Office of
Energy
Projects

July 2014

FERC/DEIS-0255D

DRAFT MULTI-PROJECT ENVIRONMENTAL IMPACT STATEMENT FOR HYDROPOWER LICENSES

Susquehanna River Hydroelectric Projects

York Haven Project—FERC Project No. 1888-030–Pennsylvania

Muddy Run Project—FERC Project No. 2355-018–Pennsylvania

Conowingo Project—FERC Project No. 405-106–Maryland/Pennsylvania

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, D.C. 20426

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FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON, D.C. 20426

OFFICE OF ENERGY PROJECTS

To the Agency or Individual Addressed:

Reference: Draft Environmental Impact Statement

Attached is the draft environmental impact statement (EIS) for the York Haven, Muddy Run, and Conowingo projects, collectively referred to as the Susquehanna River Projects (Nos. 1888-030, 2355-018, and 405-106), located on the Susquehanna River in York, Dauphin, and Lancaster counties in Pennsylvania and Cecil and Harford counties in Maryland.

This draft EIS documents the view of governmental agencies, non-governmental organizations, affected Indian tribes, the public, the license applicants, and Federal Energy Regulatory Commission (Commission or FERC) staff. It contains staff evaluations of the applicants' proposals and the alternatives for relicensing each of the Susquehanna River Projects.

Before the Commission makes a licensing decision, it will take into account all concerns relevant to the public interest. The draft EIS will be part of the record from which the Commission will make its decision. The draft EIS was sent to the U.S. Environmental Protection Agency and made available to the public on or about July 30, 2014.

Copies of the draft EIS are available for review in the Commission's Public Reference Branch, Room 2A, located at 888 First Street, N.E., Washington, D.C. 20426. The final EIS also may be viewed on the Internet at www.ferc.gov/docs-filing/elibrary.asp. Please call (202) 502-8222 for assistance.

Any comments should be filed by September 29, 2014. The Commission strongly encourages electronic filing. Please file comments using the Commission's efiling system at http://www.ferc.gov/docs-filing/efiling.asp. Commenters can submit brief comments up to 6,000 characters, without prior registration, using the eComment system at http://www.ferc.gov/docs-filing/ecomment.asp. You must include your name and contact information at the end of your comments. For assistance, please contact FERC Online Support. In lieu of electronic filing, please send a paper copy to: Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, 888 First Street, NE, Washington, D.C. 20426. Please affix the project number(s) (Project No. 405-106, Project No. 2355-018, or Project No. 1888-030) to all comments.

Attachment: Draft Environmental Impact Statement

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COVER SHEET

a. Title:	**Relicensing the York Haven, Muddy Run, and Conowingo Projects, FERC Project Nos. 1888-030, 2355-018, and 405-106**
b. Subject:	Draft Environmental Impact Statement
c. Lead Agency:	Federal Energy Regulatory Commission
d. Abstract:	The existing projects are located on the Susquehanna River in York, Dauphin, and Lancaster counties in Pennsylvania, and Cecil and Harford counties in Maryland. Each project has one development, and together they span about 55 river miles from the mouth of the Susquehanna River to upstream of the York Haven impoundment. The York Haven Power Company, LLC (York Haven Power), executed a Settlement Agreement pertaining to relicensing the York Haven Project among York Haven Power, U.S. Fish and Wildlife Service, the Commonwealth of Pennsylvania, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, and the Susquehanna River Basin Commission. The Settlement Agreement resolved all outstanding issues pertaining to project relicensing. Exelon Generation Company, LLC's Muddy Run and Conowingo projects are located on the Susquehanna River in Lancaster and York counties, Pennsylvania, and Cecil and Harford counties, Maryland. Conowingo Pond acts as the lower reservoir for the Muddy Run Project. The three projects do not occupy any federal lands. The staff's recommendation is to relicense the three projects as proposed, with certain modifications and additional measures recommended by the agencies.
e. Contact:	Emily Carter Federal Energy Regulatory Commission Office of Energy Projects 888 First Street, N.E. Washington, D.C. 20426 (202) 502-6512

f.	Transmittal:	This draft environmental impact statement to relicense the York Haven, Muddy Run, and Conowingo Hydroelectric Projects is being made available for public comment on or about July 30, 2014, as required by the National Environmental Policy Act of 1969[1] and the Commission's Regulations Implementing the National Environmental Policy Act (18 CFR, Part 380).

[1] National Environmental Policy Act of 1969, amended (Pub. L. 91-190. 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, §4(b), September 13, 1982).

FOREWORD

The Federal Energy Regulatory Commission (Commission), pursuant to the Federal Power Act (FPA)[2] and the U.S. Department of Energy Organization Act[3] is authorized to issue licenses for up to 50 years for the construction and operation of non-federal hydroelectric development subject to its jurisdiction, on the necessary conditions:

> That the project…shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, including irrigation, flood control, water supply, and recreational and other purposes referred to in section 4(e)…[4]

The Commission may require such other conditions not inconsistent with the FPA as may be found necessary to provide for the various public interests to be served by the project.[5] Compliance with such conditions during the licensing period is required. The Commission's Rules of Practice and Procedure allow any person objecting to a licensee's compliance or noncompliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration.[6]

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[2] 16 U.S.C. §791(a)-825r, as amended by the Electric Consumers Protection Act of 1986, Public Law 99-495 (1986), the Energy Policy Act of 1992, Public Law 102-486 (1992), and the Energy Policy Act of 2005, Pub. L. 109-58 (2005).

[3] Public Law 95-91, 91 Stat. 556 (1977).

[4] 16 U.S.C. § 803(a).

[5] 16 U.S.C. § 803(g).

[6] 18 C.F.R. § 385.206 (2014).

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ACRONYMS AND ABBREVIATIONS

ADA	Americans with Disabilities Act
Advisory Council	Advisory Council on Historic Preservation
APE	area of potential effects
ASMFC	Atlantic States Marine Fisheries Commission
BMP	best management practice
CDP	census-designated place
CFR	Code of Federal Regulations
certification	water quality certification
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
Conowingo Project	Conowingo Hydroelectric Project
Corps	U.S. Army Corps of Engineers
CPUE	catch-per-unit-effort
CZMA	Coastal Zone Management Act
dbh	diameter at breast height
DO	dissolved oxygen
DPS	distinct population segment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
Exelon	Exelon Generation Company, LLC
ºF	degrees Fahrenheit
FEMP	Fish passage effectiveness monitoring plan
FERC	Federal Energy Regulatory Commission
FPOP	fish passage operating procedures
FPA	Federal Power Act
FPMP	fish passage monitoring plan
FWS	U.S. Fish and Wildlife Service
HPMP	Historic Properties Management Plan
Interior	U.S. Department of the Interior
IVM	Integrated Vegetation Management
kV	kilovolt
LSRWA	Lower Susquehanna River Watershed Assessment
Maryland DOE	Maryland Department of the Environment
Maryland DNR	Maryland Department of Natural Resources
mgd	million gallons per day
mg/L	milligrams per liter
Muddy Run Project	Muddy Run Pumped Storage Project
MW	megawatt
MWh	megawatt-hour
MWUA	maximum weighted usable area

National Register	National Register of Historic Places
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge and Elimination System
NTU	nephelometric turbidity unit
PA	Programmatic Agreement
PBAPS	Peach Bottom Atomic Power Station
Pennsylvania DEP	Pennsylvania Department of Environmental Protection
Pennsylvania FBC	Pennsylvania Fish and Boat Commission
Pennsylvania DCNR	Pennsylvania Department of Conservation and Natural Resources
PPL BI	PPL Brunner Island LLC
ppt	parts per thousand
RM	river mile
RSP	Revised Study Plan
SAV	submerged aquatic vegetation
SD1	Scoping Document 1
Settling Parties	York Haven Power, FWS, Pennsylvania FBC, Maryland DNR, and SRBC
SHPO	State Historic Preservation Officer
SMP	Shoreline Management Plan
SPM	surplus production method
SRAFRC	Susquehanna River Anadromous Fish Restoration Cooperative
SRBC	Susquehanna River Basin Commission
Susquehanna River Projects	York Haven, Muddy Run, and Conowingo projects
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey
WMA	Wildlife Management Area
York Haven Power	York Haven Power Company, LLC

EXECUTIVE SUMMARY

The Federal Energy Regulatory Commission (Commission or FERC) staff is reviewing applications to continue operating (relicense) three hydropower projects located on the lower Susquehanna River (the Susquehanna River Projects): the 19.62-megawatt (MW) York Haven Hydroelectric Project (York Haven Project); the 800.25-MW Muddy Run Pumped Storage Project (Muddy Run Project); and the 574.54-MW Conowingo Hydroelectric Project (Conowingo Project).

Proposed Actions

On August 30, 2012, York Haven Power Company, LLC (York Haven Power) filed an application for a new license for the existing York Haven Hydroelectric Project No. 1888. On January 30, 2014, York Haven Power filed an Offer of Settlement. In the accompanying Explanatory Statement, York Haven Power stated that the Settlement Agreement represents a complete resolution among the Settling Parties of all issues pending in the proceeding.[7] The York Haven Project is located on the Susquehanna River at river mile (RM) 55 in the city of York, in York, Dauphin, and Lancaster counties, Pennsylvania. The project does not occupy any federal lands.

On August 29, 2012, and August 31, 2012, respectively, Exelon Generation Company, LLC (Exelon) filed applications for new licenses with the Commission for the existing Muddy Run Pumped Storage Project No. 2355 and the existing Conowingo Hydroelectric Project No. 405. The Muddy Run and Conowingo projects are located on the Susquehanna River at RM 22 and RM 10, respectively, in Lancaster and York counties, Pennsylvania, and Cecil and Harford counties, Maryland.[8] Conowingo Pond, the reservoir for the Conowingo Project, acts as the lower reservoir for the Muddy Run Project. The Muddy Run Project also includes an upper reservoir for pumped storage operation. The projects do not occupy any federal lands.

Project Descriptions

<u>York Haven Project</u>

The York Haven Project consists of a headrace wall, main dam, east channel dam, powerhouse, and forebay bulkhead. The main dam is attached to the north end of the

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[7] The Settling Parties are York Haven Power, U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, and the Susquehanna River Basin Commission.

[8] The authorized capacity for Muddy Run is from the original license issued September 21, 1964, and the authorized capacity for Conowingo is from the Commission Order issued March 3, 2010.

headrace where it runs diagonally across the main channel of the river to the west shore of Three Mile Island. The main dam has a maximum height at the crest of 18 feet and an average height of 10 feet. The east channel dam extends from the east shore of Three Mile Island to the east bank of the river, and it has an average height of 9 feet. The stone masonry forebay bulkhead wall extends west from the south end of the powerhouse to the transformer building, perpendicular to the shoreline. From the transformer building, the forebay bulkhead wall extends north along the property line to the west bank of the river. A trash sluice gate and associated spillway are located adjacent to the southern end of the powerhouse at the eastern end of the forebay wall.

York Haven's impoundment, Lake Frederic, is 3.5 miles long with 29 miles of total shoreline length within the project boundary, including the shoreline of the islands in Lake Frederic. At the normal water surface elevation of 277.86 feet, Lake Frederic has a surface area of 2,218 acres and 9,600 acre-feet of gross storage capacity. The impoundment provides approximately 22.5 feet of net head for power generation purposes.[9]

The brick and stone masonry powerhouse is integral with the dam and includes 20 turbine-generator units and appurtenant equipment. Water flowing through the turbines is discharged into the tailrace immediately downstream of the dam.

There are no primary transmission lines included as part of the project. The York Haven Project interconnects with the 115-kilovolt (kV) electric grid at the substation located immediately downstream of the project's forebay wall.

An east channel upstream fish passage facility located at the western end of east channel dam has been operational since April 2000.

The project includes 10 recreation facilities that York Haven Power owns and operates: the Historic Canal Lock, East Shore Boat Launch, Goosehorn Island Picnic Area, Shelley Island Recreation Area, Goodling Island Picnic Area, Beshore Island Recreation Area, Battery Island Recreation Area, Cly Shore recreational lot sites, York Haven Power Plant Recreation Area, and Canoe Portage trail.

The project is operated in a run-of-river mode and maintains a normal pool elevation of 277.86 feet under low to moderate flow conditions, less than 17,000 cubic feet per second (cfs). Under low-flow conditions, York Haven Power has the ability to draw down the impoundment by up to 1.10 feet, generally for purposes of dam maintenance. During periods of moderate to high flow conditions of greater than 17,000 cfs, the project turbines cannot control water levels and the impoundment elevation varies above normal pool elevation depending upon river flow. Under these

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[9] Unless otherwise noted, all elevations are referenced to National Geodetic Vertical Datum of 1929.

conditions, water overtops the main dam, east channel dam, and headrace walls when their crest elevations are exceeded.

Muddy Run Project

The Muddy Run Project consists of four dams and two reservoirs.

The upper reservoir emergency spillway is a non-gated concrete ogee-type structure that is 200 feet long, 20 feet high, and has a crest elevation of 521 feet that is directed to a vegetated natural ravine.

Total storage in the 900-acre Muddy Run reservoir (upper reservoir) is about 56,731 acre-feet, and the total usable storage is 33,894 acre-feet at the maximum pool elevation of 520 feet. The maximum pool elevation is about 411 feet above the normal elevation of Conowingo Pond (lower reservoir), which has a surface area of 9,000 acres and design storage of 310,000 acre-feet at the normal full pool elevation of 109.2 feet.

A separate pool, designated as the Recreation Lake, is located adjacent to the upper reservoir. The pool is used for recreation purposes and is not used for water storage for power production purposes. The Recreation Lake spillway is a rock-cut channel approximately 140 feet wide with a crest elevation of 520 feet.

The power intake facilities at the west end of the upper reservoir consist of four cylinder gates with trashracks in a cylindrical tower, and each intake supplies two units. Each intake leads to a horizontal power tunnel, which divides into two sections. The power tunnel sections transition to a penstock that leads to one of the eight reversible pump-turbine units in the powerhouse. The powerhouse is located along the shore of the Susquehanna River. The powerhouse houses eight Francis turbines each equipped with a 100-MW generator. The turbines have a total discharge capacity from the powerhouse of 32,000 cfs. The total powerhouse pumping capability is 28,000 cfs. Water flowing through the turbines is discharged via the draft tubes into the Susquehanna River adjacent to the powerhouse. The units are equipped with trashracks between the draft tube outlet and the river. Electricity generated at the project is transmitted by two individual 220-kV transmission lines extending from the project switching station approximately 4.25 miles to the Peach Bottom Atomic Power Station North Substation located in York County.

The project also includes three recreation areas: Muddy Run Park, owned by Exelon and operated by a vendor; Wissler's Run Park, owned and operated by Exelon; and Muddy Run Wildlife Management Area, owned by Exelon and leased to and managed by the Pennsylvania Game Commission.

The Muddy Run Project is a pumped storage hydroelectric facility. Water is pumped at night (typically) from the lower reservoir (Conowingo Pond) to the upper reservoir that has 33,894 acre-feet of active storage available for pumped storage operation. Water is then released from the upper reservoir through the powerhouse units to the Susquehanna River (Conowingo Pond). Typically, pumping occurs during low-load periods when energy costs are low (nights and weekends), while generation occurs during high-load periods.

Conowingo Project

The existing Conowingo Project consists of a concrete gravity dam with a non-overflow gravity section, an ogee-shaped spillway section, an intake-powerhouse section, and a 127-foot-long abutment section. The spillway consists of a 2,250-foot-long section with a crest elevation of 86.0 feet, and a 135-foot-long section with a crest elevation of 99.2 feet. The spillway is fitted with 50 Stoney-type crest gates and two regulating gates. Each Stoney crest gate is 22.5 feet high by 38 feet wide and has a discharge capacity of 16,000 cfs at a reservoir elevation of 109.2 feet. The two regulating gates are 10 feet high by 38 feet wide and have a discharge capacity of 4,000 cfs per gate at a reservoir elevation of 109.2 feet. The dam includes two fish lifts: a west fish lift and a newer east fish lift.

Conowingo dam impounds the Conowingo reservoir (Conowingo Pond) which extends 14 miles upstream from the dam. Total storage in the 8,500-acre reservoir is approximately 310,000 acre-feet at the normal full pool elevation of 109.2 feet. The elevation of the normal river surface below the dam is approximately 20.5 feet. The impoundment provides approximately 89 feet of gross head for power generation purposes.

The powerhouse is integral with the dam and is composed of 13 turbine-generator units, draft tubes, and transformer bays. Water flowing through the turbines is discharged via the draft tubes into the tailrace immediately downstream of the dam. There are no primary transmission lines associated with the project.

The project also includes 15 recreation facilities and public access areas owned by Exelon: Lock 13, Lock 15, Muddy Creek Boat Launch, Cold Cabin Boat Launch, Dorsey Park, Line Bridge, Broad Creek Public Landing, Glen Cove Marina, Conowingo Swimming Pool and Visitor's Center, Peach Bottom Marina, Conowingo Creek Boat Launch, Funk's Pond, Conowingo Dam Overlook, Fisherman's Park/Shures Landing, and Octoraro Creek Access. Exelon operates seven of these facilities and leases the other eight to local and state entities or commercial operators.

The Conowingo Project is a peaking hydroelectric facility that uses reservoir storage to generate during peak electricity demand periods. The current Conowingo Project license allows for Conowingo Pond to fluctuate daily between elevation 101.2 and 110.2 feet.

Proposed Facilities

York Haven Project

York Haven Power proposes to construct a nature-like fishway[10] at the north end of the main dam where it abuts Three Mile Island. The installation would require modifications to the north end of the dam. No other major modifications are proposed to project facilities.

Muddy Run Project

Exelon is not proposing any major modifications to the Muddy Run Project; however, it proposes minor improvements at the project's recreation facilities.

Conowingo Project

Exelon proposes to construct an eel trapping facility on the western shore of the Susquehanna River downstream of Conowingo dam and a temporary eel trapping facility on Octoraro Creek which enters the Susquehanna River approximately 4,500 feet downstream of Conowingo dam on the east shore. If the temporary facility is successful after 3 years, then Exelon would construct a permanent eel trapping facility on Octoraro Creek. No other major modifications to project facilities are proposed at the Conowingo Project; however, minor improvements are proposed for the project's recreation facilities.

Proposed Environmental Measures

York Haven Project

Under the terms of the Settlement Agreement, York Haven Power proposes the following environmental measures at the York Haven Project:

- Develop an erosion and sediment control plan for construction of the nature-like fishway.
- Continue to operate and maintain the existing east channel upstream fishway for upstream fish passage.
- Continue the current downstream juvenile American shad passage protocol that calls for the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30), and opening the forebay sluice gate at specific times for downstream fish passage. If river flows exceed the capacity of units 1-6, unit 14 would be

[10] A nature-like fishway is a fishway that is designed to appear and operate similar to a natural riffle, with a gradually sloping channel interspersed with rock weirs and pools. These fishways are typically suitable for a wide range of species.

operated, and if flows exceed the capacities of units 1-6 and 14, units 7-13 and 15-30 would be operated in ascending order.

- Provide a year-round, continuous, minimum flow from the project of 1,000 cfs and an average daily minimum flow of 2,500 cfs, or inflow, whichever is less, to protect and enhance aquatic resources downstream of the project.
- Continue to operate the project in a run-of-river mode when inflow to the project is less than 3,000 cfs.
- Pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, flows through the nature-like fishway, once constructed, flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad, and any day that river flow exceeds the combined hydraulic capacity during the fall American shad emigration period to facilitate downstream passage of juvenile American shad.
- Pass about 370 cfs through the forebay sluice gate between the hours of 5 p.m. and 11 p.m. during the entire fall juvenile American shad passage period to facilitate downstream passage of juvenile American shad.
- Develop designs within 4 years of license issuance for: (1) removal of obstructions in or deepening of the downstream plunge pool for the forebay sluice gate, and (2) a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad passing into the downstream plunge pool.
- Cooperate with resource agencies and other interested parties to conduct a lower Susquehanna River downstream eel migration study including monitoring silver eels at the project and providing $25,000 to support the study.
- Conduct a site-specific silver eel route of passage study and a survival study as described in appendices G and H of the Settlement Agreement including the potential for providing $50,000 to resource agencies for collection and tagging of silver eels at upstream locations.
- Conduct a downstream eel passage improvement study if downstream eel passage goals are not achieved with provisions for subsequent monitoring and adjustments.

- Prior to construction of the proposed nature-like fishway:
    - Provide a minimum flow of 2,000 cfs at east channel dam and a spillage flow of 4,000 cfs at the main dam during the American shad upstream passage season when the east channel fishway is in operation.
    - After the American shad upstream passage season until the end of the resident fish passage season maintain a minimum flow of 400 cfs in the east channel downstream from the east channel fishway during the period that the east channel fishway is operated to allow upstream passage of resident fish species, per the June 2010 Consent Order and Agreement between York Haven Power and Pennsylvania Department of Environmental Protection (Pennsylvania DEP).
    - Conduct vegetation surveys, wetlands delineations, invasive species surveys, rare species surveys, bog turtle habitat assessments, and bald eagle surveys in the area of the nature-like fishway.[11]
- After construction of the nature-like fishway:
    - Conduct American shad upstream passage effectiveness studies using radio telemetry beginning during the second year of the nature-like fishway operation. If the project area passage success criterion is not achieved, York Haven Power would implement corrective measures, followed by two additional years of radio telemetry studies to confirm achievement of the project area passage success criterion.
    - Conduct a juvenile American shad headrace turbine avoidance study consistent with design criteria included in appendix D of the Settlement Agreement.
    - If the juvenile American shad headrace turbine avoidance goals are not achieved, implement measures that would enhance the effectiveness of downstream passage and conduct a supplemental juvenile American shad headrace turbine avoidance study within 2 years of implementing the measures.

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[11] These proposed measures cited in the explanatory statement accompanying the Offer of Settlement would be implemented prior to the construction of the nature-like fishway.

- Provide an average daily minimum flow in the east channel below east channel dam of 267 cfs year round to protect aquatic resources in the east channel and provide a minimum passage flow for fish ascending the east channel and using the east channel fishway.
- Provide a minimum of 5 percent of the river flow through the nature-like fishway during the American shad upstream passage season such that when inflows to the project are between 5,000 and 150,000 cfs, total flow through the nature-like fishway would range from about 1,000 to 7,500 cfs, depending on inflow.
- Provide a minimum flow of 200 cfs through the nature-like fishway outside of the American shad upstream passage season when the river elevation is at the crest of the main dam.
- When flows exceed the hydraulic capacity of all available generating units, and to the extent controllable by York Haven Power, manage flows to maximize flow over the main dam and the nature-like fishway to provide attraction flow to the vicinity of and from the nature-like fishway to maximize fishway effectiveness.

- To prevent a buildup of debris that could affect project and fish passage operations, remove non-natural debris from the forebay and sluice remaining natural debris downstream, after notifying the downstream PPL Brunner Island Station.
- Contribute $25,000 per year to the York Haven Conservation District or such other entity identified by the Pennsylvania DEP for the purposes of debris removal in the lower Susquehanna River watershed.

In addition to the measures specified in the Settlement Agreement, York Haven Power also proposes to implement the following measures.

- Maintain existing project recreation facilities on four islands in Lake Frederic and the project recreation facilities at the powerhouse, including an existing portage trail for canoeists and fishing access along the downstream face of the powerhouse, and consult with the resource agencies on recreation resources and management strategies every 10 years after the effective date of any new license.
- Continue the current permitting program for the approximately 300 recreational lots located within the project boundary, but terminate permits and remove lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures.

- Implement the Historic Properties Management Plan (HPMP) filed with the Commission on December 28, 2012, to manage project effects on properties eligible for listing on the National Register of Historic Places (National Register).

Muddy Run Project

Exelon proposes the following environmental measures at the Muddy Run Project:

- Develop a dissolved oxygen (DO) monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards.
- Develop fish passage operating procedures (FPOP) for minimizing delay and potential fish entrainment during upstream and downstream fish passage past the project tailrace during generating and pumping cycles.
- Develop a plan and schedule for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run Project boundary if resource agencies determine that operation of the Muddy Run Project is causing the Holtwood Project to fail to meet the Tier I upstream American shad target specified in the water quality certification for the Holtwood Project.
- Develop a downstream eel passage plan to ensure safe and timely passage past the Muddy Run Project.
- Implement the American Eel Passage Plan[12] filed with the license application for an eel trap and truck program to trap, hold, and transport American eels from the Conowingo Project and Octoraro Creek to designated points in the Susquehanna River watershed until at least 2030, and then either continue the trap and truck program or construct a volitional eel passage facility at Conowingo dam.
- Implement the Bald Eagle Management Plan filed with the license application to minimize impacts to bald eagles and their habitat within the project boundary in accordance with recommendations from *the National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance.

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[12] Exelon filed an Eel Management Plan with its final license application. In the water quality certification for the Muddy Run Project, the Pennsylvania Department of Environmental Protection called this plan an American Eel Passage Plan, and we use this title throughout the EIS.

- Implement the Bog Turtle Management Plan filed with the license application to minimize impacts to bog turtles and that includes: (1) the restriction of mowing in the wetland documented to support bog turtles; (2) invasive plant and woody plant control, particularly for reed canary grass; and (3) limits on public access to the wetland without advertising the reason.
- Once every 10 years through the term of the license, evaluate all state and federal endangered and threatened species that may be present within the project boundary, and if the evaluation identifies the presence, critical habitat, or critical dependence of endangered species, propose and implement a protection plan for each species.
- Provide annual grants of up to $450,000 each to the Lancaster County and York County Conservation Districts for the implementation of agricultural pasture and barnyard best management practices (BMPs) to control sediment loading into the Susquehanna River.
- Provide $50,000 annually to the Pennsylvania Fish and Boat Commission (Pennsylvania FBC) for habitat improvement projects, including removal of small dams.
- Implement the Recreation Management Plan filed with the license application that includes the following improvements to project recreation facilities: an improved launching ramp and Americans with Disabilities Act (ADA)-compliant dock; shoreline erosion measures; an improved retaining wall; electric upgrades; expanded playground area near the Visitor's Center; and construction of a 2,000-square-foot water spray park near the park entrance, along with paving resurfacing (see section 2.2, *Applicants' Proposals*, for a full description of proposed capital improvements at each site).
- Implement the Shoreline Management Plan (SMP) filed with the license application that includes measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands and BMPs for controlling sediment introduction.
- Implement the osprey management policy described in Exelon's proposed SMP.
- Prepare a cultural resources management plan if cultural materials are identified during project-related activities.

Conowingo Project

Exelon proposes to continue the following environmental measures:

- Operate the project with a normal daily range of operation of Conowingo Pond between elevations 101.2 and 110.2 feet, with a minimum elevation of 107.2 feet on weekends between Memorial Day and Labor Day, to meet recreational needs.
- Provide minimum downstream flow releases from the project as follows:
  - March 1 – March 31: 3,500 cfs or natural inflow,[13] whichever is less;
  - April 1 – April 30: 10,000 cfs or natural inflow, whichever is less;
  - May 1 – May 31: 7,500 cfs or natural inflow, whichever is less;
  - June 1 – September 14: 5,000 cfs or natural inflow, whichever is less;
  - September 15 – November 30: 3,500 cfs or natural inflow, whichever is less; and
  - December 1 – February 28: 3,500 cfs intermittent (maximum six hours off followed by equal amount on).
- Enhance DO at the project using the turbine venting systems on Units 1 through 7 and the aerating runners on Units 2 and 5, and continuously monitor DO levels from May 1 through October 1 at the Station 643 location about 0.6 mile downstream of Conowingo dam.
- Operate the east fish lift to pass American shad, river herring, and other migratory fishes, and the west fish lift for American shad egg collection and other research purposes.
- Manage debris to include clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes and floating surficial debris in front of the powerhouse intakes, and sponsoring community-based clean-ups in the pond and downstream of the dam.
- Maintain the project's public recreation facilities.

Exelon proposes the following new environmental measures:

- Implement the Sediment Management Plan filed with the license application that identifies benchmarks and thresholds for actions to address sediment issues that may affect project operation.

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[13] As measured at the upstream U.S. Geological Survey (USGS) Marietta gage (No. 01576000).

- Conduct a bathymetric survey of Conowingo Pond every 5 years to monitor sediment transport and depositional patterns within the pond.
- Implement a preventive maintenance program for the east fish lift to extend the useful life of the facility over the next license term.
- Use the project turbines as the route for downstream passage of American shad and river herring.
- Construct a permanent trap and transport facility for the upstream passage of American eel, consisting of an eel ramp and collection facility on the west and east banks of the Conowingo tailrace (an alternative east bank facility would be in Octoraro Creek).
- After 2030, construct volitional eel passage facilities on the west and east banks that consist of full eel ramps with resting pools.
- Participate in a trap and transport program for downstream eel passage, in cooperation with the other hydroelectric project operators on the lower Susquehanna River to trap and transport adult American eels from smaller tributaries upstream of York Haven dam to below Conowingo dam.
- Implement the Bald Eagle Management Plan filed with the license application to minimize impacts to bald eagles and their habitat within the project boundary in accordance with recommendations from the *National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance.
- Implement the Recreation Management Plan filed with the application that provides for improvements to 13 project recreation facilities, including directional signage to facilities and canoe portages, expanded parking, ADA-compliant and boat trailer parking spaces, fencing, shoreline stabilization, new or repaired boat ramps, improved access, picnic tables, portable restrooms, and other amenities.
- Implement the SMP filed with the license application that includes measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, BMPs for controlling sediment introduction from lands within the project boundary, and use of project lands.
- Implement the osprey management policy described in Exelon's proposed SMP.
- Implement the HPMP filed with the license application for the management of archaeological and historic resources, including: (1) a schedule and methodology for completing any additional recommended studies and

implementing monitoring measures; (2) management measures for identified historic properties including Conowingo dam and powerhouse; (3) protection of any historic properties threatened by project-related activities, including project operation, shoreline and aquatic recreation, shoreline development, routine project maintenance, and other project activities or operations; and (4) public outreach, education, and signage for the purpose of reducing looting and vandalism of sites.

Project Boundary Revisions

York Haven Project

York Haven Power proposes to add 1.9 acres to the total York Haven Project boundary acreage to encompass the project's East Shore Boat Launch and Canal Lock recreation area.

Conowingo Project

Exelon proposes to modify the Conowingo Project boundary by removing lands that are not necessary for operation and maintenance of the project or for public recreation or protection of environmental resources. These lands include: 0.06 acre of land not owned by Exelon in the upper reaches of Conowingo Pond; 34.4 acres along the Susquehanna River shoreline at the Muddy Run Project (to minimize the overlap of project lands between the two projects); and lands from upper Broad Creek and from the Susquehanna River downstream of Rowland Island that were originally included for construction of the project, including 205.6 acres on upper Broad Creek, a tributary to Conowingo Pond; and 1,758.7 acres of the Susquehanna River and shoreline downstream of Conowingo dam. The proposed project boundary would contain 9,919 acres, including 8,850 acres of project waters and 1,069 acres of land above the normal high water elevation in Lancaster and York counties, Pennsylvania, and Harford and Cecil counties, Maryland. Exelon would negotiate leases with existing recreation facility operators for the continued operation of those facilities located on lands owned by Exelon, but no longer within the project boundary. Exelon would also negotiate a new lease with Maryland Department of Natural Resources (Maryland DNR) for the continued protection and use of the collocated Lower Susquehanna Greenway Trail and Mason-Dixon Trail on Exelon-owned lands outside of the project boundary. The existing lease expires in August 2014.

Alternatives Considered

In addition to the applicants' proposals, as outlined above, this draft environmental impact statement considers the following alternatives: (1) the applicants' proposals with staff-recommended modifications (staff alternative), and (2) a no-action alternative.

Staff Alternative

Under the staff alternative, the projects would be operated as proposed by York Haven Power and Exelon with the modifications and additional staff-recommended measures described below for each project:

York Haven Project

- Develop a recreation management plan that provides for York Haven's proposed maintenance of its existing recreation facilities with additional provisions to update the plan every 12 years consistent with every other Form 80 reporting period deadline, include safety measures during construction of the nature-like fishway, continue the licensing program for approximately 300 recreational lots within the project boundary, and implement revisions to the program to allow for the termination of permits and removal of lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures.
- Develop an SMP that includes specific measures and policies related to shoreline management at the project and include a provision to update the plan every 10 years.
- Modify York Haven's proposed HPMP with the following additional provisions: (a) include a requirement to request landowner permission to access sites on private lands within the project boundary and evaluate them for listing on the National Register and for project impacts if project impacts are identified during monitoring activities; (b) a plan and schedule to evaluate archaeological sites on York Haven lands within the project boundary for their National Register eligibility to ensure that any effects to sites owned by York Haven Power are fully considered in accordance with section 106; and (c) include two additional sites (36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded.

Muddy Run Project

- Visit the U.S. Fish and Wildlife Service's (FWS) Chesapeake Bay Field Office and the Pennsylvania Field Office websites prior to any ground disturbance, and follow the bog turtle and bald eagle guidelines.
- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other Form 80 reporting deadline.
- Modify Exelon's proposed SMP to include a provision to update the plan every 10 years.

- Develop an HPMP that provides for the management of historic properties and unevaluated cultural resources within the project's area of potential effects (APE) and includes: (a) a detailed discussion of the three sites (36LA67, 36LA103, 36LA368) identified during Phase IA cultural resources surveys and two additional sites (36LA70, 36LA47) located outside of the project boundary but within the area of potential affect; (b) requirements for National Register evaluation of affected sites in consultation with the Pennsylvania State Historic Preservation Officer (SHPO); (c) requirements for formal National Register evaluation of the Muddy Run Project; and (d) documentation of consultation with Indian Tribes.

Although required by the water quality certification issued by Pennsylvania DEP for the project, the staff alternative does not include Exelon's proposals to implement the American Eel Passage Plan for an eel trap and truck program and provide annual grants to the York County and Lancaster County conservation districts and the Pennsylvania FBC. The American Eel Passage Plan addresses measures to be implemented at the Conowingo Project, and the Commission cannot require a condition in the Muddy Run license that would need to be implemented through the Conowingo license. For the annual grants, the certification does not specify nor describe what the compensation is mitigating, nor do the requirements appear to be related to any specific project impact. In addition, providing funds is inconsistent with the Commission's guidelines on environmental measures.[14] Finally, the staff alternative does not recommend Exelon's proposal to evaluate all state and federal endangered or threatened species that may be present within the project boundary once every 10 years through the term of the license. The Commission typically includes in its licenses a standard license article with a fish and wildlife reopener provision that could be used to require changes to project facilities upon Commission motion or as recommended by the appropriate federal and state fish and wildlife agencies after notice and opportunity for hearing. This standard reopener provision retains authority for the Commission to implement any measures that may be needed to protect threatened or endangered species or other fish and wildlife resources over the term of any license issued for the project.

<u>Conowingo Project</u>

- Modify Exelon's proposed Sediment Management Plan to include periodic dredging at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediments have been accumulating, to improve and maintain recreational boating access; and include with the

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[14] *See* Policy Statement on Hydropower Licensing Settlements, issued September 21, 2006.

results of each bathymetric survey an analysis of any change in sediment deposition or scour in the pond from the previous survey(s).

- Modify Exelon's proposed minimum flow regime to enhance minimum flows from December through February, by eliminating periods with no minimum flow, and by increasing the minimum flow during the first 2 weeks of June, summarized as follows:
  - September 15 – March 31: 3,500 cfs or natural inflow (as measured at the U.S. Geological Survey Marietta gage No. 0157600), whichever is less;
  - April 1 – April 30: 10,000 cfs or natural inflow, whichever is less;
  - May 1 – June 15: 7,500 cfs or natural flow, whichever is less;
  - June 16 – September 14: 5,000 cfs or natural inflow, whichever is less.
- Implement measures designed to improve upstream fish passage through modification to the existing west and east fish lifts, including: (a) replacing the existing hopper at the west fish lift with a 1,500 gallon hopper; (b) improving the west fish lift sorting and loading process to facilitate trap and truck operations and implement a trap and truck program for American shad; (c) conducting a feasibility study for adding attraction flow at the west fish lift and if feasible and beneficial, install additional flow capacity; (d) restoring the original design for the 900-cfs attraction flow in the east fish lift; (e) adding a second 3,300-gallon hopper to the east fish lift in the space provided for in the original design, and upgrading the electrical and mechanical equipment to allow for a 15 minute lift cycle; and (f) if 2 years of effectiveness studies, after restoration of the 900-cfs attraction flow, show poor attraction at the east fish lift, conducting a feasibility study for modifying the locations of entrances A and B, and implement if feasible
- Modify Exelon's proposed Bald Eagle Management Plan to include measures to minimize recreation-related disturbance in proximity to roosting or foraging eagles.
- Develop a northern map turtle protection plan to minimize project impacts to map turtles through monitoring, habitat management, and nest site protection.
- Develop a waterfowl nesting protection plan to identify waterfowl nesting habitat that is routinely flooded during the breeding season, and where feasible, establish mitigation measures to minimize impacts to waterfowl nests.

- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other the Form 80 reporting deadline and a plan to provide angler access to the catwalk on a limited basis with security measures in place that address the vulnerability of the facility and the safety of the users of the catwalk.
- Modify Exelon's proposed SMP with the addition of a provision to update the plan every 10 years.
- Modify Exelon's proposed HPMP to include the following additional provisions: (a) a revised APE with the narrow strip of land in the current project boundary extending downstream from Spencer Island along the west side of the river to Havre de Grace, Maryland; (b) a discussion of all 48 sites and 27 historic structures identified to date within the project APE or an explanation of why they are not considered; (c) correction to identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad eligible for listing; (d) requirements to inventory any lands within the revised APE, evaluate identified cultural resources for eligibility, and address potential effects before sale or transfer of those lands; (e) a requirement to make good faith effort to obtain access to private property to conduct studies if project effects on cultural resources on private lands are identified; (f) a revised list of project activities involving the Conowingo Project that can be completed without Maryland SHPO review; (g) a process for assessing project-related ground-disturbing activities to determine whether or not archaeological sites would be affected, particularly in areas that have not had archaeological surveys; (h) requirements to ensure confidentiality of cultural resources location information during implementation of public outreach programs; and (i) a description of project-related activities that would require consultation with the Delaware Nation and the Onondaga Nation in accordance with section 106 of the National Historic Preservation Act and documentation of Native American consultation.

The staff alternative does not include the U.S. Department of the Interior's (Interior's) recommended bog turtle protection plan. Interior did not provide evidence that bog turtles are present within the Conowingo Project boundary, or that bog turtles are potentially affected by project operation or maintenance.

No Action Alternative

Under the no-action alternative, each project would continue to operate under the terms and conditions of the existing licenses, and no new environmental protection, mitigation, or enhancement measures would be implemented.

Public Involvement and Areas of Concern

Before filing the license applications for the Susquehanna River Projects, York Haven Power and Exelon conducted pre-filing consultation under the integrated licensing process. The intent of the Commission's pre-filing process is to initiate public involvement early in the project planning process and to encourage citizens, government entities, Indian tribes, and other interested entities to identify and resolve issues prior to a license application being formally filed with the Commission. During pre-filing, Commission staff conducted scoping to determine what issues and alternatives should be addressed. Scoping documents (SD1s) were distributed to interested agencies and others on July 24, 2009, for the York Haven Project, and on May 11, 2009, for the Muddy Run and Conowingo projects. In addition, scoping meetings were held on August 26 and 27, 2009, for the York Haven Project; June 10, 2009, for the Muddy Run Project; and June 11 and 12, 2009, for the Conowingo Project to request comments on the projects. Revised scoping documents, addressing the comments received, were issued on November 13, 2009, for the York Haven Project, and on August 24, 2009, for the Muddy Run and Conowingo projects.

The primary issues associated with relicensing the projects are sedimentation effects on aquatic resources downstream of Conowingo dam, including Chesapeake Bay; instream flows downstream of Conowingo dam; the effects of project operations on water quality; effective fish passage for American shad, American eel, and other diadromous species; protection of sensitive plant and wildlife species including the bald eagle, osprey, bog turtle, and northern map turtle; and enhancements to recreation opportunities and facilities.

Staff Alternative

Geology and Soils – Continued run-of-river operation of the York Haven Project would have minimal effect on shoreline erosion in Lake Frederic. Development of the proposed erosion and sediment control plan prior to ground-disturbing activities associated with construction of the nature-like fishway would ensure BMPs are in place to minimize erosion and sedimentation.

Shoreline erosion effects from the operation of the Muddy Run and Conowingo Projects are also considered minimal, and the implementing erosion control measures proposed by Exelon in the SMPs would help minimize adverse effects on water quality in the respective reservoirs.

Exelon's proposed Conowingo Sediment Management Plan would identify action benchmarks and thresholds at the powerhouse intakes to address sedimentation-related issues as they might affect project operation. Exelon's proposed bathymetric surveys in Conowingo Pond at 5-year intervals would allow for verification of predictions from the anticipated U.S. Army Corps of Engineers' study and identify appropriate management actions. A final Sediment Management Plan that includes detailed benchmarks for

dredging, a schedule, and commitment to dredging three boating access areas affected by sedimentation in Conowingo Pond as soon as the benchmark sediment depths are reached would protect recreation access.

Aquatic Resources – Continued operation of the York Haven, Muddy Run, and Conowingo projects would have minimal effects on water quality in the lower Susquehanna River, and Exelon's continued DO monitoring at the Muddy Run and Conowingo projects would ensure that state standards are maintained at those projects.

Establishing a modified minimum flow regime at Conowingo that would enhance Exelon's minimum flows from December through February and in the first 2 weeks of June would allow continued operation of the Muddy Run and Conowingo projects while improving downstream aquatic habitat.

Constructing and operating the nature-like fishway at York Haven, improving the fish lifts at the Conowingo Project, and implementing American eel passage measures at the three projects would enhance upstream fish migration and maintain required downstream survival of diadromous fish species in the lower Susquehanna River.

Interior filed preliminary fishway prescriptions for the York Haven, Muddy Run, and Conowingo projects. At York Haven, the prescription is consistent with the Settlement Agreement, requiring nature-like fishway and downstream passage measures. At Muddy Run, the prescription requires FPOP for minimizing delay and potential fish entrainment, and an upstream eel passage program from the downstream Conowingo Project. At Conowingo, the Interior prescription requires major renovations to the existing east and west fish lifts, and implementation of upstream eel passage at the project. The staff is in agreement with Interior's fishway prescriptions for York Haven and Muddy Run, but notes that the Muddy Run requirements for eel passage cannot be enforced via another project's license (Conowingo). In addition, while the final fishway prescriptions would become a requirement of any licenses issued, staff recommends an alternative at Conowingo that would provide substantial improvements to the fish passage facilities at the project and would involve renovations to the existing east and west fish lifts, but at a lower cost and more appropriate scale considering the current size of the American shad run.

Terrestrial Resources – Raptors, including state sensitive species such as bald eagle and osprey, and waterfowl occur on the projects' lands and waters, and these species could be affected by project operation, maintenance activities, and use of project recreation facilities. Implementing Exelon's Bald Eagle Management Plan, as proposed for the Muddy Run Project, and with the staff modifications for the plan at the Conowingo Project to include measures to minimize recreation-related disturbance in proximity to roosting or foraging eagles, would ensure that bald eagle nesting, roosting, and foraging areas are protected within the Muddy Run and Conowingo project boundaries.

Exelon's proposed osprey management policies at the Muddy Run and Conowingo projects would benefit ospreys by implementing BMPs and protection measures to minimize effects on osprey nesting within the project boundary.

A waterfowl nesting protection plan at the Conowingo Project, as recommended by Interior would identify waterfowl nesting habitat that is routinely flooded during the breeding season, and where feasible, establish mitigation measures to minimize impacts to waterfowl nests.

A northern map turtle protection plan would minimize project impacts to map turtles, through monitoring, habitat management, and nest site protection, as described in Towson University's 2014 final map turtle report.

Threatened and Endangered Species – Six federally listed species are known to occur in the general vicinity of one or more of the projects: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus),* bog turtle (*Glyptemys* [*Clemmys*] *muhlenbergii*), Indiana bat (*Myotis sodalis*), Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*), and swamp pink (*Helonias bullata*).

The York Haven and Muddy Run projects would have no effect on the shortnose and Atlantic sturgeons because neither species has been collected or passed via the Conowingo fish lifts since they began operation in 1972. While there is suitable habitat downstream of Conowingo for both species, there is no evidence of their occurrence in the lower Susquehanna River. Therefore, continued operation of the York Haven, Muddy Run, and Conowingo projects would not likely adversely affect the shortnose and Atlantic sturgeon.

Bog turtles have been confirmed near the Muddy Run Project. Implementing Exelon's Bog Turtle Management Plan for the Muddy Run Project, including habitat management at any confirmed breeding locations and other practices to protect the existing population and improve bog turtle habitat would minimize effects on bog turtles and their habitat due to project maintenance or recreation. Therefore, we conclude that relicensing the Muddy Run Project may affect, but would not be likely to adversely affect the bog turtle.

For the Conowingo Project, although Interior states that bog turtles have been observed close to Conowingo dam and recommends a bog turtle management plan, it has yet to provide evidence to indicate that bog turtles are present within the Conowingo Project boundary, and Exelon states that there is no evidence of bog turtles in the project area. Thus, staff cannot presently determine if bog turtles would be affected by the Conowingo Project. Further consultation with Interior is necessary to determine the potential for project effects and the need for Interior's recommended bog turtle management plan.

Potential Indiana bat habitat may exist within the three project areas, along the riparian forested edges of the river and reservoirs, and forested edges along transmission line rights-of-way and recreational areas. Neither York Haven Power nor Exelon propose

any activities that would result in more than a minimal amount of tree clearing. At the Muddy Run Project, continued routine vegetation management practices, such as trimming and herbicide application, would be unlikely to affect trees large enough to provide roosting habitat. Therefore, the York Haven, Muddy Run, and Conowingo projects would not be likely to adversely affect the Indiana bat.

Swamp pink have been previously documented in Cecil and Harford counties where the Conowingo Project is located but are not known to occur in those project areas according to FWS' Information, Planning, and Conservation System website. Therefore, the York Haven and Muddy Run projects would have no effect on the swamp pink.

The three projects would have no effect on the Delmarva Peninsula fox squirrel. Although it was noted in SD1 as occurring in the vicinity of the Muddy Run and Conowingo projects, it is not known to exist in the project area.

Recreation and Land Use – Continued operation of the York Haven, Muddy Run, and Conowingo projects would enhance the recreational facilities and benefit recreationists in the region. Implementing a recreation management plan at the York Haven Project that includes a facility inventory with ownership and management responsibilities for each site, as well as measures to provide for periodic monitoring and consultation and protection of human safety during construction of the nature-like fishway, would ensure that recreational opportunities are maintained and enhanced.

Revising the York Haven Project boundary to include the entirety of the Lock 15 facility would bring a facility associated with the East Shore boat launch within the project boundary.

Implementing the proposed Recreation Management Plans at the Muddy Run and Conowingo projects that include measures for maintenance and capital improvement, with staff modifications that include providing angler access to the catwalk at Conowingo, would ensure that the visitation and facilities are monitored periodically to ensure that the project recreation facilities continue to meet recreation use and demand at the projects.

Revising the Conowingo project boundary to remove lands that were necessary during construction of the project but are no longer used for project purposes (such as project-related recreation or protection of environmental resources not related to the project) would be consistent with FERC policy that only lands and waters needed for project purposes should be included in the project boundary.

Cultural Resources – Continued operation of the York Haven, Muddy Run, and Conowingo projects could affect historic properties located within the projects' boundaries. Implementing York Haven Power's and Exelon's HPMPs with the staff modifications to the plans for the York Haven and Conowingo projects would provide for the management and protection of cultural resources and any historic properties associated with the projects.

No-Action Alternative

Under the no-action alternative, the projects would continue to operate under the terms and conditions of the existing licenses, and no new environmental protection, mitigation, or enhancement measures would be implemented.

Conclusions

Based on our analysis, we recommend licensing the projects as proposed by York Haven Power and Exelon with some staff modifications and additional measures.

In section 4.2, *Comparison of Alternatives*, we estimate the likely cost of alternative power for each of the alternatives identified above. For the York Haven Project, our analysis shows that, during the first year of operation under the proposed action, the project would produce power at a cost which is $336,690 or $2.56/megawatt-hour (MWh) more than the cost of alternative power. Under the staff alternative, the project would produce power at a cost which is $332,650 or $2.52/MWh more than the cost of alternative power.

For the Muddy Run Project, our analysis shows that, during the first year of operation under the proposed action, the project would produce power at a cost which is $50,233,890 or $31.09/MWh less than the cost of alternative power. Under the staff alternative, the project would produce power at a cost which is $50,498,040 or 31.28/MWh less than the cost of alternative power.

For the Conowingo Project, our analysis shows that, during the first year of operation under the proposed action, the project would produce power at a cost which is $32,270,040 or $17.70/MWh less than the cost of alternative power. Under the staff alternative, the project would produce power at a cost which is $31,099,900 or $17.06/MWh less than the cost of alternative power.

We chose the staff alternatives as the preferred alternatives for the Susquehanna River Projects because: (1) the York Haven, Muddy Run, and Conowingo projects would provide a dependable source of electrical energy and ancillary services for the region (131,771 MWh, 1,614,313 MWh, and 1,823,293 MWh annually, respectively); (2) the combined 1,394.16 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; and (3) the recommended environmental measures proposed by York Haven Power and Exelon, as modified by staff, would adequately protect and enhance environmental resources affected by the projects. The overall benefits of the staff alternatives would be worth the cost of the proposed and recommended environmental measures.

1.0 INTRODUCTION

1.1 APPLICATION

On August 30, 2012, York Haven Power Company, LLC (York Haven Power) filed an application for a new license with the Federal Energy Regulatory Commission (Commission or FERC) for the existing York Haven Project (FERC Project No. 1888).[15] The 19.62-megawatt (MW) project is located on the Susquehanna River at river mile (RM)[16] 55 in the city of York, in York, Dauphin, and Lancaster counties, Pennsylvania (figure 1-1). The project does not occupy any federal lands. The project generates an average of about 132,271 megawatt-hours (MWh) of energy annually. York Haven Power proposes no new capacity and no new construction; however, the company is proposing the construction of a new fishway as part of its proposed environmental measures.

On August 29, 2012, Exelon Generation Company, LLC (Exelon) filed applications for new licenses with the Commission for the existing Muddy Run Pumped Storage Project (Muddy Run Project) (FERC Project No. 2355)[17] and the existing Conowingo Hydroelectric Project (Conowingo Project).[18] The 800.25-MW Muddy Run and the 574.54-MW Conowingo projects are located on the Susquehanna River at RM 22 and RM 10, respectively, in Lancaster and York counties, Pennsylvania, and Cecil and Harford counties, Maryland (figure 1-1).[19] Conowingo Pond acts as the lower reservoir for the Muddy Run Project. Neither project occupies any federal lands. The Muddy Run and Conowingo projects generate an average of about 1,615,813 MWh and 1,823,193 MWh of energy annually, respectively. Exelon proposes no new capacity and no new construction at either project.

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[15] The current license for the York Haven Project was issued on August 14, 1980, and expires on September 1, 2014.

[16] The river mile is calculated from the mouth of the Susquehanna River at its confluence with the Chesapeake Bay.

[17] The current license for the Muddy Run Project was issued on September 21, 1964, and expires on August 31, 2014.

[18] The current license for the Conowingo Project was issued on August 14, 1980, and expires on September 1, 2014.

[19] The authorized capacity for Muddy Run is from the original license issued September 21, 1964, and the authorized capacity for Conowingo is from the Commission Order issued March 3, 2010.

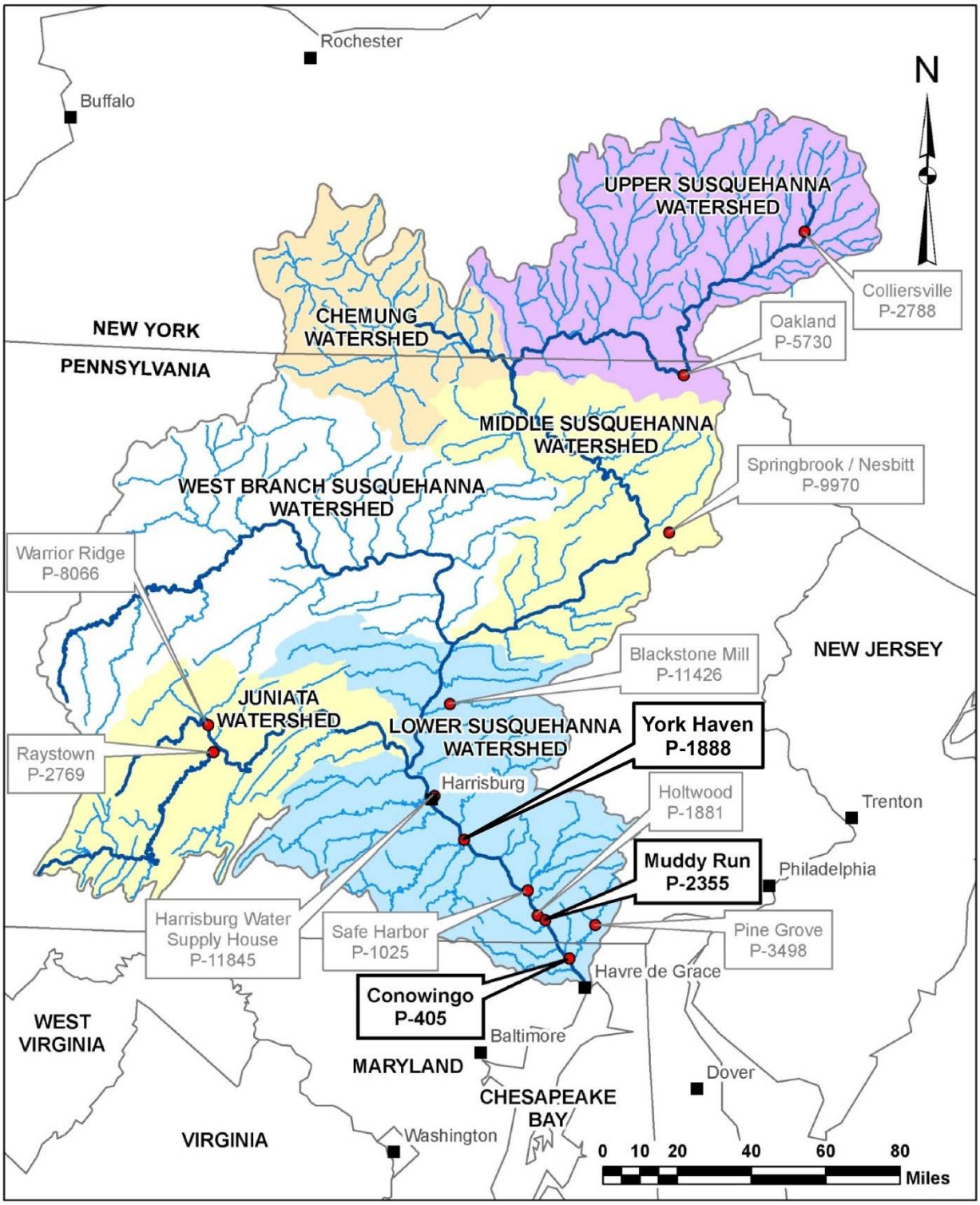

Figure 1-1. Susquehanna River Projects location (Source: FERC, 2009, as modified by Staff).

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the York Haven, Muddy Run, and Conowingo projects (Susquehanna River Projects) is to continue to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a license to York Haven Power for the York Haven Project and to Exelon for the Muddy Run and Conowingo projects and what conditions should be placed on any licenses issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the projects will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, or water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing new licenses for the Susquehanna River Projects would allow York Haven Power and Exelon to generate electricity at the projects for the term of each new license, making electric power from a renewable resource available to their customers. This multi-project draft environmental impact statement (EIS) assesses the effects associated with operation of the projects, alternatives to the proposed projects, and makes recommendations to the Commission on whether to issue a new license, and if so, recommends terms and conditions to become a part of any licenses issued.

In this draft EIS, we assess the environmental and economic effects of continuing to operate the projects: (1) as proposed by York Haven Power and Exelon; and (2) with our recommended measures. We also consider the effects of the no-action alternative. Important issues that are addressed include the effects of continued project operation on shoreline erosion and sediment transport, water quality, fishery resources and fish passage, terrestrial resources, threatened and endangered species, recreation and land use, and cultural resources.

1.2.2 Need for Power

The Susquehanna River Projects provide hydroelectric generation to meet part of Maryland's and Pennsylvania's power requirements, resource diversity, and capacity needs. The existing York Haven Project has an installed capacity of 19.62 MW and generates approximately 132,271 MWh per year (average 2001-2011). The existing Muddy Run Project has an installed capacity of 800.25 MW and generates approximately 1,615,813 MWh per year (average 1996-2010). The existing Conowingo Project has an installed capacity of 574.54 MW and generates approximately 1,823,193 MWh per year (1996-2010).

The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The projects are located in the Pennsylvania-New Jersey-Maryland region of NERC. According to NERC's 2013 forecast, the summer and winter planning reserve margins (capacity resources in excess of demand) are expected to drop from 32.04 percent in 2014 to 19.73 percent in 2023 and from 42.99 percent in 2014 to 32.87 percent in 2023, respectively (NERC, 2013).

In addition to energy and capacity, the Conowingo and Muddy Run projects provide ancillary services that benefit the electric grid. The Conowingo Project provides peaking generation, regulation control, and black start capabilities. The Muddy Run Project provides peaking generation, peak load following, spinning reserve, and black start capability, and also is able to use excess baseload energy during pumping operation.

Baseload facilities operate at maximum output. They shut down or reduce power only to perform maintenance or repairs. Baseload facilities typically include coal, fuel oil, nuclear, hydroelectric, geothermal, biomass, and combined cycle natural gas facilities.

Pumped storage facilities can be operated at a generating level that is much lower than baseload facilities and can therefore avoid the need to run a baseload unit at low efficiencies below the minimum load rating of the baseload unit. Pumped storage facilities can also use excess energy provided by baseload units that run continuously at night to pump water to the upper reservoir so that it can be used for generation during daily peak demand periods.

Peaking facilities operate during times of peak electric demand. Conowingo and Muddy Run have the ability to meet peak energy demands by increasing generation needed when water is available. They have the ability to start within minutes, if not seconds, depending upon available water supply. Muddy Run is able to draw from storage in the Muddy Run Project reservoir (the upper reservoir) when needed to provide peak generation, while Conowingo relies on inflows and impoundment storage.

Spinning reserve is the extra generating capacity that is available by increasing the power output of generators that are already connected to the power grid. Facilities like Muddy Run that provide spinning reserve can be on line, synchronized with the electric grid, and quickly add power to the system as needed. Muddy Run can also perform "load following," whereby the output of the facilities is increased or decreased in response to variations in electric demand.

Hydroelectric facilities can also provide frequency and/or voltage regulation benefits to the system. Operating in frequency control mode, they alter their output to keep the system frequency near the required value to avoid system imbalance. Similarly, they can also provide system voltage control.

Black start is the procedure to recover from a total or partial shutdown of the transmission system, such as the blackout that occurred in August 2003, which was the

largest ever blackout of the North American power grid. The outage affected an estimated 50 million people and more than 70,000 MW of electrical load in parts of Ohio, Michigan, New York, Pennsylvania, New Jersey, Connecticut, Massachusetts, Vermont, and the Canadian provinces of Ontario and Quebec. Power was successfully restored to most customers within hours, while some areas in the United States did not have power for 2 days, and parts of Ontario experienced rotating blackouts for up to 2 weeks. Conowingo and Muddy Run were some of the first units used to bring the system back on line. These facilities were started individually and gradually brought on line to stabilize the system before the baseload units were brought back on line.

We conclude that power from the projects would help meet a need for power and ancillary services in the Pennsylvania-New Jersey-Maryland region in both the short- and long-term. The projects would provide low-cost power that displaces generation from non-renewable sources. Displacing the operation of non-renewable facilities may avoid some power plant emissions, thus creating environmental benefits.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

Licenses for the Susquehanna River Projects are subject to numerous requirements under the FPA and other applicable statutes. We summarize the major regulatory requirements in table 1-1 and describe them below.

Table 1-1. Major statutory and regulatory requirements for the Susquehanna River Projects.

Requirement	Agency	Status
Section 18 of the FPA (fishway prescriptions)	U.S. Department of the Interior (Interior); National Marine Fisheries Service (NMFS)	Interior filed preliminary fishway prescriptions for the York Haven Project on January 30, 2014, and for the Muddy Run and Conowingo projects on January 31, 2014. NMFS filed reservations of authority for the Muddy Run and Conowingo projects on January 30, 2014.
Section 10(j) of the FPA	Interior; Pennsylvania Fish and Boat Commission (Pennsylvania FBC)	Interior filed 10(j) recommendations for the York Haven, Muddy Run, and Conowingo projects on January 30 and 31, 2014; Pennsylvania FBC filed 10(j) recommendations for the

Requirement	Agency	Status
		Conowingo Project on December 11, 2013.
Clean Water Act—water quality certification	Pennsylvania Department of Environmental Protection (Pennsylvania DEP); Maryland Department of the Environment (Maryland DOE)	York Haven Project – Pennsylvania DEP received an application for water quality certification on August 29, 2013; certification is due August 28, 2014.
		Muddy Run Project – Exelon applied to Pennsylvania DEP for certification on August 28, 2013; Pennsylvania DEP issued a certification for the Muddy Run Project on June 3, 2014.
		Conowingo Project – Maryland Department of Natural Resources received an application for certification on January 31, 2014; certification is due January 30, 2015.
Endangered Species Act Consultation	U.S. Fish and Wildlife Service (FWS)	We will seek concurrence from FWS on our not likely to adversely affect determinations for the bog turtle, Indiana bat, shortnose sturgeon, and Atlantic sturgeon.
Coastal Zone Management Act Consistency	Pennsylvania Coastal Resource Management Program (Pennsylvania CRM Program); Maryland DOE	Pennsylvania CRM Program determined both York Haven and Muddy Run are located outside the state's coastal zone and would not affect coastal resources; Maryland DOE has until January 30, 2015 to determine consistency.

Requirement	Agency	Status
National Historic Preservation Act	Pennsylvania State Historic Preservation Officer (Pennsylvania SHPO); Maryland SHPO	A Programmatic Agreement is to be executed between the Commission and the SHPOs.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be prescribed by the Secretaries of Commerce and Interior.

On January 30, 2014, the U.S. Department of the Interior (Interior) timely filed a preliminary fishway prescription for the York Haven Project, including conditions consistent with a Settlement Agreement filed on January 30, 2014 (see section 1.5, *Settlement Agreement*). Interior filed a corrected version of the preliminary fishway prescription on February 7, 2014, requesting that it replace the original filing that contained inadvertent word processing artifacts. These conditions are described under section 2.2, *Applicants' Proposals*, *York Haven Project.*

On January 31, 2014, Interior timely filed a fishway prescription for the Muddy Run and Conowingo projects, which it modified by letter filed on February 28, 2014. These conditions are described under section 2.2.4, *Modifications to the Applicants' Proposals – Mandatory Conditions.*

The National Marine Fisheries Service (NMFS), by letter dated January 30, 2014, requests that a reservation of authority to prescribe fish passage under section 18 be included in any license issued for the Muddy Run and Conowingo projects.

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

Interior timely filed 10(j) recommendations for the York Haven Project on January 30, 2014, and for the Muddy Run Project on January 31, 2014, and the Pennsylvania Fish

and Boat Commission (Pennsylvania FBC) and Interior timely filed, on December 11, 2013, and January 31, 2014, respectively, recommendations under section 10(j) for the Conowingo Project. These recommendations are summarized in table 5-1, in section 5.3, *Fish and Wildlife Agency Recommendations*. In section 5.3, we discuss how we address the agency recommendations and comply with section 10(j).

1.3.2 Clean Water Act

Under section 401 of the Clean Water Act, a license applicant must obtain either certification from the appropriate state water pollution control agency verifying compliance with the Clean Water Act or a waiver of certification by the appropriate agency. Here, the facilities of the York Haven and Muddy Run projects are located in Pennsylvania and the discharges from these two projects are located in Pennsylvania. The Conowingo Project facilities are located in both Pennsylvania and Maryland, but the discharge occurs in Maryland. Therefore, the Pennsylvania Department of Environmental Protection (Pennsylvania DEP) is the appropriate state water pollution certifying agency to act on York Haven Power's request for the York Haven Project and Exelon's request for the Muddy Run Project. The Maryland Department of the Environment (Maryland DOE) is the appropriate agency to act on Exelon's request for the Conowingo Project.

York Haven Project

On August 29, 2013, York Haven Power applied to Pennsylvania DEP for 401 water quality certification (certification) for the York Haven Project. Pennsylvania DEP received this request on August 29, 2013. Pennsylvania DEP has not yet acted on the request. The certification is due by August 28, 2015.

Muddy Run Project

On August 28, 2013, Exelon applied to Pennsylvania DEP for the Muddy Run Project. Pennsylvania DEP issued certification on June 3, 2014. In its reply comments filed on March 18, 2014, Exelon requested that the Commission incorporate the conditions of the draft certification into Exelon's licensing proposal and reflect the conditions as Exelon's preferred alternative in the EIS. While Exelon has not indicated the final certification represents its proposal, our review of the draft and final certifications found that they are nearly identical, and therefore this EIS treats the conditions in the certification as part of Exelon's proposal. The certification conditions are summarized here and described in detail in sections 3.3.1.2, *Geology and Soils, Environmental Effects*, and 3.3.2.2, *Water Resources, Environmental Effects*:

- Develop a dissolved oxygen (DO) monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards.

- Develop fish passage operating procedures (FPOP) for upstream and downstream fish passage, with specific targets for upstream and downstream passage at the Muddy Run Project, and corrective actions if targets are not met.
- Develop a plan and schedule, as part of the fish passage requirements, for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run Project boundary if resource agencies determine that operation of the Muddy Run Project is causing the Holtwood Project to fail to meet its Tier I upstream American shad target specified in the water quality certification for the Holtwood Project.[20]
- Implement the American Eel Passage Plan for an eel trap and truck program to trap, hold, and transport American eels from the Conowingo Project and Octoraro Creek to designated points in the Susquehanna River watershed until at least 2030, and then either continue the trap and truck program or construct a volitional eel passage facility at Conowingo dam.
- Once every 10 years through the term of the license, evaluate all state and federal endangered and threatened species that may be present within the project boundary, and if the evaluation identifies the presence, critical habitat, or critical dependence of endangered species, propose and implement a protection plan for each species.
- Provide annual grants up to $450,000 equally to the Lancaster County and York County Conservation Districts for the implementation of agricultural pasture and barnyard best management practices (BMPs) to control sediment loading to the Susquehanna River.
- Provide $50,000 annually to the Pennsylvania FBC to perform habitat improvement projects including removal of small dams.
- Provide the version of the Lower Susquehanna River OASIS Model to the Susquehanna River Basin Commission (SRBC) as provided in the *Letter Agreement Addressing Exelon's Provision of an OASIS Model to SRB*C dated November 19, 2013.

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[20] The Tier I target under the Holtwood Project certification is that at least 75 percent of the shad that pass the downstream Conowingo Project also pass through the Holtwood Project fish passage facilities. If the Tier I target is not met after 3 years of studies, then 4 years of Tier II studies would be conducted using radio telemetry and other methodologies to determine if at least 85 percent of the shad that enter Holtwood Project waters successfully pass through the Holtwood fish facilities.

Conowingo Project

On January 30, 2014, Exelon applied to Maryland DOE for certification for the Conowingo Project. Maryland DOE received this request on January 30, 2014, and has not yet acted on the request. The certification is due by January 30, 2015.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Six federally listed species are known to occur in the general vicinity of one or more of the projects: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)*, bog turtle (*Glyptemys* [*Clemmys*] *muhlenbergii*), Indiana bat (*Myotis sodalis*), Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*), and swamp pink (*Helonias bullata*) (letters from FWS, to K.D. Bose, Secretary, FERC, Washington, D.C., January 4, 2007).[21] Our analysis of project impacts on threatened and endangered species is presented in section 3.3.4, *Threatened and Endangered Species*, and our recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*.

We conclude that relicensing of the York Haven and Muddy Run projects would have no effect on the shortnose or Atlantic sturgeon because neither species is known to have been collected or passed via the Conowingo fish lifts since they began operation in 1972. While there is suitable habitat downstream of Conowingo for both species, there is no evidence of their occurrence in the lower Susquehanna River. Therefore, continued operation of the York Haven, Muddy Run, and Conowingo projects would not likely adversely affect the shortnose and Atlantic sturgeon.

Bog turtles have been confirmed near the Muddy Run Project. Implementing Exelon's Bog Turtle Management Plan for the Muddy Run Project, including habitat management at any confirmed breeding locations and other practices to protect the existing population and improve bog turtle habitat would minimize effects on bog turtles and their habitat due to project maintenance or recreation. Therefore, we conclude that

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[21] On June 5, 2013, staff requested updated species information from FWS for threatened and endangered species in the vicinity of the projects. The Pennsylvania Game Commission responded and provided information on state-listed birds and mammals in the vicinity of the three projects in a letter filed July 2, 2013. Staff also referred to FWS' website (http://ecos.fws.gov/ipac/; accessed March 11, 2014 and May 12, 2014) to gather recent information on the potential presence of federally listed threatened and endangered species within the counties that contain the three projects, and contacted FWS and Maryland DNR regarding a bog turtle record close to Conowingo dam (see telephone and e-mail memoranda of April 23, 2014 and June 9, 2014).

relicensing the Muddy Run Project may affect, but would not be likely to adversely affect the bog turtle.

For the Conowingo Project, although Interior states that bog turtles have been observed close to the Conowingo dam and recommends a bog turtle management plan, it has yet to provide evidence to indicate that bog turtles are present within the Conowingo Project boundary. Exelon conducted a bog turtle habitat study in 2008 and concluded that no project wetlands contained bog turtle habitat. Thus, staff cannot presently determine if bog turtles would be affected by the Conowingo Project. Further consultation with Interior is necessary to determine the potential for project effects and the need for Interior's recommended bog turtle management plan.

Potential Indiana bat habitat may exist within the three project areas, along the riparian forested edges of the river and reservoirs, and forested edges along transmission line rights-of-way and recreational areas. Neither York Haven Power nor Exelon propose any activities that would result in more than a minimal amount of tree clearing. At the Muddy Run Project, continued routine vegetation management practices, such as trimming and herbicide application, would be unlikely to affect trees large enough to provide roosting habitat. Therefore, the York Haven, Muddy Run, and Conowingo projects would not be likely to adversely affect the Indiana bat.

Because the swamp pink is not listed by the U.S. Fish and Wildlife Service (FWS) as occurring in the counties occupied by York Haven or Muddy Run projects, these projects would have no effect on the species and it is not analyzed further in this document. Although swamp pink has been previously documented in Cecil and Harford counties where the Conowingo Project is located, we conclude the Conowingo Project would have no effect on the swamp pink because this species is not known to occur in those project areas according to FWS' Information, Planning, and Conservation System website.

The three projects would have no effect on the Delmarva Peninsula fox squirrel because it is not known to exist in the projects' action areas.

1.3.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), 16 U.S.C. § 1456(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The York Haven and Muddy Run projects are not located within the Pennsylvania-designated coastal management zone. The projects are located outside of Pennsylvania's Lake Erie and Delaware Coastal Zones, and the projects would not affect Pennsylvania's coastal resources. Therefore, the projects are not subject to Pennsylvania coastal zone

program review, and no consistency certification is needed for the action. By emails dated June 24, and December 10, 2009, the Pennsylvania Coastal Resource Management Program concurred.

On September 4, 2012, Exelon filed a letter with the Maryland Consistency Coordinator of the Maryland DOE stating that the Conowingo Project complies with the enforceable polices of the Maryland Coastal Zone Management Program and would be operated in a manner consistent with this program. On March 5, 2013, the Maryland Office of the Attorney General filed a letter with the Commission that included a written agreement between Maryland and Exelon to extend the coastal zone consistency review period to 1 year from when Exelon files its request for certification. Exelon filed its request for certification with Maryland DOE on January 30, 2014, and with the Commission on January 31, 2014. Consequently, a coastal zone management program consistency determination is due from Maryland by January 30, 2015.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every federal agency "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

In response to York Haven Power's May 29, 2009, request, and Exelon's March 12, 2009, request, the Commission designated York Haven Power and Exelon as non-federal representatives for the purposes of conducting section 106 consultation under the NHPA on July 24, 2009, and May 11, 2009, respectively. Pursuant to section 106, and as the Commission's designated non-federal representative, York Haven Power consulted with the Pennsylvania State Historic Preservation Officer (SHPO) and affected Indian tribes, and Exelon consulted with the Pennsylvania and Maryland SHPOs to locate, determine National Register eligibility, and assess potential adverse effects on historic properties associated with the projects.

In April 2012, York Haven Power prepared a draft Historic Properties Management Plan (HPMP) to address project-related effects on historic properties and unevaluated cultural resources. The Pennsylvania SHPO provided comments on the draft HPMP (letter from D.C. McClearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to D. Weaver, York Haven Power Company, York Haven, Pennsylvania, September 14, 2012), and York Haven Power addressed those comments in a revised HPMP filed with the Commission on December 28, 2012 (Stallings and Franz, 2012).

In its application, Exelon stated that continued operation of the Muddy Run Project would not affect historic properties that are listed or eligible for listing on the

National Register. For this reason, an HPMP for the Muddy Run Project was not developed. However, Exelon proposes a license article that would require section 106 consultation prior to any project-related ground-disturbing activity, including recreational development, and a requirement to develop a cultural resources management plan should any previously unidentified cultural materials be discovered during project activities.

In December 2012, Exelon prepared an HPMP to address project-related effects on historic properties and unevaluated cultural resources at the Conowingo Project (Sara et al., 2012). No comments on the HPMP received from the Pennsylvania SHPO or Maryland SHPO have been filed with the Commission.

To meet the requirements of section 106, the Commission intends to execute Programmatic Agreements (PAs) for the protection of historic properties from the effects of the operation of the York Haven Project, Muddy Run Project, and Conowingo Project. The terms of the PAs would ensure that York Haven Power and Exelon address and treat all historic properties identified within the projects' areas of potential effects (APE) through the finalization of the existing draft HPMPs for the York Haven Project and the Conowingo Project and the development of an HPMP for the Muddy Run Project.

1.3.6 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act requires federal agencies to consult with NMFS on all actions that may adversely affect essential fish habitat. In correspondence during scoping and in response to the ready for environmental analysis notices, NMFS did not identify any essential fish habitat in segments of the Susquehanna River affected by the projects. Therefore, we conclude that the Susquehanna River Projects would have no effect on essential fish habitat.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 Code of Federal Regulations [CFR] §§5.1-5.16) require that applicants consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, ESA, NHPA, and other federal statutes. Prefiling consultation must be complete and documented according to the Commission's regulations

1.4.1 Scoping

Before preparing this draft EIS, we conducted scoping to determine what issues and alternatives should be addressed. Scoping documents (SD1s) were distributed to interested agencies and others for the York Haven Project on July 24, 2009, and for the Muddy Run and Conowingo projects on May 11, 2009. A publicly noticed scoping meeting for the York Haven Project was held in New Cumberland, Pennsylvania, during the evening of August 26, 2009, and a second daytime meeting was held in Harrisburg, Pennsylvania, on August 27, 2009. A publicly noticed evening scoping meeting for the

Muddy Run Project was held on June 10, 2009, in Holtwood, Pennsylvania, and for the Conowingo Project on June 11, 2009, in Darlington, Maryland. A joint daytime meeting to discuss both the Muddy Run and Conowingo projects was held on June 12, 2009, in Darlington, Maryland. A court reporter recorded all comments and statements made at the scoping meetings, and these are part of the Commission's public record for the projects. In addition to comments provided at the scoping meetings, the following entities provided written comments.

Commenting Entities	Date Filed
York Haven Project	
York Haven Planning Commission	August 7, 2009
Honorable Todd Platts	September 21, 2009
Pennsylvania Department of Natural Resources	September 24, 2009
York Haven Power Company, LLC	September 28, 2009
Borough of Goldsboro	September 28, 2009
The Nature Conservancy	September 29, 2009
U.S. Fish and Wildlife Service	September 29, 2009
Susquehanna River Basin Commission	September 29, 2009
Pennsylvania Fish and Boat Commission	September 29, 2009
Exelon Generation Company, LLC	September 29, 2009
U.S. Army Corps of Engineers	September 29, 2009
Pennsylvania Department of Environmental Protection	September 29, 2009
James Toothaker	October 5, 2009
Cynthia Gross	October 5, 2009
Muddy Run Project	
Maryland Department of Natural Resources	July 10, 2009
Susquehanna River Basin Commission	July 10, 2009
U.S. Fish and Wildlife Service	July 10, 2009
Pennsylvania Fish and Boat Commission	July 10, 2009
Pennsylvania Department of Environmental Protection	July 10, 2009
Conowingo Project	
Town of Port Deposit	June 16, 2009
Alex Balboa	June 19, 2009
Ronald Steelman	July 6, 2009
Susquehanna River Basin Commission	July 10, 2009
Maryland Department of Natural Resources	July 10, 2009
Pennsylvania Fish and Boat Commission	July 10, 2009
Robert B. Campbell	July 13, 2009
Jere Hess	July 13, 2009
Pennsylvania Department of Environmental Protection	July 13, 2009
Lower Susquehanna River Keeper	July 13, 2009

U.S. Fish and Wildlife Service	July 13, 2009
Honorable Benjamin L. Cardin	August 3, 2009
Muddy Run and Conowingo Projects	
American Rivers	July 10, 2009
Exelon Corporation	July 10, 2009
Lancaster County Planning Commission	July 10, 2009
The Nature Conservancy	July 10, 2009
National Marine Fisheries Service	July 10, 2009
PPL Holtwood, LLC	July 10, 2009

In addition to the commenting entities listed above for the York Haven Project, more than 1,400 individuals signed petitions that were filed between September 12 and October 5, 2009, opposed to the decommissioning of the York Haven Project.[22]

A revised scoping document addressing these comments was issued for the York Haven Project on November 13, 2009, and on August 24, 2009, for the Muddy Run and Conowingo projects.

1.4.2 Interventions

On April 29, 2013, the Commission issued notices accepting the York Haven Power and Exelon applications to relicense the York Haven, Muddy Run, and Conowingo projects, and soliciting motions to intervene. These notices set September 30, 2013, as the deadline for filing protests and motions to intervene; however, by notices issued August 30, 2013, and December 13, 2013, the Commission granted extensions of time for stakeholders to file motions to intervene and protests until January 31, 2014. In response to the notices, the following entities filed motions to intervene:

Intervenors	Date Filed
York Haven Project	
PPL Brunner Island, LLC	November 13, 2012
U.S. Department of the Interior	May 31, 2013

[22] A number of federal and state resource agencies, the SRBC, and The Nature Conservancy recommended that the Commission consider decommissioning as a reasonable alternative to relicensing. The Borough of Goldsboro, York Haven Power, and a petition signed by more than 1,400 individuals, requested that the Commission not consider project decommissioning as a reasonable alternative to relicensing. Those opposed to project decommissioning cite the potential loss of Lake Frederic, a significant economic and recreation resource in the area.

Intervenors	Date Filed
Susquehanna River Basin Commission	June 11, 2013
Safe Harbor Water Power Corporation	June 17, 2013
PPL Holtwood, LLC	June 20, 2013
Pennsylvania Department of Environmental Protection	June 21, 2013
Pennsylvania Fish and Boat Commission	June 21, 2013
New Energy Capital Partners, LLC[23]	October 21, 2013
Exelon Corporation	December 5, 2013
The Nature Conservancy	January 31, 2014
American Rivers	January 31, 2014
Maryland Department of Natural Resources, Maryland Department of the Environment	January 31, 2014
Muddy Run Project	
PPL Holtwood, LLC	November 13, 2012
U.S. Department of the Interior	May 31, 2013
Susquehanna River Basin Commission	June 11, 2013
Safe Harbor Water Power Corporation	June 17, 2013
Pennsylvania Department of Environmental Protection	June 21, 2013
Pennsylvania Fish and Boat Commission	June 21, 2013
New Energy Capital Partners, LLC	September 27, 2013
Olympus Power Company, LLC	December 6, 2013
NOAA Fisheries	January 31, 2014
The Nature Conservancy	January 31, 2014
American Rivers	January 31, 2014
Maryland Department of Natural Resources, Maryland Department of the Environment	January 31, 2014
Conowingo Project	
Stewards of the Lower Susquehanna, Inc.	September 7, 2012
PPL Holtwood, LLC	November 13, 2012
U.S. Department of the Interior	May 31, 2013
Susquehanna River Basin Commission	June 11, 2013
Safe Harbor Water Power Corporation	June 17, 2013
Pennsylvania Department of Environmental Protection	June 21, 2013
Pennsylvania Fish and Boat Commission	June 21, 2013
Clean Chesapeake Coalition	June 25, 2013
Stewards of the Lower Susquehanna, Inc., Lower Susquehanna Riverkeeper, and Waterkeepers	July 17, 2013

[23] On November 4, 2013, York Haven Power filed a motion in opposition to the intervention of New Energy Capital Partners, LLC. The Commission issued a notice granting intervention on June 12, 2014.

Intervenors	Date Filed
Chesapeake	
Calpine Corporation	July 24, 2013
Chesapeake Conservancy	July 24, 2013
Chesapeake Bay Foundation	August 20, 2013
Mason-Dixon Trail System, Inc.	September 5, 2013
Citizens for Pennsylvania's Future	September 25, 2013
New Energy Capital Partners, LLC	September 27, 2013
The Susquehanna River Boater's Association, Peach Bottom Marina	September 27, 2013
Cecil Land Use Association	October 30, 2013
Olympus Power Company, LLC	December 6, 2013
Midshore Riverkeeper Conservancy, Inc.	December 11, 2013
Chester River Association and Sassafras River Association	December 23, 2013
Onondaga Nation	December 24, 2013
National Marine Fisheries Service	January 30, 2014
The Nature Conservancy	January 31, 2014
American Rivers	January 31, 2014
Maryland Department of Natural Resources, Maryland Department of the Environment	January 31, 2014

1.4.3 Comments on the Application

On April 29, 2013, the Commission issued Ready for Environmental Analysis notices for the three projects and requested comments, recommendations, preliminary terms and conditions, and preliminary fishway prescriptions. By notices issued August 30, 2013, and December 13, 2013, the Commission granted extensions of time for stakeholders to file comments, recommendations, and terms and conditions until January 31, 2014. The following entities filed comments, terms and conditions, recommendations, or prescriptions:

Commenting Agencies and Other Entities	Date Filed
York Haven Project	
Lancaster County Conservancy	January 17, 2014
U.S. Department of the Interior	January 30, 2014
The Nature Conservancy et al.	January 31, 2014
American Rivers et al.	January 31, 2014
Muddy Run Project	
New Energy Capital Partners	November 22, 2013
Lancaster County Conservancy	January 17, 2014
National Marine Fisheries Service	January 31, 2014
U.S. Department of the Interior	January 31, 2014
American Rivers et al.	January 31, 2014

Commenting Agencies and Other Entities	Date Filed
The Nature Conservancy et al.	January 31, 2014
Conowingo Project	
U.S. Environmental Protection Agency	August 6, 2013
New Energy Capital Partners	November 19, 2013
Henry Immanuel	November 19, 2013
Pennsylvania Fish and Boat Commission	December 11, 2013
Chesapeake Conservancy	December 13, 2013
Vicki Rinkerman	December 13, 2013
Lancaster County Conservancy	January 17, 2014
Midshore Riverkeeper Conservancy	January 29, 2014
National Marine Fisheries Service	January 30, 2014
Citizens For Pennsylvania's Future	January 31, 2014
Maryland's Department of Natural Resources and Department of the Environment	January 31, 2014
Clean Chesapeake Coalition	January 31, 2014
City of Havre de Grace	January 31, 2014
Town of Fort Deposit, Maryland	January 31, 2014
Town of Perryville, Maryland	January 31, 2014
Susquehanna River Basin Commission	January 31, 2014
Harford County Government	January 31, 2014
Cecil County Government	January 31, 2014
Power Plant Research Program	January 31, 2014
Chesapeake Bay Foundation	January 31, 2014
Lower Susquehanna Heritage Greenway Inc.	January 31, 2014
Stewards of the Lower Susquehanna Inc.	January 31, 2014
U.S. Department of the Interior	January 31, 2014
American Rivers et al.	January 31, 2014
The Nature Conservancy et al.	January 31, 2014

1.5 SETTLEMENT AGREEMENT

On January 30, 2014, York Haven Power, FWS, Pennsylvania FBC, Maryland Department of Natural Resources (Maryland DNR), and the SRBC[24] (Settling Parties) filed a Settlement Agreement for the York Haven Project.

The Settlement Agreement resolves among the Settling Parties all issues associated with issuance of a new license for the project regarding upstream passage of American shad and American eels, downstream passage of juvenile and post-spawning American shad, downstream passage of silver stage American eel, resident fish passage, flow management, water quality and debris management, and endangered species and species of special concern. We consider the Settlement Agreement to represent the Proposed Action regarding these issues for this project.

On February 19, 2014, the Commission issued a Notice of Settlement Agreement. In response to that notice, PPL Brunner Island, LLC, filed a Protest and Comment in Opposition to the proposed Settlement Agreement. The basis for the opposition is that during low-flow periods, the measures specified in the Settlement Agreement could limit the amount of water available for withdrawal by the downstream Brunner Island Steam Electric Station which would restrict generation. York Haven Power filed a response to the opposition on March 4, 2014.

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[24] SRBC was established by the Susquehanna River Basin Compact, a federal interstate agreement among Maryland, Pennsylvania, and the United States. Pub. L. No. 91-575, 84 Stat. 1509 (1970). Pursuant to the Compact, SRBC has duties and responsibilities for comprehensive planning, programming, and management of the water and related resources of the Susquehanna River Basin.

In 1975, the Commission and SRBC entered into a Memorandum of Understanding. Under the November 5, 1975, Memorandum of Understanding, the Commission and SRBC committed to cooperate in the processing of license applications to the extent feasible, and the Commission agreed to give due regard to any SRBC recommendations.

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2.0 PROPOSED ACTIONS AND ALTERNATIVES

2.1 NO-ACTION ALTERNATIVE

Under the no-action alternative, the Susquehanna River Projects would continue to operate under the terms and conditions of the existing licenses, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative to establish baseline environmental conditions for comparison with other alternatives and to judge the benefits and costs of any measures that might be required under a new license.

2.1.1 Existing Project Facilities

Figure 2-1 shows the location and project boundaries of the Susquehanna River Projects.

2.1.1.1 York Haven Project

The project is located on the Susquehanna River in York, Dauphin, and Lancaster counties in south central Pennsylvania (figure 2-2). The Susquehanna River Basin above York Haven dam has a drainage area of about 24,973 square miles. The project powerhouse is located at about RM 55, 17 miles downstream of the city of Harrisburg.

The project is located upstream of the Muddy Run Project at about RM 22 and the Conowingo Project at about RM 10. The Three Mile Island nuclear station, also owned by Exelon, is on Three Mile Island in Lake Frederic, the impoundment formed by York Haven dam. Pennsylvania Power and Light's (PPL) Brunner Island Station, a coal-fired steam electric generating plant, is located about 1.5 miles downstream of the project.

The project includes an east channel dam, main dam, headrace wall, impoundment, powerhouse, substation, fish passage facilities, and recreation facilities. The project operates in a modified run-of-river mode, in that there is limited storage in the reservoir (about one hour worth of storage). During periods of moderate to high runoff in the Susquehanna River that exceed the station's maximum hydraulic capacity (about 17,000 cubic feet per second [cfs] under optimal head conditions), the project cannot control water levels and spills water. Spills can occur at the main dam, headrace wall, and east channel structures.

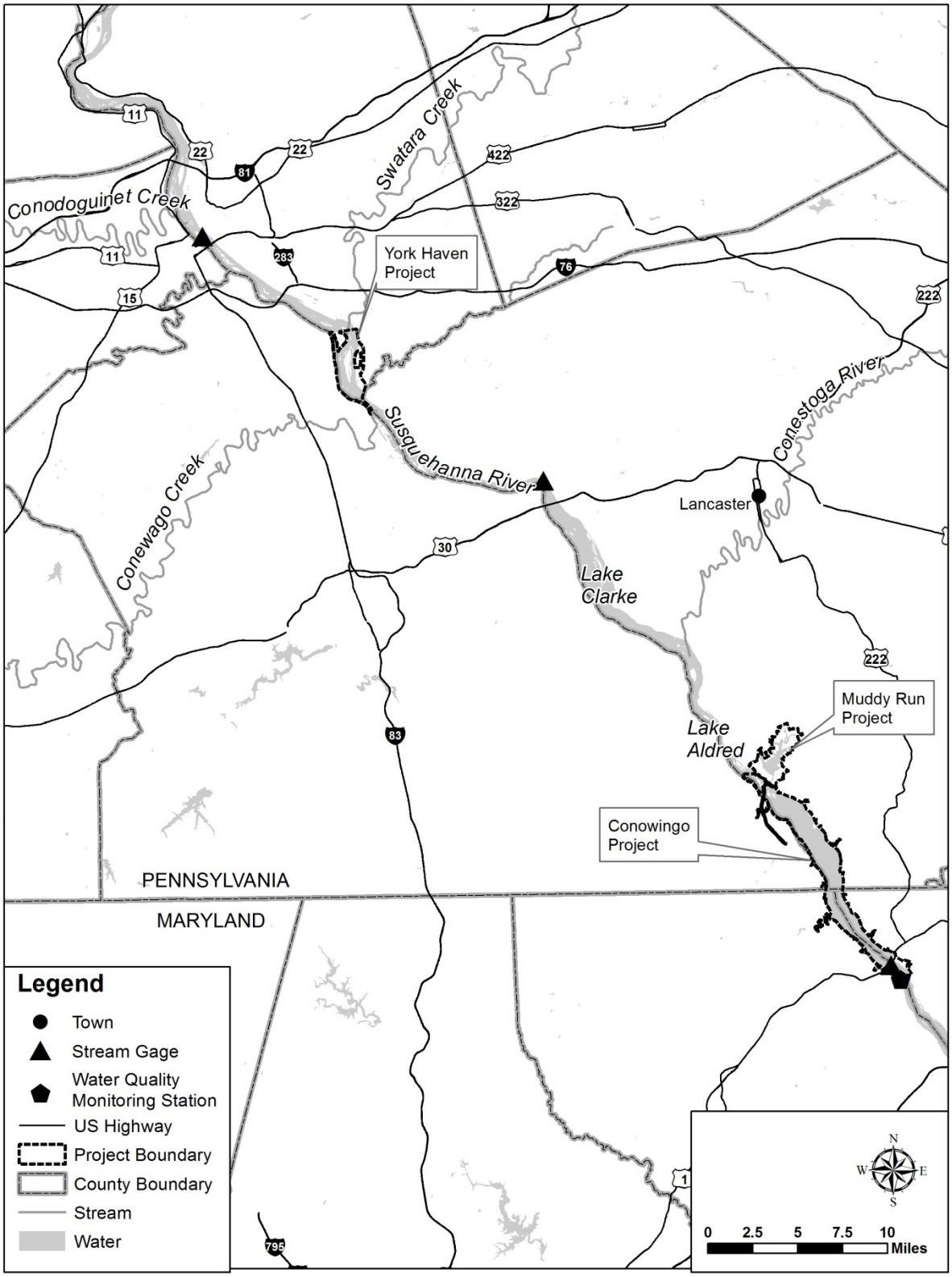

Figure 2-1. Location and project boundaries for lower Susquehanna Projects (Source: Staff).

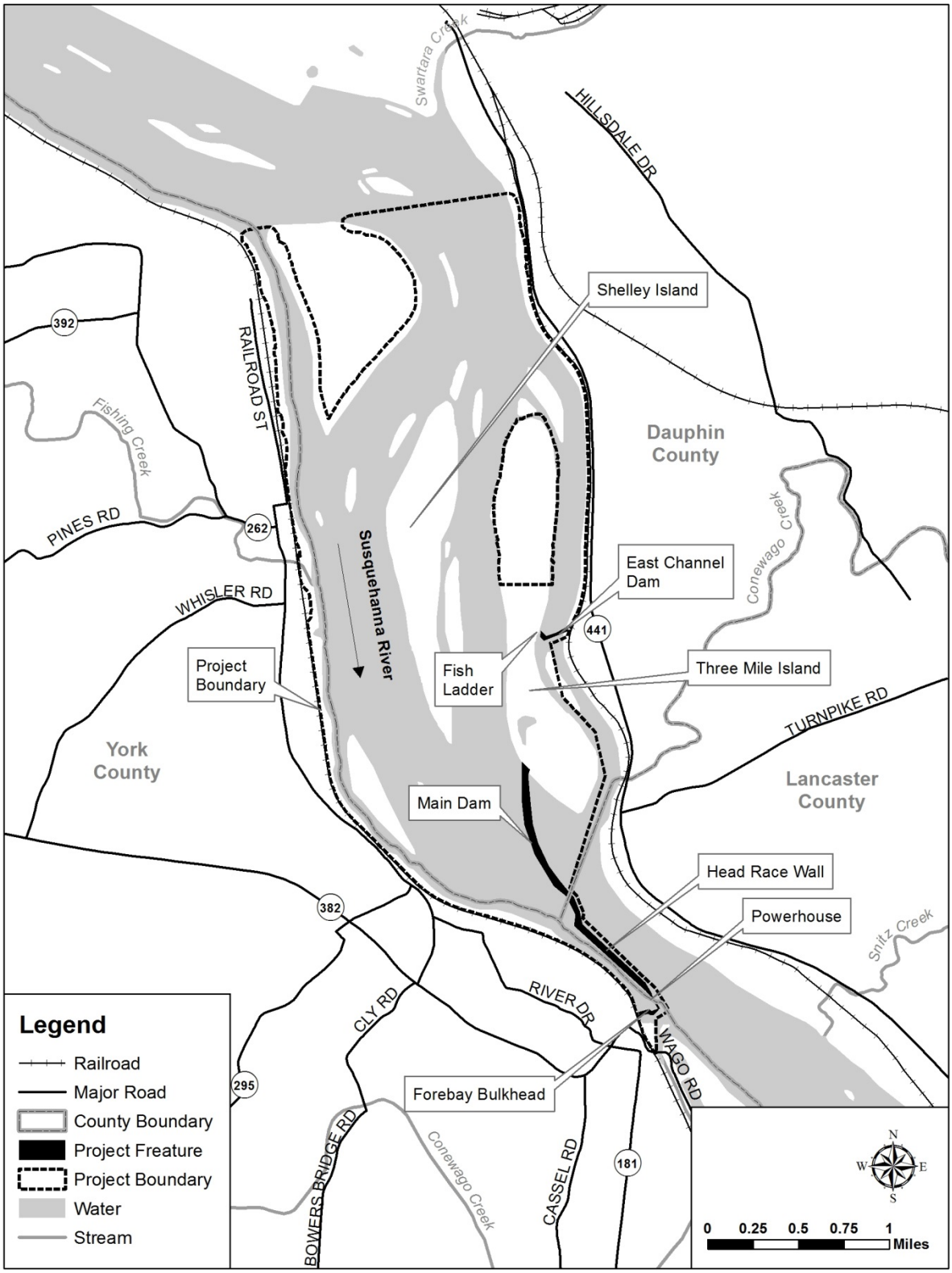

Figure 2-2. Project facilities for the York Haven Project (Source: Staff).

East channel dam is a concrete gravity overflow dam, which extends about 928 feet in an easterly direction from the east shore of Three Mile Island to the east bank of the river. It has an average height of 9 feet. The crest of east channel dam is at elevation 278.95 feet National Geodetic Vertical Datum of 1929,[25] and it incorporates a vertical slot fishway.

The main dam extends diagonally downstream approximately 4,970 feet from the west shore of Three Mile Island to the upstream (north) end of the headrace wall. The main dam is constructed of concrete-covered rock fill and rock fill/timber crib sections with a maximum height at the crest of 18 feet and an average height of 10 feet. The crest elevation of the majority of the main dam crest ranges from 277.86 feet[26] to 278.78 feet. Two short sections of the dam crest are at about elevation 280.00 to 280.20 feet.

The stone masonry headrace wall extends 3,000 feet downstream from the south end of the main dam to the powerhouse. The headrace wall serves to direct water to the powerhouse. The elevation of the crest of the headrace wall includes sections at elevations 280.00 and 282.45 feet.

The project impoundment, Lake Frederic, is about 3.5 miles long with about 29 miles of total shoreline length within the project boundary, including the shoreline of the islands in Lake Frederic. The maximum depth of Lake Frederic is about 18 feet with a mean depth of about 6 feet. At the normal water surface elevation of 277.86 feet, Lake Frederic has a surface area of 2,218 acres and about 9,600 acre-feet of gross storage capacity. Usable storage capacity is limited to the allowable 1.1-foot fluctuation providing about 1,700 acre-feet of storage, or about 1 hour of storage at the plant's maximum hydraulic capacity.

The brick and stone masonry powerhouse is about 472 feet long and 48 feet wide and is located parallel to the west bank of the Susquehanna River. This structure contains the turbines, generators, and appurtenant power generating equipment. Steel trashracks with 4-inch clear spacing are installed at the intakes at each of the 20 turbine-generator units. The forebay includes a trash sluice gate at its downstream end that is 14 feet wide and 10.5 feet high. The sluice gate is capable of releasing about 600 cfs.

The powerhouse contains 20 turbine units with an installed capacity of 19.62 MW. Six are vertical shaft propeller turbines, and 14 are horizontal Francis turbines.

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[25] Unless otherwise noted, all elevation data in this EIS are given in National Geodetic Vertical Datum of 1929.

[26] The value of 277.86 feet represents the low point of the main dam, which under current operations is considered to be the normal elevation when river flows are less than the maximum turbine capacity of about 17,000 cfs.

Each of the turbines has a fixed gate and, therefore, no adjustments can be made to discharge less than the maximum turbine discharge other than reducing the water level in Lake Frederic. The minimum discharge from the powerhouse is about 700 cfs and occurs when only Unit 14 is operating. The project does not include a traditional tailrace, and each of the units discharges directly into the Susquehanna River.

The project includes an outdoor substation that contains the station's generator step-up transformers, station service transformers, and manual switching structures. There are no primary transmission lines included as part of the project, but it interconnects with the 115-kilovolt (kV) electric grid at the substation immediately downstream of the project's downstream forebay wall. A secondary service feed comes into the project substation via Line No. 722 at 13.2 kV.

The present upstream fish passage facility (the east channel fishway), located at the western end of east channel dam and operational since April 2000, includes two sections: a weir cut and a vertical-slot fish ladder. The weir cut section provides supplemental attraction flows to the fishway, and the upper portion of the weir cut includes three, 25-foot-diameter cofferdam cells between which two 20-foot-wide fixed-wheel gates are installed, with each gate having a 1,000-cfs discharge capacity. The lower section of the weir cut includes a 67-foot-wide adjustable weir and a stop gate. The 250-foot-long fish ladder has an entrance diffuser, serpentine baffles that form eight pools, and an exit flume. A counting station is located in the exit channel just upstream of the last fish ladder pool.

York Haven Project recreation facilities include: the Historic Canal Lock, East Shore Boat Launch, Goosehorn Island Picnic Area, Shelley Island Recreation Area, Goodling Island Picnic Area, Beshore Island Recreation Area, Battery Island Recreation Area, Cly Shore recreational lot sites, York Haven Power Plant Recreation Area, and a Canoe Portage trail. These facilities are owned and operated by York Haven Power.

2.1.1.2 Muddy Run Project

The Muddy Run Project (figure 2-3) is a pumped storage hydroelectric generating facility 22 miles upstream of the Chesapeake Bay on the eastern shoreline of the Susquehanna River, within Drumore and Martic townships, Lancaster County, Pennsylvania. The project includes a Recreation Lake dam and spillway, main dam embankment, the east dike, upper reservoir spillway, canal dam embankment, upper reservoir (Muddy Run reservoir), intake structure, powerhouse, lower reservoir, a primary transmission line, and recreation facilities.

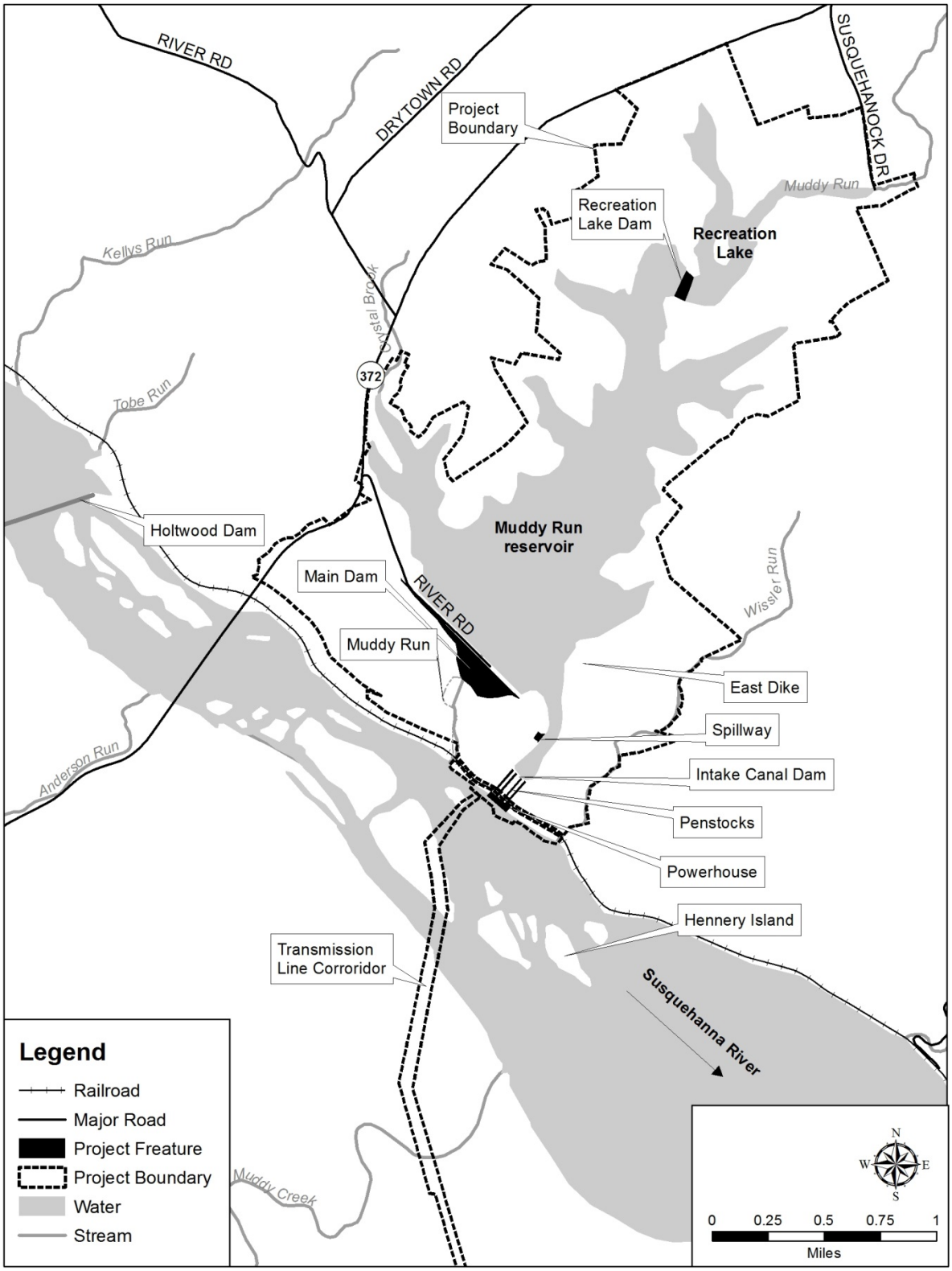

Figure 2-3. Project facilities for the Muddy Run Project (Source: Staff).

Recreation Lake dam, located in the drainage for the upper reservoir about 2 miles upstream of the main dam, is a zoned earth and rockfill embankment. The dam is approximately 750 feet long, and it has a maximum height of about 90 feet and a crest width of 34 feet. The crest of the non-overflow section of the Recreation Lake dam is at elevation 530.00 feet. Recreation Lake dam includes a 4-foot-diameter concrete outlet pipe controlled from the upstream end by a flap gate. The Recreation Lake spillway consists of a nearly level rock cut channel approximately 140 feet wide with a concrete weir at crest elevation 520.00 feet. The spillway is traversed by a steel and concrete bridge that is used by pedestrian traffic and recreation area maintenance vehicles. Recreation Lake has a total storage capacity of 709 acre-feet and is maintained at a constant elevation of 520 feet for recreational purposes. The surface area is approximately 100 acres at that elevation.

The main embankment dam is constructed as a zoned embankment with an impervious core. The dam is 4,800 feet long and has a maximum height of 260 feet. The crest of the dam is at elevation 533.00 feet, and it is 34 feet wide and traversed by a 20-foot-wide, two-lane roadway (River Road). The east dike is also a zoned earth and rock-fill embankment with an impervious core. The dike is approximately 800 feet long, has a crest width of 20 feet, and a maximum height of about 12 feet. The crest of the east dike is at elevation 530.80 feet.

The upper reservoir 200-foot-long ogee spillway is located on the west side of the intake canal. The spillway is 20 feet high, has a crest elevation of 521 feet, and discharges into a vegetated natural ravine that joins Muddy Run Creek just above its confluence with the Susquehanna River. The spillway is constructed within the canal dike and is flanked by concrete retaining walls. Since initial filling of the upper reservoir in 1967, the spillway has never been required to pass discharges from either natural inflows or over-pumping.

The canal embankment (also referred to as the intake channel dam), forms the upper part of the intake channel, which leads from the upper reservoir to the powerhouse intake structure. The lower part of the channel is excavated in rock. The embankment has a maximum height of about 35 feet and a minimum crest width of 25 feet. The upstream face of the embankment and the rock cut channel are lined with a 9-inch-thick reinforced concrete slab extending about 1,000 feet upstream on both sides of the canal from the powerhouse intake structure. The upstream portion of the canal is an unlined soil and rock cut. A bridge for River Road crosses this section of the canal.

The normal operating elevation of the upper reservoir ranges from 470 to 520 feet. At elevation 520 feet, the upper reservoir has a total storage capacity of 56,731 acre-feet with a usable capacity of 33,894 acre-feet, and a surface area of 892 acres. At the maximum drawdown elevation (470 feet), the upper reservoir has a surface area of 471 acres.

The intake structure consists of four cylinder gates with trashracks having clear spacing of 5.37 inches. Each intake supplies two units and includes a cylindrical tower

that leads to a 430-foot-deep vertical shaft. The vertical shaft and horizontal power tunnels are concrete lined with a diameter of 24.50 feet. The concrete-lined power tunnels bifurcate approximately 500 feet upstream of the powerhouse, transitioning to 14-foot-diameter steel penstocks that connect to one of eight pump turbine units in the powerhouse. There are no inlet valves at the downstream end of the penstocks.

The Muddy Run powerhouse is approximately 600 feet long by 133 feet wide, and is constructed entirely of concrete. The powerhouse is a semi-outdoor structure located on the east bank of the Susquehanna River and contains eight vertical-shaft, reversible pump-generating units that each have a rated capacity of 100 MW and a hydraulic capacity of 4,000 cfs, for a total discharge capacity of 32,000 cfs. The pumping capacity of the pump turbines is 3,500 cfs each, for a total powerhouse pumping capability of 28,000 cfs. The units are equipped with trashracks, also with clear spacing of 5.75 inches, between the draft tube outlet and the river.

The lower reservoir for the Muddy Run Project is Conowingo Pond, which is a portion of the Susquehanna River impounded by Conowingo dam. The lower reservoir has a total surface area of approximately 8,500 acres and approximately 310,000 acre-feet of gross storage at the maximum normal level of 109.2 feet.

The primary transmission line consists of two 230-kV three-phase, three-wire circuits. The lines, owned by Exelon, but leased to the PECO Energy Company, an affiliate of Exelon, are identified as lines 220-06 and 220-07. Both lines begin at a 220-kV switching station on the roof of the powerhouse and run about 4.25 miles to the Peach Bottom Atomic Power Station (PBAPS) North Substation located in York County.

Muddy Run Project recreation facilities include: (1) Muddy Run Park (owned by Exelon, operated by a vendor); (2) Wissler's Run Park (owned and operated by Exelon); and (3) Muddy Run Wildlife Management Area (WMA) (owned by Exelon and leased and managed by Pennsylvania Game Commission).

Exelon holds title or rights to all project lands within the project boundary. The project boundary encompasses all of the project facilities and lands required for project operation and maintenance. However, only a portion of the 800-acre Muddy Run WMA is within the existing project boundary.

2.1.1.3 Conowingo Project

The Conowingo Project (figure 2-4) consists of a main dam, spillway, reservoir (Conowingo Pond), intake structure, powerhouse, two fish lifts, and recreation facilities. The dam is a concrete gravity dam with a maximum height of 94 feet and a total length of 4,648 feet. The dam has four distinct sections from east to west: a 1,190-foot-long, non-overflow gravity section with a crest elevation of 115.70 feet; an ogee-shaped spillway, the major portion of which is 2,250 feet long with a crest elevation of 86.70 feet, and the minor portion of which is 135 feet long with a crest elevation of 99.2 feet; an intake-powerhouse section which is 946 feet long; and a 127-foot-long abutment section.

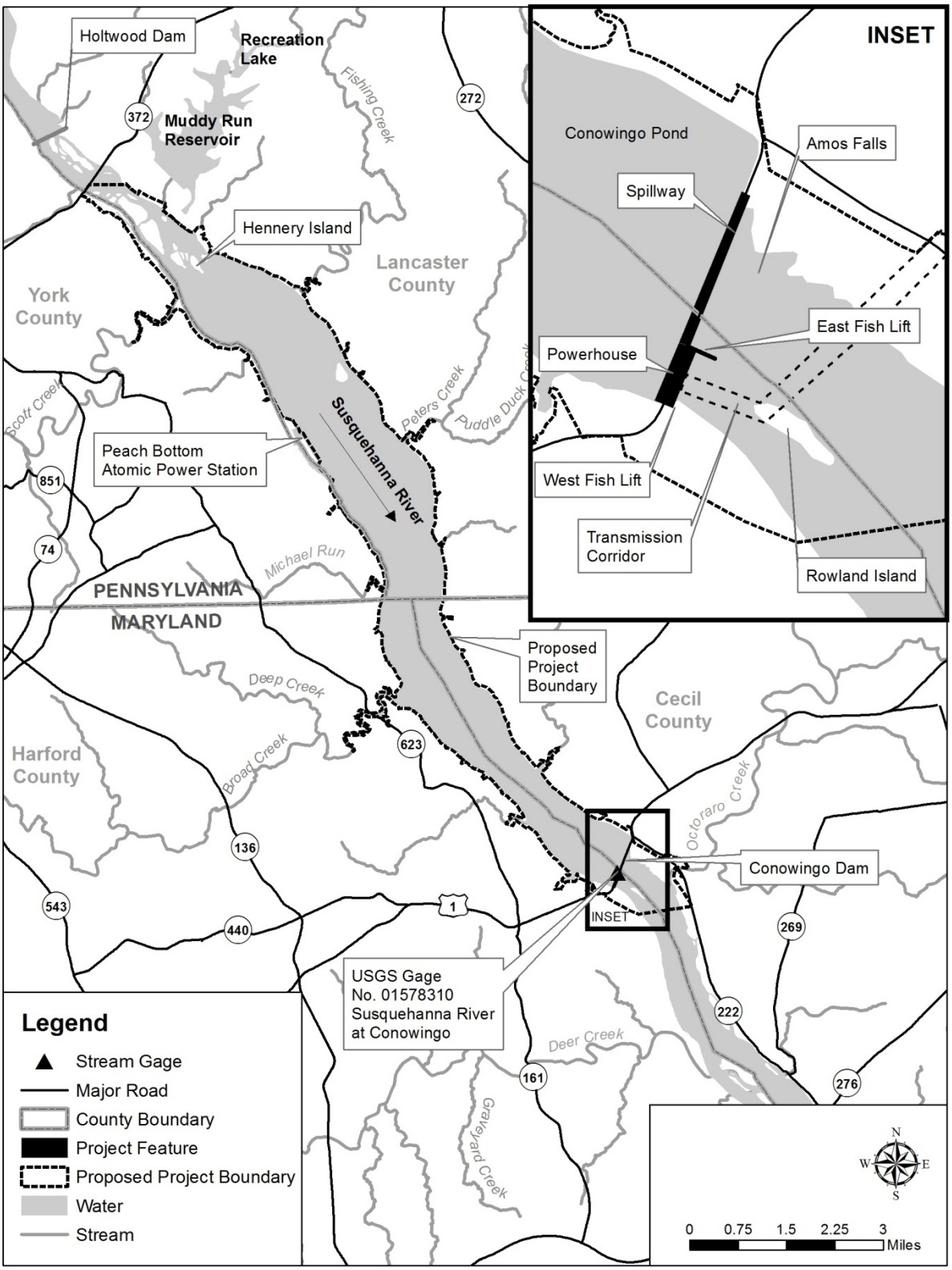

Figure 2-4. Project facilities for the Conowingo Project (Source: Staff).

The tailrace and spillway sections of the dam are separated by a dividing wall extending 300 feet downstream of the powerhouse. The dam and powerhouse also support U.S. Route No. 1 which passes over the top of Conowingo dam.

Flow over the ogee spillway sections is controlled by 50 stony-type crest gates with crest elevations of 86.70 feet and two regulating gates with crest elevations of 99.2 feet. Each crest gate is 22.50 feet high by 38 feet wide, and the gates have a collective discharge capacity of about 16,000 cfs at a reservoir elevation of 109.2 feet.

The two regulating gates are 10 feet high by 38 feet wide and have a discharge capacity of about 4,000 cfs per gate at a reservoir elevation of 109.2 feet. The effective usable storage between the licensed minimum and maximum pond elevations of 101.2 feet and 110.2 feet is 75,287 acre-feet.

Conowingo Pond extends 14 miles upstream from Conowingo dam to the lower end of the Holtwood Project (FERC Project No. 1881) tailrace. Conowingo Pond is generally maintained at an elevation of 109.2 feet, with a surface area of about 8,500 acres and a total impoundment volume of 310,000 acre-feet at that elevation. The pond serves as the lower reservoir for the Muddy Run Project, located 12 miles upstream of Conowingo dam.

The intakes for each turbine are individually protected by seven trashracks; the five lower racks are entirely steel with a clear spacing of 5.37 inches, and top two are steel-framed with wood racks with a clear spacing of 4.75 inches.

The 13 project generating units have a total installed capacity of 574.54 MW. The estimated total maximum hydraulic capacity of the project is about 86,000 cfs under optimum head conditions. Units 1 through 7 and the two house (station service) units are completely enclosed within the powerhouse, while Units 8 through 11 are of outdoor type construction, without superstructure.

The powerhouse enclosing Units 1 through 7 includes a generator room and an electrical bay. The electrical bay is located between the generator room and the powerhouse intakes and consists of the 13.8-kV bus and switching equipment.

The tailrace is approximately 2,800 feet long, extending from the powerhouse to the downstream end of Rowland Island. The tailrace width ranges from about 900 feet near the powerhouse to 1,500 feet near Rowland Island. The tailwater elevation downstream of the dam, which varies with discharge, is at an approximate elevation of 20.5 feet with all units operating with no spillway discharge.

The project currently operates two fish lifts: the west fish lift and the newer east fish lift. There are no primary transmission lines associated with the project. Electricity generated at the project is transmitted by two 220-kV generation leads extending from the project substation to the East Nottingham substation.

The Conowingo Project recreation facilities include: Lock 13, Lock 15, Muddy Creek Boat Launch, Cold Cabin Boat Launch, Dorsey Park, Line Bridge, Broad Creek

Public Landing, Glen Cove Marina, Conowingo Swimming Pool and Visitor's Center, Peach Bottom Marina, Conowingo Creek Boat Launch, Funk's Pond, Fisherman's Park/Shures Landing, Conowingo Dam Overlook, and the Octoraro Creek Access area. Exelon operates seven of these facilities and leases the other eight to local and state entities or commercial operators.

