill permits issued by the Corps of Engineers in the State of New Jersey during the period 1985-1992, every Schmid & Company mitigation project was judged in the field to exhibit full compliance with all permit requirements and mitigation goals. Schmid & Company mitigation projects represented 21% of all the mitigation projects judged fully successful in New Jersey by USFWS in its written report to USEPA. Dr. Schmid analyzed and secured Wetland Mitigation Council approval for the first major freshwater mitigation bank in New Jersey on behalf of DuPont. That bank was donated to The Nature Conservancy.

Dr. Schmid has often analyzed environmental regulatory programs and commented on proposed regulations. His clients continue to include the construction industry, conservation groups, and government agencies, including the Pennsylvania Department of Environmental Protection.

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