Exelon holds title or rights to all of the lands within the project boundary. The project boundary encompasses all of the project facilities and lands required for project operation and maintenance.

2.1.2 Project Safety

The York Haven Project has been operating for almost 110 years under past and current licenses (current license issued in 1980). The Muddy Run Project has been operating for almost 47 years under the existing license issued in 1964, and the Conowingo Project has been operating for almost 86 years under previous and the current licenses (current license issued in 1980). During this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the licenses, and proper maintenance. The York Haven Project was exempted from the requirement to file Part 12 independent consultant safety inspection reports every 5 years. The Muddy Run and Conowingo projects have been inspected and evaluated every 5 years by an independent consultant, and a consultant's safety report has been submitted for Commission review. As part of the relicensing process, the Commission staff would evaluate the continued adequacy of the proposed project facilities under new licenses. Special articles would be included in any license issued, as appropriate. Commission staff would continue to inspect the projects during the new license terms to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.3 Existing Project Operation

2.1.3.1 York Haven Project

The York Haven Project is operated in a run-of-river mode and maintains a normal pool elevation of 277.86 feet under low to moderate flow conditions (<17,000 cfs). Under lower flow conditions, York Haven Power has the ability to draw down the impoundment by up to 1.10 feet, generally for purposes of dam maintenance. During periods of moderate to high flow conditions (>17,000 cfs), the project turbines cannot control water levels and the impoundment elevation varies above normal pool elevation depending upon river flow. Under these conditions, water overtops the main dam, east channel dam, and headrace walls when their crest elevations are exceeded.

Flows required by the current license are discussed in section 2.1.4.1, *Existing Environmental Measures, York Haven Project*. A license requirement to maintain

continuous flow is accomplished by maintaining at least two of the York Haven turbines operating at full gate providing approximately 1,000 to 1,500 cfs downstream and supplementing the turbine discharge with spill over the main dam spillway.

The York Haven powerhouse is manually operated at all times with two operators on duty during the day and one operator on duty at night. During normal operation, units are brought on-line based on anticipated flow rates given that the only available method of flow control at the project is through on/off operation of each of the 20 generating turbines. Project outflow adjustments typically occur in 700- to 1,100-cfs increments, up to the station hydraulic capacity. Historically, adjustments are made during the day-shift or at a shift change. Project operators ensure run-of-river operation through a series of checks and balances, monitoring operation and streamflow gage data, observing impoundment elevations, and applying project operational experience.

2.1.3.2 Muddy Run Project

The Muddy Run Project is a pumped storage hydroelectric facility. Water is pumped from the lower reservoir (Conowingo Pond) to the upper reservoir which has 33,894 acre-feet of active storage available for pumped storage operation. Typically, pumping occurs during low-load periods when energy costs are low, while generation occurs during high-load periods.

The Muddy Run Project is typically operated from control panels at the Muddy Run powerhouse. The project, however, has automatic generation control equipment capable of starting, running, and stopping the units. This equipment permits remote operation of the plant in generation mode from the corporate office in Kennett Square, Pennsylvania.

Operation of the Muddy Run Project is generally not affected by changes in hydrologic conditions when compared to conventional hydroelectric projects. Pumped storage projects are typically considered to be closed systems, in that they maintain a usable volume of water that is cycled between the upper and lower reservoirs without the need to store or use water flowing through the project from the upper reaches of the drainage basin. Given this, the operation of the Muddy Run Project depends upon maintaining a specific total usable volume of water between the Muddy Run upper reservoir and Conowingo Pond, to limit effects on power production.

During mean flow years, flow issues do not typically arise at the project, as there are sufficient flows to maintain the total usable volume of water for project operation and to provide flows downstream of Conowingo dam. During a high-flow year, the project also has sufficient water available to maintain the total usable volume in the system, while also passing higher levels of flow downstream.

However, during extreme high-flow events, project operation could be affected by having excess water in the system. Exelon typically adjusts Muddy Run operation to reduce the levels in the upper reservoir prior to high Susquehanna River flow conditions. This allows the upper reservoir to be re-filled during high-flow periods and possibly

reduce spill conditions at Conowingo dam. Extended periods of high-flow conditions (potential spill situation at Conowingo dam) could reduce the generation at the Muddy Run Project when Conowingo Pond is at or near full pond conditions, in order to reduce spill over Conowingo dam.

During adverse water years, with limited inflow, the water management for the project requires adjustments in the generation cycle. The most typical occurrence is a reduction in the total usable volume of water available for project operation. The extent of the adjustments in flow and the volume of water retained in the Muddy Run upper reservoir and Conowingo Pond depends upon the level of low flow experienced, as well as the length of time of the adverse low-flow conditions. Maintaining the licensed Conowingo Pond levels and minimum flow requirements below Conowingo dam are the primary factors affecting the total usable volume of water.

2.1.3.3 Conowingo Project

The Conowingo Project is a peaking hydroelectric facility that uses a limited active storage reservoir to generate during peak electricity demand periods. The project is typically operated semi-automatically as the generation setting (in MW) is programmed into the control system; however, turbines are brought on- line manually by an operator to ensure an efficient start-up until the generation setting is reached. At times, the project is also operated in either full manual or automatic mode, and this type of operation is typically dictated by the prevailing river flow and system load conditions. The current Conowingo Project license allows for the Conowingo Pond to fluctuate between elevation 101.2 feet and 110.2 feet. There are critical water levels associated with water withdrawals that influence reservoir levels in Conowingo Pond (see section 3.3.2, *Water Resources*, for details).

The current flow regime downstream of Conowingo dam is as follows:

Date	Minimum Flow
March 1 - March 31	3,500 cfs or natural inflow (as measured at the U.S. Geological Survey [USGS] Marietta gage), whichever is less;
April 1 - April 30	10,000 cfs or natural inflow, whichever is less;
May 1 - May 31	7,500 cfs or natural inflow, whichever is less;
June 1 - September 14	5,000 cfs or natural inflow, whichever is less;
September 15 - November 30	3,500 cfs or natural inflow, whichever is less; and
December 1 - February 28	3,500 cfs intermittent (maximum 6 hours off followed by equal amount on).

The downstream discharge must equal these values or the discharge measured at the Susquehanna River at the Marietta U.S. Geological Survey (USGS) gage (No. 01576000), whichever is less. The Marietta gage is located approximately 35 miles

upstream of Conowingo dam above Safe Harbor dam. The gage is generally considered reflective of the lower Susquehanna River's natural flow regime. During high electrical demand periods with low inflow Exelon uses water from the available Conowingo Pond storage (within its license constraints) to meet this demand. During non-peak periods of electrical demand, some combination of turbine units is used to provide the minimum flow requirements at the project. When inflows are below the minimum turbine capacity, any additional water needed to meet minimum flow requirements would be taken from storage.

During periods of regional drought and low river flow, Exelon has requested and received Commission approval for a temporary variance in the required minimum flow release from the Conowingo Project. As a result of a recent agreement with resource agencies, beginning in 2012, when the minimum flow variance is in effect, leakage flows (which total about 800 cfs) counts as approximately 580 cfs towards the minimum flow discharge at the Conowingo Project. The remaining portion of the project leakage (approximately 220 cfs) is credited to the PBAPS facility, as part of its consumptive use agreement. This temporary variance is typically approved by the Commission and the resource agencies (i.e., SRBC, Maryland DNR, Pennsylvania FBC, and FWS), as well. The temporary variance allows Exelon to maintain an adequate pond level elevation and storage capacity throughout a low-flow period, not only for electric generating capacity, but also to ensure an adequate water supply is available for recreational interests and consumptive water usage on Conowingo Pond.

During high flow events, typically all units are operated at maximum wicket gate opening and crest gate operation is used to pass the remainder of the streamflow. Under such conditions, Conowingo Pond is usually kept near elevation 109.2 feet to prevent splashing of water onto the U.S. Route 1 roadway and debris from "floating over" the closed crest gates. There is a skimmer beam, bottom elevation 109.2 feet, that provides protection to motorists and prevents floating debris from going over the closed crest gates, whose top elevation is 110.2 feet.

2.1.4 Existing Environmental Measures

2.1.4.1 York Haven Project

Article 30 of the current FERC license requires York Haven Power to discharge a continuous minimum flow of 1,000 cfs from the powerhouse and an average daily flow of not less than 2,500 cfs, unless the inflow to the impoundment is less than these amounts, in which case the discharge from the project shall not be less than the inflow. These flows may be temporarily modified if required due to operating emergencies beyond the control of York Haven Power.

The project includes a weir cut and vertical-slot fish ladder at the east channel dam, which became operational in 2000. When the east channel fish ladder is operated for the upstream migration of adult American shad (typically mid-April to mid-June), York Haven Power is required to spill 4,000 cfs at the main dam and to release 2,000 cfs

at the east channel dam, which includes 67 cfs provided directly through the fish ladder. After the American shad upstream passage season and during the resident fish passage period, the project maintains a minimum flow of 400 cfs in the east channel until the seasonal closure of the fish ladder. Fish ladder closure occurs the earlier of December 15 or when average daily river water temperature is equal to or less than 40 degrees Fahrenheit (°F) for 3 consecutive days.

Downstream passage for adult and juvenile American shad is provided at the powerhouse by an operating protocol that includes: (1) when river flow is less than the project hydraulic capacity, prioritization of powerhouse generation through units 1 through 6 (propeller units) on a first-on/last-off basis, followed by units 7 through 20 (Francis units); (2) opening the forebay sluice gate located in the lower forebay corner adjacent to unit 1 for downstream fish passage; and (3) using temporary lighting above the forebay sluice gate to aid in attracting alosine species to the sluice gate exit.[27] At river flow greater than project hydraulic capacity, which occurs about 60 percent of the time, downstream fish passage occurs via spillage over the dam.

York Haven Power owns and operates the following project recreation facilities: the Historic Canal Lock, East Shore Boat Launch, Goosehorn Island Picnic Area, Shelley Island Recreation Area, Goodling Island Picnic Area, Beshore Island Recreation Area, Battery Island Recreation Area, Cly Shore recreational lot sites, York Haven Power Plant Recreation Area, and Canoe Portage trail. In addition, York Haven Power implements a recreational lot permitting program to accommodate boating, fishing, and other day use activities.

2.1.4.2 Muddy Run Project

Prior to predicted high Susquehanna River flow events, Exelon typically voluntarily adjusts Muddy Run operation to reduce the levels in the upper reservoir. This allows the upper reservoir to be re-filled during high-flow periods and possibly reduce spill conditions at Conowingo dam.

Exelon maintains three recreation areas at the project. The primary project recreation site is Muddy Run Park, a 700-acre park that includes day use areas, a 189-site campground, 100-acre Recreation Lake that abuts the upper reservoir, and a visitor information center. Immediately downstream of the powerhouse is Wissler's Run Park, a day use area with parking for 130 vehicles. In addition, the project includes the 800-acre

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[27] This downstream passage protocol was reported to the Commission by filing of a "Downstream Passage Report" on March 19, 2002. That report was required by Ordering Paragraph (C) of the Commission's June 30, 1994, Order Approving Fish Passage Settlement Agreement, which was the agreement that led to the eventual construction of the east channel fish ladder.

Muddy Run WMA, located on project and non-project land. Roads and trails within this area provide access for hunters, hikers, birders, and equestrians.

2.1.4.3 Conowingo Project

The current license allows Conowingo Pond to fluctuate between elevation 101.2 and 110.2 feet, except on weekends between Memorial Day and Labor Day, when the elevation must be at or above 107.2 feet to meet recreational needs. However, other operating constraints (see section 3.3.2, *Water Resources*, for details) result in Conowingo Pond typically being maintained at or above elevation 109.2 feet. Pursuant to a Settlement Agreement approved by the Commission on January 24, 1989, Exelon operates the east and west fish lifts at Conowingo dam, and maintains seasonal minimum flows downstream of the dam ranging from 3,500 to 10,000 cfs, and described in more detail in section 2.1.3.3, *Existing Project Operation, Conowingo Project*. Article 37 of the current license includes provisions to protect cultural resources.

Exelon currently enhances DO by a turbine venting system at units 1-7 and aerating runners at units 2 and 5. Downstream DO is continuously monitored by Exelon from May 1 through October 1. Exelon also removes floating and submerged debris from in front of the powerhouse intakes and sponsors community-based clean-ups at Conowingo Pond and downstream of Conowingo dam.

Exelon provides 16 project-related recreation facilities that include parks, day use areas, marinas, boat launches, and a visitor center: (1) Lock 13; (2) Lock 15; (3) Muddy Creek Boat Launch; (4) Cold Cabin Boat Launch; (5) Dorsey Park; (6) Line Bridge; (7) Broad Creek Public Landing; (8) Glen Cove Marina; (9) Conowingo Swimming Pool and Visitor's Center; (10) Peach Bottom Marina; (11) Conowingo Creek Boat Launch; (12) Funk's Pond; (13) Fisherman's Park/Shures Landing; (14) Octoraro Creek Access; (15) 3.5 miles of the Mason-Dixon Trail; (16) and the Susquehanna State Park.

2.2 APPLICANTS' PROPOSALS

2.2.1 Proposed Project Facilities

York Haven Power proposes to construct a nature-like fishway[28] at the north end of the York Haven Project main dam where it abuts Three Mile Island. Construction would require modifications to the north end of the dam. No other modifications are proposed to project facilities.

No modifications are proposed to project facilities at the Muddy Run Project.

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[28] A nature-like fishway is a fishway that is designed to appear and operate similar to a natural riffle, with a gradually sloping channel interspersed with rock weirs and pools. These fishways are typically suitable for a wide range of species.

Exelon proposes to construct an eel trap and transport facility on the west side of the Conowingo Project tailrace, and to construct a similar facility on the east side of the tailrace or in Octoraro Creek. No other modifications to project facilities are proposed at the Conowingo Project.

2.2.2 Proposed Project Operation

In conjunction with the construction of the nature-like fishway, York Haven Power proposes to modify project flow releases to provide fish passage attraction flows to the nature-like fishway and to establish the nature-like fishway as the primary fish passage facility and the existing east channel fishway as the secondary passage facility. The proposed flow release changes would redistribute minimum flow releases among the various project flow release structures (east channel spillway, east channel fishway, nature-like fishway, main dam, and powerhouse). The overall project minimum flow requirements downstream of the project would not change. The flow release changes are also discussed in section 2.2.3.1, *Proposed Environmental Measures, York Haven Project*.

No modifications to Muddy Run or Conowingo project operation are proposed.

2.2.3 Proposed Environmental Measures

2.2.3.1 York Haven Project

The Settlement Agreement resolves among the Settling Parties all issues associated with issuance of a new license for the project regarding upstream passage of American shad and American eels, downstream passage of juvenile and post-spawning American shad, downstream passage of silver stage American eel, resident fish passage, flow management, water quality and debris management, and endangered species and species of special concern. We consider the Settlement Agreement to represent the proposed action regarding these issues for this project.[29] For measures related to other environmental issues (i.e., recreation, land use, and cultural resources) we assume the proposed measures presented in the final license application continue to be proposed.

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[29] Our summary of the measures in the Settlement Agreement may differ from the specific language of the Settlement Agreement. Details of individual components of the measures listed in section 3.0 of the Settlement Agreement (measures that the parties agree should be incorporated in the terms of the license), including programmatic elements such as schedules for developing plans and details of monitoring, evaluation, and reporting, are not listed. Characterization of these measures is our attempt to provide a concise summary of the measures for this draft EIS and is not intended to modify any of the terms of the Settlement Agreement.

Under the terms of the Settlement Agreement, York Haven Power would continue the following existing environmental measures at the project (we indicate the designation of the measure in the Settlement Agreement in parenthesis):

- Provide a year-round, continuous, minimum flow from the project of 1,000 cfs and an average daily minimum flow of 2,500 cfs, or inflow, whichever is less, to protect and enhance aquatic resources downstream of the project (measures 3.2.1[c][i], 3.2.1[c][ii],3.2.2[c][i], and 3.2.2[c][ii]).
- Operate the project in a run-of-river mode when inflow to the project is less than 3,000 cfs, without deliberate impoundment drawdown or storage for purposes of generating electricity in particular time periods (measures 3.2.1[c][iii] and 3.2.2[c][iii]).
- Operate and maintain the existing east channel upstream fishway for upstream fish passage (measure 3.1.8[a]).
- Provide a minimum flow of 2,000 cfs at the east channel dam and a spillage flow of 4,000 cfs at the main dam during the American shad upstream passage season when the east channel fishway is in operation. The upstream passage season is determined by the Fish Passage Technical Advisory Committee but generally extends from mid-April through mid-June (measures 3.2.1[a][i] and 3.2.1[a][ii]).
- After the American shad upstream passage season until the end of the resident fish passage season (the earlier of December 15 or until the average daily river temperature is $\leq 40^{o}$F, maintain a minimum flow of 400 cfs in the east channel downstream from the east channel fishway during the period that the east channel fishway is operated to allow upstream passage of resident fish species, per the June 2010 Consent Order and Agreement between York Haven Power and Pennsylvania DEP (measures 3.2.1[b][i] and 3.2.1[b][ii][1]).
- Continue the current downstream juvenile American shad passage protocol, which calls for the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30), and opening the forebay sluice gate at specific times for downstream fish passage. If river flows exceed the capacity of units 1-6, unit 14 would be operated, and if flows exceed the capacities of units 1-6 and 14, units 7-13 and 15-30 would be operated in ascending order (measures 3.1.6[a][i], 3.1.6[b][i], and 3.2.1[b][ii][2]).
- To prevent a buildup of debris that could affect project and fish passage operations, remove non-natural debris from the forebay and sluice

remaining natural debris downstream after notifying the downstream PPL Brunner Island Station (measure 3.3 [b]).

- Contribute $25,000 per year to the York County Conservation District or such other entity identified by Pennsylvania DEP for the purposes of debris removal in the lower Susquehanna River watershed (measure 3.3[a]).

The Settlement Agreement includes provisions for York Haven Power to implement the following suite of measures designed to reallocate the existing minimum flows to facilitate migration of American shad and American eel:

- Pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, flows through the nature-like fishway, once constructed, flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad, and during the juvenile American shad downstream passage period to facilitate downstream passage of juvenile American shad.
- Pass about 370 cfs through the forebay sluice gate between the hours of 5 and 11 p.m. during the entire juvenile American shad passage period to facilitate downstream passage of juvenile American shad (measures 3.1.6[a][ii] and 3.1.6[b][ii]).
- Develop designs within 4 years of license issuance for: (1) removal of obstructions in or deepening of the plunge pool below the forebay sluice gate, and (2) a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad that pass into the downstream plunge pool.
- Cooperate with resource agencies and other interested parties to conduct a lower Susquehanna River downstream eel migration study. This cooperation would include monitoring silver eels at the project and providing $25,000 to support the study (measures 3.1.7[b], 4.1.1[a], and 4.1.2[a]).
- Conduct a site-specific silver eel route of passage study as described in appendix G of the Settlement Agreement including the potential for providing $50,000 to resource agencies for collection and tagging of silver eels at upstream locations (measures 3.1.7[c] and 4.1.1[b]).
- Conduct a site-specific silver eel survival study as described in appendix H of the Settlement Agreement (measure 3.1.7[c]).
- Conduct a downstream eel passage improvement study if downstream eel passage goals are not achieved with provisions for subsequent monitoring and adjustments (measures 3.1.7[e], 3.1.7[f], 3.1.7[g], and 3.1.7[h]).

York Haven Power proposes to construct, operate, and maintain a nature-like fishway in the vicinity of the apex of the main dam and Three Mile Island in compliance with design criteria specified in appendix A of the Settlement Agreement (measures 3.1.1 and 3.1.2). Prior to and upon completion of the nature-like fishway, York Haven Power proposes to implement the following measures:

- Develop an erosion and sediment control plan for construction of the nature-like fishway.
- Prior to construction of the nature-like fishway, conduct vegetation surveys, wetlands delineations, invasive species surveys, rare species surveys, bog turtle habitat assessments, and bald eagle surveys in the area of the nature-like fishway.
- Conduct American shad upstream passage effectiveness studies using radio telemetry beginning during the second year of nature-like fishway operation. If the project area passage success criterion is not achieved, York Haven Power would implement corrective measures, followed by two additional years of radio telemetry studies to confirm achievement of the project area passage success criterion (measure 3.1.3).
- Conduct a juvenile American shad headrace turbine avoidance study consistent with design criteria included in appendix D of the Settlement Agreement (measure 3.1.6[d]).
- If the juvenile American shad headrace turbine avoidance goals are not achieved, implement measures that would enhance the effectiveness of downstream juvenile shad passage and conduct a supplemental juvenile American shad headrace turbine avoidance study within 2 years of implementing the measures. Provisions are made for subsequent measures and evaluations (measures 3.1.6[f], 3.1.6[g], and 3.1.6[h], and 3.1.6[i]).
- Provide an average daily minimum flow in the east channel below the east channel dam of 267 cfs year round to protect aquatic resources in the east channel and provide a minimum passage flow for fish ascending the east channel and using the east channel fishway (measures 3.2.2[a][i] and 3.2.2[b][b][i]).
- Provide at least 5 percent of river flow through the nature-like fishway and supplemental attraction flow channels when flows entering the project during the American shad upstream passage season are between 5,000 and 150,000 cfs. This would equate to a minimum flow through the nature-like fishway of between 1,000 and 7,500 cfs depending on inflow (measure 3.2.2[a][ii]).

- Provide a minimum flow of 200 cfs through the nature-like fishway outside of the American shad upstream passage season when the river elevation is at the crest of the main dam (measures 3.1.6[b][iii] and 3.2.2[b][ii]).
- To the extent controllable by York Haven Power, when flows exceed the hydraulic capacity of all available generating units, manage flows to maximize flow over the main dam and the nature-like fishway to provide attraction flow to the vicinity of and from the nature-like fishway to maximize fishway effectiveness (measure 3.2.2[b][iii]).

York Haven Power also proposes to implement the following additional environmental measures included in the final license application but not included in the Settlement Agreement:

- Maintain existing recreation facilities on four islands in Lake Frederic and the recreation facilities at the powerhouse, including a portage trail for canoeists and fishing access along the downstream face of the powerhouse and consult with the resource agencies on recreation resources and management strategies every 10 years after the effective date of any new license.
- Continue the current permitting program for the approximately 300 recreational lots located within the project boundary, but terminate permits and remove from the licensing program existing recreational lots upon abandonment by the lessee, or when existing structures become damaged and are not replaced by structures conforming to all applicable federal, state, and local regulations.
- Implement the HPMP filed with the Commission on December 28, 2012, to manage project effects on historic properties eligible for listing on the National Register.

2.2.3.2 Muddy Run Project

Exelon proposes the following environmental measures at the project:

- Develop a DO monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards.
- Develop FPOP for minimizing delay and potential fish entrainment during upstream and downstream fish passage past the project tailrace during generating and pumping cycles, with specific targets for upstream and downstream passage at the Muddy Run Project, and corrective actions if targets are not met.
- Develop a plan and schedule as part of the fish passage requirements for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run project boundary if resource agencies

determine that operation of the Muddy Run Project is causing the Holtwood Project to fail to meet its Tier I upstream American shad target specified in the water quality certification for the Holtwood Project.

- Implement the American Eel Passage Plan[30] filed with the license application for an eel trap and truck program to trap, hold, and transport American eels from the Conowingo Project and Octoraro Creek to designated points in the Susquehanna River watershed until at least 2030, and then either continue the trap and truck program or construct a volitional eel passage facility at Conowingo dam.[31]
- Implement the Bald Eagle Management Plan filed with the license application providing for the management of bald eagle habitat on Exelon lands in accordance with recommendations from the *National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance. Bald eagle habitat, including nest sites, forage sites, and communal roost sites, on Exelon lands would be managed through a range of measures that would be tailored to the types of activities with potential to affect eagles. These measures would include, but not be limited to, seasonal restrictions on maintenance activities such as herbicide applications during the breeding season, distance buffers, and landscape buffers.
- Implement the Bog Turtle Management Plan filed with the license application to minimize impacts to bog turtles and that includes: (1) restricting mowing in the wetland documented to support bog turtles; (2) controlling invasive and woody plants, particularly reed canary grass; and (3) limiting public access to the wetland without advertising the reason.
- Once every 10 years through the term of the license, evaluate all state and federal endangered and threatened species that may be present within the project boundary, and if the evaluation identified the presence, critical habitat, or critical dependence of endangered species, propose and implement a protection plan for each species.

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[30] Exelon filed an Eel Management Plan with its final license application. In the water quality certification for the Muddy Run Project, the Pennsylvania Department of Environmental Protection called this plan an American Eel Passage Plan, and we use this title throughout the EIS.

[31] Exelon is proposing that a Muddy Run Project measure be implemented at the Conowingo Project, which is not under the same license. It is Commission policy that a condition for one license cannot be required and implemented at a different licensed project.

- Provide annual grants up to $450,000 equally to the Lancaster County and York County Conservation Districts for the implementation of agricultural pasture and barnyard BMPs to control sediment loading to the Susquehanna River.
- Provide $50,000 annually to the Pennsylvania FBC to perform habitat improvement projects including removal of small dams.
- Implement the Recreation Management Plan filed with the license application that includes measures for maintenance and capital improvements and contains specific enhancements at project recreation facilities.

  At Muddy Run Park: (1) replace the Recreation Lake boat launching facility and boat dock with an improved launching ramp and Americans with Disabilities Act (ADA)-compliant dock; (2) implement shoreline erosion measures to improve runoff and stability in the vicinity of an ADA-compliant picnic area and boat rental dock; (3) replace an existing wood retaining wall with a sheet pile retaining wall to reduce shoreline erosion near the boat dock area; (4) upgrade the electric service to 50 campsites in the park, and monitor future need and upgrade additional sites when the demand occurs; (5) expand an existing playground area near the Visitor's Center with safety swings and three modular play structures suitable for younger children (tot lots); and (6) install a mulch safety surface, and construct a 2,000 square foot water spray park near the park entrance, along with paving resurfacing.

  At Wissler's Run Park: (1) complete the replacement of the picnic pavilion;[32] (2) designate and sign two additional ADA-compliant parking spaces near the picnic pavilion for compliance with standards set by *ADA Accessibility Guidelines for Buildings and Facilities*; and (3) remove the existing non-functioning fish cleaning station.

  At Muddy Run WMA: (1) continue to lease the Muddy Run WMA to the Pennsylvania Game Commission for the management of the Muddy Run WMA to provide hunting opportunities in the area; and (2) erect and maintain FERC Part 8 signs at the River Road and Furniss Road WMA parking areas to identify the conditions of access to the site.
- Implement the Shoreline Management Plan (SMP) filed with the license application and consistent with *Guidance for Shoreline Management*

[32] The walkway from the parking area to the picnic area and the parking lot were both repaved in 2011.

Planning at Hydropower Projects (FERC, 2001). The SMP includes specific measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands and BMPs for controlling sediment introduction from lands within the project boundary.

- Implement the osprey management policy described in Exelon's proposed SMP.
- Implement a cultural resources management plan if cultural materials are identified during project-related activities.

2.2.3.3 Conowingo Project

Exelon proposes to continue the following environmental measures at the project:

- Operate the project with a normal range of operation of Conowingo Pond between elevations 101.2 and 110.2 feet, with a minimum elevation of 107.2 feet on weekends between Memorial Day and Labor Day, to meet recreational needs.
- Provide minimum flow releases from the project, as described below, or a minimum flow equal to the discharge (natural inflow) measured at the Marietta USGS gage (No. 01576000), whichever is less:
  - March 1 – March 31: 3,500 cfs or natural inflow;
  - April 1 – April 30: 10,000 cfs or natural inflow;
  - May 1 – May 31: 7,500 cfs or natural inflow;
  - June 1 – September 14: 5,000 cfs or natural inflow;
  - September 15 – November 30: 3,500 cfs or natural inflow; and
  - December 1 – February 28: 3,500 cfs intermittent (maximum 6 hours off followed by equal amount on).
- Enhance DO at the project using the turbine venting systems on Units 1 through 7 and the aerating runners on Units 2 and 5, and continuously monitor DO levels from May 1 through October 1 at the Station 643 location about 0.6 mile downstream of Conowingo dam.
- Operate the east fish lift for upstream passage of American shad, river herring, and other migratory fishes, and the west fish lift for American shad egg collections and other research purposes.
- Manage debris to include clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes and floating surficial debris in front of the powerhouse

intakes, and the sponsorship of community-based clean-ups in the pond and downstream of the dam.

- Maintain the project's public recreation facilities.

Exelon proposes the following new environmental measures at the project:

- Implement the Sediment Management Plan filed with the license application that identifies benchmarks and thresholds for action to address sediment issues that may affect project operation.
- Conduct a bathymetric survey of Conowingo Pond every 5 years to monitor sediment transport and depositional patterns within the pond.
- Implement a preventive maintenance program for the east fish lift that would extend the useful life of the facility over the next license term.
- Use the project turbines as the route for downstream passage of American shad and river herring, based on studies that show high survival for fish passing through the turbines.
- Construct a permanent trap and transport facility for upstream passage of American eel, consisting of an eel ramp and collection facility on the west and east banks of the Conowingo tailrace (an alternative east bank facility would be in Octoraro Creek).
- After 2030, construct volitional eel passage facilities on the west and east banks that consist of full eel ramps with resting pools.
- Participate in a trap and transport program for downstream eel passage, in cooperation with the other hydroelectric project operators on the lower Susquehanna River to trap and transport adult American eels from smaller tributaries upstream of York Haven dam to below Conowingo dam.
- Implement the final Bald Eagle Management Plan filed with the license application providing for the management of bald eagle habitat on Exelon lands in accordance with recommendations from the *National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance. Bald eagle habitat, including nest sites, forage sites, and communal roost sites, on Exelon lands would be managed through a range of measures that would be tailored to the types of activities with potential to affect eagles. These measures would include, but not be limited to, seasonal restrictions on maintenance activities such as herbicide applications during breeding season, distance buffers, and landscape buffers.
- Implement the Recreation Management Plan filed with license application to guide the operation and maintenance of Exelon's recreation facilities and the implementation of recreation facility enhancements as outlined above.

- Implement improvements to project recreation facilities as follows:

Recreational Facility	Summary of Capital Improvements
Lock 13	Install a trailhead directional sign at the Lock 12 parking area (access to Lock 13 is from Lock 12, a facility owned by Holtwood-PPL), and clear vegetation from within the lock to provide an unobstructed view of the structure; construct light fencing on each side of the lock structure to protect visitors
Lock 15	Designate two ADA-compliant parking spaces in the existing parking area and install a dock on the shoreline near the picnic area to allow boaters to access the site; construct a concrete pad for portable restroom placement; stabilize the open shoreline area near the parking area to prevent erosion
Muddy Creek boat launch	Designate two boat trailer spaces and one vehicle space for ADA-compliant parking in the existing parking lot; stabilize areas adjacent to the southwest corner and southerly side of the parking area to improve drainage and redirect flow away from the parking area and the river; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out
Cold Cabin boat launch	Improve access by designating a one-way directional traffic pattern through the site and constructing parking for 11 vehicles (five boat trailer and six vehicle spaces), including two ADA-compliant spaces; reinforce existing boat ramp to prevent undermining of the ramp and install a boat dock; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out; provide two ADA-compliant picnic tables; install a concrete pad for the placement of two portable restrooms (one ADA-compliant, one standard)
Dorsey Park	Rebuild both boat ramps at Dorsey Park; designate one ADA-compliant boat trailer space and one ADA-compliant vehicle space in the existing lot; install a concrete pad for three portable restrooms (one ADA-compliant, two standard); install a sign

Recreational Facility	Summary of Capital Improvements
	providing information on the Conowingo dam canoe portage and the location of the portage take-out
Conowingo Creek boat launch	Designate one ADA-compliant parking space in the existing parking area; stabilize a roadside ditch along Mt. Zoar Road and construct a stone-lined drainage ditch along the south side of the parking lot to redirect runoff from the parking lot and boat ramp; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out
Glen Cove Marina	Expand parking at the marina by adding seven additional boat trailer spaces (one ADA-compliant) and 11 vehicle (two ADA-compliant) spaces; repair the marina's bulkhead wall
Funk's Pond	Designate one ADA-compliant parking space in the existing parking area
Line Bridge	Perform shoreline erosion control and stabilization work at this unimproved carry-in boat access area
Conowingo swimming pool	Install an ADA-compliant access facility at the swimming pool and an ADA-compliant access ramp at the wading pool
Conowingo dam overlook	Reopen the facility and designate three ADA-compliant vehicle spaces in the existing parking lot; demolish the existing pavilion and replace it with a new 24-foot by 24-foot wooden pavilion; remove pavement from the easterly corner of the existing paved parking area, loam and seed, and install three ADA-compliant pathways and picnic tables; install security fencing around the site to restrict access to Conowingo dam, while allowing unobstructed views from the pavilion and picnic area
Fisherman's Park and Shures Landing	Widen the access road to the facility by 3 to 5 feet to allow construction of 12-foot wide lanes; construct a retaining wall along the easterly 250 feet of the existing parking area along the access road; designate five additional ADA-compliant parking spaces in the existing parking lot; widen the access road leading to Shures Landing by 4 feet along the eastbound lane for 320 feet, and widen the access road from the trailhead

Recreational Facility	Summary of Capital Improvements
	parking northerly to the retaining wall by 2 feet; construct an additional 13-space parking area near the Lower Susquehanna Heritage Greenway trailhead at the southerly end of Fisherman's Park; demolish the existing hard surface boat launch and asphalt access at Shures Landing and place stone fill next to the existing wall down to existing grade along the Susquehanna River shoreline; construct a new 20-foot wide hard surface carry-in boat launch with a floating dock and breakwater at Shures Landing, to replace the existing launch area
Peach Bottom access	Construct a small (approximately four vehicle) road-side parking area near the existing informal boat launch area south of Peters Creek; install a sign providing information on Conowingo dam canoe portage and the location of the portage take-out

- Implement the SMP filed with the license application that includes specific measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, BMPs for controlling sediment introduction from lands within the project boundary, and use of project lands.
- Implement the osprey management policy described in Exelon's proposed SMP.
- Implement the HPMP filed with the license application for the management of archaeological and historic resources throughout the term of any new license, including: (1) a schedule and methodology for completing any additional recommended studies and implementing monitoring measures; (2) management measures for identified historic properties including Conowingo dam and powerhouse; (3) protection of any historic properties threatened by project-related activities, including project operation, shoreline and aquatic recreation, shoreline development, routine project maintenance, and other project activities or operations; and (4) public outreach, education, and signage for the purpose of reducing looting and vandalism of sites.

Project Boundary Revisions

York Haven Power proposes to add 1.9 acres to the total York Haven Project boundary acreage to encompass the project's East Shore Boat Launch and Canal Lock recreation area.

Exelon proposes to modify the Conowingo Project boundary by removing lands that are not necessary for operation and maintenance of the Conowingo Project or for other specified project purposes, such as public recreation or protection of environmental resources. These lands include: 0.06 acre of land not owned by Exelon in the upper reaches of Conowingo Pond; 34.4 acres along the Susquehanna River shoreline at the Muddy Run Project (to minimize the overlap of project lands between the two projects); 205.6 acres on upper Broad Creek, a tributary to Conowingo Pond; and 1,758.7 acres of the Susquehanna River and shoreline downstream of Conowingo dam. This modification would remove lands from upper Broad Creek and from the Susquehanna River downstream of Rowland Island that were originally included for construction of the project. The proposed project boundary for the Conowingo Project would contain 9,919 acres, including 8,850 acres of project waters and 1,069 acres of land above the normal high water elevation in Lancaster and York counties, Pennsylvania, and Harford and Cecil counties, Maryland. Exelon would negotiate leases with existing recreation facility operators for the continued operation of those facilities located on lands owned by Exelon, but no longer within the project boundary. Exelon would also negotiate a new lease with Maryland DNR for the continued protection and use of the collocated Lower Susquehanna Greenway Trail and Mason-Dixon Trail on Exelon-owned lands outside of the project boundary. The existing lease expires in August 2014.

2.2.4 Modifications to the Applicants' Proposals – Mandatory Conditions

The following preliminary mandatory conditions have been provided and are evaluated in this document. In this draft EIS, we do not analyze a staff alternative with mandatory conditions (composite alternative) because the section 18 prescriptions are preliminary and the Commission has only received a final section 401 certification for the Muddy Run Project. If we receive final prescriptions and certifications for all three projects, we may include a composite alternative in the final EIS.

Section 18 Prescriptions

York Haven Project

Interior's section 18 preliminary prescription specifies:

- A reservation of authority to prescribe fishways during the term of the license.
- Design populations for American shad, river herring, and American eel.
- Operational flows at the project that are the same as provided in the Settlement Agreement as described above.
- An operational schedule for upstream and downstream fish passage facilities.
- Fishway operating procedures for each fishway.

- Construction of a nature-like fishway at the apex of the main dam by November 30, 2012.
- Required monitoring and effectiveness studies for the nature-like fishway, to ensure that at least 75 percent of the shad passed at the downstream Safe Harbor Project be passed at the York Haven Project, or that at least 85 percent of the shad that arrive in the York Haven Project area be passed above the York Haven Project.
- Criteria for determining if required effectiveness is met, and measures to be implemented if effectiveness is not met.
- That the upstream end of the nature-like fishway be designed to accommodate installation of Passive Integrated Transponder (PIT) tag monitoring devices at such time that PIT tag monitoring devices become available and feasible for reliably monitoring American shad exiting the nature-like fishway.

Muddy Run Project

Interior's section 18 preliminary prescription specifies:

- A reservation of authority to prescribe fishways during the term of the license.[33]
- FPOP to describe Muddy Run Project operation during the fish passage season, including regular maintenance activities and emergency procedures to allow safe, timely, and effective fish passage past the Muddy Run Project.
- A fish passage monitoring plan (FPMP), including an American shad passage monitoring plan, for post-FPOP implementation monitoring, and the criteria for success consistent with the goals and objectives set forth in the Susquehanna River Anadromous Fish Restoration Plan.
- An eel passage program with other licensees on the river, so that Muddy Run operation does not interfere with passage objectives at the upstream Holtwood Project.
- An American Eel Passage Plan at the project, including an eel trap and transport program from the downstream Conowingo Project to upstream locations, with design plans due to FERC within 1 year of license issuance.
- Financial support to FWS of $20,000/year for its eel trapping facility at Conowingo dam until the Muddy Run facility is completed.

[33] NMFS also specifies a Reservation of Authority to later prescribe fishways.

- Field testing to determine the best locations for eel traps for upstream passage of elvers, prior to construction of permanent traps that would consist of two ramp-style traps with the capacity to capture 50,000 eels/day, along with facilities for holding and transport, and a quality assurance/quality control program to ensure target survival of 95 percent.
- Instream evaluation of the presence of eels in the river and tributaries every 3 years, and a 2-year downstream passage study of silver eels within 3 years of license issuance.

Conowingo Project

Interior's section 18 preliminary prescription specifies:

- A reservation of authority to prescribe fishways during the term of the license.[34]
- Construction of upstream eel passage facilities (trap and trucking) near the west fish lift and on the east side of the tailrace, or in Octoraro Creek, to be operated until 2029, transitioning to volitional passage in 2030.
- Post-construction efficiency testing for all fish facilities and efficiency testing for downstream juvenile shad and adult eel passage.
- Alternative G of the preliminary prescription in three phases as described below.
- Phase I: Construct a new west fish lift for both trap and trucking and direct volitional upstream shad passage (two 6,500-gallon hoppers), with an auxiliary water system of 2,600 cfs. The objective would be to truck 50,000 adult shad per year. Create a 5,000-foot-long zone of passage on the east and west shores of the tailrace below the dam. Implement a maximum downramping rate of 20,000 cfs/hour. Make channel modifications downstream to eliminate stranding in the spillway channel.
- Phase II: Modify the east fish lift stilling basin to allow a 900-cfs attraction flow, as originally designed. Relocate east fish lift entrance A to upstream of the Kaplan unit boils. Construct new entrance D and collection gallery to the east fish lift along the Kaplan units and connect to a new second hopper. Reconstruct entrance B to east fish lift at 45 degrees to the river flow as shown in figure 3-15.
- Phase III: If passage efficiency is not met in Phase I and II, make daily adjustments to minimum flows and turbine operation, construct an east fish

[34] NMFS also specifies a reservation of authority to later prescribe fishways.

lift auxiliary water supply of 4,325 cfs, and upgrade east fish lift equipment to allow a 15-minute cycle time.

Water Quality Certification Conditions

Pennsylvania DEP issued a draft certification for public comment for the Muddy Run Project. In its reply comments filed on March 18, 2014, Exelon requested the Commission incorporate the conditions in the draft certification in its licensing proposal. Pennsylvania DEP issued final certification on June 3, 2014, and filed the final certification with the Commission on June 9, 2014. While Exelon has not indicated the final certification represents its proposal, our review of the draft and final certifications found that they are nearly identical; therefore, we include these measures in the list of Exelon's proposed measures in section 2.2.3.2, *Proposed Environmental Measures, Muddy Run Project*, and identify them in the discussions in the resource sections to which they apply.

2.3 STAFF ALTERNATIVE

York Haven Project

Under the staff alternative, the project would include most of York Haven Power's proposed measures as outlined in section 2.2.3.1, *Proposed Environmental Measures, York Haven Project*, above, with the following additions and modifications:

- Develop a recreation management plan that provides for York Haven's proposed maintenance of its existing recreation facilities with additional provisions to update the plan every 12 years consistent with every other Form 80 reporting period deadline, include safety measures during construction of the nature-like fishway, continue the licensing program for approximately 300 recreational lots within the project boundary, and implement revisions to the program to allow for the termination of permits and removal of lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures.
- Develop an SMP that includes specific measures and policies related to shoreline management at the project and include a provision to update the plan every 10 years.
- Modify the proposed HPMP to add: (a) a requirement to request landowner permission to access sites on private lands within the project boundary and evaluate them for listing on the National Register and for project impacts if project impacts are identified during monitoring activities; (b) a plan and schedule to evaluate archaeological sites on York Haven lands within the project boundary for their National Register eligibility to ensure that any effects on sites owned by York Haven Power are fully considered in accordance with section 106; and (c) inclusion of two additional sites

(36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded.

Muddy Run Project

Under the staff alternative, the project would include most of Exelon's proposed measures as outlined above with the following additions and modifications:

- Visit FWS' Chesapeake Bay Field Office and the Pennsylvania Field Office websites prior to any ground disturbance and follow the bog turtle and bald eagle guidelines.
- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other Form 80 reporting deadline.
- Modify Exelon's proposed SMP to include a provision to update the plan every 10 years.
- Develop an HPMP that provides for the management of historic properties and unevaluated cultural resources within the project APE and includes: (a) a detailed discussion of the three sites (36LA67, 36LA103, 36LA368) identified during the Phase IA cultural resources survey and two additional sites (36LA70, 36LA47) located outside of the project boundary; (b) requirements for National Register evaluation of affected sites in consultation with the Pennsylvania SHPO; (c) requirements for formal National Register evaluation of the Muddy Run Project; and (d) documentation of consultation with Indian Tribes.

Conowingo Project

Under the staff alternative, the project would include most of Exelon's proposed measures as outlined above, with the addition of a modified minimum flow regime that would enhance current Exelon minimum flows from December through February and in the first 2 weeks of June.[35] The following measures would also be included:

- Modify Exelon's proposed Sediment Management Plan to include periodic dredging at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediments have been accumulating, to improve and maintain recreational boating access; and include with the

[35] Under the staff alternative, Exelon would be required to provide a continuous minimum flow of 3,500 cfs from September 15 to March 31, eliminating periods of no minimum flow in December through February, and a minimum flow of 7,500 cfs from June 1 to 15, an increase from the current minimum flow of 5,000 cfs during that period.

results of each bathymetric survey an analysis of any change in sediment deposition or scour in the pond from the previous survey(s).

- Modify Exelon's proposed minimum flow regime to enhance minimum flows from December through February, by eliminating periods with no minimum flow, and by increasing the minimum flow during the first 2 weeks of June, summarized as follows:
  - September 15 – March 31: 3,500 cfs or natural inflow (as measured at the USGS Marietta gage No. 0157600), whichever is less;
  - April 1 – April 30: 10,000 cfs or natural inflow, whichever is less;
  - May 1 – June 15: 7,500 cfs or natural flow, whichever is less; and
  - June 16 – September 14: 5,000 cfs or natural inflow, whichever is less.
- Implement measures designed to improve upstream fish passage through modification to the existing west and east fish lifts that would include: (a) replacing the existing hopper at the west fish lift with a 1,500 gallon hopper; (b) improving the west fish lift sorting and loading process to facilitate trap and truck operations and implementing a trap and truck program for American shad; (c) conducting a feasibility study to determine engineering feasibility, potential fish passage benefits, and costs for additional attraction flow at the west fish lift and if determined feasible and beneficial, install additional flow capacity; (d) restoring the attraction flow in the east fish lift to its original design capacity of 900 cfs; (e) adding a second 3,300-gallon hopper to the east fish lift in the space provided for in the original design, and upgrading the electrical and mechanical equipment to allow for a 15-minute lift cycle; and (f) conducting a feasibility study for modifying the locations of entrances A and B if 2 years of effectiveness studies, after restoration of the 900-cfs attraction flow, show poor attraction at the east fish lift, and make the necessary modifications if feasible.
- Modify Exelon's proposed Bald Eagle Management Plan to include measures to minimize recreation-related disturbance in proximity to roosting or foraging eagles.
- Develop a northern map turtle protection plan to minimize project impacts to map turtles through monitoring, habitat management, and nest site protection.
- Develop a waterfowl nesting protection plan to identify waterfowl nesting habitat that is routinely flooded during the breeding season, and where feasible, establish mitigation measures to minimize impacts to waterfowl nests.

- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other the Form 80 reporting deadline and a plan to provide angler access to the catwalk on a limited basis with security measures in place that address the vulnerability of the facility and the safety of the users of the catwalk.
- Modify Exelon's proposed SMP with the addition of a provision to update the plan every 10 years.
- Modify Exelon's proposed HPMP to include the following additional provisions: (a) a revised APE with the narrow strip of land in the current project boundary extending downstream from Spencer Island along the west side of the river to Havre de Grace, Maryland; (b) a discussion of all 48 sites and 27 historic structures identified to date within the project APE or an explanation of why they are not considered; (c) correction to identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad eligible for listing; (d) requirements to inventory any lands within the revised APE, evaluate identified cultural resources for eligibility, and address potential effects before sale or transfer of those lands; (e) a requirement to make good faith effort to obtain access to private property to conduct studies if project effects on cultural resources on private lands are identified; (f) a revised list of project activities involving the Conowingo Project that can be completed without Maryland SHPO review; (g) a process for assessing project-related ground-disturbing activities to determine whether or not archaeological sites would be affected, particularly in areas that have not had archaeological surveys; (h) requirements to ensure confidentiality of cultural resources location information during implementation of public outreach programs; and (i) a description of project-related activities that would require consultation with the Delaware Nation and the Onondaga Nation in accordance with section 106 of the NHPA and documentation of Native American consultation.

Under the no-action alternative, each project would continue to operate under the terms and conditions of the existing licenses, and no new environmental protection, mitigation, or enhancement measures would be implemented.

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

We considered several alternatives to the applicants' proposals, but eliminated them from further analysis because they are not reasonable in the circumstances of this case. They are: (1) issuing non-power licenses, (2) federal takeover, and (3) retiring one or more of the projects.

2.4.1 Issuing a Non-Power License

A non-power license is a temporary license that the Commission will terminate when it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to takeover any of the three projects. No party has sought a non-power license and we have no basis for concluding that any of the Susquehanna River Projects should no longer be used to produce power. Thus, we do not consider issuing a non-power license a realistic alternative to relicensing in this circumstance.

2.4.2 Federal Government Takeover of the Projects

We do not consider federal takeover to be a reasonable alternative. Federal takeover and operation of any of the projects would require Congressional approval. Although that fact alone would not preclude further consideration of this alternative, there is no evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating any of the three projects.

2.4.3 Retiring the Project

Project retirement could be accomplished with or without dam removal. Either alterative would involve denial of the relicense application and surrender or termination of the existing license with appropriate conditions. No participant has suggested that dam removal at any of the projects would be appropriate in this case, and we have no basis for recommending it. Energy currently generated at the projects by a renewable resource would be lost. In addition, the project reservoirs are a major source of water supply for the region and support significant recreational activities, regardless of whether power is produced. Thus, dam removal is not a reasonable alternative to relicensing the projects with appropriate protection, mitigation, and enhancement measures.

The second project retirement alternative would involve retaining the dam and disabling or removing equipment used to generate power. Project works would remain in place and could be used for historic or other purposes. This would require us to identify another government agency with authority to assume regulatory control and supervision of the remaining facilities. No agency has stepped forward, and no participant has advocated this alternative. Nor have we any basis for recommending it. Furthermore, because the power supplied by the projects is needed, a source of replacement power would have to be identified. In these circumstances, we do not consider removal of the electric generating equipment at any of the projects to be a reasonable alternative.

3.0 ENVIRONMENTAL EFFECTS

In this section, we first describe the general environmental setting in the project vicinity and any environmental resources that could be cumulatively affected by relicensing the Susquehanna River Projects. Then, we address each affected environmental resource. For each resource, we first describe the affected environment—the existing condition and the baseline against which to measure the effects of the proposed project and any alternative actions—and then the environmental effects of the proposed projects, including the proposed measures discussed in section 2.2.3, *Proposed Environmental Measures*. Unless otherwise identified, the sources of our information are the license applications for the projects (York Haven Power, 2012a; Exelon, 2012a and 2012b) and the Settlement Agreement (January 30, 2014). We provide citations for information obtained from other sources. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative*.

3.1 GENERAL DESCRIPTION OF THE RIVER BASIN

The Susquehanna River originates near Cooperstown, New York, at Otsego Lake, and flows for about 444 miles to the Chesapeake Bay at Havre de Grace, Maryland (SRBC, 2008a). The drainage area of the Susquehanna River encompasses portions of New York, Pennsylvania, and Maryland and covers 27,510 square miles. The Susquehanna River Basin can be divided into six major subbasins: the Upper Susquehanna, Chemung, West Branch Susquehanna, Middle Susquehanna, Juniata, and Lower Susquehanna (see figure 1-1).

The Susquehanna River Projects are located in the Lower Susquehanna River subbasin. The lower Susquehanna River subbasin contains ridges spanning southwest to northeast and valleys of moderate width. The river cuts through these ridges in a perpendicular direction and widens as it flows south to southeast through hills and valleys. The southern portion of the Lower Susquehanna River subbasin consists of carved deep gorges in the narrowing river valley, and it is the most developed and suited for hydropower development because of the steep river slope.

The York Haven Project is located at RM 55 on the mainstem of the Susquehanna River, about 17 miles downstream from the city of Harrisburg, Pennsylvania. The upper reservoir of the Muddy Run Project is located on Muddy Run, a tributary (at RM 22) of the Susquehanna River, and the drainage area above the Muddy Run dam is

9.2 square miles. The Muddy Run Project uses Conowingo Pond as its lower reservoir. The Conowingo Project is at RM 10 of the Susquehanna River, in Maryland.[36]

The major tributaries to the Lower Susquehanna River subbasin are the Conestoga River and Conodoguinet, Swatara, Conewago, and Penn's creeks (see figures 2-1, 2-2, and 2-3). Muddy Creek is a major tributary to Conowingo Pond. Smaller named tributaries to Conowingo Pond include Conowingo Creek, Broad Creek, Hanes Branch, Michaels Run, Peters Creek, Barnes Run, Fishing Creek, Wissler's Run, and Muddy Run. Numerous unnamed tributaries also discharge to Conowingo Pond. The major tributaries of the Conowingo Project below Conowingo dam are Octoraro Creek and Deer Creek.

Climatic conditions vary within the Lower Susquehanna River subbasin. The Ridge and Valley physiographic province in the northwest part of the subbasin experiences a humid continental climate with large seasonal temperature variations. This contrasts to the more coastal-type climate experienced in the Piedmont physiographic province in the southeastern part of the subbasin where temperatures are more moderate and precipitation is slightly greater. The average annual precipitation in the Susquehanna River Basin is 39.15 inches per year and is distributed fairly evenly throughout the year; however, long-term records indicate wet and dry periods, and droughts have been fairly common, at times threatening groundwater supplies. During the 1990s through the mid-2000s, droughts have occurred in 8 of 16 years (SRBC, 2013). The annual average temperature ranges from 53°F at the Maryland-Pennsylvania border to 45°F in the upper Susquehanna River Basin.

3.2 CUMULATIVELY AFFECTED RESOURCES

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (50 CFR §1508.7), an action may cause cumulative impacts on the environment if its impacts overlap in space or time with the impacts of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time, including hydropower and other land and water development activities.

Based on information in the license applications, agency comments, other filings related to the projects, and preliminary staff analysis, we identified the following resources that have the potential, in combination with other activities, to be cumulatively

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[36] The Safe Harbor Project (FERC No. 1025) and the Holtwood Project (FERC No. 1881) are located downstream of the York Haven Project at RM 32.2 and RM 24.6, respectively. The licenses for these two projects expire on April 22, 2030 (Safe Harbor), and August 31, 2030 (Holtwood). Table 3-1 contains further information about these two projects.

affected by the continued operation of the Susquehanna River Projects: water quantity, water quality, migratory fisheries, and Chesapeake Bay habitat. We chose these resources because operation of the York Haven, Muddy Run, and Conowingo projects, in combination with other hydroelectric projects on the river, regulate river flows and in turn may affect water quality. In addition, along with the other hydroelectric projects on the river, all three projects affect migratory fish migration throughout the lower Susquehanna River. All four mainstem dams (York Haven, Safe Harbor, Holtwood, and Conowingo) have fish passage facilities, but each one provides a different level of effectiveness. Finally, flow regulation from Conowingo and the other hydroelectric projects affects aquatic habitat downstream to the upper Chesapeake Bay.

3.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effects on the resources. Because the proposed action would affect resources differently, the geographic scope for each resource may vary. For the four identified resources, we identified the geographic scope as extending from Harrisburg, Pennsylvania, located upstream of the York Haven Project, downstream to the mouth of the Susquehanna River at Chesapeake Bay. We chose the above geographic bounds because the effects of proposed project operation and potential environmental measures on the identified resources, in combination with other activities in the basin, are limited to these areas. Flows and water quality are not affected by the York Haven Project, in concert with other water uses, once upstream of the influence of the York Haven reservoir. Migratory fishes are affected by the five lower river hydroelectric projects (including Muddy Run Project), but once migratory fishes reach upstream of the influence of the York Haven reservoir, any effects experienced from other dams on the river (low head, non-hydroelectric dams are located at Harrisburg and farther upstream in Sunbury, Pennsylvania) are unrelated to lower river hydroelectric operation. Upper Chesapeake Bay habitat may be affected by operation of the lower river projects, but those effects generally do not extend downstream of the mouth of the river. The river becomes tidal about 5 miles downstream of the dam, and an additional 5 miles of tidal river from this point to the mouth of the river tends to dampen any effects of the projects.

3.2.2 Temporal Scope

The temporal scope of our cumulative analysis in the EIS will include a discussion of past, present, and future actions and their effects on each resource that could be cumulatively affected. Based on the terms of the new licenses, the temporal scope will look 30 to 50 years into the future, concentrating on the effects on the resources from reasonably foreseeable future actions. The historical discussion will, by necessity, be limited by the amount of available information for each resource.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

This section outlines the proposed action and the action alternatives with regard to: (1) geology and soils, (2) water resources, (3) terrestrial resources, (4) threatened and endangered species, (5) recreation and land use, (6) cultural resources, (7) aesthetics, and (8) socioeconomics.

3.3.1 Geology and Soils

3.3.1.1 Affected Environment

Geology

The Susquehanna River Basin is located within the Appalachian Highlands physiographic region, and the Susquehanna River Projects are located within the Piedmont Province of this region, which is dominated by rolling lowlands, broad highlands, and ridges. Rock types consist predominantly of red shale, siltstone, sandstone, and some conglomerate that formed in the Jurassic and Triassic periods. Upland terraces of river-transported material occur at various elevations above the present river channel.

The York Haven Project is located within the Gettysburg-Newark Lowland Section within the Piedmont Province. The project's main dam is bounded by diabase, a hard igneous rock. The geology of the remaining project area consists mostly of shale.

Both the Muddy Run and Conowingo projects are within the Piedmont Upland Section of the Piedmont Province and are underlain by igneous and metamorphic rocks. The bedrock islands along the Susquehanna River below Holtwood dam (known as the Holtwood Gorge) are recognized as an outstanding geologic feature of Pennsylvania. Specifically, the Pennsylvania Department of Conservation and Natural Resources (Pennsylvania DCNR) considers the potholes and cliffs along the gorge as heritage geology sites called erosional remnants.

Prior to construction of Conowingo dam, the river in the current impoundment reach and below the dam was a bedrock channel that was difficult-to-navigate for boats. Preconstruction maps show two sets of falls upstream of the current Conowingo dam (Hector's Falls and Amos's Falls), although they were essentially a series of rapids where the river profile was steeper than in nearby reaches.

Soils

Surficial geologic sediments form a mantle of predominantly unconsolidated weathered bedrock, river-transported sediment (alluvium), and gravity-transported material (colluvium). Soils are predominantly non-hydric. Some hydric soils exist mainly along tributaries.

Shoreline Erosion

Shoreline erosion as a result of fluctuations in the impoundment elevation is relatively minor at the York Haven Project because it is operated as a run-of-river facility. Erosion occurs from natural causes (flood flows, storm waves, runoff, freeze/thaw action, ice scour) and from recreational usage (boat wakes, foot traffic along the shore). Erosion rates are not available but are expected to be small and typical for a river in this type of setting, with large floods being the primary erosion driver.

The Muddy Run Project upper reservoir shoreline consists largely of a wide and gently sloping non-vegetated zone that is alternately exposed and inundated. The zone contains unweathered bedrock covered with fragmented weathered bedrock, colluvium, and alluvium. It is crossed by gullies, rills, and sheet flow features formed by runoff from the surrounding riparian areas or by groundwater seeps. Parts of the excavated intake canal consist of near-vertical walls of exposed bedrock.

There are three locations with high and moderate erosion along the upper reservoir shoreline: weathered bedrock is eroded along the intake canal embankment near the east side of the River Road crossing; gully erosion has created deep crevasses in a steep channel downstream of the Recreation Lake spillway; and, on the northside of the finger-shaped cove to the south of the recreation dam, a top-of-bank erosion scarp face in soils developed from the underlying bedrock. Exelon is monitoring erosion at these locations regularly and is prepared to mitigate adverse effects as needed. There is minimal to no erosion along the remainder of the shoreline with the exception of a 300-foot-long location with moderate erosion (i.e., signs of slumping without adverse effects on resources) in the northeastern corner of the upper reservoir.

The shorelines around Conowingo Pond and below Conowingo dam consist largely of bedrock, unconsolidated natural materials (alluvium, colluvium), and disturbed/artificial materials (e.g., walls, fill, rail embankment, and canal tow path berm). Low to moderate erosion has been observed along unconsolidated shorelines. Instances of high erosion rates have not been observed to encroach on infrastructure. Shoreline erosion along tributaries is also considered low to moderate. Shoreline accretion occurs at the downstream ends of existing islands in the Conowingo Pond and at or near tributary mouths. Deposits are eventually stabilized by natural vegetation growth.

Sediment Transport

The Susquehanna River is the largest tributary to Chesapeake Bay and consequently contributes the largest sediment load (i.e., 25 percent of the load from non-tidal sources; Langland, 2009). The sediment loading is largely a function of flow, but is affected by the trapping ability of the lower Susquehanna River reservoirs.

As a result of the run-of-river operation and small reservoir (Lake Frederic), the York Haven Project has little control over sediment accumulation in the impoundment. However, given its shallow depth of less than 18 feet (with a mean depth of 6 feet),

sediment that may accumulate in the impoundment during low-flow periods is likely flushed out to a large extent during high-flow events.

The Muddy Run Project in essence does not contribute to sediment loading in the Susquehanna River because it is an off-stream reservoir. Instead, a fraction of the suspended sediment contained in the Susquehanna River water that is regularly pumped into the Muddy Run reservoir is expected to settle out of the water column. Net sediment deposition rates in the reservoir are not available.

USGS assessed the potential sediment trapping capacity of the lower Susquehanna River reservoirs and potential effects on Chesapeake Bay (Langland, 2009). Of the three lower river reservoirs—Lake Clarke (Safe Harbor Project), Lake Aldred (Holtwood Project), and Conowingo Pond (Conowingo Project)—USGS estimated that only Conowingo Pond has any sediment trapping capacity remaining (figure 3-1). Both Lake Clarke and Lake Aldred have been in long-term equilibrium for 50 years or more, with the amount of sediment exiting the reservoirs equal to the amount of sediment entering the reservoirs. USGS estimates that the sediment trapping capacity of the upper and middle parts of Conowingo Pond is minimal and that the only remaining capacity is in the lower part of the reservoir. In 2008, an estimated 174 million tons of sediment were stored in the reservoir; the reservoir's remaining storage capacity is about 30 million tons. The volume of sediment entering Conowingo Pond is estimated at 3 million tons/year, of which about two thirds (2 million tons/year) is currently being trapped by the reservoir (Langland, 2009). The suspended sediment loads carried past Conowingo dam into Chesapeake Bay are on average 1.1 million tons per year, although the amount varies widely, ranging in recent years from 0.3 million ton per year in 2001 to 3.5 million tons per year in 1993 (a very wet year).

Sediment trapping will continue until the storage capacity of Conowingo Pond is reached, which is projected to occur by 2023 to 2028 (i.e., 15 to 20 years after the 2008 bathymetric survey). However, the sediment trapping efficiency can be highly variable, depending on rainfall and river flows, reduced sediment loading from the watershed due to source control measures, and frequency and magnitude of scour removal events. For example, a 20 percent reduction in sediment loading to the river from the watershed could extend that period by another 5 to 10 years (i.e., up to year 2038; Langland, 2009). Once Conowingo Pond reaches the sediment trapping capacity, sediment loads delivered to the Chesapeake Bay via the Susquehanna River would equal the load delivered into the head of the three reservoirs (Lake Clarke), resulting in a load increase relative to current conditions.

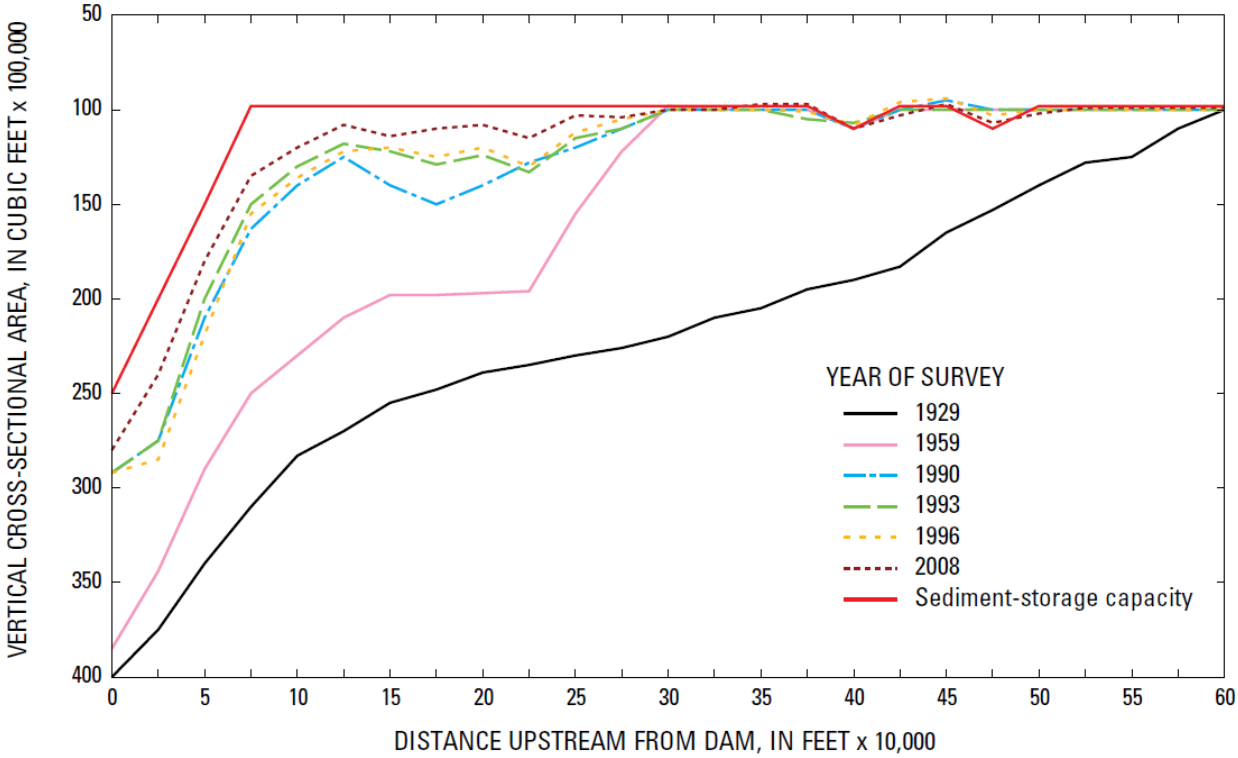


Figure 3-1. Changes in vertical cross-sectional area for selected years and remaining sediment-storage capacity in Conowingo Pond (Source: Langland, 2009).

Sediment transport processes in the lower Susquehanna River are strongly affected by discharge rates. The river carries high sediment loads during peak flow events. In addition, sediment is mobilized during such events through scour in the lower Susquehanna River reservoirs (Lake Clarke, Lake Aldred, and Conowingo Pond). These peak flow events interrupt periods of gradual sediment accumulation in the reservoirs. Langland (2009) indicated that the threshold for scour in Conowingo Pond occurs at 390,000 cfs. He suggested that tropical storm Agnes, with a peak discharge rate of 1,120,000 cfs, resulted in scour of 20 million tons of sediment from the three reservoirs. However, the *Sediment Introduction and Transport Study* (URS and Gomez and Sullivan, 2012a) prepared for Exelon suggests that a threshold of approximately 400,000 cfs is not adequate to trigger scour in Conowingo Pond. Hirsch (2012) suggested that Conowingo Pond is approaching a long-term equilibrium where the average rate of deposition would equal the average rate of scour; he suggested that the threshold flow rate for scour is now between 175,000 and 300,000 cfs. Zhang et al. (2013) observed increasing flow-normalized loads of suspended sediment at Conowingo dam since the mid-1990s, which supports the gradual filling of the reservoir.

Downstream of Conowingo dam, the streambed consists of a discontinuous surface of exposed bedrock or bedrock with a much thinner alluvial cover than in Conowingo Pond. The streambed is likely in similar condition to the bed prior to dam

construction because the flow in the rapids was strong enough to inhibit sediment deposition.

3.3.1.2 Environmental Effects

Shoreline Erosion

Minor shoreline erosion effects at the York Haven Project would continue to occur as a result of natural forces similar to current conditions, considering that project operation would remain unchanged. York Haven Power does not propose any shoreline erosion control measures.

In preparation for the construction of the nature-like fishway, York Haven Power proposes to develop an erosion and sediment control plan and apply to Pennsylvania DEP for a National Pollutant Discharge and Elimination System (NPDES) permit for stormwater discharge associated with construction activities, as specified in the explanatory statement filed with the Settlement Agreement. York Haven Power would also map usable rocks and boulders downstream of the dam to be used for the construction of the fishway. Construction would occur during three low-flow seasons. Rocks and boulders retrieved from the river would be stored in designated staging areas until fishway construction begins.

Shoreline erosion due to upper reservoir level fluctuations at the Muddy Run Project, combined with occasional natural overflows over the Recreation Lake spillway after rain events, surface runoff, mass-wasting, and wind induced waves, is considered minimal with the exception of three locations. Specifically, as described above, weathered bedrock is eroded along the intake canal embankment, gully erosion has created crevasses downstream of the Recreation Lake spillway, and a top-of-bank scarp face formed along the shoreline of the finger-shaped cove to the south of the recreation dam. Aside from regular monitoring for erosion at these locations, Exelon plans to implement an SMP that would allow modifications to shoreline vegetation to construct erosion control measures, provided the modifications do not impair the overall function of the vegetated buffer. Trees and shrubs on steep slopes will be maintained whenever possible.

Shoreline erosion within Conowingo Pond and downstream of the Conowingo Project dam is minor and largely caused by natural processes. Project-induced erosion effects are not discernible from natural effects. As part of its SMP measures, Exelon proposes to adopt BMPs for controlling sediment introduction from lands within the project boundary (see further discussion in section 3.3.5, *Recreation and Land Use Resources*). Proposed erosion control measures include monitoring and remediation of identified and characterized erosion-prone areas.

Our Analysis

Shoreline erosion from the continued operation of the York Haven Project would be minor. For construction of the nature-like fishway, any effects would be minimal with the proper implementation of York Haven's proposed erosion and sediment control plan. In addition, the number of rocks and boulders required for the construction of the fishway would be small relative to the size of the river and the area where the rocks and boulders would be harvested; furthermore, these rocks and boulders would essentially remain part of the riverbed, although placed in a different location (i.e., within the course of the nature-like fishway).

Overall, shoreline erosion effects from the operation of the Muddy Run Project would also be minor. We find that regular monitoring and mitigation (if needed) of the active erosion locations along with the implementation of the SMP would provide adequate measures to control erosion at the upper reservoir.

Shoreline erosion effects in the Conowingo Project area are largely a function of natural high-flow events, wave scour, and mass-wasting processes. Minor shoreline erosion, and deposition of eroded shoreline sediment in the reservoir, is expected to continue at similar rates as at present, considering that there are no significant changes to project operation. We find that the SMP includes adequate measures to address erosion control issues in the reservoir.

Sediment Transport

York Haven Project Area

The small size and shallow depth of the project reservoir, along with the project's run-of-river operation, minimally affects sediment transport in the river. Sediment that settles in the reservoir during low-flow periods would be remobilized during high-flow events and transported downstream of the dam. York Haven Power is not proposing any measures related to sediment transport. The proposed flow redistribution across the dam after the proposed new fish passage facility is in place would not affect overall sediment transport through the project area.

Muddy Run Project Area

As a pumped storage facility, Muddy Run Project operation would not affect sediment loading and transport processes in the Susquehanna River. Sediment suspended in the water that is pumped into the upper reservoir would largely remain in suspension and be returned to the river during power generation. A small fraction of the suspended sediment would settle in the reservoir. The amount of sediment eroded from the upper reservoir shoreline and added to the water column would be minimal.

The certification for the Muddy Run Project requires Exelon to pay a total of $500,000 per year of "compensatory mitigation" from 2014 to 2030, to the Lancaster County Conservation District, the York County Conservation District, and the

Pennsylvania FBC, or to such other conservation district, resource agency, or 501(c)(3) organization as directed by Pennsylvania DEP, for the implementation of agricultural pasture and barnyard BMPs to address sediment loading to the Susquehanna River and other habitat improvement projects including small dam removals.

Conowingo Project Area

As stated above, sediment trapping in Conowingo Pond would continue until its storage capacity is reached sometime between 2023 and 2038. Thereafter, the full sediment and nutrient load carried by the river would pass through the reservoir to Chesapeake Bay.

The U.S. Army Corps of Engineers (Corps) is currently assessing the lower Susquehanna River watershed to identify strategies for reducing sediment loading and habitat restoration in the river and in Chesapeake Bay (LSRWA, 2014a). The study includes a review of existing data and watershed-level modeling to characterize the complex relationship among river flow, sediment loading, and ecological resources. Project partners include Maryland DOE, Maryland DNR, SRBC, USGS, Chesapeake Bay Program, and The Nature Conservancy. The study, which is expected to be completed in the fall of 2014, will include an assessment of the role of scour in the reservoirs and evaluate appropriate sediment management strategies to address the effects of future scour events. Management options considered by the study could include dredging, modifying dam operation, and sediment bypass strategies. Exelon is cooperating with the Corps' Lower Susquehanna River Watershed Assessment (LSRWA) study.

Several agencies and organizations comment that the findings of the Corps' study should be available before the Commission completes its National Environmental Policy Act analysis for project relicensing. These entities include the U.S. Environmental Protection Agency (EPA); Maryland DNR; SRBC; NMFS; Chesapeake Bay Foundation; Stewards of the Lower Susquehanna, Inc.; Midshore Riverkeeper's Conservancy, Inc.; and the Clean Chesapeake Coalition. The commenters state that Exelon's proposed management plans are not ready for analysis without an understanding of the sediment-related effects of scour in Conowingo Pond during peak flow events on the water quality and living resources in Chesapeake Bay.

The Stewards of the Lower Susquehanna, Inc., also recommend that Exelon remove at least 4 million tons of sediment annually from the reservoir to eventually remove all sediment subject to scouring. The Clean Chesapeake Coalition requests that Exelon be required to dredge Conowingo Pond and restore oyster beds north of the Bay Bridge and submerged aquatic vegetation (SAV) in the upper Bay and its tributaries that were buried by sediment scoured from Conowingo Pond. The Town of Port Deposit, American Rivers, and Henry Immanuel also recommend that Exelon prevent and mitigate for the downstream effects of scoured sediments. Maryland DNR notes, however, that it is premature to conclude that the Corps' LSRWA study will be adequate to appropriately identify and evaluate sediment and nutrient effects on the Bay's resources related to the Conowingo Project.

The Nature Conservancy comments that the elimination of coarse-grained sediments (sand, gravel, and cobble) via storage in Conowingo Pond, and turbulence and high velocities resulting from hydropower operation at the Conowingo Project, adversely affect the amount of lower river habitat available to fish species, such as American shad, river herring, shortnose and Atlantic sturgeon, map turtle, and freshwater mussels, as well as SAV. The Nature Conservancy and American Rivers recommend developing alternatives to mitigate the effects of continued operation on living resources.

Exelon responds that its operation does not increase the volume of sediment discharged into Chesapeake Bay and that sediment and nutrients are almost entirely introduced to the river during runoff from the watershed, which is outside of Exelon's control. Therefore, Exelon states that it should not be required to mitigate any potentially resulting effects and, in fact, Conowingo Pond has been functioning as a BMP preventing sediment and nutrients from being transported to the Chesapeake Bay.

Exelon proposes to conduct a bathymetric survey every 5 years to monitor sediment transport and deposition patterns in Conowingo Pond. In addition, as part of its Sediment Management Plan, Exelon would control sediment runoff from project lands and identify action benchmarks and thresholds at the powerhouse intakes to address sedimentation-related issues that might affect project operation. Exelon states that sediment going through the turbine typically does not damage the runner, although it might cause slight wear of the shaft packing and wicket gate end bushings. The turbines would be inspected regularly for signs of abrasion, which would be a benchmark for considering sediment removal.

Exelon is further evaluating potential management actions (e.g., hydraulic or mechanical dredging) to improve recreational boat access to three recreation areas where sediment has been accumulating around the boat launches (Conowingo Creek, Peach Bottom Marina, and Broad Creek; see further discussion in section 3.3.5, *Recreation and Land Use Resources*).

Our Analysis

The York Haven Project minimally affects sediment loading. Sediment accumulated in the reservoir during low-flow periods is remobilized during high-flow events, slightly increasing the suspended sediment concentration and the bedload carried by the river at those times. The increase is relatively small due to the shallow depth and limited storage capacity of the reservoir and we would not expect the continued run-of-river operation with the 1.1-foot fluctuation to change the existing minimal contribution to sediment loading in the river.

The Muddy Run Project has a negligible effect on sediment transport processes in the Susquehanna River and sediment loading to Chesapeake Bay. The "compensatory mitigation" requirement of the draft certification does not specifically state what the mitigation is compensating for. Funds would be used for BMPs to reduce sediment loading to the river and for habitat improvement, including dam removal. This

requirement appears not to be related to any specific project effect, or would not necessarily be implemented in the project area. The specific projects that would be funded are not identified, and we have no basis for evaluating the benefits of any such measures and if they are related in any way to the Conowingo Project.

Sediment transport issues for the Conowingo Project are more complex. Nearly all sediment entering Conowingo Pond is contributed by the river's upstream watershed; contributions from project lands are minimal. Conowingo Pond may be filled sometime between 2023 and 2038 and then would reach a state of dynamic equilibrium in which the net change in sedimentation (deposition during low flows and scour during floods) would remain relatively constant. At that time, on a long-term basis, the full sediment load carried by the river would be transported into Chesapeake Bay, as would have occurred prior to construction of the lower Susquehanna River reservoirs. High-flow events would carry suspended sediment from the river's watershed, as well as sediment scoured from the three lower river reservoirs (Lake Clarke, Lake Aldred, and Conowingo Pond). Some of the sediment during high-flow events is currently still being redeposited within the remaining storage space in the lower part of Conowingo Pond. Once that space is filled, generally all scoured sediment would be carried past the dam. The relative contribution of scoured sediment within the total volume of sediment passing the dam would vary substantially, as it is a function of factors such as peak flow discharge, duration of the high-flow event, and length of time between high-flow events when sediment could accumulate in the reservoirs. USGS estimated that the scoured sediment load within the total river sediment load below Conowingo dam during 10-year, 25-year, and 80-year recurrence flow events would be 22, 25, and 43 percent, respectively (Langland, 2013), although these preliminary estimates may be modified in the Corps' final study report.

At steady state, areas immediately upstream of the dam would remain turbulent with high velocities and inhibit sediment deposition. However, over time, this zone of turbulence near the dam could narrow, and there is potential for sediment accumulation near the intakes that could affect hydropower operation. As sediment builds up near the intakes, sediment-laden water could damage turbines and other hydropower components due to increased abrasion (Neopane, 2011). Benchmarks established under Exelon's Sediment Management Plan should help identify appropriate actions to allow for continued operation of the project.

Sand and gravel would continue to be trapped by the three lower Susquehanna River reservoirs. However, grain size data show that, as the storage capacity is decreasing, the grain size of the bottom sediments in Conowingo Pond has become increasingly sandy (Langland, 2013). Once Conowingo Pond has reached its storage capacity, more sand is expected to reach the Susquehanna River below the dam, as mobilized from the pond during high-flow events. The substrate below Conowingo dam consists mainly of bedrock, with some boulders, cobbles, and areas of finer sediments. Flow conditions in the river are naturally turbulent with high velocities, inhibiting deposition until the change in gradient near the mouth of Deer Creek, about 4 miles

downstream from the dam. The river substrate in this reach was likely similar to today's conditions prior to the construction of Conowingo dam, with areas of localized sediment inflows from tributaries. Therefore, high-velocity turbulent flow conditions in the river below the dam would eventually transport the sand and gravel that bypass the Conowingo dam toward Chesapeake Bay.

The Nature Conservancy expressed concern about the effect on downstream habitat of interception of coarser grained sediment (sand, gravel, and cobble) by Conowingo Pond. We find that any attempt to mitigate that effect by placement of coarser grained sediments downstream of the dam would likely have limited success because of high velocities and turbulence that would transport those materials farther downstream and away from areas where habitat enhancement was targeted.

Once the river enters Chesapeake Bay, and flow velocities and thus the sediment carrying capacity of the water decreases, the coarser grained scoured sediments settle out of the water column first in the northern part of the Bay. Finer grained particles remain suspended in the water column longer and are transported further to the south in the Bay. This was observed after Hurricane Lee when sands were deposited on the Susquehanna Flats, and finer grained sediments were distributed more widely in the Bay (Cheng et al., 2013).

The lower Susquehanna River and Chesapeake Bay are affected by sediment transport (including sediment scoured from Conowingo Pond). On December 29, 2010, EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL) for sediment, nitrogen, and phosphorus, with rigorous accountability measures to restore water quality in the Bay (EPA, 2013). This TMDL considered the loading of the Bay after the storage capacity in the lower Susquehanna River reservoirs has been reached. The current TMDL incorporated an estimated current trapping efficiency of Conowingo Pond of 55 percent for sediment, 2 percent for nitrogen, and 40 percent for phosphorus (see additional discussion in section 3.3.2, *Water Resources*). The TMDL will be implemented in phases with an interim target allocation of 60 percent total load reductions by 2017, and 100 percent by 2025. EPA will assess a state's progress toward meeting TMDL goals every 2 years.

EPA assumed that the current trapping capacity will continue through the TMDL planning horizon of year 2025. If future monitoring shows a reduction in trapping capacity, EPA would adjust the milestone loads for upland jurisdictions. These jurisdictions might need to increase their sediment-reduction efforts to accommodate the loss of trapping capacity in Conowingo Pond. EPA does not expect that changes in the sediment-trapping efficiency capacity would alter the amount of sediment that the Bay is able to assimilate and, therefore, the allocations in the Chesapeake Bay TMDL are expected to remain unchanged.

The ongoing LSRWA (LSRWA, 2014) is evaluating a number of sediment management alternatives to reduce the volume of sediment scoured from the three lower Susquehanna River reservoirs during peak flows. These sediment management

alternatives include reduction of sediment loading from the watershed, dredging of the three reservoirs combined with various dredged sediment transport and placement scenarios, agitation dredging and sluicing past Conowingo dam, a sediment bypass tunnel to Conowingo dam, and reservoir operational strategies. A representative from SRBC reviewed the operational sediment management strategies of the three lower Susquehanna River reservoirs during the LSRWA quarterly meeting on May 13, 2013 (LSRWA, 2013a). He concluded that retrofitting the existing dams with sluice gates or other bottom outlet works would be difficult and could compromise the dams' structural integrity. He further concluded that, aside from structural constraints, the cumulative effect of competing water uses and operational limitations make reservoir operational alternatives infeasible, and the significant implementation costs would not be justified by only limited spatial and volumetric effects on sediment movement. He summarized that these factors warrant dropping the reservoir operational alternatives from further consideration.

Dredging the sediment load entering the reservoirs annually would be challenging and complicated by the effects on other resources in the reservoirs (water quality, fisheries, and recreational use) and the need for suitable locations for placing large volume of sediment, year after year. Exelon estimated dredging costs of about $50 million per year just to keep up with the annual sediment load of about 3 million tons entering Conowingo Pond. However, the final dredging costs would depend significantly on a wide range of factors including dredging approach, dewatering of dredged sediments, placement locations, and constraints due to contaminants in the sediment (e.g., LSRWA, 2013b).

Other management scenarios considered in the LSRWA study, such as agitation dredging and a bypass tunnel, would in essence move sediment accumulated in the Conowingo Pond in advance of high-flow events. These scenarios would maintain the total annual sediment load entering Chesapeake Bay, although the added volume of scoured sediment in the total transported sediment load during high-flow events would be reduced. Instead, sediment loading would be spread out more evenly throughout the year with the intent to meet the TMDL in the Bay.

Based on currently available information, we find that changes in Conowingo Project structures and operation are not viable solutions to the sediment transport issue at this time. We consider it premature to conclude that dredging of Conowingo Pond would be an environmentally acceptable solution. Exelon's proposal and other entities' recommendations to use the Corps' regional study as a basis for additional analysis of this issue are reasonable. The Corps' study would provide a better understanding of sediment deposition and transport processes in Conowingo Pond, and help establish necessary benchmarks for potential actions (e.g., prediction of sediment deposition near the intakes that could impede project operation). Exelon's proposed bathymetric surveys in Conowingo Pond at 5-year intervals would allow for verification of model predictions and identify appropriate management actions ahead of time. The current schedule calls for the Corps' study to be completed in September 2014. If the study is completed on

schedule, the results of that study would be available for analysis in the final EIS. However, the ultimate resolution of this issue would require more than singular actions at the Conowingo Project, and instead would require a basin-wide approach involving many governmental jurisdictions and other entities.

3.3.1.3 Cumulative Effects

For the York Haven and Muddy Run projects, shoreline erosion in the reservoirs is minimal and the amount of sediment added to the Susquehanna River system would not contribute to cumulative effects in the river.

Conowingo Pond would continue to trap coarser grained sediment, until the sediment storage capacity of the reservoir is reached. At that time, the total contribution to the sediment load entering Chesapeake Bay would increase by approximately 2 million tons annually compared to current conditions. However, the Chesapeake Bay TMDL is designed to mitigate the effects from this increased sediment loading to the Bay by requiring specific load reductions from the seven jurisdictions within the Bay's 64,000-square-mile watershed. Regular dredging of Conowingo Pond and placement of the dredged material offsite, if deemed feasible, might reduce these load reduction requirements for jurisdictions to some extent, although, as recognized by the TMDL, the long-term solution would require a basin-wide approach.

3.3.2 Water Resources

3.3.2.1 Affected Environment

The Susquehanna River Projects affect water resources within the lower 60 miles of the mainstem of the Susquehanna River.

Water Quantity

The Susquehanna River drains portions of western and central New York State, a large portion of Pennsylvania, and a small part of Maryland. Five hydroelectric projects on the lower Susquehanna River use flow from the river and its tributaries to generate electricity (table 3-1). No large mainstem reservoirs or hydropower projects are located on the Susquehanna River upstream of the York Haven Project, although there are Corps' flood control projects on several tributaries (see figure 1-1).

Table 3-1. Hydroelectric projects on the lower Susquehanna River (Source: York Haven Power, 2012; Exelon, 2012a, 2012b; FERC, 2008).

Project	River Mile	Generating Capacity (MW)	Maximum Plant Discharge (cfs)	Drainage Area (sqm)	Reservoir Surface Area (acres)	Usable Storage (acre-feet)
York Haven	55	19.62	17,000	24,973	2,218	1,700
Safe Harbor	32.2	417	113,000	26,117	7,360	68,870[a]
Holtwood	24.6	195.5	62,100	26,794	2,400	15,224[b]
Muddy Run	22	800.25	32,000	9.2	892	33,894
Conowingo	10	574.54	85,000	27,100	9,000	71,000

[a] Storage volume is based on the upper 17 feet, although actual drawdowns are much less.

[b] Between elevation 163.5 feet and the top of the flashboards/rubber dam at elevation 169.75 feet.

York Haven Project

Table 3-2 shows monthly flow statistics for the Susquehanna River at York Haven Project, based on flows at the Marietta USGS gage, about 10 miles downstream from the York Haven Project (figure 3-2). Monthly flows are generally highest in March and April and lowest in July, August, and September. The range of monthly flows observed at the Marietta gage is substantial, from a low of 2,066 cfs to a high of nearly 1 million cfs (Hurricane Agnes).

Table 3-2. Prorated flows at York Haven Project based on monthly flow data from USGS gage no. 01576000 Susquehanna River at Marietta, Pennsylvania, for October 1, 1967, to September 30, 2009 (Source: USGS, 2013, as modified by Staff).

Month	Mean	Median	Maximum	Minimum	10% Exceedance	90% Exceedance
Jan	41,560	25,943	534,243	4,036	90,312	11,636
Feb	47,042	30,940	428,548	6,342	98,970	14,413
Mar	70,392	54,001	426,626	8,648	134,522	23,263
Apr	73,049	58,325	414,135	16,815	140,383	27,260
May	44,318	35,552	214,274	11,050	77,811	17,872
Jun	32,006	21,572	999,304	4,641	52,954	10,570
Jul	18,278	13,356	214,274	3,565	33,707	6,458
Aug	13,467	9,196	191,213	2,527	24,983	4,892
Sep	16,977	8,316	523,674	2,066	30,757	4,256
Oct	21,599	10,762	236,374	3,430	49,446	5,150
Nov	33,162	25,223	254,630	4,314	65,772	7,625
Dec	46,623	35,552	334,383	4,910	92,243	15,480
Annual	38,133	24,694	999,304	2,066	83,115	6,774

Note: Data from USGS gage no. 01576000 about 10 miles downstream from the York Haven Project were prorated by 24,973/25,990 to account for the difference in the drainage area between the gage and York Haven dam.

Safe Harbor Project

Water discharged from York Haven dam flows downstream through about 13 miles of riverine habitat to the beginning of the 10-mile-long Lake Clarke, the impoundment of the Safe Harbor Project. The Safe Harbor Project does not have a minimum flow requirement in its license (which expires in 2030), and normal maximum impoundment elevation ranges between 227.2 feet in summer to 228.0 feet in winter. The project is operated to support peak electricity demands and, since 1997, a fish lift has operated at this facility to pass resident and migratory fish upstream during the spring.

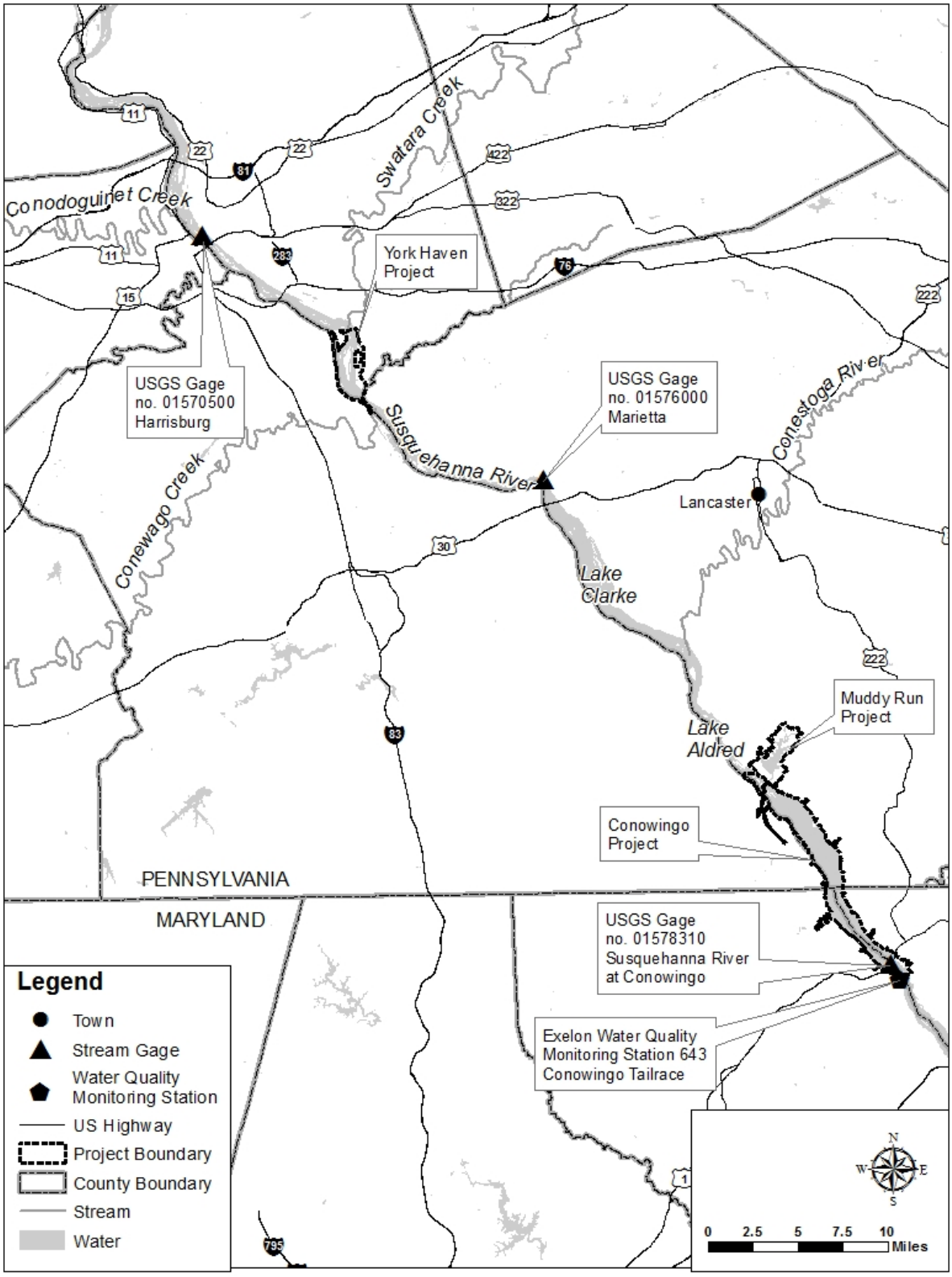


Figure 3-2. Stream gages in the Susquehanna River Projects area (Source: Staff).

Holtwood Project

Water discharged from Safe Harbor dam flows immediately into Lake Aldred, the Holtwood Project impoundment. Holtwood dam is located about 8 river miles downstream of Safe Harbor dam, and full generation from the Safe Harbor Project substantially exceeds the hydraulic capacity of the Holtwood Project, which results in spillage at Holtwood dam and a water surface gradient within Lake Aldred; at lower releases from Safe Harbor the water surface gradient within Lake Aldred is generally flat. The generation capacity of the Holtwood Project was recently upgraded to 195.5 MW with a daily minimum flow of 800 cfs and a flow capacity of about 62,100 cfs. Even after the Holtwood expansion, the Safe Harbor maximum discharge still exceeds the Holtwood capacity by about 40,000 cfs. Lake Aldred is managed to maintain a minimum operating level of elevation 167.5 feet from May 15 through September 15 to support reservoir recreational uses and access. The top of the flashboards at the dam are at elevation 169.75 feet, and the minimum operating level during the balance of the year is elevation 163.5 feet. Leakage through the dam and flow from a 10-inch-diameter pipe through the dam maintain a small, continuous flow in the bypassed reach. The flow rate through the pipe depends on the water surface elevation of Lake Aldred, but PPL estimated it at 11 cfs at maximum normal water elevations. Leakage through the flashboards, which varies based on reservoir elevation and the adequacy of seals between flashboards, ranges between 4 and 40 cfs. When generating units are not operating, leakage through the units maintains about 210 cfs continuous flow in the tailrace (FERC, 2008).

When the Holtwood Project is not generating, the water level in Conowingo Pond, created by Conowingo dam 14.6 miles downstream, normally controls the tailwater elevation below the Holtwood powerhouse. The bypassed reach on the western side of the river is primarily rock ledge interspersed with shallow, interconnected pools with some vegetation and receives flow only during spillage over the dam.

Muddy Run Project

The Muddy Run Project, which is on the east side of the Susquehanna River, uses Conowingo Pond as its lower reservoir. Although there are no USGS gaging stations on Muddy Run, according to Exelon, the average annual flow from Muddy Run to the Muddy Run reservoir is about 7 cfs.

Muddy Run's upper reservoir has a usable storage of 33,894 acre-feet between elevations 470 and 520 feet. Conowingo Pond has an effective storage of about 34,050 acre-feet between elevation 105.2 feet and 109.2 feet, the typical fluctuation range. The Conowingo Project's existing license conditions allow fluctuations between 101.2 and 110.2 feet. The Muddy Run powerhouse turbines have a maximum generating discharge capacity of 32,000 cfs and a maximum pumping capability of 28,000 cfs.

Recreation Lake, which was created by impounding an arm of the Muddy Run reservoir, is maintained at a constant elevation of 520 feet with a surface area of about 100 acres.

Table 3-3 provides the average monthly withdrawal and discharge for 2006 through 2010 and shows that the average daily withdrawals and discharges range from about 11,750 to about 15,100 acre-feet. The monthly numbers in this table indicate that the annual discharge is about 35 acre-feet higher than the withdrawal from Conowingo Pond. Table 3-4 provides the water withdrawal and return characteristics for three 30-day high-flow periods (between March and April) and three 30-day low-flow periods (between August and September). These data show that Muddy Run operation does not substantially vary between low-flow and high-flow periods.

Table 3-3. Muddy Run Project monthly average withdrawals and discharge for 2006 to 2010 (Source: Gomez and Sullivan and Normandeau, 2012b).

Month	**Average Daily Withdrawal (acre-feet)**	**Average Daily Discharge (acre-feet)**
January	13,899	14,074
February	13,825	13,828
March	11,757	11,840
April	11,938	11,754
May	14,381	14,675
June	14,915	15,102
July	14,568	14,206
August	13,571	13,844
September	14,448	14,289
October	14,522	14,451
November	13,227	13,350
December	13,924	13,979

Table 3-4. Summary of daily and hourly Muddy Run Project discharge and withdrawal characteristics for 30-day high- and low-flow periods for 2008 to 2010 (Source: Exelon, 2012a, as modified by Staff).

Flow Period	**Average Flow at the Marietta USGS gage (cfs)**	**Average Daily Withdrawal from Conowingo Pond (acre-feet per day)**	**Average Daily Discharge to Conowingo Pond (acre-feet per day)**	**Maximum Daily Withdrawal from Conowingo Pond (acre-feet per day)**	**Maximum Daily Discharge to Conowingo Pond (acre-feet per day)**	**Maximum Hourly Withdrawal from Conowingo Pond (cfs)**	**Maximum Hourly Discharge to Conowingo Pond (cfs)**
Water Withdrawal and Returns Statistics for 30-Day High-Flow Periods							
Mar 5 - Apr 3, 2008	132,645	28,537	29,028	43,345	46,163	34,274	36,539
Mar 11 - Apr 9, 2009	54,194	17,597	18,378	35,793	39,409	29,410	32,120
Mar 13 - Apr 11, 2010	96,459	19,074	18,801	34,932	36,535	29,484	32,158
Water Withdrawal and Returns Statistics for 30-Day Low-Flow Periods							
Aug 28 - Sep 26, 2008	6,523	28,823	28,087	40,299	41,891	29,187	37,616
Sep 1 - Sep 30, 2009	13,722	25,697	26,381	33,186	47,640	29,187	34,460
Sep 1 - Sep 30, 2010	5,691	26,678	27,060	37,732	49,785	27776	37,022

Conowingo Project

The Conowingo Project is the farthest downstream dam on the Susquehanna River. It is located 10 miles upstream from the Chesapeake Bay and impounds the river about 14 miles upstream to the Holtwood Project, creating a 9,000-acre reservoir that contains 310,000 acre-feet of design storage capacity and 71,000 acre-feet of usable storage. On a daily basis, the Conowingo Project operates on a run-of-river/peaking basis and generates 574.54 MW at full generating capacity. Conowingo dam uses a limited active storage in combination with the operation of the Muddy Run Project to meet peak electrical demand. Two fish lifts at this facility (east and west) seasonally pass resident and migratory fish upstream.

Conowingo Pond serves as the source of cooling water for the 2,186-MW PBAPS, about 7 miles upstream of Conowingo dam, which has a maximum withdrawal capacity of 3,450 cfs. The York Energy Center is permitted to withdraw up to 20 cfs for cooling water. The pond is also a public water supply source for the city of Baltimore, Harford County (Maryland), and the Chester (Pennsylvania) Water Authority. The permitted range of water level fluctuation in the impoundment is 9 feet, from elevation 101.2 to 110.2 feet (figure 3-3). Exelon states that, although 9 feet of fluctuation is permitted, the current operating regime typically restricts fluctuations to about 4.5 feet (between elevation 104.7 to 110.2 feet) to minimize the potential for intake difficulties at PBAPS and cavitation within the Muddy Run turbines. During summer weekends, the impoundment water level is maintained at elevation 107.2 feet to provide a water level suitable for summertime recreational use. Critical water level elevations for Conowingo Pond include the following:

- 107.2 feet: The pond must be maintained at this elevation on weekends between Memorial Day and Labor Day to meet recreational needs;
- 104.7 feet: Below this level, Muddy Run cannot operate its pumps due to cavitation;
- 104.2 feet: PBAPS begins experiencing cooling water problems when the elevation of the pool drops to this level;
- 100.5 feet: Below this elevation, the Chester Water Authority is unable to withdraw water from the pond;
- 99.2 feet: The Nuclear Regulatory Commission license for PBAPS requires the plant to shut down completely at this water level;
- 98.0 feet: The York Energy Center cannot withdraw water below this elevation; and
- 91.5 feet: The city of Baltimore cannot withdraw water from the pond below this water elevation.

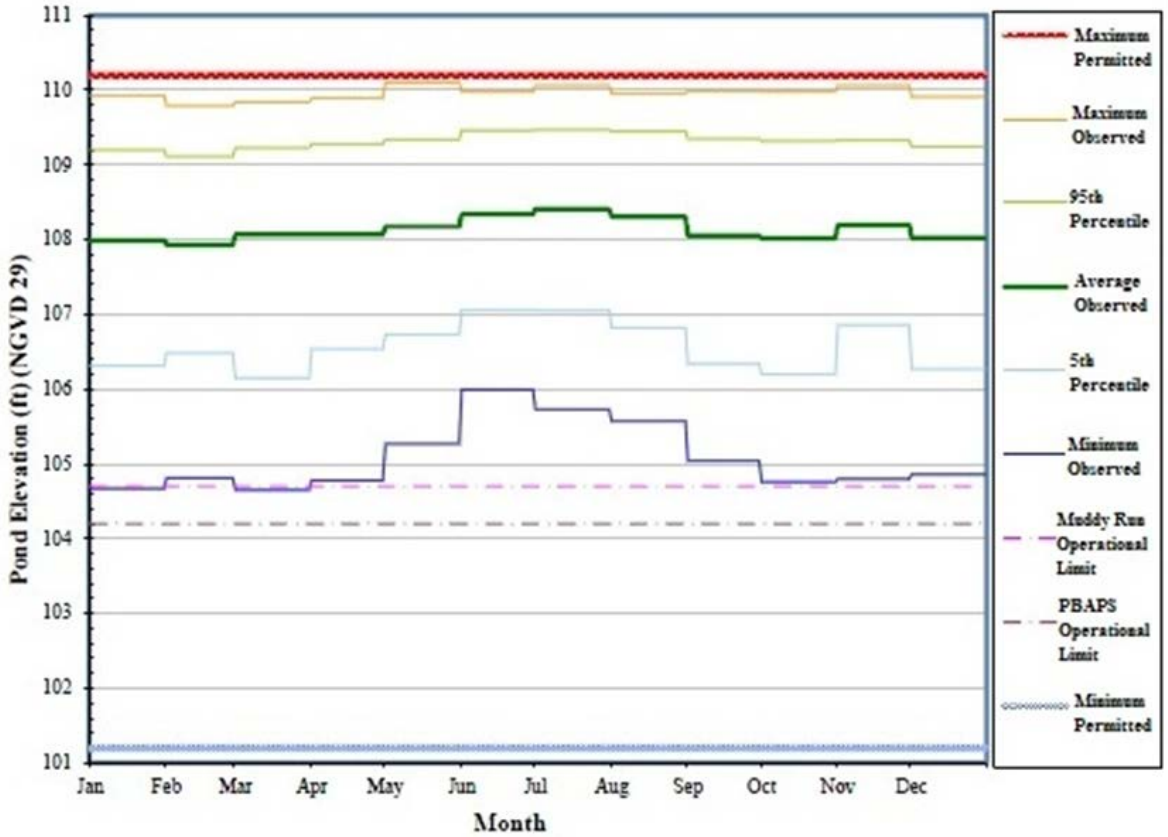


Figure 3-3. Conowingo monthly pond elevations, January 2004 through December 2010 (Source: URS and Gomez and Sullivan, 2012b).

A minimum flow regime was established in a Settlement Agreement in 1989 between Exelon and several federal and state resource agencies. The Settlement Agreement specifies that the flows represent turbine releases and exclude gate leakage. Table 3-5 shows the 1989 negotiated minimum flow schedule agreed to by all parties.

The Commission granted temporary flow variances to Exelon on six occasions over the period 1998 to 2011(1998, 1999, 2001, 2002, 2005, and 2007) during summer drought periods, permitting leakage to be counted toward the minimum flow requirement. Flows released from Conowingo dam are measured by USGS gage no. 01578310 immediately downstream of the dam (table 3-6). Flows are generally highest in March and April and lowest in July, August, and September. The peaking operation of the Conowingo Project during lower flow periods often results in substantial changes in the flow and stage (figure 3-4) in the river below Conowingo dam. Muddy Run Project operation also affects the water level of Conowingo Pond as figure 3-5 shows.

Table 3-5. Minimum flows for the Conowingo Project agreed upon in 1989 Settlement Agreement as measured at the upstream USGS Marietta gage (Source: Exelon, 2012b).

Date	Minimum Flow
March 1 - March 31	3,500 cfs or natural inflow, whichever is less;
April 1 - April 30	10,000 cfs or natural inflow, whichever is less;
May 1 - May 31	7,500 cfs or natural inflow, whichever is less;
June 1 - September 14	5,000 cfs or natural inflow, whichever is less;
September 15 - November 30	3,500 cfs or natural inflow, whichever is less; and
December 1 - February 28	3,500 cfs intermittent (maximum 6 hours off followed by equal amount on).

Table 3-6. Monthly flow data (cfs) from USGS gage no. 01578310 Susquehanna River at Conowingo, Maryland, for October 1, 1967, to September 30, 2009 (Source: Exelon, 2012b).

Month	Mean	Median	Maximum	Minimum	10% Exceedance	90% Exceedance
Oct	23,755	13,800	245,000	295	57,170	3,750
Nov	36,037	28,700	272,000	303	70,410	5,807
Dec	50,533	40,300	357,000	777	98,350	13,610
Jan	45,340	30,250	622,000	511	93,980	10,210
Feb	50,783	36,800	470,000	758	98,500	15,500
Mar	73,846	58,900	462,000	287	139,000	24,410
Apr	76,957	61,800	467,000	6,090	144,000	29,690
May	47,092	39,400	235,000	5,220	81,100	18,100
Jun	34,894	24,500	1,120,000	622	59,000	8,658
Jul	20,001	15,700	213,000	269	37,500	5,421
Aug	14,917	10,650	202,000	367	28,280	4,490
Sep	19,109	10,400	662,000	363	35,240	3,037
Annual	41,026	27,800	1,120,000	269	85,400	5,840

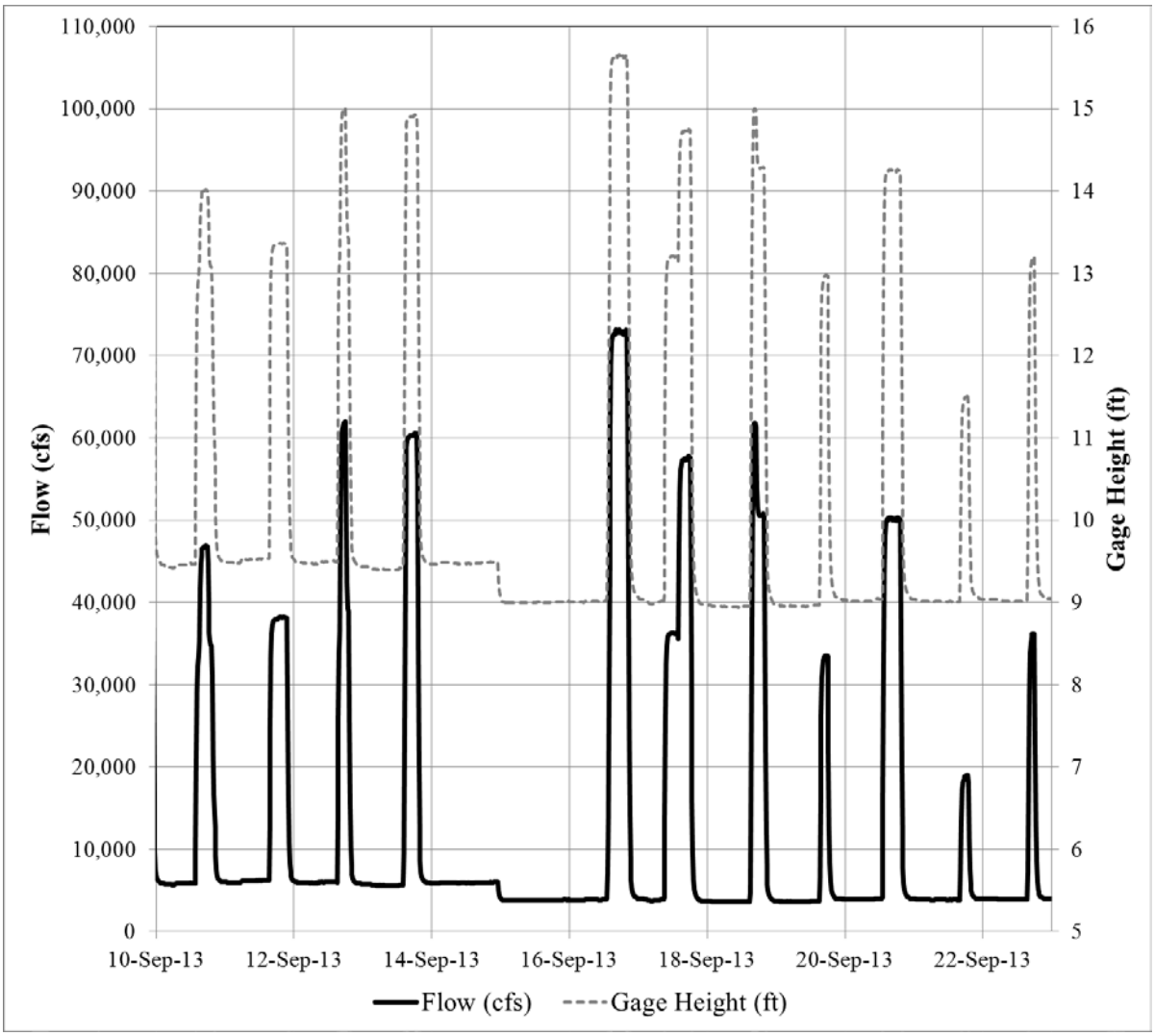


Figure 3-4. Flow and stage variation at USGS gage no. 01578310 downstream of Conowingo dam (Source: USGS, 2013, as modified by Staff).

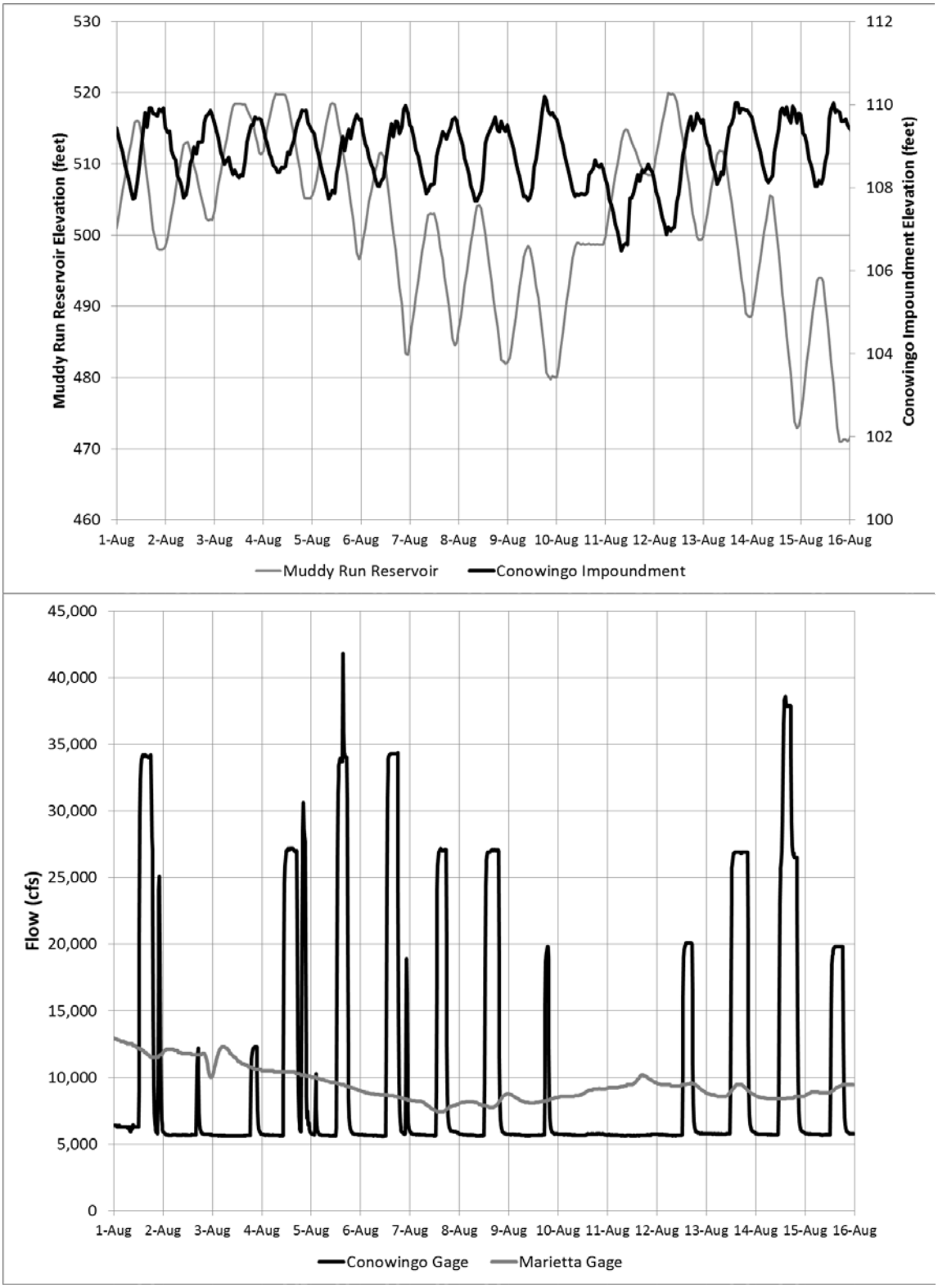
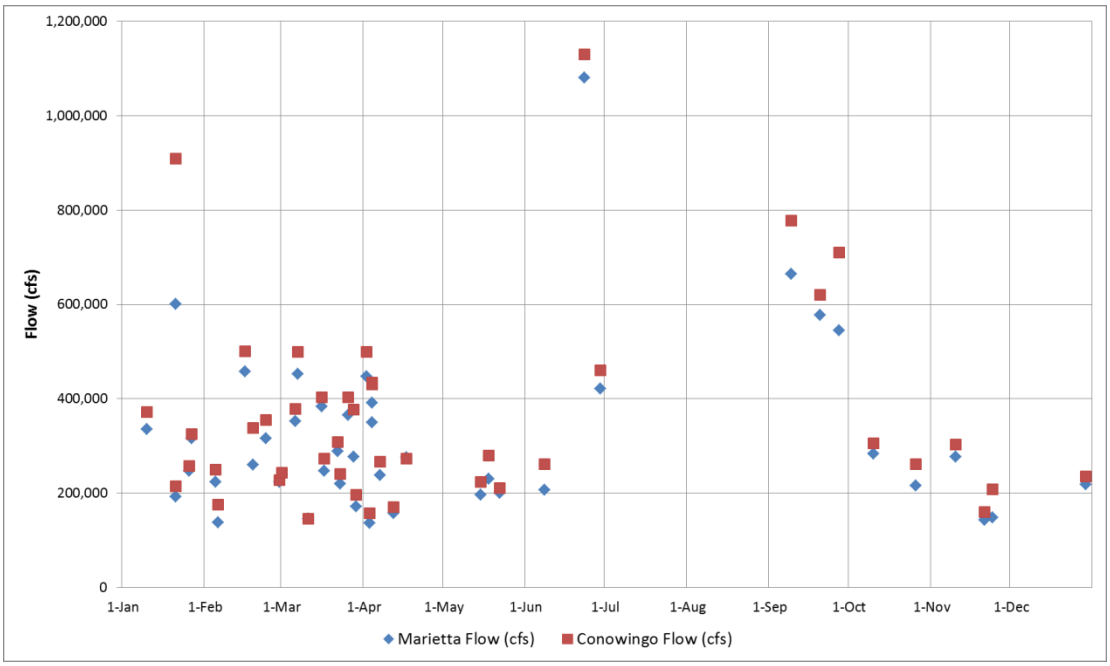


Figure 3-5. Typical impoundment and Conowingo tailrace flow fluctuations during a low-flow period (Source: USGS, 2013; Gomez and Sullivan and Normandeau, 2012b, as modified by Staff).

Peak Flows

Normal annual high flows (figure 3-6) in the lower Susquehanna River occur in the late winter and spring. Extreme flood events such as those in late June 1972, and September of 1975, 2004, and 2011 were the result of rainfall from tropical systems Agnes, Eloise, Ivan, and Lee, respectively. The other noticeable high-flow event (January 1996) was the result of heavy rain, snowmelt, and ice jams.



Note: Data for the Marietta gage are not prorated.

Figure 3-6. Peak annual flows at the Marietta and Conowingo USGS gages, 1968 to 2012 (Source: USGS, 2013, as modified by Staff).

Water Use

Water in the Susquehanna River Basin is used for hydropower production and cooling for fossil and nuclear power plants, as well as for municipal and private water supply, agricultural production, and recreation. Consumptive water use in the basin is largely for public water supply diversion and utility power generation, with smaller uses for recreation, manufacturing, mining, and educational facilities (figure 3-7). The maximum approved daily consumptive water use in the Susquehanna River Basin is 563.1 million gallons per day (mgd), and the majority of the use occurs in the lower basin. About half of the water used each year occurs during low-flow periods (i.e., July through November), with peak use in July.

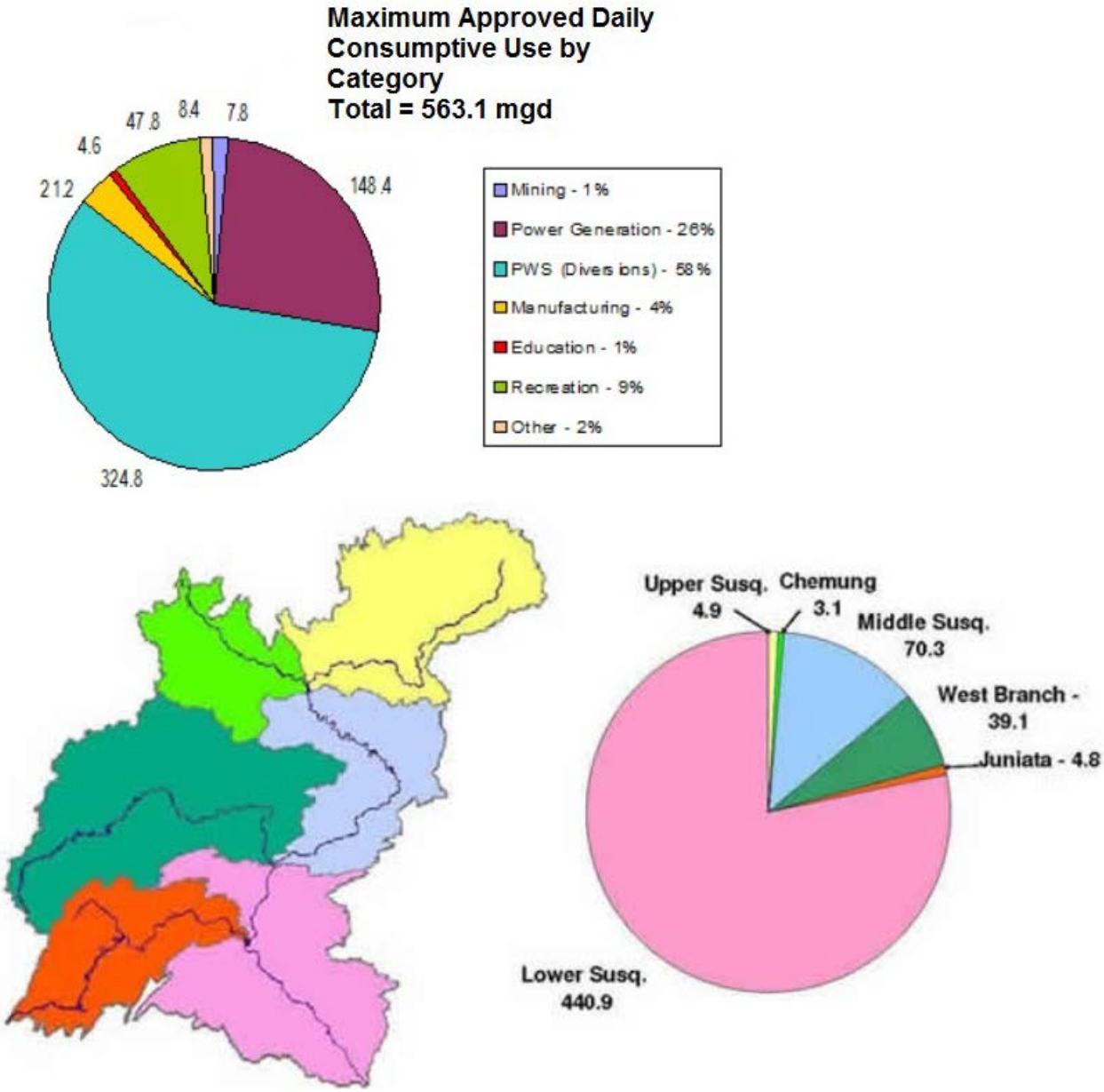


Figure 3-7. Consumptive water use in the Susquehanna River Basin (Source: SRBC, 2013).

Water use for utility power generation in the lower Susquehanna River includes five hydroelectric projects (York Haven, Safe Harbor, Holtwood, Muddy Run, and Conowingo) and two nuclear power plants (Three Mile Island and PBAPS).[37] PBAPS requires about 2,230 mgd (3,450 cfs) at full power operation, and the majority of the water is returned to Conowingo Pond. The York Energy Center, a natural gas electric generation facility, withdraws cooling water about 8 miles upstream of Conowingo dam, at RM 18. Table 3-7 summarizes the consumptive water use for these electric generation projects.

Table 3-7. Consumptive use for power generation in the lower Susquehanna River (Source: York Haven Power, 2012; Exelon, 2012b).

	Daily Consumptive Water Use	
Facility	**(mgd)**	**(cfs)**
Three Mile Island	21.0	32.5
York Energy Center	12.62	19.5
PBAPS	28.0	43.3

Note: The 30-day average consumptive use at Three Mile Island is 18.0 mgd.

Water transported from the Susquehanna River Basin for use outside the basin is considered an out-of-basin diversion. Table 3-8 provides the existing out-of-basin diversion locations and their authorized diversion volumes as approved by SRBC.

[37] In addition, on June 30, 2014, Exelon filed an application for Non-Project Use of Conowingo Lands and Reservoir with the Commission. The application requests the approval of an agreement to allow Old Dominion Electric Cooperative (ODEC) to use project lands and waters for the withdrawal and discharge of water from and into the Conowingo Reservoir necessary to support the combined-cycle electric power generating plant that ODEC proposes to build and operate in Cecil County, Maryland (Wildcat Point Project). Construction of the Wildcat Point Project is scheduled to commence in January 2015.

Table 3-8. Out-of-basin diversions in the lower Susquehanna River (Source: York Haven Power, 2012; Exelon, 2012b).

Name	Location/Description	Million Gallons Per Day (mgd)	cfs
City of Aberdeen, Maryland	Deer Creek to Chesapeake Bay	3.0 mgd, but limited to 1.8 mgd as of 2008	4.6 and 2.8
Baltimore, Maryland	Susquehanna River to Chesapeake Bay	250 mgd, but limited by pumping capacity to 137 mgd; limited to 64 mgd during low flows[a]	387, 212, 99, respectively[a]
Chester, Pennsylvania Water Authority	Susquehanna River to Delaware River Basin	30	46
Chester, Pennsylvania Water Authority	Octoraro Creek to Delaware River Basin	30	46
Coatesville, Pennsylvania, Municipal Water Authority	West Branch Octoraro Creek to Delaware River Basin	2.0	3.1
Morgantown Properties, L.P., New Morgan Borough, Pennsylvania	Conestoga River to Delaware River Basin	0.004	0.006
Perryville, Maryland	Susquehanna River to Chesapeake Bay	1.0	1.5

[a] These values are from the Conowingo final license application; the remaining values are from the York Haven final license application.

Water Quality

Because the Susquehanna River Projects may affect water quality within the lower 60 miles of the mainstem Susquehanna River, we discuss the overall water quality within this reach of the lower river, as well as water quality conditions at each project.

The mainstem of the Susquehanna River in York, Lancaster, and Dauphin counties, Pennsylvania (the reach from York Haven downstream to Conowingo Pond), is classified as a warmwater fishery and migratory fishery (25 Pa. Code §93.9o) and is subject to specific water quality criteria that are applicable statewide for warmwater fishery and migratory fishery streams. The Pennsylvania-Maryland border bisects

Conowingo Pond about 5.7 miles upstream of Conowingo dam, so the lower 15.7 miles of the Susquehanna River are within the state of Maryland, which has its own stream classification system and water quality criteria. Under the Maryland classification system (Code of Maryland Regulations Title 26, Subtitle 08, Chapter 2), Conowingo Pond is classified as Use I-P (Water Contact Recreation, Protection of Aquatic Life and Public Water Supply). The Susquehanna River from Conowingo dam downstream to the confluence with Chesapeake Bay is classified as Use II (Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting – includes applicable Use I-P categories). Chesapeake Bay tidal tributaries, including the Susquehanna River (which is tidal in the lower 5 miles of the reach below Conowingo dam), have sub-category designations of "Migratory Spawning and Nursery Use" and "Open Water Fish and Shellfish Use" on a Bay Segment scale during specified periods of the year. Table 3-9 summarizes the stream classifications and associated water quality criteria for the lower Susquehanna River.

Table 3-9. Summary of stream classifications and water quality criteria for the lower Susquehanna River (Source: 25 Pa. Code §93.7; Code of Maryland Regulations Title 26, Subtitle 08, Chapter 2).

Stream Classification	Parameter	Criteria
Pennsylvania		
Warmwater fishery and migratory fishery	Water temperature	Maximum allowable temperature varies by month, ranging from 40°F (4.4°C) in the over-winter period to 87°F (30.6°C) in the mid-summer
	DO	Minimum daily average of 5.0 milligrams per liter (mg/L); minimum instantaneous of 4.0 mg/L
	pH	Between 6.0 and 9.0 units
Maryland		
Use I-P	Water temperature	The maximum temperature outside of a mixing zone (i.e., an area where an effluent mixes with surface waters) may not exceed 90°F (32°C) or the ambient temperature of the surface water, whichever is greater; a thermal barrier that adversely affects aquatic life may not be established
	DO	Minimum instantaneous of 5.0 mg/L

Stream Classification	Parameter	Criteria
Use II (downstream of Conowingo Dam)	Water temperature	Same as above for Use I-P
	DO	*2/1 through 5/31*: ≥ 6.0 mg/L for 7-day average; 5.0 mg/L as instantaneous minimum
		6/1 through 1/31: ≥ 5.5 mg/L for 30-day average; 4.0 mg/L for 7-day average; 3.2 mg/L as instantaneous minimum (year-round); *Shortnose sturgeon criteria*: 4.3 mg/L as instantaneous minimum at water temperature greater than 77°F (29°C)

An excellent source of long-term data for water quality in the lower Susquehanna River (although with some data gaps) is from the USGS Harrisburg gage No. 01570500, located 13 miles upstream of the York Haven Project. Figures 3-8 through 3-10 provide a summary of water temperature, DO, and pH data available from the Harrisburg gage for the period November 2008 to November 2013 (the past 5 years). These data indicate that Susquehanna River water quality entering the York Haven Project area generally meets Pennsylvania water quality standards for these parameters during most of the past 5 years. For water temperature, in 3 of the past 5 years (2010, 2011, and 2012) water temperatures did exceed the maximum state standard during parts of the summer period, but this did not occur in 2009 and 2013 (figure 3-8). For DO levels, there was only one event in the past 5 years when DO failed to meet the minimum instantaneous criteria of 4.0 milligrams per liter (mg/L), and that minimum DO levels generally exceeded 5 mg/L except in the summer of 2010 (figure 3-9). Generally, pH levels remained within the criteria range, except for short periods in 2009, 2010, and 2012 when the maximum level of 9.0 was exceeded (figure 3-10).

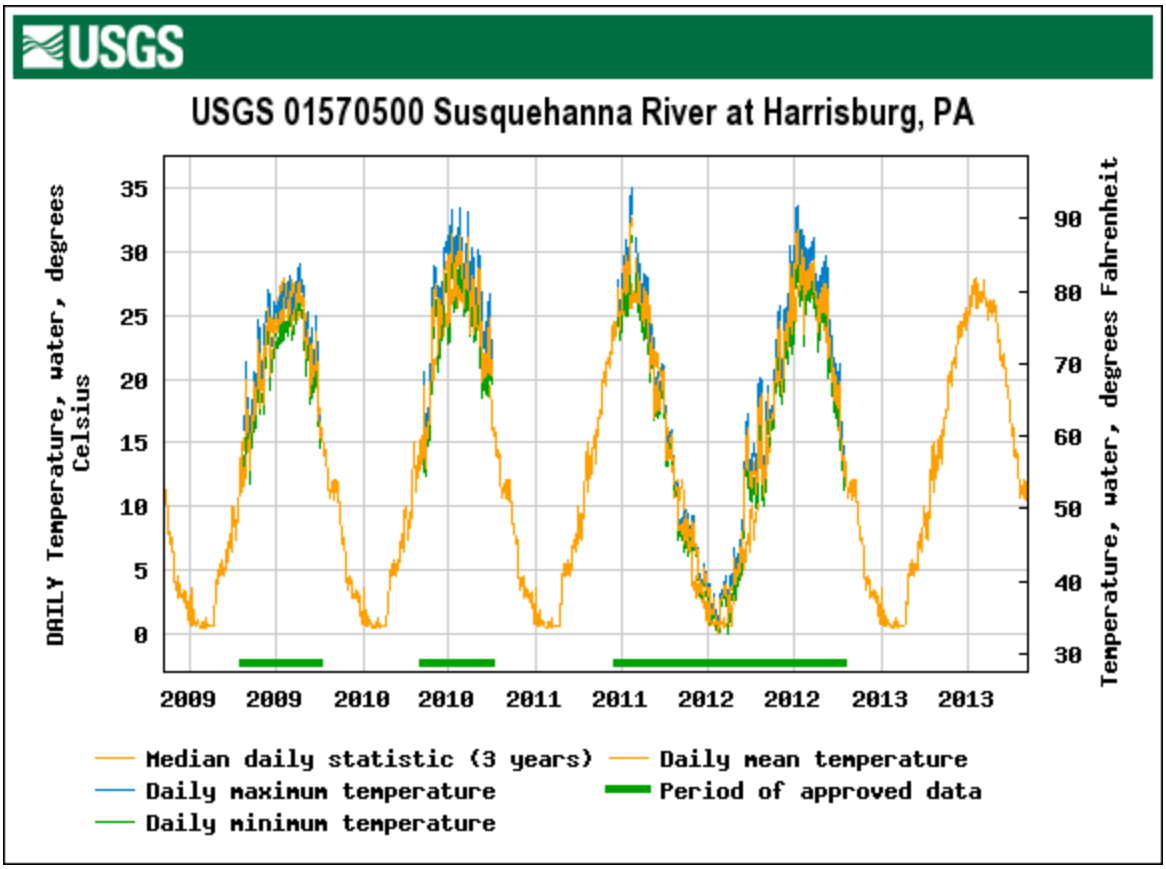


Figure 3-8. Summary of Susquehanna River water temperature data at Harrisburg, Pennsylvania, 2008 to 2013 (Source: http://waterdata.usgs.gov/pa/nwis/uv?site_no=01570500).

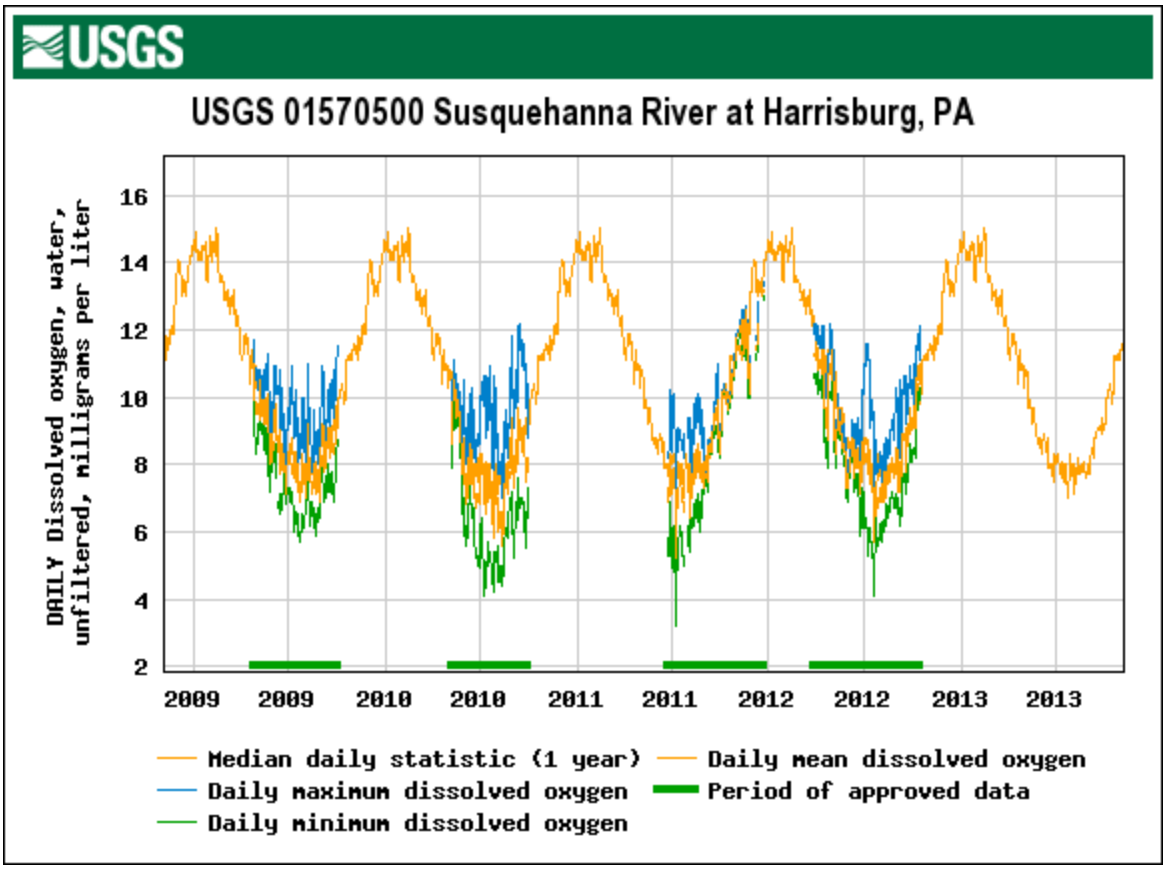


Figure 3-9. Summary of Susquehanna River DO data at Harrisburg, Pennsylvania, 2008 to 2013 (Source: http://waterdata.usgs.gov/pa/nwis/uv?site_no=01570500).

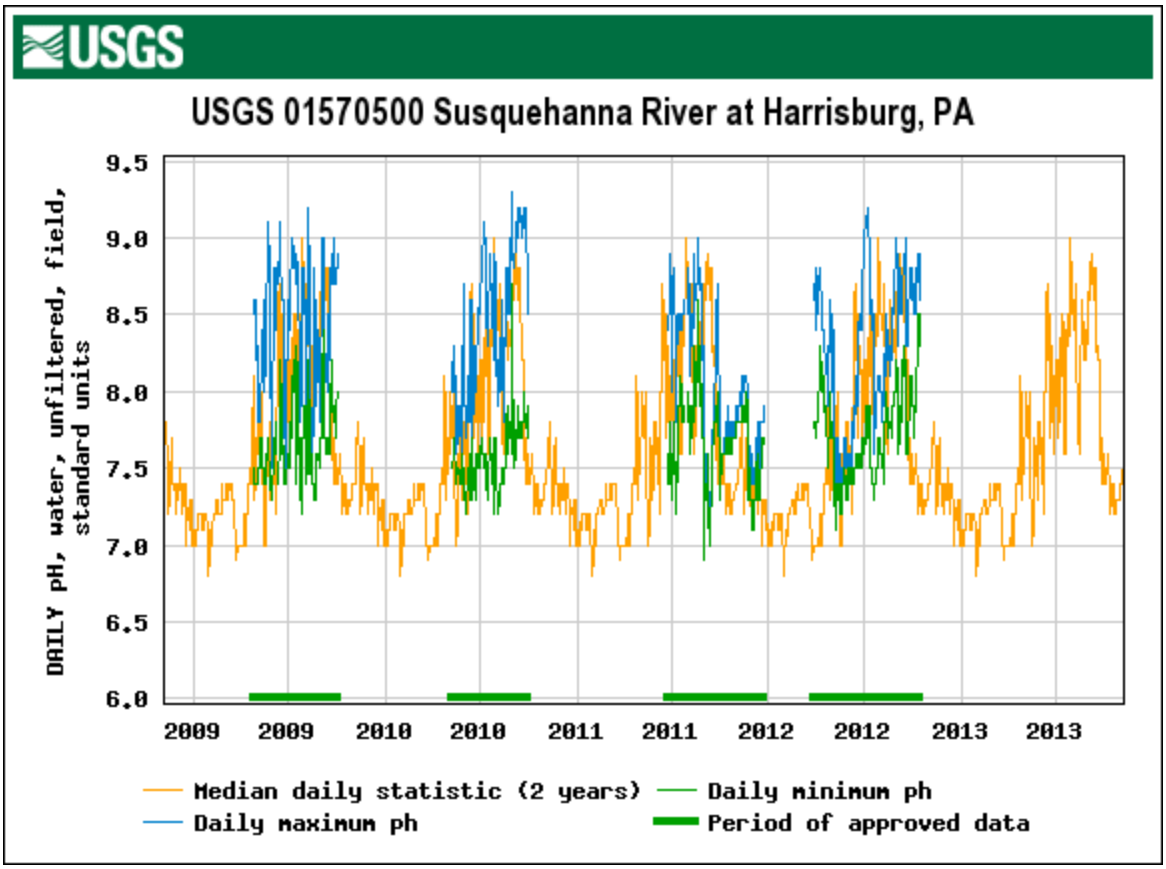


Figure 3-10. Summary of Susquehanna River pH data at Harrisburg, Pennsylvania, 2008 to 2013 (Source: http://waterdata.usgs.gov/pa/nwis/uv?site_no=01570500).

Other water quality data are available for the lower Susquehanna River from several other sources, including monitoring studies conducted by government agencies and other studies conducted by utilities associated with the operation of hydroelectric, nuclear, and fossil-fuel generating stations. SRBC monitors water quality throughout the Susquehanna River Basin and periodically publishes reports on the results of its monitoring. Its large river assessment project has monitored water quality and biological (macroinvertebrates) parameters throughout the basin since 2007, and released its most recent report on that program in September 2011 (Shenk, 2011). Shenk (2011) concluded that overall water quality in the Susquehanna River is fairly good. For the monitoring station closest to the lower Susquehanna River, located at the mouth of the tributary Juniata River upstream of Harrisburg, monitoring at that station indicated slightly impaired conditions (Shenk, 2011). Because many of the other monitoring studies have been related to the operation or licensing of energy facilities in the lower river, those study results will be discussed for each project discussed in this draft EIS.

York Haven Project

York Haven Power conducted continuous water quality monitoring from May through October 2010, to support relicensing. Parameters sampled at seven sites within the project area included water temperature, DO, and pH.

Water temperatures ranged from 52°F to 93°F and closely mimicked ambient air temperatures. Water temperatures occasionally exceeded the maximum state criteria (87°F) at sample sites, although those exceedances occurred most often at the shallow shoreline sample site on Shelley Island and at the most upstream sample site at the head of the project impoundment. In contrast, the powerhouse tailrace sample site had generally cooler water temperatures with fewer exceedances of state water temperature criteria.

DO levels generally met or exceeded state standards, except at a shoreline sample site on Hill Island in Lake Frederic and at the east channel site upstream of the dam. However, the Hill Island site failed to meet average daily minimum DO levels on only 4 percent of the sample days, and failed to meet instantaneous minimums in only 2.7 percent of the data. The east channel site only failed to meet minimum DO standards 0.9 percent of the time. Diurnal DO patterns were observed in all locations, as influenced by photosynthesis and respiration, and fluctuations in DO levels were greatest in the warmer summer months and in areas of Lake Frederic with denser growth of SAV.

Generally, pH levels remained within state standards, but did show diurnal variation, probably due to fluctuations in carbon dioxide levels associated with biological activity. Inflowing waters to the project had fewer exceedances of state standards than waters being discharged from the project, but project outflows exceeded state criteria (higher than a pH of 9.0) only 2.9 percent of the time. Most of those exceedances ranged from 9.1 to 9.3 units. Minimum pH levels seldom dropped below neutral (pH = 7.0), with the lowest value of 6.3 observed at the shoreline sample site on Shelley Island.

Muddy Run Project

Exelon conducted water quality studies in multiple years prior to filing the final license application: 2006, 2007, 2010, and 2011. The surveys are summarized as follows:

- In 2006, Exelon continuously monitored water temperature, DO, and pH in the project discharge for one month from August 8 to September 3.
- The 2007 surveys involved spot measurements of water temperature and DO in the project discharge during low-flow and high-temperature periods in July and August.
- In 2010, Exelon monitored water temperature, DO, pH, specific conductivity, turbidity, and chlorophyll *a* via biweekly depth profile sampling from April through October along a single transect (three stations) in the upper reservoir, and continuously monitored water temperature, DO, pH, and specific

conductivity at the cylinder gate intake for Unit 1 and Unit 2 in the upper reservoir power canal, and in the tailrace where Units 3 and 4 discharge into Conowingo Pond.

- In 2011, Exelon continued water quality monitoring in July and August in both the reservoir and the tailrace by weekly sampling of water quality depth profile data (water temperature, DO, pH, specific conductivity, and turbidity) at two locations in the project's upper reservoir, and three locations in Conowingo Pond both upriver and downriver of the tailrace. Exelon also conducted continuous monitoring of water quality parameters (water temperature, DO, pH, and specific conductivity) at the cylinder gate intake for Unit 1 and 2 in the upper reservoir power canal, from the tailrace at the Unit 1 and 2 discharge into Conowingo Pond, and in Conowingo Pond 0.25 mile upriver of the project tailrace.

Tables 3-10 and 3-11 summarize the water quality data collected by Exelon over the 4 years of monitoring in the tailrace and the upper reservoir. These data indicate that waters discharged from the project generally met state standards (table 3-10), although DO levels occasionally dropped below state standards during the warmer summer months. The Muddy Run reservoir does not thermally stratify, but does exhibit DO stratification in the main body of the reservoir in some locations, with DO levels as low as 2.4 mg/L at depth (table 3-11). The monitoring also found that there is substantial mixing occurring in the reservoir near the head of the intake canal during project operation, particularly during pumping operation when Susquehanna River (Conowingo Pond) waters, which are typically well-oxygenated, are entering the reservoir. In 2011, monitoring at times showed a weak inverse DO stratification (higher DO in deeper water and lower DO in surface water) as Susquehanna River waters entered the reservoir at depth, under the Muddy Run reservoir surface waters that were lower in DO. All other measured parameters met state standards.

Table 3-10. Summary of water quality data collected in or near the tailrace of the Muddy Run Pumped Storage Project, 2006 through 2011 (Source: Exelon, 2012a; Normandeau and Gomez and Sullivan, 2012p).

Parameter	2006	2007	2010	2011
Water temperature	Met state water quality criteria; max recorded=86.7°F	Met state water quality criteria; temperatures in July about 4°F cooler than in August	Met state water quality criteria; temperatures ranged from 57.6 to 86.0°F; temperatures were higher than the long-term 53-year average (up to 10°F in some months) in April through September and lower in October	Generally met state water quality criteria; minimum and maximum recorded temperatures ranged from 72.1 to 87.3°F with cooler temperatures in August; no temperature stratification was observed at any of the tailrace monitoring locations, but diurnal cycles were observed, particularly in Muddy Run reservoir waters
DO	Met state water quality criteria; min recorded=5.2 mg/L. DO levels in the tailrace typically decreased by 1 to 1.5 mg/L during generation and increased when generation stopped or the number of generating units was reduced	Met state water quality criteria; average DO was 6.6 mg/L in July and 6.1 mg/L in August	Some violations of state water quality criteria; seasonal decrease in DO levels from high in April to lows in August; average daily DO value < 5.0 mg/L on 3 days in July and 1 day in August; instantaneous DO values were less than 4.0 mg/L on 12 days in July and 2 days in August	Mostly met state water quality criteria; average daily DO values were above 5.0 mg/L at all stations and dates, but continuous DO readings decreased from early July highs of 8.2 mg/L to early August lows of 3.5 mg/L, with increases in mid to late August; only one hourly reading less than 4.0 mg/L in July in the tailrace monitor, and other

Parameter	2006	2007	2010	2011
				nearby river monitors were generally 1 to 2 mg/L higher
pH	Met state water quality criteria; within pH range of 7.4 to 8.0	NA	Generally met state water quality criteria; fluctuated between 7.0 and 8.0, with the lowest pH of 6.7 and highest of 9.1	Met state water quality criteria; pH range of 7.5 to 8.5
Turbidity	NA	NA	NA	Met state water quality criteria; observed range of 3.3 to 26.1 nephelometric turbidity units (NTUs) (state standard ≤40 NTU)

Table 3-11. Summary of water quality data collected in the Muddy Run Pumped Storage Project reservoir, 2010 and 2011 (Source: Exelon, 2012a; Normandeau and Gomez and Sullivan, 2012p).

Parameter	2010	2011
Water temperature	Met state water quality criteria; thermal stratification did not occur in the reservoir; surface water temperatures ranged from 52.2 °F on April 5 to 84.6 °F on July 26; 98.4-foot-deep water temperatures ranged from 48.2°F on April 5 to 84.2°F on July 26	Met state water quality criteria; thermal stratification did not occur in the reservoir; surface water temperatures ranged from 75.2 to 85.5 °F with cooler temperatures in August; temperatures at depth ranged from 75.2 to 85.3°F
DO	Some violations of state water quality criteria; seasonal decrease in DO levels from high in April to lows in August; strong DO vertical stratification in main	Some violations of state water quality criteria; DO vertical stratification in main reservoir in some locations, with DO levels as low as 2.4 mg/L at depth; a weak

Parameter	2010	2011
	reservoir with DO less than 5.0 mg/L at depths deeper than 25 feet in July and throughout the water column in August; no stratification at head of intake canal because of mixing of flows at that location; continuous monitoring found 70 instantaneous hourly DO values less than 4.0 mg/L with most (42 or 60 percent) recorded at the cylinder gate (intake) monitor in August when the project was in an idle mode; average daily DO value was also less than the state standard of 5.0 mg/L on 7 days in August and 1 day in September at the cylinder gate monitor	inverse DO stratification (higher DO in deeper water and lower DO in surface water) observed at head of intake canal, likely due to higher oxygenated Conowingo Pond water being pumped into the Muddy Run reservoir; continuous monitoring found instantaneous hourly DO values less than 4.0 mg/L 15 percent of the time between July 16 and August 7, with a higher occurrence of lower DO levels during the idle mode compared to pumping or generating; consistent increase in DO in the intake canal during the pumping mode as a result of the introduction of higher oxygenated river (Conowingo Pond) water
pH	Met state water quality criteria; pH range of 7.0 to 8.6	Met state water quality criteria; pH range of 7.2 to 8.4
Conductivity	NA	Conductivity ranged from about 250 to 370 µS/cm in July and 220 to 400 µS/cm in August, with a decrease in conductivity with the onset of high flows in late-August
Turbidity	NA	Met state water quality criteria; observed range of 3.1 to 26.0 nephelometric turbidity units (NTUs) (state standard ≤40 NTU)
Chlorophyll *a*	Values ranged from 0.401 to 20.9 mg/m^3 during the 15 bi-weekly sampling events	NA

Conowingo Project

The Conowingo Project area has an extensive, long-term history of water quality sampling associated with the operational monitoring for PBAPS, and operational monitoring and prior relicensing studies for the Conowingo Project. These data extend back to the 1950s, and parameters of primary concern are water temperature and DO.

Conowingo Pond is a large temperate reservoir that follows a typical seasonal pattern of warming and cooling, with minimum temperatures of 32°F in January/February,[38] warming during the period of March through July, reaching a maximum average high temperature of about 81°F in July/August, and then cooling from August through December. Thermal stratification does not occur in Conowingo Pond, although during the warmest summer months, bottom temperatures may be a few degrees cooler than the surface temperatures in the deeper parts of the reservoir, especially on sunny, calm days.

Average surface DO levels show an opposite trend to water temperatures, with highest DO levels of nearly 14 mg/L occurring in January/February, and lowest DO levels in July/August/September, with the lowest average level of 7 mg/L in August. DO levels remain well mixed throughout the water column during much of the year, but DO stratification occurs in the deeper parts of the reservoir closer to Conowingo dam during the warmer, low-flow summer months. Stratification generally occurs when river flows are less than 20,000 cfs and water temperatures are greater than 70°F. The stratification usually begins in late June or early July, with low DO levels (<5 mg/L) occurring by mid to late July, and most common at depths greater than 30 feet. The deepest portions of the pond may approach or become hypoxic (DO <2 mg/L) and even anoxic under certain conditions. This DO stratification can persist for up to 60 days depending on river flows and other weather conditions, with an increase in river flows and the onset of strong winds mixing the pond and eliminating stratification. Diurnal variation in DO levels occurs in surface waters in Conowingo Pond at depths less than 20 feet, with this variation sometimes as great as 5 mg/L. Peak DO levels normally occur in the mid to late afternoon as a result of photosynthesis, and reach their low point at dawn as a result of plant respiration overnight.

Conowingo Pond water quality directly affects water quality in the tailrace and lower Susquehanna River. Exelon's Station 643, located along the Susquehanna River west shore 0.6 mile downstream of the dam and a long-term monitoring station for water temperature and DO, is designated as the primary Maryland State standard compliance

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[38] Conowingo Pond may freeze over in colder winters, but not in all winters, as strong northwest winds may act to break up any ice cover that forms. Conowingo Pond also receives the heated discharge from PBAPS, which may act to maintain open water along the west shore of the reservoir downstream of PBAPS.

monitoring location. Water temperature in the tailrace closely reflects the temperatures in the pond, with similar seasonal trends and minimum and maximum levels. Because the Conowingo generating units withdraw water from the bottom of the reservoir, DO levels in the project discharge have been similar to levels at depth (40 to 70-foot depths) in the pond. During low-flow, high-temperature periods in the summer, when reservoir bottom DO levels approached anoxic conditions, DO levels in the tailrace were historically as low as 2 mg/L. However, from 1989 to 1991, Exelon installed aeration (turbine venting) on all the Francis units (Units 1 through 7). Prior to installation of aeration, in some years, hourly DO levels were less than 5 mg/L up to 40 percent of the time. Following installation of aeration, hourly DO readings were less than 5 mg/L only 0.03 percent of the time (from 1989 to 2007), and no readings were less than 4.3 mg/L. Exelon also installed aerating turbine runners in two Francis units in 2005 and 2008, further enhancing its ability to provide additional aeration in the tailrace.

Other water quality data were collected by USGS in the discharge from Unit 8 from 1978 to 2000, and a subset of those data are summarized in table 3-12.

Table 3-12. Selected water quality parameters recorded by USGS at the Unit 8 discharge from January 1978 to June 2000 (Source: Exelon, 2012b).

Parameter	Minimum	Mean	Maximum
Water temperature (°F)	32.0	56.2	87.8
Turbidity (nephelometric turbidity units)	0	13	410
Conductivity (µS/cm)	110	218	420
DO (mg/L)	1.4	10.4	17.8
pH	6.0	7.5	8.8
Alkalinity (mg/L CaCO3)	8	40	82
Total dissolved solids (TDS)(mg/L)	53	120	246
TDS loading (tons/day)	490	29,332	99,500
Total suspended solids (mg/L)	1	45	1200
Total suspended solids loading (tons/day)	12	32,230	2,020,000
Dissolved nitrogen (mg/L N)	0.4	1.8	6.6
Total phosphorus (mg/L P)	0.010	0.072	1.500

Recent Water Quality Studies

Exelon conducted additional studies in 2010 to better understand water temperature, DO, and other water quality parameters upstream and downstream of the project, and to provide information for project relicensing. Sampling occurred in both Conowingo Pond and the tailrace from April through October, and focused on water temperature, DO, pH, turbidity, and fecal coliform bacteria. Conowingo Pond sampling confirmed historical observations of the absence of thermal stratification in the pond, although small differences in temperature (less than 4°F) were observed between the surface and bottom in some locations.

The 2010 sampling also showed that, similar to historical data, DO stratification occurs in Conowingo Pond during July and August, with DO levels less than 2 mg/L in the deeper locations of the pond. Figure 3-11 shows the DO profiles taken immediately upstream of Conowingo dam from July through September 2010. These profiles show the summertime stratification but also show that DO levels were below 4 and 5 mg/L (the state standards) from surface to bottom during many weeks of sampling. Exelon also reported that during those weeks, sampling stations upriver in Conowingo Pond showed stratification, but this stratification broke down in the lower pond just upstream of the dam. The water column was being mixed in the lower pond, and the mixing of the lower DO and higher DO waters resulted in an overall lower DO profile from top to bottom. Stratification begins to break down throughout the pond in September, and by early-October stratification has disappeared and DO levels are above 8 to 9 mg/L throughout the water column.

Turbidity and pH data in 2010 (collected at midpoint stations in Conowingo Pond) remained within the ranges observed in long-term sampling at Conowingo dam (see table 3-12). Turbidity ranged from 1.2 to 146.5 NTUs, and pH ranged from 7.0 to 8.9.

Fecal coliform sampling in Conowingo Pond found generally low levels during the April through October sampling period. The Pennsylvania state standard for swimming (full body contact) is no greater than 200 colonies/100 milliliters, and only five samples out of a total of 28 samples collected in the Pennsylvania part of Conowingo Pond in 2010 had fecal coliform levels greater than the state standard, one in the swimming season (May through September) and the remainder in October. Similarly, in the Maryland portion of Conowingo Pond, only three of 28 samples had fecal coliform levels greater than 200 colonies/100 milliliters, all in October.

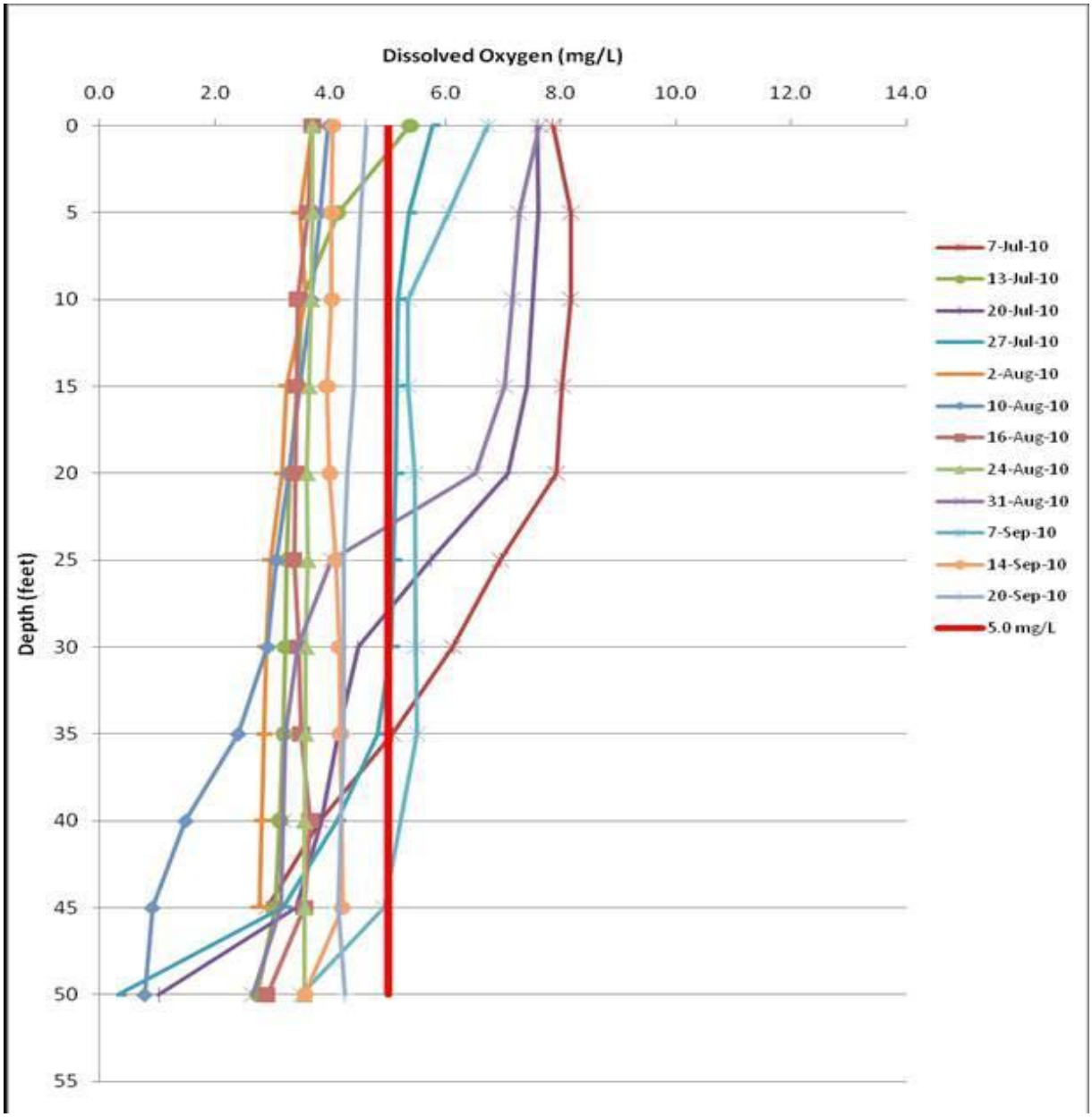

Figure 3-11. DO profiles taken immediately upstream of Conowingo dam from July through September 2010 (Source: Exelon, 2012b).

Conowingo tailrace sampling in April through October 2010 involved monitoring water temperature and DO using three methodologies: sampling at specific stations in the tailrace, continuous monitoring at the long-term station 643 located 0.6 mile downstream of the dam, and discharge boil sampling on 20 dates in July and August. Water temperatures were similar to long-term data described above, with peak temperatures recorded in late-July and early-August, and then decreasing into October. Water temperatures measured at station 643 were representative of those measured elsewhere in the tailrace. Maximum water temperatures observed in the discharge boils

generally ranged from 84 to 86°F in July, but reached as high as 90°F. Only small differences in temperature were observed among the discharge boils, indicating relatively homogeneous temperatures in the overall discharge from the dam.

Tailrace DO levels remained relatively high (met state standards) throughout the 2010 sampling, likely reflecting the effects of the aeration systems in place on the seven Francis generating units. Minimum DO levels exceeded the state standard of 5 mg/L in the discharge boils 97.8 percent of the time, with minimum recorded levels of 4.4 to 4.9 mg/L. At station 643, no DO levels less than 5 mg/L were recorded, and minimum levels were generally above 6 mg/L. DO levels at station 643 were usually slightly higher than measured at the dam, but the difference was small (less than 1 mg/L) and sampling indicated that station 643 monitoring results were representative of conditions in the tailrace. Variability in DO levels was observed among the discharge boils across the powerhouse, especially between the Francis units that have aeration systems and the Kaplan units (8 through 11) that do not have aeration. Differences were also observed among the Francis units, sometimes as high as almost 3 mg/L.

Salinity Encroachment on the Lower Susquehanna River

Exelon investigated the extent of salinity encroachment in the lower Susquehanna River (Gomez and Sullivan, 2012b). The Susquehanna River is tidally influenced up to about 5 river miles downstream of Conowingo dam (at RM 10). Both Maryland DNR and the City of Havre de Grace, Maryland, maintain salinity monitors near the mouth of the Susquehanna River and have salinity data available since 1997. The City of Havre de Grace monitors salinity at its water supply intake to ensure that salinity levels do not exceed federal requirements for drinking water (less than 0.25 parts per thousand [ppt]). The Maryland DNR station is closer to the Chesapeake Bay (it is about 0.5 mile downstream of the City of Havre de Grace's station). Salinity levels at both stations are relatively low, with median daily salinity levels between 0.005 and 0.02 ppt, although occasionally (less than 0.1 percent of the time) they exceed the federal criteria of 0.25 ppt. Observed salinities ranged from 0.01 to 0.26 ppt at the City monitoring station, and from 0.08 to 0.46 ppt at the Maryland DNR monitoring station. Levels varied seasonally with salinity generally highest in the fall and late-winter and lowest during spring and summer, coinciding with or immediately after the period of highest Susquehanna River flows.

Gomez and Sullivan (2012b) analyzed the relationship of salinity to river flows, including short-term project operational changes, as well as the influence of tidal fluctuations on salinity. This analysis found that salinity appears to be primarily affected by longer term flows (30-, 45-, and 60-day moving average), with short-term flow variations having little effect. The highest salinities were observed after extended low-flow periods. Tidal fluctuations also had an effect on salinity during higher salinity periods because saltwater is pushed upstream and downstream in the river as the tide rises and falls.

Sediment Loading

USGS prepared an assessment of the potential sediment trapping capacity of the lower Susquehanna River reservoirs, including Conowingo Pond, and the potential effects on Chesapeake Bay (Langland, 2009). The details of the USGS study are described in section 3.3.1, *Geology and Soils*, but essentially that study concluded that Conowingo Pond may have the capacity to trap additional sediment for another 15 to 30 years (i.e., up to years 2023 to 2038). Once Conowingo Pond reaches its sediment trapping capacity, sediment and nutrient loads delivered to the Chesapeake Bay via the Susquehanna River would equal the load delivered into the head of the three lower river reservoirs (at Lake Clarke), resulting in an increase in nitrogen, phosphorus, and sediment loading into the Bay (Langland, 2009).

Aquatic Biota

Fishery resources in the lower Susquehanna River are substantial with both an important resident warmwater fishery and anadromous and catadromous species that are passed upstream and downstream over the mainstem hydroelectric dams. Primary warmwater game species in the river include smallmouth bass, largemouth bass, walleye, channel catfish, flathead catfish (a recent introduction), and panfish species such as redbreast sunfish, bluegill, black and white crappie, and pumpkinseed. Other common species include gizzard shad, quillback, spotfin shiner, other shiners, and common carp. Juvenile gizzard shad and the shiners serve as forage species for game species.

Each project reservoir has substantially different characteristics and aquatic habitat. Lake Frederic is about 3.5 miles long with about 29 miles of total shoreline within the York Haven project boundary, including the shoreline of the islands in Lake Frederic. The maximum depth of Lake Frederic is about 18 feet and the mean depth is about 6 feet. At the normal water surface elevation of 277.86 feet, Lake Frederic has a surface area of 2,218 acres. The normal drawdown is about 1.1 feet. Lake Frederic has a substrate of primarily bedrock, boulder, cobble, and gravel with limited areas of finer substrates (sand, silt, clay). One such area is located in the east channel immediately upstream of east channel dam, and has one of the few dense stands of SAV in the reservoir. Two other areas of SAV are located along the shorelines of Hill and Shelley islands.

Muddy Run reservoir has a maximum depth of about 100 feet, a surface area of 892 acres at elevation 520 feet, and 471 acres at the maximum drawdown elevation (470 feet). The arm of the reservoir that is Recreation Lake has a total area of about 100 acres and is maintained at a constant elevation of 520 feet for recreational purposes. Aquatic habitat in the power reservoir consists of a wide and gently sloping non-vegetated shoreline that is subject to large daily and weekly water level fluctuations (up to 50 feet on a weekly basis). Substrates are primarily unweathered bedrock covered in places with fragmented weathered bedrock, colluvium, and alluvium. Bedrock

outcroppings and overhangs also occur along the shoreline littoral areas. Little SAV occurs within Muddy Run reservoir because of the constantly fluctuating water levels.

Conowingo Pond extends 14 miles upstream from Conowingo dam to the lower end of the Holtwood Project tailrace. The Conowingo Pond normal maximum elevation is 109.2 feet, resulting in a surface area of about 8,500 acres and a maximum depth of about 100 feet. Normal drawdown is about 2 feet, although it may reach 3 feet and greater during brief periods, but generally not during the summer recreation season. The Conowingo Pond shoreline is relatively steep, but through the years the pond has substantially filled in with sediment (except in the more upstream riverine, bedrock dominated reach), so the substrate in a large part of the pond is now primarily sand, silt, and gravel with several areas of dense SAV along the shoreline. An estimated 312 acres of SAV occurs within Conowingo Pond at full reservoir elevation, and that acreage substantially declines at elevations lower than 106 feet. The largest areas of SAV occur along the east shoreline of Conowingo Pond across from the PBAPS, in shallow areas that have filled over the years. Five SAV species were identified as dominant within Conowingo Pond: Eurasian watermilfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), water stargrass (*Heteranthera dubia*), Canadian waterweed (*Elodea canadensis*), and coontail (*Ceratophyllum demersum*). Hydrilla, an invasive species, however, dominates SAV beds within the pond. Exelon also investigated SAV downstream of Conowingo dam in 2010 (URS and Gomez and Sullivan Engineers, 2012d). That study found that SAV communities were primarily located in the lower portion of the reach below Conowingo dam in areas with fine-grained substrates and lower velocities. The upper portion closer to the dam with its higher water velocities and primarily bedrock/boulder substrate contains little or no SAV growth. Four SAV species were identified downstream of Conowingo: Eurasian watermilfoil, hydrilla, water stargrass, and wild celery (*Vallisneria americana*); Eurasian watermilfoil dominates SAV beds, covering more than 95 percent of the area occupied by SAV beds.

The Conowingo Pond and the Muddy Run Recreation Lake support an active boat and shoreline sport fishery for resident species, and fishing also occurs in both project tailwaters, from the shoreline and by boat. The tailrace fishery downstream of Conowingo, however, is more intense than in the Muddy Run tailrace. Muddy Run reservoir contains essentially the same species composition as Conowingo Pond, via the pumping of eggs, larvae, and other life stages from Conowingo Pond. Exelon reports that the fish standing crop is higher than many conventional reservoirs, but carp dominated the overall standing crop estimate (69 percent), with walleye, smallmouth bass, white crappie and channel catfish comprising 12.8 percent of the mean standing crop. Muddy Run reservoir is closed to fishing. However, the Recreation Lake is open to boat and shoreline fishing and is stocked annually with rainbow trout. Other species (walleye, tiger muskellunge, and channel catfish) have been stocked over the years.

There has been an active program for restoring anadromous fish populations to the Susquehanna River for the past 35 years or more. Historically, the river supported large

runs of American shad, river herring (blueback herring and alewife), hickory shad, as well as the catadromous American eel. These populations declined in the late 1800s and early 1900s because of the construction of canal feeder dams, overfishing, water pollution, and eventually the construction of the hydroelectric dams between 1904 and 1928. The York Haven Project at RM 55 was the first hydroelectric dam on the river, having been constructed in 1904. The dam, however, is a low-head structure from 6 to 22 feet high, and may have been partially passable by shad during higher flow periods. Holtwood dam was constructed in 1910 at RM 25, and at 55 feet high, totally blocked upstream fish migration. Two fishways were constructed at Holtwood at the time of its initial construction—a rock ramp type fishway on the west shore of the bypassed reach, and a pool-and-weir type fishway on the east shore of the tailrace. Neither fishway reportedly ever passed shad successfully, but the rock ramp fishway did pass some American eel, although the numbers are not known. In 1928, the 95-foot-high Conowingo dam was constructed at RM 10 without fish passage and became the downstream-most obstruction to upstream fish migration on the river.

Modern anadromous fish restoration efforts on the Susquehanna River began in the 1950s and 1960s with a number of feasibility studies, followed by the construction of a trap and truck facility (the west fish lift) at Conowingo dam in 1972, the initiation of fertilized shad egg stocking in the basin, the construction of a shad hatchery by Pennsylvania FBC in the mid-1970s, and the total closure of the shad fishery in the Susquehanna River and upper Chesapeake Bay by the state of Maryland in 1980. The number of shad returning to the river increased through the years, and by 1991 a new fish lift (east fish lift) was constructed at the Conowingo Project, followed by new fish lifts at the Holtwood and Safe Harbor projects in 1997. The York Haven Project east channel vertical slot fishway became operational in 2000.

The Holtwood Project fish lifts (tailrace and spillway) were renovated as part of the expansion of the Holtwood Project, which includes the addition of a new powerhouse and 88.3 MW of generating capacity. To improve migratory fish passage at the project, PPL: (1) modified the existing spillway fish lift, (2) rerouted the discharge of Unit 1 in the existing powerhouse to improve attraction to the spillway fish lift, and (3) excavated in the project tailrace and Piney Island Channel to improve fish access to the fish lifts. These improvements were completed in 2013, and the improved fish passage facilities were operational for the first time in 2014.

Table 3-13 summarizes the passage of American shad at the four lower river hydroelectric projects since 1997. Table 3-13 shows that passage success at Holtwood has generally been poor, as a percentage of Conowingo shad passage. Generally, higher success rates have occurred during years with lower river flows, while lower success rates have occurred in years with higher flows. The current fish passage improvements at Holtwood should increase the efficiency of the Holtwood fish lifts. Operation in 2014 showed a small increase in the percentage of shad lifted at Holtwood, but not a substantial improvement because the overall number of shad in the Susquehanna River was the lowest since volitional passage was established in 1997. Safe Harbor Project

passage has generally been excellent, with a relatively high percentage of the fish passed at Holtwood also passed at Safe Harbor. Lake Aldred, which backwaters into the Safe Harbor tailrace is only about 7 miles long, and the design of the Safe Harbor fish lift, along with the usual lack of spillage during the fish migration season, allows migrating fish to more easily locate the Safe Harbor fish lift. Only low numbers of shad typically are counted at the York Haven east channel fishway (table 3-13). However, the river reach from Safe Harbor to York Haven is about 22 miles, including about 10 miles of Lake Clarke and 12 miles of free-flowing river that includes habitat suitable for shad spawning. Not all shad passing Safe Harbor would need to pass York Haven if they spawn downstream of York Haven, and, as a result, fish counts at the east channel fishway do not indicate the actual efficiency of the fishway.

Table 3-13. Summary of American shad passage on the Susquehanna River, 1997–2014 (Source: Pennsylvania FBC, 2014).

Year	Conowingo[a]	Holtwood	Safe Harbor	York Haven
1997	90,971	28,063	20,828	--
1998	39,904	8,235	6,054	--
1999	69,712	34,702	34,150	--
2000	153,546	29,421	21,079	4,675
2001	193,574	109,976	89,816	16,200
2002	108,001	17,522	11,705	1,555
2003	125,135	25,254	16,646	2,536
2004	109,360	3,428	2,109	219
2005	68,926	34,156	25,425	1,772
2006	56,899	35,968	24,929	1,913
2007	25,464	10,338	7,215	192
2008	19,914	2,795	1,252	21
2009	29,272	10,896	7,994	402
2010	37,757	16,472	12,706	907
2011	20,571[b]	21	8	0
2012	22,143	4,238	3,089	224
2013	12,733	2,503	1,927	202
2014	10,425	2,528	1,336	8

[a] Passage numbers are for the east fish lift, which releases fish into Conowingo Pond. The west fish lift is operated to collect shad for hatchery egg supply, and for other experimental purposes.

[b] In 2011, Conowingo fish passage operations were terminated earlier than normal because construction at Holtwood dam prevented successful operation of the fish lifts. Therefore, all upstream fish lifts were also shut down after only brief operation.

Few other anadromous species currently pass upstream through the lower Susquehanna projects. Table 3-14 provides passage data for the other anadromous species and the gizzard shad, which is a non-anadromous migratory species that moves upstream from Chesapeake Bay to spawn in the spring. All the lower Susquehanna River reservoirs also contain landlocked gizzard shad populations, so fish passage counts at Holtwood, Safe Harbor, and York Haven may also reflect individuals from those populations. The peak passage of river herring occurred at Conowingo in 1997 and 2001, when about 243,000 herring passed in 1997 and 285,000 herring passed in 2001. During those same years, only about 1,000 to 1,300 herring passed the Holtwood Project, less than 1 percent of the number passed at Conowingo, with less than 1,000 herring reaching Safe Harbor in both years. The highest alewife passage (7,458) occurred in 2001. Since 2003, the number of blueback herring and alewife passed at Conowingo has been less than 1,000 fish, with few or no herring and alewife recorded in some years. Since 2003, only sporadic herring and alewife passage has occurred at upriver dams with no herring or alewife passage recorded at York Haven since 2002. Only occasional hickory shad have been passed at Conowingo since 1997, with essentially none appearing at upriver dams. Small numbers of striped bass have been lifted at Conowingo dam (typically in the hundreds of fish per year), and a few of those have been passed at upriver dams, with a few striped bass consistently recorded at York Haven dam.

Catadromous American eel elvers[39] occur at the base of Conowingo dam, and a few may be passed upstream at Conowingo through the fish lift, although fish lifts are generally not effective in passing elvers, which are also difficult to quantify because they are small enough to pass through crowding devices and screens. Some of the eels that manage to pass Conowingo may appear at Holtwood and the upstream dams. Both FWS and Exelon have been collecting eels downstream of Conowingo dam since 2005, to assess the spatial distribution and size characteristics of American eels in the Conowingo tailrace, to assist in determining the feasibility and potential locations for upstream eel passage facilities. These studies used both experimental eel ramps and eel pots on the west shoreline of the tailrace near the west fish lift, as well as in locations near the east

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[39] Elvers are juvenile American eel that ascend the river during the spring and summer months.

fish lift and in the spillway. Catches have been variable, ranging from total annual catches typically in the hundreds up to a maximum of 85,000 eels in eel ramps near the west fish lift in 2011. FWS collected more than 400,000 eels in 2013.[40] Eels collected by the ramps have ranged in length from 76 to 225 millimeters (about 3 to 9 inches) and are likely primarily elvers, while eels collected in the eel pots are generally larger, up to 770 millimeters (30 inches) in length, indicating the presence of older age classes that are residents to the lower river downstream of Conowingo dam.

Table 3-14. Summary of other anadromous fish (not including American shad) and gizzard shad passage on the Susquehanna River, 1997–2014 (Source: Pennsylvania FBC, 2014; SRAFRC annual reports).

Year	Conowingo[a]	Holtwood	Safe Harbor	York Haven
1997				
Blueback herring	242,815	1,042	534	-
Alewife	63	0	1	-
Gizzard shad	344,332	167,916	116,158	-
Hickory shad	0	1	0	-
Striped bass	1,015	4	0	-
1998				
Blueback herring	700	62	16	-
Alewife	6	0	4	-
Gizzard shad	654,575	138,713	102,702	-
Hickory shad	0	0	0	-
Striped bass	1,467	116	12	-
1999[b]	NA	NA	NA	NA
2000				
Blueback herring	14,963	27	159	0
Alewife	2	0	657	2
Gizzard shad	317,753	141,176	120,696	72,972
Hickory shad	0	0	0	0
Striped bass	802	4	3	12

[40] Email from Steve Minkkinen, FWS, Annapolis, MD, to Seth Johnson, Earthjustice, Washington, D.C. December 11, 2013.

Year	Conowingo[a]	Holtwood	Safe Harbor	York Haven
2001				
Blueback herring	284,921	1,300	710	4
Alewife	7,458	1	13	0
Gizzard shad	429,461	188,098	151,873	89,272
Hickory shad	0	0	0	0
Striped bass	543	4	5	8
2002				
Blueback herring	2,037	13	0	0
Alewife	74	0	1	1
Gizzard shad	513,794	107,600	98,137	60,247
Hickory shad	6	0	0	0
Striped bass	913	7	1	10
2003				
Blueback herring	530	3	0	0
Alewife	21	2	0	0
Gizzard shad	459,634	145,732	110,652	112,000
Hickory shad	0	0	0	0
Striped bass	267	2	1	26
2004				
Blueback herring	101	0	0	0
Alewife	89	2	1	0
Gizzard shad	602,677	170,411	127,628	84,234
Hickory shad	0	0	0	0
Striped bass	391	3	0	2
2005				
Blueback herring	4	0	0	0
Alewife	0	0	0	0
Gizzard shad	305,100	52,708	44,331	11,969
Hickory shad	0	0	0	0
Striped bass	49	0	11	6
2006				

Year	Conowingo[a]	Holtwood	Safe Harbor	York Haven
Blueback herring	0	0	0	0
Alewife	0	0	0	0
Gizzard shad	655,990	227,443	179,150	164,869
Hickory shad	4	0	0	0
Striped bass	75	0	8	5
2007				
Blueback herring	460	0	0	0
Alewife	429	0	0	0
Gizzard shad	508,627	121,927	84,466	21,843
Hickory shad	0	0	0	0
Striped bass	127	3	2	0
2008				
Blueback herring	1	0	0	0
Alewife	4	0	0	0
Gizzard shad	919,975	234,967	163,354	15,930
Hickory shad	0	0	0	0
Striped bass	20	0	3	5
2009				
Blueback herring	71	0	0	0
Alewife	160	0	0	0
Gizzard shad	876,412	228,370	170,686	76,995
Hickory shad	0	0	0	0
Striped bass	66	0	0	7
2010				
Blueback herring	4	0	0	0
Alewife	1	0	0	0
Gizzard shad	813,429	182,929	130,482	48,152
Hickory shad	0	0	0	0
Striped bass	34	2	5	6
2011 [c]				
Blueback herring	17	-	-	-

Year	Conowingo[a]	Holtwood	Safe Harbor	York Haven
Alewife	2	-	-	-
Gizzard shad	257,522	-	-	-
Hickory shad	20	-	-	-
Striped bass	21	-	-	-
2012				
Blueback herring	24	0	0	0
Alewife	27	0	0	0
Gizzard shad	1,064,708	211,478	136,369	86,515
Hickory shad	0	0	0	0
Striped bass	122	2	1	5
2013				
Blueback herring	7	0	0	0
Alewife	0	8	0	0
Gizzard shad	1,076,048	418,310	348,753	106,395
Hickory shad	1	0	0	0
Striped bass	200	3	3	7
2014				
Blueback herring	6	0	0	NA[b]
Alewife	130	2	0	NA
Gizzard shad	1,170,200	297,522	216,826	NA
Hickory shad	2	0	0	NA
Striped bass	110	1	6	NA

[a] Passage numbers are for the east fish lift, which releases fish into Conowingo Pond. The west fish lift is operated to collect shad for hatchery egg supply, and for other experimental purposes.

[b] Data were not available from the Pennsylvania FBC website.

[c] In 2011, Conowingo fish passage operations were terminated earlier than normal because construction at Holtwood dam prevented successful operation of the fish lifts. Therefore, all upstream fish lifts were also shut down.

Several other species have successfully used the fish lifts in the lower Susquehanna River, including substantial numbers of game species such as walleye and smallmouth bass. In a review of resident fish passage from 1997 to 2007, 49 fish species were recorded in the fish passage facilities of the lower Susquehanna River (Shiels, 2007). The species that dominates fish passage through the lower river dams is the gizzard shad. The gizzard shad, however, is not considered a game or sport species, does not support a directed fishery, and is considered by many to be useful only as a forage species for other fish during its juvenile life stage, because of its large adult size. The number of gizzard shad annually passing the lower river dams typically numbers in the hundreds of thousands, reaching over a million fish at Conowingo in 2012 and 2013 (see table 3-14). Shiels (2007) reported that gizzard shad comprised about 75 percent of all fish passed over the lower river dams from 1997 to 2007. While the number of gizzard shad passed at each upstream dam decreases substantially between dams, large numbers of gizzard shad are passed annually at York Haven, often exceeding 100,000 fish, as in 2003, 2006, and 2013.

Engineered downstream fish passage facilities have generally not been provided at any of the lower Susquehanna River projects. Studies have been conducted at all of the projects to assess downstream passage of anadromous clupeids and the American eel. In addition, behavioral devices (lights and sound) were tested with shad at the York Haven Project, both as a deterrent to prevent turbine passage and as a guidance mechanism to move fish toward the forebay sluice gate for safe passage. Downstream passage at York Haven occurs via natural spillage over the dam or via the forebay sluice gate in combination with lights and sequencing of unit operations. Downstream passage at the other projects has generally been via the turbines, where passage survival has been found to be relatively high for juvenile anadromous clupeids (particularly at Safe Harbor and Conowingo). For example, at Safe Harbor dam, downstream passage survival was estimated at 97 percent for juvenile shad and 88 percent for adult shad (RMC Environmental, 1991; Normandeau, 1998), and at Conowingo dam at 90 to 95 percent for juvenile shad and about 90 percent for adult shad (Normandeau and Gomez and Sullivan, 2012f; 2012i). Some fish may also pass downstream over the project spillways if a high-flow event and spillage coincides with the outmigration period.

Freshwater Mussels

York Haven Project

Strayer and Fetterman (1999) list 14 mussel species from the Susquehanna River system. Spoo (2008) reported 13 species from the Susquehanna River system, and the Pennsylvania Natural Heritage Program reported seven mussel species from Lancaster County in the vicinity of Brunner (Lows) Island and Conewago Creek. Meyer (2010) reported an apparent decline in populations of the eastern elliptio in Pennsylvania, although it is considered stable throughout most of its north Atlantic slope distribution (NatureServe, 2010).

A mussel reconnaissance survey was conducted in July 2010 during low-flow conditions (6,000 cfs at USGS 01570500 gage at Harrisburg, Pennsylvania) at the York Haven Project. Based on substrate conditions, water depth, and velocity, representative aquatic habitat types within the project area were searched for live mussels and shells. Shoreline and exposed bars were checked for shell material and middens.[41] Using results from the reconnaissance survey, seven sites were chosen for detailed analysis in four areas: main channel 1 (spillway reach), main channel 2 (middle section), main channel 3 (lower section including the powerhouse area) and the east channel of the river (figure 3-12).

A detailed survey was conducted in August 2010 when discharge was 6,000 to 7,000 cfs at USGS 01570500 gage at Harrisburg, Pennsylvania. Five species and 56 live mussels were collected during 23.4 hours of searching (tables 3-15 and 3-16). An additional four species were found only as dead shells. Catch-per-unit-effort (CPUE) ranged from 2.7 to 9.3 at three locations, and with an average value of 2.6 for all sites combined. The mussel assemblage was dominated by eastern floater which comprised 58.9 percent of the fauna and was approximately three times more abundant than the second most common species, yellow lampmussel. Several small eastern floaters and a single juvenile yellow lampshell were collected, which indicates that these species are likely recruiting in the area.

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[41] Middens are small collections or piles of mussel shell material, often accumulating as a result of river flow patterns.

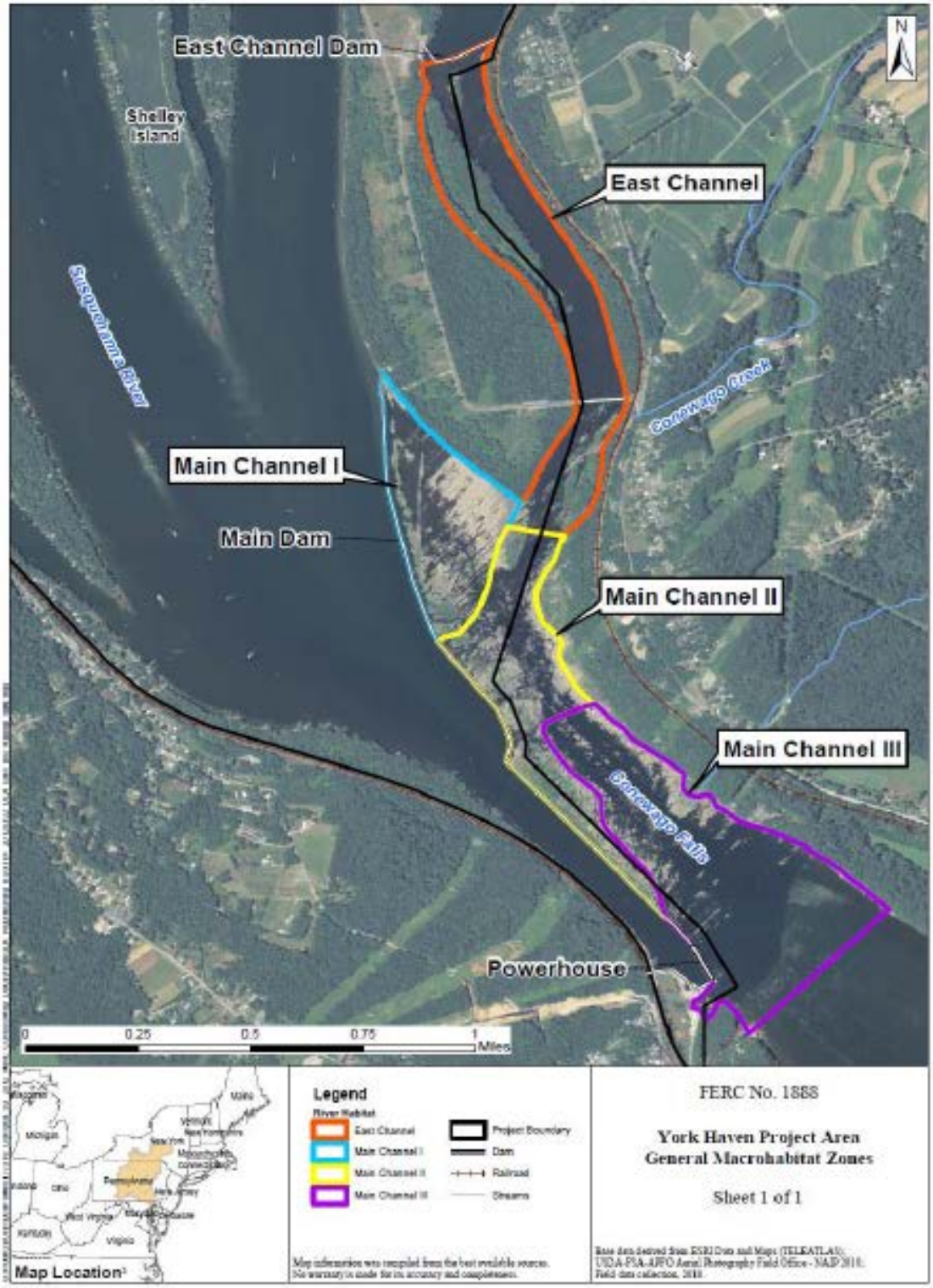

Figure 3-12. Mussel sampling sites located below the York Haven Power Plant, Susquehanna River (Source: York Haven Power, 2012a).

Table 3-15. Mussel species collected in the Susquehanna River, York Haven Project, August 2010 (Source: York Haven Power, 2012a).

		Live Mussels			
Common Name	**Scientific Name**	**Number**	**% Abundance**	**Shell Material**	**Status[a]**
Eastern floater	*Pyganodon cataracta*	33	58.9	X	Not listed
Yellow lampmussel	*Lampsilis cariosa*	10	17.9	X	S3, S4
Eastern elliptio	*Elliptio complanata*	7	12.5	X	Not listed
Alewife floater	*Anodonta implicata*	4	7.1	X	S3, S4
Creeper	*Strophitus undulatus*	2	3.6	X	Not listed
Rainbow mussel	*Villosa iris*			X	S1
Green floater	*Lasmigona subviridus*			X	S2
Susquehanna elktoe	*Alasmidonta marginata*			X	S4
Triangle floater	*Alasmidonta undulata*			X	S3, S4
Total live mussels		56			

[a] Status designations are based on Pennsylvania Natural Heritage Program (PNHP, 2011a) and PNHP (2011b): S1-Criticially imperiled; S2-Imperiled; S3S4-Vulnerable/apparently secure; and S4-Apparently secure.

Table 3-16. Live mussels collected using semi-quantitative methods in the Susquehanna River, York Haven Project, August 17 to 18, 2010 (Source: York Haven Power, 2012a).

Location	Total Search Time, hours	CPU, #/hour	Species	Number
1-Main Channel tailrace	3.65	0.0	None	
2a-Main Channel, LDB	2.00	0.0	None	
2b-Main Channel, RDB	0.35	0.0	None	
3-Main Channel	1.52	0.0	None	
4-Spillway Con	5.25	2.7	Eastern floater	8
			Alewife floater	3
			Yellow lampmussel	3
5-East Channel DS Bridge	3.20	0.0	None	
6-East Channel, US Bridge	2.08	3.4	Eastern floater	5
			Yellow lampmussel	2
7-Upper East Channel	3.75	9.3	Eastern floater	20
			Eastern elliptio	7
			Yellow lampmussel	5
			Creeper	2
			Alewife floater	1
For the project Area	21.80	2.6		56

Aquatic habitat in the project area consisted mainly of bedrock and boulders, which is not particularly suitable for freshwater mussels. No live mussels were found at sites 1-3 in the main channel. Virtually all of Site 1 was unsuitable, and the unconsolidated substrate between boulders and bedrock outcrops at Sites 2a, 2b, and 3 was only marginally suitable for mussels. Fourteen mussels representing three species were found at Site 4, in the upper reach of the main channel in the project area, which consisted mainly of bedrock with only small amounts of gravel.

No live mussels were found at Site 5 in the lower east channel, which was characterized by high velocity water, bedrock, boulders, and only small areas of cobble and gravel overlain by sand. Live mussels were collected at Sites 6 and 7, in the mid and upper east channel, respectively. Seven live mussels (eastern floater and yellow lampmussel) were collected during 2.08 hours of searching at Site 6. Habitat at this

location was more suitable for mussels than at Site 5, and was a shallow pool/slow run with a mixture of cobble, gravel, and sand with some bedrock and boulders. Site 7 in the upper east channel supported the most abundant assemblage in the project area; 5 species and 35 individuals were collected and overall CPUE equaled 9.3. Substrate was a mixture of gravel, cobble, and sand with some areas of silt.

Comparatively small numbers of live native mussels were taken in this semi-qualitative survey; therefore it is not possible to provide a thorough analysis of population demography or recent recruitment in the York Haven Project area. Based on survey results, total shell length for eastern floater ranged from 40-110 millimeters, and for yellow lampmussel from 43-98 millimeters. Intermediate sized organisms of both species were collected, and presence of comparatively small-sized individuals indicates that at least these two species had recruitment in or immediately outside the project area within the last several years. No federally listed threatened or endangered mussel species were found during this survey.

Muddy Run Project

Native freshwater mussels were not collected in Muddy Run reservoir or in the Susquehanna River below the dam. No federally listed threatened or endangered mussel species have been reported within the project boundary.

Conowingo Project

Marshall (1930) surveyed for mussels in September 1929, approximately 1 year after Conowingo dam was constructed. He reported two live eastern elliptio, as well as yellow lampmussel (one shell) and eastern lampmussel (*Lampsilis radiata*) (four shells). Ashton (2009) described results from three surveys conducted during 2008 and 2009. Methods included benthic trawling and SCUBA diving by personnel from Marshall University, West Virginia, and collections by personnel from Maryland DNR's Monitoring and Non-tidal Assessment Division. Live individuals and dead shells of six species were found in 2008 and 2009, including eastern elliptio, alewife floater, eastern floater, tidewater mucket, northern lance (*Elliptio fisheriana*), and creeper. Ashton (2009) also reported that eastern lampmussel was collected in 1990 and 1998 by personnel of Maryland DNR's Natural Heritage Program. In 2010, Ashton conducted mainly timed-snorkel searches in suitable mussel habitat downstream of Conowingo dam (Ashton, 2011). He collected dead shells of northern lance (*Elliptio fisheriana*), not taken in his previous two surveys, and was the first to report the presence of the invasive zebra mussel (*Dreissena polymorpha*) in the project area.

Contact with nine museums yielded few historical records for mussels in the project area. Three records from the National Museum of Natural History in Washington, D.C., were from upper Chesapeake Bay approximately 8 to 10 miles downstream of the study reach; one was for tidewater mucket and two were for eastern lampmussel. The Canadian Museum of Nature had two records from the Susquehanna River near the mouth of Deer Creek. One is for eastern elliptio and the other is for

Anodonta fluviatilis, a taxon that is no longer recognized. It is likely this was the eastern floater (*Pyganodon cataracta*) based on synonymies in Strayer and Jirka (1997). Two additional records at the Canadian Museum of Nature were for eastern elliptio and the eastern lampmussel. The exact location of these records was not clear, although they were likely from downriver of the project area.

In 2010 and 2012, semi-quantitative (timed searches) mussel surveys were conducted in the Susquehanna River below Conowingo dam (figure 3-13). The 2010 studies were conducted by Normandeau and Gomez and Sullivan (2012e), and the 2012 studies were conducted by Biodrawversity and Gomez and Sullivan (2012). A total of 128 sites were sampled using semi-quantitative methods during the 2 years. In 2010, locations likely to support live mussels were sampled; the 2012 study was designed to include areas not covered during the first survey. Semi-quantitative collections were obtained by wading, snorkeling, or SCUBA diving. During the 2012 survey, notes were made on water depth, substrate type, and flow conditions.

Five species and 6,301 native mussels were collected in 2010 and 2012 using semi-quantitative methods (table 3-17). For all species and sites combined, CPUE ranged from 0 to 612 (mean = 64.1, standard deviation = 94.5). Most of the sites with the greatest number of mussels were within or near tidal areas at the downstream end of the study reach. CPUE values of less than 5.0 were recorded at 21.1 percent of the sites. Although sites with comparatively few mussels were found throughout the area, most were located near the mouth of Octoraro Creek, near Bird Island, Rowland Island, or in the back channel of Mud Island at the upstream end of the study reach. Overall, the fauna was strongly dominated by eastern elliptio which comprised 96.3 percent of the assemblage and was found at 93.7 percent of the sites. Average CPUE for this species was 61.7 (standard deviation = 91.8). Eastern elliptio was particularly abundant in the downstream portion of the project area, mainly in tidal areas. The remaining four species together comprised less than 4 percent of the fauna; average CPUE for each ranged from 1.55 (standard deviation = 2.99) to 0.10 (standard deviation = 0.48). A single shell of the creeper was found in the project area by Maryland DNR in 2010.

No federally listed threatened or endangered mussel species were found during this survey. In the state of Maryland, alewife floater was listed as S3, eastern lampmussel was listed at S1 and S2, and tidewater mucket was listed as SU (table 3-17).

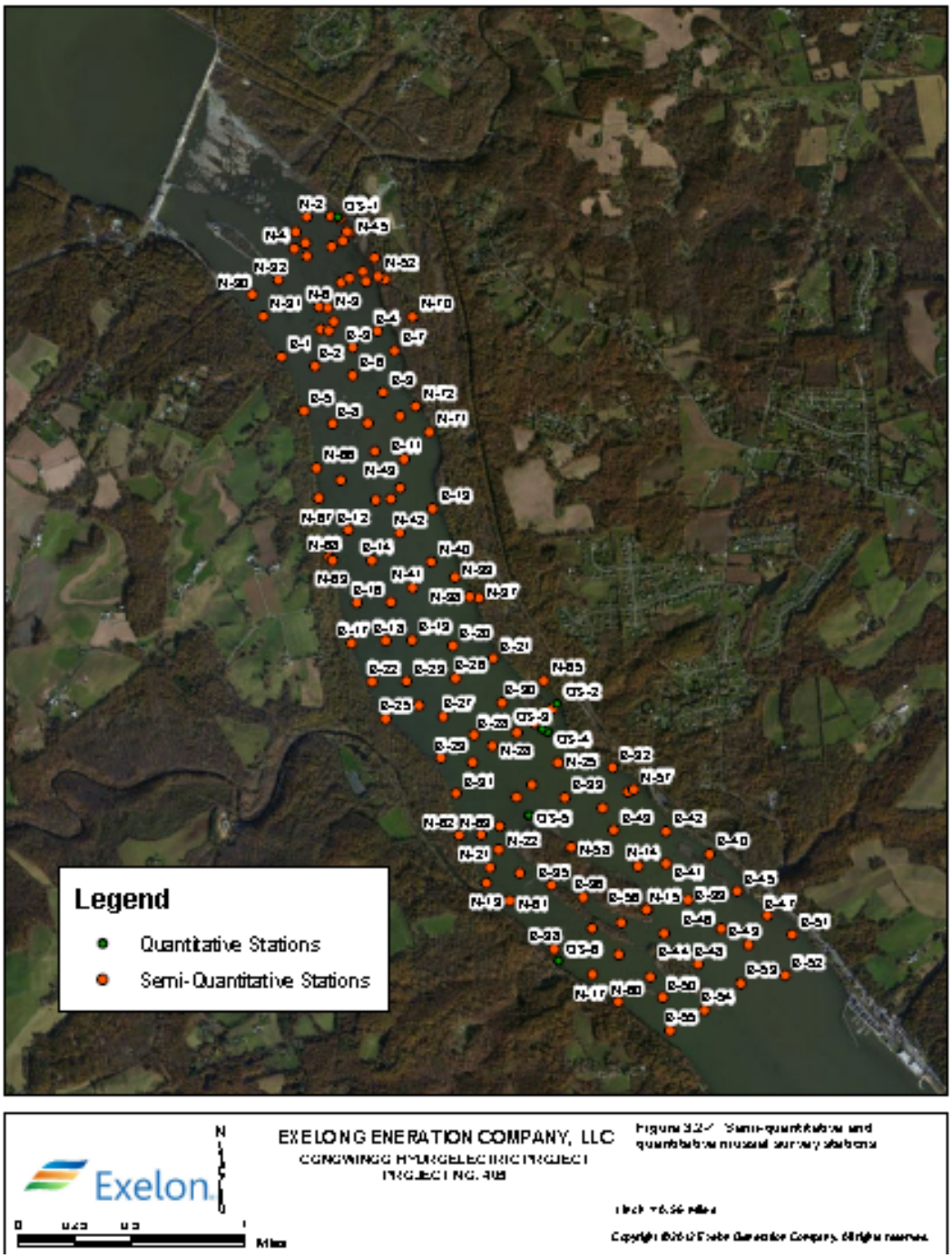

Figure 3-13. Mussel sampling sites located below Conowingo dam, Susquehanna River.

Table 3-17. Freshwater mussels collected in the Conowingo Project area (Source: Biodrawversity Inc. and Gomez and Sullivan Engineers, 2012).

Common Name	Species	Percent Abundance	Frequency of Occurrence	CPUE		
				Mean	SD	Status[a]
Eastern Elliptio	*Elliptio complanata*	96.3	93.8	61.70	91.8	
Alewife Floater	*Anodonta implicata*	2.1	35.9	1.55	2.99	S3
Eastern Floater	*Pyganodon cataracta*	1.1	22.7	0.47	1.11	
Tidewater Mucket	*Leptodea ochracea*	0.4	17.2	0.25	0.69	SU
Eastern Lampmussel	*Lampsilis radiata*	0.1	5.5	0.10	0.48	S1, S2

Notes: Results of two similarly conducted surveys were combined: Normandeau Associates (August 9– September 3, 2010), and Biodrawversity (July 16-19, 2012). A total of 6,301 live mussels were collected using semi-quantitative methods at 128 sites.

[a] Status from the Maryland Natural Heritage Program (2010): S1-Criticially imperiled; S2-Imperiled; S3-Vulnerable; and SU - Possibly rare in Maryland, but of uncertain status.

A total of 117 live mussels were collected in the 66 quadrat samples collected during both study years. The fauna was dominated by eastern elliptio (95.7 percent), and equal numbers of alewife floater and eastern floater (both 3.1 percent). Mean total density ranged from a low of 0.11 (99 percent confidence interval: -0.07 to 0.29) to a high of 4.26 (99 percent confidence interval: 1.39 to 7.15). The highest densities were obtained at two locations in the secondary channel of McGibney Island. Mussels were more likely to be found in quadrats where silt, sand, and gravel comprised 30 to 80 percent of total substrate. Population estimates for all species combined for the 450 m^2 plots ranged from 50 mussels (90 percent confidence interval = -32 to 132 mussels) to 1,920 mussels (90 percent confidence interval = 623 to 3,217 mussels).

The mussel fauna in the project area was characterized by dominance (>95 percent) of a single species (eastern elliptio), and fewer numbers of five other species. Physical conditions of substrate and water velocity were patchy throughout the project area, and this likely caused the high variability in overall CPUE, which ranged from at or near 0 to over 600. Although it can be difficult to assess recent recruitment of these long-

lived organisms over a short sampling period, few small individuals of any species were taken in either type of sampling. Based on quantitative sampling, 95 percent of eastern elliptio measured 60 to 130 mm and only two were less than 40 mm total shell length. Only a single (0.01 percent of the total collection) juvenile-sized (32.0 mm) eastern floater was collected using semi-quantitative methods.

The distribution of freshwater mussels varies with distance from Conowingo dam, proximity to tidal influence, substrate conditions, and hydraulic conditions. Results indicate that water velocity, shear stress, and substrate type affect mussel distribution. In the project area, mussel species were either very uncommon or not collected in habitats prone to frequent dewatering, areas with poor substrate, or areas subjected to high shear stress. Mussels were more prevalent where modeled shear stress was relatively low. Areas of highest CPUE observed in this study were typically along the east side of the river in the downstream half of the project area, where flow is considerably less than near the dam in the upstream half of the project area. In addition to this overall trend, the several sites with highest CPUE values in the project area also occurred in zones of local flow refugia, where stream flow models showed shear stress to be lower than in immediate surrounding areas. These results are similar to findings from other mussel studies from other parts of the country (Layzer and Madison, 1995; Strayer, 1999; Morales et al., 2006; Allen and Vaughn, 2010).

Invasive Species

York Haven Project

Asian clams (*Corbicula* sp.) were collected downriver of the York Haven Project as part of macroinvertebrate studies. Although zebra mussels have been found in the upper Susquehanna River drainage (Kazyak et al., 2005), none were found in Lake Frederic or downriver of the project area.

Muddy Run Project

Dead zebra mussel shells were observed along the shore of Muddy Run reservoir in November 2008, approximately 1 month after they were discovered in Conowingo Pond.

Conowingo Project

Zebra mussel veligers were found in 2009 and 2010 in the intake canal at PBAPS on the west bank of Conowingo Pond in Delta, Pennsylvania, during Exelon's ongoing zebra mussel monitoring program at PBAPS. Zebra mussels were found at eight sites downstream of Conowingo dam; three were close to the dam, and the remainder were collected either at the mid- or extreme-lower portion of the project area. Asian clams were observed at nearly every site in the project area (Ashton, 2009).

3.3.2.2 Environmental Effects

Brunner Island Station Cooling Water

The Brunner Island Station, owned by PPL Brunner Island LLC (PPL BI), is located 1.5 miles downstream of the York Haven powerhouse on the west side of the Susquehanna River. The station is a coal-fired generating station that uses up to 1,200 cfs of water from the river for cooling when operating at full capacity. Stations such as this typically run at a set output, preferably peak or full capacity, to provide baseload electricity to the power grid. They are typically operated at that level for a set period of time, or run continuously, as needed. On August 6, 2012, PPL BI filed comments pertaining to the York Haven Project draft license application with the Commission expressing its concerns that, under low-flow conditions, new minimum flow requirements could allow the river flow in the vicinity of the Brunner Island Station water intake to fall below 1,200 cfs (PPL BI, 2012). PPL BI's concern is that, during low-flow conditions when flows fall to or below 1,200 cfs, large areas of exposed rock can cause debris to affect water flow patterns in the natural channel upstream of, and in the vicinity of, the Brunner Island Station water intake.

In the final license application, York Haven Power stated that it did not anticipate changing its flow releases, and that it would consult with PPL BI if that changed. York Haven Power also stated in exhibit B of the license application that it voluntarily releases 1,000 cfs on the west side of the river for the benefit of the Brunner Island cooling water intake. Although the Settlement Agreement would change where flows are released from York Haven dam and generally reduces the magnitude of the releases at those locations, the minimum flows at the project would remain as a continuous minimum flow of 1,000 cfs and a 2,500 cfs average daily minimum flow (or inflow, if less) downstream of the project as currently licensed. Inflow is based on river flows as recorded at the USGS gaging station at Harrisburg, Pennsylvania.

On February 19, 2014, PPL BI filed a Protest and Comments on the Settlement Agreement (PPL BI, 2014). PPL BI stated that York Haven Power had not consulted with it during the settlement process and reiterated its concerns that the proposed minimum flow releases would result in periods of time when river flows downstream of the York Haven Project in the vicinity of the Brunner Island Station water intake would fall below 1,200 cfs, requiring PPL BI to reduce output at Brunner Island Station accordingly. PPL BI also stated that this has happened in the past, resulting in a station shutdown, further resulting in fish kills due to thermal changes in the Brunner Island Station discharge channel. PPL BI requested that a new license for the project include a requirement to release a continuous minimum flow of 1,500 cfs to ensure that Brunner Island Station operation is not affected.

On March 4, 2014, York Haven Power filed additional information with the Commission to support its proposal and contend that PPL BI's concerns about the proposed operation of the York Haven Project are unfounded. It provided the additional

information to demonstrate that York Haven Power is not responsible for any detrimental effects on Brunner Island Station due to instream flows (York Haven Power, 2014b).

York Haven cited historical flow data provided in the license application that show extreme low flows in the range of 2,000 cfs.[42] York Haven Power notes that sections 3.2.1(cc) and 3.2.2 of the Offer of Settlement state that, when inflows are less than 3,000 cfs, the project (York Haven) would be operated on a run-of-river basis, adding or suspending operations at turbines to reflect, to the extent practicable, inflow from upstream and without adding or suspending turbine operations to deliberately draw down or store water for purposes of generating electricity during particular time periods. As such, York Haven Power would have no ability to provide additional flows to ensure that Brunner Island had sufficient flows to operate at full capacity.

York Haven Power suggests that PPL BI did not understand York Haven Power's proposed minimum flow releases related to the proposed nature-like fishway and the reduced flows for the east channel fishway. A flow of 200 cfs would be diverted from the east channel fishway and passed through the nature-like fishway. Because the nature-like fishway is farther downstream of the east channel on the west shore of the bypassed reach, the flows passing downstream of the project would be distributed in a similar pattern to existing releases. York Haven Power expects that the result would be at least as favorable, if not more favorable flow conditions for operation of the Brunner Island station, than what is currently occurring.

In response to PPL BI's concern that the distribution of flows in the vicinity of the Brunner Island cooling water intake may affect its ability to receive adequate flows at Brunner Island, York Haven Power notes that once the flows pass downstream of the York Haven Project, the project has no control over the distribution of flows in the natural channel.

With regard to debris in the channel that could hinder flows reaching the Brunner Island intake, York Haven Power points to its debris management program, which entails the passing of natural debris that accumulates in the forebay following notification to PPL BI that debris would be released. Any other debris passes over the east channel and main dams without being handled by York Haven Power. York Haven Power states that it has no control over the debris or where it may accumulate downstream of the project.

Our Analysis

Under the terms of the Settlement Agreement, the York Haven Project would operate under run-of-river operation during extreme low-flow periods, and would therefore have no ability or responsibility to provide supplemental flows to enable the Brunner Island station to operate at full capacity under such flow conditions. The Settlement Agreement would change where flows are released from York Haven dam and

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[42] The actual minimum value from the record was 2,066 cfs.

generally reduces the magnitude of the releases at those locations, but the minimum flows at the project would remain as a continuous minimum flow of 1,000 cfs and a 2,500 cfs average daily minimum flow (or inflow, if less) downstream of the project as currently licensed. Thus, these changes would not be noticed at Brunner Island. Further, York Haven Power would provide PPL BI with advanced notice when debris is going to be manually passed downstream, and York Haven Power has no control over the debris once it passes downstream.

Competing Water Withdrawals within Conowingo Pond

There are several entities that draw water from the Conowingo Pond as discussed in section 3.3.2.1, *Water Resources, Affected Environment*, some of which are consumptive uses; others return water to Conowingo Pond. Although the current license allows Exelon to operate Conowingo Pond between elevation 101.2 feet and 110.2 feet, the pond is typically not drawn below elevation 105.2 feet to ensure adequate volume to meet the water withdrawals from Muddy Run and PBAPS. The other water withdrawals are very small in comparison to the withdrawals from Muddy Run and PBAPS. The pond is typically maintained at about elevation 109.2 feet. Exelon proposes to continue the current water level management in Conowingo Pond.

Although competing water withdrawals was included as a scoping issue, no specific stakeholder concerns were raised in regard to competing withdrawals in response to the license application for the Conowingo Project and the proposed project operation.

Our Analysis

The current water level management has provided adequate water supply for the existing water withdrawals, and the proposed continuation of this management should continue to be adequate.

Downstream Flooding at the Conowingo Project

Flooding downstream of Conowingo dam in the town of Port Deposit, Maryland, was raised as an issue during scoping by the mayor of the town. The mayor indicated that flooding occurs frequently and that it should be adequately evaluated during scoping studies. The mayor also indicated that the relationship between dam releases, coordination of those releases with the upriver dams, and flooding should be examined and the full range of solutions explored. The mayor also suggested that solutions could include better flow anticipation, management, and coordination of releases and physical/structural actions to prevent flooding (i.e., flood control doors on the underpasses in town and storm drain check valves devices).

Exelon does not propose any project operational changes in regard to downstream flooding, and none of the stakeholders recommended changes in the agency terms and conditions or public comments filed with the Commission following the filing of the final license application.

Our Analysis

Exelon conducted a study in 2011 (Gomez and Sullivan, 2012a) using a HEC-RAS model to evaluate the Conowingo Project's actual and potential influence on downstream flooding at Port Deposit during several flood events (10-, 50-, 100-, and 500-year floods). Three alternative operating scenarios were investigated for their potential to reduce downstream flooding. The first alternative simulated drawing down Conowingo Pond prior to arrival of high-flow events. The second alternative simulated the effect of targeting lower pond levels during the storm. The third alternative simulated using the reservoir storage during the storm peak to reduce downstream flows. Additionally, a no-dam scenario was included, which simulated Port Deposit stage time series to estimate what conditions would be like if Conowingo dam did not exist.

The study results indicated that none of the alternative operating scenarios evaluated would substantially reduce downstream flooding. The first alternative was found to have no effect on downstream flooding magnitude and only a slight reduction in flooding duration. The second alternative had no considerable effect on flooding magnitude or duration (less than 15 minutes). The third alternative negligibly reduced flooding magnitudes (less than 0.02 foot) and duration (less than 15 minutes). The no-dam scenario had slightly increased (0.00 to 0.08 foot) flooding magnitudes and slightly decreased flooding durations, relative to existing conditions.

Based on the study results, Conowingo Project operation has little effect on downstream flooding. The three alternatives investigated that were considered to be the best possible mitigation alternatives showed negligible or no improvement over existing conditions. The storage available in Conowingo Pond is not enough to mitigate even relatively small events such as the 10-year flood. The no-dam scenario showed the current flooding durations would only be slightly different than if the dam did not exist. The study concluded that substantially higher storage capacity would be required in Conowingo Pond in order for the project to be a viable flood control mechanism. There do not appear to be any operational changes that could be made that would reduce Port Deposit flooding for the 10-, 50-, 100-, or 500-year storm events.

Water Quality Effects

<u>York Haven Project</u>

As described in section 3.3.2.1, *Water Resources, Affected Environment*, water quality in the York Haven Project area generally meets state water quality standards, and there have been no specific recommendations made by commenting entities regarding measures required to protect or enhance water quality. The Settlement Agreement also did not include any specific measures to address water quality.

Our Analysis

Water temperatures exceeded the maximum state standard of 87°F (temperatures as high as 93°F were recorded) up to about 19 percent of the time in sampling locations at

the head of the project impoundment and at the upstream tip of Shelley Island. This indicates that inflows to the project reservoir already exceeded state standards due to normal summer warming. Water temperatures recorded in the project tailrace exceeded the state standard only about 12 percent of the time. While small localized deviations from water quality standards (water temperature and DO) have been reported in parts of the reservoir, those deviations are not a result of project operation. The operation of the Three Mile Island nuclear station does not appear to have any effect on water temperatures or thermal stratification at the project. The station has a closed-loop cooling system and does not discharge heated waters to the project reservoir.

DO levels were below state standards for 4 percent and about 1 percent of the sampling observations at only two of the sampling sites--the shoreline of Hill Island and a location in the east channel upstream of the dam--respectively. Diurnal fluctuations in DO were also observed in the reservoir as a result of the natural photosynthesis/respiration cycle, particularly in areas with substantial SAV beds. Fluctuations in pH levels in the reservoir also appeared to reflect natural variations.

Muddy Run Project

As described in section 3.3.2.1, *Water Resources, Affected Environment*, waters discharged from the project generally meet state standards, although DO levels occasionally drop below state standards during the warmer summer months. The Muddy Run reservoir does not thermally stratify, but does exhibit DO stratification in the main reservoir in some locations, with DO levels as low as 2.4 mg/L at depth. Substantial mixing occurs in the reservoir near the head of the intake canal during project operation, particularly during pumping operation when Susquehanna River (Conowingo Pond) waters are entering the reservoir. In 2011, monitoring at times showed a weak inverse DO stratification (higher DO in deeper water and lower DO in surface water) as Susquehanna River waters entered the reservoir at depth, under the Muddy Run reservoir surface waters that were lower in DO. All other measured parameters met state standards.

Exelon proposes to implement the conditions in the draft certification, which states that it must maintain state water standards at the project, and requires that it submit a DO monitoring plan to Pennsylvania DEP no earlier than November 1, 2027; implement the plan; and if violations in state standards occur (fail to meet criteria less than 99 percent of the time), submit a plan to Pennsylvania DEP to resolve any DO violations. Pennsylvania DEP issued a final certification on June 3, 2014. While Exelon has not indicated the final certification represents its proposal, our review of the draft and final certifications found that they are nearly identical, and therefore we assume that Exelon's proposal has not changed.

There were no other specific recommendations from stakeholders or agencies regarding water quality measures in response to the final license application. However, during scoping, questions were raised by FWS about the potential effects of flow

reversals[43] in Conowingo Pond associated with Muddy Run pumping operation during low-flow conditions, and the possible re-distribution of heated discharges from PBAPS.

Our Analysis

Exelon recorded some instances when DO levels within the Muddy Run reservoir and in discharges from the project did not meet state standards (see table 3-10 and 3-11). In general, project releases had fewer instances where DO did not meet the state standard than did the reservoir. The Muddy Run Project discharges into the upper, more riverine reach of Conowingo Pond where river velocities are typically strong as a result of discharges from the upstream Holtwood Project. This results in immediate mixing of Muddy Run discharges with the Susquehanna River flow and would act to quickly raise DO levels to above state standards. Based on Exelon's monitoring studies, and the location of the project at the upstream reach of Conowingo Pond, there appears to be no need to require measures to further protect or enhance water quality. Nevertheless, the certification conditions when implemented would ensure that state DO standards are maintained.

Regarding the potential for Muddy Run pumping operation to result in flow reversals that would draw heated water from the downstream PBAPS in an upstream direction toward the Muddy Run Project, Exelon's studies did not find any instances of the PBAPS' heated discharge reaching as far upstream as the Muddy Run tailrace.

Conowingo Project

In section 3.3.2.1, *Water Resources, Affected Environment*, we describe existing water quality conditions in both Conowingo Pond and in the river downstream of Conowingo dam. Based on many years of monitoring in Conowingo Pond, the pond exhibits DO stratification (higher DO levels in near-surface waters and low DO levels at depth) resulting in the potential for entrainment of lower DO waters through the low-level intakes. This occurred over a period of years until Exelon installed turbine venting in Units 1 through 7 between 1989 and 1991, and aerating turbine runners in two of the seven Francis units (Units 2 and 5) in 2005 and 2008. As a result of these modifications, releases from Conowingo dam now meet state standards nearly 100 percent of the time. Water temperature has not been an issue at Conowingo, and normally meets state standards, even with the presence of the heated discharge from PBAPS into Conowingo Pond.

Commenting entities did not recommend additional water quality enhancement measures at Conowingo, although The Nature Conservancy recommends that project

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[43] Flow reversals mean that flow patterns in Conowingo Pond may be affected by Muddy Run Project pumping such that currents would move upstream toward the project, potentially pulling the heated PBAPS discharge upstream or causing a wider distribution of heated waters in the pond.

operation not result in violation of water quality standards or non-attainment of water quality criteria established for the river and Chesapeake Bay, including the Chesapeake Bay TMDL. Maryland DOE, in its comments in response to the REA notice, states that it is premature to make conclusions as to the effect of the project on water quality, because it would fully assess project effects during its review of the certification application.

Our Analysis

For the two water quality parameters that may be typically affected by hydroelectric project operation, water temperature and DO, existing project operation generally does not exceed state standards. Past violations of state DO standards have been eliminated by the addition of turbine venting to seven Francis units and aeration to two of the seven Francis units. While comments were filed regarding the effects of the project on nutrients and sediment loading (discussed in the following section), there appears to be no need for further measures to protect or enhance water temperature and DO at the project.

Sediment and Nutrient Loading

Sediment transport in the Susquehanna River and the effects of the presence of the lower river hydropower reservoirs on that transport are of concern to many stakeholders. This is primarily an issue for the Conowingo Project, because it has the largest and deepest reservoir on the lower river, and the greatest capacity for sediment storage. The York Haven Project reservoir has minimal storage capacity, because of its small size and shallow depth. The Muddy Run Project, because it is an off-stream pumped storage reservoir, also has minimal effect on sediment transport or storage in the river. Sediment transport is discussed in detail in section 3.3.1, *Geology and Soils*.

Sediment transported by the river is also rich in nutrients (nitrogen and phosphorus). With the Susquehanna River being the largest source of freshwater to Chesapeake Bay, it is also the largest source of nutrients, contributing about 70 percent of the total nitrogen and 55 percent of the total phosphorus (Smullen et al., 1982, as cited by Cheng et al., 2013). These nutrients and organic matter in the sediment support the growth of phytoplankton, algae, and aquatic plants, but if high nutrient loading occurs, this may enhance eutrophication and result in hypoxia (the depletion of DO in the water column). High turbidity levels associated with high sediment loads may also block sunlight in the water column, adversely affecting plant photosynthesis and the production of DO. As we previously described, EPA has set a TMDL for Chesapeake Bay with total watershed limits on the contribution of nitrogen, phosphorus, and sediment to the Bay. The TMDL calls for a reduction in that loading from current levels.

Exelon proposes a sediment management plan to control sediment from project lands, to identify benchmarks for actions needed to address sediment issues that would affect project operation, and it would conduct a bathymetric survey every 5 years to track depositional patterns in the pond. EPA, Maryland DNR, SRBC, NMFS, Chesapeake Bay Foundation, Stewards of the Lower Susquehanna, Inc., Midshore Riverkeeper's

Conservancy, Inc., and the Clean Chesapeake Coalition state that Exelon's proposed management plans are not ready for analysis without an understanding of the sediment-related effects of scour in Conowingo Pond during peak flow events on the water quality and living resources in Chesapeake Bay. The Stewards of the Lower Susquehanna, Inc., also recommend that Exelon remove at least 4 million tons of sediment annually from the reservoir to eventually remove all sediment subject to scouring. The Clean Chesapeake Coalition requests that Exelon be required to dredge Conowingo Pond and restore oyster beds north of the Bay Bridge and SAV in the upper Bay and its tributaries that were buried by sediment scoured from Conowingo Pond. The Town of Port Deposit, American Rivers, and Henry Immanuel also recommend that Exelon prevent and mitigate for the downstream effects of scoured sediments. Maryland DNR notes, however, that it is premature to conclude that the Corps' LSRWA study (described above in *Geology and Soils*) will be adequate to appropriately identify and evaluate sediment and nutrient effects on the Bay's resources related to the Conowingo Project.

Our Analysis

As we describe in *Geology and Soils*, sediment and nutrient loading from the Susquehanna River Basin is a long-term natural process that has been interrupted by the construction of the lower river hydropower reservoirs. Beginning in 1910, with the construction of Holtwood dam, followed by the construction of Conowingo and Safe Harbor dams in 1928 and 1930, a portion of the Susquehanna River sediment and nutrient load has been stored in these reservoirs, and has not reached Chesapeake Bay. So, during parts of the past 100 or so years, nutrient loading in the Bay has been lower than it would have been without the lower river reservoirs. Some of this sediment and nutrient load, however, has been and continues to be re-suspended and scoured from the reservoirs during flood events, and deposited in the Bay. The Bay TMDL does recognize that this is a watershed-wide issue.

Some commenters have suggested dredging Conowingo Pond, to allow for continued storage of sediment and nutrients, and to avoid the large spikes in loading that may occur during scouring flood events. The TMDL recognizes the existing storage capacity of the three lower river reservoirs, and that storage capacity may be reduced over time as the reservoirs fill in. If that occurs, the TMDL requires that governmental jurisdictions in the watershed might need to increase their sediment and nutrient-reduction efforts to meet the allocations they have been assigned in the Bay TMDL. A primary focus of the TMDL is the preparation of watershed implementation plans that detail how and when the six Chesapeake Bay states and the District of Columbia will meet their pollution allocations in the TMDL. It is reasonable that Exelon and the other project owners on the lower river are not considered the primary source of sediment and nutrient loading to the Bay, and that the TMDL recognizes that it is a watershed issue. We find no justification at this time for requiring Exelon to implement measures such as dredging to help control sediment and nutrient loading in the Bay, which would occur in the long term whether or not Conowingo dam was in place.

Reservoir Fluctuations

York Haven Project

Reservoir fluctuations have the potential to dewater shoreline habitat, which could strand nearshore biota such as young fish, especially if drawdowns occur during the spawning and rearing season for shoreline spawning nestbuilders such as smallmouth bass, largemouth bass, and sunfish. Fluctuations can also limit the development of SAV and emergent vegetation. Nearshore aquatic vegetation is often an important habitat element for benthic macroinvertebrates and fish.

York Haven Power proposes to continue to operate the York Haven Project as it has in the past, in a run-of-river mode with a maximum drawdown of 1.1 feet for purposes of dam maintenance. No specific recommendations pertaining to reservoir fluctuations have been made by any commenting entities, and the Settlement Agreement does not include any measures that pertain to reservoir fluctuations.

Our Analysis

The proposed continued operation of the project in a run-of-river mode would result in nearly constant reservoir water surface elevations, when the project has sufficient control over river flows. Flow and reservoir level fluctuations would continue to occur during high-flow events, or changing natural inflows, but this would be beyond the control of the project. Drawdowns of up to 1.1 feet are reserved for specific project maintenance activities and are generally scheduled for late summer through fall. This timing avoids the spring to mid-summer spawning period of nearly all resident fish, and the young of shoreline nest building species would have reached the juvenile life stage and be mobile enough to leave shallow shoreline habitat prior to any maintenance drawdown. There has been no evidence of fish stranding or any negative effect on nearshore spawning habitat attributed to the current drawdown regime.

Muddy Run Project

Muddy Run reservoir can have water surface elevation changes of up to 50 feet on a weekly basis during typical operation. Although such fluctuations create poor nearshore habitat for aquatic biota, creel surveys in 1972 and 1987 (when the public was allowed to fish the reservoir) indicate that populations of game fish are present in Muddy Run reservoir; large white crappie dominated the catch. This suggests that the forage base in the reservoir is adequate. The likely source of both forage and game fish is pumping operation from Conowingo Pond. However, Muddy Run reservoir is currently off-limits to public recreation and is surrounded by fencing that precludes public access. Muddy Run Recreation Lake abuts Muddy Run reservoir. This 100-acre lake provides a stable water level habitat that supports an important recreational fishery from the entire shoreline and small boats.

Exelon is not proposing any changes in its operation of the Muddy Run Project, and no specific recommendations pertaining to reservoir fluctuations have been made by any commenting entities.

Our Analysis

Sufficient angling opportunities exist at this project at the Recreation Lake under current conditions, and they would continue during the term of a new license. Significant fluctuations in the Muddy Run reservoir would continue to affect fish populations, but given that the reservoir is not open to the public and is not proposed to be opened under a new license, there would be little benefit to restricting current fluctuations. We discuss reservoir fluctuations at Conowingo Pond, the lower reservoir of the Muddy Run Project, in the following section.

Conowingo Project

Exelon proposes to continue to operate the Conowingo Project as it has in the past. This includes maximum reservoir fluctuations between elevations 101.2 and 110.2 feet. On weekends between Memorial Day and Labor Day, however, the water level would be maintained at or above elevation 107.2 feet to accommodate recreational boating and associated activities. No entity has recommended an alternative reservoir fluctuation regime. However, The Nature Conservancy and American Rivers suggest run-of-river operation of the Conowingo Project. Such operation would result in a relatively constant water surface elevation except when inflow to the project exceeds the hydraulic capacity of the turbines.

Our Analysis

Conowingo Pond fluctuations primarily influence aquatic habitat in the lower 11 miles of the reservoir (from Hennery Island to Conowingo dam, referred to as the lower pond). Upstream of Hennery Island, flow releases from the Holtwood Project have a greater influence on water surface elevations than operation of the Conowingo Project. Although the current license for the Conowingo Project allows the reservoir to fluctuate between elevations 101.2 and 110.2 feet, typical operation results in reservoir fluctuations between elevations 105.2 and 109.2 feet. As shown in figure 3-3, the minimum average monthly reservoir elevation from January 2004 through September 2010 was at or above elevation 104.7 feet for nearly the entire 6+ year period. This is most likely because the Muddy Run Project experiences pumping cavitation when Conowingo Pond is below this elevation. Exelon estimates that there are a total of 453 acres of habitat within the 9-foot permitted reservoir fluctuation zone based on an analysis of bathymetry and reservoir fluctuations in the lower pond. Of this total, 380 acres (84 percent) are between elevations 101.2 and 106.0 feet. The greatest amount of habitat in any 1-foot increment in the maximum drawdown zone (98 acres) is between elevations 104 and 105 feet. Consequently, under current and proposed future operation, most of the aquatic habitat in the drawdown zone would remain submerged.

A key element of nearshore habitat for aquatic biota in lakes and reservoirs is cover, where benthic macroinvertebrates and young fish can forage and hide from larger predators. In Conowingo Pond, a substantial amount of cover is provided by SAV. Exelon estimates that 320.8 acres of SAV occupy the drawdown zone, which is 71

percent of the total aquatic drawdown zone habitat of the lower pond. Most of the SAV was found between elevations 104 and 107 feet. The primary growing season for SAV is during the warm summer months (June, July, and August). This also is the primary spawning and nursery period for important nearshore spawning fish such as black bass and sunfish. This corresponds with the period when Exelon is required to maintain the water level of Conowingo Pond at or above elevation 107.2 feet on weekends for recreational purposes. The net result of this requirement is evident in figure 3-3, where the minimum monthly elevation during June, July, and August is above elevation 105.5 feet and the average monthly elevation is above elevation 108.0 feet. During this period, weekly average water surface fluctuations range between elevation 107.5 and 108.8 feet. This likely explains why most but not all of the SAV occurs below elevation 107 feet under current conditions.

Consequently, continuing to maintain the existing reservoir fluctuation regime within an overall range between elevations 101.2 and 110.2 feet and a summer weekend minimum elevation of 107.2 feet would be protective of nearshore aquatic habitat and associated biota. We note that when inflow to Conowingo Pond exceeds the hydraulic capacity of the turbines, Exelon would operate the spill gates to maintain reservoir level control, but under spillage conditions the maximum water level in the pond may exceed the elevation 110.2-foot high end of the permissible range. We acknowledge that if the Conowingo Project would be operated in a run-of-river mode, as The Nature Conservancy and American Rivers suggest, the reservoir level would be essentially constant at elevation 110.2 feet, which would represent a slight enhancement to nearshore habitat compared to existing conditions. An elevation of 110.2 feet would provide an additional 55 acres of aquatic habitat, compared to the current normal maximum elevation of 109.2 feet. We expect the incremental benefits of run-of-river operation over existing conditions to be minimal.

While a constant reservoir elevation of 110.2 feet would result in a slight enhancement to nearshore habitat, it would also allow nuisance invasive plant species such as hydrilla to infest areas between the 107-foot contour and the full pond elevation of 110.2 feet. This would likely negatively affect shoreline fishing and boating. In addition, as discussed in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, it would also negatively affect the ability of larger boats to access the reservoir from the tributary boat ramps because at full pond they are not able to pass under the railroad bridges at Peters and Conowingo creeks.

Downstream Flow Releases

In the Settlement Agreement, York Haven Power proposes a continuous minimum flow release of 1,000 cfs and an average daily minimum flow release of 2,500 cfs, or inflow if less, as measured at the Harrisburg, Pennsylvania, USGS gaging station (York Haven Power, 2014a). However, York Haven Power also proposes to install a new nature-like fishway at the north end of the main dam, which would serve as the primary fish passage facility. The east channel fishway would continue to operate as a secondary

passage facility. York Haven Power proposes to continue the existing flow releases at the east channel dam until the nature-like fishway is operational, and then attraction flows would be reallocated. Table 3-18 presents a summary of the flow management distribution at the project before and after the proposed nature-like fishway construction.

The proposed flow distribution once the nature-like fishway is operational would result in a lower minimum flow in the east channel during the upstream passage seasons for American shad and resident species, and more flow at the apex of the main dam, to enhance passage through the nature-like fishway.

The only comment received by the Commission in opposition to the settlement agreement proposed flow releases was from PPL BI in regard to adequate flows for its cooling water purposes, as discussed above.

Our Analysis

York Haven Power's flow proposal is similar to its currently licensed flow regime that has been provided for more than 30 years. The primary difference is that there would be less flow in the east channel, which has had additional flow releases since the east channel fishway went into operation in 2000, to attract fish to that facility. With the current proposal to shift the primary upstream fish passage route to the nature-like fishway, less flow would be provided to the east channel and more flow would be shifted to the nature-like fishway and main dam most of the year. The current 4,000-cfs flow provided along the main dam during the shad migration season (2 months) would no longer be provided, but a 1,000-cfs flow would be provided at the apex of the main dam with Three Mile Island. The changes would likely have minimal effects on aquatic habitat downstream of the dam, although some areas that were previously wetted would receive less flow, while other areas would receive more flow. No concerns were expressed by stakeholders regarding the environmental effects of these flow distribution changes, which overall should improve upstream fish passage at the project, once the nature-like fishway is operational. Because the York Haven Project has a low hydraulic capacity and minimal control over river flows, with spillage occurring on average about 60 percent of the time, these flow distribution changes would only be evident at extremely low river flow levels.

Table 3-18. Proposed minimum flow schedule for York Haven Project (Source: York Haven Power, 2014a).

Location and Season	Before Nature-like Fishway Construction (existing conditions)	After Nature-like Fishway Construction	Reason for Change (from existing conditions to after fishway construction)
Minimum flow below project (powerhouse + main dam + east channel) (all year)	Continuous: 1,000 cfs or inflow, whichever is less Average daily: 2,500 cfs or inflow, whichever is less	Continuous: 1,000 cfs or inflow, whichever is less Average daily: 2,500 cfs or inflow, whichever is less	No change. These flows may be delivered via any combination of turbines, spill at the main dam, and gate releases.
East channel dam			
(1) Resident upstream fish passage (April 1 through beginning of American shad passage season (about mid-April)	400 cfs	267 cfs	Flow shift to nature-like fishway as primary resident fish passage route; discourage migration into east channel
(2) American shad upstream passage (about mid-April through mid-June)	2,000 cfs	267 cfs	Flow shift to maximize attraction flow to nature-like fishway; discourage migration into east channel
(3) Resident fish passage (mid-June to end of upstream passage season – December 15)	400 cfs	267 cfs	Flow shift to the nature-like fishway as primary resident fish passage route; discourage migration into east channel
(4) Winter (December 15 through April 1)	0	267 cfs	Enhance east channel winter habitat conditions; east channel fishway to be left open during winter

Location and Season	Before Nature-like Fishway Construction (existing conditions)	After Nature-like Fishway Construction	Reason for Change (from existing conditions to after fishway construction)
Main channel dam/ nature-like fishway			
(1) American shad upstream passage season (about mid-April through mid-June)	4,000 cfs	1,000 cfs (total) through nature-like fishway channel and nature-like fishway supplemental attraction flow channel Design to provide total attraction flow ≥ 5 percent of river flow from 5,000 to 150,000 cfs.	Provide attraction flow to nature-like fishway at main dam apex; maintain habitat and adequate migration flow below main dam
(2) Resident fish passage (mid-June through mid-April)	0	200 cfs minimum flow through nature-like fishway channel[a]	Provide attraction flow to nature-like fishway at main dam apex for resident fish; enhance main channel habitat conditions; maintain nature-like fishway as resident fish passage route year round

[a] When river flows are greater than the hydraulic capacity of the generating units plus the required flows in the east channel, and at the main dam/ nature-like fishway, flows would be managed to maintain an east channel flow of 267 cfs, and maximize the remainder of flows over the main dam and through the nature-like fishway, with the supplemental attraction flow channel to be operated with the objective of maintaining a higher attraction flow through the nature-like fishway (except during the winter period of December 15 to the earlier of April 1 or the start of the American shad upstream passage season, when total nature-like fishway flow would be 200 cfs).

Conowingo Project

Exelon proposes to continue to provide the minimum flow releases required under the current license, as follows:

- March 1 – March 31: 3,500 cfs or natural river flow (as measured at the upstream USGS Marietta gage No. 0157600), whichever is less;
- April 1 – April 30: 10,000 cfs or natural river flow, whichever is less;
- May 1 – May 31: 7,500 cfs or natural river flow, whichever is less;
- June 1 – September 14: 5,000 cfs or natural river flow, whichever is less;
- September 15 – November 30: 3,500 cfs or natural river flow, whichever is less; and
- December 1 – February 28: 3,500 cfs intermittent release (maximum 6 hours off followed by equal amount on).

Several commenters made statements regarding the adverse effects of flow releases from the project. Interior, in its section 10(j) recommendation, states that Exelon should finalize and implement a flow management plan and implement the flow recommendations of The Nature Conservancy or any more restrictive flows required by the Maryland certification (when that is issued), returning the river downstream of Conowingo to more natural conditions. The Nature Conservancy, in its comments filed January 31, 2014, recommended flows be released downstream of Conowingo dam sufficient to achieve the following objectives:

(1) restore persistent habitat and maximum weighted usable area (MWUA)[44] for the spawning, migration, and egg and larval development of diadromous and resident fish and for macroinvertebrates by providing at least 50 percent of historic maximum persistent habitat, minimize the amount of time that less than 25 percent of historic maximum persistent habitat is available, and target 70 percent of MWUA across species and life stages;

(2) increase the probability of lift entry for American shad, river herring, and American eel;

(3) eliminate stranding-related mortality of adult and juvenile fish;

(4) provide at least 50 percent of available mussel habitat with suitable shear stress;

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[44] Weighted usable area is an index of aquatic habitat that is calculated using the Instream Flow Incremental Methodology. It is meant to be used as a comparative statistic (for comparing alternative flow levels) and is not an absolute measure of habitat.

(5) increase the stability and suitability of basking and hibernation habitats for map turtles; and

(6) increase the suitability for SAV and emergent vegetation establishment.

The Nature Conservancy also recommends that the EIS evaluate two operational alternatives: (1) run-of-river operation (passage of the daily average flow measured at the USGS Marietta, Pennsylvania, gage plus any intervening flows that enter the river between the Marietta gage and Conowingo dam); and (2) the set of operational constraints that The Nature Conservancy identified as a potential approach for meeting its performance goals, listed above. We refer to this second alternative as the TNC Flow Regime. Table 3-19 summarizes the components of the TNC Flow Regime, and includes Exelon's proposed flow regime. The TNC Flow Regime includes restrictions on upramping and downramping. In addition, Pennsylvania FBC recommends that Exelon should reduce ramping-related stranding of migratory fish by (1) extending the retaining wall at the east end of the east fish lift or adding boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation, or (2) dredging a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes.

Table 3-19. Summary of Exelon and TNC flow recommendations (Source: Staff).

	Minimum flow (cfs)				**TNC**	**TNC**
	Exelon	**TNC**		**TNC**	**Maximum**	**Maximum**
Month	**Minimum**	**Minimum Q>50[b]**	**Minimum Q<50**	**Maximum flow (cfs)**	**Downramping (cfs/hr)**	**Upramping (cfs/hr)**
January	0/3,500[a]	11,000		86,000 (January and February)	20,000 (January through June)	40,000 (year-round)
February	0/3,500	12,500				
March	3,500	30,000	24,000			
April	10,000	35,000	29,000			
May	7,500	25,500	17,500	65,000 (March through September)	10,000 if Q<30,000 20,000 if Q<86,000 (July through September)	
June	5,000	14,000	10,000			
July	5,000	8,500	5,500			
August	5,000	6,000	4,500			
September 1-14	5,000	5,500	3,500			

Month	Minimum flow (cfs) Exelon Minimum	Minimum flow (cfs) TNC Minimum Q>50[b]	Minimum flow (cfs) TNC Minimum Q<50	TNC Maximum flow (cfs)	TNC Maximum Downramping (cfs/hr)	TNC Maximum Upramping (cfs/hr)
September 15-30	3,500	5,500	3,500			
October	3,500	6,000		86,000 (October through December)	20,000 (October through December)	
November	3,500	11,000				
December	0/3,500	11,000				

[a] From December 1 through February 28, Exelon proposes an intermittent flow regime, with 6 hours of 3,500 cfs followed by 6 hours with no minimum flow.

[b] If natural inflow is greater than the median flow.

Under Exelon's proposed flows, minimum flow releases would range from as low as 0 cfs for up to 6 hours at a time from December through February, up to 10,000 cfs in April. Minimum flows under the TNC Flow Regime would range from 3,500 cfs in September when natural flows at the Marietta gage are less than the median flow, up to 35,000 cfs in April when flows at the Marietta gage are greater than the median flow. Under the TNC Flow Regime, the maximum generating flow would also be limited to 65,000 cfs from March through September, upramping rates would be limited to 40,000 cfs per hour year-round, and downramping rates would be limited to 20,000 cfs per hour overall and 10,000 cfs from July through September if flows are less than 30,000 cfs.

Exelon, in its reply comments filed on March 18, 2014, states that (1) commenting entities have no basis for stating that the existing flow regime harms fish and wildlife, (2) stranding has not resulted in adverse effects on migratory and resident fishes, (3) a robust fishery occurs both upstream and downstream of the project, and (4) the recommended TNC Flow Regime would have a major adverse effect on project power production and economics.

Our Analysis

The flow regime downstream of Conowingo dam has the potential to affect a wide range of resources, including SAV; the spawning, incubation, and rearing habitat for a variety of fish species; and habitat for freshwater mussels, other invertebrates, map turtles, and waterfowl nesting. Flow fluctuations associated with project operation also has the potential to cause fish mortality due to stranding and to affect upstream fish migration. We assess the effects of Exelon's proposed operation, alternative run-of-river operation, and the TNC Flow Regime on SAV, fish habitat, fish migration, fish stranding,

freshwater mussels, and other aquatic invertebrates. Effects on map turtles and waterfowl nesting habitat are evaluated in section 3.3.3, *Terrestrial Resources*.

SAV. As we previously described, SAV downstream of Conowingo dam is limited to areas that have finer-grained substrate or are protected from high water velocities associated with high river flows. The highest concentrations of SAV are in the lower part of the river closer to the mouth of the river, where river levels are influenced by tidal flow from the Chesapeake Bay and velocities tend to be lower. Portions of the river closest to Conowingo dam have a steeper gradient, a substrate of primarily bedrock and boulder, and little SAV. SAV distribution downstream of the dam is more influenced by existing substrate conditions and natural high-flow events, which have the potential to scour and redistribute finer-grained substrate, than by normal day-to-day project operation.

Fish Habitat. To assess the effects of proposed operation and alternative flow regimes on habitat for fish and invertebrates, Exelon conducted study 3.16, *Instream Flow Habitat below Conowingo Dam* (Gomez and Sullivan and Normandeau, 2012a). The study included evaluation of effects on different life stages of American shad, striped bass, shortnose sturgeon, smallmouth bass, several taxa of aquatic insects (mayflies, stoneflies, caddisflies), and freshwater mussels. The study used the River2D model to simulate hydraulic conditions in a study reach extending from Conowingo dam to the downstream end of Spencer Island (where tidal effects begin). The calibrated hydraulic model was used to simulate habitat conditions over a range of flows. In addition, a habitat persistence analysis was performed to assess the effects of peaking operation by determining the area of habitat that maintained a habitat rating of "good" (composite habitat suitability index of 0.5) or higher over the flow range that represents a given peaking cycle. The Nature Conservancy used the results of this persistence analysis to develop the TNC Flow Regime.

Implementing run-of-river operation downstream of Conowingo dam would benefit mobile life stages of fish (fry, juveniles and adults) by reducing the frequency and magnitude of flow changes compared to current and proposed operation, which would improve habitat stability. This would help fish to seek out and remain in areas with suitable depth, velocity, and substrate conditions, without incurring the energetic costs associated with shifting locations to seek favorable habitat when flow conditions change. Implementing the TNC Flow Regime flows would reduce the magnitude and rate of flow changes compared to existing and proposed operation, which would provide an intermediate level of reduction in energetic costs. Reducing the magnitude and extent of flow fluctuations would provide even greater benefits to non-mobile life stages of fish (eggs) and less mobile organisms including fish larvae and aquatic invertebrates. Any increase in the production of aquatic insects would increase the amount of forage available and the potential production of juvenile fish.

Assessing the extent of the benefit that would be provided to any individual life stage and species of fish or invertebrate from reducing the magnitude of flow fluctuations

is a complex challenge. Evaluating the effects on any individual life stage requires substantial assumptions to be made regarding the effects of changes in amount, quality, and location of the available habitat for that life stage, as well as the influence of the rate at which those attributes change. Any benefits that may occur to a particular species and life stage from a specific flow level, however, may not necessarily transfer to another species and life stage. These uncertainties are magnified during the assessment of potential population effects for a species, which requires incorporating effects on each life stage.

Focusing the instream flow evaluation on the spring migration and spawning period for American shad, river herring, and hickory shad may have the most merit. Enhancing flows during the spring period has the potential to provide increases in the production of these anadromous species without unnecessarily constraining project operation in other seasons, including the summer and winter seasons when there are peaks in the demand for power for cooling and heating. Substantial use of the river downstream of Conowingo dam for spawning by each of these species has been documented (Normandeau and Gomez and Sullivan, 2012b), and juveniles of these species (as well as gizzard shad) likely provide a seasonal source of forage for migratory striped bass. We provide a further analysis of effects on anadromous and resident species below under "*Alternative Flow Regime*."

Fish Migration. Although Exelon's studies have found little evidence of a relationship between operational flow releases and the ability of upstream migrating fish to find and enter the east and west fish lifts, it is possible that reducing the frequency and magnitude of flow fluctuations could improve fish passage efficiency. The results of radio telemetry studies conducted in 2010 and 2012 (Normandeau and Gomez and Sullivan, 2011; 2012c) indicate that many American shad that migrate upstream to the tailrace area subsequently returned downriver within a few hours or days. While this type of movement has been observed on other rivers unaffected by fluctuating flow releases, if the magnitude of operational flow changes was reduced during the migration season, it is possible that some of these fish would remain in the tailrace area for a longer period of time and increase their success in finding and entering one of the fish lifts. Additional discussion of effects on fish migration is included below under our discussion of upstream fish passage.

Fish Stranding. Reducing the magnitude and frequency of flow fluctuations could benefit fisheries resources by reducing the number of fish that are injured or killed when they are stranded as flow and water levels downstream of Conowingo dam are reduced. However, stranding studies conducted by Exelon (Normandeau and Gomez and Sullivan, 2012d) indicated that few fish are killed by stranding under existing operation, and about 90 percent of those killed were gizzard shad, carp, and catfish species (table 3-20). Although implementing run-of-river or TNC Flow Regime flows could reduce this source of mortality, the results of Exelon's stranding surveys indicate that the magnitude of this benefit would be minor. There would also be minimal benefit in implementing the Pennsylvania FBC recommendation to extend the retaining wall at the east end of the east

fish lift, add boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation, or dredge a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes.

Table 3-20. Total number of dead fish and crabs observed during 12 stranding surveys (4 in each season) conducted within and just downstream of the spillway reach below Conowingo dam (Source: Normandeau and Gomez and Sullivan, 2012d).

	Spring	**Summer**	**Fall**	**Total**	**%**
American eel		1		1	0.1
River herring	1			1	0.1
American shad	46			46	4.4
Gizzard shad	675	40	41	756	72.5
Carp	80	4	3	87	8.3
Minnows			1	1	0.1
Quillback	2			2	0.2
Shorthead redhorse	1		1	2	0.2
Catfishes	75	7	12	94	9.0
White perch		1		1	0.1
Striped bass	1			1	0.1
Banded killifish			6	6	0.6
Smallmouth bass		2	1	3	0.3
Largemouth bass		9	1	10	1.0
Sunfish		4		4	0.4
Walleye		1	4	5	0.5
Darters		3		3	0.3
Unidentified	19			19	1.8
Blue crabs		1		1	0.1

Freshwater Mussels. As part of study 3.16, *Instream Flow Habitat Below Conowingo Dam* (Gomez and Sullivan and Normandeau, 2012a), Exelon examined the effects of operational flows on mussel habitat by calculating and mapping shear stress at the river bed in the study area over a range of flows. The study found that mussel CPUE versus shear stress plots showed that model-predicted shear stress related fairly well to

observed mussel densities. However, the distribution of mussels below Conowingo dam is likely limited by the shear stress that occurs during spring runoff, and locations that are sufficiently protected from high shear stress during spring runoff would also be sufficiently protected from shear stress during peaking operation. Accordingly, we conclude that reducing flow fluctuations by implementing run-of-river or the TNC Flow Regime operations would provide a limited benefit to mussels.

Alternative Flow Regime. Our analysis of Exelon's instream flow study indicates that several combinations of minimum and maximum flows may improve habitat for some species and life stages, but those flow combinations are not consistent among the evaluation species. Certain flows may improve habitat for some species and life stages, while those same flows would reduce habitat for other species and life stages. Selection of an alternative flow regime would require balancing among the several target species and life stages (determine which life stage is most important for each time interval), as well as consideration of the effects of an alternative regime on project power production and economics. As we note above, Exelon's instream flow study included a habitat persistence analysis, and the report summarized that analysis by month, using only the species and life stage that may be present during that month and for which there is a relatively high amount of structural habitat available (relative to total wetted area). Table 3-21 summarizes the results of that analysis, showing the range of flows that would provide the TNC target of 70 percent of MWUA by month, and also showing the normal range of flows in Exelon's existing and proposed operation, and the median unregulated flow. This table, however, only shows evaluation *fish* species, because use of invertebrates and the "guilds" life stages would consistently show a low end of the flow range less than current minimum flows.[45] In addition, we adjust the life stages by month to those key life stages present, to reflect the changing importance of certain species and life stages during certain months (such as when anadromous species are present).

Table 3-21 indicates that, overall, the current and proposed Exelon operation generally bracket the range of flows that would provide 70 percent of MWUA as determined by the instream flow study. From December through March, when Exelon reduces to zero minimum flow for 6-hour intervals, however, the MWUA criterion would not be met for those 6-hour intervals. Eliminating the zero minimum flow periods during those months would likely provide some benefits to aquatic habitat, and Exelon should have no trouble in meeting a continuous flow requirement (of 3,500 cfs), because median flows are higher during those months. For the remainder of the year, Exelon's minimum flows are lower than the low end of the 70 percent MWUA criterion in April, May, and

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[45] Gomez and Sullivan and Normandeau (2012a) state that some flow ranges were limited by the lowest or highest production run flow, thus the true flow range providing this habitat may fall outside of the modeled flows. However, even some fish life stages selected for our analysis showed this low end of the flow range.

June, but higher than the criterion the remainder of the year. In April, Exelon provides a minimum flow of 10,000 cfs (compared to the 70 percent minimum criterion of 13,008 cfs), but because April is the highest flow month of the year, Exelon overall maintains higher average releases during April, and there would be no need to adjust minimum flows.[46] In May, Exelon's minimum flow is very close to the 70 percent minimum criterion. In June, at the end of the spawning period for shad and striped bass, Exelon currently reduces its minimum flow from 7,500 to 5,000 cfs. If that reduction occurs on June 1 (as it does currently), that could adversely affect spawning and early-fry development for later spawning shad by reducing the area of suitable spawning and incubation habitat during the period of the day when only the minimum flow is provided. Areas that would be available for spawning and incubation during higher generation periods of the day may not be available or may be dewatered at a minimum flow of 5,000 cfs, and extending a 7,500-cfs minimum flow until mid-June would provide additional protection to spawning and incubation habitat. There would be no need to extend this minimum flow into late June, after spawning and early-fry development has ended. Maximum flows have also been a concern at Conowingo, and The Nature Conservancy recommended that maximum flows be capped at 65,000 cfs from March through September. The habitat persistence analysis, however, does not support such a restriction, as some of the key life stages in all months still maintain the 70 percent minimum criterion at the full station discharge of 86,000 cfs. While 86,000 cfs is the high end of the flow range that was limited by the production run flow, according to Gomez and Sullivan and Normandeau (2012a), that analysis still indicates that there is little basis for a 65,000-cfs maximum flow cap.

We understand that this is a somewhat "broad-brush" analysis of instream flows downstream of Conowingo, and that certain species and life stages may have narrower or higher flow bands where MWUA is provided. As we discuss earlier, the flow issue is complex downstream of Conowingo, but Exelon's studies have provided substantial information on the effects of flow releases from Conowingo. Based on this information, Exelon's current flow regime is generally adequate for protection of aquatic resources downstream of the project, although some adjustments to these flows as we discussed (eliminating periods of zero minimum flow in December through February, and increasing the minimum flow to 7,500 cfs in the first half of June) could provide additional protection to downstream aquatic habitat.

The Nature Conservancy recommends that run-of-river operation be considered at Conowingo. We previously briefly discussed potential benefits of such operation, but strict run-of-river operation does not appear to be technically feasible at Conowingo. If

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[46] The 90 percent exceedance flow in April at the Conowingo USGS gage is 29,690 cfs (see table 3-6).

any run-of-river operation is tied to inflow at the Marietta gage (plus inflow downstream of Marietta), Exelon may not be able to duplicate Marietta flows, because of the operation of the upstream Safe Harbor and Holtwood projects. Safe Harbor, with a total hydraulic capacity of 110,000 cfs, generally controls river flows at flows less than its hydraulic capacity. Safe Harbor is a peaking station with no minimum flow releases, so downstream flows may fluctuate from zero up to full capacity on a daily basis. The Holtwood Project is immediately downstream of Safe Harbor and also controls the river up to its current newly expanded capacity of about 61,000 cfs. If Conowingo was to attempt to operate so that it passes on a continuous basis the daily average flow at the Marietta gage, plus inflow downstream of Marietta, as recommended by The Nature Conservancy, it would likely be an operational challenge. Exelon's operation would likely be in a constant state of flux because actual inflow to Conowingo Pond would be fluctuating over a wide range (as a result of upstream operation at Safe Harbor and Holtwood), potentially causing major fluctuations in Conowingo Pond as Exelon attempted to match Conowingo releases to the Marietta flows (plus other inflow). In addition, not all of the tributaries between Marietta and Conowingo are gaged, so Exelon would not have reliable inflow data for all of the tributaries.

Table 3-21. Summary of Exelon's habitat persistence analysis by month, showing the range of flows (cfs) providing 70 percent of the MWUA for fish species and life stages likely to occur during each month, compared to Exelon's current operation and median unregulated flow (Source: Gomez and Sullivan and Normandeau, 2012a; Staff).

Parameter	Jan.[a]	Feb.[a]	March[a]	April[b]	May[c]	June[d]	July[e]	Aug.[f]	Sept.[f]	Oct.[f]	Nov.[f]	Dec.[g]
70% of MWUA	3,127 – 86,000	3,127 – 86,000	3,127 – 86,000	13,008 – 86,000	7,744 – 86,000	7,744 – 86,000	2,000 – 86,000	2,000 – 86,000	2,000 – 86,000	2,000 – 86,000	2,000 – 86,000	2,000 – 86,000
Exelon operation	0/3,500 – 86,000	0/3,500 – 86,000	3,500 – 86,000	10,000 – 86,000	7,500 – 86,000	5,000 – 86,000	5,000 – 86,000	5,000 – 86,000	5,000/ 3,500 – 86,000	3,500 – 86,000	3,500 – 86,000	0/3,500 – 86,000
Median unregulated flow	27,732	32,617	61,744	63,752	38,768	20,661	13,045	9,201	7,995	9,845	22,927	30,672

[a] Includes only adult smallmouth bass and adult striped bass.

[b] Includes adults and spawning for American shad, shortnose sturgeon, and striped bass.

[c] Includes adults, spawning, and fry for American shad, shortnose sturgeon, and striped bass.

[d] Includes adults, spawning, fry, and juveniles for American shad and striped bass.

[e] Includes adults, fry, and juveniles for striped bass and fry and juveniles for American shad.

[f] Includes adult and juvenile striped bass and smallmouth bass and juvenile American shad.

[g] Includes adult and juvenile striped bass and smallmouth bass.

Upstream Fish Passage

As we described in section 3.3.2.1, *Water Resources, Affected Environment,* volitional upstream fish passage for anadromous species has been provided at the four lower-river hydroelectric projects since the year 2000. An experimental fish trap (with trucking) was first installed in 1972 at Conowingo dam, but passage was not provided at all four dams until completion of the east channel fishway at York Haven in 2000. While fish passage facilities have been in place for many years, inefficiencies in their operation have been documented at some of the projects. Only the Safe Harbor Project has demonstrated consistently high efficiency. Inefficiencies in upstream passage were a stakeholder concern at both York Haven and Conowingo, and those issues are discussed separately by project. American eel passage to date has been limited to experimental operations and trapping and trucking from Conowingo, but is also an issue for all the projects on the Susquehanna River. The American eel issue is discussed separately below.

York Haven Project

York Haven Power is proposing, consistent with the Settlement Agreement, to improve upstream fish passage at the project by constructing a nature-like fishway where the upstream end of the main dam joins Three Mile Island (referred to as the "apex"). Pennsylvania DEP did not sign the agreement but has indicated it would issue certification that is consistent with the agreement.

Our Analysis

American shad passage counts on the river (table 3-13) show that shad passage at the east channel fishway has been relatively low, generally only from about 2 to 22 percent of the count at the downstream Safe Harbor dam, and not exceeding 10 percent since 2003. This may not have been entirely as a result of inefficiency at the east channel fishway.[47] Radio telemetry studies conducted by York Haven Power in 2010 found that many shad that did reach the project area did not reach the east channel fishway. Of 174 radio-tagged shad exiting the downstream Safe Harbor fish lift, 70 percent reached the York Haven Project area. Of those, 100 percent passed through the York Haven tailrace and 78 percent were detected in the apex area of the main dam, where tagged fish spent the most time of any of the locations at York Haven. Only

[47] There is spawning habitat in the 22 river miles between the Safe Harbor Project and York Haven and in years when spring water temperatures increase rapidly in the river, shad may cease migration once spawning temperatures are reached and use spawning habitat downstream of York Haven. While some shad may spawn downstream of York Haven in any year that portion of the run may be greater if water temperatures increase rapidly.

4 percent (5 tagged shad) successfully passed above York Haven dam through the east channel fishway, and another 2 fish passed through the fishway but immediately dropped back downstream through the attraction flow gates (York Haven Power, 2011; 2013). These data indicate that the apex area of the main dam would be a good location for a fishway, likely a better location than the existing east channel fishway.

Fish passage options at this site, which has a maximum head of only 7 feet, would be a pool and weir or vertical slot fishway, similar to the east channel fishway, or a nature-like fishway. A fish lift would not be a good option at this site because of the low head and the somewhat remote location, making operation and maintenance more difficult. As the record shows, consultations with the fisheries agencies resulted in the selection of the nature-like fishway as the preferred alternative, ultimately resulting in the inclusion of this design in the Settlement Agreement. The proposed fishway would consist of an approximately 300-foot-wide and 500-foot-long channel with arched weirs made from natural stone and boulders to be harvested from the river immediately downstream of the main dam. The fishway base material would consist of a large stone mix with a median diameter (D50) of 18 inches, and large rock/boulders that form the fishway weirs would be 3- to 5-foot-diameter rock set into the 18-inch D50 base material. The large rocks would be arranged to form an arched weir, with the large rocks approximately 1-foot apart. Flows through the fishway would pass between and over the large rocks with the water level dropping approximately 0.7-foot from the upstream to downstream side of each rock weir. There would be a 65-foot-wide 'thalweg' located within the fishway, which would have a channel invert approximately 1-foot lower in elevation than the adjacent fishway channel. This would provide a deeper channel to concentrate flows during periods of low headpond elevations and river flows outside of the adult American shad migration season. The gradient through the fishway would be approximately 1.5 percent. Figure 3-14 shows the location of the proposed nature-like fishway, the east channel dam, the rock harvesting area, and staging areas.

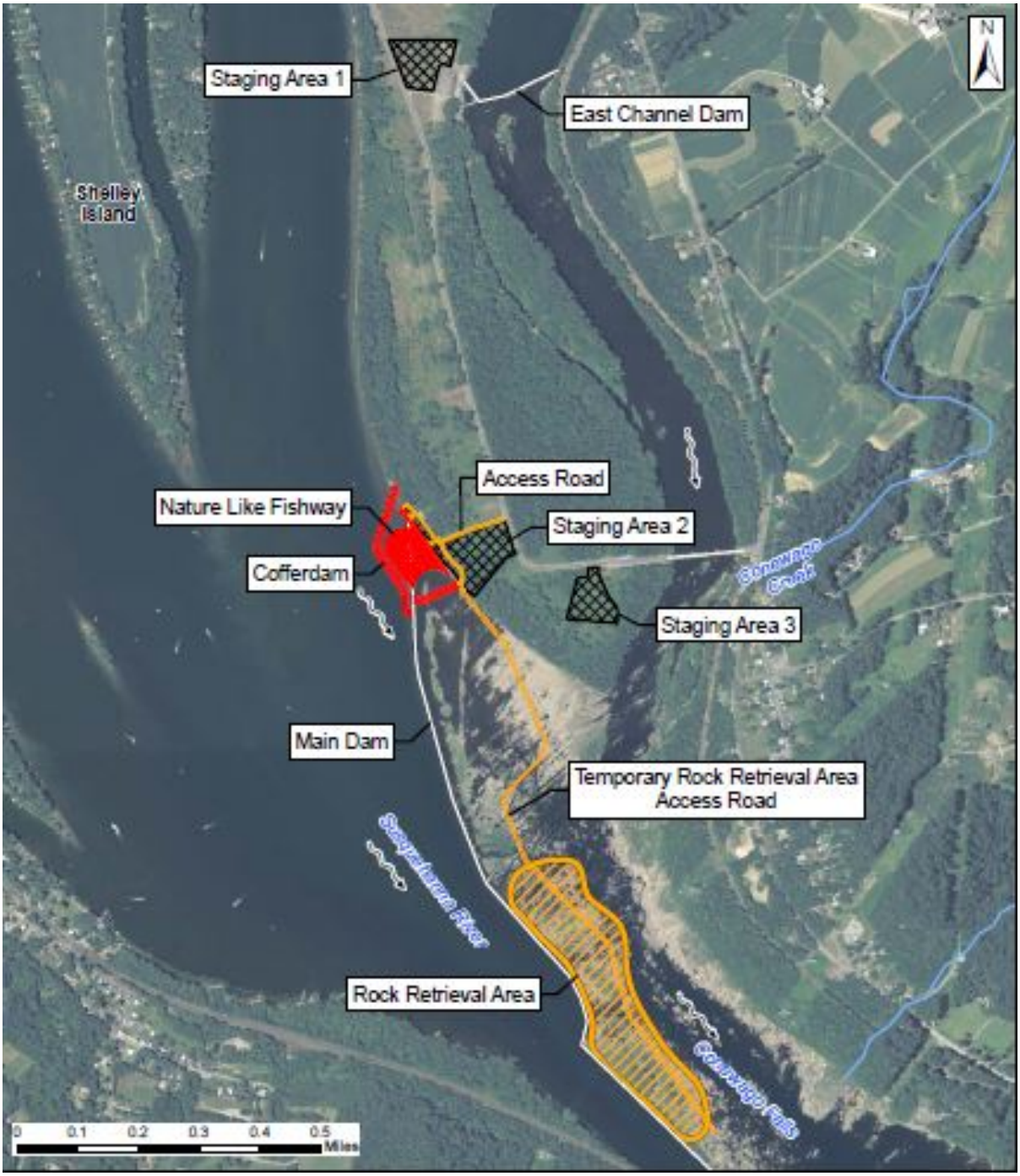

Figure 3-14. Proposed location of the York Haven nature-like fishway and associated construction sites (Source: York Haven Power filing of updated figure for Nature-like Fishway Conceptual Design Final Report, filed June 10, 2013).

The fishway would have a normal minimum flow through the fishway of 200 cfs and would include a supplemental attraction water supply of 800 cfs, to be provided via a parallel concrete channel. This would result in a total minimum flow of 1,000 cfs from the apex area of the dam, to attract shad to the fishway location. At the same time, the

minimum flow from the east channel would be reduced to 267 cfs year-round (from the current minimum of 2,000 cfs during the shad passage season). This would reduce attraction of shad to the east channel and increase attraction toward the nature-like fishway, which would become the primary route for upstream passage at the project. The east channel fishway would continue to operate year-round for resident fish passage, but it would become a secondary route for shad and other anadromous species. The nature-like fishway would also be designed so that a full range of anadromous, catadromous, and resident species could use the facility for upstream passage, and downstream passage if fish can locate the facility on their downstream migration. Downstream passage is discussed below in greater detail.

With this arrangement for fish passage, some shad would likely continue to be attracted to the powerhouse tailrace, because under lower flow conditions the majority of flow from the project would be released from the powerhouse (up to full powerhouse capacity). However, the applicant's radio telemetry studies found that 78 percent of the fish that were detected in the tailrace ended up in the apex area, where the nature-like fishway would be located, and those fish lingered in that area for the longest time of any of the locations monitored. The proposed location and design of the nature-like fishway would constitute an enhancement of existing upstream fish passage facilities at the project, and should improve fish passage effectiveness at the project. Another future monitoring technology provided for in the Settlement Agreement is the use of PIT tag monitoring devices. While the methodology for using these devices in a 300-foot-wide nature-like fishway has not yet been developed, the upstream end of the nature-like fishway would be designed to accommodate future installation of PIT tag monitoring devices at such time that these tag monitoring devices become available and feasible for reliably monitoring American shad exiting the fishway.

Under the Settlement Agreement, York Haven Power proposes to conduct an effectiveness study beginning in year 2 of fishway operation, continuing for 2 years, using radio-tagged shad. The Settlement Agreement establishes an "Upstream Shad Passage Target" that at least 75 percent of the shad counted at the downstream Safe Harbor Project be passed above York Haven dam (using all passage routes), and a "Project Area Passage Success Criteria" that 85 percent of the shad that reach the York Haven Project successfully pass upstream of the project (using all passage routes). If the passage target or success criteria are met after 2 successive years of study, then the project would be considered as successfully meeting its target and no additional passage studies would be needed. If the target effectiveness is not met, after consideration of extenuating circumstances such as unusual river flows or high water temperatures, 2 additional years of study would be conducted after a hydraulic evaluation of the fishway and possible modifications to the design or operation (attraction flows) of the fishway.

Radio telemetry studies can be an effective methodology for monitoring fish movements as they approach a fishway and for determining the percentage of fish that are able to pass it. The proposed studies are appropriate for a major new fish passage facility, particularly because a nature-like fishway design has never been constructed for

American shad at a hydroelectric project on a major North American river.[48] The establishment of passage targets and success criteria, used properly, allow a determination of whether the fishway is operating as designed. Caution is needed, however, because many factors beyond engineering design and hydraulics may affect effectiveness, particularly for shad.

The Safe Harbor Project is considered to have the most effective upstream fish passage facilities on the Susquehanna River, and perhaps one of the most effective on the Atlantic coast. Safe Harbor consistently lifts on-average about 71 percent of the shad counted at the downstream Holtwood Project, but that has ranged from 45 to 98 percent since 1997, with 13 of 17 years not reaching the target effectiveness of 75 percent (table 3-22). While Safe Harbor has not met the 75 percent criteria proposed for York Haven in all years, Safe Harbor is still considered highly effective. The distance between Holtwood and Safe Harbor is only 7 miles of reservoir habitat, while the distance between Safe Harbor and York Haven is about 22 miles, including both large reservoir (about 10 miles) and riverine habitat (about 12 miles) that contains suitable spawning habitat. It may be unrealistic to expect that the same effectiveness can be achieved at York Haven, especially because fish reaching York Haven would be doing so at the end of the migration period when water temperatures may be warming quickly, and reaching the range when fish would begin spawning.[49]

The Settlement Agreement acknowledges this issue, and while the upstream shad passage target is at least 75 percent of the shad counted at the downstream Safe Harbor Project to be passed above York Haven dam, compliance is based on the project area passage success criteria that 85 percent of the shad that successfully reach the York Haven Project area successfully pass upstream of the project. This properly recognizes that York Haven Power has no control over whether or not shad reach the project area.

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[48] A nature-like fishway was recently installed on a lock and dam on the Cape Fear River in North Carolina, but effectiveness data are not yet available for that facility.

[49] In fact, York Haven Power's 2010 radio telemetry study found that only 70 percent of the tagged fish released at Safe Harbor reached the York Haven Project area, indicating that some fish did use the habitat between the projects, or had no motivation to continue upstream migration to York Haven.

Table 3-22. Numbers of shad lifted at Holtwood and Safe Harbor dams, and the effectiveness of the Safe Harbor fish lift, reported as percent of the Holtwood passage (Source: Staff).

Year	Holtwood	Safe Harbor	% of Holtwood
1997	28,063	20,828	74
1998	8,235	6,054	74
1999	34,702	34,150	98
2000	29,421	21,079	72
2001	109,976	89,816	82
2002	17,522	11,705	67
2003	25,254	16,646	66
2004	3,428	2,109	62
2005	34,156	25,425	74
2006	35,968	24,929	69
2007	10,338	7,215	70
2008	2,795	1,252	45
2009	10,896	7,994	73
2010	16,472	12,706	77
2011	21	8	--[a]
2012	4,238	3,089	73
2013	2,503	1,927	77
2014	2,528	1,336	53
		Average	71

[a] The Conowingo and Holtwood fish lifts were not operated the entire migration season because of construction at Holtwood, so 2011 was not a representative year.

Muddy Run Project

The Muddy Run Project is a pumped storage project with an offstream upper reservoir that does not physically block upstream fish migration, but instead may affect migration by creating flow patterns that may confuse migrating fish or create areas with high velocities that may delay migration. There is no proposal or need for passing fish into the Muddy Run upper reservoir, and in fact the objective is to keep migrating fish out of the reservoir. Some migrating fish would be entrained and pumped into the upper reservoir, resulting in a loss of those fish to the overall population, unless those fish are able to survive passage back to the Susquehanna River/Conowingo Pond during the

generation cycle. Both Interior and NMFS reserve their authority to prescribe fishways during the term of the license, and both agencies recommend that the project be operated to allow safe, timely, and effective fish passage past the project. Interior, as part of its preliminary fishway prescription, requires preparation of FPOP to describe Muddy Run Project operation during the fish passage season including regular maintenance activities and emergency procedures. Interior also requires an FPMP, including an American shad passage monitoring plan, for post-FPOP implementation monitoring, with the criteria for success to be consistent with the goals and objectives set forth in the Susquehanna River Anadromous Fish Restoration Plan (85 percent passage effectiveness, with target passage of 80 percent within 36 hours). However, in a letter filed with the Commission on February 28, 2014, Interior amended its preliminary fishway prescription, and dropped the requirement for specific target effectiveness at Muddy Run (80 percent within 36 hours), but instead would require that Muddy Run demonstrate safe, timely, and effective fish passage past the project, based on site-specific studies or other available information. Interior states that while it believes that Muddy Run operation may affect fish migration, the effects may not be sufficient to affect the fisheries agencies goals for this reach of the river. As part of the FPMP, Exelon would be required to conduct an effectiveness monitoring study every 10 years beginning in 2018, and if effectiveness is not met, Exelon would be required to implement operational or structural measures to improve effectiveness.[50] NMFS is concerned that flow patterns in the vicinity of the project may delay American shad migration, and recommends that FWS' reanalysis of a 2008 shad radio telemetry study be considered in the analysis of this issue. Passage measures related to American eel are discussed below in a separate section.

In its reply comments filed on March 18, 2014, Exelon states that it is opposed to Interior's preliminary fishway prescription, but is in agreement with the conditions of the draft certification. Pennsylvania DEP issued a final certification on June 3, 2014. While Exelon has not indicated the final certification represents its proposal, our review of the draft and final certifications found that they are nearly identical. Thus, Exelon is in agreement with the fish passage conditions of the certification that require at least 88 percent successful passage of upstream-migrating adult shad past the Muddy Run

[50] By its filing of March 28, 2014, Interior notified the Commission that it had reached an agreement in principle with Exelon on a modified fishway prescription, but that agreement has yet to be reduced to writing and signed. Because we are unsure of the details of that agreement, our analysis focuses on the preliminary fishway prescription, as amended by Interior's February 28, 2014, filing.

Project,[51] 80 percent survival of downstream-migrating adult shad, and 95 percent survival of downstream-migrating juvenile shad. In addition, Exelon agrees to conduct additional effectiveness studies at Muddy Run if the upstream Holtwood Project fails to meet its target effectiveness and Pennsylvania DEP determines that Muddy Run operation is a proximate cause for Holtwood failing to meet its target. Radio telemetry studies would be conducted over a 4-year period, and if the studies demonstrate that less than 88 percent of the tagged shad are successful in passing upstream of the Muddy Run Project area, Exelon would amend its FPOP to provide measures to enhance upstream passage past Muddy Run. Exelon would also submit a plan to continue to provide for the target downstream passage survival rates (80 percent for adult shad and 95 percent for juvenile shad) by January 15, 2015. By February 15, 2026, Exelon would prepare a plan for Pennsylvania DEP approval to measure the passage of American shad moving downstream through the project area. If the studies determine that the project is not achieving the minimum passage rates, then Exelon would be required to develop a mitigation plan.

Our Analysis

Exelon conducted multiple studies on the effects of Muddy Run operation on migratory fishes, summarized in Normandeau and Gomez and Sullivan (2012k). These studies included three radio telemetry studies involving more than 500 radio-tagged adult shad, data from other lower Susquehanna River studies pertaining to shad run timing, hydraulic modeling from the expansion of the upstream Holtwood Project, and near-field velocity profiles at Muddy Run. Other available reports included FWS re-analysis of Exelon telemetry data and juvenile shad entrainment at Muddy Run (Sweka, 2013; Pugh, 2013). The Exelon studies concluded that the effects of the Muddy Run Project on upstream and downstream shad passage are negligible. Radio telemetry studies found that a majority of shad in upper Conowingo Pond migrate upstream along the east bank of the river and would pass in close proximity to the Muddy Run tailrace. This would be expected because higher flows occur on the east side of the river associated with flows discharging from the upstream Holtwood tailrace and Muddy Run releases. Those studies found that successful upstream passage of tagged (and detected) shad past the Muddy Run Project was 91 percent in 1989, 80 percent in 2001, and 84.5 percent in 2008 (average of 85.2 percent). Telemetry studies in 2001 and 2008 provided data on the adult shad entrainment rate during Muddy Run pumping operation from April to June, and those rates ranged from 3.6 to 5.1 percent. Exelon's review of Holtwood Project modeling found that river velocities may approach 7.5 to 10.0 fps when both post-

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[51] This differs slightly from Interior's previously recommended 85 percent passage effectiveness, with target passage of 80 percent within 36 hours. However, Interior commented that the Pennsylvania DEP certification conditions for fish passage (when issued) should be considered an alternative for consideration.

expansion Holtwood and Muddy Run are generating at or near full capacity (total flow of about 94,000 cfs). This indicates that parts of the river channel would be reaching velocities that may deter shad, potentially causing some migratory delays, but Exelon states that large portions of the river channel would remain with suitable velocities for upstream migration, based on field measurements of velocities in the immediate project vicinity. For downstream juvenile shad passage, Exelon estimated that for fish that were in the zone of influence during pumping, 22.6 percent of those fish could be entrained. For the overall population, however, Exelon estimated that only 2.9 to 6.6 percent of the population would be vulnerable to entrainment during peak outmigration times, because the project is not pumping during many of the peak hours of outmigration (Normandeau and Gomez and Sullivan, 2012g). These data indicate that the project already meets the agencies' effectiveness targets for upstream adult shad passage and downstream juvenile shad passage.

The reviews by Sweka (2013) and Pugh (2013), however, do not agree with the Exelon study results and argue that Exelon has understated the effects of the project on upstream migration and entrainment of juvenile shad. Sweka (2013) states that the Exelon data show that project releases do result in a slower travel time for adult shad migrating upstream in those flows. He also states that only 18 percent of upstream forays by migrating shad were successful at continued passage past the Muddy Run tailrace from the downstream Sicily Island to the upstream Deepwater Island with no fall back behavior, and some individual fish needed to make several forays prior to successfully passing Muddy Run. Sweka concludes that project operation results in migratory delays and possible termination of upstream migration by shad. Pugh (2013) states that by adjusting the periods when juvenile shad may actually be passing the project, based on information from the scientific literature, the actual entrainment rate for juvenile shad would be from 12.3 to 14.5 percent of the population, and not 2.9 to 6.6 percent as estimated by Exelon.

Exelon, in its reply comments filed on March 18, 2014, states that the Sweka (2013) and Pugh (2013) reviews of the data were flawed and that they overstate the actual effects of the project.

Our assessment of these conflicting studies and analyses is that the argued differences in migration and entrainment rates may be within the range of error for the field studies and the data analysis. While the field studies may do a reasonable job of representing the "real world," there are issues with any field study (tag losses, differences in behavior of tagged fish, equipment failures, etc.) that may influence the study results. Instead of trying to determine whose studies or analyses are most correct, our conclusion is that the studies and analyses have overall shown that the Muddy Run Project does not have an adverse effect on a major proportion of the shad population migrating past the project, and has not resulted in major delays to the shad migration. In addition, with Exelon now agreeing to the conditions of the certification, Exelon has committed to maintaining the effectiveness targets required by Pennsylvania DEP, would monitor this

effectiveness via the studies required by the certification as part of its FPOP, and would mitigate any effects of the project if the target effectiveness is not maintained.

Both the fishway prescription and the certification would require additional effectiveness studies, but on different time schedules. The fishway prescription would require periodic studies (every 10 years) beginning in 2018, while the certification would require upstream passage effectiveness studies only if Pennsylvania DEP determines that Muddy Run operation is causing the upstream Holtwood Project to not meet its effectiveness targets. Downstream passage effectiveness studies would be required beginning in 2026, for the certification. Both the fishway prescription and the certification would require that additional measures be implemented if effectiveness targets are not met. It appears that the fishway prescription and the certification would accomplish the same goals, but on a slightly different timetable.

Conowingo Project

The Conowingo Project currently operates two fish passage facilities: the east fish lift for volitional upstream passage into Conowingo Pond, and the west fish lift, for collection of shad for egg-taking and other experimental purposes. Exelon proposes to continue operating these facilities and to implement a preventive maintenance program at the east fish lift, to extend the life of the facility through the new license term. Several commenting entities have stated that the current facilities are inadequate and outdated and fail to meet the required effectiveness to achieve successful anadromous fish restoration in the Susquehanna River. Both Interior and NMFS reserve their authority to prescribe additional fishways during the term of the license, and Interior also provides a preliminary fishway prescription for the project for both anadromous and catadromous species.[52] Interior also recommends that Conowingo fish passage facilities need an operation and maintenance plan and a fish passage effectiveness monitoring plan (FEMP), and as a section 10(j) measure recommends that alternative G of the fishway prescription be implemented. Alternative G would include:

- Phase I: Construct a new west fish lift for both trap and trucking and direct volitional upstream shad passage (two 6,500-gallon hoppers), with an auxiliary water system of 2,600 cfs. The objective would be to truck 50,000 adult shad per year. Create a 5,000-foot zone of passage[53] on the east and west shores of the tailrace below the dam. Implement a maximum downramping rate of 20,000 cfs/hour. Make channel modifications downstream to eliminate stranding in the spillway channel.

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[52] Fish passage for American eel is discussed below in a separate section.

[53] A zone of passage is a reach within a stream where depth and velocities are maintained within suitable ranges for upstream or downstream fish passage.

- Phase II: Modify the east fish lift stilling basin to allow a 900-cfs attraction flow, as originally designed. Relocate east fish lift entrance A to upstream of the Kaplan unit boils. Construct a new entrance D and collection gallery to east fish lift, along the Kaplan units and connect to a new second hopper. Reconstruct entrance B to the east fish lift at 45 degrees to the river flow (see figure 3-15).
- Phase III: If passage efficiency is not met in Phase I and II, make daily adjustments to minimum flows and turbine operation, construct an east fish lift auxiliary water supply of 4,325 cfs, and upgrade east fish lift equipment to allow a 15-minute cycle time.

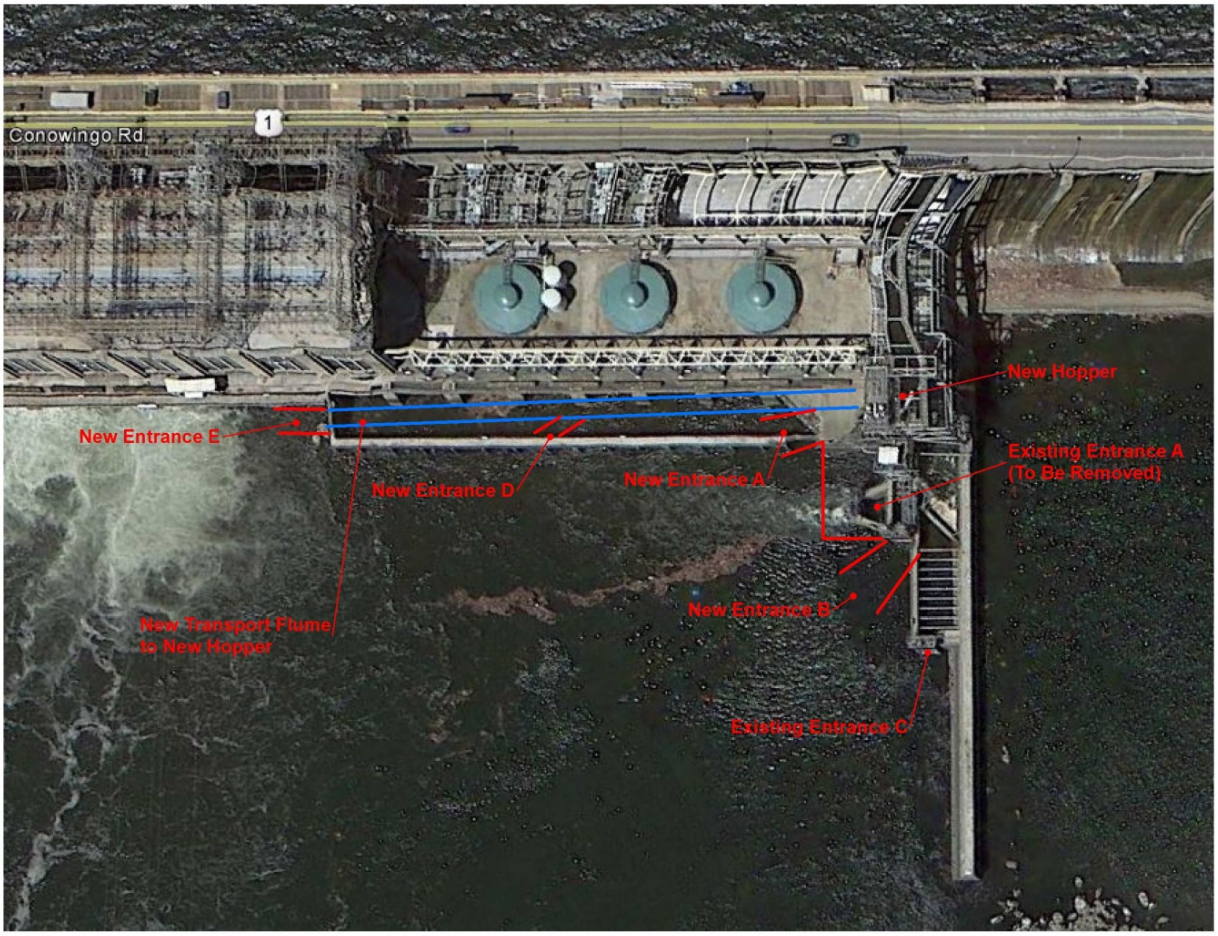

Figure 3-15. View of the east end of the Conowingo powerhouse showing the approximate locations of Interior's recommended entrance modifications to the east fish lift (Source: Google Earth; Morales and Towler, undated; Staff).

Exelon, in its reply comments, states that there is currently no need to construct additional fish passage facilities at Conowingo dam, that the recent shad population trends in the Susquehanna River and along the Atlantic coast do not indicate that large increases in shad populations are likely, and that there is no scientific basis for the target

effectiveness rates that Interior and other agencies have recommended for fish passage facilities at Conowingo and the other Susquehanna River hydroelectric projects. Exelon also comments that past agency management decisions for the Susquehanna River have been flawed, including the decision to terminate shad trap and truck operations from Conowingo after 1996, resulting in a decrease in the number of spawners reaching upriver spawning habitat.

Our Analysis

Exelon conducted several studies as part of relicensing to assess the effectiveness of the existing fish lifts and to identify which operating conditions at the project resulted in the best fish passage. Exelon also conducted an engineering evaluation to assess alternatives for improvements to the facilities to improve fish passage. In addition to the current studies, there are more than 40 years of operational experience with the fish passage facilities at Conowingo dam, with a multitude of associated studies. Numerous other studies and operational experiences at fish passage facilities for American shad and other anadromous species are also available for other projects on the Atlantic and Pacific coasts that may have some applicability to the Susquehanna River. Fish passage at Conowingo is one of the primary issues for relicensing, as passage at Conowingo has a major effect on fish passage upstream of Conowingo and on the restoration program for the Susquehanna River. Ultimately, the final fishway prescriptions from Interior and NMFS would become conditions of any license issued for Conowingo, but we are presenting our independent analysis of this issue at Conowingo, including our assessment of Interior's preliminary fishway prescription.

Fishway Effectiveness

Fishway effectiveness is an important aspect of fishway operations on the Susquehanna River, as the objective is to pass as many spawners as possible to areas upstream of York Haven dam, where the best spawning habitat for shad occurs. Some spawning habitat is also available between the Safe Harbor and York Haven projects (about 12 miles of river), in some of the tributaries (such as the Conestoga River), and in limited areas in the upper reaches of Conowingo Pond and Lake Aldred (Holtwood reservoir). But the primary focus of the shad restoration program has always been a target population as measured at the York Haven Project. As stated in the current restoration plan for the river (SRAFRC, 2010), the goal of the program is: "*Restore self-sustaining, robust, and productive stocks of migratory fish capable of producing sustainable fisheries, to the Susquehanna River Basin throughout their historic ranges in Maryland, Pennsylvania, and New York. The goals are 2 million American shad and 5 million river herring spawning upstream of the York Haven Dam. Goals for American eel and other migratory species are yet to be determined.*" In order to achieve that goal, the plan also states as a primary objective: "*Develop and implement upstream passage plans and performance measures at all four lower river hydroelectric dams to ensure that each facility passes at least 75 percent of the adult American shad passed at the next downstream facility, or at least 85 percent of the adult American shad reaching project*

tailwaters." The fishway effectiveness target has also recently been revised slightly by Interior to say that 80 percent of the fish in each tailwater must pass within 36 hours, to reduce delay at each project.[54] The basis for these effectiveness targets is not provided in the restoration plan, but is believed to be a reflection of the effectiveness at the Safe Harbor Project, which has the highest effectiveness of any facility on the Susquehanna River (or perhaps on the Atlantic coast), averaging about 71 percent of the passage at the downstream Holtwood Project. Recent population modeling by both Exelon (Normandeau and Gomez and Sullivan, 2012j) and FWS (Sweka, 2014) also indicate that the most important factor in achieving a population growth in line with restoration goals is providing a sufficient numbers of spawners to upriver habitat. Without high fishway effectiveness or trucking of spawners to that habitat, the shad population would not substantially grow or reach restoration goals. This modeling also included hatchery contributions of shad fry, and while hatchery production may result in some population growth, the most important factor is providing sufficient numbers of spawners to upriver habitat (see discussion below on *Susquehanna River Shad Population Trends*).

While fishway effectiveness is important, we previously discussed our concerns about specific target effectiveness goals at the York Haven Project, and whether target effectiveness is something that can entirely be controlled by the licensees. At Conowingo, Exelon's studies showed that the east fish lift attraction efficiency[55] ranged from 73 percent in 2010 to about 44 percent in 2012 (Normandeau and Gomez and Sullivan, 2012a; 2012b). Total fish passage effectiveness[56] ranged from 45 percent in 2010 to 26 percent in 2012. Several variables were assessed for the two study years; river flows and project discharges were generally higher in 2012 than 2010, possibly resulting in lower attraction efficiency in 2012. The portion of those fish that entered the fish lift and ended up successfully passing the fish lift was similar in both years (61.5 percent in 2010 and 58.6 percent in 2012). This would be expected as once fish are inside the facility the hydraulic conditions are more controlled than what fish may experience in the river or tailrace. However, in both years fish made multiple forays, both successful and unsuccessful, into the fish lift and were detected in many areas of the tailrace, indicating searching behavior.

This searching behavior results in delay of fish locating the fish lift entrances and achieving passage, and is a concern expressed by Interior and other agencies. Fish that

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[54] However, Pennsylvania FBC has a slightly different criterion that 80 percent of the fish should pass a project within 5 days.

[55] That is, the percentage of radio-tagged shad documented in the tailrace that subsequently entered the east fish lift.

[56] That is, the percentage of radio-tagged shad documented in the tailrace that successfully completed passage through the east fish lift.

experience delays in passing Conowingo and the other lower river hydroelectric projects may not reach upstream spawning areas in time to complete spawning, as Susquehanna River water temperatures typically increase quickly in late spring as river flows recede. FWS analyzed radio telemetry data from the 2010 and 2012 studies, to assess the amount of delay that fish encountered in entering and passing the east fish lift (Morales, undated). According to this analysis, fish in 2010 required from 3.5 hours to 383 hours (average of 129 hours – about 5.4 days) from their initial entry into the tailrace (as detected by radio telemetry), for successfully completing passage into Conowingo Pond, and only 10.1 percent of the fish met the current Interior criteria that passage occur within 36 hours. In 2012, fish required from 56 hours to 768 hours (average of 276 hours – 11.5 days) for completing passage, and no fish met the Interior criterion that passage occur within 36 hours.

We are unsure of the basis for the Interior 36-hour criteria, and what an acceptable delay may be. To further assess potential "acceptable" delays, we examined water temperature data from the Harrisburg USGS gage (No. 01570500), located just upstream of York Haven, for 2008 through 2013 (data not available for 2011), to determine when water temperatures typically reach the upper range of most suitable spawning temperatures for shad (71°F – Walburg and Nichols, 1967). The assumption is that once the maximum suitable temperature is reached and maintained and then exceeded, there would be little successful spawning after that point. In reality, however, some spawning would likely continue at higher temperatures, as Walburg and Nichols (1967) report that spawning may occur at temperatures as high as 78°F. The following summarizes when a temperature of 71°F was first reached and then maintained at Harrisburg:[57]

- 2008 – May 31
- 2009 – June 7
- 2010 – May 26
- 2012 – June 9
- 2013 – May 28.

Conowingo dam typically begins fish lift operations by about April 1, although substantial numbers of shad are usually not available until mid-April. An approximate average of the above dates when water temperatures would exceed 71°F would conservatively be about May 31, which would mean that shad reaching Conowingo dam in mid-April would need to pass York Haven in about 45 days. This would mean that

[57] There were instances when this temperature was reached for a short time, but then decreased after a few days as a result of colder weather or higher flows. We used the date when the temperature first reached 71°F and then remained above that for a prolonged period.

fish would need an average of about 10 days to pass each project dam and migrate the distance between each project.[58] For later arriving fish, however, this window would be shorter, with fish arriving by May 1 having a 30-day window, needing to pass each project in an average of about 7 days. If we subtract the travel time (5 to 6 days – see footnote below), this would further reduce the window at each project to an average of about 6 days for fish to locate and successfully pass the fishway at each dam. While we understand Interior's objective to reduce delay at each project, our simple analysis indicates that Interior's 36-hour criteria may be overly conservative, and that fish could still reach habitat upstream of York Haven at suitable spawning temperatures as long as they could pass each project within a matter of days. Our estimate is more in line with the Pennsylvania FBC criteria that 80 percent of the fish pass a project within 5 days.

In any event, the fish passage effectiveness at Conowingo dam, based on Exelon's studies, appears relatively low (45 percent in 2010 to 26 percent in 2012), with average delay ranging from 5.4 to 11.5 days. While this effectiveness may be within the range of other fish passage facilities in the Northeast (such as Holyoke dam on the Connecticut River), the Holyoke dam is located at RM 86, and has suitable and ample spawning habitat both downstream and upstream of the dam. On the Susquehanna River, fish must pass four dams before reaching the best spawning habitat.

The best example of a multiple-dam system that has an established healthy shad run is the Columbia River, although the American shad is an introduced species in the Columbia River and is not a management species of interest. The Columbia River shad runs have reached more than 6 million fish annually, probably the largest run in North America, and the hydroelectric projects have large fishways designed for salmon with high volumes of attraction water not typically seen in Atlantic coast projects. Table 3-23 summarizes American shad counts on the Columbia River for three lower-river dams: The Dalles, John Day, and McNary. Bonneville dam is the lowermost dam on the river, but because a large segment of the shad run passes through the navigation lock at

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[58] The distances between projects on the lower Susquehanna River, however, are not large, although fish would also have to pass by the Muddy Run Project. With Conowingo dam at river mile 10 and York Haven dam at river mile 54, shad would only need to travel 44 river miles to reach York Haven. At a shad cruising speed of about 3 fps (2 miles per hour) (Bell, 1991), an unobstructed shad could travel 44 miles in about 22 hours (about a day), if it migrated continuously. However, Normandeau and Gomez and Sullivan (2012h) reported much slower migration speeds in Conowingo Pond of 4 to 6.7 miles per day. At an average speed of 5 miles per day, fish would require about 9 days to reach York Haven. Because the 44-mile-reach is a combination of reservoir and riverine habitat, we assume that travel time to York Haven may be in the range of 5 to 6 days, for a freely-migrating shad.

Bonneville (resulting in higher counts at the next upstream dam, The Dalles), we are using The Dalles counts as the "beginning" count on the Columbia.

While some shad may use navigation locks for passage at all the dams on the Columbia River, the fishway counts at The Dalles and above dams are believed to reasonably represent shad passage at these dams. These data show that John Day dam passes an average of 51 percent of the count at The Dalles (range of 27 to 70 percent), and McNary dam passes an average of 55 percent of the John Day passage (range of 32 to 108 percent [potential counting error]). The Dalles reservoir is about 24 miles long, and John Day reservoir is about 76 miles long, and both reservoirs may contain suitable shad spawning habitat. The passage at McNary dam averages 28 percent of the passage at The Dalles (range of 13 to 58 percent). These data show that there has been a wide range in passage effectiveness through the years, but the long-term average is that about 50 percent of the fish passed at the lower dam is passed at the next upstream dam. These long-term data show that the target passage effectiveness recommended for the Susquehanna River (75 percent from dam to dam) has only been occasionally met on the Columbia River, and in most years is much less than that target. While the shad is not a target species of interest on the Columbia River, the Corps and fisheries agencies still have an interest in effectively passing the shad at each dam, so that shad successfully move through the fishways and do not affect or block the passage of the salmonid species of interest, many of which are federally listed. Consistently maintaining a high fish passage effectiveness (75 percent) on all the Susquehanna River projects, as recommended by Interior and other commenting entities, may not be a realistic objective, but as fish counts on the Columbia River have shown, somewhat lower passage efficiencies may still result in substantial growth and maintenance of a large shad population (table 3-23).

Table 3-23. American shad passage at lower Columbia River dams, and passage effectiveness between dams, 1984 to 2013 (Source: http://www.fpc.org/, accessed March 22, 2014).

Year	The Dalles (RM 192)[a]	John Day (RM 216)	JD % of The Dalles	McNary (RM 292)	McN % of John Day	McN % of The Dalles
2013	--[b]	--	--	1,246,494	--	--
2012	--	--	--	675,421	--	--
2011	--	--	--	224,905	--	--
2010	1,241,770	--	--	276,673	--	22
2009	1,641,362	--	--	486,725	--	30
2008	1,805,516	--	--	623,010	--	35
2007	3,591,988	--	--	985,466	--	27
2006	4,611,592	--	--	1,176,899	--	26

Year	The Dalles (RM 192)[a]	John Day (RM 216)	JD % of The Dalles	McNary (RM 292)	McN % of John Day	McN % of The Dalles
2005	6,067,028	--	--	1,951,001	--	32
2004	5,472,400	--	--	1,751,728	--	32
2003	4,258,889	2,735,108	64	1,077,670	39	25
2002	3,218,050	1,850,942	58	599,294	32	19
2001	2,724,946	1,796,826	66	1,063,568	59	39
2000	1,556,619	851,598	55	350,457	41	23
1999	1,718,679	763,007	44	248,895	33	14
1998	2,149,097	1,025,044	48	393,305	38	18
1997	2,571,260	1,007,896	39	340,090	34	13
1996	2,648,553	959,262	36	352,755	37	13
1995	1,959,564	1,033,727	53	481,081	47	25
1994	1,801,545	935,958	52	668,528	71	37
1993	2,394,394	647,097	27	701,404	108	29
1992	2,824,313	1,963,060	70	1,635,089	83	58
1991	2,191,077	1,382,009	63	674,483	49	31
1990	3,706,855	1,641,943	44	866,940	53	23
1989	2,971,017	1,773,938	60	1,076,473	61	36
1988	2,008,572	908,741	45	665,925	73	33
1987	1,289,698	748,767	58	575,338	77	45
1986	1,361,854	609,363	45	307,361	50	23
1985	1,389,547	682,344	49	438,329	64	32
1984	1,135,982	586,015	52	281,793	48	25
		Average %	51		55	28

[a] Bonneville dam is at RM 146.

[b] The Corps ended shad counts at The Dalles in 2011 and at John Day in 2004.

Susquehanna River American Shad Population Trends

The resource agencies and cooperating project owners have made progress in restoration of shad to the Susquehanna River over the past 40 years. As described in Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC, 2010), the number of shad collected annually in the west fish lift generally numbered in the hundreds of fish in the 1970s and early 1980s, and did not consistently exceed 1,000 fish until 1985. As table 3-13 shows, the numbers of shad passed at Conowingo increased substantially into the late 1990s with the completion of the east fish lift and reached a peak of 193,574 in 2001. Since 2001, however, the numbers have consistently declined. Maryland DNR has also been making shad population estimates for the Conowingo tailrace since the 1980's (SRAFRC, 2013), using both a Petersen mark/recapture methodology and surplus production method (SPM).[59] These estimates are shown in figure 3-16, and show a similar trend to the fish lift counts, with strong population growth up until 2000 to 2001, with an overall decline since then. The Petersen estimates show much higher numbers than the SPM method in some years, believed to be because of very low recapture rates in some years. Both methods show a small increase in population estimates from 2007 to 2012. In 2012, Maryland DNR estimated a tailrace shad population of 150,743 fish using the Petersen method and 111,500 fish using the SPM.[60] Maryland DNR finds that the Petersen method may overestimate the actual population size, while the SPM may underestimate the population, but also indicates that the cessation of trucking in 1997 has been a factor in the decline of the shad population in the lower river (SRAFRC, 2013).

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[59] The SPM is a mathematical technique in which the population estimate is based on the previous-year's population, the intrinsic rate of population increase, the estimated maximum population size, and assumed losses associated with upstream and downstream fish passage and by-catch mortality in the Atlantic herring fishery in the previous year.

[60] The east fish lift passed 22,143 shad in 2012, or about 15 percent of the Petersen population estimate and 20 percent of the SPM estimate. An additional 1,486 shad were collected in the west fish lift and used for egg collections and other experimental purposes.

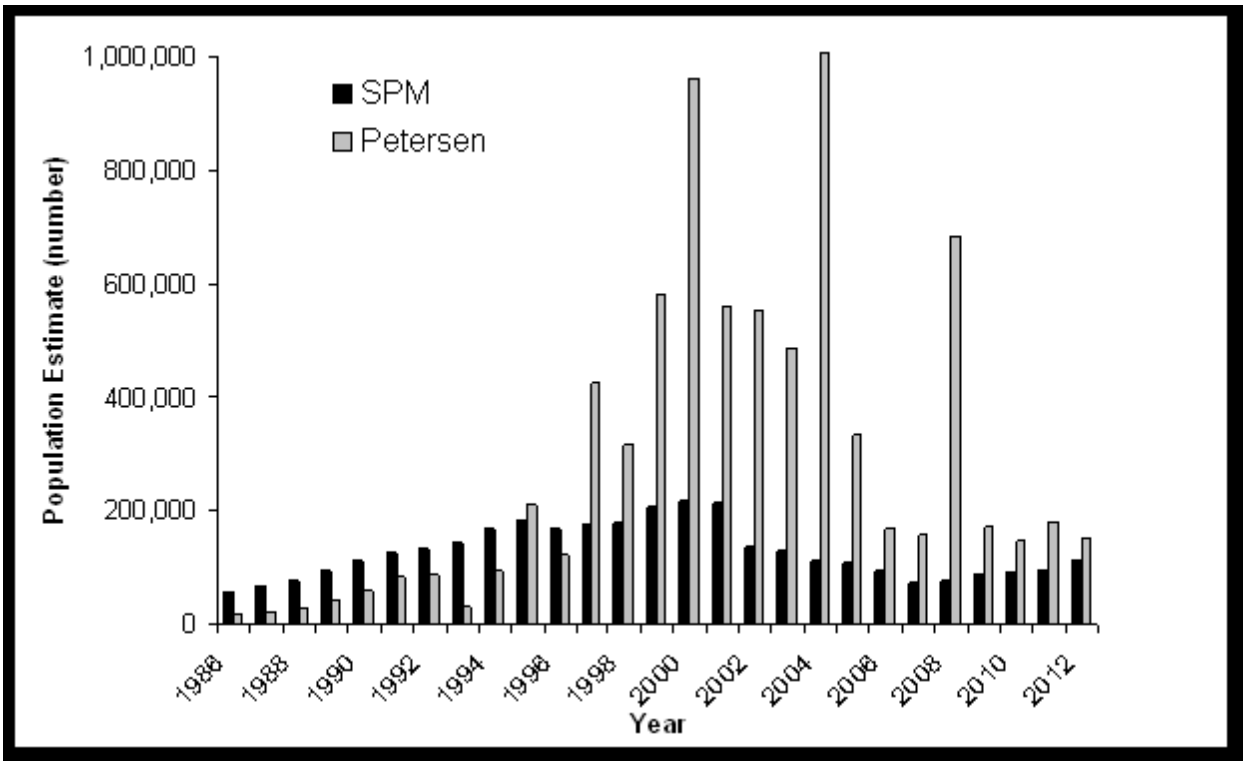

Figure 3-16. Maryland DNR American shad population estimates for the Conowingo tailrace, 1986 to 2012 (Source: SRAFRC, 2013).

Other factors in the decline may include the strong growth of the gizzard shad population, the increase in the number of predators in the river (including the introduction of the flathead catfish), and continued harvest of shad in offshore fisheries. Table 3-14 illustrates the strong increase in the gizzard shad population in the river, with annual passage at the Conowingo east lift now reaching more than 1 million gizzard shad, and an additional 300,000 to 400,000 gizzard shad taken in the west lift. The effects of crowding in the fish lifts are unknown but there is the potential that large numbers of gizzard shad may delay or hinder American shad entry to the lifts. Another effect of gizzard shad on American shad and other species that rely on zooplankton as a food source for early life stages (larvae and juveniles), is that large numbers of larval and juvenile gizzard shad may have an adverse effect on zooplankton populations via extensive grazing of that population (Sullivan et al., 2011). With a large population of juvenile gizzard shad in the lower river, interspecific competition for that food source may affect the growth and survival of juvenile American shad. The effects of a voracious predator such as flathead catfish has not been quantified, but this invasive species is now regularly caught throughout the lower river, with hundreds now typically collected in the Conowingo lifts and in the York Haven east channel ladder, and is also recorded in the Holtwood and Safe Harbor fish lifts (SRAFRC, 2013). Flathead catfish has also now become a target species of interest for anglers in the Susquehanna River, and the Pennsylvania FBC reports that flathead catfish in excess of 40 pounds are commonly

caught within Pennsylvania (http://www.fish.state.pa.us/catfish_flathead.htm, accessed May 15, 2014). An offshore ocean fishery for American shad, both directed and by-catch, continues along the Atlantic coast, although that fishery has shown declines as the stocks have reached lower levels and with the closure of an ocean intercept fishery in 2005.[61] Because of its concern about this continued source of mortality to American shad stocks, including the Susquehanna River, the Atlantic States Marine Fisheries Commission (ASMFC) has adopted a strategy to quantify and manage sources of by-catch mortality where possible (ASMFC, 2010).

Several comments have been made by both the agencies and Exelon that the cessation of trucking to upriver habitat has been a factor in the recent decline of the shad population, and that reinstatement of some trucking would likely benefit the population by "jump-starting" population growth. We further examined this issue by summarizing the total number of spawners reaching upriver habitat by trucking from the east and west fish lifts since the beginning of the program, as well as out-of-basin trucking,[62] and compared that to the number of spawners reaching upriver habitat since volitional passage was established at all the dams in 2000. Table 3-24 and figure 3-17 show that the number of spawners reaching upriver spawning habitat since trucking was eliminated in 2000 has decreased significantly, particularly after 2001. Based on these data, it is likely that the recent decrease in the shad numbers at Conowingo is related to the significant decrease in spawners reaching upriver habitat. The peak number of upstream spawners occurred from 1994 to 1996, followed by peak returns to the east lift in 2000 to 2004, from 4 to 8 years after the peak number of upstream spawners occurred. Most shad return to spawn at ages IV to VII, with some age VIII fish reported (SRAFRC, 2013). To illustrate the potential benefits of trucking, simple math shows that if fish are allowed to pass the three dams upstream of Conowingo via volitional passage at 75 percent effectiveness at each dam, only about 42 percent of the fish exiting the Conowingo fish lifts would reach above York Haven. In contrast, 100 percent of the fish trucked from Conowingo would reach habitat upstream of York Haven, minus any mortalities in transport, which in past trucking operations were minor. A sustained trucking program would have the potential to maintain greater numbers of spawners in upriver locations when the shad population is low, as now, than volitional passage over four dams.

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[61] An ocean intercept fishery is a commercial fishery in the ocean directed at stocks of migratory fishes on their way to spawning streams.

[62] From 1980 to 1987 pre-spawn shad were trucked to the Susquehanna River from other river basins (most from the Delaware River).

Table 3-24. Number of American shad spawners, from multiple sources reaching upriver spawning habitat (primarily upstream of York Haven), 1980 to 2014 (Source: SRAFRC, 2010; Pennsylvania FBC, 2014).

Year	Out-of-basin Trucking	Trucking from Conowingo	Volitional Passage to York Haven	Total Spawners
1980	114	--	--	114
1981	1,165	--	--	1,165
1982	2,565	800	--	3,365
1983	4,310	64	--	4,374
1984	3,777	0	--	3,777
1985	2,834	967	--	3,801
1986	4,965	4,172	--	9,137
1987	6,051	7,202	--	13,253
1988	--	4,736	--	4,736
1989	--	6,469	--	6,469
1990	--	15,075	--	15,075
1991	--	24,662	--	24,662
1992	--	15,674	--	15,674
1993	--	11,717	--	11,717
1994	--	28,681	--	28,681
1995	--	56,370	--	56,370
1996	--	33,825	--	33,825
1997	--	10,528	--	10,528
1998	--	4,593	--	4,593
1999	--	5,508	--	5,508
2000	--	1,351	4,675	6,026
2001	--	--	16,200	16,200
2002	--	--	1,555	1,555
2003	--	--	2,536	2,536
2004	--	--	219	219
2005	--	--	1,772	1,772

Year	Out-of-basin Trucking	Trucking from Conowingo	Volitional Passage to York Haven	Total Spawners
2006	--	--	1,913	1,913
2007	--	--	192	192
2008	--	--	21	21
2009	--	--	402	402
2010	--	--	907	907
2011	--	--	0	0
2012	--	--	224	224
2013	--	--	202	202
2014	--	--	8	8

Figure 3-17. Graphical depiction of number of American shad spawners, from multiple sources reaching upriver spawning habitat (primarily upstream of York Haven), 1980 to 2014 (Source: SRAFRC, 2010; Pennsylvania FBC, 2014).

Hatchery production of shad has also been a part of the Susquehanna River restoration program since 1976. Fertilized American shad eggs have been collected over the years on several rivers on the Atlantic coast (Susquehanna, Delaware, Connecticut, Hudson, Potomac, York, James River and its tributaries) and from the Columbia River in Oregon/Washington. In recent years, egg-taking has also occurred at the west fish lift via artificial tank spawning. Since the Pennsylvania FBC Van Dyke hatchery went into operation in 1976, more than 220 million shad fry and juveniles (mostly fry) have been stocked into the Susquehanna River and its tributaries, ranging on an annual basis from 660,000 to 13.5 million. In the last 5 years the numbers stocked have ranged from about 2.5 to 5.5 million, totaling 18.6 million, almost exclusively fry. SRAFRC (2013) estimated that for the 1986-2007 year classes, stocking of approximately 404 hatchery larvae was required to return one adult to the Conowingo lifts. Assuming that 400 fry are required for each adult return, stocking in the past 5 years could result in a return of about 46,500 adult shad to the lifts, but spread over 4 to 5 years and longer. For trucked fish, SRAFRC (2013) estimated that transport of 1.28 adults to upstream areas was required to return one wild fish to the lifts. Thus, 59,520 fish would need to be trucked to produce a return of 46,500 fish. However, past experience has shown that up to 56,000 fish were

trucked in 1 year (see table 3-24), so this production could occur in 1 year, instead of being spread over 5 years, as with the recent hatchery program. Even a more modest trucking program of 30,000 fish per year over 5 years (stocking of 150,000 spawners) would result in the production of about 117,000 returning adults to the lifts, using current survival rates. A modest trucking program would have the potential to produce more adult returns than a hatchery program similar to that of the recent 5 years. Actual survival rates and adult returns to the Conowingo tailrace may even be higher, however, than estimated by SRAFRC because not all returning adults successfully enter the lifts.

Atlantic coast and Chesapeake Bay American shad population trends

The current decline in shad populations on the Susquehanna River parallels declines that have been occurring coast wide, including in the Chesapeake Bay. A report by the Chesapeake Bay program (http://www.chesapeakebay.net/indicators/indicator/american_shad_abundance, accessed March 26, 2014) states that in 2013, the Bay-wide shad restoration program reached 41 percent of its goal, but most of the increase in recent years has been due to the improvement in the Potomac River shad run. The recent trend for all the other major tributaries to the Bay has been either a decline or continued maintenance of low levels well short of the goals. These other rivers include the York, James, Rappahannock, and Susquehanna. Fish passage impediments were removed on the James River (Bosher's dam fishway) and on the Rappahannock River (removal of Embrey dam) some years ago, but shad populations has not responded as expected to this increased availability of habitat.

For other Atlantic coast rivers, ASMFC (2010) reports that shad populations in most of the Atlantic coast rivers remain at historic lows and are not recovering to acceptable levels. ASMFC (2010) notes that data on annual numbers of fish passing upriver at dams on several Atlantic coastal rivers showed a coast-wide pattern of an increase followed by a decrease in the past 20 to 30 years. In fact, most fish passage numbers declined at about the same time (beginning in the late 1990s to early 2000s). This simultaneous decline suggests a coast wide change in environmental conditions or mortality factors that affected stocks from South Carolina to Maine within the last 5 to 10 years. This suggests that operation of hydroelectric projects on Atlantic coast rivers, many of which have fish passage facilities, have not been a primary cause of the population declines observed, and that additional or more effective fish passage facilities on these rivers may not necessarily result in population increases.

Interior preliminary fishway prescription and improvements to Conowingo fish lifts

As described above, in its preliminary fishway prescription, Interior specifies major renovations to the Conowingo fish lifts. Other agencies and other entities also generally recommend major renovations to the lifts to improve the effectiveness of the lifts, but only Pennsylvania FBC provides specific step by step recommendations for fish

lift improvements. Table 3-25 summarizes the recommended improvements by Interior and Pennsylvania FBC.

Table 3-25. Summary of Interior preliminary fishway prescription and Pennsylvania FBC recommendations for upstream anadromous fish passage at Conowingo dam (Source: Interior and Pennsylvania FBC terms and conditions; Staff).

Interior preliminary fishway prescription	**Pennsylvania FBC recommended improvements**
Phase I: Construct a new west fish lift for both trap and trucking and direct volitional upstream shad passage (two 6,500-gallon hoppers), with an auxiliary attraction water system of 2,600 cfs. The objective would be to truck 50,000 adult shad per year. Create a 5,000-foot zone of passage on the east and west shores of the tailrace below the dam. Implement maximum downramping rate of 20,000 cfs/hour. Make channel modifications downstream to eliminate stranding in the spillway. Timeline: No schedule given, but we assume 1 year for design and 2 years for construction, for total of 3 years.	Item 1: Incorporate performance criteria into new license where 80 percent of the shad that enter the project area must pass the project within 5 days, to be based on telemetry study of 150 shad per year for 3 years. If goal is not reached, initiate operational changes as specified by the agencies and test for 3 years using telemetry study. If goal is still not reached after 3 years, make structural changes to the fish lifts as specified by the agencies, and test for an additional 3 years using a telemetry study. If goal is still not reached within 3 years, additional structural changes may be required, depending on behavior of tagged shad. Timeline: Potential for 12 years – 3 years for initial studies, 3 years for study of operational changes, 3 years for structural changes, and 3 years for additional monitoring.
Phase II: Modify the east fish lift stilling basin to allow 900-cfs attraction flow, as originally designed. Relocate east fish lift entrance A to upstream of the Kaplan unit boils. Construct new entrance D and collection gallery to east fish lift, along the Kaplan units and connect to a new second hopper. Reconstruct entrance B to east fish lift at 45 degrees to the river flow (see figure 3-15).	Item 2: Modify east fish lift to include a larger hopper, increased attraction flow, and addition of a collection gallery in front of units 8-11. Timeline: No schedule given as to when improvements would be required in relation to item 1, but we assume these would be the structural changes that would occur after the first 6 years of studies. Assume 1 year for design and 2 years for construction. Similar to Interior Phase II.

Interior preliminary fishway prescription	Pennsylvania FBC recommended improvements
Timeline: To begin when new west fish lift begins operation; we assume 1 year for design and 2 years for construction, for total of 3 years	
Phase III: If passage efficiency is not met in Phase I and II, make daily adjustments to minimum flows and turbine operation, construct an east fish lift auxiliary attraction water supply of 4,325 cfs, and upgrade east fish lift equipment to allow a 15-minute cycle time. Timeline: No timeline given but we assume 1 year for design and 1 year for construction, for total of 2 years.	Item 3: Complete the rebuild of the west fish lift to include additional attraction water and provision to expand to volitional passage if needed. Ultimately, fish passage facilities at Conowingo will need to pass a design population of 5 million fish, and fish lifts will be required on both sides of the tailrace. Timeline: No schedule given as to when improvements would be required in relation to item 1, but we assume these would be the structural changes that would occur after the first 6 years of studies. Assume 1 year for design and 2 years for construction. Similar to Interior Phase I. Item 4: Telemetry study of gizzard shad is needed to understand the issues of passage efficiency, capacity, and interference with American shad, and the recycling of gizzard shad in the west fish lift. Timeline: No schedule given but we assume a 1-year study during the first 3 years of study in Item 1.

The Interior preliminary prescription and Pennsylvania FBC recommendations are similar in that they both call for the complete re-build of the west fish lift and major improvements to the east fish lift that would involve major structural changes. The Pennsylvania FBC recommendations differ from the Interior preliminary prescription, in that the Pennsylvania FBC appears to recommend that at least 6 years of radio telemetry studies first be conducted to determine fish passage effectiveness before structural changes are made, and after first studying operational changes for 3 of those 6 years. Interior does not specify any studies prior to making structural improvements, only after the improvements are made.

While we understand that the final Interior fishway prescription would become conditions of any license issued, the requirements to re-build both the east and west fish lifts do not appear to be justified at this time. Although we describe above that the effectiveness of the Conowingo fish lifts have not been high in two recent years of studies (2010 and 2012), we also find that other fish passage facilities for American shad have similarly exhibited a wide range of effectiveness, with some exhibiting low effectiveness. Even at Safe Harbor dam, which has demonstrated the highest effectiveness of the four fish passage facilities on the Susquehanna River (and perhaps of any fish passage facility on the Atlantic coast), has not met the minimum Interior criteria in many years. The current declining trend in the shad population in the Susquehanna River and elsewhere along the Atlantic coast also does not indicate that the existing fish passage facilities will be exceeding their current design capacity for American shad anytime soon. There is, however, a concern about the continuing increase in the gizzard shad population in the Susquehanna River, and the ability of the current lifts to handle that population.

Other concerns are that the existing facilities have not been well maintained by Exelon, are showing their age, and have not been operating as originally designed. For example, the west fish lift first began operation in 1972 for a 5-year period, and is still in operation, but with a hopper that is relatively small and that has the capacity to hold fewer numbers of fish than desired in light of current fish populations in the tailrace (particularly gizzard shad). The east fish lift was designed to operate with an attraction flow of 900 cfs (about 1 percent of the full Conowingo station capacity of about 86,000 cfs), but because of excessive turbulence within the fish lift at that flow, and issues with some of the gates, it now operates at an attraction flow of only 300 cfs (0.3 percent of full capacity). The west fish lift was designed with a total attraction flow of 300 cfs, so current total attraction flow at Conowingo is 600 cfs (about 0.7 percent of full capacity). Experience has shown that the Conowingo fish lifts are most effective when station discharge is much less than full capacity, so that the total attraction flow is a greater percentage of ambient station discharge. The Interior and NMFS criterion for attraction flow is that it should be from 3 to 5 percent of full powerhouse capacity (Towler and Orvis, 2013), which at Conowingo would range from 2,580 to 4,300 cfs. Towler and Orvis (2013) also provide a summary table of attraction flows at fish passage facilities along the Atlantic coast, and for the major fish passage facilities listed (including those on the Connecticut, Merrimack, Penobscot, and Santee rivers), Conowingo attraction flows are the lowest percentage of any of the major facilities. Conowingo also has the lowest attraction flows of the Susquehanna River fish passage facilities. Making structural modifications within the east lift to increase the east lift attraction flow to its original design capacity of 900 cfs would be a reasonable way to increase attraction to the east lift without having to make major changes to the lift associated with constructing a new attraction water supply system.

Another operational deficiency of the existing east fish lift is that entrance A, which faces the Kaplan units (numbers 8 through 11), is not usable when the Kaplan units

are operating. The Kaplan units' discharge drowns out the attraction flow from entrance A, resulting in the closure of that entrance when the Kaplan units are operating. Interior's prescription would result in relocating entrance A to upstream of the Kaplan unit boils, to provide a better attraction flow jet to the quiescent area upstream of the boils (see figure 3-15). While this may have some merit, in that it would be similar to one of the Safe Harbor dam fish lift entrances that operates with good effectiveness, this would involve a major modification of the east lift. An alternative approach would be to first restore the 900-cfs attraction flow, and determine whether that additional flow, combined with operational modifications with the Kaplan units, would provide better attraction to entrance A when the Kaplan units are in operation. If the attraction problem persists after restoration of the 900-cfs flow, then the feasibility of relocating the entrance could be investigated. Interior's prescription would also require the reconstruction of entrance B to a 45-degree angle to the river flow. This appears to be counter to normal Interior guidance that attraction flow should be parallel to river flow, but this is another entrance modification that could be investigated if restoration of the 900-cfs attraction flow does not produce improvements in attraction flow patterns.

Interior's prescription would require and Pennsylvania FBC recommends construction of a collection gallery upstream of the Kaplan units' discharge, with Interior prescribing that the collection gallery be connected to a new second hopper, to increase the capacity of the east fish lift, in light of the large number of gizzard shad now being lifted, and to help meet the American shad design capacity. Addition of a collection gallery would also be a major modification to the east lift, and may not be warranted, based on the current population size and the questionable value of a collection gallery for shad. Few of the major passage facilities for shad on the Atlantic coast have collection galleries,[63] and where small collection galleries have been installed (Holyoke and Turners Falls dams on the Connecticut River), shad primarily use the shoreline entrances and the gallery entrances have collected few fish and in some cases have been closed. The Safe Harbor Project, which has a similar size tailrace to Conowingo with a total hydraulic capacity of 110,000 cfs (larger than Conowingo), does not have a collection gallery and has the highest fishway effectiveness on the river. Construction of a collection gallery should be a last step in making improvements to the fish lift entrances at Conowingo, and only if the previously discussed steps (restoring 900-cfs attraction water, and reconstructing entrances A and B) are unsuccessful, and there is evidence that large numbers of shad are in the tailrace and not locating the entrances. The past operation of the east fish lift has shown the capability to collect and lift large numbers of shad (193,574 in 2001), so making a major modification such as a collection gallery should not

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[63] The Columbia River projects that pass shad have collection galleries, originally built for salmon, but the extent of collection gallery use by shad has not been reported.

be required unless a preponderance of information indicates that large numbers of shad are not locating the entrances.

The installation of a second hopper, however, is an east lift improvement that warrants consideration. The current hopper at the east lift has a stated design capacity of 750,000 shad annually, and an unknown number of other species. As we illustrated in table 3-14, large numbers of adult gizzard shad are now lifted at Conowingo (and all the Susquehanna River projects), and the gizzard shad, which is only slightly smaller than the American shad, occupies much of the available space in the east-lift hopper. Addition of a second hopper, while it may not double the capacity at the lift, should provide an increase in capacity of at least 150 percent (Gomez and Sullivan and Normandeau, 2012). The original design of the east lift included the provision for adding a second hopper, so the space is there and no major modifications to the overall fish lift structure would be required. We have additional discussion of required hopper size below, under our discussion of west lift improvements.

Phase III of the Interior prescription also requires addition of an auxiliary attraction water supply of 4,325 cfs at the east lift (5 percent of the maximum powerhouse discharge) if passage efficiency is not met in Phase I and II, and the modification of fish lift equipment to allow a 15-minute lift cycle time. While we do not agree that an auxiliary attraction water supply is needed at this time,[64] we do agree that the fish lift should be able to achieve a lift cycle time of 15 to 20 minutes (the original design was to be a 15-minute cycle). Gomez and Sullivan and Normandeau (2012) report that the current lift cycle time is about 1 hour, which is inadequate for a fish lift that is handling millions of clupeids and other species annually. A shorter lift cycle time is needed to minimize the delay in lifting fish, and to reduce the potential for overcrowding the hopper on days of peak fish movement. Gomez and Sullivan and Normandeau (2012) state that one of the main reasons that the cycle time is about an hour is that the hopper floats when it is lowered back into the collection channel, and takes a while to fill with water and sink to the bottom. This has not been a major issue at other fish lifts on the Susquehanna and elsewhere, and it appears it could be easily remedied by the installation of hinge flap valves on the hopper floor.

Interior prescribes and Pennsylvania FBC recommends complete reconstruction of the west fish lift so that it can serve as a trap and truck facility and for volitional passage. Interior prescribes volitional passage at the same time that the trap and truck facility (50,000-fish capacity) is constructed with two large hoppers (6,500-gallon) and a 2,600-cfs attraction water supply. Pennsylvania FBC does not specify the facilities required at the west lift, although it appears to also recommend a trap and truck facility

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[64] As we describe earlier in this section, we conclude that the originally designed 900-cfs attraction flow should first be restored and tested before making any major changes to the attraction flow system.

with the provision to expand to volitional passage if needed in the future, to meet the design population of 5 million shad at Conowingo. We agree that the west lift should be improved and used for trap and trucking of shad, but it is premature to completely reconstruct the lift on the scale that would be required by Interior's prescription. Even in its current condition, the west lift continues to collect about 5 to 20 percent of the shad lifted at the east lift, with 2,030 collected in 2013 (16 percent of the east lift catch).[65] During the peak year of trap and trucking (1995) when about 56,000 shad were trucked upstream from Conowingo, about 12,000 shad were collected in the west lift and trucked upstream (21 percent of the total trucked). While trucking of shad has not occurred since the year 2000, the current fish sorting process at the west lift is labor-intensive and is essentially the same process using the same sorting tank initially installed in 1972. Trap and trucking operations at more recently constructed fish lifts typically involve a more automated process where transported fish can be more efficiently delivered to the transport truck, reducing the stress on trucked fish. Modifying the west lift facilities to improve the sorting and loading process would be an important measure as part of the reestablishment of a trap and trucking program from Conowingo. While Interior would establish an objective to truck 50,000 shad per year, the peak shad catch for the west lift was about 16,000 fish in 1990, so the initial handling facilities could be sized with a lower capacity but use a design that could be expanded in the future if needed. Reestablishment of trap and trucking would also require purchase of trucks and transport tanks and associated aeration systems, unless some of that equipment is available from the previous program.

Another prescribed west lift improvement would be replacement of the existing hopper, which has a volume of 900 gallons, or the capacity to hold 700 fish (1.3 gallons per fish) according to Gomez and Sullivan and Normandeau (2012).[66] Interior has commented that the current hopper volumes at both lifts are inadequate for the design population and the other non-target species collected with shad (particularly gizzard shad that vastly outnumber American shad). Towler and Morales (2012) have estimated that using a design population of 2 million shad, and the Interior criterion of 0.10 cubic foot per pound of fish in a hopper, the required hopper size at Conowingo (total of both lifts) would range from 842 to 1,768 cubic feet (depending on whether a 1963 log-correlation or a 2011 regression is used). At 7.48 gallons per cubic foot, this would require hopper sizes of 6,298 gallons to 13,225 gallons (the Interior prescription requires hopper sizes of 6,500 gallons at a new west lift). Towler and Morales (2012), however, also factor in a non-target species allowance (gizzard shad), which increases these hopper sizes by 9 times with an 800 percent non-target species allowance. Towler and Morales (2012) conclude that sufficient hopper volume, as per the Interior criterion, cannot be achieved

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[65] The west lift also collected 480,000 gizzard shad in 2013.

[66] In contrast, the east lift hopper has a capacity of 3,300 gallons.

through any reasonable number of lifts at Conowingo, and recommend sorting as a way to eliminate nontarget species from the lifts.

At the current hopper size and using the Interior criterion of 0.10 cubic foot per pound of fish, the west lift hopper with 900 gallons (120.3 cubic feet) would have a capacity of about 1,200 pounds of fish. The east lift hopper at 3,300 gallons (441.2 cubic feet) would have a capacity of about 4,400 pounds of fish. If we use a combined average weight of 2 pounds for American and gizzard shad,[67] the west lift hopper has a capacity of about 600 fish and the east lift hopper has a capacity of about 2,200 fish. Gomez and Sullivan and Normandeau (2012) estimated that the current west lift hopper has a capacity of 700 fish (which would be an average weight of 1.7 pounds). Gomez and Sullivan and Normandeau (2012) also describe that the existing west lift hopper could be replaced with a larger 1,500-gallon hopper without changing the existing footprint of the west lift, although it would require changes in the steel superstructure and electrical and other mechanical components. This would have a capacity of about 2,000 pounds of fish, or about 1,000 fish using our calculations, and 1,150 fish as stated by Gomez and Sullivan and Normandeau (2012). While this would not meet the Interior prescription for a 6,500-gallon hopper (capacity of about 8,700 fish), the Interior prescription is well in excess of what is currently needed. A new 1,500-gallon hopper would increase the fish capacity by about 40 percent, which would be a substantial improvement over the existing hopper, particularly if hopper replacement is combined with structural and electrical/mechanical improvements, and an improved fish sorting and delivery system. Adding a second hopper of 3,300 gallons to the east lift as we describe above, would increase the lifting capacity of the east lift by an average of 2,200 fish, meaning that the total lifting capacity at Conowingo would increase to about 1,100 cubic feet (8,100 gallons), with a fish lifting capacity of about 5,500 fish. Even if the lifts were only able to cycle at one lift per hour (which we believe should be shortened), this would provide a lifting capacity of about 55,000 fish over a 10-hour day, a substantial improvement over the existing capacity at Conowingo.

Interior's prescription would require a major increase in attraction flows at the west lift to 2,600 cfs under phase I, and an increase in attraction flows at the east lift to 4,325 cfs under phase III, as we previously discussed. A flow of 2,600 cfs would be 3 percent of the powerhouse full capacity, while the combined attraction flows of 6,925 cfs would be 8 percent of powerhouse capacity. We previously discussed that it would be appropriate to increase the east lift attraction flow to its original design capacity of 900 cfs. For the west lift, the current attraction flow is supplied by the house generating units,

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[67] Walburg and Nichols (1967) state that male American shad average 2 to 3 pounds, and female shad average 3 to 4 pounds. Gizzard shad are generally smaller than American shad, but larger gizzard shad do overlap in size with American shad. Morales (2013) uses an average weight of 1.2 pounds for gizzard shad.

which provide on-site local power to the station, and is limited to about 300 cfs. This is a somewhat low attraction flow for the west side of the tailrace, and an attraction flow similar to the restored east lift flow (900 cfs) would be desirable, providing a total attraction flow from Conowingo of 2.1 percent, coming close to the Interior minimum of 3 percent of total station discharge. In addition, if higher attraction flows could be provided during periods of lower generation, these attraction flows could be more effective in attracting shad during off-peak generation. Providing additional attraction flow at the west lift would require additional structures at the lift, because the current supply through the house units could not be increased. Tailrace pumps or additional withdrawals from the reservoir would be required, and it is not known if the existing lift structure could accommodate an additional 600 cfs through its entrance weir gates without modification. Gomez and Sullivan and Normandeau (2012) did not include an assessment of adding additional attraction flow to the west lift, so a feasibility study would be required before additional action could be taken on this measure.

Interior prescribes and Pennsylvania FBC recommends that the west lift be modified so that it could be used for direct volitional passage to Conowingo Pond. The Interior preliminary prescription appears to require volitional passage now, while the Pennsylvania FBC recommendation is that a new west lift be designed so that volitional passage could be provided later if needed. We agree with Pennsylvania FBC that there would be no immediate need for west lift volitional passage, which would be a challenging engineering project. The west bank has no easy access route to Conowingo Pond for a volitional fish passage facility because of the west dam embankment, the presence of U.S. Route 1 on the dam, and the administrative offices on the west end of the powerhouse. Any fish passage channel conveying fish to Conowingo Pond would need to tunnel through the dam embankment and under U.S. Route 1, or pass through the administrative offices. An alternative approach would be to dedicate the west lift to trap and trucking, egg taking, and experimental purposes, while the east lift would continue operating exclusively for volitional passage. Upstream project owners also have major investments in fish passage facilities, so it wouldn't be appropriate to substantially reduce volitional upstream migration from Conowingo. The east lift has been shown to be capable of lifting large numbers of shad in the past, and if additional improvements are made as we describe, this capability should be enhanced. Enhancing the west lift for trap and trucking, as we discuss, would provide an important boost to the overall shad population if good numbers of shad can be successfully trucked to upstream habitat. A decision on volitional passage at the west lift could be postponed until all the project fish passage improvements (including trap and trucking) that we describe are implemented and are operated for a period of time, to determine (based on fish returns) whether any additional volitional passage is required, or whether trap and trucking is still needed.

The Interior preliminary fishway prescription also includes in phase I the creation of a 5,000-foot zone of passage on the east and west shores of the tailrace below the dam, implementation of a maximum downramping rate of 20,000 cfs/hour, and channel modifications downstream of the dam to eliminate stranding in the spillway. Our review

of Exelon's report on tailrace water velocities (Normandeau and Gomez and Sullivan, 2012o) and several other studies conducted in the tailrace (such as shad radio telemetry studies in 2010 and 2012), found no indication of a blockage or substantial hindrance to migration associated with high water velocities. While high velocities were observed in the tailrace, there were also adequate zones of passage along the shoreline and in other locations, and none of the radio telemetry studies indicated that fish were unable to reach the powerhouse. While rapid downramping can cause fish stranding below hydroelectric projects, Exelon's fish stranding survey did not find evidence of substantial stranding of target species downstream of Conowingo dam (Normandeau and Gomez and Sullivan, 2012d). Although some fish stranding was observed, non-target species such as carp and gizzard shad comprised more than 90 percent of those observed. Total mortality of stranded fish ranged from 18 percent of the fish observed in the spring to 4 percent in other seasons. There appears to be little justification for requiring specific measures to prevent stranding below the dam.

Pennsylvania FBC recommends additional effectiveness studies for 3 to 6 years before any structural improvements to the fish lifts are made. We find that this additional round of studies would be unnecessary. Exelon has decade's worth of operational experience with the Conowingo fish lifts, and also conducted several studies during relicensing to address the fish passage issues. Sufficient information is available now to serve as the basis for fish passage improvements. We agree that additional effectiveness studies would be necessary to evaluate improvements made, but not prior to making the improvements. Pennsylvania FBC also recommends a gizzard shad telemetry study to understand the issues of passage efficiency, capacity, and interference with American shad, and the recycling of gizzard shad in the west fish lift.[68] This would be an important study to better understand how the gizzard shad affects the passage of American shad in the Conowingo lifts.

Downstream Passage and Fish Entrainment

York Haven Project

At each of the hydroelectric projects on the Susquehanna River, fish are susceptible to injury or mortality if they are entrained through the powerhouse turbines. Migratory fish species in the Susquehanna River that are susceptible to entrainment during their migration to the ocean include American shad, river herring (alewife and blueback herring) and American eel. River herring and American eel, however, have only been documented in the York Haven project area a few times since fish passage in the east channel became operational in 2000. Resident game fish including smallmouth bass, walleye, sunfish, and catfish that occur in the project area do not need to migrate

[68] Recycling means that fish enter the west fish lift, are sorted and released back to the tailrace, and then the fish re-enter the fish lift.

downstream past the project to complete their life history, but these species may also be subject to entrainment through the project turbines.

Post-spawned adult American shad in the Susquehanna generally migrate downstream from June through mid-July, and juveniles migrate downstream from mid-September through mid-November. Post-spawned river herring tend to migrate downstream during the late-spring and summer, and the juvenile outmigration extends into the early fall. Adult American eel migrate downstream in the fall.

Under the terms of the Settlement Agreement, York Haven Power has agreed to implement several measures that are intended to or may serve to reduce fish entrainment mortality. These include: (1) increasing spill flows at the east channel and main dams during the American shad upstream passage season[69]; (2) continuing the current downstream juvenile American shad passage protocol, which schedules the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30); (3) pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, flows through the nature-like fishway (once constructed), flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad; (4) pass about 370 cfs through the forebay sluice gate between the hours of 5 p.m. and 11 p.m. during the entire juvenile American shad passage period to facilitate downstream passage of juvenile American shad; and (5) develop designs within 4 years of license issuance for removal of obstructions in or deepening of the downstream plunge pool from the forebay sluice gate, and a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad that land in the downstream pool.

Under the terms of the Settlement Agreement, York Haven Power also proposes to construct, operate, and maintain a nature-like fishway in the vicinity of the apex of the main dam and Three Mile Island in compliance with design criteria specified in appendix A of the Settlement Agreement. Upon completion of the nature-like fishway, York Haven Power proposes to implement several additional measures that may reduce fish entrainment mortality. These include: (1) conducting a juvenile American shad headrace turbine avoidance study; (2) if the juvenile American shad headrace turbine avoidance goals are not achieved, implement measures that would enhance the effectiveness and conduct a supplemental juvenile American shad headrace turbine avoidance study within

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[69] The magnitude of these flows would vary depending on whether the nature-like-fishway is in operation or not. Post-spawned shad begin downstream migration immediately after spawning, and could take advantage of increased spillage flow during the upstream passage season.

2 years of implementing the measures; (3) provide an average daily minimum flow of 267 cfs in the east channel below the east channel dam year round; (4) provide at least 5 percent of river flow through the nature-like fishway and supplemental attraction flow channels when flows entering the project during the American shad upstream passage season are between 5,000 and 150,000 cfs; (5) provide a minimum flow of 200 cfs through the nature-like fishway when the river elevation is at the crest of the main dam and outside of the American shad upstream passage season; and (6) to the extent controllable by York Haven Power, when flows exceed the hydraulic capacity of all available generating units, manage flows to maximize flow over the main dam and the nature-like fishway.

Our Analysis

Currently, both migratory and resident fish species can move downstream past the project via four routes: (1) the powerhouse turbines, (2) the sluice gate located at the downstream end of the powerhouse, (3) the main dam spillway, and (4) the east channel dam spillway and gates. Once construction of the nature-like fishway has been completed, this will provide a fifth potential avenue for downstream passage.

As part of study 2.3, Assessment of American Shad at the York Haven Project, York Haven Power conducted a desktop assessment of turbine entrainment and mortality, which was included as Appendix G in the Initial Study Report. The assessment included a literature review of relevant fish entrainment and passage survival data applicable to the project and an evaluation of the flows passed via each potential passage route to assess the overall effects of entrainment and passage survival at the project.

Passage survival over the project spillways and sluice gate was evaluated by reviewing studies conducted at other low-head (equal to or less than 60 feet) non-turbine exit routes including sluices, spillways, and bypass pipes. These studies were conducted at seven different hydroelectric projects under a total of 17 different release locations or test conditions (head or spill volume). Survival rates estimated during these studies using the balloon-tag testing method ranged from 91 to 100 percent. Based on a comparison of site characteristics to the sites where the field studies were collected, York Haven Power concluded that the survival rate of fish passing the spillways and sluice gate at York Haven is likely about 97 percent.

York Haven Power used a variety of approaches to estimate the likely fish passage survival rates for fish that are entrained through the project turbines, based on an assessment prepared by Normandeau (2011), which was included as Attachment B of the desktop assessment. This included a review of site-specific data, analysis of comparable data from similar projects, and the use of a predictive turbine blade strike model developed by Franke et al. (1997). For outmigrating juvenile American shad, Normandeau estimated that the survival rate of juvenile American shad likely ranges between 83 and 98 percent at the six Kaplan units (units 1-6), and 66-92 percent at the 14 Francis units (units 7-20). The available data for juvenile American shad included the results of site-specific tests conducted in 2000, which produced survival estimates of 92.7

percent at unit 3 and 77.1 percent at unit 7, both of which fell within the ranges estimated for Kaplan and Francis units, respectively. For outmigrating post-spawned adult American shad, Normandeau estimated that the survival rate likely ranges between 61 and 91 percent at the Kaplan units (units 1-6), and 60-78 percent at the Francis units (units 7-20). The turbine blade strike model predicted that survival rates at all turbines would decline with increasing fish size, from about 95 percent for 4-inch fish to about 54 percent for a 40-inch fish, the approximate maximum length for an adult American eel. More typical sizes for adult eels are from 18 to 30 inches (Scott and Crossman, 1973), so survival should be higher for the more typical sizes.

The percentage of fish passing the project that are entrained through the powerhouse and subject to potential turbine entrainment mortality is likely to be roughly proportional to the percentage of the river flow that passes through the powerhouse. The hydraulic capacity of the project is exceeded about 60 percent of the time, and on average the proportion of the flow that passes through the project powerhouse varies from about 23 percent in April to nearly 100 percent from July through September. However, fall rainstorms that increase Susquehanna River flows (and may trigger downstream migrations of juvenile shad and American eel) may also result in spillage at York Haven, providing for safe downstream passage. Each of the measures proposed by York Haven Power that would increase the amount of flow that passes the project via routes other than the turbines (including spillways, sluice gates and the nature-like fishway, once constructed) are likely to reduce the number of fish that are entrained through the turbines and subject to potential injury or mortality. York Haven Power's proposal to remove obstructions in or deepen the plunge pool below the forebay sluice gate, and a chute structure to convey flows beyond the roadway, would help to ensure that fish passed via the sluice gate would be subject to minimal, if any, injury or mortality.

York Haven Power's proposal is to continue the current downstream juvenile American shad passage protocol, which requires the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30), and to pass about 370 cfs through the forebay sluice gate between the hours of 5 and 11 p.m. during the entire juvenile American shad passage period. This protocol would reduce entrainment mortality by reducing the amount of flow that passes through the Francis turbines and by increasing the proportion of fish that emigrate through the sluice gate, as opposed to the turbines. Conducting a juvenile American shad headrace turbine avoidance study and implementing any measures that may be needed to meet headrace turbine avoidance goals would further improve the survival rate of juvenile American shad passing the project.

York Haven Power's proposal for downstream passage of post-spawned adult American shad is to pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, pass flow through the nature-like fishway (once constructed), continue flow through the east channel, and utilize any spillage flow over the main dam from May 1

through June 30. During the radio telemetry monitoring conducted by York Haven Power in 2012 (York Haven Power, 2012b), 13 out of 59 adult American shad (22 percent) that were documented passing the project passed through the forebay sluice gate. Continuing the operation of this sluice gate would ensure that a considerable portion of downstream-migrating adults can utilize this safe passage option, while other passage routes would provide additional options for safe passage.

Muddy Run Project

Downstream passage concerns at Muddy Run are somewhat different than at the other projects, because Muddy Run does not form a blockage to migration (like a dam), and fish do not require passage through the project to reach the ocean. The primary concern at Muddy Run is that downstream-migrating fish may be entrained and killed or pumped to the upper reservoir, and lost to the population. Resident species may also be entrained but few concerns were expressed by stakeholders about effects on resident fishes. Commenting agencies have generally recommended the same downstream passage survival rates at Muddy Run as recommended at the other projects (80 percent survival of adult shad and 95 percent survival of juvenile shad). Exelon states that it believes the downstream passage survival criteria are already met, but also has agreed to the Pennsylvania DEP certification conditions. Those conditions state that: (1) Exelon must submit a plan and schedule to provide for 95 percent survival of juvenile American shad and 80 percent survival of adult American shad that pass through the project area, with full implementation of the plan by 2015; (2) by February 15, 2026, or later, Exelon would be required to submit a plan to measure the passage of American shad moving downstream past the project to Pennsylvania DEP for approval (the "discrete passage study"); (3) Exelon would conduct the discrete passage study, and if results indicate that passage goals are met, specific operational measures or protocols would be incorporated into the FPOP to ensure that goals are continued to be met; and (4) if study results indicate that passage goals are not met, Exelon would propose a plan and schedule for mitigation to meet the passage goals.

Our Analysis

We previously discussed the downstream migration of juvenile shad past the Muddy Run Project. Exelon's studies estimated that for juvenile shad that were in the zone of influence during pumping, 22.6 percent of those fish could be entrained. For the overall population, however, Exelon estimated that only 2.9 to 6.6 percent of the population would be vulnerable to entrainment during peak outmigration times, because the project is not pumping during many of the peak hours of outmigration (Normandeau and Gomez and Sullivan, 2012g). These data indicate that the project essentially already meets the target effectiveness for downstream juvenile shad passage. The FWS review of Exelon's study (Pugh, 2013) stated, however, that by adjusting the periods when juvenile shad may actually be passing the project, based on information from the scientific literature, the actual entrainment rate for juvenile shad would be from 12.3 to 14.5 percent of the population, and not 2.9 to 6.6 percent as estimated by Exelon. Exelon, in

its reply comments filed on March 18, 2014, states that the Pugh (2013) review of the data was flawed and that he overstates the actual effects of the project. We previously concluded that: (1) these conflicting studies and analyses and the argued differences in migration and entrainment rates may be within the range of error for the field studies and the data analysis; and (2) the studies and analyses have overall shown that the Muddy Run Project has not had an adverse effect on a major proportion of the shad population migrating downstream past the project. Interior also states, in an amendment to its preliminary fishway prescription filed on February 28, 2014, that while it believes that Muddy Run operation may affect fish migration, the effects may not be sufficient to affect the fisheries agencies goals for this reach of the river.

In addition, with Exelon now agreeing to the conditions of the Pennsylvania DEP certification, Exelon has committed to maintaining the effectiveness targets required by Pennsylvania DEP, would monitor this effectiveness via the studies required by the certification as part of its FPOP, and would mitigate any effects of the project if the target effectiveness is not maintained.

Conowingo Project

The Conowingo Project has the potential to entrain and injure or kill migratory fish moving downstream, as well as non-migratory species from Conowingo Pond. As is the case for the upstream hydroelectric projects, large numbers of American shad migrate past the project each year (although those numbers have decreased in recent years), while very few American eel and river herring occur upstream of Conowingo dam. Resident game fish species that are common in Conowingo Pond that may be subject to turbine entrainment include channel catfish, smallmouth bass, largemouth bass, walleye, green sunfish, pumpkinseed, bluegill, and white crappie. The reservoir currently supports a large population of gizzard shad as well as other species of forage fish, which may also be subject to entrainment.

Exelon proposes to continue to provide downstream passage via the project turbines at the Conowingo Project for juvenile and adult American shad. Interior, The Nature Conservancy, Pennsylvania FBC, and the Chesapeake Bay Foundation all recommend that Exelon implement measures to meet the downstream passage survival goal of 95 percent for juvenile American shad passing the Conowingo Project, as specified in the SRAFRC 2010 Restoration Plan. The Nature Conservancy and the Chesapeake Bay Foundation further recommend that Exelon meet the 80 percent downstream passage survival goal for adult American shad established in the SRAFRC 2010 Restoration Plan.

Interior also recommends that Exelon develop an FEMP in consultation with Interior, to ensure that any changes in structure or operation as a result of relicensing continue to meet the survival goal for juvenile American shad of 95 percent. Interior recommends that Exelon provide an annual report detailing implementation of the FEMP to the resource agencies, including any deviations from the FEMP, followed by an annual meeting. Any required modifications to the FEMP would have to be submitted to the

resource agencies within 30 days of receipt of a request for the modification unless a longer period is approved by Interior. The modifications to the FEMP would have to be implemented consistent with the approval of Interior.

In its reply comments, Exelon contends that relicensing studies demonstrate that the project meets the downstream targets requested by the parties and it is unnecessary to include these passage rates as conditions in the license.

Our Analysis

As part of Revised Study Plan 3.2, Exelon conducted a desktop study of turbine entrainment and mortality (Normandeau and Gomez and Sullivan, 2012i). The study included an assessment of the potential for fish impingement on the trashracks, assessment of entrainment potential based on habitat use, and estimation of passage survival rates for the Francis and Kaplan turbines at the project. The turbine passage survival assessment included a review of site-specific studies, analysis of comparable data from similar projects, and the use of a predictive turbine blade strike model developed by Franke et al. (1997).

To evaluate the potential for impingement on the trashracks, the desktop assessment included an evaluation of the swimming capability of American shad, American eel, and six representative resident fish species in relation to the approach velocity at the powerhouse trashracks, estimated fish widths, and trashrack spacing. The estimated approach velocity at the trashracks ranged from 2.4 to 3.7 feet per second at Units 1-11, which have trashracks with a 5.37-inch clear spacing. The two smaller house units have a clear spacing of 1.5 inches and an estimated approach velocity of 1.4 feet per second. The results of this analysis indicate that the potential for fish impingement at the project is minimal, because most larger fish would have sufficient swimming ability to avoid being swept into the trashracks, and smaller fish with lower swim speeds would likely pass through the trashracks and pass through the units. A possible exception is that larger channel catfish could be impinged, because they may have lower swimming speeds than other species, although no swim speed information was available. Results of the habitat use assessment indicated that entrainment potential was low for littoral species such as bluegill, largemouth bass and smallmouth bass because the bottom intakes are in the deepest part of the reservoir and not located near shallow water littoral areas where these species are typically found.

The desktop assessment also included an evaluation of turbine passage survival rates measured at other sites, but the results of these studies showed a wide range of values that are likely less informative than the results of site-specific testing that Exelon performed using juvenile and adult American shad.

Site-specific testing of turbine passage survival of juvenile American shad was conducted in 1993 (RMC, 1994) at one of the Kaplan turbines and in 2011 (Normandeau and Gomez and Sullivan, 2012n) at one of the Francis turbines using the balloon tag testing technique. Testing at the Kaplan turbine (unit 8) was conducted with a wicket

gate opening of 55-56 percent, which was considered to provide less than optimal passage conditions, and resulted in a short-term (1-hour) survival estimate of 94.9 percent. Testing of juvenile American shad passed through the Francis turbine (unit 5) in 2011 resulted in a survival estimate of 89.9 percent. Testing at the Francis unit was conducted at near-peak efficiency, the setting the unit operates at most of the time when juvenile American shad would be moving past the Conowingo Project.

Site-specific testing of the turbine passage survival of adult American shad was conducted in 2011, also using the balloon tag testing technique (Normandeau and Gomez and Sullivan, 2012f). Testing was conducted at the Francis turbine (unit 2) at near-peak efficiency, and testing at the Kaplan turbine (unit 8) was conducted at a turbine discharge of 8,842 cfs (efficiency not given, but assumed to be near-peak). The resulting survival estimates for adult American shad passed through the Francis and Kaplan turbines were 93.0 and 86.3 percent, respectively. The turbine passage survival rate of adult American shad was also estimated using the turbine blade strike model developed by Franke et al. (1997). The blade strike model predicted a survival rate of 79.8 to 90.4 percent for the Francis unit and 82.1 to 94.5 percent for the Kaplan unit.

The site-specific turbine passage survival rates estimated for adult American shad using the balloon-tag testing technique were consistent with survival rates estimated using the blade strike model, providing a reasonable degree of assurance that the passage survival rates for adult American shad meet or exceed the 80 percent downstream passage survival goal for adult American shad established in the SRAFRC 2010 Restoration Plan. The site-specific passage survival estimated for juvenile American shad indicates that survival rates likely equal the downstream passage survival goal of 95 percent at the Kaplan turbines, but are about 5 percent below this goal in the Francis turbines.

An FEMP, as recommended by Interior, would provide additional information on any variations in turbine passage survival associated with differences in operating conditions, and would provide an improved understanding of the survival rates of juvenile and adult American shad that are entrained through turbines at the Conowingo Project. Although the available data indicate that the passage survival rate for juvenile American shad through the Francis units may be about 5 percent lower than the passage survival goal of 95 percent, none of the stakeholders have suggested measures that may be feasible to improve passage survival in order to meet this goal. In the absence of any potentially feasible measures that could be implemented, the benefit of conducting additional testing of passage survival rates is unclear.

American Eel Passage

Our previous discussion of upstream and downstream fish passage focused on anadromous species. Because American eel differ in life history (a catadromous species), behavior, and swimming ability, they require different types of passage facilities. Accordingly, we discuss American eel passage separately.

York Haven Project

Eel passage has not been a major issue at York Haven because American eel have not occurred in appreciable numbers in the project area since construction of the lower river dams blocked upstream migration. American eel have occasionally been experimentally stocked in the upper river through the years, and recent studies and restoration efforts to date have been focused at Conowingo. Some eels collected at Conowingo have been transported to Susquehanna River tributaries upstream of York Haven (York Haven Power, 2011).[70]

York Haven Power conducted a review of potential upstream and downstream eel passage measures at the project (York Haven Power, 2011), and included provisions for eel passage in the Settlement Agreement. No additional upstream fish passage measures are proposed for eels, because York Haven Power and the signatories to the Settlement Agreement believe that the proposed nature-like fishway and the low-head nature of the dam would provide adequate upstream passage. For downstream passage, York Haven Power would cooperate with the agencies and other project owners in a lower Susquehanna River downstream eel study to investigate the behavior and passage routes for migrating silver eels in the lower river and in the vicinity of York Haven. This would be a 2-year study to occur in about 2017-2020. York Haven Power would also conduct an eel survival study for passage through the turbines. If studies indicate that eel survival objectives are not met, York Haven Power would conduct a downstream eel improvements study, to identify measures that could be implemented to improve survival, to be followed by implementation and testing of those measures, and additional consultations as required.

Our Analysis

American eels do not occur in the project area in any numbers, with only experimental upstream stockings to date. Because upstream passage at downstream dams on the river would require several years to be implemented, it would be many years before upstream migrating eels arrive in the project area through volitional migrations. We agree that the nature-like fishway and the low-head configuration of the dam would likely provide for adequate upstream passage once upstream migrating eels arrive at the project. If trap and trucking of eels is implemented at Conowingo as proposed, it is likely that eels would be trucked upstream of York Haven in the immediate coming years.[71] These eels would remain in the river for 10-20 years before maturing to the silver eel

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[70] FWS has been trapping and trucking eels from the Conowingo tailrace since 2008, and transported about 300,000 eels through 2012.

[71] Exelon would begin trap and trucking after issuance of any new license and would continue that program until 2029, when volitional passage would begin.

phase and out-migrate to the ocean. At that time, downstream passage over the project would be needed.

The Settlement Agreement includes provisions for the eventual downstream passage of eels at the project, including studying the migratory pathways at the project and survival through the turbines, and then implementing protective measures if needed. These provisions of the Settlement Agreement would adequately protect downstream migrating eels once they arrive at the project.

Muddy Run Project

American eel are not currently migrating through the Muddy Run Project area, as existing studies are focused downstream of Conowingo dam, and any experimental trucking has focused on upriver areas. However, the certification for the project has several measures related to eel, although many of those measures would be implemented at Conowingo. Exelon would be required to implement its American Eel Passage Plan with all measures to occur at Conowingo. Thus, we discuss those measures below under the Conowingo Project.[72] For downstream passage, Exelon would comply with downstream eel passage rates of at least 85 percent through the Muddy Run Project area. However, the compliance date when that would be required is October 1, 2026, once sufficient numbers of eels have been released into the Susquehanna River to produce a substantial number of downstream migrating silver eels. Exelon would be required to conduct studies to demonstrate compliance with the passage rate, and if not achieved would be required to provide mitigation.

Both NMFS and Interior reserve their authority to require fishways during the term of the license, and Interior also provides a preliminary fishway prescription. For American eel, the preliminary fishway prescription requires an eel passage program with other licensees on the river, so that operation at Muddy Run does not interfere with passage objectives at the upstream Holtwood Project. The prescription also requires establishment of an Eel Passage Advisory Group within 6 months of license issuance, and an American Eel Passage Plan that would be implemented at the downstream Conowingo Project, which we discuss below.[73]

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[72] Although mandatory conditions such as those contained in the certification would be requirements of any license issued, the Commission could not enforce a condition on another licensed project (Conowingo) through the Muddy Run license.

[73] Interior does not specify the location of upstream eel passage facilities, only that immigrating juvenile eels be trapped "from a point downstream of the Muddy Run Project, and transport them to designated points in the Susquehanna River watershed." We assume that this unnamed location would be the Conowingo dam tailrace, where the FWS has been conducting eel trapping investigations for more than 8 years.

For downstream passage, Interior requires a downstream eel passage study to evaluate the timing, magnitude, duration, annual variation and environmental conditions associated with active migration of silver eels from tributaries stocked with elvers, through the lower Susquehanna River and past the Muddy Run Project to the Chesapeake Bay. This study would be conducted for at least 2 years and would begin 3 years after license issuance. Concurrent with the downstream eel passage study or at a later date as approved by Interior, Exelon would also conduct a site-specific route of passage study to evaluate the entrainment rate of silver eels migrating in the vicinity of the project. If the results of the study indicate that the project's existing operating measures do not meet the downstream passage criterion (survival of 85 percent of silver eels passing the project), Exelon would prepare and submit a plan and schedule for evaluating the feasibility and costs of potential physical and/or operational modifications to the project to facilitate downstream eel passage.

Our Analysis

The downstream passage measures at Muddy Run required by both the certification (which Exelon has agreed to) and the Interior preliminary fishway prescription are similar, in that they both require monitoring studies of downstream-migrating silver eels past the project. If downstream passage survival criteria are not met, then operational or physical changes to the project would be required to mitigate any effects. Exelon has already conducted a radio telemetry study of silver eel passage past the Muddy Run Project (Normandeau and Gomez and Sullivan, 2012g), and found that nearly all the eels migrated past the project with minimal delay, and that the entrainment rate (i.e., pumped to the upper reservoir) was only 7 percent (exceeding the Interior 85 percent passage survival criterion). Eels used in the study were transported from the Delaware River, because virtually no silver eels are currently available from the Susquehanna River upstream of Conowingo.

The certification and Interior preliminary fishway prescription requiring later monitoring of downstream silver eel passage past the project is reasonable, although it would be more appropriate to conduct these studies farther into the future when "native" Susquehanna River silver eels are available for passage studies. The certification requirement appears to reflect that objective, in that it would not require such studies until after 2026 (at least 12 years into the future). The Interior preliminary fishway prescription, however, requires a 2-year study that would begin 3 years after license issuance. This would be much too soon to have substantial numbers of Susquehanna River silver eels available from any required trap and trucking operation (typical freshwater residence time is 10 to 20 years), and any such study would essentially be a repeat of Exelon's recent study using eels from another river system. More valuable data would be collected if naturally migrating Susquehanna River silver eels were used in the study, instead of eels trucked from another river.

Conowingo Project

Exelon's proposal for upstream passage at Conowingo is to construct an eel trap and transport facility on the west side of the tailrace, and cooperate with other licensees in implementing a trap and transport program for eel downstream passage from tributaries upstream of York Haven. As we discussed above, as part of the Interior preliminary fishway prescription for Muddy Run, Interior is requiring an eel trap and transport program from downstream of Muddy Run (we assume Conowingo) to upstream locations. The Interior preliminary fishway prescription for Conowingo requires an eel trap and transport program beginning with a facility on the west shore of the Conowingo tailrace, to be completed within 1 year of completion of any construction at the west fish lift, or within 1 year of license issuance if no construction occurs at the west fish lift. This trap and truck facility would operate until 2029, and volitional passage would begin in 2030. Exelon would also be required to investigate a location for an eel trap on the east side of the Susquehanna River or in Octoraro Creek, and establish a temporary trap and truck facility within 2 years of license issuance and a permanent facility within 5 years of license issuance. This trap and truck facility would be operated until 2029; volitional passage would begin in 2030, we assume from a facility on the east side of the Susquehanna River below Conowingo dam.

Interior included additional details on upstream eel passage in its Muddy Run preliminary fishway prescription that it did not include in its Conowingo preliminary fishway prescription. However, because it appears the Muddy Run preliminary fishway prescription actually applies to actions at Conowingo, we discuss those details here.[74] Interior requires Exelon to provide financial support to Interior of $20,000/year for its eel trapping facility at Conowingo dam until Exelon's facility is completed. The prescription would require field testing to determine the best locations for eel traps, prior to construction of permanent traps that would consist of two ramp-style traps with capacity to pass 50,000 eels/day. Exelon would also be required to provide facilities for holding and transport and implement a quality assurance/quality control program to ensure that a target survival of 95 percent is achieved. An instream evaluation of the presence of eels in the river and tributaries would be required every 3 years, and a 2-year downstream passage study of silver eels would be required within 3 years of license issuance (discussed above under Muddy Run).

The certification for Muddy Run also provides substantial detail for American eel passage in its specified American Eel Passage Plan. This plan is very similar to the Interior Muddy Run preliminary fishway prescription, requiring facilities at Conowingo

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[74] As previously noted, although mandatory conditions such as those contained in a fishway prescription would be requirements of any license issued, the Commission could not enforce a condition on another licensed project (Conowingo) through the Muddy Run license.

and the detailed steps and schedules required. The certification also requires an eel trap and truck facility on the east shore, although it specifies that the facility be placed in Octoraro Creek, with the caveat that the location may be changed to other locations on the east side of the tailrace if the Octoraro Creek location is not successful. Similar to the preliminary fishway prescription, the certification also requires volitional passage at Conowingo, but states that will occur *if* the eel trap and transport program terminates in 2030.

Our Analysis

Because Exelon has accepted the conditions of the certification for Muddy Run, it has essentially also accepted the FWS preliminary fishway prescription, with some minor differences. As American eel restoration in the Susquehanna River is in its beginning stages, a phased approach for passage at Conowingo as agreed upon by Exelon, FWS, and Pennsylvania DEP is a reasonable way to proceed. We note that all parties have agreed to proceed with volitional passage at Conowingo at a fixed date in the year 2030. The assumption may be that over the next 15-year period the number of juvenile eels approaching the dam would increase to the point that trucking would no longer be a viable option, or that it may take that long to properly design and construct effective volitional facilities at all projects that may need them. The former may or may not be a good assumption, because even if the number of silver eels emigrating from the Susquehanna River increases over the next several years of trap and trucking, that would not necessarily translate into an increasing number of juvenile eels returning from the sea. Because American eel are thought to be one, well-mixed, single-breeding population (panmictic), the distribution of juvenile eels along the Atlantic coast is random with no homing to specific watersheds (Interior, 2007). A trap and trucking program may still be viable past 2030 and would give managers the option to stock specific watersheds that may not be available with volitional passage, or in the event volitional passage facilities at the three lower Susquehanna River projects are not highly effective.

For downstream passage, Exelon is proposing to cooperate with other licensees on the lower Susquehanna River in implementing a trap and transport program and studies on eel passage from upstream of York Haven. Because essentially no silver eels are currently emigrating from the Susquehanna River, downstream eel passage is not a major issue at this time. It would be reasonable for Exelon and the other licensees on the river to cooperate in studies and in a possible trap and transport program for downstream passage, as more silver eels become available as a result of trap and truck efforts. If potentially good locations for trapping and trucking of silver eels are identified upstream of York Haven, or in tributaries upstream of any of the projects, such a program may be an effective measure for reducing mortality associated with downstream passage over the four lower-river dams.

Freshwater Mussels

York Haven Project

Because substratum in the project area consists mainly of bedrock and large boulders and is subjected to frequent periods of elevated water velocity, this river reach provides little optimum mussel habitat. Based on sampling conducted in August 2010, five mussel species and 56 individuals were collected during 21.8 hours of searching; half of the sites yielded no live mussels. Weathered shells and shell material were observed along the shore and in shallow water, and there were no large deposits of fresh shells that indicate presence of a nearby dense mussel assemblage. Although obtaining quantitative, total substratum sampling was not an objective of this survey, the fact that some small mussels were collected using qualitative methods indicates that conditions are suitable for limited mussel recruitment.

The American eel is one of many other fish species that is host for eastern elliptio (Nadeau, 2008). Because eel passage is limited by the dams in the lower Susquehanna River, it is possible that distribution and abundance of eastern elliptio could be affected by lack of eels. Exelon proposes to develop a trap and transport program to restore passage of American eel to tributaries in the project area, which would likely start in two small tributaries upstream of York Haven dam that were previously stocked by FWS.

Our Analysis

The York Haven Project operates run-of-river and is not designed for flood control; therefore, downstream frequencies of major hydraulic events remain largely unchanged from pre-project conditions. There are no specific effects on resident mussels associated with operation of this project. The relatively low habitat value of the project area, compared with other reaches of the Susquehanna River, results mainly from existing conditions of substratum and water flow.

In June 2010, York Haven Power agreed to maintain minimum releases of 400 cfs in the east channel for aquatic habitat enhancement and resident fish passage.[75] Continuing this minimum release would benefit mussels and other aquatic organisms in the east channel. Based on results of York Haven Power's mussel surveys, the east channel provides the best aquatic habitat for mussels in the project area.

The results of fish sampling by York Haven Power indicate that a diverse fish assemblage is present in this reach of the Susquehanna River. Based on a review of laboratory fish host studies (Strayer and Jirka, 1997; Nadeau et al., 2000; Wick, 2006; Spoo, 2008; NatureServe, 2010; PNHP, 2011b), it was determined the project area supports appropriate fish species to serve as fish hosts for mussels inhabiting this river

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[75] The minimum releases are pursuant to the June 2010 Consent Order and Agreement between York Haven Power and Pennsylvania DEP.

reach. Given that many species of fishes act as fish host for eastern elliptio, it is unlikely that dams on the lower Susquehanna River, which are limiting passage of eels, are negatively affecting this mussel.

Conowingo Project

The Conowingo Project has the potential to affect freshwater mussels downstream of the dam by causing flow and water level fluctuations associated with peaking operation, impeding the passage of fish species that serve as hosts for mussel species, and altering substrate composition downstream of the dam. Exelon proposes to implement measures to restore passage of American eel to tributaries upstream of the project by implementing a trap and truck program, which could benefit the eastern elliptio by expanding the range of this host species. The Nature Conservancy recommends that Exelon mitigate for loss of coarse sediments (such as sand, gravel, and cobble) within the project area between Conowingo dam and Chesapeake Bay, to enhance the habitat for living resources, including freshwater mussels.

Our Analysis

The Nature Conservancy suggests that loss of coarse sediments below Conowingo dam could be mitigated by extracting appropriate material from another location and placing it in appropriate areas that would not be subjected to erosive flow. Although this would likely increase the quantity of suitable habitat, it is unlikely that this would cause a notable increase in either mussel density or species richness. Mussel habitat below the dams is negatively affected by high discharge events, and increasing the amount of substrate appropriate for mussels would not eliminate the effects of high flow events.

Implementing Exelon's proposal to transport American eel to and from tributaries upstream of the York Haven Project could provide some benefit to the eastern elliptio, but because many other species of fishes act as fish host for eastern elliptio this benefit is likely to be minimal. Given the diverse fishery that occurs upstream and downstream of Conowingo dam and the variety of fish that are passed upstream of Conowingo dam via the existing fish lifts, it is likely that there would continue to be sufficient fish host species to support a diverse freshwater mussel fauna.

We addressed the potential effects of flow and water level fluctuations associated with project operation and recommendations to modify operational constraints earlier in this section in our discussion under *Downstream Flow Releases*.

Invasive species

Limited numbers of zebra mussels have been detected downstream of Conowingo dam and York Haven dam, although no major infestations have been documented at the lower Susquehanna River projects. The projects do not directly influence the spread of the invasive zebra mussel and other exotic mollusks. Because of the concern over fouling by non-native bivalves at power plants, Exelon developed a set of mussel fouling prevention/control options that would provide a starting point in developing an effective zebra mussel control program. The measures include oxidizing biocides, non-oxidizing

molluscicides, as well as a series of non-chemical options such as manual cleaning, use of pigs,[76] high pressure water jets, strains, traps, filters and thermal treatment. Personnel would be prepared to further evaluate and deploy any of these control methods if required.

3.3.2.3 Cumulative Effects

We previously identified water quantity, water quality, migratory fishes, and Chesapeake Bay habitat as resources that could be cumulatively affected by operation of the three projects, in combination with other projects and activities in the basin. While there would be some continuing effects from all the lower river hydroelectric projects related to flow regulation and effects on migratory species, the applicants for the York Haven, Muddy Run, and Conowingo projects are proposing a number of environmental enhancement measures that would offset some of the continuing effects. Staff is also recommending modifications to the applicant-proposed measures, and additional measures that would act to minimize cumulative effects. In addition to measures already implemented (such as minimum flows and fish passage facilities at the projects), new measures proposed and recommended include: (1) a nature-like fishway at the York Haven main dam, as well as measures to protect eel passage once they arrive in the project area; (2) investigations to ensure that migratory fish are successfully migrating past the Muddy Run Project; (3) increased minimum flows at Conowingo as recommended by staff; (4) improvements to the existing fish lifts at Conowingo as recommended by staff; and (5) provision of eel passage at Conowingo. All of these measures, in combination with fish passage improvements recently completed at the Holtwood Project, and the ongoing operation of the highly effective Safe Harbor Project fish lift, would result in an overall positive cumulative effect on migratory fish passage in the Susquehanna River. Flow regulation in the lower Susquehanna River would not be substantially changed under alternatives evaluated by the staff, although we evaluated an increase in minimum flows at Conowingo, which should enhance aquatic habitat downstream of the project into the Chesapeake Bay. Water quality has generally been protected in the lower river, including downstream of Conowingo dam with the addition of turbine venting and aeration that now maintains state DO standards nearly 100 percent of the time. Exelon is proposing to continue DO monitoring downstream of Conowingo and at Muddy Run in the future, and this would help ensure that state DO standards are continuing to be met. Overall, these measures would have a net beneficial cumulative effect on water quality, and aquatic habitat in the lower Susquehanna River and parts of the upper Chesapeake Bay that are influenced by project operation.

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[76] Pigs are devices that are placed inside pipes, to clean the inside of the pipe, often while the pipe remains in operation.

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment

Vegetation

The dominant upland cover classes in the vicinity of all three projects form a mosaic of agricultural, forest, and developed lands. Agricultural land ranges from intensely cropped cornfields and horticultural nurseries to less intensely used hayfields and pastures. Upland forest is typically found on land that has marginal utility for contemporary agricultural use, such as steep slopes and poorer quality soils.

Natural overstory vegetation within the York Haven project boundary includes red and silver maple, yellow birch, and black and northern red oak. Common shrub species include northern arrowwood, hornbeam, witch-hazel, and spicebush. The herbaceous layer is highly variable. Representative species include wild oats, false Solomon's-seal, May-apple, and pipissewa. The major upland vegetation type within the project boundary is red oak-mixed hardwood forest, which is characterized by a well-developed canopy of mature red and black oak and red maple. Most of this community is located on the southern section of Three Mile Island.

Overstory vegetation within the Muddy Run and Conowingo project boundaries includes green ash, sycamore, black willow, and box elder along the reservoir shorelines; red and white oak, American beech, eastern hemlock, pignut hickory, sweet birch, black cherry, tulip polar, and sugar maple in forest interiors, with black locust and black walnut along forest edges. Evergreen communities are present in the project area, including eastern red cedar and Virginia, white, and sort-leaf pine. Representative shrub species include pawpaw, bladdernut, rosebay, eastern rebud, witch-hazel, northern arrowwood, maple-leaved viburnum, and spicebush. Herbaceous vegetation may include wild oats, may-apple, and striped wintergreen. The major upland vegetation type within both project boundaries is mixed mesophytic and species-rich hemlock-mesic hardwood forest (1,260 acres at Muddy Run and 856 acres at Conowingo). Lesser amounts of upland vegetation types include dry oak-mixed hardwood or red oak-mixed hardwood forest (265 acres at Muddy Run and 202 acres at Conowingo) and Virginia pine-mixed hardwood forest (38 acres at Muddy Run and 357 acres at Conowingo). In addition, maintained lawns comprise about 257 acres and agricultural croplands about 148 acres of vegetation within the Muddy Run project boundary. About 800 acres, some of which is within the Muddy Run project boundary, is the Muddy Run WMA, which is managed to provide food and cover for wildlife. As noted in section 2.1.1, *Existing Project Facilities*, of the three projects, only the Muddy Run Project has primary transmission lines, two 4.25-mile-long, 230-kV transmission lines running from the powerhouse to the PBAPS North Substation along a 300-foot-wide corridor. The transmission lines pass from the powerhouse across about 0.5 mile of open water of the Susquehanna River. On the east side of the Susquehanna River, the transmission lines are surrounded by

deciduous forest for about 1 mile after which the lines pass through agricultural fields (pasture and cropland) to the substation.

Wetland and Riparian Habitat

York Haven Project

York Haven Power characterized wetland habitats occurring within the project boundary using FWS' National Wetland Inventory digital mapping, which provides information on wetland habitats using remote sensing and aerial photo interpretation techniques (table 3-26). Extensive vegetated wetland communities are generally lacking in the project boundary. Wetlands within the project area are represented by riverine (open-water), palustrine forested, and palustrine emergent wetland types.

Open-water areas are well represented in and adjacent to the project boundary, and Lake Frederic is an example of this open-water wetland habitat. Open-water habitats associated with Lake Frederic occupy about 2,363 acres. Lake Frederic contains many areas of SAV (primarily wild celery; Torocco et al., 2012) mostly found along island perimeters and areas of shallow water depth.

The palustrine forested wetland habitats located within the project boundary are primarily forested silver maple floodplain areas. This forested wetland type typically occurs along larger rivers with a well-developed floodplain. Aside from the usually dominant silver maple, other trees include red maple, black willow, river birch, and American elm. Shrubs include poison ivy, spicebush, American elder, and northern arrow-wood. Common herbs include jewelweed, Japanese stiltgrass, and sensitive fern.

The largest areas of emergent wetlands occur on the southern section of Three Mile Island, within topographic depressions separate from the riparian zone associated with Lake Frederic. Several small emergent wetlands are mapped in the vicinity of where the main dam abuts Three Mile Island. Large areas of emergent vegetation are found bordering the western side of the access road leading to Three Mile Island. This area supports a variety of communities located within the floodplain of the Susquehanna River that are formed naturally by river flows and sedimentation. However, York Haven Power observed evidence of fill berms, old access roads, and other types of disturbance during various site visits associated with relicensing studies.

Table 3-26. York Haven Project wetland types and acreages (Source: York Haven Power, 2012).

Class (FWS map code)	Subclass	Water Regime	Total Acres Within Project Boundary
Unconsolidated bottom (R2UBH)	Not applicable	Permanently flooded	2,240
Unconsolidated shore (R2USC)	Not applicable	Seasonally flooded	111
Emergent (R2EM2H)	Nonpersistent	Permanently flooded	10
Unconsolidated bottom (R2UBHx)	Not applicable	Permanently flooded	3
Forested (PFO1E)	Broad-leaved deciduous	Seasonally flooded/saturated	31
Forested (PFO1C)	Broad-leaved deciduous	Seasonally flooded	4
Scrub-shrub (PSS1)	Broad-leaved deciduous	Seasonally flooded	6
Forested (PFO1A)	Broad-leaved deciduous	Temporarily flooded	13
Unconsolidated bottom (PUBHx)	Not applicable	Permanently flooded	1
Emergent (PEM1Cx)	Persistent	Seasonally flooded	17
Total wetland acreage			**2,436**

Three Mile Island has a mixture of floodplain forest located along the island boundaries, areas of emergent wetland, and large areas of open water bordered by palustrine forested and palustrine scrub-shrub wetland communities. York Haven Power notes that during overbank flooding this area holds a considerable amount of floodwater as the open water areas are inundated with water up to several feet in depth. The water regime in this system is typically seasonally flooded (i.e., surface water present for extended periods at certain times of the year). The vegetation associated with the wetlands on Three Mile Island consists of a mature canopy of various trees including red maple, silver maple, river birch, and sycamore. Common shrubs include species contained in the over-story layer, as well as black willow, elderberry, and silky dogwood. The herbaceous layer contains cattails, bur-reed, common rush, sedges, and smartweeds.

Muddy Run Project

The Muddy Run Project power reservoir and Recreation Lake provide open water habitat, and Exelon estimates that 84 percent of the reservoir shoreline is bordered by riparian woody vegetation, such as green ash, sycamore, black willow, and box elder. The littoral zone around the power reservoir is about 240 acres, and the reservoir margin is free of emergent or submergent vegetation because of the magnitude and frequency of rapid water fluctuations (up to 50 feet on a weekly basis). Exelon identified six wetlands within the project boundary using FWS National Wetland Inventory mapping but did not quantify the area of each, although the descriptions suggest that they are relatively small. Each of these six wetlands was reviewed in the field to enable further characterization.

Three wetlands are emergent wetlands (PEM) that appear to be supported by springs or seeps, and only one is adjacent to the power reservoir. Two of these emergent wetlands are dominated by sedges, rushes, and jewelweed. One of these two wetlands is within the transmission line right-of-way in a pasture. The third emergent wetland, located along a non-project natural gas pipeline, is dominated by the invasive common reed and reed canary grass; sedges, rushes, and jewelweed are also present along with cattails, goldenrod, and aster. This wetland has compacted soils related to the presence of the pipeline.

One wetland is a forested wetland (PFO1) along a small stream that drains into the power reservoir. It is dominated by red maple, spicebush, and skunk cabbage. A second forested wetland with emergent components (PFO1/EM) is associated with a stream that ultimately flows into the reservoir. Dominant vegetation in this wetland includes sycamore and skunk cabbage.

The sixth wetland within the Muddy Run project boundary is an emergent/scrub-shrub (PEM/SS1) wetland adjacent to the upper reaches of the recreation lake. Dominant vegetation in this wetland includes sedges, rushes, cattails, rice cutgrass, sweetflag, and blue vervain.

Conowingo Project

Wetland habitat within the Conowingo Project boundary is governed by predominant substrate type and river hydrology. Conowingo Pond is generally operated at a maximum elevation of 109.2 feet, at which 8,605 acres of open-water habitat is provided. In the 7,000-foot-long reach from Holtwood dam to the downstream end of Hennery Island (see figure 2-2), the substrate is predominantly exposed bedrock. Downstream of Hennery Island, the bedrock channel bottom is covered with a thickening wedge of alluvial sediment that has been accumulating behind Conowingo dam since its construction in 1928. Downstream of Conowingo dam, a bedrock channel similar to that downstream of Holtwood dam influences the types of wetlands that are present. We discuss wetland habitat separately for the bedrock and alluvial channel types within the project boundary.

Bedrock reach--The bedrock reach at the upstream end of Conowingo Pond is characterized by riverbed emergent wetlands (REM). The wetland vegetation in the upper portion of the reach grows in cracks and crevasses on the protected downstream side of rocks. Pools in this upper reach are smaller (less than 100 square feet) and more isolated than further downstream where the pools are larger with more contiguous areas of open water (up to 10,000 square feet). Upstream vegetation is generally shorter and less abundant than downstream vegetation because the upstream, more-constricted reach is subjected to higher water levels and velocities than lower reaches. As the energy conditions diminish downstream, the vegetation becomes more prominent, growing on most available rock surfaces. Dominant vegetation within the lower elevation channel with longer periods of inundation includes water willow and purple loosestrife. Dense root mats with trapped sediment ultimately develop and may be stripped from the rock during high flow events. This lower elevation zone transitions to grasses, sedges, and rushes, the width of which is a function of slope. Along the shore margins of the river and islands, the riverbed emergent wetlands transition to a riparian wetland community dominated by woody vegetation such as black willow and red maple saplings (PSS1). The vegetation near the shoreline is composed of elements found growing on the riverbed as well as elements that encroach from the riparian forest located upgradient.

Similar to the riverbed emergent wetlands described in the previous paragraph, wetlands downstream of Conowingo dam consist largely of water willow that has taken root in fine sediment trapped within bedrock crevasses and interstices among boulders. However, emergent vegetation does not extend across the channel, as it did at places in the upper end of Conowingo Pond, but is restricted to river and island margins and tributary mouths.

Alluvial reach--In the alluvial-dominated reach of Conowingo Pond, opportunities for the establishment of wetlands occur at sites of accumulating sediment, often at the mouths of tributaries. Wetland surveys of the alluvial reach conducted by Exelon in 2008 and 2010 identified 32 emergent wetlands (PEM) within the project boundary with varying degrees of open-water and scrub-shrub elements. The distribution of these wetlands reflects different geomorphic settings, water sources, and hydrodynamics. Although these wetlands are mapped, no indication of the area of each wetland or the total acreage of wetlands is provided. From the descriptions of the wetlands, they appear to be relatively small (i.e., each less than 1 acre). During typical, non-storm conditions, Exelon determined that the major driver of wetland properties of 9 wetlands was primarily flows in the Susquehanna River (pond margin), 2 wetlands were strongly influenced by both the river and tributaries (pond/tributary), and 21 wetlands were influenced primarily by tributaries.

Common species occurring in the emergent wetlands include water willow, water pepper, broadleaf cattail, purple loosestrife, and Japanese stiltgrass. Although water willow was observed in most emergent wetlands, wetland vegetation generally comprised more than one dominant species (URS et al., 2012).

Invasive Plant Species

Invasive upland, wetland, and aquatic plants are known to occur at all three projects. The applicants did not propose and no entities requested that directed invasive plant surveys be conducted. However, incidental observations of invasive species were made during other studies at all three projects. York Haven Power identified invasive species that have the potential to occur at the York Haven Project, and this listing would also be applicable to the other two projects (table 3-27).

Table 3-27. Invasive plants with potential to occur in the vicinity of the Susquehanna River Projects (Source: York Haven Power, 2012; Exelon, 2012a, 2012b, Staff).

	Observed in Vicinity of Projects[a]		
Common name	**York Haven**	**Muddy Run**	**Conowingo**
		Aquatic	
Eurasian water-milfoil			X
Hydrilla			X
Water chestnut			
Brittle waternymph			X
Terrestrial			
Goutweed			
Garlic mustard			
Musk thistle			
Canada thistle			
Bull thistle			
Jimsonweed			
Goatsrue			
Giant hogweed			
Dame's rocket			
Purple loosestrife			X
Star-of-Bethlehem			
Wild parsnip			
Beefsteak plant			
Japanese knotweed	X		X

	Observed in Vicinity of Projects[a]		
Common name	**York Haven**	**Muddy Run**	**Conowingo**
Lesser celadine			
Cheatgrass			
Japanese stiltgrass	X	X	X
Reed canary grass		X	
Shattercane			
Common reed		X	X
Johnson grass			
European barberry			
Russian olive			
Autumn olive		X	
Border privet			
Common privet			
Amur (bush) honeysuckle		X	
Morrow's honeysuckle			
Bell's honeysuckle			
Standish honeysuckle			
Tartarian honeysuckle			
Common buckthorn			
Glossy buckthorn			
Wineberry			
Multiflora rose			X
Sycamore maple			
Tree-of-heaven		X	X
Empress tree			
Siberian elm			
Fiveleaf akebia			

	Observed in Vicinity of Projects[a]		
Common name	**York Haven**	**Muddy Run**	**Conowingo**
Porcelain-berry			
Oriental bittersweet			
Japanese honeysuckle			
Mile-a-minute vine	X	X	
Kudzu			

[a] Directed surveys for invasive plant species were not conducted at any of the three projects, but incidental observations were made during fieldwork associated with other studies.

At the York Haven Project, Japanese stiltgrass, Japanese knotweed, and mile-a-minute vine were observed along old road edges and disturbed areas in the southern section of Three Mile Island. Within the floodplain of the Susquehanna River below the east channel dam and spillway, located in the southern section of Three Mile Island, large infestations of Japanese stiltgrass were observed in monotypic stands, where mile-a-minute vine was also commonly observed.

Invasive species, including mile-a-minute, tree-of-heaven, autumn olive, bush honeysuckle, and Japanese stiltgrass, were prevalent in areas along the western shore of the Muddy Run reservoir, but less so along the eastern shore. Invasive plants were most common along edge areas near the recreation park and in transmission line rights-of-way. Hydrilla and Eurasian water-milfoil were often the dominant species in SAV beds in the alluvial-dominated reach of Conowingo Pond. Downstream of Conowingo dam, Eurasian water-milfoil is the dominant SAV species. Hydrilla and purple loosestrife are also present in this reach. SAV is discussed in greater detail in section 3.3.2, *Water Resources*.

Sensitive Plants

York Haven Power and Exelon consulted with state natural resource agencies during pre-filing consultation and reviewed available literature to identify state-protected plant species and plant species that could be state-protected in the future with the potential to occur in the vicinity of each project. This process identified 31 such species that could occur near at least one of the projects (table 3-28), along with habitat preferences and whether or not the species was observed.

Table 3-28. State protected plant species with potential to occur in the vicinity of the York Haven, Muddy Run, and/or Conowingo projects (Source: York Haven Power, 2012; Exelon, 2012a, 2012b).

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Bradley's spleenwort (*Asplenium bradleyi*)	PA -- Threatened	C	Acidic rock outcrops and barrens, within crevices and ledges, and on cliff faces	Historically occurred in the vicinity of the Conowingo project area. Although the general habitat for a plant may be present in the project area, Bradley's spleenworts were not observed in the project area.
Aster-like boltonia (*Boltonia asteroides*)	PA, MD -- Endangered	YH, C	Open canopy wetlands with sandy to loamy acidic soils; gravel shores; sandy, wet thickets, alluvial meadows and marshes, and openings in forested floodplains	Reportedly found in the riverside outcrop community of the Holtwood dam spillway area; however, none were observed in the project area.
Reflexed flatsedge (*Cyperus refractus*)	PA -- Endangered	MR, C	Found in dry woods with an open canopy and sandy soils; also associated with fields, barrens	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, reflexed flatsedges were not observed in the project areas.

Common Name (*Scientific Name*)	State--Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
Flat-stemmed spike-rush (*Eleocharis compressa*)	PA, MD -- Endangered	YH, C	Found in wet depressions in woodlands and limestone glades, wet prairies, roadside ditches; and other wet seeps in calcareous grasslands, fens, sandy ground, stream banks and waste places	Reportedly found between Conowingo dam and the mouth of Octoraro Creek (in or near Susquehanna Floodplain Protection Area). However, this species was not observed within the project boundary.
Ellisia (*Ellisia nyctelea*)	PA -- Threatened	YH	Found in damp, shady stream banks with rich alluvial soils and sometimes on disturbed ground	Potentially could occur within 0.5 mile of the York Haven Project area. Although the general habitat for the plant may be present in the project area, ellisia was not observed in the project area.
Harbinger-of-spring (*Erigenia bulbosa*)	PA -- Threatened	C	Found in rich, mixed hardwood forests located in lowlands, coastal plains, and mountain valleys	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for the plant may be present in the project area, harbinger-of-spring was not observed in the project area.

Common Name (*Scientific Name*)	State--Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
Bicknell's hoary rockrose (*Helianthemum bicknellii)*	PA, MD -- Endangered	C	Found in dry, open areas with abundant sun and generally thin soil; around exposed banks, dry rocky slopes and outcrops, open woods, serpentine barrens and open forests	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, Bicknell's hoary rockroses were not observed in the project area.
American holly (*Ilex opaca*)	PA -- Threatened	C	Typically found in shallow, well-drained, sandy soil; also found in coastal dunes and deciduous woodlands; and within moist alluvial woods and along wooded slopes	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, American hollies were not observed in the project area.
Common hemicarpa (*Lipocarpha micrantha)*	PA -- Endangered	C	Prefers moist, sandy soil; found along sparsely vegetated ponds, streams, and sandy beaches without large water level fluctuations or strong currents	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, common hemicarpas were not observed in the project area.

Common Name (*Scientific Name*)	State--Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
False loosestrife seedbox (*Ludwigia polycarpa)*	PA -- Endangered	C	Found on level terrain in open canopy areas, including former oxbows, river channels in floodplain swamps, marshes, and wet prairies, and on the shores of ponds and other wet places	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, false loosestrife seedbox were not observed in the project area.
Umbrella magnolia (*Magnolia tripetala)*	PA -- Threatened	MR, C	Prefers upland areas with fine to medium textured soils that are neutral to slightly acidic; found in rich woods and ravines, near mountain streams and other wet areas, and in mesic shaded coves	Historically occurred in the vicinity of both Muddy Run and Conowingo Project areas. Although the general habitat for a plant may be present in the project areas, umbrella magnolias were not observed in the project area.
Three-flowered melicgrass (*Melica nitens*)	PA -- Threatened	C	Prefers a partly open canopy and calcareous or sandy loam soil; found in open dry woods; rocky grasslands; streambanks; and dry to mesic prairies	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, three-flowered melicgrasses were not observed in the project area.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Sticky goldenrod (*Solidago simplex ssp. randii var. racemosa*)	PA -- Endangered	C	Typically found in boulder/cobble river bars	Documented community in a riverside outcrop below Holtwood Dam, included areas downstream of the Norman Wood Bridge within the Conowingo Project. However, this species was not identified within the project boundary.
Slender goldenrod (*Solidago erecta*)	PA -- Endangered and MD -- Threatened	C	Found in both loamy and sandy soils; typically in open woods and fields	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, slender goldenrods were not observed in the project area.
Tawny ironweed (*Vernonia glauca*)	PA -- Endangered	C	Typically found in sandy to clay soils that can be acidic, neutral, or basic; usually in upland woods, dry fields and clearings, and rich woods	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, tawny ironweeds were not observed in the project area.

Common Name (*Scientific Name*)	State--Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
Appalachian gametophyte fern (*Vittaria appalachiana*)	PA -- Threatened	C	Found on noncalcareous rocks, in dark moist cavities, and occasionally as an epiphyte on tree bases	Historically occurred in the vicinity of the Conowingo Project area. Although the general habitat for a plant may be present in the project area, Appalachian gametophyte ferns were not observed in the project area.
Davis' sedge (*Carex davisii*)	MD -- Endangered	C	Found in both upland and floodplain woodlands where the canopy is somewhat open; also inhabits deciduous forested floodplains and moist limestone woodlands, rocky shores, abandoned fields and wet meadows, and unpaved trails	Documented scattered populations found in forested floodplains, rocky shores, and moist woods in or near the Northern Susquehanna Canal Protection Area north of the mouth of Deer Creek. However, this species was not observed within the project boundary.
Hitchcock's sedge (*Carex hitchcockiana)*	MD -- Endangered	C	Found under a mostly closed canopy of rich mesic woods, in rock soils along unstable slopes, and in calcium-rich loams on slopes near streams	Documented occurrences in or near the Susquehanna Slopes Protection Area along the wooded shoreline slopes north of Conowingo Creek. However, this species was not observed within the project boundary.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Glade fern (*Diplazium pycnocarpon*)	MD -- Threatened	C	Prefers neutral to slightly alkaline soils and found in moist open woods and slopes, moist meadows, swamps, and forested ravines	Documented scattered populations found in forested floodplains, rocky shores, and moist woods in or near the Northern Susquehanna Canal Protection Area north of the mouth of Deer Creek. However, this species was not observed within the project boundary.
Sweet-scented Indian plantain (*Hasteola suaveolens*)	MD -- Endangered	C	Prefers an open Canopy; found in alluvial soils on high-energy floodplains and stream banks but can also be found within open woodlands and along the edges of thickets	Documented scattered populations were found in forested floodplains, rocky shores, and moist woods in or near the Northern Susquehanna Canal Protection Area north of the mouth of Deer Creek. However, this species was not observed within the project boundary.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Goldenseal (*Hydrastis canadensis*)	MD -- Threatened	C	Found in moist, well-drained acidic sandy loam soil that contains abundant organic matter; possibly found within mixed hardwood forests (Henson, 2001), rich moist woodlands, and along wooded streams	Documented population in the wooded bluffs in or near Glen Cove Marina and in or near the Susquehanna Slopes Protection Area along the wooded shoreline between U.S. Route 1 and Conowingo Creek boat landing and north of Conowingo Creek. However, this species was not observed within the project boundary.
American gromwell (*Lithospermum latifolium*)	PA -- and MD -- Endangered	C	Prefers a partly closed canopy with light to medium shade; found in loamy soil that contains abundant organic matter in rich deciduous woods, wooded slopes, and along shaded riverbanks	Documented along the shoreline, mostly in rich moist woods, between U.S. Route 1 and Conowingo Creek boat landing (in or near the Susquehanna Slopes Protection Area). However, this species was not observed within the project boundary.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Tall dock (*Rumex altissimus)*	MD -- Endangered	C	Prefers full to part sun and rich fertile soil and may tolerate gravel and/or clay; found in wet depressions, stream margins and low areas along ponds, lakes and riverbanks	Documented on the north and south sides of the Octoraro Creek mouth (in or near the Susquehanna Floodplain Protection Area). However, this species was not observed within the project boundary.
Veined skullcap (*Scutellaria nervosa)*	MD -- Endangered	C	Found in wet to mesic deciduous woodlands, near wetland edges, and in wet depressional floodplain forests	Documented along the shoreline, mostly in rich moist woods, between U.S. Route 1 and Conowingo Creek boat landing (in or near the Susquehanna Slopes Protection Area). However, this species was not observed within the project boundary.
Virginia mallow (*Sida hermaphrodita*)	PA -- and MD -- Endangered	C	Prefers mostly open canopy; found in sandy or rocky alluvial soil and on stream and riverbanks	Documented in the WSSC of Wildcat Ravine. However, this species was not observed within the project boundary.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Star-flowered false Solomon's seal (*Smilacina stellata*)	MD -- Endangered	C	Prefers wetlands and shallow soils; also found on rocky, well-drained side hills, coastal plains, thickets, and open forests adjacent to streams	Scattered populations observed in the forested floodplains, rocky shores, and moist woods in or near the Northern Susquehanna Canal Protection Area north of the mouth of Deer Creek. However, this species was not observed within the project boundary.
Swamp oats (*Sphenopholis pensylvanica*)	MD -- Threatened	C	Requires full sun and grows in wet meadows and woods, swamps, and stream sides	Documented along the shoreline in swamp habitat between U.S. Route 1 and Conowingo Creek boat landing (in or near the Susquehanna Slopes Protection Area). However, this species was not observed within the project boundary.

Common Name (*Scientific Name*)	State--Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
Valerian (*Valeriana pauciflora*)	MD -- Endangered	C	Found in the rich loamy soils associated with forested floodplains, mesic forests, and along moist wooded stream banks	Documented on the floodplain downstream of Octoraro Creek (in or near the Susquehanna Floodplain Protection Area) and in forested floodplain, rocky shore, and moist woods habitat in or near the Northern Susquehanna Canal Protection Area north of the mouth of Deer Creek. However, this species was not observed within the project boundary.
Eastern gama-grass (*Tripsacum dactyloides)*	PA -- Undetermined	MR	Found in wetter areas associated with swales, thickets, woodland borders, abandoned fields, wet shores, roadsides, and limestone glades and prefers an open canopy	Historically, may have occurred in the vicinity of Muddy Run Project area. Although the general habitat for a plant may be present in the project area, this species was not observed in the project area.
Cranefly orchid (*Tipularia discolor*)	PA -- Rare	MR	An upland plant species found in rich well-drained soils within in mixed hardwood forests. Known to occur within the boundaries of the Ferncliff Wildlife and Wildflower Preserve	Historically occurred in the vicinity of Muddy Run Project area. Although the general habitat for a plant may be present in the project area, cranefly orchids were not observed in the project area.

Common Name (*Scientific Name*)	**State--Status**	**Potential Project Occurrence[a]**	**Preferred Habitat**	**Documented Occurrence**
Netted chainfern (*Woodwardia areolata*)	PA -- Non-listed	MR	Typically found in wetlands with moist, acidic soils; found in acidic bogs, woodland swamps, thickets, on seeps, siliceous cliffs and ledges, and near still water	Historically occurred in the vicinity of Muddy Run Project area. Although the general habitat for a plant may be present in the project area, this species was not observed in the project area.

[a] YH= York Haven, MR= Muddy Run, C= Conowingo

Wildlife

Open-water, wetland, riparian, and upland habitat within the three project boundaries supports a variety of wildlife. Wildlife occupying each habitat type at all three projects is expected to be similar.

Reptiles and Amphibians

Representative reptile and amphibians that are typically found in open-water, riparian, and wetland habitats such as Lake Frederic, tributaries, and the Susquehanna River include snapping turtle, red-eared slider, common musk turtle, map turtle, northern water snake, northern spring peeper, bullfrog, northern leopard frog, pickerel frog, and green frog. These species use aquatic habitats for foraging, resting, protection, reproduction, and hibernation. Representative reptiles and amphibians typically found in upland and riparian habitat in the vicinity of the projects include: eastern garter snake, northern ribbon snake, American toad, gray tree frog, wood frog, spotted salamander, and northern red-backed salamander.

Birds

The Susquehanna River and associated water resources and bottomland areas in the projects' vicinity are used by migratory waterfowl and neotropical passerines. Representative avian species typically found in wetland habitats and along the shoreline include the great blue heron, cattle egret, great egret, yellow-crowned night heron, red-winged blackbird, swamp sparrow, song sparrow, mallard, wood duck, American black duck, common merganser, and Canada goose. Species such as the ducks may nest within vegetated shallows and bottomlands and forage in open water.

Upland and riparian habitat associated with the project areas provide breeding, migratory stopover, and wintering habitat for a high diversity of bird species including neotropical songbirds and resident species. Species such as the black capped chickadee, house wren, song sparrow, white-breasted nuthatch, brown creeper, and an assortment of woodpeckers occur along the wooded shorelines of the project areas. Birds that inhabit non-forested areas within the project areas include American robin, eastern bluebird, mourning dove, and rock dove. A high diversity of migrating warblers also use the upland habitats, and several species of birds of prey are known or suspected to use the project areas. Some of these birds of prey include: bald eagle, osprey, Cooper's hawk, red-tailed hawk, American kestrel, great horned owl, and barred owl. These species use many different habitat types throughout the year including woodland, scrub-shrub or early successional areas, and wetland, and open-water areas.

Mammals

White-tailed deer is the most common big game species in the project vicinities, commonly occurring along forest edges characterized by brushy and woody vegetation, swamp borders, and areas interspersed with fields and woodland openings. Raccoon are

also common, especially along the riparian corridor associated with the Susquehanna River. Other mammals present in the project vicinities include: urban and suburban species such as striped skunk and opossum; furbearers such as red and gray fox and long-tailed weasel; small game species such as gray and red squirrel and eastern cottontail; rodents such as white-footed, deer and house mouse; and little and big brown bat.

Sensitive Wildlife Species

York Haven Power and Exelon consulted with state natural resource agencies during pre-filing consultation and reviewed available literature to identify state-protected wildlife species with the potential to occur in the vicinity of the Susquehanna River Projects, and identified 13 state-listed species that either do or could occur in the vicinity of at least one of the three projects. Several of these species, including eastern redbelly turtle (York Haven), bald eagle (Muddy Run and Conowingo), osprey (Muddy Run and Conowingo), black-crowned night-heron (Conowingo), and rough green snake (Muddy Run), were studied during the licensing proceedings. In addition, FWS has proposed to list the northern long-eared bat for protection under the ESA. Table 3-29 shows the 13 state-protected species and the one species proposed for federal listing, along with habitat preferences and whether or not the species were observed in the vicinity of the project. The bog turtle is both state and federally listed and is discussed in section 3.3.4, *Threatened and Endangered Species*. Existing and potential future project operation could affect the bald eagle, osprey, northern map turtle, and northern long-eared bat, and we provide more detailed information regarding these species in the following subsections.

Bald eagle

The bald eagle is listed as threatened in Pennsylvania and is federally protected under the Bald and Golden Eagle Protection Act of 1940, as amended. Bald eagles are currently found in every state except Hawaii. Eagles prefer undisturbed areas near large lakes and reservoirs, marshes and swamps, and stretches along rivers where they can find open water and their primary food, fish. Nests are primarily constructed in dominant mature trees (often pine, sycamore, red oak, and red maple), or cliffs near water but occasionally are also built on man-made structures. Egg laying and incubation by local populations occur between January and April with fledging occurring as early as mid-June and as late as the end of July. Nesting eagles are particularly sensitive to human intrusions and such activities can compel eagles to abandon a nest.

At the York Haven Project, one bald eagle nest was reported to occur at the southern end of Three Mile Island based on York Haven Power's review of available information (no site specific surveys for bald eagles were proposed by the applicant or recommended by other entities). Lake Frederic provides large populations of warm-water fish species that form a reliable source of live prey for foraging bald eagles. One active nest and a communal roosting site have been documented within the Muddy Run

Project boundary and a reported nest was found on a Conowingo Pond island traversed by the Muddy Run transmission line corridor. At the Conowingo Project, bald eagle surveys conducted by Exelon documented 11 pairs of breeding bald eagles, 18 communal bald eagle roosts, and many foraging bald eagles along Conowingo Pond and downstream of Conowingo dam. Exelon observed up to 153 bald eagles per week during bald eagle surveys of known roosting areas in 2010 and 2011 (Center for Conservation Biology et al., 2012). Bald eagles occur in the vicinity of the three projects year round, but are less common during the winter.

Osprey

The osprey is listed as threatened in Pennsylvania and is federally protected under the Migratory Bird Treaty Act of 1918. Ospreys are found along seacoasts and major waterways on every continent except Antarctica. Fish are the primary prey for osprey, although they also feed on small waterfowl, mammals, and carrion. Ospreys typically inhabit salt marshes, large inland rivers, lakes, ponds, and wetlands bordered by mature trees. Nests are usually built near water in large, often dead, trees but nests have also been found on channel markers, telephone poles, chimneys, and manmade platforms built specifically for their use. Preferred foraging habitat of local osprey populations was reported to be shallow water with low turbidity. Osprey pairs typically return to Pennsylvania in late March to early April to nest and depart by the end of September.

At the York Haven Project no directed osprey surveys were proposed or requested, but an osprey nest is located on the York Haven powerhouse and field staff performing other studies frequently observed osprey flying in the vicinity of Lake Frederic. Exelon conducted osprey nest surveys at the Muddy Run and Conowingo projects in 2010 and 2011. During both years an active osprey nest was documented along the shore of Muddy Run reservoir. Eleven osprey nests were documented in the Conowingo project area in 2010, and a twelfth in 2011 (8 were in Pennsylvania and 4 in Maryland). All of the nests observed in 2010 were active in 2011, with the exception of two nests in Pennsylvania. Osprey activity was frequently observed at the Muddy Run transmission line crossing of the river and entailed ospreys using the transmission towers for perching.

Northern map turtle

The northern map turtle is listed by Maryland as an endangered species. Map turtles are found in deep, slow-moving large rivers and lakes with ample locations for basking. Muddy bottom with aquatic vegetation are preferred and vegetation comprises the majority of the map turtle diet. Mollusks and crayfish are also occasionally consumed. Eggs are laid from April to mid-July in areas with open canopies most often on sunny days after rain events. Turtles were found to make almost immediate use of newly-opened gaps (i.e., tree-falls) in the forest canopy. Hatching occurs from mid-August through September.

According to Towson University studies, a reproductively active population occurs both upstream and downstream of Conowingo dam, although most turtles are concentrated in a 1.2-mile-long river reach downstream of the dam in the vicinity of Port Deposit and Susquehanna State Park in Maryland (Seigel et al., 2014). Nesting occurs in relatively open areas on both in-river islands, along the banks of Octoraro and Deer creeks, and in the town of Port Deposit. Most nesting areas are heavily disturbed by recreational visitors, raccoons, foxes, and feral dogs. Towson University biologists observed basking map turtles from late April through mid-November, with the most intensive activity in September. Basking occurs predominantly on rocks and large woody debris, but can also occur on man-made structures such as bulkhead footings and riprap. Basking is an essential activity for most aquatic turtles, serving to raise body temperatures so that physiological processes such as digestion and egg development are maximized. Reptiles that are precluded from basking may suffer reduced reproductive output and growth rates (Seigel et al., 2014).

Northern long-eared bat

The northern long-eared bat (*Myotis septentrionalis*) is not currently federally listed, but is proposed to be listed as endangered, with a final rule expected in October 2014. FWS published a proposal to list the northern long-eared bat as endangered in the Federal Register on October 2, 2013. In Pennsylvania, it is a candidate for listing as a rare species, but more information is needed before adequate management decisions can be made (PNHP, 2014). The northern long-eared bat's range extends from Maine to North Carolina along the Atlantic coast, including the Susquehanna River in the vicinity of the three projects. The northern long-eared bat historically occurred in Lancaster County based on pre-1980 data, and currently occurs in York and Dauphin counties based on data from 1980 to the present (PNHP, 2014). During winter hibernation, the northern long-eared bat dwells in underground caves and similar sites. Suitable roosting caves need large open space with cracks and crevices, cool temperature (32 to 48°F), high humidity, and low air movement. Spring migration to new habitat happens from mid-March to mid-May. During summer migration, roosting occurs underneath bark, cavities or hollows of trees or snags (typically greater than 3 inches diameter at breast height [dbh]), although occasional roosting in barns and sheds have occurred. Preferred roosting trees such as shagbark hickory and oaks usually display exfoliating bark, hollows, cavities, and crevices. The northern long-eared bat forages in lowland woods, along forest edges and in corridors, feeding on insects. Fall migration and the return to wintering habitat occur between mid-August and mid-October (FWS, 2014a). Neither York Haven Power nor Exelon conducted surveys for the northern long-eared bat and no entity requested that surveys be conducted.

Table 3-29. State-protected wildlife species with potential to occur in the vicinity of the York Haven, Muddy Run, and/or Conowingo projects (Source: York Haven Power, 2012; Exelon, 2012a, 2012b).

Common Name	State Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
Bald eagle	PA -- Threatened	YH, MR,[b] C[c]	Undisturbed areas near large lakes and reservoirs, marshes and swamps, or stretches along rivers with open water and access to fish; nearby tall trees for roosting and nesting. Can be found in the projects' vicinities year round.	Please see previous detailed discussion.
Osprey	PA -- Threatened	YH, MR,[d] C[e]	Along seacoast and major waterways with access to fish; nests usually built near water in large trees, but also use channel markers, telephone poles, chimneys, and platforms built specifically for their use. Found near projects in spring and summer.	Please see previous detailed discussion.
Peregrine falcon	PA -- Endangered	YH	Nest and roost on high prominences, building, cliffs, and other open spaces with expansive views.	Reportedly a pair returned to nest at the Three Mile Island Unit 1 Reactor Building in 2010; however, none observed during project-related field work, and there is no suitable nesting habitat in the project area, other than

Common Name	State Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
				at Three Mile Island.
American bittern	PA -- Endangered	YH	Found in expansive wetland habitats and wetland borders along lakes, ponds, rivers and streams; breed in large wetlands, especially those with dense stands of cattails, bulrushes, grasses, and sedges, and pockets of open water.	Not observed in the vicinity of the project and expansive wetland habitats are lacking.
Yellow-crowned night-heron	PA -- Endangered	YH	Typically feed along small, shallow streams and nest in brush or trees, usually sycamores, found on islands or along streams.	The project area below the east channel dam and along the southeastern side of Three Mile Island provides riparian forest and scrub-shrub wetlands that could provide suitable habitat, but none observed during 2010 and 2011 field seasons.
Black-crowned night-heron	PA -- Endangered	YH, C[f]	Found primarily near rivers and creeks, but also margins of lakes and reservoirs and wetlands; often colonial nest on forested islands or along wooded streams.	Reported to occur in the vicinity of York Haven but none were observed during 2010 and 2011 field seasons. Three to six black-crowned night-herons were regularly observed near the Conowingo dam tailrace and spillway and on Rowland

Common Name	State Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
				Island during 2010 and 2011, foraging below the dam and roosting in trees on the island. No nests observed, but potential nesting habitat is present.
Common tern	PA -- Endangered	YH	Typically seen flying over lakes, slow-moving rivers, or occasionally marshes, or perched on beaches, sand pits, mudflats, or on structures such as buoys or piers. Nesting habitat restricted to sandy shorelines and barren islands of large lakes; currently not known to nest in PA.	No common terns were observed during 2010 or 2011 field seasons.
Black tern	PA -- Endangered	YH	When not nesting, found along the coast; move inland to nest on prairies or extensive marsh complexes that are half open water and half emergent vegetation. Northwest PA is the only location in state where nesting occurs.	Expansive wetland complexes do not occur in the vicinity of the project. No black terns observed during 2010 or 2011 field survey seasons.
Yellow-bellied flycatcher	PA -- Endangered	YH	In shady coniferous forests and forested wetlands at higher elevations; nesting occurs in	Habitat generally lacking in the project boundary. No yellow-bellied flycatchers

Common Name	State Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
			remote areas.	were observed during 2010 and 2011 field survey seasons.
Hellbender salamander	MD -- Endangered	C	Fast-moving, mid-sized streams/channels with good water quality and gravel or sand substrate and abundant large structures for hiding; breed in late summer.	Only historic (confirmed and unconfirmed) records of occurrence in Cecil County and unconfirmed historic records for Harford County, all in the Susquehanna River and tributaries (Stranko et al., 2010).
Northern map turtle	MD -- Endangered	C	Deep slow-moving large rivers and lakes with ample locations for basking; muddy bottoms with aquatic vegetation are preferred.	Please see previous detailed discussion.
Eastern redbelly turtle	PA -- Threatened	YH[g]	Water depths ranging from 6.5 to 12.0 feet deep with an abundance of aquatic vegetation, reduced current velocities, soft substrates, and rocks and logs for basking. They nest on sandy areas along shorelines.	York Haven Power conducted targeted surveys during 2011 for eastern redbelly turtles in Lake Frederic using established protocols and none were found.
Rough green snake	PA -- Endangered	YH, MR,[h] C	Moist areas such as wet meadows and the borders of lakes, marshes, and woodland	Documented in PA only from Greene and southern Chester counties although

Common Name	State Status	Potential Project Occurrence[a]	Preferred Habitat	Documented Occurrence
			streams; frequently found in woody vegetation growing along or overhanging water.	recent evidence places them in Lancaster County near the Muddy Run and Conowingo projects. Suitable habitat is present in the vicinity of the projects. No rough green snakes were observed during targeted surveys (at Muddy Run) or other field studies at all three projects.
Northern long-eared bat	PA -- Candidate for rare species designation	YH, MR, C	During the summer, roosting occurs underneath bark, cavities, or hollows of trees or snags; in winter, they hibernate in caves or similar sites	Please see previous detailed discussion

[a] YH= York Haven, MR= Muddy Run, C= Conowingo
[b] Study 3.8: Study to identify habitat use areas for bald eagle, Muddy Run Pumped Storage Project.
[c] Study 3.23: Study to identify habitat use areas for bald eagle, Conowingo Hydroelectric Project.
[d] Study 3.15: Osprey nesting survey, Muddy Run Pumped Storage Project.
[e] Study 3.30: Osprey nesting survey, Conowingo Hydroelectric Project.
[f] Study 3.31: Black-crowned night-heron nesting survey, Conowingo Hydroelectric Project.
[g] Eastern redbelly turtle phase II presence/absence and nesting surveys for the York Haven Hydroelectric Project.
[h] Study 3.9B: Study to identify potential habitat and presence/inferred absence of rough green snake, Muddy Run Pumped Storage Project.

3.3.3.2 Environmental Effects

Effects of project operation and water level fluctuations on riparian, littoral, and wetland habitat

For all three projects, project operation, including water level fluctuations, could affect riparian, littoral, and wetland habitat. Reservoir fluctuations and changes in downstream flows could affect the distribution, species composition, and health of wetland and riparian habitat. Wetland and riparian habitats are important for functions such as water quality, habitat for fish and wildlife, regulating flooding, and stream recharge.

According to the terms of the Settlement Agreement, York Haven Power proposes to maintain the overall project minimum flow requirements downstream of the project, but it would modify project flow releases to redistribute minimum flow releases among the various project flow release structures (east channel spillway, east channel fishway, nature-like fishway, main dam, and powerhouse).

Exelon does not propose any changes to the existing project operation at Muddy Run or Conowingo. There are no recommended measures specifically relating to wetlands, riparian, or littoral habitat at either project; however, The Nature Conservancy recommended, and Interior endorsed, an alternate flow regime for flows below Conowingo dam, referred to as the TNC Flow Regime. The TNC Flow Regime is described in greater detail in section 3.3.2.2, *Water Resources, Environmental Effects*, but in general it would stabilize flows below the dam, particularly from March through June.

Our Analysis

Under existing and proposed operation, extensive vegetated wetland communities are and would be generally lacking in the York Haven Project boundary. Three Mile Island contains the largest of the emergent marsh wetlands as well as forested floodplain wetlands. Existing and proposed project operations would allow for 1.1 feet of draw down from the impoundment for dam maintenance activities. Because proposed operation would not change the reservoir levels or the overall minimum flows downstream of the York Haven Project, it is not expected that wetland, riparian, or wildlife habitat conditions would change.

The Muddy Run Project operates as a pumped storage facility by moving water from the upper reservoir to the lower reservoir (Conowingo Pond) via gravity to generate power. Water levels in the upper reservoir can fluctuate up to 50 feet within a week. With these large fluctuations, shoreline habitat would vary between dry and flooded periods. As a result, the upper reservoir margins are generally free of emergent or submerged vegetation. Exelon plans to implement an SMP that includes erosion control measures (see further discussion in section 3.3.5, *Recreation and Land Use Resources*) at

the Muddy Run upper reservoir to minimize erosion. Of the six wetlands identified in the project boundary, only one (which is adjacent to the upper reservoir) would appear to be affected by project operation; however, even this wetland has its own source of hydrology. Because the Muddy Run Project would be operated as it has in the past, the existing wetland and riparian habitat would remain similar to their present condition and wildlife habitat would not be affected. Fluctuations of the lower reservoir, Conowingo pond, are discussed below for the Conowingo Project.

Within the Conowingo Project, wetlands are prevalent in the alluvial reach of the Conowingo Pond where the river deposits sediment loads. Conowingo Pond generally operates with a maximum pool elevation of 109.2 feet, but allows for a maximum fluctuation of 9 feet, from elevation 110.2 down to 101.2 feet. The existing wetland and riparian habitat distribution is affected by current project operation (and the operation of the Muddy Run Project). For example, vegetation in the upstream reaches of Conowingo Pond is generally shorter and less abundant than downstream vegetation, as the upstream, more-constricted reach is subjected to higher water levels and velocities than lower reaches. As the energy conditions diminish downstream, the vegetation becomes more prominent, growing on most available rock surfaces. Because Exelon does not propose to change Conowingo Project operation, the existing wetland and riparian conditions would be expected to remain unchanged, and wildlife habitat would not be affected; however, the TNC Flow Regime would stabilize flow below the dam, which could benefit wetlands, riparian habitat, and wildlife habitat. In addition, it is likely the more stabilized minimum flows would result in less fluctuation in Conowingo Pond, which would also benefit wetlands. However, based on our evaluation of Conowingo Pond fluctuations in section 3.3.2.2, *Water Resources, Environmental Effects*, any such benefits would be minor.

Maintenance of project facilities and right-of-way

York Haven Power and Exelon manage vegetation around project facilities, including the project transmission line at Muddy Run, around powerhouses, and recreation areas during routine maintenance activities. Vegetation maintenance could affect the presence or proliferation of invasive species, rare plant species, and wildlife habitat. Neither York Haven Power nor Exelon conducted targeted surveys for rare plants at any of the three projects; however, there are multiple rare plant species known to historically occur within 0.5 mile of the three projects.

York Haven Power and Exelon propose no specific project maintenance measures, invasive species management measures, or rare plant protection measures. However, Exelon manages vegetation along the 4.25-mile-long transmission line right-of-way at the Muddy Run Project in accordance with American National Standards Institute A300 standards, which includes Integrated Vegetation Management (IVM). This approach provides for managing plant communities in which compatible and incompatible

vegetation are identified, action thresholds considered, control methods evaluated, and selected controls implemented to achieve a specific objective. IVM also includes provisions for protection of species of concern, wetlands and streams, and cultural resources. The portion of the right-of-way within the wire zone[77] is managed to promote a low-growing plant community dominated by grasses, herbs, and small shrubs less than 3 feet high. The rest of the right-of-way is managed to promote shrubs and small trees lower than 25 feet high at maturity. Exelon uses a combination of manual, mechanical, and herbicide control techniques. In addition, Exelon proposes the implementation of an SMP at both the Muddy Run and Conowingo projects. The SMP contains shoreline vegetation management measures to protect shoreline vegetation wherever feasible and sensitive natural resources policies that would limit or restrict land use in areas of rare species and wetlands.

There were no recommendations made by stakeholders regarding vegetation maintenance at any of the three projects.

Our Analysis

Rare Plants

Although it is possible that rare plant species occur within any of the three projects, no rare plant species were observed within the project boundaries during studies conducted for the projects. Project maintenance at all three projects would be expected to continue similarly to how it has in the past, with vegetation habitats remaining as they exist currently. Overall, proposed maintenance activities such as tree trimming, lawn care, herbicide use, and building maintenance would create minimal vegetation disturbance and result in minimal vegetation removal. As a result, it is expected that if rare plant species exist in the project areas they are not likely to be affected by project maintenance.

At the Muddy Run Project, Exelon uses manual, mechanical, and herbicide methods to maintain the transmission line right-of-way free of tall-growing species that could interfere with line reliability. Again, because this IVM would continue under the terms of any new license, any rare plant species that currently may exist in the right-of-way would not be expected to be affected by the proposed project maintenance. The proposed SMP at the Muddy Run and Conowingo projects would likely benefit rare plant species, if they occur, because it would limit the amount of shoreline vegetation removed and, if any rare plants are found during the life of any licenses issued, these locations

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[77] The wire zone is the section of right-of-way directly under the transmission wires and extending outward 10 feet on each side of the wires.

would be integrated into the SMP's sensitive natural resources land use protection program.

Invasive Species

Regular project maintenance activities, such as vegetation mowing, trimming, and clearing, and herbicide applications around project facilities, as well as project-related recreation facility use at all three projects would create disturbance that could contribute to the spread of invasive species. The presence and spread of invasive species could also affect rare plant populations by outcompeting such species. At the York Haven Project, York Haven Power observed invasive species along road edges and disturbed areas of Three Mile Island and at the Muddy Run Project, Exelon observed invasive species along the western shore of the power reservoir and areas near recreation facilities and in the transmission line right-of-way. All of these areas are routinely disturbed by project maintenance and, in some cases, public use. With York Haven and Exelon continuing their project maintenance activities, invasive species would continue to exist in the project boundaries and could potentially spread. Eradicating or even controlling invasive species populations is very difficult, however, because outside activities can continuously introduce new populations of invasive species into the project boundary. Because the presence and spread of invasive species is an issue that extends far beyond the three projects, the effect of project maintenance on invasive species proliferation would be minimal. In addition, at Muddy Run, at the location where invasive species could directly affect the federally listed bog turtle, Exelon proposes, as part of its Bog Turtle Management Plan, to conduct invasive species control measures. The bog turtle is discussed further in section 3.3.5.2, *Threatened and Endangered Species, Environmental Effects.*

Recreation Facilities

Existing and proposed recreation facilities at the three project areas could cause disturbance to wildlife by creating noise and human activities, which cause wildlife to leave the area. Proposed recreation facilities would result in the loss of some wildlife or possibly rare plant habitat, if any still exists.

York Haven Power does not propose any new recreation facilities. Exelon proposes improvements to existing recreational areas within the Muddy Run Project. Improvements that would disturb vegetation include: a new boat ramp and shoreline improvements at the Muddy Run Campground, and expanding the playground and other facilities at the Visitor's Center. At the Conowingo Project, Exelon proposes several recreation facility improvements that would disturb vegetation such as vegetation clearing, additional parking spaces, and new docks at Lock 13 and 15; a new parking lot and concrete pad for restroom placement at the Cold Cabin Campground; installation of new drainage ditches at the Conowingo Creek boat launch; parking lot expansion at the Glen Cove Marina; replacing the existing pavilion and removing a portion of the parking

lot at the Conowingo dam overlook; widening access roads, constructing a retaining wall, creating additional parking, constructing a new boat launch, and replacing the existing launch area at the Fisherman's parking/Shures landing site; and, constructing a new road at the Peach Bottom access. See section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, for additional details describing specific changes made in each area.

Our Analysis

Existing recreation facilities in the three project boundaries are not expected to adversely affect wildlife species because it is likely that most wildlife species that occur in those areas have adapted to current levels of activity. Some more sensitive wildlife species would likely continue to move out of the areas during high recreation use. Proposed recreation improvements at Muddy Run and Conowingo are expansions or improvements to existing facilities. As a result, increased noise and human activity would be expected to result in only minor disturbance to wildlife. Proposed recreation enhancements at Muddy Run and Conowingo would, however, result in the loss of wildlife habitat through the removal of vegetation. Although the exact amount of vegetation that would be cleared for the proposed facilities is unknown, the nature of the facilities at both Muddy Run and Conowingo is not expected to have a large construction footprint outside already disturbed areas. Because all of Exelon's proposed improvements would be at existing sites, most land clearing would likely occur in previously disturbed areas. Direct mortality of smaller, less mobile wildlife species could occur; however, more mobile species would be expected to disperse into nearby similar habitat. In addition, ground disturbance during construction could result in the increased presence and proliferation of invasive species.

Nature-like Fishway Construction at the York Haven Project

York Haven Project

In the Settlement Agreement, York Haven Power proposes, and the Settling Parties recommend, the installation of a nature-like fishway at the north end of the main dam. Further discussion can be found in section 3.3.2.2, *Water Resources, Environmental Effects*. The nature-like fishway would serve as a primary fish passage facility. The facility would consist of an in-river nature-like fishway near the toe of the main dam and reaching upstream from the main dam and would be approximately 300 feet wide. York Haven Power proposes in the explanatory statement filed with the Settlement Agreement that during the finalization of the nature-like fishway plans and required permitting it would conduct vegetation cover type mapping, wetland delineation, invasive species surveys, rare species surveys, a bog turtle habitat assessment, and a bald eagle survey in 2014 in the area right around the proposed nature-like fishway. In addition, it would follow all necessary steps to submit applications for a section 404 permit from the Corps and an NPDES Permit for Stormwater Discharge Associated with Construction Activities from Pennsylvania DEP in 2015. Interior commented that York

Haven Power should follow conservation measures that protect bald eagles in addition to adopting the National Bald Eagle Management Guidelines.

Our Analysis

Construction of the proposed nature-like fishway would disturb vegetation located at the apex of the main dam and abutment with the west shore of Three Mile Island and wetlands within the Susquehanna River. Initial construction of the nature-like fishway would result in the loss of vegetation and wildlife habitat in the construction footprint. During construction, human activity and construction noise would result in a temporary disturbance to wildlife in the area. Following construction, wildlife disturbance would return to pre-construction conditions.

Ground disturbance and vegetation removal activities associated with construction of the nature-like fishway could disturb or directly affect rare plant and wildlife species such as the bald eagle, as well as result in the spread of invasive species or wetland impacts. However, because York Haven proposes to conduct all the indicated surveys, complete the resource agency consultation required to obtain the section 404 and NPDES permits, and follow all protection measures and BMPs contained in any permits they receive, including measures to protect any bald eagles identified during surveys and FWS consultation, the proposed nature-like fishway would not adversely affect rare terrestrial resources.

Bald Eagle and Osprey Management

Bald eagle and osprey populations occur within the vicinity of all three project areas mainly along the reservoirs and river edges. Project recreation and maintenance could potentially affect raptors such as the bald eagle and osprey by creating human disturbance and cutting trees and vegetation. The Muddy Run transmission line could also potentially affect large raptors from electrocutions or collisions.

<u>York Haven Project</u>

Although York Haven Power does not propose any measures specifically for bald eagle, osprey, or raptor management, York Haven Power proposes to conduct a bald eagle survey around the proposed nature-like fishway facility. No resource agencies recommend any raptor measures at the York Haven Project other than the Settling Parties' recommendation to construct the nature-like fishway facility as included in the Settlement Agreement and Interior's comment that York Haven Power follow conservation measures that protect bald eagles and adopt the National Bald Eagle Management Guidelines. This is discussed above under *Nature-like Fishway Construction at the York Haven Project*. Overall, even though bald eagles, osprey, and other raptors occur in the York Haven project area, because York Haven Power does not propose to change the overall minimum flows below the dam or any new recreation facilities and the project does not include a transmission line, it would not affect these species and they are not analyzed further.

Muddy Run and Conowingo Projects

At both the Muddy Run and Conowingo projects, Exelon proposes to implement the Bald Eagle Management Plans included in its license applications that provide for the management of bald eagle habitat on Exelon lands based on recommendations from the FWS *National Bald Eagle Management Guidelines* and state agency guidance. This includes implementing distance and landscape buffers around nesting sites and avoiding certain activities during nesting season. In addition, the Bald Eagle Management Plans include guidelines for activities around roosting and foraging areas. The plans also include provisions for monitoring of nesting, roosting, and foraging sites every 5 years and injury and mortality procedures.

In addition, Exelon proposes, as part of the SMPs at both projects, to implement an osprey management policy that states that Exelon would work with state and federal agencies to provide appropriate buffers dictated by the types of activities carried out in either visual or auditory proximity to nests during breeding and nesting season (January to late July). This includes implementation of: (1) nest buffers during the breeding season of 330 feet for most activities and larger buffers up to 600 feet for activities with the potential to emit excessive noise (which excludes routine project operation and maintenance activities); and (2) restriction on herbicide application within 330 feet of osprey nests during breeding season. Exelon would also consult with FWS and Pennsylvania Game Commission to determine BMPs and obtain applicable permits in the event an osprey nest on project transmission line towers is identified as a problem nest that needs to be removed or relocated.

For both the Muddy Run and Conowingo projects, Interior recommends under section 10(j) that Exelon finalize and implement Bald Eagle Management Plans in consultation with FWS, Maryland DNR, and the Pennsylvania Game Commission. The management plan would manage bald eagle habitat on Exelon land in accordance with recommendations in the *National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance. Bald eagle habitat, including nest sites, forage sites, and communal roost sites, would be managed through a range of conservation measures that meet the provisions of the Bald and Golden Eagle Protection Act, including incidental take of eagles. The range of measures would include seasonal restrictions, distance buffers, and landscape buffers. For the Conowingo Project, Interior indicates two specific measures that Exelon should reconcile to avoid disturbance of eagle concentration areas: (1) enforcement of human traffic restrictions on both sides of Roland Island, under the towers in the river, and on the Cecil County side of the river where current human activities disturb perching and foraging eagles; and (2) a requirement that Exelon release information pertaining to federal regulations that protect

eagles and great blue heron rookeries, and other migratory birds if any lands are potentially donated by Exelon.[78]

Exelon, in its response to Interior's recommendations on the Conowingo Project, states that its proposed Bald Eagle Management Plan was developed in consultation with FWS and Maryland DNR. Exelon states that its proposed Bald Eagle Management Plan would manage, through a range of measures, bald eagle nest habitat, including nest sites, forage sites, and communal roost sites, on Exelon land. Exelon states that it would consult with FWS and other pertinent resource agencies to finalize the Bald Eagle Management Plan.

Our Analysis

In August 2012, Exelon completed a transmission line avian interaction study report for the Muddy Run Project. The report focused on the biology and morphology of avian species, environmental factors, and site configuration of the lines and structures. Birds that are large in size, such as eagles, osprey, herons, and vultures are thought to have a greater risk of mortality around transmission lines due to large body size and wing span contacting transmission lines during flight, and nesting on towers. Many avian species prefer nesting on these structures because of height and openness overlooking foraging areas.

As part of the study, Exelon conducted bird surveys between April 2010 and October 2010 along the 4.25-mile-long transmission line right-of-way that connected the Muddy Run powerhouse to the PBAPS north substation. Data collected were used to determine the potential risk of electrocution and collision at the project transmission line. The study covered 86 observational hours with 1,376 avian sightings and one mortality. Large raptors, including bald eagles and osprey, concentrate in a section of the project, known as the Water Crossing, where the transmission line perpendicularly crosses Conowingo Pond from the Muddy Run powerhouse to a slope above Muddy Creek Boat Launch. The 2012 study determined this area to have a higher collision risk for raptors and other birds because the abundance of large species, the configuration of lines perpendicular to shorelines in an open/shoreline environment, and the presence of shield wires. Electrocution, on the other hand, is not a risk because the separation of the transmission line's energized and grounded components is larger than the wing span of the largest bird in the area. Electrocution is unlikely to occur if a bird is not able to touch multiple components at once.

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[78] We interpret Interior's comment as recommending, in the event that Exelon donates land, that Exelon must provide information to the recipient regarding bald eagles and other migratory bird species that are present, and the state and federal protection afforded to these species.

Overall, although the Water Crossing area of the Muddy Run Project has a higher risk for avian collision, the transmission line interaction study documented only one mortality with more than 1,376 avian sightings, suggesting that raptor mortality from collisions with the transmission line may not be common. Although the study is unlikely to have observed every instance of avian mortality and occasional mortality from collisions is possible, the Muddy Run Project transmission line is not expected to result in adverse effects on raptor populations, including bald eagles and osprey.

Implementation of the Bald Eagle Management Plan, as proposed by Exelon and recommended by Interior, would benefit bald eagles within the Muddy Run and Conowingo project boundaries. FWS' *National Bald Eagle Management Guidelines* include active nest protection buffers ranging from 330 feet to 1 mile, depending on the nature of disturbance under consideration. By following the proposed Bald Eagle Management Plan, Exelon would comply with bald eagle management guidelines and state guidelines during construction of recreational facility enhancements, project maintenance, and other proposed project measures. In addition, conducting monitoring every 5 years would identify new nesting, roosting, and foraging sites and identify sites that have been abandoned. This would ensure that future bald eagle nest, roost, and foraging areas are also protected by the Bald Eagle Management Plan. Finally, the mortality reporting component of the proposed plan would ensure that FWS and the Pennsylvania Game Commission are aware of any project-related bald eagle mortality for the term of any new license and allow Exelon and the agencies to identify and address any increase in project-related mortality.

At the Muddy Run and Conowingo Projects, both the Exelon proposed and Interior recommended Bald Eagle Management Plans would result in the same benefit to nesting, roosting, and foraging bald eagles. At the Conowingo Project, Interior's recommendation for restrictions to human activity in the vicinity of eagle concentration areas would result in greater protection of foraging and communal roosting bald eagles from human disturbance. As Exelon has not proposed to donate lands as part of the proposed project, it is not necessary at this time to include a measure in the proposed Bald Eagle Management Plan that would require Exelon to release information on bald eagles or other migratory species to a recipient.

Similar to the bald eagle, Exelon's proposed osprey management policy would result in landscape and seasonal buffers around osprey nests. By implementing appropriate buffers, as determined in consultation with FWS and Pennsylvania Game Commission, Exelon is likely to protect the osprey during construction of recreational facility enhancements, project maintenance, and other proposed project measures. In addition, it would ensure that Exelon follows BMPs identified by FWS and the Pennsylvania Game Commission and obtains necessary permits before removing active osprey nests. Overall, the proposed policy would benefit the osprey by enacting protection measures.

Waterfowl Nesting Protection

Waterfowl nesting habitat is present in wetland and riparian habitat. As a result, project operations that result in water level fluctuations in project reservoirs or varying flows downstream could flood waterfowl nests.

York Haven Power and Exelon do not propose measures related to waterfowl protection, and waterfowl nesting protection was not identified as a concern by resource agencies or other stakeholders at the York Haven or Muddy Run projects.

For the Conowingo Project, Interior recommended under section 10(j) that Exelon develop a waterfowl nesting protection plan in consultation with FWS. The plan would identify waterfowl nesting areas within the project area that are vulnerable to flooding during nesting season, and create a range of alternatives and recommendations to avoid flooding active nests.

Exelon, in its response to Interior's recommendation, states that there is no evidence that Conowingo Project operation affects waterfowl or that a waterfowl protection plan would be necessary. Exelon states that it was not asked to conduct an assessment of the effects of project operation on waterfowl during the relicensing process. In addition, Exelon states that the zone of fluctuation around Conowingo Pond does not provide waterfowl nesting habitat and that project fluctuations around Conowingo Pond and flows downstream of the dam would not affect foraging habitat.

Our Analysis

Exelon does not propose to change project operation at the Conowingo Project; however, project operation would continue to result in fluctuations of Conowingo Pond of up to 9 feet. In addition, waterfowl nesting downstream of the Conowingo Project could be affected by proposed seasonal fluctuations in flow, specifically the increase in minimum flow, from 3,500 cfs in March to 10,000 cfs in April, during the early stages of waterfowl nesting. Although we acknowledge that the fluctuation zone of Conowingo Pond does not provide much waterfowl nesting habitat and nesting success would not likely decrease from existing conditions, implementation of a waterfowl nesting protection plan, as recommended by Interior, would identify areas where waterfowl nesting habitat is affected by inundation. If project-related effects on waterfowl nesting are identified, then such a plan would then allow appropriate protection or mitigation measures to be established. Overall, implementation of a waterfowl nesting protection plan at the Conowingo Project, in consultation with FWS and the state agencies, would benefit nesting waterfowl by allowing Exelon to determine if the Conowingo Project is affecting waterfowl nesting habitat, identifying which species of nesting waterfowl the project is affecting, and establishing appropriate protection or mitigation measures. In addition, the TNC Flow Regime would result in more stable minimum flows during waterfowl nesting season, which could result in less flooding downstream of the dam and around Conowingo Pond.

Northern Map Turtle Management

The northern map turtle is known to occur at several locations along the Susquehanna River both above and below Conowingo dam, including Wood Island, the town of Port Deposit, and Octoraro Beach. Operation of the Conowingo Project, including changes in minimum flow releases could affect map turtle nesting and basking sites. Maryland DNR comments that Exelon failed to address effects on the map turtle, which occurs upstream and downstream of Conowingo dam. It states that constant water level changes from the Conowingo Project affect map turtle basking sites, nesting areas, and egg production and viability.

The Nature Conservancy and Interior recommended an alternative flow regime downstream of Conowingo dam, partly to benefit basking northern map turtles. The TNC Flow Regime would result in more stable flows downstream of the dam, particularly during the spring season.

Exelon, in its response to Maryland DNR's comment, stated that it has funded several map turtle studies through Towson University since 2011; however, at this time there is no substantial evidence that project operation is adversely affecting the map turtle and that implementing any protection, mitigation, or enhancement measures would be premature. Exelon states that it is currently working with the State of Maryland and Towson University researchers to develop a plan of study for 2014, which would include the following research components: (1) nesting habitat enhancement; (2) assessment of ecology and viability of populations upstream of Conowingo; (3) development of artificial basking structures to mitigate loss of basking sites; (4) rapid assessment of population size to determine population trends; (5) hatchling and juvenile ecology; and, (6) working with the State of Maryland to develop potential protection and enhancement measures for any identified project-related adverse effects.

Our Analysis

Towson University conducted interim northern map turtle studies from 2011-2013 that discussed the effect of Conowingo Project operation on the northern map turtle (Seigel et al., 2014). The studies have indicated that turtle nest predation and disturbance is prevalent in the Conowingo Project area, particularly at the Octoraro Beach site. Encroachment of woody vegetation and brush at the site meant that the turtles had to concentrate nests in the few open areas where predators could locate nests more easily.

Exelon, at Towson's request made some nesting habitat improvements in 2012 and 2013, and Towson's study indicates that these improvements, such as opening up canopy, decreased predation and improved nesting success. In 2011, the map turtle predation rate was 96.7 percent. Following Exelon's habitat improvements in 2012 and 2013, the predation rates lowered to 44 percent and 66 percent, respectively. Towson stated that such habitat manipulations would need to continue biannually to maintain the improved conditions. In addition, human disturbance to nesting areas during nesting season is likely to limit the nesting success.

The studies also have shown that basking sites below the dam are affected by human disturbance during recreation and could be affected by water level and flow changes. According to the 2013 study, kayaks appeared to be the most likely cause of disturbance to basking turtles; however, other sources of disturbance include fishing boats, speed boats, canoes, and swimmers. Additionally, the seasonal period when boat traffic is the heaviest (specifically, June and August) and the time of day when boat traffic is heaviest (between 11a.m. and 1p.m.) coincided with the map turtle's critical basking times. The study hypothesized that the disturbance to basking turtles as a result of boat traffic during the early summer may lead to reduced production of map turtle offspring.

Although some map turtle disturbance, such as predation, is not a result of project operation, fluctuations in river flow and human disturbance from recreational activities may be partly project-related. The 2013 study determined that a combination of flow rates from the dam in combination with tide level results in water level fluctuations that submerge basking sites, limiting the ability of the map turtle to bask. As described above, initial studies indicate that project operation and project-related recreation could affect map turtle nesting and basking success. Although Exelon indicates that it is continuing to work with Towson University and the State of Maryland on northern map turtle studies and the development of protection, mitigation, and enhancement measures, if Exelon develops and implements a formal northern map turtle protection plan, in consultation with Towson University and Maryland DNR, that incorporates nest management and mitigation measures to improve and maintain nesting habitat, create new alternative nesting and basking sites, and implement measures to restrict human access to nesting sites during nesting season, the project would benefit the northern map turtle.

In addition, it appears that high flow releases from Conowingo dam may contribute to the submergence of turtle basking sites, which in turn could affect reproductive success. It is likely that more stable flows, such as those in the TNC Flow Regime, would benefit basking turtles by allowing basking sites to be available for longer periods.

Wildlife Species of Special Concern

In addition to the species of special concern discussed above (e.g., bald eagle, osprey, and northern map turtle), there are four additional species that are either known to occur or could potentially occur within the three project boundaries during the year, for breeding, foraging, migration, or overwintering. Neither York Haven Power nor Exelon proposed any measures and no stakeholders proposed measures relating to these species in response to the Commission's ready for environmental analysis notice.

The peregrine falcon has been observed in and around the York Haven Project; however, the project contains no suitable nesting habitat other than buildings. In addition, York Haven Power does not propose to change existing project operation. Because project operation would not change, York Haven Power does not propose any

additional recreation facilities which would increase human disturbance, and project maintenance is unlikely to affect falcon habitat it is unlikely that the York Haven Project would affect any peregrine falcons that may use the project area.

According to the license applications, black-crowned night-herons were not observed at either the York Haven or Muddy Run projects; however, this species has been observed regularly foraging and roosting in the Conowingo dam tailrace, spillway, and around Rowland Island. However, Conowingo Project operation and maintenance, and recreation activities at the project, particularly in the portion of Rowland Island identified as potential nesting habitat, may affect black-crowned night-heron nesting activity. Exelon does not propose to change existing project operation or maintenance, nor does it propose any recreation facilities on Rowland Island; therefore, it is likely that night-herons the presently forage within the project area would continue to do so. The TNC Flow Regime would result in more stable flows below the dam, which could improve night-heron habitat suitability.

York Haven Power and Exelon did not observe the rough green snake during any non-targeted surveys in 2010 and 2011. Although potential habitat was identified in the Muddy Run Project, no rough green snakes were observed during Exelon's targeted surveys at the Muddy Run Project. It is unlikely that this species would be affected by operation of the three projects. Project maintenance in suitable rough green snake habitat at the three projects has the potential to cause mortality to individuals, but based on the lack of observation, it is unlikely that maintenance would affect this species. Lastly, construction of staging areas for the York Haven Project's nature-like fishway would not likely affect this species, as management practices to minimize impacts to wildlife during construction would be employed.

Although potential habitat for the northern long-eared bat exists within the three project areas, along the riparian forested edges of the river and reservoirs, and forested edges along transmission line rights-of-way and recreational areas, neither York Haven Power nor Exelon propose any activities that would result in more than a minimal amount of tree clearing. Continued vegetation management practices, such as trimming and herbicide application, would be unlikely to affect trees large enough to provide roosting habitat for bats. Therefore, the York Haven, Muddy Run, and Conowingo projects are not likely to affect the northern long-eared bat.

Exelon did not observe the red-bellied turtle during any non-targeted surveys in 2010 and 2011, nor has it been identified as occurring in the project areas. Although potential habitat was identified in the York Haven area, York Haven Power conducted protocol-level surveys and did not locate any turtles. Although project operation could affect red-bellied turtle habitat, because red-bellied turtles were not observed in the project area after a thorough search, this species would not likely be affected.

Rare, Threatened, and Endangered Species Review for Muddy Run

Pennsylvania DEP filed with the Commission on June 9, 2014 a WQC for the Muddy Run Project with a mandatory condition requiring Exelon to conduct an evaluation of all state and federal endangered or threatened species that may be present within the project boundary every 10 years, and to propose a plan and schedule for protection if its evaluation identifies the presence, critical habitat, or critical dependence of such species within the Muddy Run project boundary.

Over the course of any new license, the presence and locations of rare, threatened, and endangered species in the Muddy Run project boundary is likely to change. Exelon proposes to evaluate all state and federal endangered or threatened species that may be present within the project boundary once every 10 years through the term of the license. If the evaluation identifies the presence, critical habitat, or critical dependence of endangered species, Exelon would propose and, following approval, implement a plan to ensure protection of endangered or threatened species.

Although we agree that this measure would allow Exelon to continue to be aware of the current rare, threatened, and endangered species populations in the Muddy Run Project during the length of any license, the Commission typically includes in its licenses a standard license article with a fish and wildlife reopener provision that could be used to require changes to project facilities upon Commission motion or as recommended by the appropriate federal and state fish and wildlife agencies after notice and opportunity for hearing. This standard reopener provision retains authority for the Commission to implement any measures that may be needed to protect threatened or endangered species or other fish and wildlife resources over the term of any license issued for the project.

3.3.4 Threatened and Endangered Species

3.3.4.1 Affected Environment

In a letter filed January 4, 2007, Interior provided a list of federally listed species that may occur in the project area. Staff also referred to FWS' website (http://ecos.fws.gov/ipac/; accessed March 11, 2014 and May 12, 2014) to gather recent information on the potential presence of federally listed threatened and endangered species within the counties that contain the three projects, and contacted FWS and Maryland DNR regarding a bog turtle record close to Conowingo dam. Six federally listed species are known to occur in the vicinity of one or more of the projects: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), bog turtle (*Glyptemys [Clemmys] muhlenbergii*), Indiana bat (*Myotis sodalis*), Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*), and swamp pink (*Helonias bullata*).

Aquatic Species

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) is a federally listed (endangered) species with a range along the Atlantic coast extending from New Brunswick, Canada, to Florida. NMFS recognizes 19 distinct population segments (DPSs) occurring in New Brunswick, Canada (1), Maine (2), Massachusetts (1), Connecticut (1), New York (1), New Jersey/Delaware (1), Maryland/Virginia (1), North Carolina (1), South Carolina (4), Georgia (4) and Florida (2). The species typically occurs in coastal tidal rivers and spawns in fresh water, sometimes moving substantial distances upstream. Shortnose sturgeon have been collected in the Connecticut River as far upstream as the Holyoke Project, at RM 86. Shortnose sturgeon are not considered anadromous or strongly migratory but have been found in brackish and salt water, moving some distance from its natal stream (Scott and Crossman, 1973). It is a relatively small sturgeon, seldom reaching a length of greater than 35 inches and a weight of 8 or 9 pounds. The populations of shortnose sturgeon vary substantially over their range, and it is thought that they no longer occur in some tributary rivers to Chesapeake Bay, including the Susquehanna. The nearby Delaware River, however, has been estimated to have a stable shortnose sturgeon population of from 10,000 to 20,000 fish, based on several population estimates. Delaware River fish are able to access the lower Susquehanna River via the Chesapeake and Delaware Canal, which connects Delaware Bay to the upper Chesapeake Bay.

Documented shortnose sturgeon occurrences in the Susquehanna River in recent years have been limited, with only a total of five fish reported. Three fish were recorded at the mouth of the river on the Susquehanna Flats, and two fish were reportedly caught by anglers in the Conowingo tailrace. No shortnose sturgeon are known to have been collected or passed via the Conowingo fish lifts since they began operation in 1972 (Normandeau and Gomez and Sullivan, 2012l). Additional shortnose sturgeon have been collected in upper Chesapeake Bay, but analysis of genetic samples found that the source of these fish was likely Delaware Bay. In 2010 and 2011, Exelon conducted monitoring for acoustically tagged shortnose and Atlantic sturgeon in the lower Susquehanna River downstream of Conowingo dam near Port Deposit and downstream of the I-95 bridge. The objective was to determine if any sturgeon acoustically tagged by other researchers in Chesapeake and Delaware bays made forays into the Susquehanna River. No tagged fish were recorded.

Exelon assessed Susquehanna River shortnose sturgeon (and other species) habitat downstream of Conowingo dam in the 4.5-mile non-tidal reach ending just upstream of Port Deposit (Gomez and Sullivan Engineers and Normandeau Associates, 2012). Shortnose sturgeon was selected as one of the target species of special concern, and the analysis found that there is suitable habitat for all sturgeon life stages in this reach of the river at a range of flows modeled.

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* is also federally listed with a range along the Atlantic coast from Maine to Florida. NMFS recognizes five DPSs: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. Atlantic sturgeon are listed as threatened in the Gulf of Maine DPS and endangered in the remaining four DPSs. Atlantic sturgeon are considered an anadromous species, spawning in freshwater in the spring and early-summer and returning to estuarine or marine waters where they spend most of their lives. Atlantic sturgeon are believed to be present in 32 rivers along the Atlantic coast, with spawning occurring in 20 of those rivers. Atlantic sturgeon are larger in size than shortnose sturgeon, and may reach a length of 14 feet and up to 800 pounds (http://www.nmfs.noaa.gov/pr/species/fish/atlanticsturgeon.htm#distribution, accessed March 7, 2014).

Atlantic sturgeon are commonly reported in Chesapeake Bay, particularly during the winter months, but none have been documented in the Susquehanna River, other than anecdotal reports. As with shortnose sturgeon, there is evidence that Atlantic sturgeon may use the Chesapeake and Delaware Canal for movement between the Chesapeake and Delaware bays. No Atlantic sturgeon have been collected in the Conowingo dam fish lifts since beginning operations in 1972. Exelon's instream flow study (Gomez and Sullivan Engineers and Normandeau Associates, 2012a) did not use Atlantic sturgeon as an evaluation species, but did include the species in the "deep slow" and "deep fast" habitat guilds, and found suitable habitat for all Atlantic sturgeon life stages in the lower Susquehanna River.

Bog Turtle

The bog turtle (*Glyptemys* [*Clemmys*] *muhlenbergii*) is a federally listed species (threatened) that has been documented at the Muddy Run Project, and has the potential to occur at the York Haven and Conowingo projects. The bog turtle was listed as threatened under the ESA in 1997. The bog turtle is also listed by Maryland DNR as a threatened species, and by Pennsylvania FBC as an endangered species.

The bog turtle is native to the eastern United States and ranges from Georgia to the lower New England states. In Pennsylvania, extant populations of bog turtle are known from 14 counties (including Lancaster and York) located primarily in the southeastern quadrant of the Commonwealth. Bog turtle populations are also known from the vicinity of Conowingo dam in adjoining Harford County, Maryland.

Bog turtles inhabit distinct types of headwater wetland habitats that include spring-fed hydrology and loose, saturated soils. Small spring-courses, rivulets, and shallow pockets of surface water typify the surface hydrology of bog turtle wetlands. Subterranean tunnels that access flowing groundwater are often used by bog turtles as hibernacula for winter brumation and as refugia during the hot summer months. Deep, loose, saturated soils (unofficially described as "mucky", and not to be confused with

muck) in which bog turtles can burrow are an important component of their habitat. Ideal bog turtle wetlands contain mostly emergent vegetation with open canopy (minimal woody species), though some shrubs and small trees may be scattered throughout.

Bog turtles in Pennsylvania typically emerge from hibernation in March or early April, and return to hibernacula in late October to November, depending on weather conditions. Breeding occurs from late April through early June, with nesting in Pennsylvania occurring from June through early July. Turtles typically lay eggs within or on top of suitable vegetation such as sedges or sphagnum moss. Hatchlings emerge from the nest August through September and overwinter near their nest.

York Haven Project

Although the York Haven Project is located within the range of the bog turtle, York Haven Power did not conduct specific surveys during its relicensing proceedings. Potential habitat for bog turtles may exist within the project boundary, mostly on the southern section of Three Mile Island within the relatively large wetland complexes, York Haven Power noted several small fringe riparian wetlands along the banks of the east channel and in isolated pockets below the main dam and headrace wall, but the frequent flooding of these wetlands during high-flow periods likely makes these habitats unsuitable for bog turtles. The wetland habitat located on Three Mile Island within the project boundary may provide habitat for bog turtles; however, no bog turtles were observed during the Eastern Redbelly Turtle Phase II Presence/Absence and Nesting Survey or any other surveys conducted in 2010 or 2011. York Haven Power indicates that it will conduct a bog turtle habitat assessment in the vicinity of the nature-like fishway during the 2014 field season.

Muddy Run Project

The Muddy Run Project is located within the range of the bog turtle. Exelon conducted studies during the spring and summer of 2010 and 2011 to identify potential habitat for herpetofaunal species within the Muddy Run Project area. Qualified biologists searched all land areas to identify potential habitats. Of the six wetlands identified within the project study area, four wetlands were not potential habitat and did not warrant further surveys, and two wetlands were potential habitat. Bog turtles were found to occupy one wetland within the project study area during surveys in June 2011.

Conowingo Project

According to the Muddy Run bog turtle report, bog turtles are known to exist in the vicinity of Conowingo dam in adjoining Harford County, Maryland. Exelon conducted surveys in 2008 and determined that none of the 31 wetlands surveyed around Conowingo Pond contain suitable bog turtle habitat. As documented in telephone and e-mail memoranda filed April 23, 2014, and June 9, 2014, FWS staff stated that a bog turtle was sighted close to Conowingo dam in 2013, and directed Commission staff to contact Maryland DNR for further information. However, at the time of the issuance of this

document, FWS and Maryland DNR have not provided specific information on the location of the bog turtle sighting.

Terrestrial Species

Indiana Bat

The Indiana bat (*Myotis sodalis*) was originally listed as endangered under the Endangered Species Preservation Act of 1966. Currently, the Indiana bat is federally listed as endangered. This species, mainly dominant in Indiana, ranges from Florida north to Vermont and extending as far west as Eastern Oklahoma. It could potentially occur throughout Pennsylvania. The Indiana bat is a temperate, insectivorous, migratory bat that hibernates colonially in caves and mines in the winter. Spring migration to new habitat happens from mid-March to mid-May. During spring months, females migrate, forming maternity colonies to raise their young in wooded areas. Males and non-reproductive females remain near their location for winter hibernation or migrate to summer habitat. Summer colony roosts are typically behind exfoliating bark of large, often dead, trees (typically >5 inches dbh) where individuals roost in similar smaller trees (as small as 3 inches dbh). Between mid-August and mid-October, males and females return to their dwelling to hibernate. During winter months, Indiana bats are restricted to underground dwelling, but during summer month's female roosts seek out forested habitat. Roosting Indiana bats prefer the bark of dead trees that retain large, thick slabs of peeling bark, such as shagbark hickory and oaks, that are usually located within canopy gaps, along fence lines and wooded edges. Indiana bats typically roost in riparian zones, forested wetlands and upland communities, and forage along forested edges and within forested and riparian areas (FWS, 2007).

Delmarva Peninsula Fox Squirrel

The Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*) is federally listed as endangered. Historically, the fox squirrel was found within the eight counties in the Delmarva Peninsula of Delaware, Maryland, and Virginia, including Cecil County. Although SD1 indicated that the Delmarva Peninsula fox squirrel would be assessed, the FWS website indicates that this species is not currently known to occur in Cecil County, Maryland (FWS, 2014c). Therefore, we do not analyze it further in this document.

Swamp Pink

Swamp pink (*Helonias bullata*) is federally listed as a threatened plant species. New Jersey contains the majority of the remaining populations of the species; however, according to FWS, the species is known to occur or is believed to occur in Cecil County (FWS, 2014b). Swamp pink belongs to the lily family and is characterized by a hollow flower stem (1 to 3 feet tall), evergreen, lance shaped leaves that lay flat on the ground, and topped by a cluster of pink flowers (FWS, 2006). Swamp pink inhabits forested and scrub-shrub wetlands usually bordering meandering streamlets, headwater wetlands, and

spring seepage areas, although swamp pink is limited to perennial saturated wetlands that are not inundated by floodwater. Ideal swamp pink habitat contains mainly shaded forested areas with the water close to surface level fluctuating little during the spring and summer.

Because the swamp pink is not listed by FWS as occurring in the counties occupied by York Haven or Muddy Run projects, these projects would have no effect on the species and it is not analyzed further in this document. Although Exelon did not conduct targeted swamp pink surveys at the Conowingo Project, and no swamp pink communities were incidentally observed during any of Exelon's 2010 and 2011 field survey activities, potential habitat may occur within the Conowingo Project area in forested wetland, riparian habitat along the river and reservoir edges and Rowland Island.

3.3.4.2 Environment Effects

Shortnose and Atlantic Sturgeon

Both sturgeon species have been reported in the Chesapeake and Delaware bays, but neither species has been documented in the lower Susquehanna River or in the Conowingo tailrace, other than anecdotal reports.

Our Analysis

Neither sturgeon species has any possibility of occurring near the York Haven Project, unless they were to pass upstream through the existing fish lifts at the Conowingo, Holtwood, and Safe Harbor projects. None, however, have been recorded passing these projects since the fish lifts began volitional passage in 1997. No sturgeon, likewise, have ever been reported at the Conowingo fish lifts since they first began operations in 1972. While there is suitable habitat downstream of Conowingo for both species, there is no evidence of their occurrence in the lower Susquehanna River. Therefore, continued operation of the York Haven, Muddy Run, and Conowingo projects would not likely adversely affect the shortnose and Atlantic sturgeon.

Bog Turtle

No bog turtles are known to occur within the York Haven project area. Nevertheless, there is potential habitat in the vicinity of the proposed nature-like fishway and construction activities could affect any turtles occupying that area. As bog turtles have been confirmed within the Muddy Run Project area, recreation and maintenance activities that occur within the Muddy Run Project boundary have the potential disturb bog turtles or habitat. Interior, in its January 31, 2014, letter, states that bog turtles and habitat are present near Conowingo dam.

York Haven Power proposes to conduct bog turtle surveys at the proposed nature-like fishway site during the 2014 field season. York Haven Power would provide the results of the field studies to applicable agencies for review and adhere to any provisions contained in state or federal wetland permitting and NPDES permitting. In addition,

Interior commented that York Haven Power should contact the FWS Pennsylvania Field Office prior to any land-clearing activity.

Exelon proposes, and Interior recommends, the finalization and implementation of the Bog Turtle Management Plan for the Muddy Run Project, in consultation with FWS and Pennsylvania FBC. Both the Exelon proposed and the Interior recommended Bog Turtle Management Plan would include three components: (1) restriction of mowing in the wetland documented to support bog turtles; (2) invasive plant and woody plant control, particularly for reed canary grass; and (3) possible limits on public access to the wetland without advertising the reason.

Exelon does not propose any specific bog turtle measures at the Conowingo Project. Interior recommends[79] under section 10(j) that Exelon develop and implement a bog turtle management plan in consultation with FWS, Pennsylvania FBC, and Maryland DNR as appropriate. The bog turtle management plan would include three components: (1) restriction of mowing in the wetland documented to support bog turtles; (2) invasive plant and woody plant control, particularly for reed canary grass; and (3) possible limits on public access to the wetland without advertising the reason.

In its response to Interior's 10(j) recommendation at the Conowingo Project, Exelon indicates that no study requests were made at the Conowingo Project for bog turtle and therefore it cannot respond to Interior's statement that the bog turtle is known in the project area. Exelon indicates that if there is a known bog turtle record in the Conowingo Project area, the record information and a study request should have been provided by Interior during the relicensing study plan development process. As previously mentioned, staff has been unable to obtain the location of the bog turtle record from Maryland DNR or FWS as of the time of this document issuance.

Our Analysis

<u>York Haven Project</u>

Construction of the nature-like fishway has the potential to affect potential bog turtle individuals and habitat located on Three Mile Island; however, York Haven Power states that it would conduct bog turtle habitat assessments and surveys prior to construction to determine if bog turtles exist in this area. York Haven also proposes to

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[79] Although Interior states in its January 31, 2014, terms and prescriptions letter that bog turtles are known to exist near "the dam" and makes a 10(j) recommendation that Exelon develop and implement a bog turtle management plan, it is not clear where the bog turtle record near Conowingo dam is located. According to the April 23, 2014 and June 9, 2014, telephone and e-mail memoranda, staff have requested this location from FWS and Maryland DNR, but as of the time of the issuance of this document, has not received it.

consult with FWS and Pennsylvania FBC, and adhere to any protection or mitigation measures recommended by the agencies, such as time of year restrictions or pre-construction exclusion surveys, as part of required permits. Therefore, by following the above measure construction of the nature-like fishway at the York Haven Project may affect, but is not likely to adversely affect, the bog turtle.

Muddy Run Project

Recreational and maintenance activities that occur within the Muddy Run Project boundary could affect known bog turtles if protection measures are not implemented. Maintained trails currently traverse the habitat, increasing accessibility to the area and the potential for habitat disturbance. These recreation trails would continue to be used in the same manner under any new license for the project. Exelon's proposed Bog Turtle Management Plan includes measures to prevent the public from veering off the trails and protocols for maintaining the habitat and trails. In addition, invasive species such as reed canary grass and mowing in the bog turtle wetland during the bog turtle's most active time could decrease the habitat quality and affect the bog turtle population health. Exelon's plan would ensure that invasive species are controlled in the area and the wetland is not affected by vegetation management during the emergence and breeding season. If the Exelon-proposed and Interior-recommended Bog Turtle Management Plan is developed and implemented by Exelon, in consultation with FWS and Pennsylvania FBC, it would protect the turtle by restricting access to the area, restricting mowing, and controlling invasive species. Through implementation of the Bog Turtle Management Plan, in consultation with FWS and Pennsylvania FBC, the Muddy Run Project would be not likely to adversely affect the species.

Conowingo Project

During relicensing proceedings, Exelon determined that none of the 31 wetlands surveyed in 2008 at Conowingo Pond contained potential bog turtle habitat and neither Interior, nor Maryland DNR, nor Pennsylvania FBC requested further bog turtle studies. Although Interior, in its January 31, 2014, terms and prescriptions letter states that "[a] survey for bog turtle habitat and bog turtles has confirmed their presence near the dam," it does not provide any further details on this study or where specifically the bog turtle was found. Exelon, it its reply comments also indicates it has no information on the bog turtle wetland Interior references. According to the April 23, 2014, and June 9, 2014, telephone and e-mail memoranda, FWS stated that the bog turtle sighting was "close" to Conowingo dam. Although Interior states that bog turtles have been observed close to Conowingo dam and recommends a bog turtle management plan for the Conowingo Project, it has yet to provide evidence to indicate that bog turtles are present within the Conowingo Project boundary. Thus, staff cannot presently determine if bog turtles would be affected by the Conowingo Project. Further consultation with Interior is necessary to determine the potential for project effects and the applicability of Interior's recommended bog turtle management plan.

Indiana Bat

All three project areas are located within the range of the Indiana bat. Project maintenance, such as cutting trees over 5 inches dbh, could affect the Indiana bat by removing potential roosting habitat or causing direct mortality during roosting season.

Neither York Haven Power nor Exelon proposed any measures directly related to the Indiana bat. In addition, no resource agency or other stakeholder recommended any Indiana bat measures. In its terms and conditions letters for the three projects, Interior did not identify the Indiana bat as species of concern in any of the three project areas.

Our Analysis

Although potential habitat may exist within the three project areas, along the riparian forested edges of the river and reservoirs, and forested edges along transmission line rights-of-way and recreational areas, neither York Haven Power nor Exelon propose any activities that would result in more than a minimal amount of tree clearing. At the Muddy Run Project, continued routine vegetation management practices, such as trimming and herbicide application, would be unlikely to affect trees large enough to provide roosting habitat. Therefore, York Haven, Muddy Run, and Conowingo projects would not be likely to adversely affect the Indiana bat.

Swamp Pink

Although the swamp pink is known or is believed to occur in Cecil County, where the Conowingo Project is partly located, the FWS Information, Planning, and Conservation System website (FWS, 2014c) indicates that swamp pink has not been documented within the specific project area. Because this species does not appear to occur in the immediate project area, the Conowingo Project would have no effect on the swamp pink.

3.3.5 Recreation and Land Use Resources

3.3.5.1 Affected Environment

Regional Resources

Recreation resources in the region provide a full range of activities, including boating, canoeing, swimming, fishing, water sports, hiking, camping, hunting, biking, and nature viewing. Lakes and reservoirs in the region, including the project reservoirs, provide a variety of recreation opportunities and varying levels of developed facilities for overnight and day-use activities. Paved roads and boat launches in the area provide opportunities for motorized boat use. The varying physical characteristics of the area provide for diverse recreational opportunities.

Safe Harbor and Holtwood hydroelectric reservoirs are located downstream of York Haven and upstream of Conowingo and Muddy Run. These FERC-licensed projects provide water-oriented recreation opportunities such as fishing, boating,

swimming, and nature viewing that are similar to those offered at the projects analyzed in this document.

Susquehannock State Park is located on the eastern shore of Conowingo Pond downstream of the Muddy Run powerhouse, adjacent to the Muddy Run Project boundary and just outside the Conowingo Project boundary. The park is about 224 acres and offers recreational opportunities including scenic views from the 380-foot-high cliffs that overlook the river, picnicking, hiking/walking and horseback riding trails, and organized group overnight camping.

The lower section of the Susquehanna River Water Trail (see http://www.susquehannawatertrail.org/) extends from Harrisburg, Pennsylvania, to the Broad Creek Public Landing just below the Pennsylvania/Maryland state line (about 53 miles) and is part of the Chesapeake Bay Gateways and Watertrails Network and a designated National Recreation Trail.

Ferncliff Wildflower and Wildlife Preserve in Lancaster County is a designated National Park Service National Natural Landmark.[80] The preserve is located on the east side of Conowingo Pond across from the PBAPS and encompasses old growth forest and wooded ravines home to plants common to the region. The preserve was established in 1972 due to the exceptional old growth forest and seasonal wildflowers at this 65-acre site, which has a short (0.62-mile) hiking trail for visitors. The preserve lands are privately owned and open to the public.

The Mason-Dixon Trail is a 193-mile-long trail that connects the Appalachian Trail with the Brandywine Trail. The trail begins in Cumberland County, Pennsylvania, travels east towards the Susquehanna River where it follows the western shoreline south to Havre de Grace before heading across the river and north to its terminus at Chadds Ford, Pennsylvania. The Appalachian Trail is a 2,180-mile-long continuously marked footpath along the crests and valleys of the Appalachian mountain range from Springer Mountain, Georgia, to Katahdin, Maine. The Brandywine Trail is a 36-mile-long trail along the East Branch of Brandywine Creek and the Brandywine River in Delaware. Sections of the Mason-Dixon Trail cross Exelon-owned land.

The Conestoga Trail is a 61-mile-long trail that begins in Furnace Hills where it intersects with the Horse-Shoe Trail, before meandering throughout Lancaster County, Pennsylvania and reaching its terminus with the Mason-Dixon Trail. Near the Muddy Run Project, the trail travels near the northwestern section of the Muddy Run WMA,

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[80] The National Landmark Program is administered by the National Park Service and recognizes and supports the voluntary conservation of outstanding geological and biological sites, regardless of ownership. Land acquisition by the federal government is not a goal of the program.

before travelling across Holtwood Road, Route 372, to intersect with the Mason-Dixon Trail.

Public Recreation Sites around the Projects

York Haven Project

Recreation facilities available at the York Haven Project include boat launches, fishing platforms, a portage trail, nature trails, and day-use areas with picnic facilities, ball courts, and a catwalk fishing platform on the side of the powerhouse. Lake Frederic contains five significant islands (Battery, Beshore, Goodling, Goosehorn, and Shelley) with picnic facilities and nature trails provided and maintained by York Haven Power. Beshore Island currently only includes York Haven Power-licensed recreational lot sites and a boat launch. In addition, Lake Frederic contains several smaller islands that do not have facilities, but may be accessed by boaters. Camping and overnight use of the islands outside a recreational lot lease is prohibited. None of the publicly available recreation sites accommodate overnight use. Fishing platforms are provided in the headrace and tailrace areas. The tailrace fishing access is located on a walkway along the downstream face of the powerhouse. The land immediately adjacent to the York Haven Project powerhouse provides a playground and picnic facilities as well as tennis and basketball courts and ample parking. A 0.25-mile portage trail is provided on the right bank at this location.

There are five boat launches within the project boundary owned and operated by York Haven Power or public entities: Newberry Township Boat Launch, Beshore Island Boat Launch, Goldsboro Borough Boat Launch, Pennsylvania FBC Boat Launch, and the East Shore Boat Launch (figure 3-18). Additionally, the Falmouth Boat Launch, owned and operated by Pennsylvania FBC, is located on the eastern shore of the Susquehanna River, downstream of the dam and across the river from the powerhouse. Although this boat launch is located outside of the project boundary, it often is used to gain access to the project spillway and tailrace. Three privately owned marinas and boat launches are also present along the shoreline of Lake Frederic. Fuel is available at Goldsboro Marina, Tri County Boat Club, and the Riverside Marina. Table 3-30 summarizes the recreation sites at the York Haven Project.

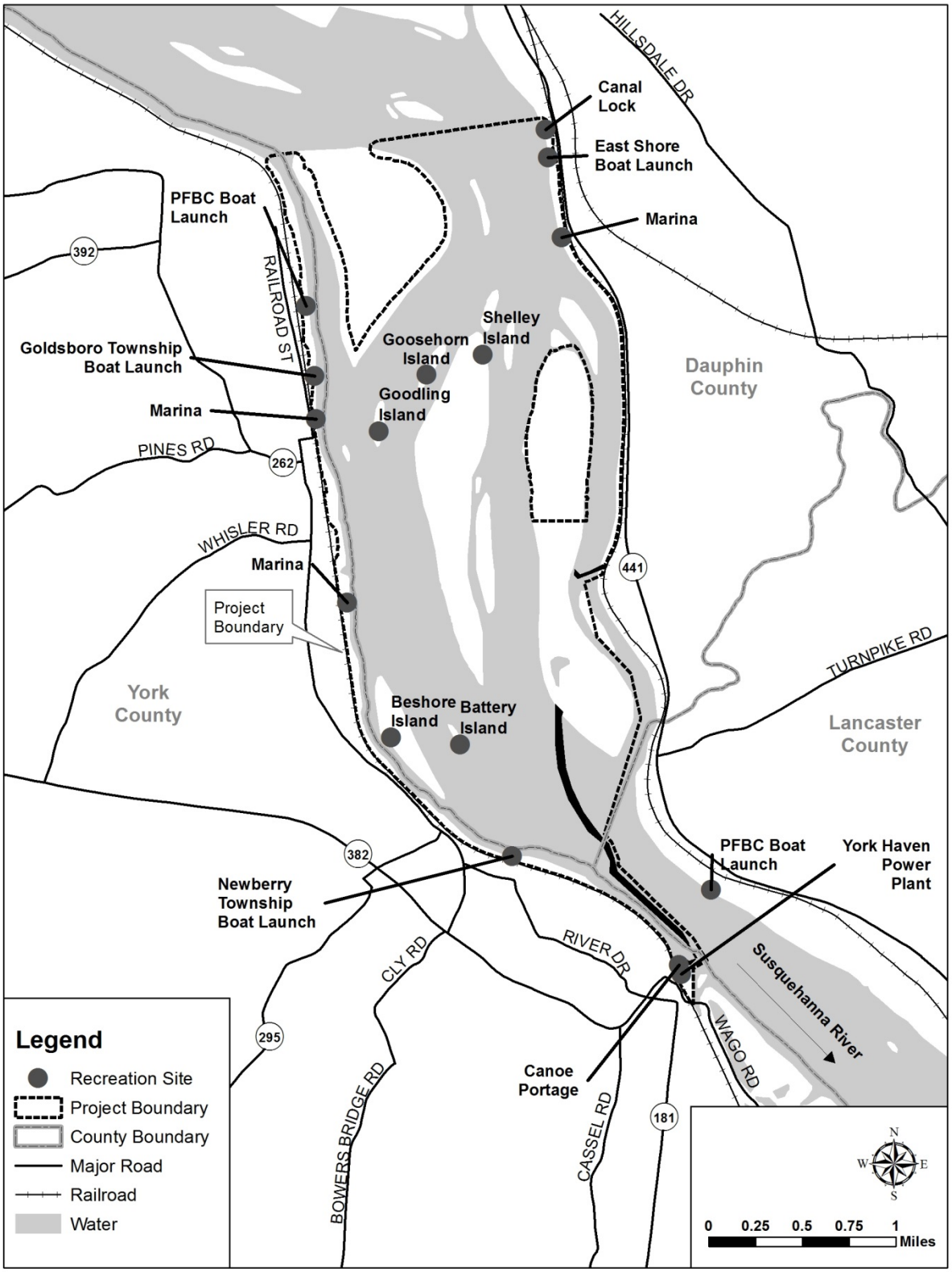

Figure 3-18. York Haven Project recreation facilities (Source: York Haven Power, 2012, as modified by Staff).

Table 3-30. Recreation sites at the York Haven Project (Source: York Haven Power, 2012, as modified by Staff).

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use[a]
(Historic) Canal Lock	York Haven Power	Yes	Abandoned canal lock, picnic area	596
East Shore Boat Launch	York Haven Power	Yes	Boat launch, trail, picnic area	1,580
Goosehorn Island Picnic Area	York Haven Power	Yes	Picnic area	3,908
Shelley Island Recreation Area	York Haven Power	Yes	Recreational lots, picnic area, interpretive display, nature trail, historic cemetery	123
Goodling Island	York Haven Power	Yes	Picnic Area	740
Pennsylvania FBC Boat Launch	Pennsylvania FBC	No	Boat launch	6,903
Goldsboro Borough Boat Launch	Goldsboro Borough	No	Boat launch	235
Beshore Island Recreation Area	York Haven Power	Yes	Recreational lot sites	not applicable
Battery Island Recreation Area	York Haven Power	Yes	Picnic area	1,292
Newberry Township Boat Launch (Falls Landing)	Newberry Township	No	Boat launch	1,006
Cly Shore	York Haven Power	Yes	Recreational lot sites	not applicable
York Haven Power Plant Recreation Area	York Haven Power	Yes	Visitor's center, fishing pier, tailwater fishing, playground, picnic area, sport court	944
Canoe Portage Trail	York Haven Power	Yes	Canoe portage	28

[a] Estimated from spot counts conducted over 32 days throughout the year; estimate presented is the highest recorded number of visitors to each site observed during all visits to each site.

Muddy Run Project

At the Muddy Run Project, existing formal recreation opportunities include the Muddy Run Park and Campground, Wissler's Run Park, and Muddy Run WMA (figure 3-19). Exelon owns all of the lands used for recreation at the Muddy Run Project, and leases the operation of Muddy Run Park and Campground and the Muddy Run WMA to other parties. Exelon reports two informal recreation areas exist within the Muddy Run Project boundary. These are areas without developed recreation infrastructure and are not managed or maintained as such by any entity. The sites provide fishing access or informal boat launch access to the project.

The 800-acre Muddy Run Park and Campground is located in the northern section of the project boundary. Within the park is the 100-acre Recreation Lake, separated from the Muddy Run reservoir by a dam and concrete sill that maintains a stable water elevation. The park is operated by a vendor, and the developed portion of the park includes overnight and day-use facilities. A 189-site campground with showers, playgrounds, covered picnic pavilions, and many other amenities is located on the northern shore of the Recreation Lake. The park also provides numerous separate facilities including picnic areas, trails, an outdoor amphitheater, ball field, sport courts, restrooms, wildlife viewing areas, and shoreline fishing opportunities. Boat rentals (canoes, kayaks, paddleboats, rowboats) are available at the park, as well as a boat ramp for visitors to launch their own boats. Gasoline-powered boats, swimming, and wading are not allowed in the Recreation Lake. A visitor's information center contains displays (static and interactive) and meeting rooms. The center also is used for park-related programs and rental functions. Table 3-31 summarizes the recreation facilities associated with the Muddy Run Project.

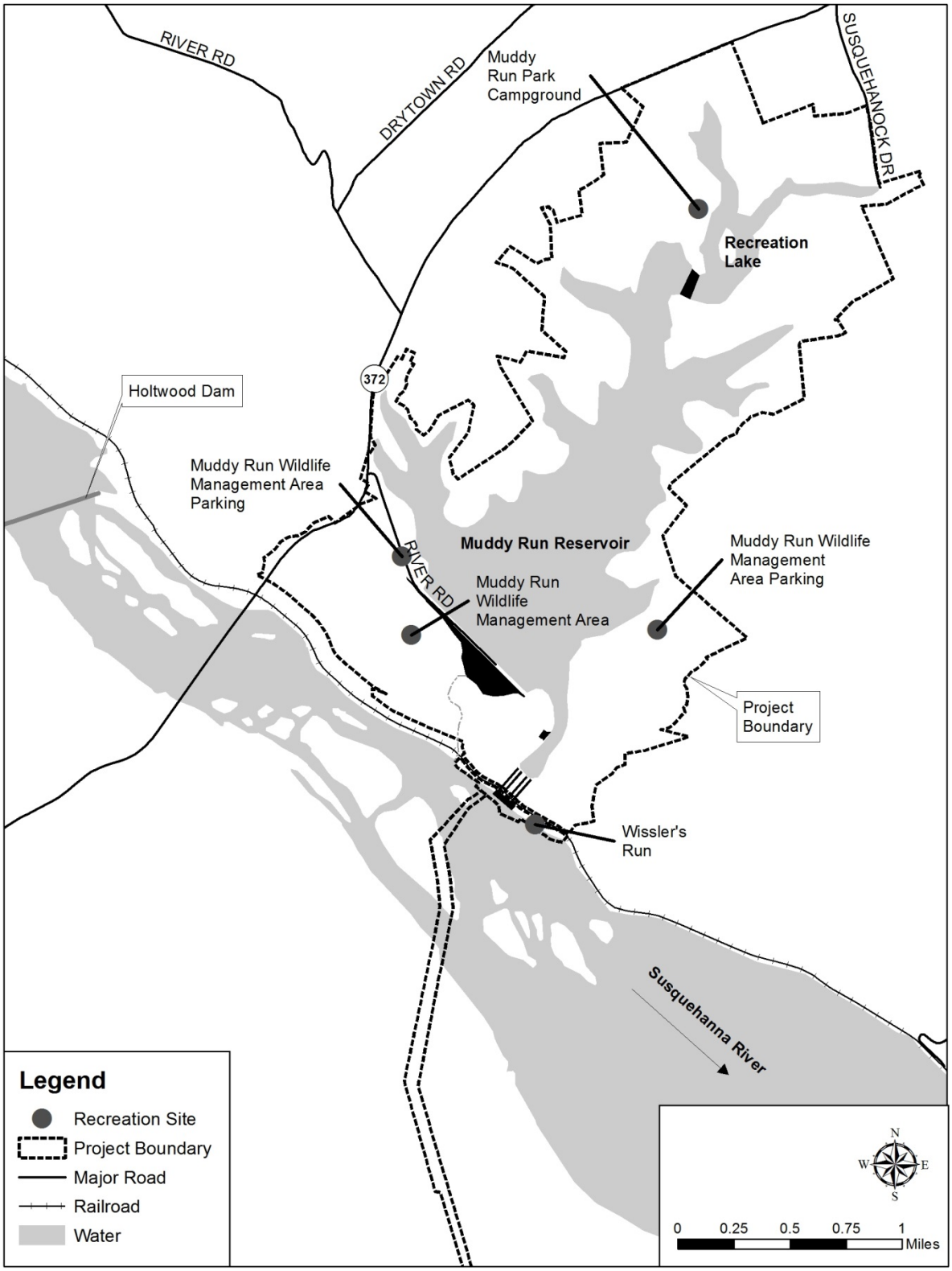

Figure 3-19. Muddy Run Project recreation facilities (Source: Exelon, 2012a, as modified by Staff).

Table 3-31. Recreation facilities in the Muddy Run Project area (Source: Exelon, 2012a, as modified by Staff).

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use
Muddy Run Park and Campground	Exelon (leased to vendor)	Yes	Camping, picnicking, fishing, boating (electric motor only), playgrounds, sports fields and courts, etc.	254,000[a]
Wissler's Run	Exelon	Yes	Fishing, picnicking, wildlife/nature viewing	5,800b
Muddy Run WMA	Exelon (leased to Pennsylvania Game Commission)	Yes	Hunting, wildlife viewing, hiking and horseback riding	7,500b

[a] Estimated from a combination of data supplied by facility operator, traffic counts, and spot counts over 12 months.

[b] Estimated from spot counts recorded 6 days a month for 12 months.

Wissler's Run is located on the eastern shore of Conowingo Pond just downstream of the Muddy Run powerhouse. The park provides a large green open space area for picnicking, bank fishing, and an overlook of the upper Conowingo Pond and islands. The site also includes a non-functioning fish cleaning station. A paved 130-space parking lot services the site. The Muddy Run WMA surrounds the southern portion of the Muddy Run reservoir. The 800-acre site is leased to Pennsylvania FBC and managed to provide food and cover for wildlife, which in turn promotes hunting and wildlife viewing opportunities. Two gravel parking areas provide vehicle access to the WMA while additional management roads and trails provide access for hunters, hikers, birders, and equestrians.

Within the Muddy Run Project, the Mason-Dixon Trail crosses the transmission parcels located in York County, and travels near several recreation sites in the Conowingo Project. Exelon entered into a license agreement with the Mason-Dixon Trail System, Inc., allowing sections of the trail to be located on Muddy Run Project land.

Conowingo Project

The Conowingo Project is the most downstream of the FERC projects on the Susquehanna River and offers a large component of recreation opportunities in the lower Susquehanna River. There are 15 project recreation public access areas (see figure 3-20). Table 3-32 summarizes the public recreation facilities associated with the Conowingo Project. Exelon also identifies numerous informal access points around the reservoir and downstream of the dam.

Lock 13 is located at the site of the Susquehanna and Tidewater Canal Lock 13. The facility is maintained in a primitive state with no public amenities or interpretive improvements. Lock 13 is owned and managed by Exelon, but is accessed from the PPL Holtwood LLC Lock 12 parking lot (Holtwood Project, FERC No. 1881) via the Mason-Dixon Trail. Recreation opportunities at Lock 13 include the Mason-Dixon trail and shoreline fishing.

Lock 15 is owned and operated by Exelon as a day-use and interpretive area. The site has a 36-space gravel parking lot and portable restrooms, and offers picnicking and shoreline fishing opportunities. There are interpretive signs on-site that describe the Susquehanna and Tidewater Canal system, how the lock worked, and the history of the site. A pathway connects the picnic area with the Muddy Creek Boat Launch immediately downstream. The Mason-Dixon Trail runs through the site and connects Lock 15 with Lock 13 to the north and Muddy Creek Boat Launch to the south.

Muddy Creek Boat Launch is owned by Exelon and leased and operated by Pennsylvania FBC. The facility provides shoreline fishing access, a 20-foot-wide hard surface ramp, courtesy docks, and portable toilets. The site is serviced by a paved parking lot (44 boat trailer spaces and 26 vehicle spaces) and used by both power boaters and car-top boaters. The Mason-Dixon Trail connects the site to the Lock 15 interpretive area.

Cold Cabin Boat Launch is owned by Exelon and managed by Peach Bottom Township, which developed the recreation facilities. Amenities include a 12-foot-wide hard surface boat launch, informal parking for approximately five vehicles, and a small picnic area. The Mason-Dixon Trail passes through this site.

Dorsey Park Boat Launch is located just upstream of PBAPS. Although the majority of the site is located outside of the project boundary, the boat ramps extend into and provide access to project waters. The site, which is owned and operated by Exelon, includes boat launching, shoreline fishing, and picnicking opportunities with several tables and grills. Amenities include two 32-foot-wide boat ramps, courtesy docks, a paved parking lot (25 boat trailer spaces and 30 vehicle spaces), portable toilets, picnic tables, and grills.

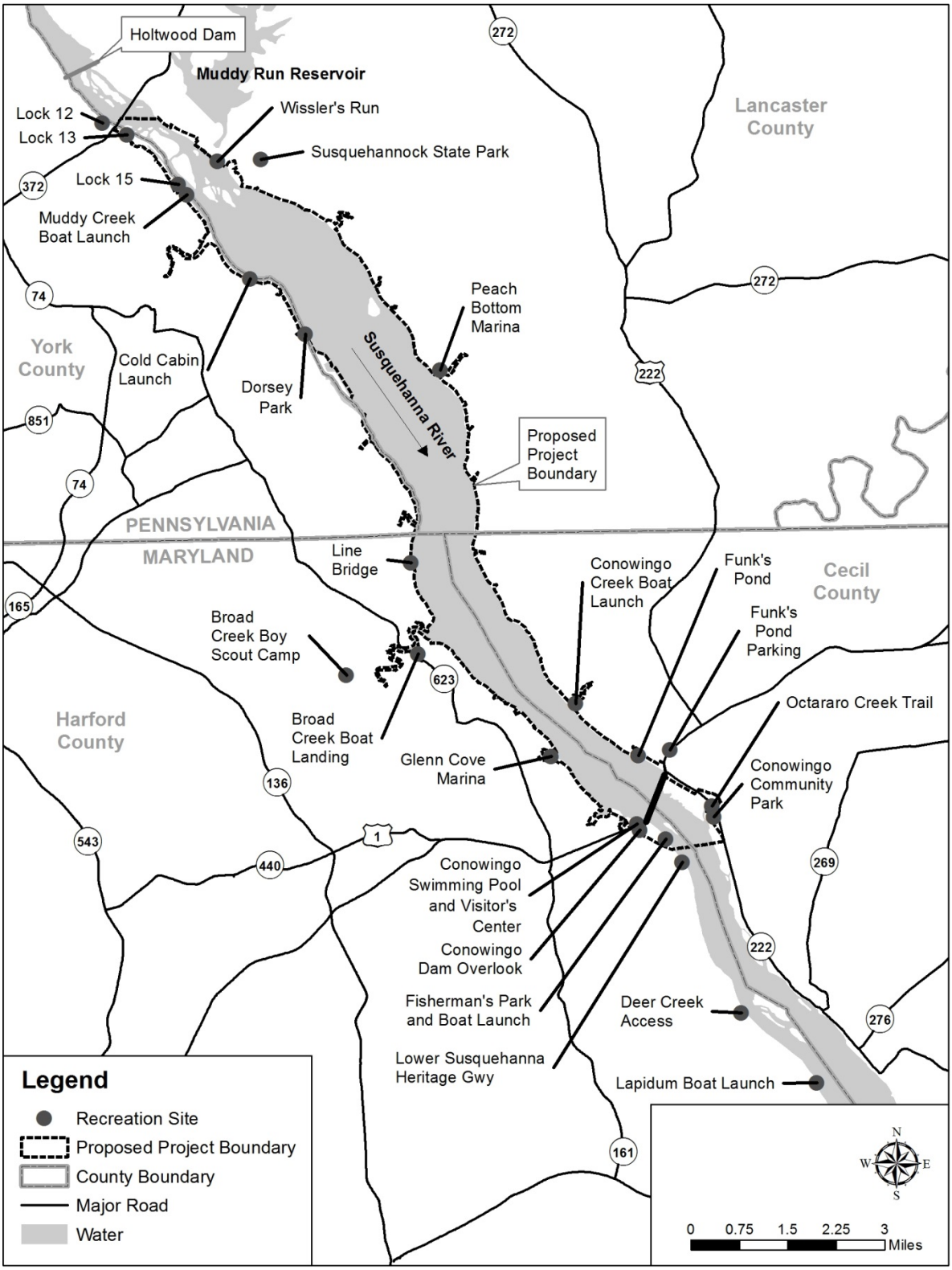

Figure 3-20. Conowingo Project recreation facilities (Source: Exelon, 2012b, as modified by Staff).

Table 3-32. Recreation facilities in the existing Conowingo Project boundary (Source: Exelon, 2012b, as modified by Staff).

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use[a]
Lock 13	Exelon	Yes	Unrestored site with no public amenities or interpretive improvements	782
Lock 15	Exelon	Yes	Interpretive displays, picnic tables, bank fishing	13,066
Muddy Creek Boat Launch	Exelon (leased to Pennsylvania FBC)	Yes	Boat ramp, courtesy docks, and interpretive panels	38,742
Cold Cabin Boat Launch	Exelon (leased to Peach Bottom Township)	Yes	Boat ramp, picnic tables, and interpretive sign	11,968
Dorsey Park	Exelon (as part of Peach Bottom Nuclear Station)	Yes	Boat ramp, picnic tables, grills, benches, and interpretive signs	16,706
Peach Bottom Marina	Exelon (operated by commercial operator)	Yes	Boat ramp, docks, fuel, and boat maintenance	538
Line Bridge	Exelon (leased to Harford County)	Yes	Informal shoreline access; hand launch	5,789
Broad Creek Public Landing	Exelon (leased to Harford County, Maryland)	Yes	Boat ramp and courtesy dock, small open space for day use	10,138
Conowingo Creek Boat Launch	Exelon	Yes	Boat ramp, courtesy dock	10,594

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use[a]
Glen Cove Marina	Exelon (operated by commercial operator)	Yes	Boat ramp, docks, picnic area, fuel, repair services, store and boat slips. Also serves as the take out for the Conowingo dam portage.	707
Funk's Pond	Exelon	Yes	Shoreline fishing, picnic area, and pedestrian trail	4,380
Conowingo Swimming Pool and Visitors Center	Exelon (operated by commercial operator)	Yes	Swimming pools, picnic tables, restrooms, playground, and visitor center	8,471
Conowingo Dam Overlook	Exelon	Yes	Picnic tables and view of the powerhouse and dam	closed during study period
Fisherman's Park/Shures Landing	Exelon	Yes	Shoreline and platform fishing, carry-in boat launch, observation areas, picnic areas	141,580
Octoraro Creek Access	Exelon	Yes	Creekside trail connecting to Susquehanna River, informational kiosk	7,485

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use[a]
3.5 miles of Mason-Dixon Trail	Exelon (managed and maintained by Mason-Dixon Trail System, Inc.)	No	Trail passes through Lock 13, Lock 15, Muddy Creek, Cold Cabin, Broad Creek, Glen Cove, Swimming Pool/Visitors Center, and Fisherman's Park)	No estimate available
Lower Susquehanna Heritage Greenway Trail	Exelon (leased to State of Maryland)	No	Paved trail from Fisherman's Park to Deer Creek, collocated with Mason Dixon Trail, benches, tables, interpretive displays, and boardwalk	No estimate available
Susquehanna State Park	Exelon (leased to State of Maryland)	No	Camping, picnicking, shoreline fishing, walking trails, boat ramps, playgrounds, bike and equestrian riding trails, hunting area and an archery range	No estimate available
Deer Creek Access	Part of Susquehanna State Park	No	Informal car top boat launch, parking and shoreline access	No estimate available

Site Name	Owner	Project Facility	Facilities and Opportunities	Annual Estimated Use[a]
Lapidum Boat Launch	Part of Susquehanna State Park	No	Boat ramp, parking, restrooms, interpretive displays	No estimate available
McLhinney Park	Exelon (leased to City of Havre de Grace)	No	Playground, picnic area, restrooms, green space and non-motorized trails	No estimate available

[a] Estimated from one or a combination of methods depending on the type of site and could include spot counts, traffic counters, or facility operator records recorded over 12 months.

Peach Bottom Marina is owned by Exelon and operated by a commercial contractor. The marina offers boat launching, shoreline fishing, and picnicking opportunities. The facility amenities include a 25-foot-wide boat hard surface ramp, a paved parking area (17 boat trailer spaces and 33 vehicle spaces), boater courtesy docks, tie-up rental space, boat storage, repair shop, portable toilet, fueling facilities, and picnic tables. There is a launch fee charged to use the ramp. The marina is located on Peters Creek, a tributary on the east side of Conowingo Pond. The Norfolk Southern rail line extends along the entire east shore of the pond and access to/from the marina requires boating under the train trestle spanning Peters Creek.

The Line Bridge Access site is owned by Exelon and managed and maintained by Harford County under an agreement with Exelon. The property provides informal shoreline access, a three car parking area, and an unimproved carry-in boat access area.

The Broad Creek Public Landing is owned by Exelon and managed and maintained by Harford County under agreement with Exelon. The facility provides a hard surface boat launch, small dock, shoreline fishing opportunities, and parking for four vehicles. A 33-space boat trailer off-site parking lot was constructed on nearby Paddrick Road due to the steep terrain and limited parking available at the boat launch site. The Mason-Dixon Trail extends through this site.

The Conowingo Creek boat launch is owned and operated by Exelon. The facility provides an 80-foot-wide hard surface boat ramp, two parking areas (one for 9 boat trailers and one for 10 vehicles), a small picnic area and shoreline fishing opportunities. The site is located on Conowingo Creek, a tributary on the east side of Conowingo Pond. The Norfolk Southern rail line extends along the entire east shore of the pond and access to/from the ramp requires passing under the train trestle spanning Conowingo Creek.

Glen Cove Marina is owned by Exelon and operated by a commercial contractor. Recreation opportunities include boat launching and picnicking. Facility amenities include a hard surface boat ramp, boat slips, portable toilets, fueling facilities, picnic tables, and parking for 16 boat trailers and 20 vehicles. There is a launch fee charged to use the ramp. The operator also provides repair services and a small onsite store. This facility also serves as the take-out for the Conowingo dam canoe portage. The Mason-Dixon Trail runs through the site.

Funk's Pond is a small inlet separated from Conowingo Pond by the Norfolk Southern rail line. The "pond" is within the project boundary and accessed from a 24-vehicle parking lot and trail on adjacent non-project land. The site is owned and operated by Exelon. The site provides a non-motorized, 0.45-mile trail, picnicking and shoreline fishing opportunities.

The Conowingo swimming pool complex and Visitor's Center are located just upstream of Conowingo dam on U.S. Route 1. The Conowingo swimming pool complex is owned by Exelon and operated by a commercial contractor. Pool facilities include a swimming pool, wading pool, playground area, picnic area, concession stand, and changing/restrooms. The pool is open 11:00 a.m. to 7:00 p.m. from May to September, and users are charged an entrance fee. The Visitor's Center contains informational displays and brochures, restrooms, conference rooms, and office space for the Lower Susquehanna Heritage Greenway. The center is owned, operated, and staffed by Exelon. A small picnic area is also provided. A 213-space paved parking lot is shared by these two facilities. The Mason-Dixon Trail extends through the site.

Fisherman's Park is located on the western shore of the Susquehanna River immediately downstream of Conowingo dam and powerhouse. Fisherman's Park is owned and operated by Exelon and is a popular fishing and bird watching area. Amenities at the park include shoreline and platform fishing, a carry-in boat launch (Shure's Landing), observation areas, portable toilets, picnic areas, and scenic views. This area also serves as a trailhead for the Lower Susquehanna Heritage Greenway Trail to Deer Creek and a wildflower viewing area. There is a 124-space paved vehicle parking lot, a 14-space paved boat trailer parking lot, and a 12-vehicle gravel parking lot associated with this site. The fishing platform is ADA-compliant. The Mason-Dixon Trail passes through the lower part of the parking lot. The park is open 1 hour before sunrise to 1 hour after sunset.

Exelon investigated tributary access to the main reservoir between full pond (109.2 feet) and the minimum weekend recreation pool level (107.2 feet) between Memorial Day and Labor Day. Exelon reported that five tributaries provide recreational value; four due to the presence of public boat launch facilities, all of which are also commercial marinas (Peters Creek/Peach Bottom Marina, Conowingo Creek, Glen Cove, and Broad Creek). The fifth tributary, Muddy Creek, provides recreation value due to its large size.

Shallow water depths due to sediment accumulation limit boat launch egress and ingress at Peters Creek (Peach Bottom Marina), Conowingo Creek, and Broad Creek. The minimum recreation pool elevation is 107.2 feet. During a field reconnaissance of navigability conducted in August 2012 when the pool elevation ranged between 107.32 to 107.64 feet, Exelon documented that the boat launch and areas immediately surrounding the ramp at Broad Creek were not usable for motorized boats due to the shallow water and dense vegetation. Water depths leading to the boat launch were generally 2 feet with areas near the launch being less than 1 foot. At Conowingo Creek, water depths in the main channel were 4.5 feet and 2 feet in the vicinity of the boat launch. At Peters Creek, water depths were 4 to 5 feet in the main channel and zero at mud flats exposed at the time of the survey.

Exelon concluded that pond elevations do influence boat access at three of the four tributary boat launches. At full pond, boats higher than 5.2 feet above the water cannot navigate under the railroad bridge at Peters Creek. Similarly, boats higher than 4.9 feet cannot navigate under the railroad bridge at Conowingo Creek. Conversely, the minimum weekend recreation season elevation is too shallow to launch a boat limiting access from three tributary launches: Peters Creek, Conowingo Creek, and Broad Creek ramps. In addition, dense beds of SAV hamper the approach for boaters attempting to use these ramps at elevations of 107.2 feet or less. When Conowingo Pond elevation reaches 105.9 feet, boat access is denied at three of the four tributary boat launches.

Recreation in the River Downstream

York Haven Project

Pennsylvania FBC owns and operates the Falmouth Boat Launch located across from the York Haven powerhouse on the east shore of the Susquehanna River. The launch is outside the project boundary but provides water access, albeit shallow, to the bypassed reach, project spillway, and tailrace areas, as well as points further downstream within the Safe Harbor reservoir.

Conowingo Project

The Conowingo Project boundary extends 2.5 miles downstream of the dam along the east bank of the river and 0.5 mile downstream along the west bank of the river. In addition to Fisherman's Park/Shures Landing, access to the river below the dam within the project boundary is provided at the Octoraro Creek Access on the east bank and Susquehanna State Park on the west bank. Land based, non-project recreation exists further downstream along the Lower Susquehanna Heritage Greenway, which provides trails and informal access points to the river. Access to the Susquehanna River also is available at non-project public launch and commercial marinas downstream of Conowingo dam. Public access is provided at Deer Creek Access about 3 miles downstream of the dam, Lapidum boat launch, within Susquehanna State Park, about 5 miles downstream of the dam, in Port Deposit, Maryland, across the river from

Lapidum boat launch, and McLhinney Park (or North Park) in Havre de Grace, which provides shoreline fishing and other predominantly passive recreational opportunities.

Recreation Use

York Haven Project

York Haven Power estimates that the York Haven Project supported more than 17,000 recreation days[81] during the 2008-2009 sampling season. The greatest use occurs during weekends during the late May through early September, peak season. The Goldsboro Borough Boat Launch was the most visited recreation site (see table 3-30). York Haven Power reports that an overwhelming majority of visitors to recreation facilities at the project are from Pennsylvania (99 percent), with many of those from the local, southeastern region of Pennsylvania, including the Harrisburg, Lancaster, and York areas. York Haven Power notes that peak weekend use approaches or exceeds capacity when the weather is favorable; however, the sites are capable of absorbing a great deal more use if visitors were to shift their use patterns and use the project sites more frequently or in greater numbers outside the peak weekends.

During the 2008-2009 recreation study, York Haven Power estimated the physical utilization for each recreation site. Table 3-33 shows the parking site utilization rates observed during the recreation study. Typically, use of the parking areas is well below the capacity; however, both Goldsboro Borough Boat Launch and East Shore Boat Launch were observed at or near capacity on holiday weekends. In general, all sites were observed well below capacity throughout the peak season.

[81] A recreation day is considered each visit by a person to a development for recreational purposes during any portion of a 24- hour period.

Table 3-33. Physical capacity utilization of York Haven Project recreation sites (Source: York Haven Power, 2012, as modified by Staff).

Site Name	Number of Parking Spaces	Highest Number of Spaces Used on Summer Weekend	Average Percent Utilization	Maximum Percent Utilization
Pennsylvania FBC Goldsboro Boat Launch	242[a]	209	23	86
East Shore Boat Launch	57	57	31	100
York Haven Power Plant Recreation Area	31	6	3	19

[a] Covering three parking areas.

Muddy Run Project

Exelon estimates that the Muddy Run Project supported slightly more than 267,000 recreation days during 2008-2009, with 95 percent occurring within the Muddy Run Park and Campground (see table 3-31). Exelon reports the majority of visitation occurs during summer (late May to late August) and that an estimated 21 percent of the recreation days spent at the park were coupled with overnight stays (camping). Swimming and wading are not permitted at any location within the park, and this limitation was cited most frequently in the Exelon visitor survey (27 percent). Activities in the WMA vary by season with hunting popular in the fall and winter, and running and walking popular in the summer. Wissler's Run Park saw the greatest usage during the spring season (52 percent), followed by summer (35 percent). Sightseeing is the most popular activity (71 percent), followed by shoreline fishing (21 percent).

During its 2008-2009 recreation study, Exelon estimated the physical utilization for each recreation site. Table 3-34 shows the utilization rates observed during the recreation study by recreation site.

Table 3-34. Physical capacity utilization of Muddy Run Project recreation sites (Source: Exelon, 2012b, as modified by Staff).

Site Name	Number of Parking Spaces	Average Spaces Used on Summer Weekend	Percent Utilization
Muddy Run Park & Campground	582	338	58
Muddy Run WMA	80	3	4
Wissler's Run Park	130	3	2

Conowingo Project

Exelon estimates that the Conowingo Project supported just under 271,000 recreation days in 2008-2009, with about half of those recorded at Fisherman's Park/Shures Landing immediately downstream of the dam (see table 3-32). The vast majority of recreation days were recorded during the summer season. Within the Conowingo Project, the top three recreation activities were sightseeing (29 percent of total use), shoreline fishing (22 percent), and boating (21 percent). These three activities accounted for more than 7 out of every 10 visitors to the project in 2008-2009.

Exelon conducted a user preference survey that revealed recreation sites within the Conowingo Project were well regarded as a whole. Fisherman's Park received positive scores with 9 of 10 respondents giving the park a good or excellent rating. The most frequently requested specific improvements throughout the Conowingo Project were restrooms, boat ramps, parking, and trash cans/clean-up of site. Highest on the list for Fisherman's Park was the desire to reopen the catwalk on the downstream side of the powerhouse for fishing.

During the recreation study, Exelon also estimated the physical capacity utilization for each recreation site. Table 3-35 shows utilization rates observed during 2008-2009 by recreation site. As the table indicates, many of the sites are used well below the site capacity, with the exception of Cold Cabin Boat Launch and Line Bridge, both of which offer only a small number of parking spaces.

Table 3-35. Physical capacity utilization of Conowingo Project recreation sites (Source: Exelon, 2012b, as modified by Staff).

Site Name	Number of Parking Spaces	Average Spaces Used on Summer Weekend	Percent Utilization
Lock 13	22	1	5
Lock 15	36	1	3
Muddy Creek Boat Launch	69	31	45
Cold Cabin Boat Launch	5	5	100
Dorsey Park	57	6	11
Line Bridge	3	3	100
Broad Creek Public Landing	41	4	12
Glen Cove Marina	47	22	47
Conowingo Swimming Pool and Visitors Center	213	80	38
Peach Bottom Marina	48	7	15
Conowingo Creek Boat Launch	19	3	16
Funk's Pond	24	2	8
Fisherman's Park/Shures Landing	124	34	27
Octoraro Creek Access	12	2	17

Land Use

Land use in the Susquehanna River Basin is primarily forest (70 percent), farmland (22 percent), and urban areas (7 percent). All three projects are located within the Lower Susquehanna Subbasin, which exhibits similar land use patterns to the overall basin. Harrisburg, the capital of Pennsylvania, is about 17 miles upstream of the York Haven Project. Most of the population is centered in the urban areas of Harrisburg, York, and Lancaster, all within an hour drive from at least one of the projects. The larger cities of Baltimore, Wilmington, and Philadelphia are generally within a 2-hour drive of some portion of project waters.

Below the Conowingo Project, the Susquehanna River flows about 10 miles to the head of the Chesapeake Bay at Havre De Grace, Maryland. Counties in the project areas include Dauphin, York, and Lancaster in Pennsylvania and Harford and Cecil in Maryland.

York Haven Project

The York Haven Project includes about 3,220 acres, of which York Haven Power has acquired fee title and flowage rights to land within the project boundary, and claims by easement to all other near shore lands adjoining Lake Frederic. All of the islands within the impoundment are within the project boundary except for the portion of Hill Island located above the 282.5-foot contour, and the northern portion of Three Mile Island, where Exelon's Three Mile Island nuclear facility is located. The Three Mile Island nuclear facility has a 2,000-foot exclusion zone from the two nuclear reactors on the site that encompasses a small slice of shoreline on Shelley Island. The lands within the exclusion zone on Shelley Island are considered non-project lands located in the project boundary. The impoundment is about 3.5-miles-long with approximately 29 miles of shoreline. The York Haven Project boundary extends about 3.5 miles from the top of the impoundment to the downstream face of the dam and powerhouse. There are no lands of the United States within the project boundary.

York Haven Power leases 288 recreational lots at Cly Shore, Shelley Island, and Beshore Island. Sites are available to the public for a small fee. Current York Haven Power policy does not provide for new permitted recreational lots within the project boundary. In addition, permits for existing recreational lots that are abandoned or where existing structures become damaged and are not replaced by structures conforming to all applicable federal, state, and local regulations would be terminated.

York Haven Power lease conditions and rules require lot residents to comply with applicable federal, state, and local laws, including requirements related to potable water, sanitation, sewage facilities, waste disposal, and dock placement and use. Lease holders are not allowed to cut trees without York Haven's permission nor plant any non-indigenous or invasive plants on the islands. York Haven Power conducted an assessment of the sewage disposal systems by recreational lots on Shelley and Beshore Islands and five parcels near Cly Shore. York Haven Power reported that almost every

site had water service through a well or withdrawal from the Susquehanna River and every site appeared to have sewage disposal means, either through an outhouse, septic tank, or a drain line that went underground.

The Pennsylvania Sewage Facilities Act and regulations adopted under that statute, including the Londonderry Township On-Lot Disposal Systems ordinance, cover sewage waste at leased recreational lots. The York Haven Power lot lease states that lot lessees are responsible for completing any sewage system upgrades or replacements required to comply with these statutes and ordinances.

In 2010, after a sewerage assessment on the islands, York Haven Power prohibited the use of water withdrawn from wells or the river for any potable purposes (drinking, cooking, showering, dishwashing, oral hygiene, etc.). Lot lease holders are expected to provide their own supplies of bottled water for potable purposes. York Haven Power further noted that the Pennsylvania Sewage Facilities Act required ordinances related to sewage facilities are adopted at the local level and that new language in the local ordinance (2012) would force upgrades or replacements at the majority of leased lots. York Haven Power lease agreements make it clear this is the responsibility of the lease holder.

Muddy Run Project

The Muddy Run Project lands include the 900-acre power reservoir and the 100-acre Recreation Lake in Lancaster County, and the transmission line corridor that spans the Susquehanna River and extends into York County. In total, the project consists of about 2,790 acres, 1,790 of which are upland consisting primarily of agricultural fields and forested land. The Muddy Run project boundary is irregularly shaped around the upper reservoir, parallels the Susquehanna River in the areas of Wissler's Run and the powerhouse and then extends east, and continues to parallel the river for another roughly 5,000 feet. The project boundary extends west across the Susquehanna River encompassing the transmission lines for about 4.5 miles to PBAPS.

Exelon has classified land use throughout the project based on its primary use. Existing classifications include:

- Project Operation (425 acres) – Lands used for power generation and electric transmission/distribution infrastructure and purposes;
- Developed Recreation (667 acres) – Lands managed for developed public recreation facilities and activities. This includes commercial recreation facilities.
- Public Access Lands (701 acres) – Lands generally open to the public but that are managed by a federal, state, county, or conservation entity.

Exelon has an SMP for the Muddy Run Project to manage shoreline resources through the following programs and policies: shoreline erosion control; general maintenance; woody debris management; game species management; sensitive natural

resource projection overlays and policies; leased premises policy; and a policy restricting certain recreational uses. No lands of the United States are within the project boundary.

Conowingo Project

The Conowingo Project is located in Pennsylvania and Maryland. The northern 8 miles lie within Lancaster and York counties, Pennsylvania, while Conowingo dam and the southern 5 miles within the project boundary are within Cecil and Harford counties, Maryland. The Conowingo Project boundary extends approximately 14 miles upstream from Conowingo dam to the lower end of the Holtwood Project tailrace. The project boundary crosses the river just below Holtwood Road (Route 372) at the Norman Wood Bridge on the western shoreline, to approximately 0.5-mile south of the bridge on the eastern shoreline. The project boundary extends 2.5 miles downstream of Conowingo dam along the west bank of the river and 0.5 mile downstream along the east bank of the river. No lands of the United States are within the project boundary.

The Conowingo Project encompasses 11,721 acres: 9,951 acres of flowed land and 1,770 acres above the normal high water elevation. The land in and around the project boundary is mostly rural, consisting primarily of agriculture fields and forested lands.

Exelon leases more than 420 lots on project lands for seasonal residential cottage use. The leases stipulate that the cottages must remain shuttered from November through March 1. In addition to complying with all environmental regulations, zoning standards, and building codes, the cottage leases include a uniform set of standards that address the size, materials, and floatation materials used in dock construction as well as erosion control, vegetation removal, wastewater disposal, shoreline development, and cultural resource protection. Residents cannot dig wells, install septic systems, or expand homes without permission from the county and Exelon. It is Exelon's current policy not to create any new cottage lease lots within the project boundary and that any leases for existing cottages that are abandoned or become damaged and are not replaced by structures conforming to all applicable regulations will be terminated. All structures and improvements will be removed from the leased lot, the land will be restored to a natural condition, and the site will be precluded from future cottage leases.

3.3.5.2 Environmental Effects

Recreation Management

York Haven Project

York Haven Power proposes to maintain the existing public recreation facilities at the York Haven Power Plant Recreation Area (including the canoe portage trail), Battery Island Picnic Area, Goodling Island Picnic Area, Shelley Island Recreation Area, Goosehorn Island Picnic Area, and the East Shore Boat Launch and Canal Lock to ensure continued public use and enjoyment of project lands and waters through a future license.

York Haven Power does not propose any improvements to these project recreation sites. York Haven Power also does not propose a recreation management plan; however, it proposes to consult with the Pennsylvania DEP, Pennsylvania DCNR, SRBC, and Pennsylvania FBC to consider the recreation resources and management strategies at the York Haven Project 10 years after the effective date of a future license. The review would take into consideration the recreation facilities, use levels, and operation and maintenance of both York Haven Power project facilities, as well as private and commercial facilities at the project. York Haven Power suggests it would conduct a recreation study if such information would be helpful in the consultation process.

The adequacy and condition of existing recreation facilities and access at the York Haven Project, including the ease of portaging and the potential for additional recreation facilities, was raised as a concern during project scoping. Specifically, Pennsylvania FBC recommended improvements to non-motorized watercraft portages at the project so that boaters would not have to notify York Haven Power in advance for assistance.

Our Analysis

York Haven proposes a number of operational and maintenance activities related to recreation, such as allowing anglers to fish the project's catwalk, maintaining public boat access areas, consulting on the recreation resources 10 years after license issuance, and complying with FERC Form 80 reporting requirements. York Haven Power does not, however, include a plan for implementing these measures or investigating whether or not the sites are meeting the demand over the course of a license. Developing a formal recreation management plan would provide a more cohesive guide for the protection, mitigation, and enhancement of these resources. Effective recreation management plans ensure that the project adequately provides for the recreation needs of the area. An effective plan would include procedures to consult with the Pennsylvania FBC, Pennsylvania DNR, and Pennsylvania Game Commission over the course of any license. Comprehensive recreation management plans would include summaries of the facilities and uses, current and future visitation estimates, and formal monitoring plans every 10 years as proposed by York Haven Power to ensure the sites meet the demand.

There are currently no known issues of crowding, overutilization, unsafe conditions, or general issues that compromise recreation use, access, and enjoyment of the York Haven Project lands and waters. Retrieval of river rocks for the proposed nature-like fishway would require the use of heavy machinery driving back and forth downstream of the main dam to collect and deliver the large boulders in an area popular with anglers, kayakers, and general exploration of the rocks. York Haven Power does not propose any specific measures to protect human safety during this process. Development of measures to allow recreation and extraction and transport activities to coexist during construction of the fishway would ensure visitor safety is considered. Including those measures in a formalized recreation management plan would further ensure all recreation resources are considered, operated, and maintained for the duration of any license.

Muddy Run and Conowingo Projects

Exelon proposes to implement Recreation Management Plans for both the Muddy Run and Conowingo projects. The plans address recreation resources, including: recreation facilities that are located within the FERC project boundary, are owned and managed by Exelon, and are on lands owned in fee title by Exelon. The plans would address maintenance and capital improvements to ensure continued public use and enjoyment of project lands and waters through a future license. The three recreation areas addressed by the proposed Recreation Management Plan at the Muddy Run Project include: Muddy Run Park and Campground, Muddy Run WMA, and Wissler's Run Park. The 15 recreation sites addressed by the proposed Recreation Management Plan for the Conowingo Project include: Lock 13, Lock 15, Muddy Creek Boat Launch, Cold Cabin Boat Launch, Dorsey Park, Line Bridge, Broad Creek Public Landing, Glen Cove Marina, Conowingo Swimming Pool and Visitors Center, Peach Bottom Marina, Conowingo Creek Boat Launch, Funk's Pond, Conowingo Dam Overlook, Fisherman's Park/Shures Landing, and Octoraro Creek Access. Specific elements of the plans, such as facility improvements, operation and maintenance, monitoring, and plan updates, are addressed below in our analysis.

Recreational Facility Improvements and Rehabilitation

As part of the proposed Recreation Management Plans, Exelon would make capital improvements to two facilities at the Muddy Run Project and 13 facilities at the Conowingo Project. Proposed improvement projects would be implemented within the first year of license issuance. In addition, Exelon suggests it would pursue dredging as a means to maintain boater access at Peters, Conowingo, and Broad creeks.

Exelon proposes to upgrade a variety of amenities within Muddy Run Park and make repairs at Wissler's Run Park near the Muddy Run powerhouse. As part of the improvements, Exelon would replace the existing boat launch facility at Recreation Lake with a new concrete plank ramp that includes a new gangway and floating dock (ADA compliant) and also make shoreline improvements to limit erosion. Exelon also proposes to upgrade the ADA picnic site, stabilize 150 feet of the shoreline at Recreation Lake between the ADA picnic site and the rental boat dock, convert the timber retaining wall to sheetpile retaining wall, upgrade service to 50-amp electrical service at 50 sites, expand the playground adding a tot lot, construct a spray park, and provide Wi-Fi service to park users.

At Wissler's Run Park, Exelon proposes improvements that include removing the non-functioning fish cleaning station, rebuilding and repaving the existing walkway along the top of the bank, and designating two parking spaces near the picnicking pavilion as meeting ADA standards. The walkway from the parking area to the picnic area and the parking lot were both repaved in 2011.

As part of the plan, Exelon also proposes to erect and maintain FERC Part 8 signs at River Road and Furniss Road Muddy Run WMA parking areas. Exelon proposes to

continue to lease these lands to Pennsylvania Game Commission for the term of a future license.

The State of Maryland agrees that Exelon's proposed improvements to existing recreation facilities would enhance recreation use at the projects; however, it recommends additional measures, such as providing additional facilities for bird watchers and more hiking trails.

A number of individuals commented that the biggest issue at Peach Bottom Marina is that the harbor and river just outside of the railroad bridge are so badly silted in that boats cannot access the marina at normal low or even medium water levels.

Exelon proposes to upgrade and improve 13 existing recreation facilities at the Conowingo Project. The proposed recreation enhancements include:

- adding fencing and vegetation removal at Lock 13;
- new restrooms, dock, and parking enhancements at Lock 15;
- boat launch enhancements at Muddy Creek;
- parking, picnic area, and boat ramp upgrades at Cold Cabin;
- restroom and boat ramp upgrades at Dorsey Park;
- creek stabilization at Conowingo Creek;
- parking and wall improvements at Glen Cove Marina;
- improved signage at Funk's Pond;
- providing ADA improvements at Conowingo Pond;
- upgrading pavilion, picnic area, fence and parking at Overlook;
- providing improvements to the boat ramp at Fisherman's Park;
- bank stabilization at Line Bridge; and
- providing shore access at Peach Bottom.

Recreation Facility Operation and Maintenance

As part of the proposed Recreation Management Plans, Exelon would maintain the existing and proposed recreation facilities as described in the plan for the term of a FERC license. Exelon, at its discretion, may also restrict use and access to (or close) a site, or any portion thereof, on a short-term basis for maintenance/construction activities, unsafe conditions, emergencies, and operational reasons. At the Conowingo Project, Exelon also proposes a number of programs and measures to meet safety objectives including: water release safety devices, upstream boat buoys and warning signs, flow information, a canoe portage shuttle, boat launch channel markers, security fencing/warning signs, maintaining water levels during the boating season, and general facility maintenance.

Exelon states that, should additional project facilities be developed over the term of the FERC license, it would be receptive to partnering with interested parties for the development, operation, and management of such facilities. Exelon would ensure that project facilities, existing and future, that are managed and operated by third parties, would be managed and operated in accordance with FERC rules and regulations and any license articles.

Recreation Monitoring Program

As part of the Recreation Management Plans, Exelon proposes to use the FERC Form 80 Licensed Hydropower Development Recreation Use Report to assess and report recreation use and capacity every 6 years. Exelon states this level of monitoring would provide a comparison with the recreation use projections provided in the Recreation Management Plans to help determine if additional recreation facilities are warranted during the license period.

Our Analysis

Exelon (2012a and 2012b) concludes that, although visitors indicated high satisfaction with the facilities, many of the recreation sites managed by Exelon exhibited deferred maintenance (e.g., boat ramp upgrades, parking resurfacing) or a complete lack of highly desired amenities, such as restrooms. The lack of restrooms or restrooms in disrepair could pose potential health risks if visitors are forced elsewhere. Broken amenities, amenities in a state of disrepair, or amenities in need of routine maintenance also provide unsafe and uninviting conditions that diminish the quality of the recreation experience and resources. Implementation of the proposed Recreation Management Plans and the specific enhancements would provide a framework to guide the management of recreational resources to ensure that these sites receive updated amenities.

As currently proposed, the plans for the Muddy Run and Conowingo projects put an increased emphasis on facility improvements, especially boater access and parking, and restrooms. Overall, 96 percent of survey respondents rated the facilities at Muddy Run Park as ‘good’ or ‘excellent.’ The comment received most frequently (27 percent) was that a swimming pool within the park or a roped-off swimming area at the recreation reservoir was desired by visitors. Construction of Exelon’s proposed spray park would provide the body-contact recreation visitors requested while preserving the no-swimming policy at Recreation Lake.

Improvements to the Recreation Lake boat ramp, ADA picnic area, shoreline and retaining walls would improve boater access and maintain water quality by reducing erosion from these areas. Improvements to the ramp would enhance boater access; a popular activity on the lake. Similarly, improvements to the campground electrical service, such as more 50-amp service campgrounds and Wi-Fi, would address modern

camper needs such as increased use of electronic devices (e.g., recreational vehicles with air conditioning, personal computers, smart phone charging).

Removal of the non-functioning fish cleaning station at Wissler's Park would eliminate the temptation for users to clean fish on site and leave the waste, which could negatively impact the aesthetics of the area. Enhancements to the pathway and designating two additional parking areas ADA would improve the overall recreation resources at the site.

As licensee, Exelon is responsible for providing reasonable public access to project lands and waters. Through the proposed Recreation Management Plans, Exelon recognizes the importance the two projects play in providing recreation in the region and acknowledge that the recreation facilities will be maintained for the duration of any license. However, the plans are limited in scope by failing to identify specifics of any monitoring programs to ensure the sites are meeting demand throughout any license other than through the FERC Form 80 process.

The FERC Form 80 is useful to analyze overall use levels and project-wide capacity; however, it provides broad, rather than site-specific, recreation information. Development of a monitoring program that includes input from users that mimics the methods used during the relicensing studies would enable Exelon to meet its stated goal of comparing recreation data, by site, with future use estimates, as described in the Recreation Management Plans. As required now, the FERC Form 80 reports annual use estimates for the entire project, while Exelon is proposing a strategy that looks more closely at recreation use levels at each site. Including the methods of this monitoring effort in revised Recreation Management Plans for both projects would ensure the proper data collection to guarantee all the facilities are meeting the demand. Visitation rates can change dramatically year to year and through time; however, given the proposed facility enhancements, conducting a recreation use study every 12 years, consistent with every other FERC Form 80 reporting deadline throughout the license term, would ensure the proposed plans are current and the sites are meeting the demand.

Similarly, Exelon does not include provisions to update the plans. Since the projects were first constructed, recreation demand for water-based recreation has steadily grown. Over time, the facilities have aged, and as documented in the recreation reports, they exhibit wear and tear associated with regular use. Addressing maintenance of the recreation facilities is an important component of a recreation management plan. Recreation is not static and ensuring that facilities are the right type for the demands over the term of a typical license requires monitoring to ensure the proposed Recreation Management Plans are revised to prevent any drop off in the quality of the resource. A revised recreation management plan that includes scheduled updates coordinated around a recreation use study could capitalize on the timing and information to address any changes in recreation resources that may be necessary in the middle of any license term. Having a scheduled update ensures the plan is kept current regardless of the extent of changes between plans. Development of the recreation use monitoring methods in

consultation with interested agencies and stakeholders would ensure sites and uses are monitored to guarantee the recreation management plan remains current and includes appropriate diversity in recreation resources.

Exelon's proposed boat ramp and boat launch enhancements at existing recreation facilities would provide significant improvements to the project's recreational resources. Implementation of the proposed Sediment Management Plan, as discussed in section 3.3.1, *Geology and Soils*, would include monitoring the water depth at Peter's Creek (Peach Bottom Marina), Conowingo Creek, and Broad Creek (Harford County boat launch) every 5 years; however, the plan stops short of identifying at what depths the locations need to be dredged and scheduling dredging. These three boat ramps represent half of the boat ramps providing access to Conowingo Pond for motorized boating. Visitor survey results indicate that 6 percent of the comments received at Conowingo Creek targeted shallow water/dredging needs; however, because Exelon maintains the minimum pond elevation at 107.2 feet on weekends between Memorial Day and Labor Day, boaters may not perceive a need for dredging at most sites. Maintaining the minimum pond elevations as currently required would ensure the boating resources are maintained through the term of any license.

At Broad Creek Public Landing, the two most common comments received were the need for an improved boat ramp (29 percent) and higher water levels (14 percent) as mentioned by those fishing in the spring and summer. Stakeholders consulted in development of the Recreation Management Plan expressed dissatisfaction with the water depths and amount of siltation at Peach Bottom Marina. Because this is the only marina with gas on the Pennsylvania side of the river, siltation of the marina compromises boater's ability to access the marina and weakens the businesses' ability to operate. Exelon reported that the depth of water at the toe of the Peach Bottom boat ramp was 3 feet, meeting the *States for Organizational Boating Access Design Handbook for Recreational Boating & Fishing Facilities* recommended minimum water depth of 3 feet. Overall, Peach Bottom Marina received the smallest share of visitation to the Conowingo Project; however, it is not clear how much sedimentation of the marina or other factors played in the site receiving such low amounts of use.

Exelon study results indicate the combination of pool elevation and sediment accumulation compromises motorboat launches from these sites under specific conditions. Cross referencing the bathymetric mapping proposed under the Sediment Management Plan at the three sites into the final Conowingo Recreation Management Plan would ensure bathymetric mapping sediment monitoring results are included in discussions related to boater access to the reservoir. Development of a final Sediment Management Plan that includes detailed benchmarks for dredging, a schedule, and commitment to dredging the three access areas as soon as the benchmark water depths are reached would ensure that recreation access is not lost or compromised indefinitely.

Reopening Catwalk on Conowingo Dam

Not included as part of the proposed Conowingo Recreation Management Plan is the continued closure of the catwalk on the downstream face of Conowingo dam. The catwalk is a narrow, steel and reinforced concrete extension walkway attached to the exterior of the powerhouse wall. The catwalk spans 820 feet along the length of the powerhouse.

The catwalk was very popular with anglers prior to its closure after the events of September 11, 2001. On May 1, 2007, the Director of the Office of Energy Projects issued an Order Amending Exhibit R (119 ¶ FERC 62,088) removing the catwalk as a project recreation facility. The order authorized new recreation facilities at Fisherman's Park on the west side of the river, which now provides anglers the only opportunity to fish just below the dam (the Fisherman's Wharf). This order also authorized public fishing access along the north and south banks of Octoraro Creek on the east side of the river. Exelon completed construction of the Octoraro Creek facility in May 2008 and completed the Fisherman's Park/Wharf in 2009. Fishing is allowed along the shoreline of the park (about 700 yards) except for an area within 100 yards of Conowingo dam.

Exelon evaluated closing of the catwalk to recreational fishing and concluded that while reopening the catwalk is physically feasible, opportunities at the project are sufficient to meet existing and reasonably projected demand without the catwalk. Exelon further questions the benefit gained by investing in security upgrades prior to opening the catwalk.

The State of Maryland disagrees with Exelon's proposal to keep the powerhouse catwalk closed to the public, and believes the new fishing pier does not mitigate for the loss of the catwalk. About a half dozen private citizens also recommend that Exelon reopen the catwalk because it provides a better angling experience.

Private anglers also recommend that Exelon expand the operating hours of Fisherman's Park/Wharf so as to be open between 4 a.m. to midnight. The comments received indicate the current policy of dawn to dusk limits the hours for boating access downstream of Conowingo dam because anglers would prefer to launch early in order to get lines in the water before sunrise when light changes drastically. Similarly, anglers would appreciate launching in the evening and being able to stay on the water later into the night to take advantage of feeding times around the changing light. According to the comment letters, striped bass, a popular game fish residing in the tailwater, feed closest to the surface and shore during these predawn and post dusk times.

Our Analysis

Reopening the catwalk would provide access to a historically popular angler opportunity. Fishing from the catwalk offers a different opportunity and experience than fishing from the shoreline, allowing anglers to cast with the river flow and directly into the middle of the channel. Seasonally, this can be advantageous depending on the fish run(s) because some species are more likely to be caught from the middle of the channel than from the bank (casts from the bank are pushed to the sides of the channel by the flow).

Since Exelon closed the catwalk in October 2001, it constructed a new fisherman's platform along the west bank of the shoreline and developed new trail access to the river on the east bank at Octoraro Creek. The Fisherman's Wharf provides ADA-compliant ramps and a concrete platform above the shoreline for anglers, while Octoraro Creek provides parking and a trail to the shore along the creek. Although neither provides anglers a chance to fish the main channel in a way that was similar to fishing from the catwalk, the enhancements do provide additional opportunities for this reach of the project. A third site, the Lower Susquehanna Greenway, provides shoreline access between the Fisherman's Park and Deer Creek. Exelon estimates that Fisherman's Park and Octoraro Creek receive the greatest percent of shoreline fishing activity downstream. Exelon estimates a reopened catwalk could support 150 anglers at one time. Exelon projections show the existing access below capacity out to year 2050; however, the estimates are based on general recreation trends and are not specific to unique features like the catwalk or tailraces of dams like at Conowingo.

Upstream of Conowingo, angling on the downstream faces of dams is popular on the catwalks at the York Haven and Safe Harbor projects. York Haven Power can close the site with a single chain-link fence gate. Access is provided in proximity to both the sluice gate and the base of the powerhouse wall. Similarly, anglers at Safe Harbor are afforded access directly below the powerhouse; however, they must pass a security guard station prior to gaining access to fish. Additionally, Corps' lock and dam systems that also produce power often provide similar fishing opportunities in the tailrace below the powerhouses.

Exelon security experts recommend a number of improvements to the catwalk before considering reopening, including measures that deter, detect, and assess any unwanted activity; delay escape; respond to a threat; and harden the physical structure.

If Exelon were to reopen the catwalk to provide better angler access to the middle of the channel, it could implement select security measures that were identified as appropriate in its catwalk study report for addressing security risks at the catwalk (Security Management Solutions, 2012). Security measures, such as installing a new security guard station, checking anglers in and out, and operating on a limited basis, could provide angler opportunities while minimizing any potential security risks Exelon has reservations about public use of the catwalk. Limited operation of a reopened catwalk could follow specific fish species open seasons when use would be expected to

be highest. On-line discussion forums warn anglers that fishing the shoreline downstream of Conowingo dam can be shoulder to shoulder during certain seasons with multiple anglers, indicating the shoreline immediately downstream of the dam is crowded (Stripers Online, 2014). Given the relative proximity of the dam to the large metropolitan areas of Baltimore, Maryland, and Wilmington, Delaware, reopening the catwalk would enhance the angling resources by providing access to a historically popular site and a different opportunity than is currently available.

Debris Management

Debris accumulation, removal, and passing are part of operating a hydroelectric project. The presence of debris in project reservoirs can present safety and aesthetic hazards; however, the dynamic nature of the volume and timing of debris within any reservoir at any given time makes managing it dynamic as well. The removal and/or passing of debris that has accumulated in front of the trashracks is an important component of operating hydroelectric projects of any size. Given the size of the lower Susquehanna River watershed, the amount of debris arriving and passing these projects can be significant.

York Haven Project

York Haven Power estimates the project traps an estimated 5,000 cubic yards of debris in the powerhouse trashracks annually. It states that almost all of the debris arrives at the project during high-flow events when river flows far exceed the hydraulic capacity of the project. In those conditions, much of that debris passes over the main dam. Non-natural debris that accumulates in the forebay is removed, and the remaining debris is sluiced downstream through a gated opening in the masonry non-overflow wall at the downstream end of the forebay. Prior to opening the sluice gate, York Haven Power notifies PPL's Brunner Island Station that debris is to be sluiced.

In 2010, York Haven Power and Pennsylvania DEP reached an agreement that is reflected in the project's current NPDES permit and in section 3.3 of the Settlement Agreement, providing for an annual payment of $25,000 to the York County Conservation District to finance debris removal in the Lower Susquehanna River Watershed. The Settlement Agreement requires York Haven Power to continue its current debris management practices, including prior notice to PPL's Brunner Island Station when debris is to be sluiced (absent extraordinary or emergency conditions).

Conowingo Project

During the initial scoping meeting held on the evening of June 11, 2009, the Lower Susquehanna Riverkeeper expressed concern that debris passing the Conowingo dam under high-flow conditions often gets deposited in the Sassafras River, causing damage and expense for cleanup to those living along the river. The Sassafras River is located in Maryland, approximately 10 miles downstream of the mouth of the Susquehanna River at the head of Chesapeake Bay on the east side of the bay. The

conditions described by the Riverkeeper were that the high flows entering Chesapeake Bay from the Susquehanna River cause a backwater flow up the Sassafras River, such that instead of the debris passing out through Chesapeake Bay, some of it gets trapped in the Sassafras River.

Debris is removed from the Conowingo powerhouse intakes using gantry cranes with grapple attachments. Debris removal occurs during low and normal flow conditions, but cannot take place during high river flows due to safety concerns. The methods and practices employed at Conowingo are comparable to methods employed at the York Haven, Safe Harbor, and Holtwood dams.

The amount of natural and human-made debris reaching Conowingo dam fluctuates from year to year. Between 1989 and 2011, (for years Exelon removed debris), Exelon estimates between 60 and more than 4,000 cubic yards have been removed on an annual basis. Exelon states some of the debris build-up can be as deep as 75 feet under the water surface in front of the dam. All debris removed is taken to Hopkinton Cove where it is separated and sorted as organic, tires, plastic, trash, or metal. Organic (natural) debris is recycled and ground up for mulch. All other debris is sent to a disposal/recycling facility or landfill.

Exelon also sponsors community-based clean-up events for the shoreline upstream and downstream of the dam, such as the Exelon Clean-up Day, clean-up of the Conowingo Creek boat launch, and the Lower Susquehanna Greenway River Sweep.

Based on the results of Exelon's Debris Management Study (URS and Gomez and Sullivan, 2012c), Exelon determined that no additional practices were needed. None of the stakeholders recommended additional measures pertaining to debris management at Conowingo.

We discuss the aesthetics of the debris in section 3.3.7, *Aesthetic Resources.*

Our Analysis

A 2012 report on debris management (URS and Gomez and Sullivan, 2012c) identified quantities of debris passed and removed from the river at York Haven, Safe Harbor, Holtwood, and Conowingo dams; analyzed flow conditions that result in debris being passed naturally at the dams; and reviewed debris management methods and practices employed at the four dams.

Debris typically gets trapped at the dams when river flows are less than the hydraulic capacity of each project powerhouse, and are typically passed naturally over or through the dams when flows exceed the hydraulic capacity of the powerhouses in March and April. Since the hydraulic capacities of the four projects differ significantly (York Haven – 17,000 cfs; Safe Harbor – 110,000 cfs; Holtwood – 31,500 cfs; and Conowingo – 86,000 cfs), debris is passed naturally under different hydrologic conditions. Debris would only be passed downstream from Safe Harbor when inflows exceed 110,000 cfs. Similarly, debris is only passed at Conowingo when inflows exceed 86,000 cfs.

York Haven Project

Formalizing debris management at the York Haven Project as detailed in the Settlement Agreement would ensure debris does not pose long-term hazards to people and project operation. Notification of PPL's Brunner Island steam plant would be a continuation of the courtesy York Haven Power provides so as to allow PPL opportunity to plan or prepare for any inconvenience from passing debris.

Conowingo Project

As noted by the Lower Susquehanna Riverkeeper, debris is primarily deposited in the Sassafras River under high-flow conditions, when backwater effects on Chesapeake Bay flow upstream into the Sassafras River. When river flows are between 86,000 and 110,000 cfs, debris is passed naturally at Conowingo dam from upstream in the watershed between Safe Harbor dam and Conowingo dam. When river flows exceed 110,000 cfs, debris from the entire Susquehanna watershed can be passed downstream of Conowingo. Under these conditions, the natural passage of debris is beyond the control of the Conowingo Project.

Debris management practices employed at the Conowingo Project are consistent with BMPs and practices at the other dams upstream of Conowingo. Current practices remove up to several thousands of cubic yards of debris each year.

Effects of Proposed Shoreline Management Plans

York Haven Power is not proposing an SMP as part of its final license application; however, it is proposing to continue to implement its shoreline leases of residential lots. York Haven Power would maintain the recreation lot lease program at the project (total of 288 leases) but indicates that it would terminate any leases when lots are abandoned by the lessee or when existing structures are damaged and not replaced by structures that meet current regulations.

As part of York Haven Power's lease agreement, renters may have non-permanent structures within an 8-foot by 32-foot area; however, as noted during the environmental site visit May 21, 2013, many lots have substantial additions of a more permanent nature. Lots can be handed down from generation to generation; however, once the chain stops or the structures are more than 50 percent damaged or destroyed, the lot is eliminated from the rental program. This allows York Haven Power to slowly reduce the number of lots for rent over time.

As part of its final license applications, Exelon proposes to implement the SMPs filed in August 2012 for both the Muddy Run and Conowingo projects. The SMPs provide the framework for Exelon to manage the environmental and recreational resources within the project. Measures in the SMPs include General Maintenance, Shoreline Erosion Control, Erosion and Remediation Policy, Woody Debris Management, Non-Project Use of Project Lands, Shoreline Vegetation Management, Viewsheds, Access Trails, and Sensitive Natural Resource Protection Overlays and

Policies. Other land management-related policies include an HPMP (see section 3.3.6, *Cultural Resources*), Conowingo Island Public Use Policy, and Leased Premises Policy for Cottages. Exelon also proposes to amend the SMP as the facts and circumstances may warrant.

The project land classifications used to define allowable uses are similar for both Muddy Run and Conowingo. Land classifications at Muddy Run include: (1) Project Operations, which identifies project lands used for generation and transmission facilities; (2) Developed Recreation, which identifies lands managed for public recreation facilities (including commercial facilities) and activities; and (3) Public Access lands, which identifies lands managed by federal, state, county, or conservation organizations under agreement with Exelon, whereby public access and use of the lands is allowed according to the rules of the managing entity (these lands are typically unimproved).

The land classifications at the Conowingo Project include the same classifications as Muddy Run and also include the following three classifications:
(1) Natural/Undeveloped, which identifies lands that are primarily undeveloped and available for public access and use; (2) Industrial and Other non-project lands, which identify lands managed for industrial/commercial uses and other non-project uses including shoreline stabilization projects; and (3) Cottage Lands, which identifies lands leased to individuals for seasonal use.

The proposed leased premises policies address both private cottage lots, and public (state, county, or local agencies), or commercial vendors for the development of recreation related structures and facilities. Cottage lessees are required to comply with all applicable local, state, and federal laws for the development and use of the land, as well as the Exelon-imposed land use rules. Exelon rules and regulations for cottages address such issues as construction permits, lease transfers, erosion control, vegetation removal, water connections, wastewater disposal, shoreline development (e.g., piers, docks, boathouse, bulkhead, retaining wall), and cultural resource protection. In 2012, Exelon added language to the Conowingo lease documents that the "tenant must provide certification that all sanitary and gray water systems are in good working order in accordance w/applicable regulations, and tenant is not in default under any sewage pumping agreement by a cert. vendor on or before Nov. 1 annually." It is Exelon's policy not to create any new cottage lease lots within the project boundaries. As existing cottages are abandoned or become damaged and are not replaced due to local zoning restrictions, leases would be terminated. In such cases, all structures and improvements would be removed from the leased lot, and the property would be restored to a natural condition and the site would be precluded from future cottage leases.

Leases for public recreation and access facilities must comply with Exelon's "Rules and Regulations Governing the Use and Occupancy of Leased Premises," which parallel those developed for the cottage leases. In addition, leases must use the properties for park and public recreation access and facilities must comply with applicable local, state, and federal regulations.

Interior makes a 10(a) recommendation that Exelon prepare and implement SMPs in consultation with FWS that are consistent with *Guidance for Shoreline Management Planning at Hydropower Projects* (FERC, 2012). The SMPs shall include specific measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands. The licensee shall adopt BMPs for controlling sediment introduction from lands within the project boundary.

The lack of a central septic system for the islands where York Haven Power issues lease permits for residential lots was raised as a concern during project scoping. Each camp has some type of on-lot sewage disposal system; however, Pennsylvania FBC questions if this is an adequate, ecologically sound system for the island environment.

Our Analysis

York Haven Project

York Haven Power does not have a comprehensive shoreline permitting program; however, it does permit non-project uses via the existing standard land use article and shoreline permits for recreational lots. Implementation of York Haven Power's cottage lease agreements would continue to allow private use of portions of the islands and shoreline around Lake Fredric. York Haven Power suggests that routine monitoring would occur to ensure that cottages in disrepair are taken out of the program; however, the amount and type of monitoring of structures (e.g., conditions or encroachments) is not clearly described in the license application. Without a transparent process it is not clear what methods or interval York Haven Power uses to make findings to terminate leases and reclaim the lot area.

York Haven's policies implemented in 2010 prohibiting the use of water withdrawn from wells or the river should reduce the amount of wastewater being produced at the cottages because residents must now provide their own supply of bottled, potable water. According to York Haven Power, many of the lots are expected to use substandard sewage disposal systems. Lease agreements make it clear that leaseholders are responsible to undertake and complete any sewage system upgrades or replacements required to comply with the Pennsylvania Sewage Facilities Act and related rules and/or the Londonderry Township On-Lot Disposal System ordinance.

Although we have no reason to conclude that county and local agencies responsible for monitoring and issuing on-lot disposal system permits would allow systems to continue in an environmentally irresponsible manner, the ultimate responsibility for project land and the protection of associated water quality and recreation resources at Lake Fredric lies with York Haven Power. The Commission has no authority over the county or local agencies, and York Haven Power has an ongoing responsibility to supervise and control shoreline developments to ensure that they are not inconsistent with project purposes, including protection and enhancement of the project's scenic, recreational, and environmental values.

The Commission recognizes the need to consider multiple resource concerns and interests in the development of a comprehensive plan to manage the shoreline, and the need to involve interested parties in the development process. The lot lease agreements only address some of the resource values at the York Haven Project. Licensees have a responsibility to ensure that shoreline development activities that occur within a project boundary are consistent with project license requirements, purposes, and operation. A well prepared SMP can assist the licensee in meeting its responsibilities throughout the term of any license. While these plans are specific to a particular project, SMPs should generally contain a summary of the purpose, goals and objectives of the plan and a description of the shoreline use classifications, which identifies allowable and prohibited uses for existing and future use of the shoreline. A plan may have multiple classification or sub-classification types, but they usually fall within three general types: (1) a protected or natural resource preservation classification, (2) a limited development classification, and (3) a more intensive development classification. SMPs should also include: (a) maps showing the shoreline classifications in relation to the project reservoir, project boundary, and various other features; (b) a permitting program and guidelines developed by the licensee; (c) a monitoring and enforcement program; and (d) provisions for periodic review and update of the plan. Development and implementation of a comprehensive SMP in accordance with the Commission's published guidelines (FERC, 2012), and submitted for Commission review and approval, would ensure the shorelines are managed for the scenic, recreational, and environmental values for the duration of any future license.

Muddy Run and Conowingo Projects

Implementation of Exelon's proposed SMPs would provide a single source for shoreline management guidelines, policies, and an overall framework for managing the Muddy Run and Conowingo shorelines over the terms of any new licenses. Currently, cottage lots are managed with multiple policies and agreements, such as lot leases and erosion control permits. These documents do not, however, identify sensitive shoreline resources, public access areas, enforcement measures, or provisions for periodic review and updates. The proposed plans would bring all existing shoreline management programs and activities, such as the current residential lot and cottage lease program, and any other guidelines, into a single, comprehensive document.

Implementation of the land classification and shoreline management policies would provide for the management of land uses within the project boundaries. Project lands would remain available for public recreational uses, and private and commercial uses would continue to be allowed on project lands pending proper reviews. Exelon would review permit applications for activities such as improvements to leased cottages, construction of boat docks, piers, and landscaping, and would ensure that all residential cottages sewage systems meet local standards on an annual basis.

The proposed SMPs provide Exelon an opportunity to amend the plans as facts dictate; however, the plans do not include routine monitoring or consultation to verify the

conditions that may warrant changing the plans. A monitoring and review process would inform Exelon and other interested parties if changes to the SMPs are necessary through the term of any license. Consultation with the appropriate agencies and other stakeholders as part of periodic review would ensure that multiple interests and needs are addressed. Preparation of revised SMPs that includes regular consultation with interested stakeholders would ensure the plan is consistent with conditions at the projects.

Erosion has occurred along various segments of Muddy Run and Conowingo shorelines as discussed in section 3.3.1, *Geology and Soils*. Exelon does not propose any changes to project operations that would affect existing erosion rates. However, because wind and wave action are likely to continue, erosion issues are likely to persist.

Effects of Changes to Project Boundary

York Haven Power proposes to add 1.9 acres to the total project boundary acreage to encompass the project's East Shore Boat Launch and Canal Lock recreation area. The proposed boundary modification would include the recreation site completely within the project boundary. The lands proposed to be added to the project are all owned in fee by York Haven Power and are outside the 30-foot setback from the centerline of the adjacent railroad line that constrains the project boundary on both sides of the impoundment.

Exelon proposes to remove 1,965 acres from the Conowingo Project boundary. A 1,760-acre area would be removed from the east and west banks downstream of Conowingo dam as the existing project boundary extends to Havre de Grace. The proposed project boundary would extend from a point approximately 3,000 feet downstream of Conowingo dam on the western shoreline continuing downstream across the river to a point along Maryland State Route 222 (Susquehanna River Road), approximately 2,000 feet downstream of the confluence of Octoraro Creek and the Susquehanna River. The original area within the existing project boundary was necessary during construction of the project; however, since construction is completed, Exelon proposes the lands are no longer necessary for the operation and maintenance of the project. The boundary adjustment would remove four non-project recreation facilities from the project boundary, including portions of the Lower Susquehanna Heritage Greenway, Deer Creek Access, Lapidum Boat Launch, and McLhinney Park.

A 205-acre area would be removed near the Boy Scout dam on Broad Creek in Maryland. The area begins at a point about 1 mile downstream from the Route 623 Bridge across Broad Creek and encompasses land along Broad Creek between this point and the Boy Scout dam. The area does not contain any existing project recreation facilities and is not necessary for operation and maintenance of the project.

Exelon would negotiate leases with recreation facility operators that would no longer exist in the project boundary, and would negotiate a new lease with Maryland DNR for continued operation of the Lower Susquehanna Greenway Trail and Mason-Dixon Trail on Exelon-owned lands.

Lancaster County Conservancy commented that the landscape of the lower Susquehanna River has been designated a Pennsylvania Conservation Landscape (known as the Susquehanna Riverlands), and is part of the Susquehanna Gateway Heritage Area. The area (potentially) impacted by these projects includes a significant portion of the Captain John Smith Chesapeake National Historic Trail and part of the Mason-Dixon Trail.

Our Analysis

The addition of 1.9 acres of project lands at the York Haven Project would ensure the entire East Shore Boat Launch and Canal Lock recreation area is recognized as a project feature and managed under any future license for the project. Currently, the project boundary does not encompass the entire recreation area. These lands would be managed for their recreation resources consistent with the requirements of any license issued for the project.

A relatively thin ribbon of land on the west bank downstream of Conowingo dam was included in past licenses so as to include the railroad that was used to shuttle material to the dam during construction. The old railroad is gone and lands in this area are now used for recreation; however, these lands serve no direct project purpose. Continuation of the lease agreements with the State of Maryland for Susquehanna State Park (which includes the Lower Susquehanna Heritage Greenway Trail, Deer Creek Access, and Lapidum Boat Launch) and the City of Havre de Grace for McLhinney Park would maintain recreation access at these locations if the project boundary were changed. With the exception of the Lower Susquehanna Greenway Heritage Trail, which connects Fisherman's Park with Susquehanna State Park lands, the rest of these sites are non-project recreation sites located more than 3 miles downstream of Conowingo dam. Removal of these lands would be consistent with FERC policy that only lands and waters needed for project purposes for the continued operation of the project should be included in the project boundary. Lands and waters needed may include those for (1) construction and operation of its project, and (2) to carry out other project purposes such as recreation, wildlife protection, and enhancement, etc. Execution of a new lease with Maryland DNR would ensure these lands are maintained for public recreation purposes; however, they would not be under FERC jurisdiction.

3.3.6 Cultural Resources

3.3.6.1 Affected Environment

Section 106 of the NHPA requires the Commission to evaluate potential effects on properties listed or eligible for listing in the National Register prior to an undertaking. An undertaking means a project, activity, or program funded in whole, or in part, under the direct or indirect jurisdiction of a federal agency, including, among other things, processes requiring a federal permit, license, or approval. In this case, the undertakings are the relicensing of the Susquehanna River Projects. Potential effects associated with these undertakings include project-related effects associated with any new construction

activities associated with the projects, and the day-to-day operation and maintenance of the projects.

Historic properties are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. Traditional cultural properties are a type of historic property eligible for the National Register because of their association with cultural practices or beliefs of a living community that: (1) are rooted in that community's history or (2) are important in maintaining the continuing cultural identity of the community. In this EIS, we also use the term cultural resources to include properties that have not been evaluated for eligibility for listing in the National Register. In most cases, cultural resources less than 50 years old are not considered eligible for the National Register.

Section 106 also requires that the Commission seek concurrence with the Pennsylvania SHPO and Maryland SHPO on any finding involving effects or no effects on historic properties, and allow the Advisory Council an opportunity to comment on any finding of effects on historic properties. If Native American properties have been identified, section 106 also requires that the Commission consult with interested Native American tribes that might attach religious or cultural significance to such properties.

By letters dated May 11, 2009 (Muddy Run and Conowingo), and July 24, 2009 (York Haven), the Commission designated Exelon and York Haven Power, respectively, as the Commission's non-federal representatives for carrying out day-to-day consultation in regard to the relicensing efforts pursuant to section 106 of the NHPA. The Commission, however, remains ultimately responsible for all findings and determinations regarding project effects on any historic property, pursuant to section 106.

Area of Potential Effects

Pursuant to section 106, the Commission must take into account whether any historic property within each project's APE could be affected by the issuance of new licenses. According to the Advisory Council's regulations, the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 CFR 800.16[3]). The APE encompasses the likely extent of project operations and project-related environmental measures that could be undertaken during the term of any new licenses that are issued for the proposed projects.

In its application, York Haven Power defined the APE for the York Haven Project as the area within the project boundary as shown on the exhibit G maps provided in the application and includes all lands associated with York Haven dam and reservoir, the east channel dam, the powerhouse, transmission line, and associated project features. By letter dated April 26, 2010, the Pennsylvania SHPO concurred with this definition of the APE (letter from D.C. McLearen, Chief, Division of Archaeology and Protection, Pennsylvania Historic and Museum Commission, Bureau for Historic Preservation,

Harrisburg, Pennsylvania, to D. Weaver, York Haven Power Company, York Haven, Pennsylvania, filed December 28, 2012).

In its application, Exelon proposed an APE for the Muddy Run Project that consists of all lands located within the project boundary as shown on the exhibit G maps provided in the application and includes all lands associated with Muddy Run dam and reservoir, the powerhouse, transmission line, and associated project features. In approving Exelon's study plan dated December 22, 2009, the Commission also approved the project APE.

In its application, Exelon proposed a revised project boundary for the Conowingo Project that includes Conowingo dam and reservoir, powerhouse, transmission line, and associated project features but terminates just downstream from Conowingo dam. Exelon describes the APE as including all lands located within this proposed project boundary plus an additional 3.8 miles downstream to Spencer Island that are located in the current project boundary. While Exelon proposes to remove lands currently in the project boundary located downstream of Spencer Island from the current project boundary, it stated that these lands would remain in the project APE because cultural resource sites could be affected by project-related flows in this area (personal communication between E. Carter [FERC], T. Sullivan, K. Smith, M. Hoover, and G. Lemay [Gomez and Sullivan]; B. Lynch and C. Hicks [Exelon]; and J. Ryan [VanNess Feldman], Washington, D.C., April 8, 2013). A narrow strip of land located in the current project boundary extending downstream from Spencer Island along the west side of the Susquehanna River to the city of Havre de Grace, Maryland, was excluded from the APE because Exelon did not identify any project effects in this area.

Cultural History Overview

The following discussion is adapted from the cultural overview provided in York Haven Power and Exelon's license applications.

The prehistory of the Susquehanna River Projects area can be divided into four general time periods: Paleoindian, Archaic, Woodland, and Protohistoric. Paleoindian peoples (12,000 – 7,500 B.C.) were nomadic hunter-gatherers who routinely used natural rockshelters as dwellings. Paleoindian sites are recognized by the presence of large fluted projectile points suitable for hunting large game present at the end of the Pleistocene. There are very few documented Paleoindian sites in the region, but one important site, Meadowcroft Rockshelter, is located in southwestern Pennsylvania. During the Archaic period (7,500 – 1,000 B.C.), people adapted to a warmer climate and increasingly relied on smaller game and abundant plant resources. These changes are reflected in changes in tool technologies to include smaller notched projectile points, groundstone tools, and steatite vessels. The Woodland period (1,000 B.C. – A.D. 1600) is marked by a transition to a more sedentary settlement pattern and the appearance of horticultural practices, elaborate ceramics, and increased ceremonialism evidenced by mound construction. The Susquehanna River Project areas primarily contain evidence of Archaic and Woodland period occupations, although one site believed to date to the

Paleoindian period was identified within the York Haven APE. The final Prototohistoric period is characterized by profound changes in cultural practices as a result of contact with European explorers and settlers. Today, the Delaware Nation and the Onondaga Nation of Native Americans retain ties to the Susquehanna River region.

European exploration of the Susquehanna River region began in 1608 when John Smith reached the mouth of the river. However, European settlements did not appear until the late 1600s when William Penn began to grant settlement rights in the region. Lancaster County was established in 1729 and subsequently divided into York, Cumberland, Dauphin, Lebanon, and Northumberland counties. The economy of the region was based primarily on mining, quarrying, milling, and agriculture, with tobacco being an important crop. The Colombia and Port Deposit Railroad was completed in the middle 1930s, and the Susquehanna and Tidewater Canal was opened in 1840. These developments provided an important means of transport to the larger eastern cities.

The York Haven and Conowingo projects were two of four hydroelectric facilities built on the Lower Susquehanna River between 1904 and 1932. The York Haven Project Water and Power Company was incorporated in 1895 as a water supplier to York Haven residents and businesses. Construction of the project began in June 1901, and a powerhouse was designed by John Augustus Dempwolf using both utilitarian and Romanesque features. In March 1904, the structure was collapsed by an ice gorge and floodwaters, but repairs were completed by August of that same year. The powerhouse was expanded in 1907 to include additional generation capacity and new operating units went online in 1914. East channel dam was constructed in 1918.

Conowingo dam was constructed between 1926 and 1928 to supply power to Philadelphia and southeastern Pennsylvania. The facility also provided power to railroad lines between Washington, D.C., and New York. In 1927, PECO Energy Company, Public Service Company of New Jersey, and PPL reached a cooperative agreement to interconnect their power systems through transmission lines to concentrate power in industrial areas of New Jersey and Pennsylvania. Construction of the Conowingo Project was a large endeavor, and required the relocation of the village of Conowingo and rerouting 16 miles of Pennsylvania Railroad track and Baltimore Pike. At the time of its construction, it was the second largest hydroelectric development in the United States.

A license to construct the Muddy Run Project was issued to PECO Energy Company in September 1964. Construction of the project began that year, and the facility was in operation in 1967. At that time, it was the largest pumped storage facility in the world.

Prehistoric and Historic Archaeological Resources

York Haven Project

York Haven Power conducted research at the Pennsylvania Historical and Museum Commission and identified 24 previously recorded sites within the project APE and three areas that had been given “general site designations.” The three “general site

designations" were attributed to Shelley Island (36DA3), Three Mile Island (36DA52), and Hill Island (36DA86) for their general cultural sensitivity but are not considered to be sites per se. In June 2010, an archaeological reconnaissance of the known sites within the APE was undertaken (Stallings and Franz, 2011) to assess all known cultural sites in the APE for project-related effects. Of the 24 known sites, 17 are located on privately owned lands and were either not inspected or were surveyed by boat only. The remaining seven sites are located on lands owned by York Haven Power. None of the 24 sites have been formally evaluated for listing on the National Register, although 36DA99, 36DA100, 36DA101, and 36DA235 were described as being potentially eligible.

Muddy Run Project

Archival research conducted at the Pennsylvania Historical and Museum Commission enabled Exelon to identify three previously recorded sites within the Muddy Run Project APE (36LA67, 36LA103, 36LA368). Site 36LA67 is also located within the APE for the adjacent Conowingo Project. Phase IA archaeological studies also identified 12 areas of archaeological sensitivity. These areas of interest (AOIs) and resulting field inspections were described in *Phase IA Archaeological Study and Preliminary Historic Structures Assessment Report for the Muddy Run Pumped Storage Relicensing Application Project, Lancaster and York Counties, Pennsylvania* (Sara et al., 2011a). Field inspections indicated that one of the previously recorded sites (36LA0103) is currently inundated by Muddy Run reservoir. Two AOIs (AOI 1, AOI 9) were identified as worthy of additional field research because they contained high localized erosion as well as moderate to high probability for archaeological resources. In its December 28, 2012, response to the Commission's November 2, 2012, Additional Information Request, Exelon explained that both of these AOIs were located within the boundaries of a previously recorded site (36LA0067). These two AOIs were further investigated during Phase IB research with results presented in *Phase IB Archaeological Survey of Two High Priority Areas of Interest (AOIs 1 and 9), Muddy Run Pumped Storage Relicensing Application Project, Lancaster and York Counties, Pennsylvania* (Sara et al., 2012a). A series of 19 shovel test pits was excavated in the two AOIs; no cultural materials were identified. The Pennsylvania SHPO agreed with Exelon's Phase IB recommendations and stated that no further archaeological work at the two AOIs was required (letter from D.C. McClearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to C.E. Hicks, Exelon Corporation, Kennett Square, Pennsylvania, February 9, 2012). The third previously recorded site (36LA368) is situated above the shoreline and did not warrant further Phase IB investigations. No new archaeological resources were identified during Phase IA and Phase IB studies.

Conowingo Project

Archival research conducted at the Pennsylvania Historical and Museum Commission enabled Exelon to identify 37 previously recorded sites within the Conowingo Project APE. Phase IA studies also identified 45 areas of archaeological

sensitivity. These AOIs and subsequent boat inspections of specific shoreline locations were described in *Phase IA Archaeological Study and Preliminary Historic Structures Assessment Report for the Conowingo Relicensing Application Project, Harford and Cecil Counties, Maryland and Lancaster and York Counties, Pennsylvania* (Sara et al 2011b). During the Phase IA research, Exelon identified 19 AOIs with high localized erosion as well as a high probability for archaeological resources; nine of these were recommended for further field investigations. Subsequent Phase IB research entailed the excavation of a total of 369 shovel test pits dispersed throughout these nine AOIs. The results were presented in *Conowingo Project Relicensing Application, Harford and Cecil Counties, Maryland and Lancaster and York Counties, Pennsylvania, Phase IB Archaeological Survey of Nine High Priority Areas of Interest (AOIs 6, 18, 19, 33, 36A, 36B, 38, 39, and 45), FERC No. 405* (Sara et al., 2012b). During this study, seven new sites (18HA317, 18HA318, 18HA319, 18HA320, 18CE373, 18CE374, and 18CE375) and two isolated finds were documented bringing the total site count to 44 sites. As a result of both the Phase IA and IB studies, Exelon identified one site (18CE82) that has been previously determined to be eligible for listing on the National Register and one site (18CE16) that has been previously determined to be ineligible. Three previously recorded sites also considered to be eligible for listing (36LA51, 36LA56, 36LA67) and two sites (18CE14, 36LA69) were recommended as potentially eligible. Of these sites, 36LA67 is also located within the APE established for the Muddy Run Project. All seven of the newly identified sites were also recommended as potentially eligible. The remaining 30 sites in the Conowingo Project APE have not been evaluated, and their National Register eligibility is unknown.

Table 3-36 shows all archaeological and historic sites identified within the APEs for the Susquehanna River Projects.

Table 3-36. Recorded archaeological and historic sites identified within the Susquehanna River Projects APEs (Sources: Stallings and Franz, 2012; Exelon, 2012).

Resource Number	Resource Type	National Register Eligibility
York Haven Project		
36DA3 (general)	General prehistoric, open habitation	n/a
36DA51	General prehistoric, open habitation	Unknown
36DA52 (general)	General prehistoric, open habitation	n/a
36DA86 (general)	General prehistoric, open habitation	n/a

Resource Number	Resource Type	National Register Eligibility
36DA93	Late Woodland, open habitation	Unknown
36DA94	Transitional, open habitation	Unknown
36DA95	Late Archaic - Late Woodland, open habitation	Unknown
36DA98	General prehistoric, open habitation	Unknown
36DA99	Late Archaic, open habitation	Potentially eligible
36DA100	Early Archaic, open habitation	Potentially eligible
36DA101	Late Archaic; Late Woodland; 19th century, multi-component	Potentially eligible
36DA102	Late Archaic open habitation	Unknown
36DA103	Middle - Late Archaic open habitation	Unknown
36DA104	Late Archaic, open habitation	Unknown
36DA105	Late Archaic, open habitation	Unknown
36DA106	Late Archaic, open habitation	Unknown
36DA107	Late Archaic - Transitional Archaic, open habitation	Unknown
36DA139	Island Late Archaic; Middle-Late Archaic, open habitation	Unknown
36DA149	Late Archaic, open, unknown function	Unknown
36DA150	General prehistoric; Late Woodland, open, unknown function	Unknown
36DA151	Late Woodland, open, known function	Unknown
36DA152	Archaic-Late Woodland, open, unknown function	Unknown
36DA235	18th to 20th century, farmstead	Potentially eligible
36YO256	Archaic-Late Woodland, open habitation	Unknown
36YO264	General prehistoric, open habitation	Unknown

Resource Number	Resource Type	National Register Eligibility
36YO300	Paleoindian-Archaic, Late Woodland, general historic, open, unknown function	Unknown
36YO334	Unknown	Unknown
Muddy Run Project		
36LA67	Prehistoric open habitation	Considered eligible
36LA103	Rockshelter	Unknown
36LA368	Prehistoric open habitation	Unknown
Conowingo Project		
Maryland		
18CE14	Multi-component Prehistoric	Potentially Eligible
18CE16	Late Archaic	Ineligible
18CE82	Rock art	Eligible
18CE347	19th century domestic	Unknown
18CE348	19th-20th century farm	Unknown
18CE349	Industrial Susquehanna Canal	Unknown
18CE366	Industrial Susquehanna Canal Lock	Unknown
18CE373	Prehistoric, Archaic-Woodland village site; 18th-20th century cemetery	Potentially Eligible
18CE374	Prehistoric, open habitation	Potentially Eligible
18CE375	Prehistoric, open habitation	Potentially Eligible
18HA21	Transitional Archaic; 19th century canal	Unknown
18HA240	19th-20th century canal lock gates	Unknown
18HA248	Middle to Late Archaic short-term camp	Unknown
18HA254	Middle to Late Archaic short-term camp	Unknown
18HA255	Late Archaic short term camp	Unknown
18HA256	Late Archaic Lithic Scatter; 18th century domestic site	Unknown
18HA267	Late 19th-early 20th century barge/wreck	Unknown
18HA268	19th-20th century barge/shipwreck	Unknown

Resource Number	Resource Type	National Register Eligibility
18HA269	Historic landing or wharf site	Unknown
18HA285	Mill Ruins	Unknown
18HA317	19th-20th century domestic structure and refuse	Potentially Eligible
18HA318	Archaic-Woodland base camp, 18th-20th century	Potentially Eligible
18HA319	Prehistoric, unknown lithic scatter	Potentially Eligible
18HA320	Woodland base camp, 18th-20th century	Potentially Eligible
Pennsylvania		
36LA28	Open habitation, prehistoric	Unknown
36LA29	Open habitation, prehistoric	Unknown
35LA34	Prehistoric open habitation	Unknown
36LA35	Prehistoric open habitation	Unknown
36LA43	Open habitation	Unknown
36LA45	Open habitation	Unknown
36LA47	Historic, prehistoric	Unknown
36LA51	Open habitation	Considered Eligible
36LA56	Prehistoric, open habitation	Considered Eligible
36LA65	Late Archaic, open habitation	Unknown
36LA67	Prehistoric, open habitation	Considered Eligible
36LA68	Prehistoric, open habitation	Unknown
36LA69	Prehistoric, open habitation	Potentially Eligible
36LA70	Prehistoric, open habitation	Unknown
36LA118	Prehistoric, open habitation	Unknown
36LA120	Prehistoric, open habitation	Unknown
36LA1252	Rockshelter	Unknown
36LA1253	Prehistoric, open	Unknown
36LA1254	Shelter	Unknown
36YO381	Historic mill race	Unknown

Historic Structures

York Haven Project

York Haven Power conducted an architectural survey and identified five historic structural resources in the project APE (Stallings and Franz, 2011). Three of these structural resources are located on Shelley Island: the Shelly Island Schoolhouse and two historic cemeteries. By letter dated May 2, 2011, the Pennsylvania SHPO determined that the Shelley Island Schoolhouse is ineligible for listing[82] on the National Register (letter from D.C. McLearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to F. P. Stallings, Brockington Cultural Resources Consulting, Norcross, GA, May 2, 2011). The survey report also notes that cemeteries are generally not eligible for listing on the National Register but can be eligible under the National Register criteria if they obtain their primary significance from graves of person of transcendent importance, from age, from distinctive design features, or from an association with historic events (National Park Service, 1992). York Haven Power recommended that the two cemeteries do not meet these criteria. The Three Mile Island nuclear plant is also located within the APE and has been previously determined eligible for listing on the National Register. However, while this facility is technically located within the project APE, it is situated within an area excluded from FERC jurisdiction. Only the York Haven Project was identified within the APE as potentially eligible for listing on the National Register under Criterion A for its contribution to the history of hydroelectric power in the region between 1901 and 1904. It was also recommended as eligible under Criterion C because of its association with the John Augustus Dempwolf firm and reflects both utilitarian and Richardsonian Romanesque architectural styles. In its May 2, 2011, letter, the Pennsylvania SHPO concurred with these recommendations.

Muddy Run Project

Exelon conducted a study of potentially eligible historic structures associated with both the Muddy Run and Conowingo projects. The results of the study for the Muddy Run Project are presented in *Final Report, Historic Structures Assessment Report for the Muddy Run Pumped Storage Project Relicensing Application, Drumore and Martic Townships, Lancaster County and Lower Chanceford and Peach Bottom Townships, York County, Pennsylvania* (Henry and Jenkins, 2012a). A single structure, the historic Ritchie-Robinson House (ca. 1846), was identified. According to the report, the Pennsylvania SHPO had previously determined that the structure was ineligible for

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[82] The Pennsylvania SHPO did not indicate why the schoolhouse is ineligible for listing; however, the final license application at page 273 states: "many of the buildings on Shelley Island are replacements of earlier structures that were destroyed or heavily damaged during the Hurricane Agnes Flood of 1972."

listing on the National Register in 2001. Exelon re-evaluated the structure at the request of the Pennsylvania SHPO (letter from D. C. McLearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to F. P. Stallings, Brockington Cultural Resources Consulting, Norcross, GA, January 6, 2011). Exelon recommended that the house remain ineligible because (a) its previous occupants, William Ritchie and Michael Robinson, were not persons of historical significance on the local, state, or national level; (b) the structure has been altered with modern materials and additions that have compromised the house's integrity of design, materials, and workmanship; and (c) the farmstead itself does not contain a range of typical buildings and landscape features that would demonstrate important changes over time in the region's agricultural history. In its December 28, 2012, response to the Commission's November 2, 2012, Additional Information Request, Exelon explained that while the Pennsylvania SHPO's concurrence on this recommendation had been requested, no response had been received. The Muddy Run Project does not yet meet the 50-year threshold for National Register eligibility. However, Exelon's historic structures report states that the system is potentially eligible for listing under National Register Criterion A (energy production), Criterion C (engineering), and Criterion Consideration G, which recognizes significant architectural resources less than 50 years old. The report recommended further research and field survey to complete the Historic Structures Resource form for the Muddy Run facility and to formally evaluate its eligibility for the National Register.

Conowingo Project

A reconnaissance level architectural survey for the Conowingo Project identified a number of historic structures located within the project APE (table 3-37). The results of the study are presented in *Final Report, Historic Structures Report for the Conowingo Hydroelectric Project Relicensing Application, Hanford and Cecil Counties, Maryland, FERC Project No. 405* (Henry and Jenkins, 2012b). Archival research identified four structures or structural districts currently listed on the National Register (HA-112, HA113, HA-1551, and HA1591). By letter dated May 1, 2012, the Pennsylvania SHPO stated that the Susquehanna and Tidewater Canal (HA-112) and the Columbia & Port Deposit Railroad (CE-1554) had been evaluated for another project and were determined ineligible for inclusion in the National Register (letter from D.C. McClearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to C.E. Hicks, Exelon Corporation, Kennett Square, Pennsylvania, filed August 31, 2012). However, subsequently, the Pennsylvania SHPO reversed this determination and stated that these two structures are indeed eligible (letter from D.C. McClearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to K. Smith, Gomez and Sullivan Engineers, Henniker, NH, July 23, 2012). No reason for this change was provided. The Lower Deer Creek Valley Historic District (HA-1551) contains a number of contributing elements, nine of which are within the project APE. While the boundaries of the Havre De Grace

Historic District (HA-1591) are also located within the APE, no structures associated with the district are present in the APE. There are five additional previously documented resources in the APE, three of which (CE-874, HA-1877, and HA-1971) have also been previously determined to be eligible for listing on the National Register. Two others (HA-1035 and HA-1183) are recommended as ineligible. One historic bridge (HA-1581) was demolished in 1997. A total of seven additional resources were newly identified during the study. All seven were recommended as ineligible for listing on the National Register.

Table 3-37. Historic structures identified within the Susquehanna River Projects APEs (Sources: Stallings and Franz, 2011; Henry and Jenkins, 2012a, 2012b).

Resource Number	Resource Type	National Register Eligibility
York Haven Project		
Unassigned	Shelley Island Schoolhouse	Ineligible
Unassigned	Shelley Family Cemetery	Recommended ineligible
Unassigned	Shelley Island Cemetery	Recommended ineligible
Unassigned	Three Mile Island Nuclear Plant	Eligible
Unassigned	York Haven Hydroelectric Project	Eligible
Muddy Run Project		
Unassigned	Ritchie-Robinson House	Recommended ineligible
Unassigned	Muddy Run Hydroelectric Project	Potentially eligible
Conowingo Project		
CE-0874	Bell Manor Road Bridge	Determined eligible 2001 (per Exelon)
CE-1554/ 1558 (new)	Columbia & Port Deposit Railroad including Bridge and Tunnels	Eligible (Pennsylvania SHPO 7/23/2012)
CE-1555 (new)	Perpendicular Lock of Susquehanna Canal	Recommended ineligible
CE-1556 (new)	Palmer House 900 Susquehanna Road	Recommended ineligible
CE-1557 (new)	McClenahan Bros./John W. Malone Quarry Building	Recommended ineligible

Resource Number	Resource Type	National Register Eligibility
HA-0112	Susquehanna and Tidewater Canal Southern Terminus	National Register listed 1987, determined eligible (Pennsylvania SHPO 7/23/2012)
HA-0113	Susquehanna and Tidewater Canal Lockmasters House	National Register listed 1987
HA-1035	Old U.S. Route 1 (Glen Cove Road)	Recommended ineligible
HA-1183	Whitney Cottage	Recommended ineligible
HA-1581	MD 623 Bridge over Broad Creek	Demolished in 1997
HA-1591	Havre De Grace Historic District	National Register listed 1982
HA-1877	County Road 19 Bridge	Determined eligible 2001 (per Exelon)
HA-1971	U.S. Route 1 bridge over Conowingo Dam (Conowingo Hydroelectric Facility)	Determined eligible 2001 (per Exelon)
HA-2210/2211 (new)	Susquehanna Power Company Railroad Spur and Bridge	Recommended ineligible
HA-2212 (new)	Trenton Flint and Spar Company Building Ruins	Recommended ineligible
HA-2213 (new)	Bridge	Recommended ineligible
HA-2214 (new)	Culvert	Recommended ineligible
HA-1551	Lower Deer Creek Valley Historic District	Listed 1987
HA-191	Rock Run Mill	Contributes to District
HA-195	Rock Run Bridge Toll House	Contributes to District
HA-196	Rock Run Bridge Piers	Contributes to District

Resource Number	Resource Type	National Register Eligibility
HA-376	Lapidum Warehouse Wharf Road	Contributes to District
HA-377	Lapidum Inn site	Contributes to District
HA-380	Abrahams/Nicholson House	Contributes to District
HA-381	Pugh House/Ferncliff	Contributes to District
HA-382	Lapidum Lock	Contributes to District
HA-2190	Neff House	Contributes to District

Traditional Cultural Properties

On June 12, 2009, the Commission initiated consultation with the Delaware Nation and inquired regarding its interest in the Susquehanna River Projects relicensing (letter from A. Miles, Director of Hydropower Licensing, FERC, Washington, D.C., to K. Holton, President, Delaware Nation, Anadarko, OK, dated June 12, 2009). The Commission offered to meet with the tribe to discuss any issues or concerns that the tribe might have. York Haven Power also consulted with the Delaware Nation during study plan development and on October 26, 2010, the tribe responded by email stating that it desired to be a consulting party.[83] On April 7, 2011, York Haven Power provided the tribe with a copy of the cultural resources report for review and comment.[84] The tribe was also provided a copy of the draft and final license applications. The Delaware Nation is also included on Exelon's list of consulting parties. To date, no specific comments have been received from the Delaware Nation and no concerns regarding cultural resources in the project APE have been reported. On December 13, 2013, the

[83] October 26, 2010 email from J. Ross, Cultural Preservation Department, Delaware Nation, Anadarko, OK, to P. Stallings, Brockington and Associates, Inc. Norcross, Georgia. Filed December 28, 2012.

[84] April 7, 2011 letter from F.P. Stallings, Brockington and Associates, Inc. Norcross, Georgia, to T. Francis, Cultural Preservation Director, Delaware Nation, Anadarko, OK. Filed June 12, 2009.

Onondaga Nation expressed an interest in the lower Susquehanna River Projects.[85] The tribe expressed concerns regarding cultural resources including traditional trails and trade routes in the vicinity of the Conowingo and Muddy Run project areas.

3.3.6.2 Environmental Effects

Project-Related Effects on Cultural Resources

Project-related effects on cultural resources within the APEs could occur from project operations, any proposed modifications to project facilities, changes in project boundaries, public use of project lands, and other activities. Project effects are considered to be adverse when an activity may alter, directly or indirectly, the characteristics of a historic property that qualify the property for inclusion in the National Register. If adverse effects are found, such effects would need to be resolved in consultation with the Maryland SHPO, Pennsylvania SHPO, and other parties. For the most part, assessment of effects to archaeological resources located within the APEs of the three projects focused on erosional effects.

York Haven Project

In its application, York Haven Power stated that, because 17 of the 24 previously recorded sites are located on private lands, they were not assessed for project effects, and are not subject to the management responsibilities of York Haven Power. Six of the 17 sites (36DA100, 36DA101, 36DA235, 36DA51, 36DA98, 36DA99) are situated within a "FERC-designated exclusion zone" established for the Three Mile Island Project and are exempt from cultural resource consideration associated with the project. Several sites are located on York Haven Power fee lands that are either permitted lots (36DA139, 36DA150, 36DA151) or are subject to non-intrusive agricultural practices (36DA104, 36DA105). Two additional sites on fee lands are reported to have been heavily collected in the past (36DA102, 36DA103). Regardless, York Haven Power stated that its archaeological reconnaissance did not identify any project-related effects on any of the 24 registered sites within the APE. Although areas of erosion were observed at several sites, and one site (36DA152) was identified as intermittently inundated, York Haven Power stated that any shoreline erosion at these sites is a consequence of natural river flows and not project operation (York Haven Power, 2012a).

Five historic structural resources were identified within the York Haven Project APE. One of these has been determined to be ineligible for listing on the National Register, and three are recommended as ineligible. Effects to these resources have therefore not been assessed. The remaining two structures are eligible or potentially

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[85] December 12, 3013 Motion to Intervene of the Onondaga Nation from Chief I. Powless, Jr., Secretary, Onondaga Nation, Nedrow, New York, filed December 24, 2013.

eligible for inclusion in the National Register. Of these, the Three Mile Island nuclear plant is located within the FERC-designated "exclusion zone." No project effects on the plant were identified. However, normal operation and maintenance activities associated with the historic York Haven Hydroelectric Project facilities could adversely affect the character-defining features of this facility.

Muddy Run Project

In its November 2, 2012, Additional Information Request, the Commission requested that Exelon provide a discussion of the current status of the three previously recorded sites identified during Phase IA cultural resources studies. In its December 28, 2012, response, Exelon explained that one site is currently inundated by the Muddy Run reservoir (36LA103), and one site is unaffected by project-related erosional impacts (36LA368). Exelon stated that AOI 1 and AOI 9, which were investigated during Phase IB studies, were located within the boundaries of the third site (36LA67) and that no cultural materials or features were observed. However, because this site lies within the APEs for both the Muddy Run and Conowingo projects, the Phase IB report recommends further investigation of the site as part of the Conowingo Project relicensing to determine the site's condition and to assess erosional impacts (Sara et al., 2012a). Exelon concluded in section 3.3.8.2 of its application that the continued operation of the Muddy Run Project and "associated Project recreation" could affect cultural resources. Exelon also notes that siltation may be considered to have a positive effect in some situations because it provides a layer of protection.

Exelon's application identifies a single architectural resource present within the Muddy Run Project APE. The Ritchie-Robinson House has been recommended as ineligible for listing on the National Register and therefore, project effects on this resource need not be assessed. Exelon's historic structures report (Henry and Jenkins, 2012a) also identified the Muddy Run Hydroelectric Project system as a potential historic property. Because the system has not yet reached the 50-year threshold for National Register eligibility, Exelon did not complete an assessment of effects for this resource.

Conowingo Project

Exelon concluded in section 3.3.8.2 of its application that the continued operation of the Conowingo Project and "associated Project recreation" could affect cultural resources. Exelon also noted that siltation may be considered to have a positive effect in some situations because it provides a layer of protection. Exelon's Phase IB report (Sara et al., 2012b) also recommended additional field study of the eight sites investigated in the study to determine site boundaries and eligibility. However, by letter dated July 3, 2012 (letter from D.L. Henry, Preservation Officer, Maryland Historical Trust, Crownsville, Maryland, to K.D. Bose, Secretary, FERC, Washington, D.C., July 3, 2012), the Maryland SHPO provided comments on Exelon's cultural resources investigations and stated that no further archaeological investigations were necessary for the relicensing at this time. Additionally, by email dated April 26, 2012, the Maryland SHPO stated that the removal of specified lands from the Conowingo Project boundary and from federal

jurisdiction would not result in an adverse effect on the Susquehanna and Tidewater Canal terminus because the Maryland Historical Trust holds a perpetual preservation easement on the property (email from D.L. Henry, Preservation Officer, Maryland Historical Trust, Crownsville, Maryland, to D.S. Searman, Maryland DNR, Annapolis, Maryland, filed June 21, 2011). The Maryland SHPO concluded that continued operation of the Conowingo Project would have no adverse effect on historic properties, including the historic Conowingo Project Hydroelectric Project facilities.

A ninth site investigated during the Phase IB study is located in Pennsylvania (36LA69). By letter dated February 16, 2012, the Pennsylvania SHPO recommended completing Phase II evaluations at this site because the site is threatened by ongoing erosion.

Historic Properties Management Plans

York Haven Project

In April 2012, York Haven Power prepared a draft HPMP to address project-related effects on historic properties and unevaluated cultural resources. The Pennsylvania SHPO provided comments on the draft HPMP (letter from D.C. McClearen, Chief, Division of Archaeology and Protection, Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, Pennsylvania, to D. Weaver, York Haven Power Company, York Haven, Pennsylvania, September 14, 2012), and York Haven Power addressed those comments in a revised HPMP filed with the Commission on December 28, 2012 (Stallings and Franz, 2012).

In its HPMP, York Haven Power proposes to appoint a cultural resources coordinator and implement review procedures that would apply to non-routine maintenance activities, structural modifications, or additions that may be necessary in the future. Additionally, the HPMP includes measures and procedures for: (a) an employee cultural resources awareness program; (b) the treatment of inadvertent discoveries of cultural materials; (c) the treatment of human remains that may be identified during project activities; (d) additional archaeological investigations including protocols for any new construction activities intended to avoid affecting National Register-eligible resources; (e) any sale or transfer of project lands; (f) ground maintenance and landscaping within the project APE; (g) monitoring archaeological sites identified within the project APE including inspection and reporting policies; (h) potential effects on historic hydroelectric system structures; (i) activities that are exempt for further section 106 consultation; and (j) review and updates of the HPMP should license modifications become necessary or should regulation change. If these situations do not occur, the HPMP would be reviewed and revised every 10 years in consultation with the Commission, the Pennsylvania SHPO, interested Native American tribes, and other parties as appropriate.

Muddy Run Project

Exelon stated that continued operation of the Muddy Run Project would not affect historic properties that are listed or eligible for listing on the National Register. For this reason, Exelon did not develop an HPMP for the Muddy Run Project. However, Exelon also stated that continued operation and maintenance and project-related recreation activities have the potential to affect sites and that "in some cases, sites are being affected by siltation, which may be considered a positive effect because it provides site protection." Exelon proposes to perform section 106 consultation prior to any project-related ground-disturbing activity, including recreational development. If previously unidentified cultural resources are identified during such activity, Exelon would consult with the Pennsylvania SHPO and if necessary, prepare a cultural resources management plan to address the discovery in compliance with section 106.

In its January 31, 2014, comments, recommendations, preliminary terms and conditions, and preliminary prescriptions, Interior provides a 10(a) recommendation in accordance with the FPA that Exelon prepare an HPMP for the Muddy Run Project in consultation with the Pennsylvania SHPO and other parties.

Conowingo Project

In its HPMP, Exelon proposes to appoint a cultural resources coordinator and implement review procedures that would apply to non-routine maintenance activities, structural modifications, or additions that may be necessary in the future. Additionally, the HPMP includes measures and procedures for: (a) appointment of a cultural resources coordinator who would be responsible for overseeing implementation of the HPMP and coordinating consultation activities; (b) potential project effects on the historic Conowingo Project facility and other historic structures, including consultation with the Maryland SHPO or Pennsylvania SHPO and others as appropriate; (c) ground-disturbing activities that have the potential to affect archaeological resources; (d) monitoring all archaeological sites and 19 AOIs identified within the project APE including inspection and reporting policies and a requirement to consult with the Maryland SHPO or Pennsylvania SHPO and others as appropriate should effects be identified; (e) Phase II evaluations at site 18LA69 as requested by the Pennsylvania SHPO within 1 year of HPMP implementation; (f) archaeological public outreach and interpretation programs, (g) the treatment of inadvertent discoveries of cultural materials; (h) emergency situations with the potential to affect historic properties; (i) consultation with the Delaware Nation and the Onondaga Nation; (j) the treatment of human remains that may be identified during project activities; (k) the curation of any cultural materials that may be recovered during archaeological fieldwork; (l) annual reporting to the Pennsylvania SHPO and Maryland SHPO; and (m) review and amendment of the HPMP as needed.

Our Analysis

York Haven Project

York Haven Power's HPMP includes many of the standard requirements of a HPMP. However, some measures contained within the draft HPMP would benefit from clarification and/or more detail, and there are other measures that would be worth inclusion in the final HPMP.

A comprehensive archaeological survey of all lands within the York Haven Project APE was not undertaken, and most of the previously documented sites identified in the APE are situated on privately held lands. Where possible, these sites were inspected by boat. In its HPMP, York Haven Power states that it has no management responsibilities for these sites without right-of-way entry permission from the relevant landowners. However, section 106 requires the assessment of effects regardless of property ownership. Section 3.6 of the HPMP specifies that consultation with the Pennsylvania SHPO, Tribal Historic Preservation Officers, Indian Tribes, and other parties would be conducted if shoreline monitoring efforts identify project-related effects on archaeological sites in the future. However, it is not clear that this requirement in the HPMP also applies to sites on private lands within the project boundary. If project effects to sites on private lands are identified during monitoring, inclusion in the HPMP of a requirement to seek access to assess those sites would ensure compliance with section 106. If such consultation is necessary for sites on private lands, the HPMP should reflect that it would include specific requests for landowner access permission to evaluate any affected sites located on private property.

In its HPMP, seven sites were identified that are located on York Haven Power fee lands (36DA102, 36DA103, 36DA104, 36DA105, 36DA139, 36DA150, 36DA151). York Haven Power states that some of these sites are subject to no-till farming, and others are reported to have been heavily collected in the past. York Haven Power proposes to undertake annual monitoring of these sites. However, full recordation and National Register evaluation of these sites would not require private landowner permission and would enable an assessment of any potential effects in a timelier manner. Inclusion in the HPMP of a plan and schedule to evaluate sites on fee lands for their National Register eligibility would ensure that any effects on sites owned by York Haven Power are fully considered in accordance with section 106.

Appendix B of the HPMP provides a schedule for monitoring of archaeological sites located within the project APE based on potential effects, property ownership, and whether or not the sites are already being monitored under the requirements of an HPMP developed for the Three Mile Island Project. The monitoring plan and schedule is appropriate, but excludes monitoring of two sites: 36YO300 and 36YO334. These two sites are not listed in Appendix B. While they are situated on privately held lands, it is not clear if they are located on the shoreline and can be monitored by boat like other sites on private lands, or if they are interior sites that cannot be monitored. Inclusion of these

two sites in the monitoring schedule, or clarification regarding why they were excluded, would ensure that they are appropriately addressed.

Muddy Run Project

Exelon proposes to prepare a cultural resources management plan only if cultural materials are identified during project-related activities. However, there are several reasons why the development of an HPMP prior to that time would be beneficial.

In the Commission's November 2, 2012, Additional Information Request, we requested that Exelon provide a discussion of the current status of the three sites identified during Phase IA cultural resources studies, including archaeological site 36LA67. In its response, Exelon stated that the two AOIs (1 and 9) investigated during Phase IB studies were located within the boundaries of this site and that no cultural materials or features were observed. However, according to figure 4-1 of the Phase IA report (Sara et al., 2011a), AOI 1 is located on the northern shoreline of Muddy Run reservoir and AOI 9 is located in the vicinity of the dam.[86] According to figure 3-12 of the report, site 36LA67 is not located in either of these two locations but is in proximity to the project transmission line. Potential effects associated with the maintenance of this line are not addressed in the application. Further, this site is situated within an area that may be affected by reservoir discharge. The current condition of the site therefore remains unclear, and its National Register eligibility status, and that of the other two sites identified in the APE (36LA103, 36LA368), is unknown. Two additional sites are located outside of the project boundary (36LA70, 36LA47) but also appear to be close to the reservoir discharge area and near the transmission line. Potential project effects on these sites as a result of discharge and transmission line access and maintenance should be considered in an HPMP.

While Exelon has stated that there are no project effects on historic properties, the three sites identified in the Phase IA report have not been formally evaluated and therefore remain potentially eligible for listing on the National Register. As noted by Exelon in its application, and as discussed above, these sites and others could be affected by continued operation, maintenance, and recreational activity associated with the project. Additionally, in its application, Exelon states that "some sites" are being affected by siltation and notes that this may result in a positive effect. However, the specific sites affected by siltation are not identified, and siltation does not necessarily result in a positive effect in all situations. Only a formal assessment of effects on a case-by-case

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[86] The Phase IA report prepared for the Muddy Run Project (Sara et al., 2012a) does not identify any AOI where site 36LA67 is located. However, this area is also located within the APE for the Conowingo Project and is identified as AOI 13 in the Phase IA report prepared for that project (Sara et al., 2011b). AOI 13 is described as having a high potential for archaeological resources.

basis in consultation with the Pennsylvania SHPO would establish whether there is any effect. To our knowledge, the Pennsylvania SHPO has only concurred that no further work is needed within the two AOIs investigated during the Phase IB study and has not concurred with Exelon's recommendation that the project will not affect historic properties.

A comprehensive archaeological survey of all lands within the Muddy Run Project APE was not undertaken, and only 2 of the 12 AOIs identified during Phase IA studies were inspected during Phase IB studies. The potential for additional, previously unidentified cultural resources that may be eligible for listing on the National Register within the project APE remains. Exelon's Phase IB report recommends that additional AOIs should be surveyed during the development of a future HPMP (Sara et al., 2012a). Additionally, while the pumped storage project facility may not currently meet the general 50-year threshold for National Register eligibility, the facility will meet that threshold within 2 years. Staff agrees with Exelon's historic structures report (Henry and Jenkins, 2012a) that recommends evaluating the system for listing.

Staff agrees with Interior's recommendation that development of an HPMP would be appropriate for this undertaking because unevaluated properties that are potentially eligible for listing on the National Register and may be affected by future operation, maintenance, and project-related recreational activities, are located within the Muddy Run Project APE. Preparation of an HPMP that (1) includes a plan for additional archaeological investigations of additional AOIs and other areas, (2) addresses the National Register eligibility of the three identified archaeological sites and the Muddy Run Project system, and (3) requires evaluation of potential project-related effects on these and other resources that may be affected by maintenance, operation, and recreational activities (including sites potentially affected by transmission-related activities such as sites 36LA70, 36LA47), would ensure that cultural resources are appropriately addressed in compliance with section 106. Further, the HPMP should be prepared in accordance with the Advisory Council and Commission's joint guidance document for preparing hydroelectric project HPMPs (FERC and Advisory Council, 2002).

The Delaware Nation and the Onondaga Nation have been identified as the federally recognized tribes with cultural ties to the Muddy Run Project area. In accordance with section 106, the tribes should be included in all correspondence related to cultural resources; however, the application does not describe consultation with the tribes completed by Exelon to date. The HPMP should specify when consultation with the Delaware Nation and the Onondaga Nation would be required, and copies of all consultation documentation should be included as an appendix to the HPMP.

Conowingo Project

Exelon's August 2012 HPMP includes many of the requirements of a HPMP. However, there is background information provided that is not entirely clear, and there

are several measures that would benefit from clarification and/or more detail. We also suggest other measures worthy of inclusion in the HPMP.

Exelon proposes a new project boundary that excludes lands downstream from Conowingo dam. The project APE includes most of these lands because Exelon states they may be affected by project operation in the future. The inclusion of these lands in the project APE is appropriate. However, while the Maryland SHPO concluded in its July 3, 2012, letter that continued operation of the Conowingo Project would have no adverse effect on historic properties, it is our understanding that this determination is primarily considering erosion and other physical effects on cultural resources. Interior's January 31, 2014, comments, however, express concern for the potential loss of resource protection, including protections to cultural resources, should lands be removed from the project boundary. Further, in accordance with 36 CFR 800.5(a)(2)(vii) of the regulations implementing section 106 of the NHPA, the "transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation" of historic properties may constitute an adverse effect.

For this reason, all lands within the current project boundary could be affected by a change in the project boundary and must be included in the project APE. This would include a narrow strip of land located in the current project boundary that extends downstream from Spencer Island along the west side of the river to the city of Havre de Grace, Maryland. Exelon excluded this area from the APE because it did not identify any physical project effects here. The APE maps provided in the HPMP therefore do not include this area. According to the Phase IA report (Sara et al., 2011a), this strip of land contains four additional previously recorded archaeological sites (18HA240, 18HA267, 18HA268, 18HA269). None of these sites are discussed in the text of the HPMP, although site 18HA269 is listed in the HPMP's table 3-2. Inclusion of these lands in the project APE would ensure that all four of these sites, and any other previously unidentified resources that may be present in this area, remain protected under the HPMP.

While the Commission determined that the removal of the Susquehanna and Tidewater Canal Southern Terminus (HA-112) from the project boundary would have an adverse effect on this resource (letter from C. Yeakel, Division of Hydropower Compliance, FERC, Washington, D.C., to R. Little, Maryland SHPO, Maryland Historic Trust, Crownsville, Maryland, May 14, 2010), as mentioned above, on April 26, 2011, the Maryland SHPO subsequently determined that removal of lands from the project boundary would *not* adversely affect this structure. However, inclusion in the HPMP of requirements to inventory any lands within the project APE (particularly AOIs identified in the Phase IA study that were not subject to Phase IB study), evaluate any identified cultural resources for National Register eligibility, and address potential effects prior to any sale or transfer of those lands would ensure that cultural resources located on these lands would be appropriately considered in compliance with section 106. This requirement would primarily relate to lands owned in fee by Exelon, although sites on

privately held lands might also be affected. If project effects of any kind on cultural resources on private lands are identified over a new license term, Exelon would make a good faith effort to obtain access to the property to conduct appropriate studies.

In sections 3.3.8.1.3 and 3.3.8.2 of its application, Exelon states that nine archaeological sites were identified in the project APE during Phase IB studies. However, while Exelon is correct there were nine sites documented during this study, (two previously recorded sites and seven newly identified sites), the total number of sites identified in the Conowingo Project APE is 48, including 37 sites that had been identified during the Phase IA study and the additional four sites downstream of Spencer Island discussed above. Further, Exelon's HPMP includes a plan to monitor only 37 of the 48 archaeological sites located within the project APE. Revision of the HPMP to include all identified 48 sites would ensure that they are appropriately addressed in accordance with section 106.

A total of 27 historic structures or historic districts were identified within the Conowingo Project APE (see table 3-37). However, table 3-1 of Exelon's Conowingo HPMP lists only seven historic structures. One of the seven structures in the table is the Lower Deer Creek Valley Historic District (HA-1551); three structures (HA-191, HA-195, HA-196) are identified in the table as being contributing elements of the district that are located within the project APE. However, according to Exelon's historic structures report (Henry and Jenkins, 2012b), six additional structures that contribute to the district (HA-376, HA-377, HA-380, HA-381, HA-382, HA-2190) are also located within the project boundary and APE and have been excluded from the HPMP. Additionally, there are 14 other structures that have been excluded. Three of these structures are listed on the National Register, one is eligible for listing, and one has been demolished. The remaining nine structures have been recommended as ineligible for listing but to our knowledge, neither the Maryland SHPO nor the Pennsylvania SHPO has concurred with these recommendations. Inclusion of all 27 structures in the HPMP or an explanation regarding why they need not be considered in the HPMP would clarify their current status and ensure that they are considered under the requirements of section 106.

Of the seven structures listed in table 3-1, the National Register eligibility of the Columbia & Port Deposit Railroad is identified as both "undetermined" and "not eligible." In its letter dated July 23, 2012, the Pennsylvania SHPO determined that this structure is indeed eligible for listing on the National Register.

Exelon's historic structures report (Henry and Jenkins, 2012b), identifies site HA-1971 as both "Conowingo Hydroelectric Facility" and "U.S. 1 over Susquehanna River (Conowingo Dam)," while the description provided in table 3-1 of the HPMP identifies it as the "Conowingo Hydroelectric Facility." The structures report explains that, in 2001, a Historic Bridge Inventory Form was prepared for the U.S. Route 1 bridge (which consists of the dam), and that the bridge was recommended as eligible for listing on the National Register under Criterion C. According to the structures report, the Maryland Historical Trust accepted the Historic Bridge Inventory on April 3, 2001, and

at that time, recommended that a separate form be completed for Conowingo dam and the hydroelectric components of the structure. However, Exelon's structures report further explains that Exelon's consultant was informed by the Maryland SHPO on October 21, 2010, that a separate form and evaluation of the hydroelectric component of the facility need not be completed for the hydroelectric facility. Clear identification in the HPMP of the name of the structure provided on the form for HA-1971 and documentation of the Maryland SHPO's current position on the necessity of any new form for the Conowingo Project structures would settle the issue. Exelon's HPMP contains a list of the character-defining features of the facility, which includes the powerhouse and machinery, the bridge, and the dam. In the HPMP, Exelon stated that it would consult with the Maryland SHPO to establish a PA that would detail project activities involving the system that can be completed without Maryland SHPO review. A list of activities exempt from SHPO review is provided in the HPMP. While we are not aware of any concurrence yet received from the SHPO on this list, staff finds that the activities listed would not require specific section 106 consultation. As the Commission intends to execute a PA with the Maryland SHPO that would implement a final HPMP that includes a list of exempt activities, an additional PA between Exelon and the Maryland SHPO would not be necessary. However, should the Maryland SHPO identify additional activities not currently included on the list, the HPMP could be revised to include those activities.

Exelon's HPMP states that, should ground-disturbing activities be proposed within the APE in an area that contains an existing archaeological site or could contain an archaeological site, Exelon would consult with the appropriate SHPOs regarding potential effects of the activity. However, in areas that have not been subject to archaeological survey, the HPMP does not specify how Exelon would make the determination that archaeological sites would or would not be affected. Inclusion in the HPMP of how these determinations would be made would provide clarity.

In the HPMP, Exelon proposes to conduct a public outreach program to inform the public about culturally significant areas within the APE to discourage vandalism and looting. While such outreach programs are worthwhile, they should focus on the general sensitivity of the project as a whole and not identify the locations of specific culturally sensitive areas.

The Delaware Nation and the Onondaga Nation have been identified as the federally recognized tribes with cultural ties to the Conowingo Project area. In its HPMP, Exelon states that any correspondence would be directed to the tribe, but the HPMP does not specify when consultation with the Delaware Nation or the Onondaga Nation would be required nor does the application or HPMP describe consultation with the tribes completed by Exelon to date. In accordance with section 106, the tribes should be included in all correspondence related to cultural resources and copies of consultation documentation should be included as an appendix.

Programmatic Agreements

The Commission intends to execute PAs among the Commission, Maryland SHPO, Pennsylvania SHPO, and the Advisory Council (should it choose to participate). York Haven Power, Exelon, participating tribes, and others, as appropriate, would be invited to sign the PAs as concurring parties. Any licenses issued for the projects would include a stipulation that would implement the PA for that project. If the HPMPs are finalized prior to license issuance, the PAs would include a measure to implement the final HPMP upon license acceptance. If the HPMPs are not finalized prior to license issuance, the PAs would instead require each HPMP to be finalized within a specified period of time post license acceptance, typically 1 year. Revising and implementing the HPMPs for the York Haven and Conowingo Projects to include Commission staff's additional measures and corrections, and the development of an HPMP for the Muddy Run Project, in consultation with the Maryland SHPO, Pennsylvania SHPO, participating tribes, and the Commission, would ensure that potential adverse effects of continued operation, maintenance, recreation or other activities on cultural resources would be addressed over the term of the licenses.

3.3.7 Aesthetic Resources

3.3.7.1 Affected Environment

The Susquehanna River from Harrisburg to its confluence with the upper Chesapeake Bay passes through diverse natural and human built environments. The river corridor provides a wide range of geologic features, habitats, and human development such as hydropower plants and industrial yards dating back to the early 1900s. The river has a variety of unique geologic features including river potholes, exposed bedrock, steep cliffs, and wide deep pools. River banks and shorelines are generally covered in deciduous forest with residential lots, recreation access, and transportation infrastructure visible throughout. The river provides water to four hydroelectric facilities, one pumped storage project, two nuclear power plants, and one steam-electric station. Lands surrounding the river are rural with majority in agricultural uses. Higher elevations provide opportunities for sweeping views across the rolling topography and river valley and are dominated by the rural setting through which the river transverses.

At the York Haven Project, aesthetic features of Lake Frederic include views of surrounding shorelines, islands, and project features. Human development includes shoreline development (residential lots, recreation access, and commercial marinas), open space, and larger industrial features such as Three Mile Island nuclear generating station and Brunner Island Station, a coal-fired steam electric generating plant located about 1.5 miles downstream of York Haven.

Project features are only visible in proximity to the main dam, powerhouse, and east channel dam and fishway. The red brick powerhouse is characteristic of industrial structures built in the early 1900s while most of the other structures are of grey concrete. The islands within the impoundment consist of mixed uses including industrial (Three

Mile Island generating station), cultivated crops, recreational lots, and developed recreation sites. The remainder of the York Haven Project area visual landscape includes rural community residential and commercial development, regional infrastructure (e.g., railroad), and deciduous forests.

Aesthetic features surrounding the Muddy Run Project are dominated by rolling hills covered with deciduous forest, agricultural uses, and recreation uses associated with Muddy Run Park and WMA and adjacent to the powerhouse. Views within the Recreation Lake and Muddy Run Park areas consist of manicured park settings with maintained lawns, mature trees, and public recreation infrastructure like buildings, picnic shelters, sports areas, a boat ramp, campgrounds, and other amenities described in detail in section 3.3.5, *Recreation and Land Use Resources*. The visual setting within the WMA is natural with the majority of the area in forested setting with small tracts of land cleared for parking areas or feed plots. Large portions of the project around the upper reservoir near the intake towers are not visible to the public because of limited access. The powerhouse is visible from Conowingo Pond and is set against the steep topography between the Muddy Run powerhouse along the Conowingo Pond shoreline and the upper reservoir. The powerhouse exhibits large industrial-type features dominated by grey concrete, the riprapped shoreline, overhead crane, transformer, substation, transmission lines, and parking areas. Portions of the upper reservoir dam are also visible from Conowingo Pond.

U.S. Route 1 crosses the top of Conowingo dam providing views of the reservoir and river downstream to passing motorists. Project structures of this area include the powerhouse, Conowingo dam, and the spillway. These facilities dominate the views from Fisherman's Park/Shures Landing immediately below the powerhouse. Within Conowingo Pond, views include islands, residential lots, recreational access, and industrial features such as the Muddy Run Project facilities and PBAPS located on the west shoreline near the midpoint of the reservoir. Lands adjacent to the project boundary offer diverse aesthetic qualities because of the rolling topography, vegetation, agricultural uses, and general open space.

3.3.7.2 Environmental Effects

For all three projects, existing project facilities and operations are generally consistent with the existing visual aesthetics of the area. Some facilities are visible on the landscape and contrast with the surrounding setting, but have not been shown to detract substantially from the natural character of the area. York Haven Power and Exelon do not propose any specific measures for aesthetic resources. However, proposed environmental measures, such as construction of the nature-like fishway, operation of the Muddy Run Project, and debris removal from Conowingo Pond, may affect visual aesthetics over the term of any new licenses for the projects.

Effects of Construction of the Nature-Like Fishway

York Haven Power proposes to construct a nature-like fishway near the eastern end of the main dam and Three Mile Island. The fishway would consist of a series of rock weirs allowing fish passage over the main dam. Construction would include: improving existing access roads on Three Mile Island; a temporary, two-lane access road for retrieval and transport of river rock across the river bed below the dam; three staging areas on Three Mile Island; a cofferdam; a rock ramp fishway; an attraction water system; and concrete abutment walls. The new feature would extend from the toe of the dam into the existing reservoir, which at the apex of the main dam and Three Mile Island is about 10 feet high. The proposed fishway would be about 300 feet wide and about 500 feet long. York Haven Power expects the rock retrieval period of the project to last 3 years and final construction to be finished 8 years after any license is issued.

Our Analysis

Nature-like fishways are designed to simulate the geomorphology, hydraulics, and functions of natural river channels. Construction of the nature-like fishway would require the installation of a temporary cofferdam to isolate the construction of the rock ramp and other structures (e.g., intake gates and attraction water system). Large excavators would shuttle between extracting exposed river rock and transporting the rocks to the fishway weirs for about 3 years. The use of native river rocks would give the new structure a more naturally appearing aesthetic than traditional geometric fish ladders. The east edge of the fishway would terminate in a combination of a poured concrete abutment and conveyance system designed to control flows in the rock weirs and provide attraction flows to the base of the fishway, respectively. The finished fishway would be most visible to kayakers and other recreation users in the main channel downstream from the dam, in proximity to Three Mile Island. Between April and June when water is directed into the fishway for operations, the fishway would be covered in water as it flows through the artificial pool-riffle weirs. During times of the year when flows are not sufficient to spill and fill the fishway naturally, the rock ramp weirs would be dry with some pools of water.

Effects of Operation of the Muddy Run Pumped Storage Project

During project scoping, commenters raised concerns about the effects of lighting and project-associated noise on visitors to the area. Specifically, commenters raised concerns about the lighting and noise associated with the operations (generation and pumping) at Muddy Run; however, no specific locations or receptors were identified. Lights are installed on the intake towers in the upper reservoir and throughout the powerhouse area and access road along the shore with Conowingo reservoir.

Exelon does not propose, nor does any other entity recommend specific measures that pertain to managing light and noise specifically related to the project.

Our Analysis

Several formal recreation facilities are located within or in proximity to the Muddy Run Project boundary, including Wissler's Run Park, Muddy Creek Boat Launch, the Lock 15 Interpretive Area, Susquehannock State Park, Cold Cabin Boat Launch, Muddy Run WMA, and Muddy Run Recreation Park (see section 3.3.5, *Recreation and Land Use Resources*). Additionally, several islands are located in the Susquehanna River near the Muddy Run Project. Although there are no formal recreation facilities on these islands, they provide opportunity for passive daytime recreation, and some contain lots that are currently leased by cottage owners. Nighttime use of the islands is restricted to cottage owners.

Exelon recorded noise levels and took representative photos of day- and night-time conditions from 10 representative locations in relative proximity to project features. Figure 3-21 shows the locations of these public areas.

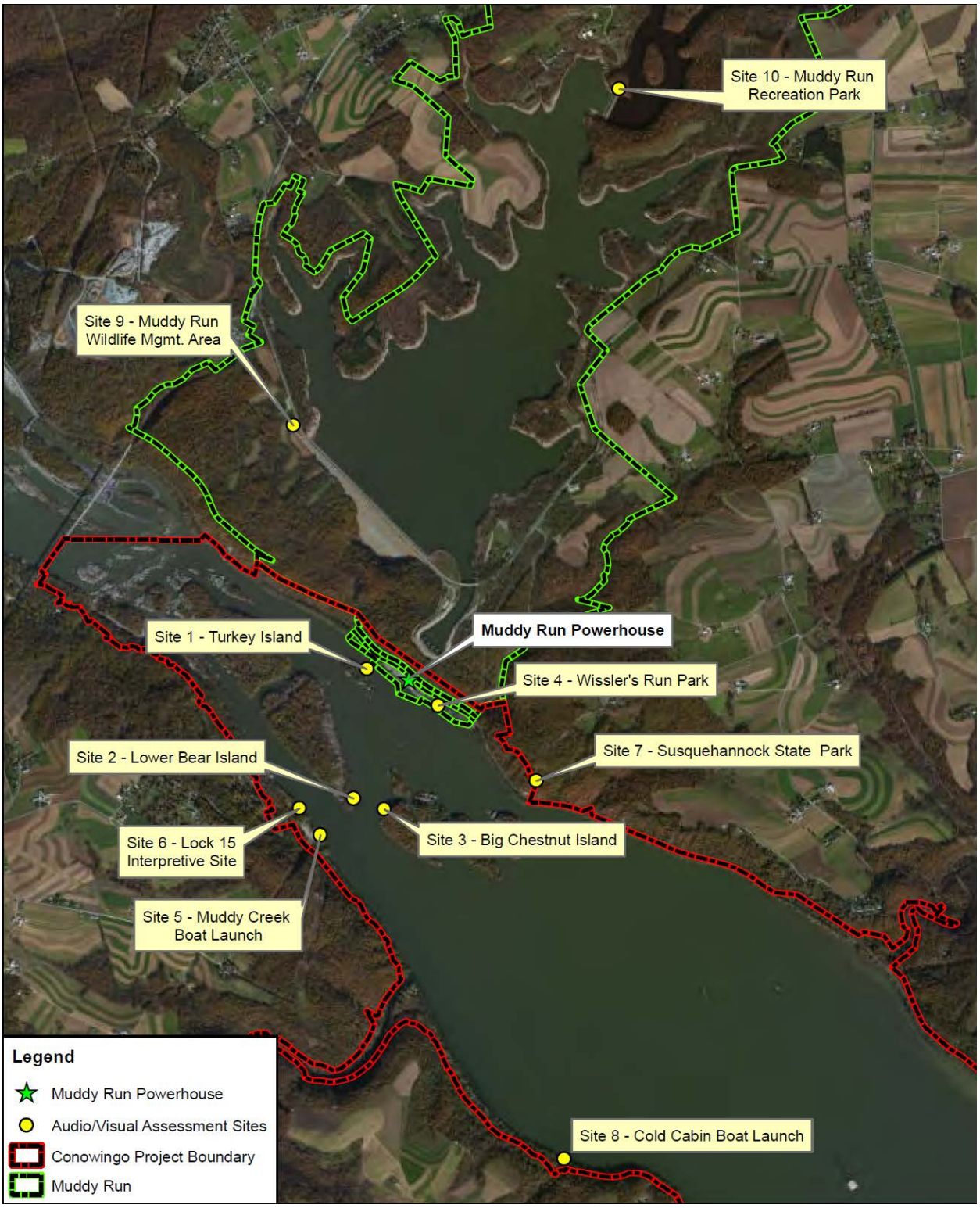

Figure 3-21. Aesthetic (audio and visual) assessment locations (Source: Exelon, 2012, as modified by Staff).

Typical operation of the Muddy Run Project consists of pumping water from Conowingo Pond to the Muddy Run reservoir during low-load (typically nighttime) periods when energy costs are low, then generating (releasing water from the Muddy Run reservoir back to Conowingo Pond) during high load (typically daytime) periods.

Exelon's aesthetic study results indicate that the level of impact (intensity of light or noise) is related to proximity to the powerhouse and that some sites are impacted more than others. The Muddy Run powerhouse is clearly visible during both day and night from islands directly across from the powerhouse (Turkey Island, Lower Bear Island, and Big Chestnut Island), as well as from Wissler's Run Park. At the Muddy Creek Boat Launch, Lock 15 Interpretive Area, and Susquehannock State Park (public recreation areas in relative proximity to the powerhouse), the powerhouse usually cannot be clearly seen during the day, but the glow of its lights is visible at night. Other facilities, such as the transmission line towers on Lower Bear Island (day) and the intake towers lights (night), are generally visible at these sites.

At Cold Cabin Boat Launch, no facilities can be seen during the day, and only the intake tower lights can be seen at night. At Muddy Run WMA, only the dam and reservoir can be seen during the day, and a faint glow from the powerhouse and/or intake towers can sometimes be seen at night. Lastly, at Muddy Run Recreation Park, only the power reservoir can be seen during the day; no lights can be seen at night.

Project lighting at nighttime is highest at select locations (i.e., Conowingo Islands); however, the Conowingo Islands have restrictions against public use at night. The amount of lighting visible from the surrounding locations changes with the seasons as leaf off conditions allow better sight lines to see the project's night lighting.

Noise has the potential to disturb visitors to the Muddy Run Project and vicinity, as well as to some of the Conowingo Project formal recreation sites. Noise-producing equipment at the project includes pump-generators, ventilation fans, transformers, fans on the transformers, and powerlines. Exelon measured the ambient acoustic environment (the all-encompassing sound in a given environment) at the 10 locations. The soundscape at each location is influenced by motorboat, vehicular, and air traffic; construction activities; human activities; and other natural sound sources. To capture the ambient sound levels, Exelon recorded 5 seconds of ambient noises occurring every 5 minutes and averaged these for the duration (deleting loud, temporary sounds like a passing truck or overhead airplane) of the recording.

Exelon's results show that average ambient noises ranged from 34 to 61 decibels (dB) across all sites and seasons.[87] Not every site was dominated by sounds emanating from the powerhouse; at some sites the project was audible and at other, more

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[87] Logarithmic scale known as the decibel scale (dB) used to quantify sound pressure into a manageable range.

distant locations, the project was not audible at all. Table 3-38 summarizes the average noise levels at each site by season for both day and night. Comparison of these measurements with table 3-39 suggests that at locations dominated by the sounds of the powerhouse, noise levels are comparable to quiet urban settings.

Table 3-38. Audio assessment results (Source: Exelon, 2012, modified by Staff).

	Spring		Summer		Fall		Winter	
Site Name	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
Turkey Island	48	52	50	56	54	57	52	57
Lower Bear Island	44	44	43	53	50	52	46	52
Big Chestnut Island	40	39	43	50	42	46	42	52
Wissler's Run Park	40	41	44	48	41	45	48	50
Muddy Creek Boat Launch	39	39	41	55	49	54	41	47
Lock 15 Interpretive Area	41	38	49	61	47	55	42	44
Susquehannock State Park	46	37	46	57	44	58	40	49
Cold Cabin Boat Launch	38	37	46	53	46	51	42	54
Muddy Run WMA	37	34	45	59	46	54	42	43
Muddy Run Park	41	36	45	52	42	50	43	43

Key: Red=powerhouse noise dominant; Yellow=powerhouse noise audible but not dominant; Green=powerhouse noise not audible.

Exelon's aesthetic assessments indicate that the current levels of light are relative to the proximity of the viewer to the light source and clearly visible from the islands and Wissler's Run park; however, nighttime use of the islands is prohibited. Public recreation sites on the west side of the river across from Muddy Run do not have clear sight lines but can see the glow of the lights on the powerhouse at night. The same assessment for noise indicates that noise at sites where powerhouse sounds are audible, but not the dominant sound, measure as much noise as the sites close to the powerhouse. This indicates that there are sufficient background noises other than the powerhouse that contribute to the overall noise levels in the project vicinity.

Table 3-39. Loudness comparison chart (Source: Exelon, 2012).

Common Outdoor Sounds	Noise Level (dBA)
Threshold of human hearing	0
Quiet rural nighttime	20
Quiet suburban nighttime	30
Quiet urban nighttime	40
Quiet urban daytime	50
Heavy traffic at 300 feet	60
Lawn mower at 100 feet	70
Boat (single outboard) at 50 feet	80
Threshold of hearing damage due to prolonged exposure	85
Jet fly-over at 1,000 feet	110

Effects of Debris Removal from the Conowingo Project

As discussed in section 3.3.5, *Recreation and Land Use Resources*, some of the natural and human-generated debris moving through the Susquehanna River watershed gets trapped behind the hydroelectric facilities on the mainstem of the lower Susquehanna River. Most debris is transported during high-flow events, particularly during March and April. Exelon has participated in clean-up efforts and debris studies dating back to 1982, and these studies reported that 75 percent of the total estimated volume of debris was discharged during high-flow events (January through May). A 1989 cooperative agreement by the operators of York Haven, Safe Harbor, Holtwood, Conowingo, SRBC, and regulatory agencies led to routine debris removal actions during normal to low flows. As such, Exelon routinely employs cranes and skimmers to reduce the amount of debris buildup behind Conowingo dam during low-flow periods.

Visitor perceptions and attitudes towards the debris were not recorded during relicensing studies. Within Conowingo Pond, debris typically accumulates near the dam intakes, within tributaries, and under or behind the railroad trestle bridges. Debris trapped in the reservoir makes its way to the dam where it is corralled and removed. The majority of the debris is natural; however, artificial debris is intermixed with the large woody and natural debris degrading the visual appearance of the accumulated materials. The large accumulation of debris near the powerhouse intakes is visible for short durations from traffic on U.S. Route 1 (most notably for vehicles moving east to west) and boaters near the dam. Most of the other areas of debris accumulation are only visible from the water.

Our Analysis

Exelon's proposal to continue to remove debris from in front of the intakes is consistent with the cooperative agreement with the upstream hydroelectric projects and agencies. The amount of debris arriving at Conowingo Pond on an annual basis is a function of the flood flows during the winter months. The Susquehanna watershed is flood-prone, so passing and removing debris is a dynamic process causing Exelon to react to what arrives. Visually, the amount of debris on the pond, in tributaries, and collected in front of the intakes varies from year to year. Although debris removal coincides with the warmer, recreation season when more visitors are able to see Exelon actively removing the debris, those activities are concentrated in the area near the dam.

3.3.8 Socioeconomics

3.3.8.1 Affected Environment

For this socioeconomics discussion, the local area is defined as the area encompassing and immediately surrounding the project areas along the Susquehanna River. This includes residential and commercial developments, in addition to recreational and park lands, along the river shorelines. Socioeconomic information is also provided for the study area, which is the five-county region surrounding the projects.

The York Haven Project is located in York, Lancaster, and Dauphin counties, Pennsylvania, with a total of eight townships and/or boroughs within the project area. The Muddy Run Project is located in Lancaster County, and Peach Bottom Township is the only census-designated place (CDP) within this project boundary. The Conowingo Project area includes Lancaster and York counties in Pennsylvania and Harford and Cecil counties in Maryland.

Population

The state of Maryland experienced a 9 percent population increase between 2000 and 2010, ranking 23rd in the United States for growth rate, and Pennsylvania experienced a 3 percent population increase between 2000 and 2010, ranking 42nd in the United States for rate of population growth (Census Scope, 2010a). Tables 3-40 and 3-41 summarize population trends for both states and all five counties.

Table 3-40. Population in Cecil and Harford Counties, Maryland, and the state of Maryland (Source: Census Scope, 2010a & b).

Year	Maryland	Cecil	Harford
2010	5,773,552	101,108	244,826
2000	5,296,486	85,951	218,590
1990	4,781,468	71,347	182,132
1980	4,216,975	60,430	145,930
1970	3,922,399	53,291	115,378
1960	3,100,689	48,408	76,722

Table 3-41. Population in Dauphin, Lancaster, and York counties, Pennsylvania, and the state of Pennsylvania (Source: Census Scope, 2010a & b).

Year	Pennsylvania	Dauphin	Lancaster	York
2010	12,702,379	268,100	519,445	434,972
2000	12,281,054	251,798	470,658	381,751
1990	11,881,643	237,813	422,822	339,574
1980	11,863,895	232,317	362,346	312,963
1970	11,793,909	223,834	319,693	272,603
1960	11,319,366	220,255	278,359	238,336

Within York County, the York Haven Project is partially located within York Haven Borough (population 709), Goldsboro Borough (population 952), and Newberry Township (population 15,285). Within Dauphin County, the project is partially located in Londonderry Township (population 5,232), Lower Swatara Township (population 8,268), Middletown (population 8,901), and Royalton Borough (population 907). The project is also partially located within Conoy Township (population 3,194) in Lancaster County (U.S. Census Bureau, 2010a).

The Muddy Run Project is located entirely within Lancaster County and partially within Peach Bottom Township (population 4,813) (United States Census Bureau, 2010a). The project is not located within any other CDPs or communities in Lancaster County.

The Conowingo Project boundary contains no CDPs or communities, but includes two incorporated municipalities in Harford County: Aberdeen and Havre de Grace. The City of Havre de Grace has a population of 12,952, and the City of Aberdeen has a population of 14,959. The project boundary includes lands within Cecil County, but no CDPs or communities.

Employment and Income

Employment

Employment in Dauphin, Lancaster, and York counties represented 2, 4, and 4 percent of total employment in the state of Pennsylvania in 2012, respectively; Cecil and Harford counties represented 2 and 4 percent of total employment in the state of Maryland in 2012, respectively (BLS, 2013). Unemployment rates in Dauphin, Lancaster, and York counties were lower than in the state of Pennsylvania as a whole; while unemployment rates were higher in Cecil and Harford counties than in the state of Maryland as a whole in 2012. Of the five counties in the study area, Lancaster County had the lowest unemployment rate in 2012, while Cecil County had the highest unemployment rate (BLS, 2013). Employment levels along with unemployment rates are presented in table 3-42.

Table 3-42. Employment and unemployment percent numbers 2012 (Source: BLS, 2013).

Geography	Total Employment	Unemployment Rate (%)
United States	142,469,000	8.1
Maryland	2,909,571	6.8
Cecil	46,810	8.4
Harford	129,802	7.0
Pennsylvania	5,973,407	7.9
Dauphin	128,581	7.7
Lancaster	250,980	6.6
York	211,027	7.7

Dauphin County is less rural than the other counties in the study area with the city of Harrisburg, the capital of Pennsylvania, located on the east side of the Susquehanna River within the county. According to the 2012 Census, the *primary* industries in Dauphin County are education (23 percent of total employment); retail trade (11 percent of total employment); and professional, scientific, management, administrative and waste

management services and public administration (10 percent of total employment) (U.S. Census Bureau, 2012).

Lancaster, York, Cecil, and Harford counties are largely rural in nature and dominated by agricultural land uses. However, employment in agriculture represents between less than 1 and 3 percent of total employment in these counties. The two industrial sectors with the largest employment in these counties are educational services and healthcare, and manufacturing sectors. The educational services and healthcare sector accounted for 23 percent of total employment in both Lancaster and York counties and 22 percent in both Harford and Cecil counties in 2012 (U.S. Census Bureau, 2010b) (EDC, 2012). Employment in manufacturing accounted for 16 and 18 percent of total employment in Lancaster and York counties, respectively, and 11 and 7 percent of total employment in Cecil and Harford counties, respectively, in 2012. Employment in retail trade accounted for between 10 and 14 percent of total employment in these counties in 2012 (U.S. Census Bureau, 2010b).

Income

Per capita income in the Pennsylvania counties is lower than per capita income in the Maryland counties within the study area. Lancaster County is lower than the Pennsylvania average, while York and Dauphin County have similar per capita incomes to that of Pennsylvania. Dauphin and Lancaster counties have experienced negative growth in per capita income between 2000 and 2010; York County has experienced no growth; and the state of Pennsylvania has only experienced a slight increase in per capita income during this period. Cecil and Harford counties have slightly lower per capita income than that of Maryland, although all per capita income in the geographies has grown in Maryland (U.S. Census Bureau, 2010b). Table 3-43 shows per capita income for the study area and the states of Maryland and Pennsylvania.

Table 3-43. Per capita income for Pennsylvania and Maryland counties in 2000 and 2010, with percent change (inflation adjusted, 2010$) (Source: U.S. Census Bureau, 2010b).

Geography	2000	2010	Percent Change
Maryland	$32,435	$34,469	6%
Cecil County	$27,079	$28,358	5%
Harford County	$30,685	$33,372	9%
Pennsylvania	$26,440	$27,004	2%
Dauphin County	$28,028	$27,052	-3%
Lancaster County	$25,830	$24,871	-4%
York County	$26,678	$26,702	0%

Project Power

All three projects offer benefits to the region in terms of providing low-cost energy; local, county, and state tax payments; employment and economic activity related to operation and maintenance of the project facilities; and public use facilities owned and operated by others that are located within the project areas. The York Haven Project has an installed capacity of 19.62 MW while the Muddy Run and Conowingo projects have installed capacities of 800.25 and 574.54 MW, respectively. This amount of capacity at York Haven is capable of providing the equivalent of approximately 14,700 households with electricity each year; while the capacity at Muddy Run and Conowingo can provide the equivalent of approximately 600,000 and 430,000 households with electricity each year, respectively, assuming 1 MW of power services an average of 750 households per year (York Haven Power, 2012a; Exelon, 2012b).

Project Taxes

York Haven Power and Exelon are subject to a variety of state income and local property taxes. In 2010, these taxes totaled $143,615 for York Haven Power. In 2011, Exelon paid $5 million and $10.5 million in state income and local property taxes on the Muddy Run and Conowingo projects, respectively. Taxes paid by these two companies positively affect the public because state taxes are deposited into general funds, which are directed, in part, back to the county and city governments (York Haven Power, 2012; Exelon, 2012).

Project Employment

The York Haven Project is operated and maintained by 22 full-time employees, and the Muddy Run and Conowingo projects are each operated by 56 employees. These employees positively affect the local and regional economy by consuming goods and services and paying taxes (York Haven Power, 2012; Exelon, 2012).

Project Recreation

As described in section 3.3.5, *Recreation and Land Use Resources*, recreation resources in the region provide a full range of activities, including boating, canoeing, swimming, fishing, water sports, hiking, camping, hunting, biking, and nature viewing. Recreation visitors spend money on activities and at business establishments during their stay in the region, supporting local and regional economies. This visitor spending supports local jobs and income, which, in turn, induces additional economic activity within the local economy, providing additional employment, income, and tax revenues to local governments.

Additionally, York Haven Power leases 288 recreational lots to the public for a small fee, while Exelon leases 420 lots for seasonal residential cottage use (as described in section 3.3.5, *Recreation and Land Use Resources*). Residents of these lots provide a positive benefit to the local economy through local spending that supports local jobs and

income, which, in turn, induces additional economic activity within the local economy, providing additional employment, income, and tax revenues to local governments. These leaseholders also provide a small income to York Haven Power and Exelon through their fee payments.

3.3.8.2 Environmental Effects

York Haven Project

Current project operation has provided significant socioeconomic benefit to the area. The continued operation of the project, which includes the proposed construction of a new fish ladder, would have a positive effect on local and regional socioeconomic conditions by providing both direct and indirect jobs and significantly contributing to state, county, and local tax revenues. There are no plans for changing the operation of the facility that would significantly reduce these benefits, and there are no proposed environmental measures that would have a significant negative socioeconomic effect per the application provided by York Haven Power.

Our Analysis

Continued operation of the project, as well as project spending related to construction of the new fish ladder and other ongoing maintenance, would have a positive effect on the regional economy. Positive effects would be realized through support of companies providing materials and services for the project, the presence of the project workforce and associated consumer spending, and project tax contributions to state and local governments. As discussed in section 3.3.5, *Recreation and Land Use Resources*, it is York Haven Power's current policy not to create any new cottage lease lots within the project boundary and that any leases for existing cottages that are abandoned or become damaged and are not replaced by structures conforming to all applicable regulations will be terminated. Termination of lot leases would likely cause a decrease in spending in the local economy, along with a decrease in local income and property taxes, and result in negative impacts to the local economy. However, these permit terminations are expected to occur over a number of decades, resulting in minimal long-term impacts to the local economy. The proposed, continued operation of the York Haven Project would have no unavoidable adverse effect on socioeconomic resources.

Muddy Run and Conowingo Projects

Current operations have provided significant socioeconomic benefit to the area. The continued operation of these projects would have a positive effect on local and regional socioeconomic conditions by providing both direct and indirect jobs and significantly contributing to state, county, and local tax revenues. There are no plans for changing the operation of the facilities at these projects that would reduce these benefits. Therefore, there are no proposed environmental measures that would impact socioeconomics per the application provided by Exelon.

Our Analysis

Changes to Muddy Run and Conowingo project operations are not proposed, so no changes to socioeconomic conditions are expected. Project operations would continue to supply low cost electricity. Continued operation of the projects would have a positive effect on the regional economy through support of companies providing materials and services for the projects, the presence of the project workforces and associated consumer spending, and project tax contributions to state and local governments. Continued maintenance of the projects' facilities, including recreation facilities, would result in some construction-related jobs, although the labor force required is likely to be small and temporary. Continued operation of the Muddy Run and Conowingo projects would have no known unavoidable adverse effects on socioeconomic resources.

Exelon's current policy of not creating any new leases on cottages within the Conowingo Project boundary, as discussed in section 3.3.5, *Recreation and Land Use Resources*, would continue. In addition, as existing cottages are abandoned or become damaged and are not replaced due to local zoning restrictions, leases would be terminated. Termination of lot leases would likely result in a decrease in spending in the local economy along with a decrease in local income and property taxes, resulting in negative impacts to the local economy. However, removal of leased cottages from Conowingo's land is expected to occur over many decades and would not result in significant adverse effects on socioeconomic resources.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative, the projects would continue to operate as they have in the past. None of York Haven Power's or Exelon's proposed measures or the resource agencies' recommendations and mandatory conditions would be required.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the York Haven, Muddy Run, and Conowingo projects' use of the Susquehanna River for hydropower purposes to see what effect various environmental measures would have on the projects' costs and power generation. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[88] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in *Mead Corp.*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EIS for the protection, mitigation, and enhancement of environmental resources affected by the projects; (2) the cost of alternative power; (3) the total project cost (i.e., for construction, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and total project cost. If the difference between the cost of alternative power and total project cost is positive, the project produces power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, the project produces power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND DEVELOPMENTAL BENEFITS OF THE PROJECTS

Table 4-1 summarizes the assumptions and economic information we use in our analysis for the York Haven Project, based on information provided by York Haven Power in its license application and subsequent submittals. Tables 4-2 and 4-3 summarize the assumptions and economic information we use in our analysis for the Muddy Run and Conowingo projects, respectively, based on information provided by Exelon in its license application and subsequent submittals. We find that the values provided by the applicants are reasonable for the purposes of our analysis. For each project, cost items common to all alternatives include: taxes and insurance costs;

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[88] See *Mead Corporation, Publishing Paper Division*, 72 FERC ¶ 61,027 (July 13, 1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

estimated capital investment required to develop the project; licensing costs; normal operation and maintenance cost; and Commission fees.

Table 4-1. Parameters for economic analysis of the York Haven Project (Sources: York Haven Power and Staff).

Parameter	Value[a]
Period of analysis (years)	30
Term of financing (years)	20
Federal income tax rate, (%)	35.00
Local tax rate, (%)	3.00
Insurance rate	Included in the operation and maintenance cost
Energy value, $/MWh	39.75
Capacity value, ($/kW-year)	45.53
Interest rate[b]	8.00
Discount rate[c]	8.00
Net investment	$900,000 (2011)
Licensing cost[d], $	$3,000,000 (2011)
Operation and maintenance, $/year	$4,822,547 (2011)
Commission fees, $/year[e]	$54,129

[a] Values provided by York Haven Power in the license application, unless otherwise noted.

[b] Interest rate assumed by Staff.

[c] Assumed by Staff to be same as interest rate.

[d] Excludes protection, mitigation, and enhancement measures.

[e] Commission fees are the estimated value for 2013 from the FERC website.

Table 4-2. Parameters for economic analysis of the Muddy Run Project (Sources: Exelon and Staff).

Parameter	Value[a]
Period of analysis (years)	30
Term of financing (years)	20
Federal income tax rate, (%)	34.9
Local tax rate, (%)	3.00
Insurance rate	Included in the operation and maintenance cost
Energy value[b], $/MWh	51.34
Pumping energy[b], $/MWh	27.76
Capacity value[b] ($/kW-year)	73.53
Ancillary services value,[b] $/year	$8,602,000
Interest rate[c]	8.00
Discount rate[d]	8.00
Net investment, $	$140,505,000 (2011)
Licensing cost, $[e]	$7,026,000 (2011)
Operation and maintenance, $/year	$6,857,000 (2011)
Commission fees, $/year[f]	$1,201,106

[a] Values provided by Exelon in the license application unless otherwise noted.

[b] Values from Exelon, filed with the Commission on March 24, 2014.

[c] Interest rate assumed by Staff.

[d] Assumed by Staff to be same as interest rate.

[e] Excludes protection, mitigation, and enhancement measures.

[f] Commission fees are the estimated value for 2013 from the FERC website.

Table 4-3. Parameters for economic analysis of the Conowingo Project (Sources: Exelon and Staff).

Parameter	Value[a]
Period of analysis (years)	30
Term of financing (years)	20
Federal income tax rate, (%)	34.9
Local tax rate, (%)	3.00
Insurance rate	Included in the operation and maintenance cost
Energy value[b], $/MWh	40.55
Capacity value[b], ($/kW-year)	73.53
Ancillary services value[b], $/year	$405,000
Interest rate[c]	8.00
Discount rate[d]	8.00
Licensing cost, $[e]	$14,989,000 (2011)
Operation and maintenance, $/year	$15,985,000 (2011)
Annual capital cost, $/year	$15,974,000 (2011)
Commission fees, $/year[f]	$1,209,228

[a] Values provided by Exelon in its license application unless otherwise noted.

[b] Values from Exelon, filed with the Commission on March 24, 2014.

[c] Interest rate assumed by Staff.

[d] Assumed by Staff to be same as interest rate.

[e] Excludes protection, mitigation, and enhancement measures.

[f] Commission fees are the estimated value for 2013 from the FERC website.

4.2 COMPARISON OF ALTERNATIVES

Tables 4-4, 4-5, and 4-6 summarize, for the York Haven, Muddy Run, and Conowingo projects, respectively, the installed capacity, annual generation, cost of alternative power, estimated total project cost, and difference between the cost of alternative power and total project cost for each of the alternatives considered in this EIS: no-action, the applicant's proposal, and the staff alternative.

Table 4-4. Summary of the annual cost of alternative power and annual project cost for three alternatives for the York Haven Project (Source: Staff).

	No Action	**York Haven Power's Proposal**	**Staff Alternative**
Installed capacity (MW)	19.62	19.62	19.62
Annual generation (MWh)	132,271	131,771	131,771
Dependable Capacity (MW)	17.57	17.57	17.57
Annual cost of alternative power ($/MWh)	$6,058,0104 5.80	$6,037,750 45.82	$6,037,750 45.82
Annual project cost ($/MWh)	$5,777,920 43.68	$6,374,440 48.38	$6,370,400 48.34
Difference between the cost of alternative power and project cost ($/MWh)	$280,090 2.12	($336,690) (2.56)	($332,650) (2.52)

Table 4-5. Summary of the annual cost of alternative power and annual project cost for three alternatives for the Muddy Run Project (Source: Staff).

	No Action	**Exelon's Proposal**	**Staff Alternative**
Installed capacity (MW)	800.25	800.25	800.25
Annual generation (MWh)	1,615,813	1,615,813	1,614,313
Annual pumping (MWh)	2,096,726	2,096,726	2,094,726
Dependable Capacity (MW)	1,070	1,070	1,070
Annual cost of alternative power ($/MWh)	$169,563,420 104.94	$169,563,420 104.94	$169,470,580 104.98
Annual project cost ($/MWh)	$118,797,090 73.52	$119,329,530 73.85	$118,972,540 73.70
Difference between the cost of alternative power and project cost ($/MWh)	$50,766,330 31.42	$50,233,890 31.09	$50,498,040 31.28

Table 4-6. Summary of the annual cost of alternative power and annual project cost for three alternatives for the Conowingo Project (Source: Staff).

	No Action	**Exelon's Proposal**	**Staff Alternative**
Installed capacity (MW)	574.54	574.54	574.54
Annual generation (MWh)	1,823,193	1,823,193	1,823,293
Dependable Capacity (MW)	566.14	566.14	566.14
Annual cost of alternative power ($/MWh)	$115,955,070 63.60	$15,955,070 63.60	$115,961,430 63.60
Annual project cost ($/MWh)	$81,232,410 44.56	$83,685,030 45.90	$84,861,530 46.54
Difference between the cost of alternative power and project cost ($/MWh)	$34,722,660 19.04	$32,270,040 17.70	$31,099,900 17.06

4.2.1 No-Action Alternative

Under the no-action alternative, the York Haven, Muddy Run, and Conowingo projects would continue as currently constructed and operated.

The York Haven Project would have a total capacity of 19.62 MW, a dependable capacity of 17.57 MW, and an average annual generation of 132,271 MWh. The average annual cost of alternative power would be $6,058,010, or $45.80/MWh. In total, the average annual project cost would be $5,777,920, or $43.68/MWh. Overall, the project would produce power at a cost which is $280,090, or $2.12/MWh, less than the cost of alternative power.

The Muddy Run Project would have a total capacity of 800.25 MW, a dependable capacity of 1,070 MW, an average annual generation of 1,615,813 MWh, and pumping energy requirements of 2,096,726 MWh. The average annual cost of alternative power would be $169,563,420, or $104.94/MWh. In total, the average annual project cost would be $118,797,090, or $73.52/MWh. Overall, the project would produce power at a cost which is $50,766,330, or $31.42/MWh, less than the cost of alternative power.

The Conowingo Project would have a total capacity of 574.54 MW, a dependable capacity of 566.14 MW, and an average annual generation of 1,823,193 MWh. The average annual cost of alternative power would be $115,955,070, or $63.60/MWh. In total, the average annual project cost would be $81,232,410, or $44.56/MWh. Overall, the project would produce power at a cost which is $34,722,660, or $19.05/MWh, less than the cost of alternative power.

4.2.2 Applicants' Proposals

Under the applicants' proposal, the existing projects would be modified or enhanced as described by the applicants, and would include environmental measures to protect and enhance project resources. The individual costs of these changes are presented in tables 4-7, 4-8, and 4-9.

Under York Haven Power's proposal, the York Haven Project would have a total capacity of 19.62 MW, a dependable capacity of 17.57 MW, and an average annual generation of 131,771 MWh. The average annual cost of alternative power would be $6,037,750, or $45.82/MWh. In total, the average annual project cost would be $6,374,440, or $48.38/MWh. Overall, the project would produce power at a cost which is $336,690, or $2.56/MWh, more than the cost of alternative power.

Under Exelon's proposal, the Muddy Run Project would have a total capacity of 800.25 MW, a dependable capacity of 1,070 MW, an average annual generation of 1,615,813 MWh, and pumping energy requirements of 2,096,726 MWh. The average annual cost of alternative power would be $169,563,420, or $104.94/MWh. In total, the average annual project cost would be $119,329,530, or $73.85/MWh. Overall, the project would produce power at a cost which is $50,233,890, or $31.09/MWh, less than the cost of alternative power.

Under Exelon's proposal, the Conowingo Project would have a total capacity of 574.54 MW, a dependable capacity of 566.14 MW, and an average annual generation of 1,823,193 MWh. The average annual cost of alternative power would be $115,955,070, or $63.60/MWh. In total, the average annual project cost would be $83,685,030, or $45.90/MWh. Overall, the project would produce power at a cost which is $32,270,040, or $17.70/MWh, less than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative would include the respective staff-recommended additions, deletions, and modifications to each applicant's proposed environmental protection and enhancement measures. For the York Haven, Muddy Run, and Conowingo Projects, tables 4-7, 4-8, and 4-9, show the respective staff-recommended additions, deletions, and modifications to each applicant's proposed environmental protection and enhancement measures, and the estimated cost of each.

For the York Haven Project, based on a total installed capacity of 19.62 MW, a dependable capacity of 17.57 MW, and an average annual generation of 131,771 MWh, the cost of alternative power would be the same as for the applicant's proposal: $6,037,750, or $45.82/MWh. The average annual project cost would be $6,370,400, or $48.34/MWh. Overall, the project would produce power at a cost which is $332,650, or $2.52/MWh, more than the cost of alternative generation.

For the Muddy Run Project, based on a total installed capacity of 800.25 MW, a dependable capacity of 1,070 MW, an average annual generation of 1,614,313 MWh, and pumping energy requirements of 2,094,726 MWh, the cost of alternative power would be $169,470,580, or $104.98/MWh. The average annual project cost would be $118,972,540, or $73.70/MWh. Overall, the project would produce power at a cost which is $50,498,040, or $31.28/MWh, less than the cost of alternative generation.

For the Conowingo Project, based on a total installed capacity of 574.54 MW, a dependable capacity of 566.14 MW, and an average annual generation of 1,823,293 MWh, the cost of alternative power would be $115,961,430, or $63.60/MWh. The average annual project cost would be $84,861,530, or $46.54/MWh. Overall, the project would produce power at a cost which is $31,099,900, or $17.06/MWh, less than the cost of alternative generation.

4.3 COST OF ENVIRONMENTAL MEASURES

Tables 4-7, 4-8, and 4-9 give the cost of each of the environmental enhancement measures considered in our analysis for the York Haven, Muddy Run, and Conowingo projects, respectively. We convert all costs to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost.

Table 4-7. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of continuing to operate the York Haven Project (Source: Staff and York Haven Power).

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Geology and Soils Resources				
1. Develop an erosion and sediment control plan for construction of the nature-like fishway.	York Haven Power, Staff	$5,000	$0	$370[c]
Aquatic Resources				
2. Continue to operate and maintain the existing east channel fishway for upstream fish passage.	York Haven Power, Settling Parties, Staff	$0	$0	$0[d]
3. Continue the current downstream juvenile American shad passage protocol, which calls for the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30). If river flows exceed the capacity of units 1-6, unit 14 would be operated, and if flows exceed the capacities of units 1-6 and 14, units 7-13, and 15-20 would be operated in ascending order.	York Haven Power, Settling Parties, Staff	$0	$0	$0[d]
4. Provide a year-round, continuous, minimum flow from the project of 1,000 cfs and an average daily minimum flow of 2,500 cfs, or inflow, whichever is less.	York Haven Power, Settling Parties, Staff	$0	$0	$0[d]
5. Continue to operate the project in a run-of-river mode when inflow to the project is less than 3,000 cfs, without deliberate impoundment drawdown or storage for purposes of generating electricity in particular time periods.	York Haven Power, Settling Parties, Staff	$0	$0	$0[d]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
6. Pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, flows through the nature-like fishway, once constructed, flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad and during the fall American shad passage period to facilitate downstream passage of juvenile American shad.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
7. Pass about 370 cfs through the forebay sluice gate between the hours of 5 and 11 p.m. during the entire juvenile American shad passage period to facilitate downstream passage of juvenile American shad.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
8. Develop designs within 4 years of license issuance for (1) removal of obstructions in or deepening of the downstream plunge pool from the forebay sluice gate; and (2) a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad during passage to the downstream plunge pool.	York Haven Power, Settling Parties, Staff	$20,000	$0	$1,480[f]
9. Cooperate with resource agencies and other interested parties to conduct a lower Susquehanna River downstream eel migration study. This compensation would include monitoring of silver eels at the project and providing $25,000 to support the study.	York Haven Power, Settling Parties, Staff	$25,000	$0	$1,850[g]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
10. Conduct a site-specific silver eel route of passage study as described in appendix G of the Settlement Agreement including the potential for providing $50,000 to resource agencies for collection and tagging of silver eels at upstream locations.	York Haven Power, Settling Parties, Staff	$50,000	$0	$3,700[g]
11. Conduct a site-specific eel survival study as described in appendix H of the Settlement Agreement.	York Haven Power, Settling Parties, Staff	$50,000	$0	$3,700[f]
12. Conduct a downstream eel passage improvement study if downstream eel passage goals are not achieved with provisions for subsequent monitoring and adjustments.	York Haven Power, Settling Parties, Staff	$0	$0	$0[h]
13. Until the nature-like fishway is completed, provide a minimum flow of 2,000 cfs at east channel dam and a spillage flow of 4,000 cfs at the main dam during the American shad upstream passage season when the east channel fishway is in operation (generally from mid-April through mid-June).	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
14. Until the nature-like fishway is completed, after the American shad upstream passage season until the end of the resident fish passage season (the earlier of December 15 or until the average daily river temperature is ≤ 40°F), maintain a minimum flow of 400 cfs in the east channel downstream of the east channel fishway during the period that the east channel fishway is operated to allow upstream passage of resident fish species, per the June 2010 Consent Order and Agreement between York Haven Power and Pennsylvania DEP.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
15. Release an instantaneous minimum flow of 1,500 cfs to ensure adequate downstream flows to allow the full capacity operation of the Brunner Island Station.	PPL Brunner Island	$0	$0	$0[i]
16. Construct, operate, and maintain a nature-like fishway with required attraction flows.	York Haven Power, Settling Parties, Interior, Staff	$6,315,520	$145,890	$549,100[j]
17. Upon completion of the nature-like fishway, conduct American shad upstream passage effectiveness studies using telemetry beginning during the second year of nature-like fishway operation.	York Haven Power, Settling Parties,	$220,000	$0	$16,280[f]
18. Upon completion of the nature-like fishway, conduct a juvenile American shad headrace turbine avoidance study consistent with design criteria included in appendix D of the Settlement Agreement.	York Haven Power, Settling Parties, Staff	$50,000	$0	$3,700[f]
19. If the juvenile American shad headrace turbine avoidance goals are not achieved, implement measures that would enhance the effectiveness and conduct a supplemental juvenile American shad headrace turbine avoidance study within 2 years of implementing the measures.	York Haven Power, Settling Parties, Staff	$0	$0	$0[h]
20. Upon completion of the nature-like fishway, provide an average daily minimum flow in the east channel below the east channel dam of 267 cfs year round.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
21. Upon completion of the nature-like fishway, provide a minimum of 5 percent of the river flow through the nature-like fishway during the American shad upstream passage season such that when inflows to the project are between 5,000 and 150,000 cfs, total flow through the nature-like fishway would range from about 1,000 to 7,500 cfs, depending on inflow.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
22. Upon completion of the nature-like fishway, provide a minimum flow of 200 cfs through the nature-like fishway when river elevation is at the crest of the main dam and outside of the American shad upstream passage season.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
23. Upon completion of the nature-like fishway, to the extent controllable by York Haven Power, when flows exceed the hydraulic capacity of all available generating units, manage flows to maximize flow over the main dam and the nature-like fishway.	York Haven Power, Settling Parties, Staff	$0	$0	$0[e]
Terrestrial Resources				
24. Conduct vegetation surveys, wetland delineations, invasive species surveys, rare species surveys, bog turtle habitat assessments, and bald eagle surveys in the area of the nature-like fishway prior to construction.	York Haven Power, Interior, Staff	$50,000	$0	$3,700[f]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Recreation and Land Use				
25. Develop and implement a recreation management plan, and update the plan every 12 years consistent with every other Form 80 reporting period deadline.	Staff	$40,000	$1,160	$3,710[l]
26. Maintain existing recreation facilities on four islands in Lake Frederic and the recreation facilities at the powerhouse, including a portage trail for canoeists and fishing access along the downstream face of the powerhouse, and consult with the resource agencies about recreation management and strategies every 10 years after the effective date of any new license.	York Haven Power, Staff	$0	$0	$0[d]
27. Continue the licensing program for approximately 300 recreational lots and terminate permits and remove from the licensing program existing recreational lots upon abandonment by the lessee, or when existing structures become damaged and are not replaced by structures conforming to all applicable federal, state, and local regulations.	York Haven Power, Staff	$0	$0	$0[k]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
28. Develop and implement an SMP to include: (a) summary of the purpose, goals, and objectives of the plan; (b) descriptions of shoreline use classifications, which identifies allowable and prohibited uses for existing and future use of the shoreline; (c) maps showing the shoreline classifications in relation to the project reservoir, project boundary, and various other features; (d) the lot lease and permitting program and guidelines developed to manage public uses; and (e) a monitoring and enforcement program; and provisions to update the plan every 10 years.	Staff	$70,000	$2,410	$6,750[m]
29. Remove non-natural debris from the forebay and sluice remaining natural debris downstream after notifying the downstream PPL BI station.	York Haven Power, Settling Parties, Staff	$0	$0	$0[d]
30. Contribute $25,000 per year to the York Haven Conservation District or such other entity identified by Pennsylvania DEP for the purposes of debris removal in the lower Susquehanna River watershed.	York Haven Power, Settling Parties	$0	$25,000	$16,250[g]
Cultural Resources				
31. Implement the HPMP filed with the Commission on December 28, 2012.	York Haven Power	$0	$5,170	$3,360

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
32. Implement York Haven's proposed HPMP with the following modifications: (a) include a requirement to request landowner permission to access sites on private lands within the project boundary and evaluate them for listing on the National Register and for project impacts if project impacts are identified during monitoring activities; (b) a plan and schedule to evaluate archaeological sites on York Haven lands in the project boundary for their National Register eligibility to ensure that any effects on sites owned by York Haven Power are fully considered in accordance with section 106; and (c) inclusion of two additional sites (36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded. Implement the final plan.	Staff	$20,000	$5,170	$4,840[n]

[a] All capital and annual costs were provided in 2011 dollars or 2013 dollars and were escalated to 2014 dollars for the purpose of this analysis. Annual costs typically include operational and maintenance costs and any other costs that occur on a yearly basis. All costs were provided by York Haven Power in its license application unless otherwise noted.

[b] All capital and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing costs.

[c] Staff estimated the cost; assumes implementation cost is included in construction cost for nature-like fishway below.

[d] Staff estimates no additional cost because this is a continuing measure.

[e] Staff assumes that the cost of any lost energy is included in the lost energy estimate for the nature-like fishway below.

[f] Staff estimated the cost.

[g] Cost provided by York Haven Power in the Settlement Agreement.

[h] No cost estimated for this measure as it is speculative and may not be needed.

[i] When inflows are under 3,000 cfs, the project is operated in a run-of-river mode (inflow = outflow), and if inflows were less than 1,500 cfs, the York Haven Project would be unable to provide supplemental flows to ensure a flow of 1,500 cfs at the Brunner Island cooling water intake. Therefore, no cost could be estimated for this measure.

[j] Cost provided by York Haven Power in its additional information response filed with the Commission on March 15, 2013. Includes 500 MWh/year lost energy cost.

[k] Staff assumed that no additional cost would be required for this measure.

[l] Staff estimated the cost; annual cost assumes $50,000 in years 13 and 25 to update the plan.

[m] Staff estimated the cost; annual cost assumes $20,000 in years 11 and 21 to update the plan.

[n] Staff estimated the cost; capital cost for item (b) only.

Table 4-8. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of continuing to operate the Muddy Run Project (Source: Staff and Exelon).

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Aquatic Resources				
1. Develop a DO monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards.	Exelon, Staff	$0	$0	$0[c]
2. Implement the minimum flow regime proposed by The Nature Conservancy and recommended by Interior for the Conowingo Project (effect on Muddy Run operation).	TNC, Interior	$0	$2,062,630	$1,809,950[d]
3. Implement the Staff-recommended flow regime determined for Conowingo (effect on Muddy Run operation).	Staff	$0	$21,490	$19,190[e]
4. Develop and implement FPOP for upstream and downstream fish passage and file with Pennsylvania DEP for review and approval by January 15, 2015.	Exelon, Staff	$0	$0	$0[f]
5. Develop and implement a plan and schedule for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run Project boundary if resource agencies determine that operation of Muddy Run is causing the Holtwood Project to fail to meet its Tier I upstream American shad target prescribed in the certification for the Holtwood Project.	Exelon, Staff	$0	$0	$0[g]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
6. Implement the Eel Management Plan filed with the license application for the eel trap and truck program to trap, hold, and transport American eels from the Conowingo Project to designated points in the Susquehanna River watershed until at least 2030 and then either continue the trap and truck program or construct a volitional eel passage facility at Conowingo dam.	Exelon	$0	$0	$0[h]
7. Develop and implement a downstream eel passage plan to ensure safe and timely passage past the Muddy Run Project.	Exelon, Staff	$0	$0	$0[i]
8. At all times, allow the project to be subject to inspection by representatives of FWS, to ensure compliance with any fish and wildlife protection, mitigation, and enhancements that may be contained in any Commission license issued for the project.	Interior	$0	$0	$0[f]
Terrestrial Resources				
9. Implement the Bald Eagle Management Plan filed with the license application.	Exelon, Interior, Staff	$0	$1,150	$750
10. Implement the Bog Turtle Management Plan filed with the license application, which includes three components that Exelon would implement: (1) restriction of mowing in the wetland documented to support bog turtles; (2) invasive plant and woody plant control, particularly for reed canary grass; and (3) limits on public access to the wetland without advertising the reason.	Exelon, Interior, Staff	$0	$12,650	$8,240

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
11. Before ground disturbance work begins, visit the FWS Chesapeake Bay Field Office and Pennsylvania Field Office websites and follow bog turtle and bald eagle management guidelines.	Interior, Staff	$0	$0	$0[f]
12. Once every 10 years through the term of the license, evaluate all state and federally listed endangered and threatened species that may be present within the project boundary, and if the evaluation identified the presence, critical habitat, or critical dependence of endangered species, propose and implement a protection plan for each species.	Exelon	$0	$70	$50[j]
13. Implement the osprey management policy, as described in the SMP.	Exelon, Staff	$0	$0	$0[k]
14. Provide annual grants up to $450,000 split equally between the Lancaster County and York County Conservation Districts for the implementation of agricultural pasture and barnyard BMPs to control sediment loading to the Susquehanna River.	Exelon	$0	$450,000	$292,960[l]
15. Provide $50,000 annually to Pennsylvania FBC to perform habitat improvement projects including the removal of small dams.	Exelon	$0	$50,000	$32,550[l]
Recreation and Land Use				
16. Implement the Recreation Management Plan filed with the license application.	Exelon, Interior	$0	$0	$0[m]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
17. At the Muddy Run Park: (1) replace Recreation Lake boat launching facilities and boat dock with an improved launching ramp and ADA-compliant dock; (2) implement shoreline erosion measures to improve runoff and stability in the vicinity of an ADA-compliant picnic area and boat rental dock; (3) replace an existing wood retaining wall with a sheet pile retaining wall to reduce shoreline erosion near the boat dock area; (4) upgrade the electric service to 50 campsites in the park, and monitor future need and upgrade additional sites when the demand occurs; (5) expand an existing playground near the visitor's center with safety swings and three modular play structures suitable for younger children (tot lot); and (6) install a mulch safety surface, and construct a 2,000 square foot water spray park near the park entrance, along with paving resurfacing.	Exelon, Staff	$2,045,000	$66,000	$194,510
18. At Wissler's Run Park: (1) complete the replacement of the picnic pavilion, (2) designate and sign two additional ADA-compliant parking spaces near the picnic pavilion for compliance with standards set by the *ADA Accessibility Guidelines for Buildings and Facilities*, and (3) demolish the existing non-functioning fish cleaning station.	Exelon, Staff	$16,000	$2,500	$2,810

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
19. At Muddy Run WMA: (1) continue to lease the Muddy Run WMA to the Pennsylvania Game Commission for the management of the Muddy Run WMA to provide hunting opportunities in the area; and (2) erect and maintain FERC Part 8 signs at River Road and Furness Road WMA parking areas to identify the conditions of access to the site.	Exelon, Staff	$0	$0	$0[f]
20. Implement Exelon's proposed Recreation Management Plan with the addition of provisions to revise the plan in year 1 to include both recreation use monitoring and plan updates every 12 years in concert with every other the Form 80 reporting deadline.	Staff	$12,000	$2,280	$2,370[n]
21. Implement the SMP filed with the license application consistent with *Guidance for Shoreline Management Planning at Hydropower Projects*.	Exelon	$0	$0	$0[o]
22. Implement Exelon's proposed SMP with the addition of a provision to review and update the plan every 10 years in consultation with appropriate agencies and other stakeholders.	Staff	$12,000	$840	$1,440[p]
Cultural Resources				
23. Prepare a cultural resources management plan if cultural materials are identified during project-related activities.	Exelon	$8,000	$0	$590

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
24. Prepare an HPMP in accordance with FERC and Advisory Council guidance to address potential project effects on historic properties including: (a) a detailed discussion the three sites identified during Phase IA cultural resources (36LA67, 36LA103, 36LA368) and two additional sites located outside of the project boundary (36LA70, 36LA47); (b) requirements for National Register evaluation of affected sites in consultation with the Pennsylvania SHPO; (c) requirements for formal National Register evaluation of the Muddy Run Pumped Storage Project facility; and (d) documentation of Native American consultation Implement the HPMP.	Interior, Staff	$25,000	$45,000	$31,150[q]

[a] All capital and annual costs were provided in 2011 dollars and were escalated to 2014 dollars for the purpose of this analysis. Annual costs typically include operational and maintenance costs and any other costs that occur on a yearly basis. All costs were provided by Exelon in its license application unless otherwise noted.
[b] All capital and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing costs.
[c] No additional cost; continuing measure.
[d] Cost based on energy estimates provided by Exelon in its response filed with the Commission on April 22, 2014; a loss of 134,800 MWh in generation and a reduction of 175,000 MWh of pumping energy).
[e] Staff estimates a loss of approximately 1,500 MWh in generation with a corresponding loss of 2,000 MWh of pumping energy.
[f] Staff assumes no additional cost to implement this measure.
[g] No cost estimated for this measure because it is speculative and may not be needed.
[h] No cost directly related to Muddy Run Project; cost would be covered by the Conowingo Project and is addressed below.
i No cost is estimated at this time as the cost would occur more than 10 years into the future, and any mitigation would be speculative and would depend on whether or not the target passage rates would be met.
[i] Staff estimated the cost; annual cost assumes $1,000 in years 10, 20, and 30.
[j] This measure is included in the SMP, and the cost is assumed to be part of the ongoing costs of the project.
[k] This measure and cost were provided by Exelon in its reply comments filed March 18, 2014.

[l] Cost of enhancements to individual recreation facilities are shown below.
[m] Staff estimated the cost; annual cost assumes $50,000 in years 13 and 25 for updates to the plan.
[n] The only element of the SMP that would have additional cost is the Bald Eagle Management Plan, and the costs of that plan are listed separately above.
[o] Staff estimated the cost; annual cost assumes $15,000 in years 11 and 21 for updates to the plan.
[p] Staff estimated the cost; capital cost for items (a), (b), and (c).

Table 4-9. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of constructing and operating the Conowingo Project (Source: Staff and Exelon).

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Geologic and Soil Resources				
1. Implement the Sediment Management Plan filed with the license application that identifies benchmarks and thresholds for action to address sediment issues that may affect project operation.	Exelon	$0	$9,550	$6,220
2. Conduct bathymetric surveys of Conowingo Pond at 5-year intervals, starting in year 2016.	Exelon	$0	$16,100	$10,480[c]
3. Implement Exelon's proposed Sediment Management Plan with the addition of provisions to (1) incorporate Exelon's proposed periodic dredging at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediments have been accumulating, to improve and maintain recreational boating access; and (2) include with the results of each bathymetric survey an analysis of any change in sediment deposition or scour in the pond from the previous survey(s).	Staff	$0	$25,650	$16,700[d]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Aquatic Resources				
4. Operate the project with a normal range of operation of Conowingo Pond between the elevations 101.2 feet and 110.2 feet with a minimum elevation of 107.2 feet on weekends between Memorial Day and Labor Day, to meet recreational needs.	Exelon, Staff	$0	$0	$0[e]
5. Provide minimum flow releases from the project as described below or a minimum flow equal to the discharge measured at the upstream USGS Marietta gage, whichever is less: (1) March 1-March 31: 3,500 cfs or natural inflow (as measured at the Marietta gage), if less; (2) April 1-April 30: 10,000 cfs or natural inflow, if less; (3) May 1-May 31: 7,500 cfs or natural inflow, if less; (4) June 1-September 14: 5,000 cfs or natural inflow, if less; (5) September 15-November 30: 3,500 cfs or natural inflow, if less; (6) December 1-February 28: 3,500 cfs intermittent (maximum 6 hours off followed by equal amount on).	Exelon	$0	$0	$0[e]
6. Develop and implement a flow management plan.	Interior	$40,000	$0	$2,960[f]
7. Implement the TNC Flow Regime.	Interior, TNC	$0	$502,820	$329,130[g]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
8. Implement the Staff-recommended modified minimum flow regime that would enhance Exelon's proposed minimum flows from December through February and in the first 2 weeks of June, as follows: September 15 – March 31: 3,500 cfs or natural inflow (as measured at the USGS Marietta gage No. 0157600), whichever is less; April 1 – April 30: 10,000 cfs or natural inflow, whichever is less; May 1 – June 15: 7,500 cfs or natural flow, whichever is less; June 16 – September 14: 5,000 cfs or natural inflow, whichever is less.	Staff	$0	($4,060)	($2,650)[h]
9. Continue the DO enhancement at the project using the turbine venting systems on units 1-7 and the aerating runners on units 2 and 5, and continuously monitor DO levels from May 1 through October 1 at the Station 643 location approximately 0.6 mile downstream of Conowingo dam.	Exelon, Staff	$0	$0	$0[e]
10. Operate the east fish lift for upstream passage of American shad, river herring, and other migratory fishes, and the west fish lift for American shad egg collections and other research purposes.	Exelon, Staff	$0	$0	$0[e]
11. Implement a preventative maintenance program for the east fish lift that would extend the useful life of the facility over the next license term.	Exelon, Staff	$0	$200,000	$130,200

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
12. Use the project turbines as the route for downstream passage of American shad and river herring, based on studies that show high survival for fish passing through the turbines.	Exelon, Staff	$0	$0	$0[e]
13. Modify the existing west fish lift as per Phase I of the Interior fishway prescription including a new west fish lift for both trap and trucking designed to truck 50,000 adult shad per year and direct volitional upstream shad passage (two 6,500-gallon hoppers), an auxiliary water system of 2,600 cfs, a 5,000-foot zone of passage on the east and west shores of the tailrace below the dam, a maximum downramping rate of 20,000 cfs/hour, and channel modifications downstream to eliminate stranding in the spillway channel.	Interior	$20,000,000	$0	$1,482,070[f]
14. Modify the existing east fish lift as per Phase II of the Interior fishway prescription including a stilling basin to allow 900-cfs attraction flow, as originally designed, relocation of the east fish lift entrance A to upstream of the Kaplan unit boils, construction of a new entrance D and collection gallery to east fish lift, along the Kaplan units connected to a new second hopper, and reconstruction of entrance B to east fish lift at 45 degrees to the river flow.	Interior	$11,500,000	$0	$852,190[f]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
15. If the passage efficiency is not met by implementing Phase I (west lift) and II (east lift) of the Interior fishway prescription, make daily adjustments to minimum flows and turbine operations, construct an east fish lift auxiliary water supply of 4,325 cfs, and upgrade the east fish lift equipment to allow a 15-minute cycle time.	Interior	$0	$0	$0[i]
16. Incorporate performance criteria into the new license where 80 percent of the shad that enter the project area must pass the project within 5 days, to be based on telemetry study of 150 shad per year for 3 years. If the goal is not met, initiate operational changes as specified by the agencies and test for 3 years using a telemetry study. If the goal is still not reached after 3 years of monitoring, make structural changes to the fish lifts as specified by the agencies, and test for an additional 3 years using a telemetry study. If the goal is still not reached after 3 years, additional structural changes may be required, depending on the behavior of tagged shad.	Pennsylvania FBC	$300,000	$0	$22,230[j]
17. If warranted by the Pennsylvania FBC study above, complete the rebuild of the west fish lift to include additional attraction water and provision to expand to volitional passage if needed. Ultimately, fish passage facilities at Conowingo would need to pass a design population of 5 million fish, and fish lifts would be required on both sides of the tailrace.	Pennsylvania FBC	$0	$0	$0[i]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
18. If warranted by the Pennsylvania FBC study above, modify the east fish lift to include a larger hopper, increased attraction flow, and addition of a collection gallery in front of units 8-11.	Pennsylvania FBC	$0	$0	$0[i]
19. Reduce stranding of migratory fish by: (1) extending the retaining wall at the east end of the east fish lift; or (2) adding boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation; or (3) dredging a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes.	Pennsylvania FBC	$1,000,000	$0	$74,100[k]
20. Conduct a study of the effect of gizzard shad on passage efficiency, capacity, and interference with American shad use of the lifts, and the recycling of gizzard shad in the west fish lift.	Pennsylvania FBC, Staff	$3,530	$0	$260[l]
21. Modify the west fish lift by replacing the existing hopper with a 1,500-gallon hopper, including associated structural, electrical, and mechanical upgrades.	Staff	$3,159,090	$0	$234,100[m]
22. Improve the west fish lift sorting and loading process to facilitate trap and truck operations, and purchase trucks, transport tanks, and associated equipment for the implementation of trap and truck operations.	Staff	$979,340	$626,030	$480,120[m]
23. Conduct a feasibility study to determine if additional attraction flow is necessary at the west fish lift.	Staff	$30,000	$0	$2,220[f]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
24. If the feasibility study determines that additional attraction flows are necessary and feasible at the west fish lift, install additional flow capacity.	Staff	$0	$0	$0[i]
25. Restore the original east fish lift design for a 900-cfs attraction flow.	Staff	$1,500,000	$0	$111,560[f]
26. Add a second 3,300-gallon hopper to the east fish lift in the space provided for the original design, and upgrade the electrical and mechanical equipment to allow a 15-minute lift cycle.	Staff	$1,683,470	$x	$124,750[n]
27. After restoration of the 900-cfs attraction flow, conduct a 2-year effectiveness study.	Staff	$100,000	$0	$7,410[f]
28. If the 2 years of effectiveness studies show poor attraction to the east fish lift at that flow, conduct a feasibility study of modifying the locations of entrances A and B.	Staff	$0	$0	$0[i]
29. If the feasibility study shows that modifications to entrances A and B are technically feasible and would result in improved effectiveness, implement changes to the entrances.	Staff	$0	$0	$0[i]
30. Construct a west bank American eel trap and transport facility that consists of a limited length eel ramp and a collection facility in the existing parking lot.	Exelon, Interior, Pennsylvania FBC, Staff	$660,120	$604,340	$442,340[o]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
31. Construct a west bank American eel volitional passage near the west fish lift that consists of a full eel ramp with resting pools from the tailrace to the pond elevation sited near the west fish lift superstructure.	Exelon, Interior, Staff	$1,751,030	$206,610	$264,260[o]
32. Construct an east bank American eel trap and transport facility that consists of a limited length eel ramp and a collection facility in the existing access area below the non-overflow section of the dam.	Exelon, Interior, Staff	$642,560	$604,340	$441,040[o]
33. Construct an east bank American eel volitional passage facility (after 2030) that consists of a full eel ramp with resting pools from tailrace below spillbay 50 to pond cored through the top of the dam.	Exelon, Interior, Staff	$1,162,190	$206,610	$203,140[o]
34. Participate in a trap and transport program for downstream eel passage, in cooperation with the other hydroelectric project operators on the lower Susquehanna River to trap and transport adult American eels from smaller tributaries upstream of York Haven dam.	Exelon, Staff	$227,000	$286,200	$203,140
35. Continue a debris management program that includes clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes and floating surficial debris in front of the powerhouse intakes, and the sponsorship of community-based clean-ups in the pond and downstream of the dam.	Exelon, Staff	$0	$0	$0[e]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Terrestrial Resources				
36. Implement the Bald Eagle Management Plan filed with the license application.	Exelon	$0	$2,670	$1,740
37. Implement Exelon's proposed Bald Eagle Management Plan with the addition of a provision to minimize recreation-related disturbance in proximity to roosting or foraging eagles.	Interior, Staff	$0	$2,670	$1,740[p]
38. Develop and implement a bog turtle management plan.	Interior	$0	$12,650	$8,240[q]
39. Develop and implement a northern map turtle protection plan.	Staff	$30,000	$19,370	$14,830[f]
40. Develop and implement a waterfowl nesting protection plan in consultation with FWS that would (a) identify any project-related effects on waterfowl, such as flooding during nesting season; (b) identify which species of waterfowl are affected, if any; and, (c) if project-related effects are identified, establish appropriate protection or mitigation measures.	Interior, Staff	$50,000	$25,000	$19,980[f]
41. Implement the osprey management policy, as described in the SMP.	Exelon, Staff	$0	$0	$0[r]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
Recreation and Land Use				
42. Maintain several public recreation facilities within the project boundary.	Exelon, Staff	$0	$0	$0[e]
43. Implement the Recreation Management Plan filed as part of the license application to guide the operation and maintenance of Exelon's recreation facilities, and the implementation of recreation facility enhancements outlined below.	Exelon	$0	$0	$0[s]
44. Implement improvements at Lock 13 to install a trailhead directional sign at the Lock 12 parking area, and clear vegetation from within the lock to provide an unobstructed view on each side of the lock structure to protect visitors.	Exelon, Staff	$30,000	$500	$2,550
45. Implement improvements to Lock 15 to designate two ADA-compliant parking spaces in the existing parking area and install a dock on the shoreline near the picnic area to allow boaters to access the site; construct a concrete pad for portable restroom placement; stabilize the open shoreline area near the parking area to prevent erosion.	Exelon, Staff	$60,000	$1,200	$5,230

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
46. Implement improvements at Muddy Creek Boat Launch to designate two boat trailer spaces and one vehicle space for ADA-compliant parking in the existing parking lot; stabilize areas adjacent to the parking area to improve drainage and redirect flow away from the parking area and the river; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out.	Exelon, Staff	$72,000	$6,000	$9,240
47. Implement improvements to the Cold Cabin Boat Launch to improve access by designating a one-way directional traffic pattern through the site and constructing parking for 11 vehicles (five boat trailer and six vehicle spaces), including two ADA-compliant spaces; reinforce existing boat ramp to prevent undermining of the ramp and install a boat dock; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out; provide two ADA-compliant picnic tables; install a concrete pad for the placement of two portable restrooms (one ADA-compliant, one standard).	Exelon, Staff	$210,000	$2,500	$17,190

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
48. Implement improvements to Dorsey Park to rebuild both boat ramps at Dorsey Park; designate one ADA-compliant boat trailer space and one ADA vehicle space in the existing lot; install a concrete pad for three portable restrooms (one ADA-compliant, two standard); install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out.	Exelon, Staff	$274,000	$18,000	$32,020
49. Implement improvements to the Conowingo Creek boat launch to designate one ADA-compliant parking space in the existing parking area; stabilize a roadside ditch along Mt. Zoar Road and construct a stone-lined drainage ditch along the south side of the parking lot to redirect runoff from the parking lot and boat ramp; install a sign providing information on the Conowingo dam canoe portage and the location of the portage take-out.	Exelon, Staff	$56,000	$3,600	$6,490
50. Implement improvements to the Glen Cove Marina to expand the marina by adding seven additional trailer spaces (one ADA-compliant) and 11 vehicle (two ADA-compliant) spaces; repair the marina's bulkhead wall.	Exelon, Staff	$220,000	$1,700	$17,410
51. Implement improvements at Funk's Pond to designate one ADA-compliant parking space in the existing parking area.	Exelon, Staff	$300	$500	$350

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
52. Implement improvements to Line Bridge to perform shoreline erosion control and stabilization at this unimproved carry-in boat access area.	Exelon, Staff	$9,000	$500	$490
53. Implement improvements at Conowingo swimming pool to install an ADA-compliant access facility at the swimming pool and an ADA-compliant access ramp at the wading pool.	Exelon, Staff	$173,000	$3,500	$15,100
54. Implement improvements at Conowingo dam overlook to reopen the facility and designate three ADA-compliant vehicle spaces in the existing parking lot; demolish the existing pavilion and replace it with a new 24-foot by 24-foot wooden pavilion; remove pavement from the easterly corner of the existing paved parking area, loam and seed, and install three ADA-compliant pathways and picnic tables; install security fencing around the site to restrict unobstructed views from the pavilion and picnic area.	Exelon, Staff	$232,000	$3,000	$19,150

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
55. Implement improvements to Fisherman's Park and Shures Landing to widen the access road to the facility by 3 to 5 feet to allow construction of 12-foot-wide lanes; construct a retaining wall along the easterly 250 feet of the existing parking area along the access road; designate five additional ADA-compliant parking spaces in the existing parking lot; widen the access road leading to Shures Landing by 4 feet along the eastbound lane for 320 feet; and widen the access road from the trailhead parking north of the retaining wall by 2 feet; construct an additional 13-space parking area near the Lower Susquehanna Heritage greenway trailhead at the southerly end of Fisherman's Park; demolish the existing hard surface boat launch and asphalt access at Shure's Landing and place stone fill next to the existing wall down to existing grade along the Susquehanna River shoreline; and construct a new 20-foot-wide hard surface carry-in boat launch with a floating dock and breakwater at Shure's Landing to replace the existing launch area.	Exelon, Staff	$1,194,000	$2,900	$90,370
56. Implement improvements at Peach Bottom access to construct a small (four vehicle) road-side parking area near the existing informal boat launch area south of Peter's Creek; install a sign providing information on Conowingo dam canoe portage and the location of the portage take-out.	Exelon, Staff	$20,000	$1,800	$2,650

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
57. Implement Exelon's proposed Recreation Management Plan with the addition of provisions to revise the plan in year 1 to include both recreation use monitoring and plan updates every 12 years in concert with every other the Form 80 reporting deadline.	Staff	$40,000	$2,280	$4,450 [t]
58. Open the catwalk (at least on a limited basis) for angling with new security gate and check in/out procedures for anglers.	Staff	$1,908,000	$0	$141,390 [u]
59. Conduct dredging at the Conowingo Creek, Peach Bottom Creek, and Broad Creek boat ramps.	Exelon, Staff	$6,653,230	$0	$493,030 [v]
60. Implement the SMP filed with the license application including specific measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, BMPs for controlling sediment introduction from lands within the project boundary, and use of project lands.	Exelon, Interior	$0	$0	$0 [w]
61. Implement Exelon's proposed SMP with the addition of a provision to update the SMP every 10 years in consultation with appropriate agencies and interested stakeholders.	Staff	$12,000	$840	$1,440 [x]

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
62. Revise the project boundary by removing lands that are not necessary for the safe and efficient operation and maintenance of the project or for other specified project purposes, such as public recreation or protection of environmental resources.	Exelon, Staff	$0	$0	$0 [c]
Cultural Resources				
63. Implement the HPMP filed with the Commission on December 28, 2012.	Exelon	$95,000	$21,150	$20,810

Enhancement/Mitigation Measure	Entity	Capital Cost[a] (2014$)	Annual Cost[a] (2014$)	Levelized Annual Cost[b] (2014$)
64. Revise and implement Exelon's proposed HPMP to include: (a) a revised APE to include the narrow strip of land in the current project boundary extending downstream from Spencer Island along the west side of the river to Havre de Grace; (b) a discussion of all 48 sites and 27 historic structures identified to date within the project APE or an explanation of why they are not considered; (c) a correction to identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad eligible for listing; (d) requirements to inventory any lands within the revised APE, evaluate identified cultural resources for eligibility, and address potential effects before sale or transfer of those lands; (e) a requirement to make good faith effort to obtain access to private property to conduct studies if project effects on cultural resources on private lands are identified; (f) a revised list of project activities involving the Conowingo Project that can be completed without Maryland SHPO review; (g) a process for assessing project-related ground-disturbing activities to determine whether or not archaeological sites would be affected, particularly in areas that have not had archaeological surveys; (h) requirements to ensure confidentiality of cultural resources location information during implementation of public outreach programs; and (i) a description of project-related activities that would require consultation with the Delaware Nation and the Onondaga Nation in accordance with section 106 of the NHPA and documentation of Native American consultation.	Staff	$105,000	$45,000	$37,080 [f]

[a] All capital and annual costs were provided in 2011 dollars and were escalated to 2014 dollars for the purpose of this analysis. Annual costs typically include operational and maintenance costs and any other costs that occur on a yearly basis. All costs were provided by Exelon in its license application unless otherwise noted.

[b] All capital and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing costs.

[c] Staff assumed that no additional cost would be required for this measure.

[d] The cost of the staff alternative plan would be the same as the cost of the proposed Sediment Management Plan plus the cost of the bathymetric surveys, with no additional cost to include the two additional provisions. The cost of the dredging is included with item 59 under *Recreation*.

[e] No additional cost; continuing measure.

[f] Staff estimated the cost.

[g] Cost based on energy estimates provided by Exelon in its response filed with the Commission on April 22, 2014; gain of 12,400 MWh of generation.

[h] Staff estimates a gain of 100 MWh for this measure.

[i] No cost estimated for this measure as it is speculative and may not be needed.

[j] Cost estimated by Staff assumes $100,000 per year in years 1-3 for the initial telemetry study; no cost was estimated beyond year 3 as the phase after year 3 is speculative and may not be needed.

[k] Cost estimate by Staff is a preliminary ballpark estimate. Actual cost would depend on the alternative selected and the design of the alternative.

[l] Staff estimated the cost; assumes $50,000 in year 3.

[m] Cost provided by Exelon in study report Revised Study Plan (RSP) 3.9, *Biological and Engineering Studies of East and West Fish Lifts*.

[n] Cost provided by Exelon in study report RSP 3.9, *Biological and Engineering Studies of East and West Fish Lifts*, for second hopper plus $200,000 estimated by Staff for electrical and mechanical upgrades.

[o] Cost estimated by Exelon in study report RSP 3.3, *Biological and Engineering Studies of American Eel*.

[p] Staff estimates the slight differences between Interior's prescribed measure and Exelon's proposed plans would not require additional costs to implement the differences.

[q] Staff assumed that the Muddy Run Bog Turtle Management Plan could be adapted for Conowingo and that the implementation costs would be comparable to the costs estimated by Exelon for Muddy Run.

[r] This measure is included in the SMP, and the cost is assumed to part of the ongoing costs of the project.

[s] Cost of enhancements to individual recreation facilities are shown below.

[t] Staff estimated the cost; annual cost assumes $50,000 in years 13 and 25 for updates to the plan.

[u] The cost was provided by Exelon in study RSP 3.32, *Re-evaluate the Closing of the Catwalk to Recreational Fishing*, filed with the Commission on January 31, 2012. Note that the report was filed as a Critical Energy Infrastructure Information document,

which is not directly available to the public. If the catwalk is reinforced instead of being replaced, the cost would be $1,484,000. In addition, Exelon based its cost estimates on a 12 hours per day and 365-day per year opening. If the catwalk is only open on a limited basis, the costs would be significantly less.

[v] Cost provided by Exelon in its March 25, 2014, filing.

[w] The only element of the SMP that would have additional cost is the Bald Eagle Management Plan, and the costs of that plan are listed separately above.

[x] Staff estimated the cost; annual cost assumes $15,000 in years 11 and 21 for updates to the plan.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for relicensing the York Haven, Muddy Run, and Conowingo projects. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on these projects and our review of the environmental and economic effects of the proposed projects and their alternatives, we selected the staff alternative as the preferred alternative for each of the projects. In each case, the staff alternative includes elements of the applicants' proposals, resource agency recommendations, and some additional measures. We recommend these alternatives because: (1) issuance of new hydropower licenses by the Commission would allow York Haven Power and Exelon to operate the projects as economically beneficial and dependable sources of electrical energy for their customers; (2) generation from the York Haven, Muddy Run, and Conowingo projects, with total installed capacities of 19.62, 800.25, and 574.54 MW, respectively, comes from a renewable resource that does not contribute to atmospheric pollution; (3) the public benefits of these alternatives would exceed those of the no-action alternatives; and (4) the recommended measures would protect and enhance water, fish and wildlife resources, protect cultural resources, and provide improved recreation opportunities at the projects.

Finally, for the reasons outlined in the following sections, we recommend that certain conditions preliminarily prescribed by Interior not be included in the staff alternative. The conditions that we are not including pertain to certain measures in Interior's fishway prescription for the Muddy Run and Conowingo projects. We recognize, however, that, if finalized, the Commission must include these conditions in any license due to their mandatory nature.

In the following sections, we make recommendations as to which environmental measures proposed by the applicants or recommended by agencies or other entities should be included in any new license issued for the projects. In addition to the applicants' proposed environmental measures, we recommend additional staff-developed environmental measures to be included in any new license issued for the projects, and we describe these requirements in the draft license articles in Appendix A.

5.1.1 York Haven Project

5.1.1.1 Measures Proposed by York Haven Power

Based on our environmental analysis of York Haven Power's proposal in section 3, *Environmental Effects*, and the costs presented in section 4, *Developmental Analysis*, we conclude that the following environmental measures proposed by York Haven Power would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project. We discuss any modification to York Haven Power's proposed measures below under *Measures Recommended by Staff for the York Haven Project.*

Under the terms of the Settlement Agreement, York Haven Power would implement the following environmental measures at the York Haven Project:

- Develop an erosion and sediment control plan for construction of the nature-like fishway.
- Continue to operate and maintain the existing east channel upstream fishway for upstream fish passage.
- Continue the current downstream juvenile American shad passage protocol that calls for the operation of units 1-6 (Kaplan and propeller units) to be first online and last offline during the juvenile shad downstream migration period (which typically is from October 1 through November 30), and opening the forebay sluice gate at specific times for downstream fish passage. If river flows exceed the capacity of units 1-6, unit 14 would be operated, and if flows exceed the capacities of units 1-6 and 14, units 7-13 and 15-30 would be operated in ascending order.
- Provide a year-round, continuous, minimum-flow from the project of 1,000 cfs and an average daily minimum flow of 2,500 cfs, or inflow, whichever is less to protect and enhance aquatic resources downstream of the project.
- Continue to operate the project in a run-of-river mode when inflow to the project is less than 3,000 cfs.
- Pass about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the turbine hydraulic capacity, flows through the nature-like fishway, once constructed, flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad, and any day that river flow exceeds the combined hydraulic capacity during the fall American shad emigration period to facilitate downstream passage of juvenile American shad.

- Pass about 370 cfs through the forebay sluice gate between the hours of 5 p.m. and 11 p.m. during the entire fall juvenile American shad passage period to facilitate downstream passage of juvenile American shad.
- Develop designs within 4 years of license issuance for: (1) removal of obstructions in or deepening of the downstream plunge pool for the forebay sluice gate, and (2) a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad passing into the downstream plunge pool.
- Cooperate with resource agencies and other interested parties to conduct a lower Susquehanna River downstream eel migration study including monitoring silver eels at the project and providing $25,000 to support the study.
- Conduct a site-specific silver eel route of passage study and a survival study as described in appendices G and H of the Settlement Agreement including the potential for providing $50,000 to resource agencies for collection and tagging of silver eels at upstream locations.
- Conduct a downstream eel passage improvement study if downstream eel passage goals are not achieved with provisions for subsequent monitoring and adjustments.
- Construct, operate, and maintain a nature-like fishway in the vicinity of the apex of the main dam and Three Mile Island in compliance with design criteria specified in appendix A of the Settlement Agreement.
- Prior to construction of the proposed nature-like fishway:
    - Provide a minimum flow of 2,000 cfs at east channel dam and a spillage flow of 4,000 cfs at the main dam during the American shad upstream passage season when the east channel fishway is in operation.
    - After the American shad upstream passage season until the end of the resident fish passage season maintain a minimum flow of 400 cfs in the east channel downstream from the east channel fishway during the period that the east channel fishway is operated to allow upstream passage of resident fish species, per the June 2010 Consent Order and Agreement between York Haven Power and Pennsylvania DEP.

- Conduct vegetation surveys, wetlands delineations, invasive species surveys, rare species surveys, bog turtle habitat assessments, and bald eagle surveys in the area of the nature-like fishway.[89]

- After construction of the nature-like fishway:
  - Conduct American shad upstream passage effectiveness studies using radio telemetry beginning during the second year of the nature-like fishway operation. If the project area passage success criterion is not achieved, York Haven Power would implement corrective measures, followed by two additional years of radio telemetry studies to confirm achievement of the project area passage success criterion.
  - Conduct a juvenile American shad headrace turbine avoidance study consistent with design criteria included in appendix D of the Settlement Agreement.
  - If the juvenile American shad headrace turbine avoidance goals are not achieved, implement measures that would enhance the effectiveness of downstream passage and conduct a supplemental juvenile American shad headrace turbine avoidance study within 2 years of implementing the measures.
  - Provide an average daily minimum flow in the east channel below east channel dam of 267 cfs year round to protect aquatic resources in the east channel and provide a minimum passage flow for fish ascending the east channel and using the east channel fishway.
  - Provide a minimum of 5 percent of the river flow through the nature-like fishway during the American shad upstream passage season such that when inflows to the project are between 5,000 and 150,000 cfs, total flow through the nature-like fishway would range from about 1,000 to 7,500 cfs, depending on inflow.
  - Provide a minimum flow of 200 cfs through the nature-like fishway outside of the American shad upstream passage season when the river elevation is at the crest of the main dam.
  - When flows exceed the hydraulic capacity of all available generating units, and to the extent controllable by York Haven Power, manage flows to maximize flow over the main dam and the nature-like

[89] These proposed measures cited in the explanatory statement accompanying the Offer of Settlement would be implemented prior to the construction of the nature-like fishway.

fishway to provide attraction flow to the vicinity of and from the nature-like fishway to maximize fishway effectiveness.

- To prevent a buildup of debris that could affect project and fish passage operations, remove non-natural debris from the forebay and sluice remaining natural debris downstream, after notifying the downstream PPL Brunner Island Station.

In addition to those measures specified in the Settlement Agreement, York Haven Power also proposes to implement the following measures included in its final license application:

- Maintain existing project recreation facilities on four islands in Lake Frederic and the project recreation facilities at the powerhouse, including an existing portage trail for canoeists and fishing access along the downstream face of the powerhouse, and consult with the resource agencies on recreation resources and management strategies every 10 years after the effective date of any new license.
- Continue the current permitting program for the approximately 300 recreational lots located within the project boundary, but terminate permits and remove lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures.
- Implement the HPMP filed with the Commission on December 28, 2012, to manage project effects on historic properties eligible for listing on the National Register.

5.1.1.2 Additional Measures Recommended by Staff for York Haven

We recommend the York Haven Power-proposed measures described above with the following additions or modifications:

- Develop a recreation management plan that provides for York Haven's proposed maintenance of its existing recreation facilities with additional provisions to update the plan every 12 years consistent with every other Form 80 reporting period deadline, include safety measures during construction of the nature-like fishway, and continue the licensing program for approximately 300 recreational lots within the project boundary, and implement revisions to the program to allow for the termination of permits and removal of lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures.

- Develop an SMP that includes specific measures and policies related to shoreline management at the project and include a provision to update the plan every 10 years.
- Modify York Haven's proposed HPMP with the following additional provisions: (a) include a requirement to request landowner permission to access sites on private lands within the project boundary and evaluate them for listing on the National Register and for project impacts if project impacts are identified during monitoring activities; (b) a plan and schedule to evaluate archaeological sites on York Haven lands within the project boundary for their National Register eligibility to ensure that any effects on sites owned by York Haven Power are fully considered in accordance with section 106; and (c) inclusion of two additional sites (36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded.

Below we discuss the rationale for recommending proposed measures, modified measures, and additional staff measures for the York Haven Project.

Erosion and Sediment Control Plan

York Haven Power, in the explanatory statement filed with the Settlement Agreement, states that it would develop and implement an erosion and sediment control plan prior to constructing the nature-like fishway. This measure, however, is not included in the Settlement Agreement. To protect water quality during construction, we recommend the development and implementation of an erosion and sediment control plan for the fishway construction as a condition of any license issued because it would minimize effects on the river's aquatic habitat. We estimate that the levelized annual cost of implementing this plan would be $370 and conclude the benefits of protecting the aquatic habitat justify the cost.

Instream Flows and Flow Distribution

York Haven Power is proposing to continue its current continuous minimum flow of 1,000 cfs from the powerhouse and an average daily flow of not less than 2,500 cfs; if inflow to the impoundment is less than these amounts, discharge from the project would not be less than the inflow. Under the Settlement Agreement, York Haven Power would provide further refinements to the minimum and other project flows, including redistribution of flows for enhancement of upstream and downstream fish passage as described below and summarized as follows: (1) operate the project in a run-of-river mode when inflow to the project is less than 3,000 cfs; (2) prior to completion of the nature-like fishway (see below), provide a minimum flow of 2,000 cfs at the east channel dam during the American shad upstream passage season and 400 cfs during the resident fish passage season, and a spillage flow of 4,000 cfs at the main dam during the shad upstream passage season when the east channel fishway is in operation; (3) after

completion of the nature-like fishway, reduce the east channel minimum flow to 267 cfs year-round, reduce the flow at the main dam to a minimum of 1,000 cfs (through the nature-like fishway and supplemental attraction flow channel) during the shad upstream passage season, and further reduce the main dam flow (through the nature-like fishway) to 200 cfs during the resident fish passage season; (4) provide at least 5 percent of river flow through the nature-like fishway and supplemental attraction flow channel when flows entering the project during the American shad upstream passage season are between 5,000 and 150,000 cfs; (5) when flows exceed the hydraulic capacity of all available generating units, manage flows to maximize flow over the main dam and the nature-like fishway; and (6) pass about 370 cfs through the forebay sluice gate at specified times for downstream passage of adult and juvenile shad (see below). The main purpose of this flow redistribution is to shift the emphasis of upstream passage to the nature-like fishway, while still providing passage through the east channel fishway. Overall, flows past the project would not be substantially different than current conditions, and because of the low hydraulic capacity of the project, would on average continue to spill about 60 percent of the time. The flow redistribution to enhance fish passage should act to guide fish to the new main route for upstream fish passage, the nature-like fishway. We estimate that the proposed minimum flows and flow redistribution can be provided at no additional cost.

Nature-Like Fishway

York Haven Power proposes to construct a nature-like fishway in the vicinity of the apex of the main dam and Three Mile Island, consistent with the design criteria set forth in appendix A of the Settlement Agreement. While the east channel fishway would remain in operation, the nature-like fishway would become the main route for upstream passage at the project. In conjunction with the installation of the nature-like fishway, York Haven Power proposes to modify project flow releases that would provide fish passage attraction flows to the nature-like fishway and establish this fishway as the primary fish passage facility and the existing east channel fishway as the secondary passage facility. The proposed flow release changes, as described above, would redistribute minimum flow releases among the various project flow release structures (east channel spillway, east channel fishway, nature-like fishway, main dam, and powerhouse). The overall minimum flow releases downstream of the project would not change. The nature-like fishway would also be designed so that a full range of anadromous, catadromous, and resident species could use the facility for upstream passage. In addition, York Haven Power proposes to conduct vegetation surveys, wetlands delineations, invasive species surveys, rare species surveys, bog turtle habitat assessments, and bald eagle surveys in the area of the nature-like fishway prior to construction. These surveys, done in consultation with the state resource agencies and FWS, would identify if any terrestrial resource protection measures would be required prior to construction. In section 3.3.2.2, *Water Resources, Environmental Effects*, under Upstream Fish Passage, we conclude that the proposed location and design of the nature-like fishway would be a substantial enhancement of existing upstream fish passage

facilities and should improve fish passage effectiveness at the project. We estimate the annual levelized cost of conducting the pre-construction surveys would be $3,700 and the annual levelized cost constructing the nature-like fishway would be $549,100, and the benefit to Susquehanna River migratory species would be worth the cost.

Fish Passage Effectiveness Study

York Haven Power proposes to conduct an effectiveness study, using radio-tagged shad, beginning in year 2 of the nature-like fishway operation and continuing for 2 years. We agree with the need for an effectiveness study for a new fish passage facility, and especially for the novel natural-like design, which has not been constructed at any hydroelectric project on a major Atlantic coast river. The establishment of passage targets and success criteria, used properly, allow a determination of whether the fishway is operating as designed. Caution is needed, however, because many factors beyond engineering design and hydraulics may affect effectiveness, particularly for shad. For example, York Haven Power's 2010 radio telemetry study found that only 70 percent of the tagged fish released at the downstream Safe Harbor Project reached the York Haven Project area, indicating that some fish used the habitat between the projects, or had no motivation to continue upstream migration to York Haven. The Settlement Agreement acknowledges this issue, and while the upstream shad passage target is that at least 75 percent of the shad counted at the downstream Safe Harbor Project be passed above York Haven dam, compliance is based on the project area passage success criteria that 85 percent of the shad that reach the York Haven Project area successfully pass upstream of the project. This properly recognizes that York Haven Power has no control over whether or not shad reach the project area, and the proposed fish passage effectiveness study would provide additional information on the behavior of shad approaching and ultimately passing the York Haven Project. We estimate that the proposed fish passage effectiveness study would have a levelized annual cost of $16,280, and would be worth the cost to ensure that the proposed fishway is effective for upstream passage.

Downstream Fish Passage

York Haven Power is proposing to continue its downstream fish passage protocol that it has been implementing for the past several years. This includes: (1) when river flow is less than the project hydraulic capacity, prioritization of powerhouse generation through units 1 through 6 (propeller units) on a first-on/last-off basis, followed by units 7 through 20 (Francis units); (2) opening the forebay sluice gate located in the lower forebay corner adjacent to unit 1 for downstream fish passage; and (3) using temporary lighting above the forebay sluice gate to aid in attracting alosine species to the sluice gate entrance. At river flow greater than project hydraulic capacity, which occurs about 60 percent of the time, downstream fish passage occurs via spillage over the dam. Under the Settlement Agreement, York Haven Power proposes a suite of additional measures for downstream passage, including: (1) passing about 370 cfs through the forebay sluice gate for 1 or 2 hours in the morning during weekdays if river flows exceed the sum of the

turbine hydraulic capacity, flows through the nature-like fishway, once constructed, flows through the east channel, and flows (if any) over the main dam from May 1 through June 30 to facilitate downstream passage of post-spawning adult American shad, and during the juvenile American shad downstream passage period to facilitate downstream passage of juvenile American shad; (2) passing about 370 cfs through the forebay sluice gate between the hours of 5 p.m. and 11 p.m. during the entire juvenile American shad passage period to facilitate downstream passage of juvenile American shad; and (3) developing designs within 4 years of license issuance for: (a) removal of obstructions in or deepening of the plunge pool below the forebay sluice gate, and (b) a chute structure to convey flows beyond the roadway on the downstream side of the cable alley structure to protect outmigrating juvenile and adult American shad that pass into the downstream plunge pool. York Haven Power is also proposing to conduct studies on the downstream migration of juvenile shad, once the nature-like fishway is in operation, including a juvenile shad headrace turbine avoidance study consistent with design criteria included in appendix D of the Settlement Agreement. If the juvenile shad headrace turbine avoidance goals are not achieved, York Haven Power would implement measures that would enhance the effectiveness of downstream passage and conduct a supplemental juvenile shad headrace turbine avoidance study within 2 years of implementing the measures. All of these measures would enhance downstream fish passage survival at York Haven, would ensure that downstream passage survival goals are met, and should be implemented by York Haven Power. We estimate that these measures would have a levelized annual cost of $1,480, while the juvenile shad headrace turbine avoidance study would have a levelized annual cost of $3,700. These measures would be worth the cost to ensure that survival goals are met.

American Eel Study

York Haven Power proposes to cooperate with resource agencies and other interested parties to conduct a lower Susquehanna River downstream American eel study including site-specific silver eel route of passage and survival studies. American eels do not currently occur in the project area in any numbers, with those present being the result of experimental upstream stockings. Because upstream passage at downstream dams, discussed under the Muddy Run and Conowingo projects below, would require several years to develop, it would be many years before upstream migrating eels arrive in the York Haven Project area through volitional migrations. If trap and trucking of eels is implemented at Conowingo as proposed, it is likely that eels would be trucked upstream of York Haven within 2 to 3 years of license issuance and would remain in the river for 10 to 20 years before reaching the silver eel phase and out-migrating to the ocean. The nature-like fishway and the low-head configuration of the dam would likely provide for adequate upstream passage once upstream migrating eels arrive at the project, either from trucking of eels to locations downstream of York Haven, or any future volitional passage at downstream projects. Once sufficient numbers of silver eels are migrating downstream at York Haven, downstream passage measures should be implemented to ensure safe and timely downstream passage. The Settlement Agreement includes provisions for the

eventual downstream passage of eels at the project, including studying the migratory pathways at the project and survival through the turbine generators, and then implementing protective measures if needed. These provisions of the Settlement Agreement would adequately protect downstream migrating eels once they arrive at the project. We estimate that the annual levelized cost of the route of passage study and survival study would be $3,700 each, and the benefit to migrating eels would be worth the cost.

Recreation Management

York Haven Power proposes a number of operational and maintenance activities related to recreation, such as maintaining canoe portage trails, fishing access, and public boat access areas and consulting with the stakeholders on recreation resources about recreation management and strategies every 10 years after license issuance. However, York Haven Power does not propose a recreation management plan. Project recreation sites, including the four islands in Lake Frederic, and sites that are leased or managed by others, receive regular use by visitors at project lands and waters. The Commission requires these facilities to be maintained and available for public recreational uses throughout the term of any future license. Development of a formal recreation management plan that includes a facility inventory with ownership and management responsibilities for each site, as well as measures to provide for periodic monitoring, would ensure the recreation facilities and sites are managed to meet use and demand over the term of any future license. Including a provision to address human safety concerns during construction of the nature-like fishway would ensure the safe access and use of existing facilities that might be affected by the construction activity. Consultation with the resource agencies, counties, and other interested stakeholders in the project, including Pennsylvania FBC and Pennsylvania DCNR, in the development of the plan would ensure that stakeholder interests are represented and the facilities meet regional needs. We also agree with York Haven Power's proposal to include the entirety of the Lock 15 facility within the project boundary because the site is associated with the project's East Shore Boat Launch. The benefit to recreation resources of the development of a recreation management plan would be worth the estimated levelized annual cost of $3,710.

Shoreline Management

Aquatic, recreational, and natural resources exist along the shorelines of the York Haven Project. Operation and management of project lands and waters would continue to affect the conditions of these shoreline resources. York Haven Power proposes to continue to provide public recreation access and lease recreational lots on the islands of the project. We conclude in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, that preparation of an SMP that combines the shoreline permit program, York Haven's proposed monitoring program, development of an enforcement program, and provides a classification system to ensure resources are balanced in a

comprehensive manner would be beneficial and ensure that the shoreline development pattern is consistent with project purposes, objectives, and any future license requirements. Development of a final SMP in consultation with the Pennsylvania FBC, Pennsylvania DCNR, and FWS would help to ensure that the management of project lands and waters along Lake Frederic's shorelines is consistent with the latest *Guidance for Shoreline Management Planning at Hydropower Projects* (FERC, 2012). Updating the SMP every 10 years would recognize the potential for growth and development along the project reservoir over the term of the license. We estimate the levelized annual cost to develop and update an SMP every 10 years would be $6,750. The benefit to the environmental resources along the shoreline would be worth the cost.

Debris Removal

York Haven Power proposes, consistent with the Settlement Agreement, to continue to remove non-natural debris from the forebay and sluice remaining natural debris downstream, with advance notification to PPL BI. As discussed in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, and section 3.3.7.2, *Aesthetic Resources, Environmental Effects*, debris accumulation, removal, and passing are part of operating a hydroelectric project. The presence of debris in project reservoirs can present safety and aesthetic hazards; however, the dynamic nature of the volume and timing of debris within any reservoir at any given time makes managing it dynamic as well. The removal and/or passing of debris that has accumulated in front of the trashracks are important components of operating hydroelectric projects of any size. Given the size of the lower Susquehanna River watershed, the amount of debris arriving and passing these projects can be significant. Implementing the debris management as detailed in the Settlement Agreement and proposed by York Haven Power would ensure debris does not pose long-term hazards to people and project operation. Notification of PPL's Brunner Island steam plant would be a continuation of the courtesy York Haven Power provides to allow PPL opportunity to plan or prepare for any inconvenience from passing debris. The continuation of debris removal immediately downstream of the York Haven Project is a benefit to the project that would not add any additional cost.

Project Boundary

The East Shore boat launch and Lock 15 provide recreation access and opportunities to York Haven Project lands and waters; however, not all of the lands associated with these two project recreational features are currently within the project boundary. The Commission would not have jurisdiction over areas if they are located outside of the project boundary. Commission regulations require that all lands necessary for the operation and maintenance of the project and for other purposes, such as recreation, be included in the project boundary. Modifying the project boundary to include all of the lands associated with the East Shore boat launch and Lock 15 would ensure these recreation amenities are provided for the public's enjoyment for the term of

any license issued for the project. We estimate that the cost of including these sites within the project boundary would be minimal, and the benefits would be worth the costs.

Cultural Resources

York Haven Power proposed to implement the HPMP, filed on December 28, 2012, that provides for the management of cultural resources and historic properties within the York Haven APE. Our analysis in section 3.3.6.1, *Cultural Resources, Affected Environment*, indicates that, while the HPMP includes many of the standard requirements of a historic properties management plan, some measures contained within the HPMP would benefit from clarification and/or more detail. In addition, there are other measures that would be worth inclusion in the HPMP, and inclusion of these measures would ensure that the York Haven Project would not adversely affect historic properties over the term of any license. As such, we recommend the implementation of York Haven's proposed HPMP, but with the following additions: (a) a requirement to request landowner permission to access sites on private lands within the project boundary and evaluate them for listing on the National Register and for project impacts if project impacts are identified during monitoring activities; (b) a plan and schedule to evaluate archaeological sites on York Haven lands within the project boundary for their National Register eligibility to ensure that any effects to sites owned by York Haven Power are fully considered in accordance with section 106; and (c) inclusion of two additional sites (36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded. We estimate that the levelized annual cost to revise and implement the HPMP for the project would be $4,840 and conclude the benefits of cultural resource protection justify the cost.

5.1.1.3 Measures Not Recommended

Minimum Flows

PPL Brunner Island requests that York Haven Power release a continuous minimum flow of 1,500 cfs to ensure adequate downstream flows for the full capacity operation of the Brunner Island Station. As discussed in section 3.3.2.2, *Water Resources, Environmental Effects*, York Haven Project would operate under run-of-river operation during extreme low-flow periods, and would therefore have no ability to provide supplemental flows to enable Brunner Island station to operate at full capacity under such flow conditions. Further, York Haven Power provides PPL BI with advanced notice when debris is going to be manually passed downstream, and York Haven Power has no control over the debris once it passes downstream.

Debris Removal in the Lower Susquehanna River Watershed

York Haven Power proposes to provide $25,000 to an entity identified by Pennsylvania DEP to remove debris in the lower Susquehanna River watershed as provided for in the Settlement Agreement. As discussed in section 3.3.2.2, *Water*

Resources, Environmental Effects, and section 3.3 5.2, *Recreation and Land Use Resources, Environmental Effects*, almost all of the debris arrives at the York Haven project and passes over the main dam during high-flow events when river flows far exceed the hydraulic capacity of the project. York Haven removes the non-natural debris that accumulates in the forebay, and the remaining debris is sluiced downstream. We find that, under these conditions, York Haven has no control over the quantity of debris that flows downstream or where it is deposited. This proposed measure appears not to be related to any specific project impact at York Haven, nor would the measures necessarily be implemented in the project area. With a lack of nexus to the project, and because providing funds is inconsistent with Commission's guidelines on environmental measures,[90] we do not recommend including this as a license condition. We have no objection to York Haven providing these funds; however, we do not include this measure in our staff alternative.

5.1.2 Muddy Run Project

5.1.2.1 Measures Proposed by Exelon

Based on our environmental analysis of Exelon's proposal in section 3, *Environmental Effects,* and the costs presented in section 4, *Developmental Analysis,* we conclude that the following environmental measures proposed by Exelon would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project. We discuss any modification to Exelon's proposed measures below under *Measures Recommended by Staff for the Muddy Run Project.*

- Develop a DO monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards.
- Develop FPOP for minimizing delay and potential fish entrainment during upstream and downstream fish passage past the project tailrace during generating and pumping cycles.
- Develop a plan and schedule for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run Project boundary if resource agencies determine that operation of the Muddy Run Project is causing the Holtwood Project to fail to meet the Tier I upstream American shad target specified in the water quality certification for the Holtwood Project.

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[90] *See* Policy Statement on Hydropower Licensing Settlements, issued September 21, 2006.

- Implement the Bald Eagle Management Plan filed with the license application to minimize impacts to bald eagles and their habitat within the project boundary in accordance with recommendations from *the National Bald Eagle Management Guidelines* (FWS, 2007a) and state agency guidance.
- Implement the Bog Turtle Management Plan filed with the license application to minimize impacts to bog turtles and that includes: (1) the restriction of mowing in the wetland documented to support bog turtles; (2) invasive and woody plant control, particularly for reed canary grass; and (3) limits on public access to the wetland without advertising the reason.
- Implement the Recreation Management Plan filed with the license application that includes the following improvements to project recreation facilities: an improved launching ramp and ADA-compliant dock; shoreline erosion measures; an improved retaining wall; electric upgrades; expanded playground area near the Visitor's Center; and construction of a 2,000-square-foot water spray park near the park entrance, along with paving resurfacing (see section 2.2, *Applicants' Proposals*, for a full description of proposed capital improvements at each site).
- Implement the SMP filed with the license application that includes measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands and BMPs for controlling sediment introduction.
- Implement the osprey management policy described in Exelon's proposed SMP.

5.1.2.2 Additional Measures Recommended by Staff for Muddy Run

We recommend Exelon's proposed measures as described above with the following additions or modifications:

- Visit FWS' Chesapeake Bay Field Office and the Pennsylvania Field Office websites prior to any ground disturbance, and follow the bog turtle and bald eagle guidelines.
- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other Form 80 reporting deadline.
- Modify Exelon's proposed SMP to include a provision to update the plan every 10 years.
- Develop an HPMP that provides for the management of historic properties and unevaluated cultural resources within the project APE and includes:

(a) a detailed discussion of the three sites (36LA67, 36LA103, 36LA368) identified during the Phase IA cultural resources survey and the two additional sites (36LA70, 36LA47) located outside of the project boundary but located within the APE; (b) requirements for National Register evaluation of affected sites in consultation with the Pennsylvania SHPO; (c) requirements for formal National Register evaluation of the Muddy Run Project; and (d) documentation of consultation with Indian tribes.

Below we discuss the rationale for recommending proposed measures, modified measures, and additional staff measures for the Muddy Run Project.

DO Monitoring

Exelon proposes, consistent with the Pennsylvania DEP certification, to develop a DO monitoring plan no earlier than November 1, 2027, with measures designed to ensure that the project does not violate DO standards. While water quality monitoring at the project found that violations of state water quality standards are rare, implementing this plan would ensure that standards are maintained. We did not estimate a cost for developing and implementing a DO monitoring plan because it would be more than 10 years before the plan would be developed, and any estimated costs developed now may not be relevant in the future.

Fish Passage

Exelon proposes, consistent with the Pennsylvania DEP certification, to develop and implement an FPOP for upstream and downstream fish passage, and to develop and implement a plan and schedule for a radio telemetry study or equivalent Tier II study of American shad passage and behavior within the Muddy Run Project boundary if resource agencies determine that operation of the Muddy Run Project is causing the Holtwood Project to fail to meet its Tier I upstream American shad target prescribed in the certification for the Holtwood Project. As we describe in our discussion of upstream fish passage in section 3.3.2.2, *Water Resources, Environmental Effects*, the Muddy Run Project is not a blockage to upstream migration, but may affect migrating fish by causing flow patterns that may confuse or delay fish passing the project, or may entrain fish during the pumping cycle. While such effects may occur, information to date indicates that the project has not had a substantial effect on upstream and downstream shad movement past the project. Nonetheless, Exelon proposes to monitor future passage by the project by use of the FPOP and a possible Tier II study, if the Holtwood Project does

not meet its Tier I target.[91] These measures would provide a mechanism for determining whether passage objectives are met, and if not, would allow application of potential corrective measures. We estimate that implementation of an FPOP would not require additional costs above current operation and maintenance costs, while a future Tier II study is speculative and may or may not occur in the future.

Downstream Eel Passage Plan

Exelon proposes, consistent with the Pennsylvania DEP certification, to implement a downstream eel passage plan to ensure safe and effective downstream eel passage past the project. Exelon would maintain downstream eel passage efficiency rates of at least 85 percent through the Muddy Run Project area. However, our recommended compliance date when that would be required is October 1, 2026, consistent with the certification, once sufficient numbers of eels have been released into the Susquehanna River to produce a substantial number of downstream-migrating silver eels. Exelon would be required to conduct studies to demonstrate compliance with the passage rate, and if not achieved would be required to provide mitigation. We have not included an estimated cost for this measure because it would occur more than 10 years into the future, and any mitigation would be speculative and dependent on whether or not the target passage rates would be met.

Bald Eagle Management Plan

Exelon proposes to implement the Bald Eagle Management Plan filed with the license application that provides for the management of bald eagle habitat on Exelon lands at the Muddy Run Project based on recommendations from the FWS *National Bald Eagle Management Guidelines* and state agency guidance. This includes implementing distance and landscape buffers around nesting sites and avoiding certain activities during nesting season. In addition, the Bald Eagle Management Plan includes guidelines for activities around roosting and foraging areas. The plan also includes provisions for monitoring of nesting, roosting, and foraging sites every 5 years and injury and mortality reporting procedures. Interior also recommends, as a 10(j) measure, the development a bald eagle management plan based on the FWS *National Bald Eagle Management Guidelines* and state agency guidance. Our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, provides our rationale for recommending the implementation of the Bald Eagle Management Plan, as proposed by Exelon and recommended by Interior, because it would benefit bald eagles within the Muddy Run

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[91] The Tier 1 target is that 75 percent of the fish passing the downstream Conowingo Project are passed at Holtwood. If that target is not met, then the Tier II requirement is that 85 percent of the fish that arrive in the Holtwood Project area must be passed upstream of Holtwood, and the only methodology currently available to make that determination is radio telemetry.

Project boundary by complying with bald eagle management guidelines and state guidelines, ensuring that future bald eagle nest, roost, and foraging areas are also protected by the Bald Eagle Management Plan, and ensuring that FWS and Pennsylvania Game Commission are aware of any project-related bald eagle mortality for the term of any new license. We estimate that the levelized annual cost of implementing the Bald Eagle Management Plan would be $750 and conclude the benefits of protecting bald eagles justify this minimal cost.

Osprey Management Policy

Exelon proposes to implement the osprey management policy described in the SMP filed with the license application that states Exelon would work with state and federal agencies to provide appropriate buffers dictated by the types of activities carried out in either visual or auditory proximity to nests during breeding and nesting season (January to late July). This includes implementation of: (1) nest buffers during the breeding season of 330 feet for most activities and larger buffers up to 600 feet for activities with the potential to emit excessive noise (which excludes routine project operation and maintenance activities), and (2) restriction on herbicide application within 330 feet of osprey nests during breeding season. Under the policy, Exelon would consult with FWS and Pennsylvania Game Commission to determine BMPs and obtain applicable permits in the event an osprey nest on project transmission line towers is identified as a problem nest that needs to be removed or relocated. We recommend adoption of Exelon's proposed osprey management policy. Our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, indicates implementation of the osprey management policy would benefit the osprey by enacting protection measures and following BMPs. The costs associated with implementation of the osprey management policy are included in the cost estimate for implementing the SMP.

Bog Turtle Management Plan

Exelon proposes to implement the Bog Turtle Management Plan filed with the license application, which is consistent with Interior's recommended measure to develop and implement, in consultation with FWS and Pennsylvania FBC, a bog turtle management plan for the Muddy Run Project. Exelon's proposed Bog Turtle Management Plan includes: (1) a restriction of mowing in the wetland documented to support bog turtles; (2) invasive plant and woody plant control, particularly for reed canary grass; and (3) possible limits on public access to the wetland without advertising the reason. We provide our rationale for recommending the Bog Turtle Management Plan in section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects.* This section indicates the Bog Turtle Management Plan would ensure that invasive species are controlled in the area and the wetland is not affected by vegetation management during the emergence and breeding season. We estimate that the levelized annual cost of the Bog Turtle Management Plan would be $8,240 and conclude the benefits of protecting the federally listed bog turtle justify the cost.

Recreation Management Plan

Exelon proposes to implement the Recreation Management Plan filed with the license application that also includes a schedule for implementing proposed recreational enhancements at the Muddy Run Project. A recreation plan would allow Exelon to implement facility improvements and install new facilities in a coordinated manner, and would ensure that the proposed recreational facility improvements meet the intended purposes. However, the plan does not include a specific provision for reviewing and updating the plan over the term of any license issued. The staff alternative would include revising the plan to specify visitation and sedimentation monitoring of the boat ramp to maintain boater access and consultation efforts as part of the plan. We recommend that the Recreation Management Plan include measures to conduct a recreation use study every 12 years, consistent with every other FERC Form 80 reporting deadline, as well as review and consultation with resource agencies, counties, and other interested stakeholders in the project area, such as Pennsylvania FBC, Pennsylvania DCNR, Maryland DOE, and Maryland DNR. We estimate the levelized annual cost of the revised plan would be $2,370. We conclude that these costs would be worth the substantial benefits that would be derived from implementing the revised plan.

Recreation Facility Improvements

As part of the Recreation Management Plan, Exelon proposes to upgrade a variety of amenities within Muddy Run Park and make repairs at Wissler's Run Park near the Muddy Run powerhouse. As part of the improvements, Exelon would replace the existing boat launch facility at Recreation Lake with a new concrete plank ramp, a new gangway, and floating dock (ADA compliant), and also make shoreline improvements to limit erosion. Exelon also proposes to upgrade the ADA-compliant picnic site, stabilize 150 feet of the shoreline at Recreation Lake between the ADA-compliant picnic site and the rental boat dock, convert the timber retaining wall to sheetpile retaining wall, upgrade service to 50-amp electrical service at 50 sites, expand the playground adding a "tot lot," construct a spray park, and provide Wi-Fi service to park users. Proposed improvements to Wissler's Run Park would include removing the non-functioning fish cleaning station, rebuilding and repaving the existing walkway along the top of the bank, and designating two parking spaces near the picnicking pavilion as meeting ADA standards. As part of the plan, Exelon also proposes to erect and maintain FERC Part 8 signs at River Road and Furniss Road Muddy Run WMA parking areas. Exelon proposes to continue to lease these lands to the Pennsylvania Game Commission for the term of a future license. In our analysis in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, we conclude that improvements to the Recreation Lake boat ramp, ADA-compliant picnic area, shoreline, and retaining walls would improve boater access and maintain water quality by reducing runoff from these areas. Further, improvements to the ramp would enhance boater access; a popular activity on the lake. Similarly, improvements to the campground electrical service that include more 50-amp service campgrounds and Wi-Fi would address modern camper needs such as increased use of

electronic devices (e.g., recreational vehicles with air conditioning, personal computers, and smart phone charging). Removal of the non-functioning fish cleaning station at Wissler's Park would eliminate the temptation for users to clean fish on site and leave the waste, which could negatively affect the aesthetics of the area. Enhancements to the pathway and designating two additional parking areas as ADA-compliant would improve the overall recreation experience. For these reasons, we recommend implementation of Exelon's proposed recreation facility improvements. The estimated levelized annual cost of these capital improvements would be $197,320. The benefit of upgrading and expanding recreational opportunities at the project recreation sites is worth the cost.

Shoreline Management Plan

Exelon proposes to implement the SMP filed with the license application that includes specific measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands and BMPs for controlling sediment loading from lands within the project boundary. In our analysis in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, we conclude that implementation of the SMP would provide policies to manage the project's shorelines and protect the environmental resources, including bald eagle and osprey habitat and aesthetics along the Muddy Run Project's upper reservoir and would help to minimize effects from erosion on the reservoir's shoreline. Revising the SMP to include regular updates every 10 years in consultation with interested stakeholders consistent with the latest *Guidance for Shoreline Management Planning at Hydropower Projects* (FERC, 2012) would ensure the plan is harmonious with conditions at the project. We conclude that the addition of regular updates and consultation to the SMP would be worth the estimated levelized annual cost of $1,440 to revise the SMP.

Historic Properties Management Plan

Exelon proposes to develop a cultural resources management plan if cultural materials are identified during project-related activities. Interior, under section 10(a), recommends that Exelon develop and implement an HPMP that provides for the management of historic properties and unevaluated cultural resources within the project APE. The HPMP would be prepared in accordance with the Advisory Council and Commission's joint guidance document for preparing hydroelectric project HPMPs (FERC and Advisory Council, 2002) and would include: (a) a detailed discussion of the three sites (36LA67, 36LA103, 36LA368) identified during the Phase IA cultural resources survey and two additional sites (36LA70, 36LA47) located outside of the project boundary but within the project's APE; (b) requirements for National Register evaluation of affected sites in consultation with the Pennsylvania SHPO; and (c) requirements for formal National Register evaluation of the Muddy Run Project facility; and (d) documentation of consultation with Indian tribes. Our analysis in section 3.3.6.2, *Cultural Resources, Environmental Effects*, concludes that implementation of this

measure would ensure that the Muddy Run Project would not adversely affect historic properties during the term of any license. We estimate that the levelized annual cost of development and implementation of an HPMP for the project would be $31,150 and conclude the benefits of protecting cultural resources and historic properties justify the cost.

5.1.2.3 Measures Not Recommended

Eel Passage Plan

The certification requires implementation of Exelon's American Eel Passage Plan, in which Exelon would establish an Eel Passage Advisory Group to help implement the plan, and would trap, hold, and transport American eels from Conowingo dam to designated points in the Susquehanna River watershed. Exelon has agreed to this measure in the certification for the Muddy Run Project, and would also implement this plan as a measure for the Conowingo Project. While we are recommending these measures at Conowingo (see section 5.1.3.1, *Conowingo Project – Measures Proposed by Exelon*), we do not recommend those measures as requirements of any license for the Muddy Run Project because the Commission cannot require a condition in any Muddy Run license that would need to be implemented at another licensed project.

Grants to Conservation Districts

Consistent with the water quality certification, Exelon proposes to provide $450,000 to be split equally between the York County and Lancaster County conservation districts for the implementation of agricultural pasture and barnyard BMPs to control sediment introduction into the Susquehanna River. Exelon would provide another $50,000 to the Pennsylvania FBC to perform habitat improvements, including the removal of small dams.

The compensatory mitigation requirement of the certification does not specify nor describe what the compensation is mitigating. Funds would be used for BMPs to reduce sediment loading to the river and for habitat improvement, including dam removal. This requirement appears not to be related to any specific project impact, nor would the measures necessarily be implemented in the project area. With a lack of nexus to the project, and because providing funds is inconsistent with Commission's guidelines on environmental measures,[92] we do not recommend it be included as a license condition. While we have no objection to Exelon providing these funds, we do not include this measure in our staff alternative. We recognize, however, that these measures are

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[92] *See* Policy Statement on Hydropower Licensing Settlements, issued September 21, 2006.

included in the certification for the Muddy Run Project, so they would be a mandatory condition of any license issued for the project.

Rare, Threatened, and Endangered Species Annual Evaluation

Exelon proposes a plan to evaluate all state and federal endangered or threatened species that may be present within the project boundary once every 10 years through the term of the license. If the evaluation identifies the presence, critical habitat, or critical dependence of endangered species, Exelon would propose and, following approval, implement a plan to ensure protection of endangered or threatened species. Our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, indicates that although we agree that this measure would allow Exelon to continue to be aware of the current rare, threatened, and endangered species populations in the Muddy Run Project during the length of any license, the Commission typically includes in its licenses a standard license article with a fish and wildlife reopener provision that could be used to require changes to project facilities upon Commission motion or as recommended by the appropriate federal and state fish and wildlife agencies after notice and opportunity for hearing. This standard reopener provision retains authority for the Commission to implement any measures that may be needed to protect threatened or endangered species or other fish and wildlife resources over the term of any license issued for the project. Although we have no objection to Exelon conducting this agency consultation, we feel that the standard license article would provide a similar level of protection as the proposed measure. We recognize, however, that this measure is included in the certification for the Muddy Run Project, so it would be a mandatory condition of any license issued for the project.

5.1.3 Conowingo Project

5.1.3.1 Measures Proposed by Exelon

Based on our environmental analysis of Exelon's proposal in section 3, *Environmental Effects*, and the costs presented in section 4, *Developmental Analysis*, we conclude that the following environmental measures proposed by Exelon would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend including these measures in any license issued for the project. We discuss any modification to Exelon's proposed measures under *Measures Recommended by Staff for the Conowingo Project.*

- Operate the project with a normal range of operation of Conowingo Pond between elevations 101.2 and 110.2 feet, with a minimum elevation of 107.2 feet on weekends between Memorial Day and Labor Day, to meet recreational needs.
- Enhance DO at the project using the turbine venting systems on Units 1 through 7 and the aerating runners on Units 2 and 5, and continuously

monitor DO levels from May 1 through October 1 at the Station 643 location about 0.6 mile downstream of Conowingo dam.

- Operate the east fish lift to pass American shad, river herring, and other migratory fishes, and the west fish lift for American shad egg collections and other research purposes.
- Manage debris to include clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes and floating surficial debris in front of the powerhouse intakes, and sponsoring community-based clean-ups in the pond and downstream of the dam.
- Implement the Sediment Management Plan filed with the license application that identifies benchmarks and thresholds for action to address sediment issues that may affect project operation.
- Conduct a bathymetric survey of Conowingo Pond every 5 years to monitor sediment transport and depositional patterns within the pond.
- Implement a preventive maintenance program for the east fish lift to extend the useful life of the facility over the next license term.
- Use the project turbines as the route for downstream passage of American shad and river herring.
- Construct a permanent trap and transport facility for upstream passage of American eel, consisting of an eel ramp and collection facility on the west and east banks of the Conowingo tailrace (an alternative east bank facility would be in Octoraro Creek).
- After 2030, construct volitional eel passage facilities on the west and east banks that consist of full eel ramps with resting pools.
- Participate in a trap and transport program for downstream eel passage, in cooperation with the other hydroelectric project operators on the lower Susquehanna River to trap and transport adult American eels from smaller tributaries upstream of York Haven dam to below Conowingo dam.
- Implement the Bald Eagle Management Plan filed with the license application to minimize impacts to bald eagles and their habitat within the project boundary in accordance with recommendations from the National Bald Eagle Management Guidelines (FWS, 2007a) and state agency guidance.
- Implement the Recreation Management Plan filed with the license application that provides for improvements to 13 project recreation facilities, including directional signage to facilities and canoe portages, expanded parking, ADA-compliant and boat trailer parking spaces, fencing,

shoreline stabilization, new or repaired boat ramps, improved access, picnic tables, portable restrooms, and other amenities.

- Implement the SMP filed with the license application that includes measures and policies related to shoreline vegetation management and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, BMPs for controlling sediment introduction from lands within the project boundary, and use of project lands.
- Implement the osprey management policy described in Exelon's SMP.
- Implement the HPMP filed with the license application for the management of archaeological and historic resources, including: (1) a schedule and methodology for completing any additional recommended studies and implementing monitoring measures; (2) management measures for identified historic properties including Conowingo dam and powerhouse; (3) protection of any historic properties threatened by project-related activities, including project operation, shoreline and aquatic recreation, shoreline development, routine project maintenance, and other project activities or operations; and (4) public outreach, education, and signage for the purpose of reducing looting and vandalism of sites.

5.1.3.2 Additional Measures Recommended by Staff for Conowingo

We recommend Exelon's proposed measures as described above, with the following additions and modifications:

- Modify Exelon's proposed Sediment Management Plan to include periodic dredging at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediments have been accumulating, to improve and maintain recreational boating access; and include with the results of each bathymetric survey an analysis of any change in sediment deposition or scour in the pond from the previous survey(s).
- Modify Exelon's proposed minimum flow regime to enhance minimum flows from December through February, by eliminating periods with no minimum flow, and by increasing the minimum flow during the first 2 weeks of June, summarized as follows:
  - September 15 – March 31: 3,500 cfs or natural inflow (as measured at the USGS Marietta gage No. 0157600), whichever is less;
  - April 1 – April 30: 10,000 cfs or natural inflow, whichever is less;
  - May 1 – June 15: 7,500 cfs or natural flow, whichever is less;
  - June 16 – September 14: 5,000 cfs or natural inflow, whichever is less.

- Implement measures designed to improve upstream fish passage through modification to the existing west and east fish lifts, including: (a) replacing the existing hopper at the west fish lift with a 1,500 gallon hopper; (b) improving the west fish lift sorting and loading process to facilitate trap and truck operations and implement a trap and truck program for American shad; (c) conducting a feasibility study for adding attraction flow at the west fish lift and if feasible and beneficial, install additional flow capacity; (d) restoring the original design for the 900-cfs attraction flow in the east fish lift; (e) adding a second 3,300-gallon hopper to the east fish lift in the space provided for in the original design, and upgrading the electrical and mechanical equipment to allow for a 15 minute lift cycle; and (f) if 2 years of effectiveness studies, after restoration of the 900-cfs attraction flow, show poor attraction at the east fish lift, conducting a feasibility study for modifying the locations of entrances A and B, and implement if feasible.
- Modify Exelon's proposed Bald Eagle Management Plan to include measures to minimize recreation-related disturbance in proximity to roosting or foraging eagles.
- Develop a northern map turtle protection plan to minimize project impacts to map turtles through monitoring, habitat management, and nest site protection.
- Develop a waterfowl nesting protection plan to identify waterfowl nesting habitat that is routinely flooded during the breeding season, and where feasible, establish mitigation measures to minimize impacts to waterfowl nests.
- Modify Exelon's proposed Recreation Management Plan to include recreation use monitoring and plan updates every 12 years in concert with every other the Form 80 reporting deadline and a plan to provide angler access to the catwalk on a limited basis and security measures in place that address the vulnerability of the facility and the safety of the users of the catwalk.
- Modify Exelon's proposed SMP with the addition of a provision to update the plan every 10 years.
- Modify Exelon's proposed HPMP to include the following additional provisions: (a) a revised APE with the narrow strip of land in the current project boundary extending downstream from Spencer Island along the west side of the river to Havre de Grace, Maryland; (b) a discussion of all 48 sites and 27 historic structures identified to date within the project APE or an explanation of why they are not considered; (c) correction to identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad eligible for listing; (d) requirements to inventory any lands within

the revised APE, evaluate identified cultural resources for eligibility, and address potential effects before sale or transfer of those lands; (e) a requirement to make a good faith effort to obtain access to private property to conduct studies if project effects on cultural resources on private lands are identified; (f) a revised list of project activities involving the Conowingo Project that can be completed without Maryland SHPO review; (g) a process for assessing project-related ground-disturbing activities to determine whether or not archaeological sites would be affected, particularly in areas that have not had archaeological surveys; (h) requirements to ensure confidentiality of cultural resources location information during implementation of public outreach programs; and (i) a description of project-related activities that would require consultation with the Delaware Nation and the Onondaga Nation in accordance with section 106 of the NHPA and documentation of Native American consultation.

Below we discuss the rationale for recommending proposed measures, modified measures, and additional staff measures for the Conowingo Project.

Reservoir Operations

Exelon is proposing to continue operating Conowingo Pond using the same reservoir operating limits as currently employed. Currently, Exelon operates Conowingo Pond between elevations 101.2 and 110.2 feet, with a minimum elevation of 107.2 feet on weekends between Memorial Day and Labor Day, to meet recreational needs. No entity made recommendations to change the current reservoir elevations, and our analysis found that current reservoir operation adequately protect aquatic resources and recreational use of the reservoir. Therefore, we are recommending continuation of existing reservoir operation, which can be implemented at no additional cost to the project.

DO Enhancement Measures

Exelon is proposing to continue DO enhancement at the project using turbine venting and aeration. Since placed into operation, these systems have been shown to maintain adequate DO levels downstream of the project nearly 100 percent of the time. Exelon would also continuously monitor DO levels from May 1 through October 1 at the Station 643 location about 0.6 mile downstream of Conowingo dam. No entities have recommended additional measures for protection or enhancement of DO levels, and because state standards are being met, we are recommending continuation of existing DO measures and DO monitoring. These measures and monitoring can be implemented at no additional cost to the project.

Sediment Management and Bathymetric Surveys

Exelon proposes to implement the Sediment Management Plan filed with the license application to identify benchmarks and thresholds for actions to address sediment

issues that may affect project operation. Exelon also proposes to conduct bathymetric surveys every 5 years. In section 3.3.1.2, *Geology and Soils, Environmental Effects*, we conclude that these measures are relevant tools for managing the sediment accumulation issues in the reservoir, ensuring effective power generation, maintaining recreation facilities, as well as providing information for environmental management of the lower Susquehanna River system and Chesapeake Bay. Implementation of the proposed Sediment Management Plan would include monitoring of the water depth at Peter's Creek (Peach Bottom Marina), Conowingo Creek, and Broad Creek (Harford County boat launch) every 5 years; however, the plan stops short of identifying at what depths the locations need to be dredged and scheduling dredging. These three boat ramps represent half of the boat ramps providing access to Conowingo Pond for motorized boating. As discussed in our analysis in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, cross referencing the bathymetric mapping proposed under the Sediment Management Plan at the three sites into the final Conowingo Recreation Management Plan would ensure bathymetric mapping results are included in discussions related to boater access to the reservoir. Development of a final Sediment Management Plan that includes detailed benchmarks for dredging, a schedule, and commitment to dredging the three access areas as soon as the benchmark water depths are reached would ensure that recreation access is not lost or compromised indefinitely. We estimate that the levelized annual cost of implementing regular bathymetric surveys at 5-year intervals and implementing the Sediment Management Plan would be $10,480 and $6,220, respectively. We estimate the levelized annual cost of dredging at the three boat ramps would be $493,030. We conclude that the benefits of understanding and managing sedimentation issues in the reservoir and ensuring accessing to the reservoir justify the cost of these measures. We note, however, that relevant findings in the Corps' LSRWA study report, if available in time, may result in additional recommendations in the final EIS or in any license order issued for the project, depending on when the study results are available to Commission staff.

Instream Flows

Exelon proposes to continue its current minimum flow releases from the project, which are an alternating 0/3,500 cfs (6 hours on/6 hours off) from December through February, 3,500 cfs in March, 10,000 cfs in April, 7,500 cfs in May, 5,000 cfs from June through September 14, and 3,500 cfs from September 15 through November.[93] Exelon is not proposing any changes in the current maximum generating flow rate from the project (86,000 cfs), or in project ramping rates. Interior, in its section 10(j) recommendation, stated that Exelon should finalize and implement a flow management plan and implement the flow recommendations of The Nature Conservancy or any more restrictive flows

[93] Exelon would provide the lesser of these flows or the natural inflow at the upstream Marietta, Pennsylvania USGS gage No. 0157600.

required by the Maryland certification (when issued), returning the river downstream of Conowingo to more natural conditions. The Nature Conservancy recommended flows be released downstream of Conowingo dam sufficient to achieve several habitat objectives for diadromous and resident fish species, mussels, map turtles, and submerged aquatic and emergent vegetation (the TNC Flow Regime). The Nature Conservancy also recommended that the EIS evaluate two operational alternatives: (1) run-of-river operation (passage of the daily average flow measured at the USGS Marietta, Pennsylvania, gage plus any intervening flows that enter the river between the Marietta gage and Conowingo dam); and (2) the set of operational constraints that The Nature Conservancy identified as a potential approach for meeting its performance goals.

Our analysis found that, overall, the current and proposed Exelon operations generally bracket the range of flows that would provide 70 percent of MWUA (a primary goal of the TNC Flow Regime) for target species, as determined by Exelon's instream flow study. However, we also found that some small adjustments to Exelon's proposed flow regime would provide additional benefits to aquatic habitat. These adjustments include: (1) eliminating the 6-hour periods of zero minimum flow from December through February, resulting in a continuous minimum flow of 3,500 cfs from September 15 through March; and (2) increasing the minimum flow from 5,000 to 7,500 cfs during the first 2 weeks in June, to protect the end of the spawning period for shad and striped bass.

While we conclude that the flow issue downstream of Conowingo dam is complex, our analysis found that Exelon's current flow regime is generally adequate for protection of aquatic resources downstream of the project, although the adjustments to these flows as we discussed would provide additional protection to aquatic habitat. Therefore, we recommend that Exelon provide, upon issuance of any new license, a modified minimum flow regime downstream of the project as follows:

- September 15 – March 31: 3,500 cfs or natural inflow (as measured at the USGS Marietta gage No. 0157600), whichever is less;
- April 1 – April 30: 10,000 cfs or natural inflow, whichever is less;
- May 1 – June 15: 7,500 cfs or natural flow, whichever is less;
- June 16 – September 14: 5,000 cfs or natural inflow, whichever is less.

This modified flow regime would provide the environmental benefits described above and would result in a small energy gain at Conowingo (annualized value of $2,650), but a small loss in energy (annualized value of $19,190) at Muddy Run. This, however, would be worth the cost in providing additional protection to aquatic resources, and it would preserve the developmental benefits of the project, including peaking generation and ancillary services.

Upstream Fish Passage

The Conowingo Project currently operates two fish lifts at the project: the west fish lift first constructed in 1972, and now operated primarily for shad egg taking and experimental purposes, and the east fish lift constructed in 1991, which provides upstream volitional passage for American shad and other species. Exelon proposes to continue operating these facilities and to implement a preventive maintenance program at the east fish lift to extend the life of the facility through the new license term. Several commenting entities have stated that the current facilities are inadequate and outdated and fail to meet the current resource agency effectiveness targets to achieve successful anadromous fish restoration in the Susquehanna River. Both Interior and NMFS reserve their authority to prescribe additional fishways during the term of the license, and Interior also provides a preliminary fishway prescription for the project for both anadromous and catadromous species. Interior also recommends that Exelon prepare an operations and maintenance plan for Conowingo fish passage facilities, and an FEMP, and as a section 10(j) measure recommends that alternative G of the preliminary fishway prescription be implemented. Alternative G includes: (1) construction of a new west fish lift with two lifts for both trap and trucking and direct volitional upstream shad passage; (2) modification of the east fish lift stilling basin to allow 900-cfs attraction flow, as originally designed, relocation and reconstruction of entrances A and B, and construction of a new entrance D and collection gallery; and (3) adjustment of minimum flows and turbine operations, construction of an east fish lift auxiliary water supply of 4,325 cfs, and upgrades to the east fish lift equipment to allow a 15-minute cycle time if FWS fish passage efficiency targets are not met after implementation of the above measures.

Exelon, in its reply comments, states that there is currently no need to construct additional fish passage facilities at Conowingo dam, that the recent shad population trends in the Susquehanna River and along the Atlantic coast do not indicate that large increases in shad populations are likely, and that there is no scientific basis for the target effectiveness rates that Interior and other agencies have recommended for fish passage facilities at Conowingo and the other Susquehanna River hydroelectric projects. Exelon also comments that past agency management decisions for the Susquehanna River have been flawed, including the decision to terminate shad trap and truck operations from Conowingo after 1996, resulting in a decrease in the number of spawners reaching upriver spawning habitat.

As part of our analysis, we assessed fish passage effectiveness for shad at Conowingo, other Susquehanna River projects, and other hydroelectric projects in North America. We also assessed shad population trends on the Susquehanna River and elsewhere on the Atlantic coast, and analyzed the fish passage designs prescribed by Interior, compared to alternative designs. Our analysis could not find any scientific basis for the agencies' effectiveness goals; however, those goals are specified in the Migratory

Fish Management and Restoration Plan for the Susquehanna River Basin (SRAFRC, 2010).[94] We also could not find any examples where shad upstream passage effectiveness has consistently reached such high levels. Safe Harbor Project has the highest effectiveness on the Susquehanna River, averaging 71 percent of the fish passed at the downstream Holtwood Project, but in many years does not reach that effectiveness. On the Columbia River, which has an established large shad population on a multiple dam system, passage effectiveness is typically only about 50 to 55 percent of the next lower dam. The effectiveness goals of Interior and other agencies may not be realistic or achievable. Our review of the shad population in the Susquehanna River found that the river exhibited strong population growth from the 1970s into the early 2000s, as a result of restoration efforts, but has been in decline since 2001. Exelon and the agencies both comment that one of the major reasons for that decline was the suspension of shad trapping and trucking in 2000, and the switch to volitional passage in that year. We agree and found that the number of shad reaching prime upstream spawning habitat has declined significantly since trucking was eliminated. We also discuss other potential reasons for the decline in the population, including the very large increase in the gizzard shad population in the river since 2000, the introduction of predator species such as the flathead catfish, and the continuation of an offshore fishery for shad. The Susquehanna River shad population trends also mirror the trends in many other rivers in the Chesapeake Bay and along the Atlantic coast, which has been acknowledged by ASMFC.

Even though the agency fishway effectiveness goals may be overly optimistic and that shad populations are depressed coast-wide, we reviewed the fish passage designs at Conowingo in light of the Interior preliminary fishway prescription, and because fish passage effectiveness at Conowingo has been shown to be low in some years. Our assessment of Interior's preliminary fishway prescription is that the designs it would require are overly ambitious and would require a major investment by Exelon in facilities that are not needed at present. We agree, however, with Interior and other commenters that improvements are needed at the fish lifts, because of maintenance requirements, the fact that these facilities are "showing their age," and that for the east fish lift, it has not been operating as it was originally designed. As such, we recommend a phased approach to these improvements. The following summarizes the improvements that we recommend: (1) replace the existing west lift hopper with a 1,500-gallon hopper, and associated structural, electrical, and mechanical upgrades; (2) improve the west lift fish sorting and loading process, to facilitate trap and trucking, and purchase trucks, transport tanks and associated equipment and implement trap and trucking at the west lift; (3) conduct a feasibility study on increasing the west lift attraction flow, and install

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[94] The agency effectiveness goals are: that 75 percent of the fish passed at a lower dam must be passed at the next upstream dam, and that of the fish that reach each dam, 80 percent of those fish must pass within 36 hours, and the total passage should be 85 percent of those fish that arrive at each dam.

additional attraction flow capacity if needed; (4) restore the original design of 900-cfs attraction flow in the east lift; (5) add a second 3,300-gallon hopper in the east lift in the space provided for in the original design, and upgrade electrical and mechanical equipment to allow a 15-minute lift cycle time; (6) after restoration of the 900-cfs attraction flow and if 2 years of effectiveness studies at that flow show poor attraction to the lift, conduct a feasibility study for modifying the locations of entrances A and B; and (7) implement changes to entrances A and B if the feasibility study indicates it would be technically feasible and result in improved effectiveness. We also recommend a study on effects of gizzard shad on passage efficiency, capacity, and interference with American shad use of the Conowingo fish lifts. This study may provide information on how lift operations may be modified to discourage gizzard shad use of the lifts, or potential sorting mechanisms to separate the two species.

Under the staff alternative, we recommend the above lift improvements so that trapping and trucking can be restored to the west lift as a primary function, along with the west lift's secondary functions for collection of shad eggs and other experimental purposes, while the east lift would continue to operate as a volitional passage facility, to supply fish to upstream fish passage facilities. We conclude that, while this alternative would involve substantial costs (levelized annual cost of $959,760 for identified engineering costs, and $260 levelized annual cost for the gizzard shad study), it would enhance American shad restoration in the Susquehanna River in a phased and economically reasonable manner.

American Eel Passage

At the Muddy Run Project, Exelon incorporated the Pennsylvania DEP certification into its proposal for the project, which requires Exelon to implement Exelon's American Eel Passage Plan, with all measures to occur at Conowingo. Thus, Exelon proposes upstream eel passage at Conowingo. That would include interim trap and truck facilities on the west side of the tailrace and another on the east side of the river, likely in Octoraro Creek. Those facilities would operate until 2030, when the facilities would be replaced with volitional passage facilities. Exelon also proposes to cooperate with other licensees on the lower Susquehanna River in implementing a downstream trap and transport program and conducting studies on eel passage from upstream of York Haven. Interior's preliminary fishway prescription for Conowingo also requires construction of eel trapping and trucking and eventually volitional facilities on both shorelines. For downstream passage, Interior prescribes that Exelon maintain downstream eel passage survival rates of at least 85 percent through the Conowingo Project, with follow-up effectiveness studies to determine whether downstream passage rates are achieved. If not achieved, Exelon would evaluate changes in operation and fish guidance systems to provide safe, timely, and effective downstream fish passage. We are in agreement with the proposed and prescribed American eel passage measures and recommend that they become conditions of any license issued. One caveat that we recommend is that the transition to volitional passage at Conowingo not be set to a fixed

date (in the year 2030), but be based on a specific need. A trap and trucking program may still be viable past 2030 and it would give managers the option to stock specific watersheds that may not be available with volitional passage, or in the event volitional passage facilities at the three lower Susquehanna River projects are not highly effective. We estimate that the levelized annual cost for the trap and transport facilities would be $883,380, and the volitional facilities would be $467,400. The annualized cost for the downstream trap and transport program at Conowingo would be $203,140. While these costs would be substantial, they are justified because implementation of these measures would allow for upstream and downstream passage of the American eel, which has been excluded from the Susquehanna River since the original construction of Conowingo dam in 1928.

Bald Eagle Management Plan

Exelon proposes and Interior recommends a measure to finalize and implement the Bald Eagle Management Plan filed with the license application that provides for the management of bald eagle habitat on Exelon lands at the Conowingo Project. The Bald Eagle Management Plan is based on recommendations from the FWS *National Bald Eagle Management Guidelines* and state agency guidance. It includes implementing distance and landscape buffers around nesting sites and avoiding certain activities during nesting season. In addition, the Bald Eagle Management Plan includes guidelines for activities around roosting and foraging areas. The plan also includes provisions for monitoring of nesting, roosting, and foraging sites every 5 years and injury and mortality procedures. Interior indicates two specific measures that Exelon should reconcile to avoid disturbance of eagle concentration areas: (1) enforcement of human traffic restrictions on both sides of Roland Island, under the towers in the river, and on the Cecil County side of the river where current human activities disturb perching and foraging eagles; and (2) a requirement that Exelon release information pertaining to federal regulations that protect eagles and great blue heron rookeries, and other migratory birds if any lands are potentially donated by Exelon.

We provide our analysis for recommending Exelon's proposed Bald Eagle Management Plan in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*. This section indicates implementation of the Bald Eagle Management Plan, as proposed by Exelon and recommended by Interior, would benefit bald eagles within the Muddy Run and Conowingo project boundaries by complying with bald eagle management guidelines and state guidelines, ensuring that future bald eagle nest, roost, and foraging areas are also protected by the bald eagle management plan, and ensuring that FWS and Pennsylvania Game Commission are aware of any project-related bald eagle mortality for the term of any new license. In addition, Interior's recommendation for restrictions to human activity in the vicinity of eagle concentration areas would result in greater protection of foraging and communal roosting bald eagles from human disturbance. As such, we recommend the plan become a condition of any license issued for the project, with the addition of Interior's recommendations for measures to minimize recreation-

related disturbance in proximity to roosting or foraging eagles. As Exelon has not proposed to donate lands as part of the proposed project, it is not necessary at this time to include a measure in the proposed Bald Eagle Management Plan that would require Exelon to release information on bald eagles or other migratory species to a recipient. We estimate that the levelized annual cost of implementing the bald eagle management plan would be $1,740 and conclude the benefits of protecting bald eagles justify the cost associated with implementing the revised plan.

Osprey Management Policy

Exelon's proposed osprey management policy, described in Conowingo's proposed SMP, states that Exelon would work with state and federal agencies to provide appropriate buffers dictated by the types of activities carried out in either visual or auditory proximity to nests during breeding and nesting season (January to late July). This includes implementation of: (1) nest buffers during the breeding season of 330 feet for most activities and larger buffers up to 600 feet for activities with the potential to emit excessive noise (which excludes routine project operation and maintenance activities); (2) restrictions on herbicide application within 330 feet of osprey nests during breeding season; and (3) consultation with FWS and Pennsylvania Game Commission to determine BMPs and obtain applicable permits in the event an osprey nest on project transmission line towers is identified as a problem nest that needs to be removed or relocated. Our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, indicates implementation of the osprey management policy would benefit the osprey by enacting protection measures and following BMPs. Therefore, we recommend adopting this recommendation. The estimated annual cost of implementing the osprey management policy is included in the cost of implementing the SMP.

Waterfowl Nesting Protection Plan

Interior recommends under section 10(j) that Exelon develop and implement a waterfowl nesting protection plan in consultation with FWS and file it with the Commission for approval. Such a plan would: (a) identify project-related effects on nesting waterfowl, such as flooding during nesting season; (b) identify which species of nesting waterfowl are affected, if any; and (c) if project-related effects are identified, establish appropriate protection or mitigation measures, in consultation with FWS. In our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, we conclude that implementation of a waterfowl nesting protection plan at the Conowingo Project would identify any specific areas that have nest flooding and allow appropriate protection or mitigation measures to be established. Overall, implementation of a waterfowl nesting protection plan at the Conowingo Project, in consultation with FWS and the state agencies, would benefit nesting waterfowl. We recommend adopting the plan and estimate that the levelized annual cost of implementing the waterfowl nesting protection plan would be $19,980. We find that the benefits of protecting nesting waterfowl at the project warrant the cost of developing and implementing a plan.

Northern Map Turtle Protection Plan

Although Exelon did not propose any specific measures for the protection of northern map turtles at the project, Exelon has worked with Towson University and Maryland DNR to develop potential measures that could enhance the map turtle population; some of these measures (i.e., artificial basking platforms) are still experimental, however, and it may take several years to develop an optimal design. Other potential measures (i.e., restricting public access at Octoraro Beach during the nesting season and educating recreational boaters regarding the need to minimize disturbance of basking map turtles) may take several years to implement and additional time after that for any positive population trend to be documented. Negative effects, such as nest destruction and predation on incubation eggs, are likely to continue in the future. Consequently, a relatively long-term population monitoring program would be necessary to document whether implemented enhancements are resulting in the expected positive population effects. We recommend the development and implementation of a formal northern map turtle protection plan at the Conowingo Project, in consultation with Maryland DNR, that incorporates nest management and mitigation measures to create new alternative nesting and basking sites. There are numerous factors that contribute to the breeding success or failure of map turtles, and some may be project-related. The northern map turtle protection plan should include the development and implementation of nest management and alternate basking site mitigation and protection measures identified and studied during the ongoing Towson University map turtle studies; annual monitoring of the northern map turtle population at the Conowingo Project for 10 years; annual monitoring of the use and success of both the mitigation and protection measures for 10 years; an assessment of the northern map turtle's response to any changes in operating regime as a result of any license issued; and methods of altering or amending protection and mitigation measures as a result of the monitoring, in consultation with Towson University and Maryland DNR. Our analysis in section 3.3.3.2, *Terrestrial Resources, Environmental Effects*, indicates that implementation of a northern map turtle protection plan would benefit the map turtle by increasing nesting success and providing more stable basking sites. We estimate that the levelized annual cost of implementing the northern map turtle protection plan would be $14,830 and conclude the benefits of protecting northern map turtles justify the cost.

Recreation Management Plan

The Conowingo Project provides a variety of recreational resources, and Exelon developed a Recreation Management Plan and schedule for implementing proposed recreational enhancements at the Conowingo Project to enhance these resources. Exelon proposes to implement the proposed Recreation Management Plan to manage the project reaction facilities. As discussed in in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, a recreation plan would allow Exelon to implement facility improvements and install new facilities in a coordinated manner, and would ensure that the proposed recreational facility improvements meet the intended purposes.

However, the plan does not include a specific provision for reviewing and updating the plan over the term of any license issued. Similarly, the sedimentation of Peach Bottom Marina, Conowingo Creek, and Broad Creek on Conowingo Pond could compromise access at these locations. The staff alternative includes revising the plan to specify visitation and sedimentation monitoring, as well as consultation efforts as part of the plan. We recommend that the final Recreation Management Plan for the project include measures for conducting a recreation use study every 12 years throughout the license term, consistent with every other FERC Form 80 reporting period, to ensure the proposed plans are current and the sites are meeting the demand. We also recommend that Exelon review and update the plan every 12 years in consultation with resource agencies, counties, and other interested stakeholders in the project area, such as Pennsylvania FBC, Pennsylvania DCNR, Maryland DOE, and Maryland DNR. We also agree with the current practice of maintaining a minimum level of 107.2 feet at Conowingo Pond during weekends between Memorial Day and Labor Day to ensure sufficient depths for boating activities over the term of any future license. We estimate the levelized annual cost of the final Recreation Management Plan would be $4,450. We conclude that this cost would be worth the substantial benefits that would be derived from implementing the plan as revised.

Recreation Facility Improvements

Exelon proposes improvements at 13 recreation facilities. In our analysis in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects,* we conclude that Exelon's proposed boat ramp and boat launch enhancements at existing recreation facilities would provide significant improvements to the project's recreational resources. Implementation of the proposed Sediment Management Plan, as discussed in section 3.3.1, *Geology and Soils*, would, at a minimum, monitor the depth of sediment at Peter's Creek (Peach Bottom Marina), Conowingo Creek, and Broad Creek (Harford County boat launch) every 5 years; however, the plan stops short of identifying at what depths the locations need to be dredged and scheduling dredging. These three boat ramps represent half of the boat ramps providing access to Conowingo Pond for motorized boating. Visitor survey results indicate that 6 percent of the comments received at Conowingo Creek targeted shallow water/dredging needs. Similarly, maintaining the minimum pond elevation at 107.2 feet on weekends between Memorial Day and Labor Day as currently required would ensure the boating resources are maintained through the term of any license. Cross-referencing the sediment monitoring proposed at the three access sites under the Sediment Management Plan into the final Conowingo Recreation Management Plan would ensure sediment monitoring results are included in discussions related to boater access to the reservoir. Development of a final Sediment Management Plan that includes detailed benchmarks for dredging, a schedule, and commitment to dredging the three access areas as soon as the benchmark sediment depths are reached would ensure that recreation access is not lost or compromised indefinitely. Implementation of the proposed improvements at Exelon's recreation facilities would have an estimated levelized cost of $218,240 (not including the Sediment Management Plan, which is

discussed separately above). The benefit of safe, accessible, and well-maintained recreation facilities at this highly used reservoir warrants the annual cost of implementing these measures.

Catwalk

Exelon has closed the catwalk for angling since October 2001, citing security concerns related to public access in close proximity to the powerhouse. Maryland DNR and a number of citizens recommend reopening the catwalk for angler access. Exelon has denied these requests citing safety and security concerns and stated that the construction of the wharf at Fisherman's Park and the new access at Octoraro Creek Park were provided to mitigate for the closure of the catwalk. Recreation use numbers collected by Exelon for Fisherman's Park indicate the site is popular and provides both shore-based fishing, as well as boat launch opportunities to the river below the dam. Although not measured directly, the latent demand for angling from a re-opened catwalk could be comparable to, or higher than use at the upstream York Haven and Safe Harbor projects. We conclude in section 3.3.5.2, *Recreation and Land Use Resources. Environmental Effects*, that the catwalk provides exceptional angling opportunities different from those currently provided at the new access sites. Angling from similar structures at upstream hydropower projects is both allowed (with minimal security measures) and popular. Comments during relicensing indicated that fishing from the shore at Fisherman's Park is difficult as the main channel is far away and lures are pushed downstream and to the shore. The proximity of Conowingo dam to large population centers offers more anglers opportunities to fish this unique and historically popular resource. Providing this opportunity at Conowingo, even on a limited basis, would expand the diversity of angler opportunities by providing anglers access to fish the main channel under a range of operating conditions. Therefore, we recommend that Exelon revise its Recreation Management Plan to include a plan to reopen the catwalk on a limited basis (for example, the catwalk could be opened for fishing derbies, during holiday weekends, during peak fishing periods, or other occasions) that would be developed in consultation with interested stakeholders. We recommend that any plan to reopen the catwalk include security measures that address the vulnerability of the facility and the safety of the users of the catwalk. Such measures could include, but not be limited to, on-site inspections, video surveillance, pre-screening procedures, capacity limits, security personnel, and physical infrastructure modifications. The cost to safely reopen the catwalk to anglers would depend upon the number of days that the facility would be open to the public and the specific measures that would be implemented to ensure a safe and secure environment. We estimate that opening the catwalk on a limited basis would cost significantly less than the $141,390 levelized annual cost estimated by Exelon, which based its cost estimates on a 12 hours per day and 365-day per year opening and factored in reconstructing the catwalk to be ADA-compliant. We conclude that, from a recreational resource perspective, the costs would be worth the benefits. Nevertheless, the ultimate decision on whether the catwalk can be reopened to the public,

even on a limited basis, would depend upon the Commission's evaluation of the plan and whether it satisfies public safety and security concerns.

Shoreline Management

The Conowingo Project provides access to many recreational, natural, and shoreline resources within the lower Susquehanna River. Through a collaborative process, Conowingo developed a single shoreline management document to address concerns while maintaining provisions to protect shoreline environmental resources.

Exelon proposes to implement the proposed SMP to manage the environmental resources around Conowingo Pond's shore. As discussed in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects,* the SMP would include specific measures and policies related to shoreline vegetation management, sediment and erosion control, woody debris management, game species management, sensitive natural resource protection, recreation use, and use of project lands. We recommend including the SMP in any new license issued but with our recommended revisions for regular updates. Revising the SMP to include regular updates every 10 years in consultation with interested stakeholders, consistent with the latest Guidance for *Shoreline Management Planning at Hydropower Projects* (FERC 2012), would ensure the plan is harmonious with conditions at the project. We conclude that the addition of regular updates and consultation to the SMP would be worth the estimated levelized annual cost of $1,440.

Historic Properties Management Plan

Exelon proposes to implement the HPMP filed with the license application for the management of archaeological and historic resources throughout the term of any new license, including: (1) a schedule and methodology for completing any additional recommended studies and implementing monitoring measures; (2) management measures for identified historic properties including Conowingo dam and powerhouse; (3) protection of any historic properties threatened by project-related activities, including project operations, shoreline and aquatic recreation, shoreline development, routine project maintenance, and other project activities or operations; and (4) public outreach, education, and signage for the purpose of reducing looting and vandalism of sites, with staff modifications. As discussed in section 3.3.6.2, *Cultural Resources, Environmental Effects,* we conclude that the following revisions would make the HPMP more comprehensive and complete: (a) revise the project APE to include the narrow strip of land located in the current project boundary that extends downstream from Spencer Island along the west side of the river to the city of Havre de Grace, Maryland that contains four additional previously recorded archaeological sites (18HA240, 18HA267, 18HA268, 18HA269); (b) inventory any lands within the project APE (particularly AOIs identified in the Phase IA study that were not subject to Phase IB study), evaluate any identified cultural resources for National Register eligibility, and address potential affects prior to any sale or transfer of those lands; (c) make a good faith effort to obtain access to private property to conduct appropriate studies should project effects of any kind to

cultural resources on private lands be identified over a new license term; (d) discuss all 48 sites identified to date within the project APE; (e) discuss all 27 historic structures identified in the APE or an explanation regarding why they need not be considered in the HPMP; (f) correctly identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad as eligible for listing on the National Register; (g) revise the list (as necessary) of project activities involving the Conowingo Project system that can be completed without Maryland SHPO review; (h) include a process for how project-related ground-disturbing activities would be assessed to determine whether or not archaeological sites would be affected, particularly in areas that have not been subject to previous archaeological survey; (i) ensure confidentiality of cultural resources locational information during implementation of public outreach programs; and (j) include a description of project-related activities that would require consultation with the Delaware Nation and the Onondaga Nation in accordance with section 106 of the NHPA and documentation of consultation with Indian tribes. Our analysis in section 3.3.6.2, *Cultural Resources, Environmental Effects*, indicates implementation of the proposed HPMP with our recommended measures would ensure that the Conowingo Project would not adversely affect historic properties during the course of any license. We estimate that the levelized annual cost to revise and implement the HPMP for the project would be $37,080 and conclude the benefits of protecting cultural resources justify the cost.

Project Boundary

Exelon proposes to remove 1,965 acres from the Conowingo Project boundary that includes areas that were necessary during construction of the project but are no longer needed for project purposes. As discussed in section 3.3.5.2, *Recreation and Land Use Resources, Environmental Effects*, removing these lands would remove four non-project recreation facilities from the project boundary, including the Lower Susquehanna Heritage Greenway, Deer Creek Access, Lapidum Boat Launch, and McLhinney Park. A relatively thin ribbon of land on the west bank downstream of Conowingo dam was included in past licenses so as to include the railroad that was used to shuttle material to the dam during construction. While the lands in this area are now used for non-project recreation, these lands serve no direct project purpose. Project recreation demand is currently met through 15 project recreation sites located around Conowingo Pond and immediately downstream. Continuation of the lease agreements with the State of Maryland for Susquehanna State Park (which includes the Lower Susquehanna Heritage Greenway Trail, Deer Creek Access, and Lapidum Boat Launch) and the City of Havre de Grace for McLhinney Park would maintain recreation access at these locations. Removal of the 1,965 acres of lands would be consistent with FERC policy that only lands and waters needed for project purposes should be included in the project boundary. Lands and waters needed may include those for (1) construction and operation of its project, and (2) to carry out other project purposes such as recreation, wildlife protection, and enhancement. While these lands provide recreation opportunities, these opportunities are not related to the project. In addition, removing these non-project recreation sites from the project boundary would not limit the recreation opportunities available in the

area downstream of Conowingo dam. Execution of a new lease with Maryland DNR would ensure these lands are maintained for public recreation purposes; however, they would not be under FERC jurisdiction. Because the lands proposed for removal from the Conowingo project boundary are no longer used for project purposes, removing these lands would be consistent with Commission policy.

5.1.3.3 Measures Not Recommended

TNC Flow Regime

We do not recommend adopting Interior's recommendation for implementing the TNC Flow Regime or a Maryland DOE certification, if more restrictive. Our reasons for not adopting are discussed in section 5.1.3.2, *Conowingo Project, Additional Measures Recommended by Staff for Conowingo, Instream Flows*. Our recommendation for a modified flow regime, however, is based on the TNC criteria for the habitat persistence analysis that the range of flows during peaking operation provides the TNC target of 70 percent of MWUA by month. Our primary reason for not adopting the TNC Flow Regime is the benefits to some species life stages would not justify the effects on project operation and costs, with a levelized annual cost of $329,130. Operation under the TNC Flow Regime would be restrained and would eliminate many of the peaking and ancillary services benefits to the PJM region from the Conowingo Project, and only provide minimal benefit to the downstream habitat for some species while negatively affecting other species. Ancillary services include those services necessary to maintain the reliability of the interconnected transmission system. Flow requirements of any future Maryland DOE certification are not known at this time, and cannot be analyzed.

Upstream Fish Passage – Alternative G

We do not recommend adopting Interior's recommendation for implementing the fishway prescription detailed as Alternative G. Our reasons for not adopting this measure are given in section 5.1.3.2, *Conowingo Project, Additional Measures Recommended by Staff for Conowingo, Upstream Fish Passage*.

Fish Stranding

Exelon is proposing to continue the same ramping rates of about 70,000 to 80,000 cfs per hour or less and maximum generating flows as currently operated. To address fish stranding, the Nature Conservancy recommends the implementation of ramping rates as part of its TNC Flow Regime. Under the TNC Flow Regime, the maximum generating flow would be limited to 65,000 cfs from March through September, upramping rates would be limited to 40,000 cfs per hour year-round, and downramping rates would be limited to 20,000 cfs per hour overall, and 10,000 cfs from July through September, if flows are less than 30,000 cfs. Interior's prescription includes a maximum downramping rate of 20,000 cfs/hour. Interior prescribes and the Pennsylvania FBC recommends channel modifications to eliminate stranding in the

spillway channel. We provide our analysis of the effects of ramping rates and channel modifications on fish stranding downstream of the Conowingo dam in section.3.3.2.2, *Water Resources, Environmental Effects*. Our assessment of stranding below the project indicates that few fish are killed by stranding under existing operation, and about 90 percent of those killed were gizzard shad, carp, and catfish species, with few diadromous fish impacted. We concluded that the existing changes in flow levels are not having significant adverse effects on aquatic resources, and that maximum flows from the project (86,000 cfs) generally remain within the TNC target of 70 percent of MWUA for the key life stages analyzed. Restraining ramping rates to those recommended in the TNC Flow Regime would adversely affect project operation by limiting the project's ability to respond to changes in load in the PJM system, reducing the ancillary services benefits of the project. There would also be minimal benefit in implementing the Pennsylvania FBC recommendation to extend the retaining wall at the east end of the east fish lift, add boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation, or dredge a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes. Implementing these structural measures downstream of Conowingo dam would have a relatively high cost (levelized annual cost of $74,100), would involve in-river construction activities that would affect both fish and wildlife usage of the area, but would benefit only a small number of fish. Therefore, we are not recommending the imposition of ramping rates, lower maximum discharges, or structural measures to reduce the potential for fish stranding. While we do not find that stranding is an issue requiring mitigation downstream of Conowingo dam, we acknowledge that Interior's downramping provision in its final prescription would become a condition of any license issued for the project.

Bog Turtle Management Plan

Interior states that bog turtles have been observed close to Conowingo dam and recommends a bog turtle management plan; however, it has yet to provide evidence to indicate that bog turtles are present within the Conowingo Project boundary. Thus, staff cannot presently determine if bog turtles would be affected by the Conowingo Project. Further consultation with Interior is necessary to determine the potential for project effects and the need for Interior's recommended bog turtle management. Therefore, we do not recommend a bog turtle management plan for the Conowingo Project.

5.2 UNAVOIDABLE ADVERSE EFFECTS

Fluctuations in reservoir levels would continue to result in unavoidable minor bank erosion for all three projects (York Haven, Muddy Run, and Conowingo). In addition, natural high-flow events would continue to mobilize bed substrate downstream of Conowingo dam.

Unless the current annual sediment load of 3 million tons is dredged from the reservoirs annually, Conowingo Pond would likely be filled with sediment sometime between years 2023 and 2038, and the full sediment load carried by the Susquehanna

River would again reach Chesapeake Bay, as it did prior to the construction of the lower river reservoirs from 1910 to 1930.

The York Haven Project would result in the unavoidable loss of vegetation and wildlife habitat during construction of the nature-like fishway within the construction footprint. At both the Muddy Run and Conowingo projects, the proposed projects would result in the unavoidable loss of vegetation and wildlife habitat during the expansion of recreation facilities.

5.3 FISH AND WILDLIFE AGENCY RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project. In response to our REA notice, Interior filed recommendations for all three projects on January 30 and 31, 2014. Pennsylvania FBC filed recommendations for the Conowingo Project on December 11, 2013.

Section 10(j) of the FPA states that whenever the Commission believes that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency will attempt to resolve any such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency. Table 5-1 lists the federal and state recommendations filed subject to section 10(j), and whether the recommendations are adopted under the staff alternative. Environmental recommendations that we consider outside the scope of section 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document and the previous section.

For the York Haven Project, Interior made two recommendations that we consider within the scope of section 10(j), and we adopt both. For the Muddy Run Project, Interior made five recommendations, two of which we consider within the scope of section 10(j), and we adopt all five recommendations. For the Conowingo Project, Interior made nine recommendations, six of which we consider within the scope of section 10(j), and Pennsylvania FBC made 13 recommendations, nine of which we consider within the scope of section 10(j). We adopt five of Interior's recommendation and nine of Pennsylvania FBC's recommendations.

The Commission staff makes a preliminary determination that three recommendations by Interior and five recommendations by Pennsylvania FBC for the Conowingo Project may be inconsistent with the purpose and requirements of the FPA or other applicable law.

Table 5-1. Fish and wildlife agency recommendations for the Susquehanna River Projects (Source: staff).

	Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
	York Haven Project				
1.	To help evaluate safe and effective passage of American eels through the project, cooperate with FWS and other interested parties in the funding, planning and conduct of a lower Susquehanna River downstream eel study to evaluate the timing, magnitude, duration, annual variation, and environmental conditions associated with the active migration of silver eels through the Susquehanna River to the Chesapeake Bay	Interior	Yes	$5,550	Yes
2.	Operate to maintain an instantaneous minimum flow below the project of 1,000 cfs or inflow, whichever is less; an average daily flow of 2,500 cfs or inflow, whichever is less; whenever river flow is less than 3,000 cfs, operate as run of river; and provide for temporary modifications resulting from operating exigencies beyond the control of the licensee.	Interior	Yes	$0	Yes

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
Muddy Run Project				
1. Before starting any ground-disturbing work, visit the FWS Chesapeake Bay Field Office and Pennsylvania Field Office websites and follow the Bog Turtle and Bald Eagle management guidelines.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$0	Yes
2. Develop and implement a bog turtle management plan.	Interior	Yes	$8,240	Yes
3. Finalize and implement the Bald Eagle Management Plan and as part of the licensee's compliance under the Bald and Golden Eagle Protection Act, FERC should require the licensee to follow conservation measures that protect bald eagles in addition to adopting the National Bald Eagle Management Guidelines.	Interior	Yes	$750	Yes
4. Develop and implement an SMP.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$1,440	Yes
5. The project shall be subject to inspection by FWS to ensure compliance with protection, mitigation, and enhancement measures.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$0	Yes

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
Conowingo Project				
1. Early in the planning process for any ground-disturbing work, visit the FWS Chesapeake Bay Field Office and Pennsylvania Field Office websites and follow the Bog Turtle and Bald Eagle Management Guidelines.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$0	Yes
2. Develop and implement a bog turtle management plan.	Interior	Yes	$8,240	No
3. Finalize and implement the Bald Eagle Management Plan and as part of the licensee's compliance under the Bald and Golden Eagle Protection Act, FERC should require the licensee to follow conservation measures that protect bald eagles in addition to adopting the *National Bald Eagle Management Guidelines*.	Interior	Yes	$1,740	Yes
4. Develop and implement an SMP.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$1,440	No

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
5. Prepare, develop, and implement a study to evaluate safe and effective downstream passage of American eels through the project. Coordinate with FWS and other interested parties in the funding, planning and conduct of a lower Susquehanna River downstream eel study to evaluate the timing, magnitude, duration, annual variation, and environmental conditions associated with the active migration of silver eels through the Susquehanna River to the Chesapeake Bay	Interior	Yes	$5,550	Yes
6. Project shall be subject to inspection by FWS to ensure compliance with protection, mitigation, and enhancement measures.	Interior	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$0	Yes
7. Prepare and implement waterfowl nesting protection plan.	Interior	Yes	$19,980	Yes

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
8. Finalize and implement a flow management plan and implement the flow recommendations of The Nature Conservancy or the Maryland DOE certification, whichever is more restrictive to return river to more natural conditions downstream.	Interior	Yes	$332,090	No
9. Install and operate fishways as described in Interior's preliminary section 18 prescription Alternative G.	Interior	Yes	$3,685,040	No
1. Incorporate performance criteria into new license where 80% of the shad that enter the project area must pass the project within 5 days, to be based on telemetry study of 150 shad per year for 3 years. If goal is not reached, initiate operational changes as specified by the agencies and test for 3 years using telemetry study. If goal is still not reached after 3 years, make structural changes to the fish lifts as specified by the agencies, and test for an additional 3 years using telemetry study. If goal is still not reached within 3 years, additional structural changes may be required, depending on behavior of tagged shad.	Pennsylvania FBC	Yes	$22,230	No

	Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
2.	Modify east fish lift to include a larger hopper, increased attraction flow, and addition of a collection gallery in front of units 8-11.	Pennsylvania FBC	Yes	$0	Adopt larger hopper and increased attraction flow. Not adopt collection gallery.
3.	Complete the rebuild of the west fish lift to include additional attraction water and provision to expand to volitional passage if needed. Ultimately, fish passage facilities at Conowingo will need to pass a design population of 5 million fish, and fish lifts will be required on both sides of the tailrace.	Pennsylvania FBC	Yes	$0	No
4.	Telemetry study of gizzard shad is needed to understand the issues of passage efficiency, capacity, and interference with American shad.	Pennsylvania FBC	No. Study could have been done pre-licensing.	$260	Yes
5.	Telemetry study to understand recycling of gizzard shad in the west fish lift.	Pennsylvania FBC	No. Study could have been done pre-licensing.	$0[95]	Yes

[95] We assume the studies recommended in Pennsylvania FBC recommendations 4 and 5 would be combined and conducted at the same time. As such, the estimated levelized cost for recommendation 4 would cover the cost for recommendation 5.

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
6. Downstream passage survival of juvenile shad must be 95% or higher.	Pennsylvania FBC	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$0	No
7. Construct eel passage facility near west fish lift, with capability to modify the location of the facility and to change to volitional passage.	Pennsylvania FBC	Yes	$442,340	Yes
8. Test additional locations for eel passage near the west fish lift.	Pennsylvania FBC	Yes	$0	Yes
9. Test additional locations for eel passage near the east fish lift and construct permanent traps as needed.	Pennsylvania FBC	Yes	$0	Yes
10. Test additional capture locations on Octoraro Creek at base of Octoraro reservoir dam, and install additional traps there.	Pennsylvania FBC	Yes	$0	Yes
11. Transport 1 million eels annually from 2015 to 2030 to sites above Conowingo and York Haven dams until permanent volitional facilities are operating effectively.	Pennsylvania FBC	Yes	$0	No

Recommendation	Agency	Within the Scope of Section 10(j)	Annual Cost	Adopted?
12. Once sufficient eels are in the system, cooperate with other utilities to conduct a study on eel downstream passage and ensure downstream passage survival of 80% at Conowingo for silver eels. Make operational and structural modifications as needed to achieve 80% survival.	Pennsylvania FBC	No. Not a specific measure to protect, mitigate, or enhance fish and wildlife resources.	$203,140	Yes
13. Exelon should reduce stranding of migratory fish by (1) extending the retaining wall at the east end of the east fish lift or adding boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation, or (2) dredging a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes.	Pennsylvania FBC	Yes	$74,100	No (see section 5.1.3.3)

We do not recommend adopting Interior's recommendation for a bog turtle management plan. As we discuss in section 5.1.3.3, *Conowingo Project, Measures Not Recommended*, Interior states that bog turtles may be found in the project area, but we have not found evidence in the record to indicate that bog turtles are present within the Conowingo Project boundary. We estimate a levelized annual cost of $8,240 for this plan, which may not be needed. Based on this information, we find that Interior's recommendation to prepare a bog turtle management plan may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Interior's recommendation for a flow management plan and for implementing the flow recommendations of The Nature Conservancy or the Maryland DOE certification, whichever is more restrictive to return

the river to more natural conditions downstream of Conowingo. As we discuss in section 5.1.3.3, *Conowingo Project, Measures Not Recommended*, our analysis found that the TNC Flow Regime would not provide substantially more aquatic habitat benefits than the staff-recommended flow regime, but would have a substantial levelized annual cost of $329,130, and would eliminate many of the peaking and ancillary services benefits to the PJM region from the Conowingo Project. Flow requirements of any future Maryland DOE certification are not yet known. Based on this information, we find that Interior's recommendation to implement a flow management plan and the TNC Flow Regime, or a yet unknown flow requirement of any Maryland DOE certification, may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Interior's recommendations for installing and operating fishways as described in Interior's preliminary section 18 prescription Alternative G. As we discuss in section 5.1.3.2, *Conowingo Project, Additional Measures Recommended by Staff for Conowingo, Upstream Fish Passage*, implementing the full suite of fish passage measures under Alternative G would not be needed at this time and would be costly, with a levelized annual cost of $2,334,260. We are recommending some fish passage improvements at the project that would still enhance upstream fish passage but at a substantially lower cost. Based on this information, we find that Interior's recommendation to install and operate fishways as described in Interior's preliminary section 18 prescription Alternative G may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Pennsylvania FBC's recommendation to incorporate performance criteria into any new license where 80 percent of the shad that enter the project area must pass the project within 5 days, along with additional studies to test that performance that would be followed up by more studies and operational and structural changes over a period of 12 years. As we discuss in section 5.1.3.2, *Conowingo Project, Additional Measures Recommended by Staff for Conowingo, Upstream Fish Passage*, intensive fish passage studies have already been conducted at Conowingo dam over a period of decades, and we are recommending a suite of fish passage improvements at the project that would enhance upstream fish passage, and that would be implemented without further delay due to additional studies. Based on this information, we find that Pennsylvania FBC's recommendation to incorporate performance criteria and conduct many more years of studies may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Pennsylvania FBC's recommendation to modify the east fish lift by adding a collection gallery in front of units 8 to 11. As we discuss in section 5.1.3.2, *Conowingo Project, Additional Measures Recommended by Staff for Conowingo, Upstream Fish Passage*, there is insufficient justification to make major structural changes to the entrances to the east fish lift at this time; these changes would be

costly with a levelized annual cost likely similar to that estimated for Interior's recommendation for improvements to the east fish lift entrances ($852,190). We are recommending improvements to the entrances only if additional studies, after implementing our recommended improvements, find that effectiveness remains low. Based on this information, we find that Pennsylvania FBC's recommendation to construct a collection gallery on the east fish lift may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Pennsylvania FBC's recommendation to complete the rebuild of the west fish lift to include additional attraction water and provision to expand to volitional passage, if needed, with an ultimate total design population of 5 million fish at the project. As we discuss in section 5.1.3.2, *Conowingo Project Resources, Additional Measures Recommended by Staff for Conowingo, Upstream Fish Passage*, implementing the full range of fish passage facilities recommended by Pennsylvania FBC, would not be needed at this time and would be costly with a levelized annual cost likely similar to that estimated for Interior's recommendation ($2,334,260). We are recommending some fish passage improvements at the project that would still enhance upstream fish passage but at a substantially lower cost. Based on this information, we find that Pennsylvania FBC's recommendation to complete the rebuild of the west fish lift and install facilities with a total design population of 5 million fish may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Pennsylvania FBC's recommendation to transport 1 million eels annually from 2015 to 2030 to sites above Conowingo and York Haven dams until permanent volitional facilities are operating effectively. There is no indication that 1 million eels are currently available in the lower Susquehanna River for capture and transport, and requiring this specific design population for any eel trap and transport program would require Exelon to expend an unknown amount of effort and financial resources in an attempt to meet this requirement. Based on this information, we find that Pennsylvania FBC's recommendation to require an American eel design population of 1 million fish to transport may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

We do not recommend adopting Pennsylvania FBC's recommendation to reduce stranding of migratory fish by (1) extending the retaining wall at the east end of the east fish lift or adding boulder fill in that area to prevent generation flow from flooding the spillway pool at high levels of generation, or (2) dredging a channel(s) from the spillway pool area to downstream areas to provide egress for stranded fishes. As we discuss in section 5.1.3.3, *Conowingo Project, Measures not Recommended*, our analysis found that few fish are currently being stranded under existing project operation, and there would be no need for implementing measures to reduce stranding, at a relatively high levelized annual cost of $74,100. Based on this information, we find that Pennsylvania FBC's

recommendation to make structural changes downstream of Conowingo dam to reduce fish stranding may be inconsistent with the comprehensive planning standard of section 10(a) and the equal consideration provision of section 4(e) of the FPA.

5.4 Consistency with Comprehensive Plans

Section 10(a)(2)(A) of the FPA, 16 U.S.C.§803(a)(2)(A) (2006), requires the Commission to consider the extent to which a project is consistent with the federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed 26 comprehensive plans listed below that are applicable to the Susquehanna River Projects, located in Pennsylvania and Maryland. No inconsistencies were found.

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APPENDIX A

DRAFT LICENSE ARTICLES

YORK HAVEN HYDROELECTRIC PROJECT

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Appendix A

Draft License Articles

York Haven Hydroelectric Project

Article 201. *Administrative Annual Charges*. The licensee shall pay the United States annual charges, effective the first day of the month in which the license is issued, and as determined in accordance with provisions of the Commission's regulations in effect from time to time, for the purposes of:

(a) reimbursing the United States for the cost of administration of Part I of the Federal Power Act. The authorized installed capacity for that purpose is 19.62 megawatts.

Article 202. *Exhibit F Drawings*. Within 45 days of the date of issuance of this license, as directed below, the licensee shall file the approved exhibit drawings in electronic file format on CD disks.

Digital images of the approved exhibit drawings shall be prepared in electronic format. Prior to preparing each digital image, the FERC Project-Drawing Number (i.e., P-1888-1001 through P-1888-###) shall be shown in the margin below the title block of the approved drawing. The licensee shall file two sets of exhibit drawings in electronic format on CD disks with the Secretary of the Commission, ATTN: OEP/DHAC. Exhibit F drawings must be identified as Critical Energy Infrastructure Information (CEII) material under 18 CFR §388.113(c). Each drawing must be a separate electronic file, and the file name shall include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this License, and file extension in the following format [P-1888-####, F-1, Description, MM-DD-YYYY.TIF]. All digital images of the exhibit drawings shall meet the following format specification:

IMAGERY - black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4
RESOLUTION – 300 dpi desired, (200 dpi min)
DRAWING SIZE FORMAT – 24” x 36” (min), 28” x 40” (max)
FILE SIZE – less than 1 MB desired

Article 203. *Exhibit G Drawings*. Within 90 days of the effective date of the license, the licensee shall file, for Commission approval, revised Exhibit G drawings enclosing within the project boundary all principal project works necessary for operation and maintenance of the project, including all of the lands encompassing the East Shore

Boat Launch and Canal Lock recreation area. The Exhibit G drawings must comply with sections 4.39 and 4.41 of the Commission's regulations.

Article 204. *Amortization Reserve*. Pursuant to section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project shall be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee shall set aside in a project amortization reserve account at the end of each fiscal year one-half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment. To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee shall deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee shall set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee shall maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves shall be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios shall be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity shall be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Article 205. *Headwater Benefits*. If the licensee's project was directly benefited by the construction work of another licensee, a permittee, or the United States on a storage reservoir or other headwater improvement during the term of the original license (including extensions of that term by annual licenses), and if those headwater benefits were not previously assessed and reimbursed to the owner of the headwater improvement, the licensee shall reimburse the owner of the headwater improvement for those benefits, at such time as they are assessed, in the same manner as for benefits received during the term of this new license. The benefits will be assessed in accordance with Part 11, Subpart B, of the Commission's regulations.

Article 301. *Contract Plans and Specifications*. At least 60 days prior to the start of any construction, the licensee shall submit one copy of its plans and specifications and

supporting design document to the Commission's Division of Dam Safety and Inspections (D2SI) – New York Regional Engineer, and two copies to the Commission (one of these shall be a courtesy copy to the Director, D2SI). The submittal to the D2SI New York Regional Engineer must also include as part of preconstruction requirements: a Quality Control and Inspection Program, Temporary Construction Emergency Action Plan, and Soil Erosion and Sediment Control Plan. The licensee may not begin construction until the D2SI-New York Regional Engineer has reviewed and commented on the plans and specifications, determined that all preconstruction requirements have been satisfied, and authorized start of construction.

Article 302. *Cofferdam and Deep Excavation Construction Drawings*. Should construction require cofferdams or deep excavations, the licensee shall: (1) review and approve the design of contractor-designed cofferdams and deep excavations prior to the start of construction; and (2) shall ensure that construction of cofferdams and deep excavations is consistent with the approved design. At least 30 days before starting construction of any cofferdams or deep excavations, the licensee shall submit one copy to the Commission's Division of Dam Safety and Inspections (D2SI) - New York Regional Engineer and two copies to the Commission (one of these copies shall be a courtesy copy to the Commission's Director, D2SI), of the approved cofferdam and deep excavation construction drawings and specifications, and the letters of approval.

Article 303. *As-built Drawings*. Within 90 days of completion of construction of the facilities authorized by this license, the licensee shall file for Commission approval, revised exhibits A, F, and G, as applicable, to describe and show those project facilities as built. A courtesy copy shall be filed with the Commission's Division of Dam Safety and Inspections (D2SI) - New York Regional Engineer, the Director, D2SI, and the Director, Division of Hydropower Administration and Compliance.

Article 304. *Project Modification Resulting From Environmental Requirements*. Any permanent or temporary modification which may affect the project works or operations shall be coordinated with the Commission's Division Dam Safety and Inspections (D2SI) - New York Regional Engineer at the beginning of the planning and design phase. This includes those modifications resulting from license environmental requirements. This schedule is to allow sufficient review time for the Commission to insure that the proposed work does not adversely affect the project works, dam safety or project operation.

Article 401. *Erosion and Sediment Control Plan*. Within 6 months of license issuance, the licensee shall file, for Commission approval, an erosion and sediment

control plan for implementation during construction of the nature-like fishway. The plan shall be based on actual-site geological, soil, and groundwater conditions and on project design, and shall include, at a minimum, the following:

(1) A detailed description of actual site conditions;

(2) Measures proposed to control erosion, to prevent slope instability, and to minimize the quantity of sediment resulting from fishway construction;

(3) Detailed descriptions, functional design drawings, and specific topographic locations of control measures; and

(4) A specific implementation schedule of control measures and monitoring and maintenance of proposed control measures during construction.

The plan shall be developed after consultation with the Pennsylvania Department of Environmental Protection; the Pennsylvania Fish and Boat Commission; and the U.S. Fish and Wildlife Service. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 402. *Minimum Flows.* The licensee shall provide a year-round, continuous, minimum flow from the project of 1,000 cubic feet per second (cfs) and an average daily minimum flow of 2,500 cfs, or inflow, whichever is less, for the protection of aquatic habitat in the Susquehanna River downstream of the project.

Minimum flow releases may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement among the licensee and the Pennsylvania Department of Environmental Protection. If minimum flows are so modified, the licensee shall notify the Commission, in writing, as soon as possible, but no later than 10 days after each such incident.

Article 403. *Run-of-River Operations.* When inflow to the project is less than 3,000 cubic feet per second, the licensee shall operate the York Haven Project in an instantaneous run-of-river mode for the protection of aquatic resources in the Susquehanna River, without deliberate impoundment drawdown or storage for purposes of generating electricity in particular time periods.

Run-of-river operation may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement between the licensee and the Pennsylvania Department of Environmental Protection. If run-of-river operation is so modified, the licensee shall notify the Commission, in writing, as soon as possible, but no later than 10 days after each such incident.

Article 404. *Debris Management.* The licensee shall implement debris management as detailed in section 9.b. of the Settlement Agreement to ensure debris does not pose long-term hazards to people and project operation. Prior to passing debris downstream of the project, the licensee shall provide notice to PPL's Brunner Island steam plant to allow PPL the opportunity to plan or prepare for any inconvenience from passing debris.

Article 405. *Reservation of Authority to Prescribe Fishways.* Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or provide for the construction, operation, and maintenance of, such fishways as may be prescribed by the Secretary of the Interior pursuant to section 18 of the Federal Power Act.

Article 406. *Pre-Construction Environmental Studies for the Nature-Like Fishway*. Six months prior to the commencement of construction of the nature-like fishway required by the U.S. Department of Interior's fishway prescription (Appendix D), the licensee shall develop and conduct the following studies in the area to be disturbed by construction of the nature-like fishway: (1) vegetation cover-type mapping, (2) wetlands delineations, (3) invasive species surveys, (4) rare species surveys, (5) a bog turtle habitat assessment, and (6) a bald eagle survey.

The licensee shall prepare study plans for each study after consultation with the Pennsylvania Department of Environmental Protection, Pennsylvania Game Commission; Pennsylvania Fish and Boat Commission, and the U.S. Fish and Wildlife Service. The licensee shall include with each study plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plans after the study plans

have been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before implementing the study plans. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons. The study plans also shall include a provision for filing the completed studies with the Commission prior to commencement of construction.

The Commission reserves the right to require changes to the study plans. The licensee shall not begin conducting the studies until notified by the Commission that the study plans are approved. Upon Commission approval, the licensee shall conduct the studies, including any changes required by the Commission.

Article 407. *Recreation Management Plan.* Within 6 months of license issuance, the licensee shall file, for Commission approval, a recreation management plan that details measures to ensure the recreation facilities and sites are managed to meet use and demand over the term of the license. The plan shall include a facility inventory with ownership and management responsibilities for each site, as well as measures to provide for periodic monitoring, to ensure the recreation facilities and sites are managed to meet use and demand over the term of the license, and a provision to address public safety during the construction of the nature-like fishway. In addition, plan shall detail how the licensee will continue the licensing program for approximately 300 recreational lots within the project boundary. The plan also shall include details on how the licensee will implement revisions to the program that allow for the termination of permits and removal of lots from the program if structures are abandoned by the lessee, or when existing structures become damaged and are not replaced by conforming structures. The recreation management plan shall be updated every 12 years in concert with every other Form 80 reporting period. The licensee shall also consult with the Pennsylvania Fish and Boat Commission, the Pennsylvania Department of Environmental Protection, the Pennsylvania Department of Conservation and Natural Resources, and the Susquehanna River Basin Commission about recreation management and strategies every 10 years after the effective date of the new license.

The plan shall be developed after consultation with resource agencies, counties, and other interested stakeholders, including the Pennsylvania Fish and Boat Commission and Pennsylvania Department of Conservation and Natural Resources. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are

accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The licensee shall continue to operate and maintain the following existing facilities for the term of the license: (1) York Haven Power Plant Recreation Area; (2) Battery Island Picnic Area; (3) Goodling Island Picnic Area; (4) Shelley Island Recreation Area; (5) Goosehorn Island Picnic Area; (6) East Shore Boat Launch; and (7) East Shore Canal Lock. If the licensee proposes changes to the existing facilities, the licensee shall file the changes with the Commission for approval.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 408. *Shoreline Management Plan.* Within one year of license issuance, the licensee shall file, for Commission approval, a shoreline management plan. The plan shall be developed in accordance with the Commission's Guidance on Shoreline Management Planning and Hydroelectric Projects and include policies to ensure that the shorelines are managed for the scenic, recreational, and environmental values for the duration of the license term, including but not limited to (1) a summary of the purpose, goals and objectives of the plan; (2) a description of the shoreline use classifications, which identifies allowable and prohibited uses for existing and future use of the shoreline; (3) a shoreline permitting program; (4) a monitoring and enforcement program; and (5) a provision to update the plan every 10 years.

As part of the SMP, the licensee shall continue the licensing program for approximately 300 recreational lots at Cly Shore, Shelley Island, and Beshore Island. The licensee shall implement revisions in the licensing program to allow the termination of permits and removal from the licensing program of existing recreational lots that are abandoned by the lessee, or when existing structures become damaged and are not replaced by structures conforming to all applicable federal, state, and local regulations.

The plan shall be developed in accordance with the Commission's *Guidelines for Shoreline Management Planning at Hydropower Projects* dated July 2012. The plan shall be developed in consultation with the Pennsylvania Fish and Boat Commission, Pennsylvania Department of Conservation and Natural Resources, and the Pennsylvania

Department of Environmental Protection. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 409. *Programmatic Agreement and Historic Properties Management Plan.* Upon license issuance, the licensee shall implement the *Programmatic Agreement Between the Federal Energy Regulatory Commission and the Pennsylvania Historic Preservation Officer for Managing Historic Properties that May be Affected by Issuing a New License to York Haven Power Company, LLC, for the Continued Operation of the York Haven Project in York, Dauphin, and Lancaster counties, Pennsylvania (FERC No. 1888-030),* executed on _____, and including but not limited to the Historic Properties Management Plan (HPMP) for the project. Pursuant to the requirement of this Programmatic Agreement, the license shall file, for Commission approval, a revised HPMP within six months of issuance of this order. The revised HPMP shall be based on the draft HPMP filed with the Commission on December 28, 2012, and include the following:

(a) a requirement to request landowner access to evaluate any affected sites located on private property;

(b) a plan and schedule to evaluate archaeological sites on fee lands for their National Register eligibility, which would ensure that any effects on sites owned by York Haven Power are fully considered in accordance with section 106; and

(c) a provision to include two additional sites (36YO300, 36YO334) in the monitoring schedule, or clarification regarding why they were excluded.

The Commission reserves the authority to require changes to the HPMP at any time during the term of the license. If the Programmatic Agreement is terminated prior to Commission approval of the HPMP, the licensee shall obtain approval from the

Commission and the Pennsylvania State Historic Preservation Officers, before engaging in any ground-disturbing activities or taking any other action that may affect any historic properties within the project's area of potential effects.

Article 410. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would

not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation;

and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this

article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX B

DRAFT LICENSE ARTICLES

MUDDY RUN PUMPED STORAGE PROJECT

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Appendix B

Draft License Articles

Muddy Run Pumped Storage Project

Article 201. *Administrative Annual Charges*. The licensee shall pay the United States annual charges, effective the first day of the month in which the license is issued, and as determined in accordance with provisions of the Commission's regulations in effect from time to time, for the purposes of:

(a) reimbursing the United States for the cost of administration of Part I of the Federal Power Act. The authorized installed capacity for that purpose is 800.25-megawatts.

Article 202. *Exhibit Drawings*. Within 45 days of the date of issuance of this license, as directed below, the licensee shall file the approved exhibit drawings and GIS data in electronic file format on CD disks.

(a) Digital images of the approved exhibit drawings shall be prepared in electronic format. Prior to preparing each digital image, the FERC Project-Drawing Number (i.e., P-2355-1001 through P-2355-###) shall be shown in the margin below the title block of the approved drawing. The licensee shall file two separate sets of exhibit drawings in electronic format on CD disks with the Secretary of the Commission, ATTN: OEP/DHAC. Exhibit F drawings must be segregated from other project exhibits, and identified as Critical Energy Infrastructure Information (CEII) material under 18 CFR §388.113(c). Each drawing must be a separate electronic file, and the file name shall include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this License, and file extension in the following format [P-2355-####, G-1, Project Boundary, MM-DD-YYYY.TIF]. All digital images of the exhibit drawings shall meet the following format specification:

IMAGERY - black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4
RESOLUTION – 300 dpi desired, (200 dpi min)
DRAWING SIZE FORMAT – 24” x 36” (min), 28” x 40” (max)
FILE SIZE – less than 1 MB desired

Each Exhibit G drawing that includes the project boundary must contain a minimum of three known reference points (i.e., latitude and longitude coordinates, or state plane coordinates). The points must be arranged in a triangular format for GIS

georeferencing the project boundary drawing to the polygon data, and must be based on a standard map coordinate system. The spatial reference for the drawing (i.e., map projection, map datum, and units of measurement) must be identified on the drawing and each reference point must be labeled. In addition, each project boundary drawing must be stamped by a registered land surveyor.

(b) The licensee shall file two separate sets of the project boundary GIS data on CD disks with the Secretary of the Commission, ATTN: OEP/DHAC. The data shall be in a georeferenced electronic file format (such as ArcView shape files, GeoMedia files, MapInfo files, or a similar GIS format). The filing shall include both polygon data and all reference points shown on the individual project boundary drawings. An electronic boundary polygon data file(s) is required for each project development. Depending on the electronic file format, the polygon and point data can be included in single files with multiple layers. The georeferenced electronic boundary data file must be positionally accurate to ±40 feet in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale. The file name(s) shall include: FERC Project Number, data description, date of this License, and file extension in the following format [P-2355, boundary polygon/or point data, MM-DD-YYYY.SHP]. The data must be accompanied by a separate text file describing the spatial reference for the georeferenced data: map projection used (i.e., UTM, State Plane, Decimal Degrees, etc.), the map datum (i.e., North American 27, North American 83, etc.), and the units of measurement (i.e., feet, meters, miles, etc.). The text file name shall include: FERC Project Number, data description, date of this License, and file extension in the following format [P-2355, project boundary metadata, MM-DD-YYYY.TXT].

Article 203. *Amortization Reserve*. Pursuant to section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project shall be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee shall set aside in a project amortization reserve account at the end of each fiscal year one-half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment. To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee shall deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee shall set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee shall maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves shall be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios shall be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity shall be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Article 301. *Project Modification Resulting From Environmental Requirements*. Any permanent or temporary modification which may affect the project works or operations shall be coordinated with the Commission's Division Dam Safety and Inspections (D2SI) - New York Regional Engineer at the beginning of the planning and design phase. This includes those modifications resulting from license environmental requirements. This schedule is to allow sufficient review time for the Commission to insure that the proposed work does not adversely affect the project works, dam safety or project operation

Article 401. *Reservation of Authority to Prescribe Fishways*. Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or provide for the construction, operation, and maintenance of, such fishways as may be prescribed by the Secretary of the Interior and/or Commerce pursuant to section 18 of the Federal Power Act.

Article 402. *Bald Eagle Management Plan*. The Bald Eagle Management Plan (BEMP), filed on August 29, 2012, is approved with the following modification: before any ground disturbance work begins within the project boundary, the licensee shall visit the U.S. Fish and Wildlife Service's (FWS) Chesapeake Bay Field Office and Pennsylvania Field Office websites and comply with current bald eagle management guidelines. If there are updated guidelines, the licensee shall revise the BEMP to incorporate any new guidelines issued by the FWS during the term of the license and provide the revised BEMP to the Commission for approval.

The Bald Eagle Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 403. *Bog Turtle Management Plan.* The Bog Turtle Management Plan, filed on August 29, 2012, is approved with the following modification: before any ground disturbance work begins within the project boundary, the licensee shall visit the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office and Pennsylvania Field Office websites and comply with current bog turtle management guidelines. If there are updated guidelines, the licensee shall revise the BEMP to incorporate any new guidelines issued by the FWS during the term of the license and provide the revised BEMP to the Commission for approval.

The Bog Turtle Management Plan shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 404. *Recreation Management Plan.* The Recreation Management Plan, filed on August 29, 2012, is approved with the following modification: conduct a recreation use study every 12 years throughout the license term, consistent with every other FERC Form 80 reporting period deadline, to ensure the proposed plans are current and the sites are meeting the demand.

Each update to the plan shall be developed in consultation with the U.S. Fish and Wildlife Service, the Pennsylvania Department of Conservation and Natural Resources, and the Maryland Department of the Environment. The licensee shall include with the updated plans an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the updated plans with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The licensee shall continue to operate and maintain the following existing facilities for the term of the license: Muddy Run Park and Campground, Wissler's Run Park, and Muddy Run Wildlife Management Area. If the licensee proposes changes to the existing facilities, the licensee shall file the changes with the Commission for approval.

The Recreation Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the

licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 405. *Shoreline Management Plan*. The Shoreline Management Plan, filed on August 29, 2012, is approved with the following modification: the plan shall be updated every 10 years.

Each updated plan shall be developed in consultation with the U.S. Fish and Wildlife Service, the Pennsylvania Department of Conservation and Natural Resources, and the Maryland Department of the Environment. The licensee shall include with the updated plans an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the updated plans with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Shoreline Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 406. *Programmatic Agreement and Historic Properties Management Plan*. Upon license issuance, the licensee shall implement the *Programmatic Agreement Between the Federal Energy Regulatory Commission and the Pennsylvania Historic Preservation Officer for Managing Historic Properties that May be Affected by Issuing a New License to Exelon Generation Company, LLC, for the Continued Operation of the Muddy Run Pumped Storage Project in Lancaster and York counties, Pennsylvania, (FERC No. 2355-018)*, executed on _____, and including but not limited to the Historic Properties Management Plan (HPMP) for the project. Pursuant to the requirement of this Programmatic Agreement, the license shall file, for Commission approval, an HPMP, within one year of issuance of this order.

The plan shall include, at a minimum:

(a) a detailed discussion of the three sites identified during Phase IA cultural resources surveys (36LA67, 36LA103, 36LA368) and two additional sites located outside of the project boundary (36LA70, 36LA47);

(b) requirements for National Register of Historic Places (National Register) evaluation of affected sites in consultation with the Pennsylvania State Historic Preservation Officer (SHPO);

(c) requirements for formal National Register evaluation of the Muddy Run Pumped Storage Project; and

(d) documentation of tribal consultation.

The Commission reserves the authority to require changes to the HPMP at any time during the term of the license. If the Programmatic Agreement is terminated prior to Commission approval of the HPMP, the licensee shall obtain approval from the Commission and the Pennsylvania SHPO, before engaging in any ground-disturbing activities or taking any other action that may affect any historic properties within the project's area of potential effects.

Article 407. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads,

retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that

discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner

that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX C

DRAFT LICENSE ARTICLES

CONOWINGO HYDROELECTRIC PROJECT

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Appendix C

Draft License Articles

Conowingo Hydroelectric Project

Article 201. *Administrative Annual Charges*. The licensee shall pay the United States annual charges, effective the first day of the month in which the license is issued, and as determined in accordance with provisions of the Commission's regulations in effect from time to time, for the purposes of:

(a) reimbursing the United States for the cost of administration of Part I of the Federal Power Act. The authorized installed capacity for that purpose is [the authorized capacity was previously determined to be 574,540 kW; but the value needs to be re-computed per the latest regulations after the ratings of each of the turbines and generators are verified] _____ megawatts.

Article 202. *Exhibit F Drawings*. Within 45 days of the date of issuance of this license, as directed below, the licensee shall file the approved exhibit drawings in electronic file format on CD disks.

Digital images of the approved exhibit drawings shall be prepared in electronic format. Prior to preparing each digital image, the FERC Project-Drawing Number (i.e., P-405-1001 through P-405-###) shall be shown in the margin below the title block of the approved drawing. The licensee shall file two sets of exhibit drawings in electronic format on CD disks with the Secretary of the Commission, ATTN: OEP/DHAC. Exhibit F drawings must be identified as Critical Energy Infrastructure Information (CEII) material under 18 CFR §388.113(c). Each drawing must be a separate electronic file, and the file name shall include: FERC Project-Drawing Number, FERC Exhibit, Drawing Title, date of this License, and file extension in the following format [P-405-####, F-1, Description, MM-DD-YYYY.TIF]. All digital images of the exhibit drawings shall meet the following format specification:

IMAGERY - black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) CCITT Group 4
RESOLUTION – 300 dpi desired, (200 dpi min)
DRAWING SIZE FORMAT – 24” x 36” (min), 28” x 40” (max)
FILE SIZE – less than 1 MB desired

Article 203. *Exhibit G Drawings*. Within 90 days of the effective date of the license, the licensee shall file, for Commission approval, revised Exhibit G drawings

enclosing within the project boundary all principal project works necessary for operation and maintenance of the project, and reflecting the removal of 1,965 acres of lands from the current project boundary that do not contain existing project facilities and are not necessary for the operation and maintenance of the project. The Exhibit G drawings must comply with sections 4.39 and 4.41of the Commission's regulations.

Article 204. *Amortization Reserve*. Pursuant to section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project shall be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee shall set aside in a project amortization reserve account at the end of each fiscal year one half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment. To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee shall deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee shall set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee shall maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves shall be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios shall be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity shall be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Article 205. *Headwater Benefits*. If the licensee's project was directly benefited by the construction work of another licensee, a permittee, or the United States on a storage reservoir or other headwater improvement during the term of the original license (including extensions of that term by annual licenses), and if those headwater benefits were not previously assessed and reimbursed to the owner of the headwater improvement, the licensee shall reimburse the owner of the headwater improvement for those benefits, at such time as they are assessed, in the same manner as for benefits received during the term of this new license. The benefits will be assessed in accordance with Part 11, Subpart B, of the Commission's regulations.

Article 301. *Public Safety Plan*. At least 60 days prior to reopening of the Conowingo powerhouse catwalk or installation of any new recreation facilities, the licensee shall submit one copy to the Commission's Division of Dam Safety and Inspections (D2SI) - New York Regional Engineer and two copies to the Commission (one of these copies shall be a courtesy copy to the Commission's Director, D2SI) of an updated Public Safety Plan. The plan shall include an updated evaluation of public safety concerns at the project site, including all updated designated recreation areas, and assess the need for the installation of safety devices or other safety measures. The submitted plan should include a description of all public safety devices and signage, as well as a map showing the location of all public safety measures. For guidance on preparing public safety plans the licensee can review the *Guidelines for Public Safety at Hydropower Projects* on the FERC website.

Article 302. *Project Modification Resulting From Environmental Requirements*. Any permanent or temporary modification which may affect the project works or operations shall be coordinated with the Commission's Division Dam Safety and Inspections (D2SI) - New York Regional Engineer at the beginning of the planning and design phase. This includes those modifications resulting from license environmental requirements. This schedule is to allow sufficient review time for the Commission to insure that the proposed work does not adversely affect the project works, dam safety or project operation.

Article 401. *Sediment Management Plan*. The Sediment Management Plan, filed on August 31, 2012, is approved with the following modifications:

(1) Include a provision to conduct dredging with the frequency and depth needed to maintain the navigation channel at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediments have been accumulating, in order to improve and maintain recreational boating access.

(2) Beginning in 2016, the licensee shall conduct a bathymetric survey of Conowingo Pond at 5-year intervals to monitor sediment transport and depositional patterns within the pond. The licensee shall file the results of each bathymetric survey with the Commission by March 31 of the following year. The results of each bathymetric survey shall include an analysis of any change in sediment deposition or scour in the pond from the

previous survey(s), including the 2011 survey,[1] so that any changes in sediment depositional or scour patterns in the pond over time since the 2011 survey can be monitored.

The Sediment Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 402. *Conowingo Pond Level Management.* Upon license issuance, the licensee shall operate the project within a normal range for Conowingo Pond between elevations 101.2 feet National Geodetic Vertical Datum of 1929 (NGVD) and 110.2 feet NGVD, with a minimum elevation of 107.2 feet NGVD on weekends between Memorial Day and Labor Day, to meet recreational needs.

Conowingo pond level may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement among the licensee, the Pennsylvania Department of Environmental Protection, and Maryland Department of the Environment. If minimum flows are so modified, the licensee shall notify the Commission, in writing, as soon as possible, but no later than 10 days after each such incident.

Article 403. *Minimum Flow Requirements.* Upon license issuance, the licensee shall provide minimum flow releases from the project, as described below, or a minimum flow equal to the natural inflow as measured at the Marietta U.S. Geological Survey gage (No. 01576000), whichever is less, according to the following schedule:

September 15 – March 31: 3,500 cubic feet per second (cfs) or natural inflow;

April 1 – April 30: 10,000 cfs or natural inflow;

May 1 – June 15: 7,500 cfs or natural inflow; and

June 16 – September 14: 5,000 cfs or natural inflow.

Minimum flow releases may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual

[1] Exelon Generation Corp. conducted a bathymetric survey of Conowingo Pond in support of Conowingo Study Revised Study Plan 3.15: Sediment Introduction and Transport study, and filed with the Commission on February 23, 2012.

agreement among the licensee and the Maryland Department of the Environment. If minimum flows are so modified, the licensee shall notify the Commission, in writing, as soon as possible, but no later than 10 days after each such incident.

Article 404. *Dissolved Oxygen Enhancements and Monitoring*. Upon license issuance, the licensee shall continue the dissolved oxygen (DO) enhancement at the project using the turbine venting systems on units 1-7 and the aerating runners on units 2 and 5. DO levels shall be continuously monitored from May 1 through October 1 at the Station 643 location, about 0.6 mile downstream of Conowingo dam. By January 1 of each year, the licensee shall file a report on the results of the previous year's DO monitoring at the project.

Article 405. *Reservation of Authority to Prescribe Fishways.* Authority is reserved to the Commission to require the licensee to construct, operate, and maintain, or provide for the construction, operation, and maintenance of, such fishways as may be prescribed by the Secretary of the Interior and/or Commerce pursuant to section 18 of the Federal Power Act.

Article 406. *Continued Fish Passage Operation*. The licensee shall continue to operate the east fish lift as the primary facility for volitional upstream fish passage, with a preventive maintenance program to extend the useful life of the facility through the license term, along with other improvements required by Article 407. The licensee shall continue to operate the project turbines as the primary route for downstream fish passage of American shad and river herring. The licensee shall also continue to coordinate annual fish passage operations with the Susquehanna River Anadromous Fish Restoration Cooperative and its member agencies and other entities.

Article 407. *Upstream Fish Passage Improvements*. The licensee shall implement measures to update and improve the effectiveness of upstream fish passage at the project by modifying the east and west fish lifts as follows:

(1) replace the existing hopper at the west fish lift with a 1,500-gallon hopper;
(2) improve the west fish lift sorting and loading process to facilitate trap and truck operations, and implement a trap and truck program for American shad;
(3) conduct a feasibility study for adding attraction flow at the west fish lift and, if feasible and beneficial, install additional flow capacity;
(4) restore the original design for the 900-cubic feet per second (cfs) attraction flow in the east fish lift;

(5) add a second 3,300-gallon hopper to the east fish lift in the space provided for in the original design, and upgrade the electrical and mechanical equipment to allow for a 15-minute lift cycle; and
(6) if 2 years of effectiveness studies, after restoration of the 900-cfs attraction flow, show poor attraction at the east fish lift for adult American shad, conduct a feasibility study for modifying the locations of entrances A and B, and implement those modifications if feasible.

Within 6 months of license issuance, the licensee shall file with the Commission for approval, a detailed plan for implementing these fish passage improvements, developed after consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Pennsylvania Fish and Boat Commission, and Maryland Department of Natural Resources. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it was prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 408. *Downstream American Eel Passage*. The licensee shall participate in a trap and transport program for downstream American eel passage, in cooperation with the operators and licensees of the York Haven Hydroelectric Project (FERC No. 1888), the Safe Harbor Hydroelectric Project (FERC No. 1025) and the Holtwood Hydroelectric Project (FERC No. 1881) on the lower Susquehanna River. This program may include a program to trap and transport adult American eels from smaller tributaries upstream of the York Haven Project (FERC No. 1888), or other measures to ensure safe and timely downstream passage. Because no timetable has yet been established for this cooperative program, the licensee shall file periodic progress reports with the Commission on the status of the program, beginning within 5 years of license issuance, and continuing on a 5-year interval, unless later modified by the Commission.

Article 409. *Debris Management Program.* Upon license issuance, the licensee shall implement a debris management program that includes clamming (with three gantry

cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes and floating surficial debris in front of the powerhouse intakes, and the sponsorship of community-based clean-ups in the pond and downstream of the dam as described in the final license application and the Debris Management Study Final Study Report filed with the Commission on August 31, 2012.

Article 410. *Bald Eagle Management Plan.* The Bald Eagle Management Plan, filed on August 29, 2012, is approved with the following modifications:

(1) require enforcement of human traffic restrictions on both sides of Rowland Island, under the towers in the river, and on the Cecil County side of the river where current human activities disturb perching and foraging eagles at eagle concentration areas; and

(2) before any ground-disturbing work begins within the project boundary, the licensee shall visit the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office and Pennsylvania Field Office websites and comply with current bald eagle management guidelines. If there are updated guidelines, the licensee shall revise the BEMP to incorporate any new guidelines issued by the FWS during the term of the license and provide the revised BEMP to the Commission for approval.

The Bald Eagle Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 411. *Northern Map Turtle Protection Plan.* Within 6 months of license issuance, the licensee shall file, for Commission approval, a northern map turtle protection plan for the protection and enhancement of the map turtle population.

The plan shall include, at a minimum:

(1) nest management and alternative basking site mitigation and protection measures identified and studied during the ongoing Towson University map turtle studies;
(2) annual monitoring of the northern map turtle population at the project for 10 years;
(3) annual monitoring of the use and success of both the mitigation and protection measures for 10 years;

(4) an assessment of the northern map turtle's response to any change in operating regime as a result of the license; and
(5) methods of altering or amending protection and mitigation measures as a result of the monitoring, in consultation with the Maryland Department of Natural Resources (Maryland DNR).

The plan shall be developed after consultation with the Maryland DNR and Towson University. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 412. *Waterfowl Nesting Protection Plan*. Within 6 months of license issuance, the licensee shall file, for Commission approval, a waterfowl nesting protection plan. The plan shall identify waterfowl nesting areas affected by the project that are vulnerable to flooding during the nesting season, identify a range of alternatives to avoid flooding active nests, and provide recommendations to avoid flooding active nests.

The plan shall be developed after consultation with the U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, and the Maryland Department of Natural Resources. The licensee shall include with the plan an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is

approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Article 413. *Recreation Management Plan.* The Recreation Management Plan, filed on August 31, 2012, is approved with the following modifications:

(1) conduct a recreation use study every 12 years throughout the license term, consistent with every other FERC Form 80 reporting period deadline, to ensure the proposed plans are current and the sites are meeting the demand;

(2) include a provision to review the results of the bathymetric mapping and dredging occurring periodically at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramp as required by the Sediment Management Plan (Article 401) intended to ensure boater access to the reservoir at these locations.

(3) update the plan every 12 years in concert with every other Form 80 reporting period; and

(4) develop a plan to provide limited access to the catwalk for anglers, with security measures in place that address the vulnerability of the facility and the safety of the users of the catwalk. Such measures could include, but not be limited to, on-site inspections, video surveillance, pre-screening procedures, capacity limits, security personnel, and physical infrastructure modifications. The ultimate decision on whether the catwalk can be reopened to the public, even on a limited basis, is dependent upon the Commission's evaluation of the plan and whether it satisfies public safety and security concerns.

Each update to the Recreation Management Plan shall be developed in consultation with the U.S. Fish and Wildlife Service, the Pennsylvania Department of Conservation and Natural Resources, and the Maryland Department of the Environment. The licensee shall include with the updated plans an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the updated plans with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The licensee shall continue to operate and maintain the following existing facilities for the term of the license: (1) Lock 13, (2) Lock 15, (3) Muddy Creek Boat Launch, (4) Cold Cabin Boat Launch, (5) Dorsey Park, (6) Line Bridge, (7) Broad Creek Public Landing, (8) Glen Cove Marina, (9) Conowingo swimming pool and visitor's center, (10) Peach Bottom Marina, (11) Conowingo Creek Boat Launch, (12) Funks Pond, (13) Fisherman's Park/Shures Landing, and (14) Octoraro Creek Access. If the licensee proposes changes to the existing facilities, the licensee shall file the changes with the Commission for approval.

The Recreation Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 414. S*horeline Management Plan.* The Shoreline Management Plan filed on August 31, 2012, is approved, with the following modification: update and file the plan with the Commission every 10 years.

Each update to the plan shall be developed in consultation with the U.S. Fish and Wildlife Service, the Pennsylvania Department of Conservation and Natural Resources, and the Maryland Department of the Environment. The licensee shall include with the updated plans an implementation schedule, documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee shall provide a minimum of 30 days for the entities to comment and to make recommendations before filing the updated plans with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific reasons.

The Shoreline Management Plan, as modified, shall be made part of this license, and may not be amended without prior Commission approval. Upon license issuance, the licensee shall implement the plan according to the schedule included in the plan. The Commission reserves the right to require any additional changes to the plan.

Article 415. *Programmatic Agreement and Historic Properties Management Plan.* Upon license issuance, the licensee shall implement the *Programmatic Agreement Between the Federal Energy Regulatory Commission, the Pennsylvania Historic Preservation Officer, and the Maryland Historic Preservation Officer for Managing Historic Properties that May be Affected by Issuing a New License to Exelon Generation*

Company, LLC, for the Continued Operation of the Conowingo Project in Lancaster and York counties, Pennsylvania, and Cecil and Harford counties, Maryland (FERC No.405-106), executed on _____, and including but not limited to the Historic Properties Management Plan (HPMP) for the project. Pursuant to the requirements of this Programmatic Agreement, the licensee shall file, for Commission approval, a revised HPMP within six months of issuance of this order. The revised HPMP shall be based on the HPMP filed with the Commission on August 31, 2012, and include the following:

(a) a revised area of potential effects (APE) with the narrow strip of land in the current project boundary extending downstream from Spencer Island along the west side of the river to Havre de Grace;

(b) a discussion of all 48 sites and 27 historic structures identified to date within the project APE or an explanation of why they are not considered eligible;

(c) a correction to identify the Susquehanna and Tidewater Canal and Columbia & Port Deposit Railroad as eligible for listing;

(d) a provision to inventory any lands within the revised APE, evaluate identified cultural resources for eligibility, and address potential effects before sale or transfer of those lands;

(e) a provision to make good faith effort to obtain access to private property to conduct studies if effects on cultural resources on private lands are identified;

(f) a revised list of project activities involving the Conowingo Project system that can be completed without Maryland State Historic Preservation Officer (SHPO) review;

(g) a process for assessing project-related ground-disturbing activities to determine whether or not archaeological sites would be affected, particularly in areas that have not had archaeological surveys;

(h) provisions to ensure confidentiality of cultural resources location information during implementation of public outreach programs; and

(i) a description of project-related activities that will require tribal consultation in accordance with section 106 of the National Historic Preservation Act.

The Commission reserves the authority to require changes to the HPMP at any time during the term of the license. If the Programmatic Agreement is terminated prior to

Commission approval of the HPMP, the licensee shall obtain approval from the Commission and the Pennsylvania and Maryland SHPOs, before engaging in any ground-disturbing activities or taking any other action that may affect any historic properties within the project's APE.

Article 16. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap would be adequate to control

erosion at the site, and (3) determine that the proposed construction is needed and would not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located

at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings

(project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings would be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX D

Preliminary Fishway Prescription – York Haven Hydroelectric Project

9. Preliminary Prescription for Fishways

Pursuant to section 18 of the Federal Power Act, as amended, the Secretary of the Department of the Interior, as delegated to the Service, proposes to exercises her authority to prescribe the construction, operation and maintenance of such fishways as deemed necessary, subject to the procedural provisions contained in Section 2 above.

The Department's Preliminary Prescription for Fishways reflects a number of issues and concerns related to fish restoration and passage that have been raised by the Licensee, Commission staff, state resource agencies, and other parties involved in these proceedings. Moreover, the Department, through the Service, reached settlement with the Licensee on matters of fish passage. The full range of issues settled are described in the Settlement Agreement, which includes its appendices.

Fishways shall be constructed, operated, and maintained to provide safe, timely and effective passage for American shad, alewife, blueback herring, and American eels and other designated resident riverine fish species at the Licensee's expense.

To ensure the immediate and timely contribution of the fishways to the ongoing and planned anadromous and catadromous fish restoration and enhancement program in the Susquehanna River, the following are included and shall be incorporated by the Commission to ensure the effectiveness of the fishways pursuant to section 1701(b) of the 1992 National Energy Policy Act (P.L. 102-486, Title XVII, 106 Stat. 3008).

9.1 Design Population: American Shad

Fish passage needs to be adequate to maintain self-sustaining annual populations of two million American shad reproducing in the free-flowing Susquehanna River above York Haven Dam and in suitable tributaries.

9.2 Design Population: River Herring (Alewife and Blueback Herring)

Fish passage needs to be adequate to maintain self-sustaining annual populations of five million river herring, reproducing in the free-flowing Susquehanna River above York Haven Dam and in suitable tributaries.

9.3 Design Population: American Eel

Fish passage needs to be adequate to pass all available upstream migrating eels that arrive to York Haven Dam to the mainstem of the Susquehanna River above the Project. Downstream migration of adult eels must be safe, timely and effective, achieving an 85% survival rate past the Project.

9.4 Operational Flows

Licensee shall operate the Project consistent with the flow management targets set forth below. The flow values set forth in this section are understood to be approximate and based upon reasonable engineering estimates.

9.4.1 Prior to NLF Facility Completion

Prior to completion and operation of the NLF Facility, Licensee shall operate the Project consistent with the following flow management criteria.

a. During the American Shad Upstream Passage Season

   i) An average daily minimum flow in East Channel below East Channel Dam of 2,000 cfs.

   ii) Spill over the Main Dam of equal to or greater than 4,000 cfs.

b. After the American Shad Upstream Passage Season until end of resident fish passage season (earlier of December 15 or until the average daily river temperature is less than or equal to 40 degrees Fahrenheit for three consecutive days)

   i) The Project shall be operated to provide a minimum stream flow in the East Channel below East Channel Dam of 400 cfs.

   ii) When river flows exceed hydraulic capacity of all available hydroelectric generating units, Licensee shall manage flows above the hydraulic capacity of available units in accordance with the following objectives:

      (1) To maintain the minimum flow in the East Channel of 400 cfs.

      (2) To maintain sufficient flow at the Main Dam to assure flow is released to the main channel in accordance with the existing Fish Passage Operational Plan (FPOP), except during times of maintenance work on the Main Dam when reservoir levels are lowered to permit such maintenance to occur safely.

      (3) To provide additional attraction flows to the East Channel Fish Passage System through operation of the wheel gates within their design capacity.

9.4.2 After NLF Facility Completion

After completion and operation of the NLF Facility, Licensee shall operate the Project consistent with the following flow management criteria

a. During the American Shad Upstream Passage Season:

i) An average daily minimum flow in East Channel below East Channel Dam of a minimum of 267 cfs, understanding that as river flow increases above 21,000 cfs, flows over the East Channel Dam will occur in excess of the minimum of 267 cfs.

ii) Flow through the NLF Facility (passage channel plus supplement attraction flow channel) equal to at least 5% of river flow when river flows above the Project are between 5,000 and 150,000 cfs.

b. During the remainder of the year, the project shall be operated to provide:

i) An average daily minimum flow in the East Channel below the East Channel Dam of 267 cfs.

ii) The NLF Facility will be designed and operated to convey a minimum of 200 cfs when the river elevation is at the elevation of the Main Dam

iii) When river flows exceed the hydraulic capacity of all available hydroelectric generating units, the Licensee shall manage flows above the hydraulic capacity of available units in accordance with the following objectives:

(1) To maintain a minimum flow in the East Channel of 267 cfs, understanding that as river flow increases above 21,000 cfs, flows over the East Channel Dam will occur in excess of the minimum of 267 cfs.

(2) To maximize the remainder of flows abo ve hydraulic capacity flowing over the Main Dam and through the NLF facility. Within the limits of available flows in excess of the hydraulic capacity, except during the period of December 15 to the earlier of April 1 or the start of the American Shad Upstream Passage Season, the supplemental attraction flow channel will be operated with the objective of maintaining a maximum attraction flow through the NLF Facility.

9.5 Scheduling

The timely installation of the prescribed fishway structures, facilities, or devices is a measure directly related to those structures, facilities, or devices and is necessary to ensure the effectiveness of such structures, facilities, or devices. Therefore, the Department's Prescription includes the express requirement that the Licensee notify and obtain approval from the Service for any extensions of time to comply with the provisions included in the Department's Prescriptions for fishways.

Regarding the timing of seasonal fishway operations, fishways shall be maintained and operated, at the Licensee's expense, to maximize fish passage effectiveness throughout the upstream and downstream migration periods for American shad, alewife, blueback herring, American eel, and designated resident riverine fish.

Table 1. Upstream and downstream migration periods for species covered in this Prescription for Fishways. (*)

Species	Upstream Migration Period	Downstream Migration Period
American shad	April 1 through June 15	July 1 through November 15 (juv.) April 15 through July 1 (adult)
Alewife & blueback herring	March 1** through June 15	June 15 through October 14 (juv.) April 15 through July 1 (adult)
American eel	April 1 through December 1, or whenever river temperature is above 50 degrees F ***	September 15–February 15, or whenever river temperature is above 37 degrees F ****

* Any of these migration periods may be changed during the term of the license by the Department, based on new information, and in consultation with the other fishery agencies and the licensee.

** This operational period is based on Alewife migration timing from other tributaries to the Chesapeake Bay (Sutherland 2000, Eyler et al. 2002, Slacum 2003)

***This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay.

**** The Department is calling for the licensee to study the magnitude and timing of downstream eel migration through the project so that the effectiveness of a reduced period can be evaluated. This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay (Welsh et al. 2009).

9.6 Specific Prescriptions for the York Haven Project

9.7 General Requirements

9.8 Fishway Operating Procedures (FOP)

a. The FOP will include, for each fishway, schedules for routine maintenance, procedures for routine operations (including: seasonal and daily periods of operation, dam and powerhouse operational measures) detailing with how the plant shall be operated during fish passage season including sequencing of turbine start-up and operation, debris management as well as any other necessary provisions for plant operation and related to attraction flow as a component of the fish passage system to the operation of the NLF, procedures for monitoring and reporting on the operation, and procedures for use in case of emergencies and Project outages significantly affecting fishway operations.

b. The Licensee shall implement the FOP consistent with the approval of the Service. The Licensee shall provide written documentation to the Resource Agencies that

all fishway operational personnel have reviewed and understand the FOP signed by the operations manager of the Amended Project.

c. Copies of the approved FOP and all modifications will be provided to the Resource Agencies.

d. By December 31 of each year, following commencement of the Amended Project, the Licensee shall provide an annual report detailing; the implementation of the FOP, including any deviations from the FOP and a process to prevent those deviations in the future to the Resource Agencies; any proposed modifications to the FOP, or in the case of emergencies or Project outages, the steps taken by the Licensee to minimize adverse effects on fishway operation or fish passage measures; and any proposed modifications to those steps to further enhance their effectiveness in the future. The Licensee shall meet with the Resource Agencies by January 31 of each year unless a different date is mutually agreed upon by the Licensee and the Resource Agencies. Any required modifications to the FOP shall be submitted to the Resource Agencies within 30 days of receipt of a request for the modification unless a longer period is approved by the Service. The modifications to the FOP shall be implemented consistent with the approval of the Service. Nothing herein shall require the Licensee to make operational or structural changes related to the fish passage facilities and measures beyond those changes provided for in Section 9.9 hereof.

e. For fish passage system enhancements and facilities that do not begin operation with the entry into operation of the Amended Project, 60 days prior to operation of the enhancements and/or facilities, the Licensee shall submit FOP provisions for any such new fish passage enhancements, facilities and measures to the Resource Agencies for review and approval and shall implement the FOP as approved by the Service.

9.9 Fish Protection and Passage

9.9.1 Upstream Fish Passage / Nature-Like Fishway Construction

a. Licensee shall finance, design, permit and install a nature-like fishway facility (NLF Facility) in the vicinity of the apex of the Main Dam and Three Mile Island (TMI) in substantial compliance with the design criteria for the NLF Facility set forth in the Settlement Agreement. Licensee shall complete engineering design, apply for and obtain required governmental approvals, construct, and place into operation the NLF Facility by November 30, 2021.

b. In consultation with the Resource Agencies, Licensee shall develop the final plans and specifications for the NLF consistent with the design concept and design criteria in Appendix A, [1]and shall submit such plans and specifications to the Resource Agencies, Licensee shall provide a minimum of 60 days for the

[1] Appendix A, D, E, G, and H are included by reference. They are integral to and attached to the Settlement Agreement on which this Preliminary Prescription for Fishways is based.

Resource Agencies to submit comments on such plans and for review by the Service and PADEP. Such comments, review and approval shall not result in a material change. After approval of such plans by PADEP and the Service, Licensee shall submit such plans to the Commission for approval. Licensee shall include the final plans submitted to the Commission evidence of Licensee does not adopt a recommendation made by a Resource Agency other than PADEP and the Service, the filing shall include the Licensee's reasons together with supporting information. The plans shall not be implemented until the Licensee is notified that the plans are approved by the Commission. Upon Commission approval and the receipt of all other required governmental approvals, the Licensee shall implement the plans, including any changes required by the Commission.

9.9.2 NLF Facility Operations

Following construction of the NLF Facility, Licensee shall perform all required routine maintenance of the NLF Facility. Licensee shall conduct periodic inspections of the NLF Facility; and manage and remove debris from the NLF Facility to maintain the functioning and operability of the NLF Facility sufficient to allow and not significantly impede the passage of fish.

Licensee shall prepare an NLF Facility operations and maintenance plan (the "NLF O&M Plan"), and will submit the NLF O&M Plan for review by the Resource Agencies and for approval by PADEP and the Service. Following review and comment by the Resource Agencies, and approval by PADEP and Service, the Licensee shall submit the NLF O&M Plan to FERC, and shall implement the NLF O&M Plan for the duration of the License. Licensee shall include in the NLF O&M Plan submitted to the Commission documentation of approval by PADEP and the Service, consultation with the other Resource Agencies, copies of the Resource Agencies' comments and recommendations, and a description of how the other Resource Agencies' comments are accommodated. Licensee shall provide a minimum of 30 days for review and approval of the NLF O&M Plan by PADEP and the Service and for review and comment by the other Resource Agencies.

Any amendment to the NLF O&M Plan that materially alters the operation, maintenance, monitoring or reporting procedures relating to the NLF Facility shall be subject to review and approval by PADEP and the Service, and review and comment by the other Resource Agencies.

Licensee shall provide copies of the approved NLF O&M Plan and all amendments thereto to the Commission and the Resource Agencies.

9.9.3 Monitoring of Shad Passage Effectiveness & Subsequent Actions

The Licensee shall perform post-construction monitoring of the NLF Facility in accordance with the following provisions in consultation with the Resource Agencies and submit the results of such monitoring to the Resource Agencies and the Commission.

(a) The period from completion of construction through the end of the first American shad upstream shad passage season following completion of the NLF Facility will be a "shake-down" period, during which Licensee shall conduct visual observations and make adjustments to the NLF Facility to address any

unanticipated inhibitions or barriers that impede the NLF Facility's performance.

(b) Starting in the second American shad upstream passage season following completion of the NLF Facility, Licensee shall commence telemetry studies to monitor the overall effectiveness of the NLF Facility, consistent with the following:

(i) The telemetry studies will be conducted for at least two years, and potentially a third year if, after consultation with the Resource Agencies, determined to be necessary by the Licensee or either the Service or PADEP in order to obtain observations over a range of high and low flows typical of American shad passage seasons on the Susquehanna River. In general, the range defining typical high and low flows during the American shad upstream passage season would be anticipated to be as follows:

- Typical low flow range: 22,000 to 35,300 cfs.
- Typical high flow range: 35,300 cfs to 55,600 cfs.

(ii) The telemetry studies will be planned to be conducted during successive shad passage seasons, but may be performed on a non-successive basis under the following circumstances:

1. Licensee may postpone conduct of the telemetry studies, after consultation with the Resource Agencies and with the concurrence of the Service and PADEP, in the event that extenuating circumstances (such as the unusual flows, construction at downstream dams or other conditions) are interfering or expected to interfere with upstream shad passage. The Resource Agencies agree that in the event that they become aware of circumstances that would warrant postponement of the telemetry studies, they will promptly notify the Licensee, with the objective of providing notice to the Licensee to the extent practicable at least 90 days prior to the anticipated start of the shad passage season.

2. Licensee may postpone a successive season's telemetry study if Licensee determines, after consultation with the Resource Agencies and with the concurrence of Service and PADEP, that some physical adjustment to the NLF Facility is advisable based on the observations during the prior shad passage seasons, in which case Licensee shall will implement the physical adjustments and perform the telemetry study in the American shad upstream passage season following implementation of the physical adjustment.

(iii) The telemetry studies will utilize American shad tagged at the Safe Harbor Project, provided that access is granted by the owner of such Project.

(iv) The telemetry studies shall utilize radio telemetry, acoustic telemetry, or such other technologies as Licensee proposes and PADEP and the Service, after consultation with the other Resource Agencies, approve. The general parameters

and protocols for such telemetry studies (number of fish, fish release sites, target areas for telemetry antennas) are described in Appendix D. At least 10 months prior to the start of the second Upstream American Shad Passage Season following completion of the NLF Facility, Licensee shall prepare and submit to the Resource Agencies for review an NLF Facility Monitoring Plan (the "NLF Monitoring Plan") containing detailed protocols for the telemetry studies. Licensee shall confer with the Resource Agencies regarding the NLF Monitoring Plan, and shall provide for at least 90 days for PADEP and the Service to review and approve, and for the other Resource Agencies to review and comment on, the NLF Monitoring Plan. At least five (5) months prior to the start of the second American shad upstream passage season following completion of the NLF Facility, Licensee shall submit the NLF Monitoring Plan to the Commission for approval. If Licensee does not adopt a recommendation made by a Resource Agency, the filing with the Commission shall include the Licensee's reasons together with supporting information.

(c) Upstream American Shad Passage Target and Effectiveness Criteria:

(i) The target established by the Resource Agencies is for at least 75% of the upstream migrating American shad passing the Safe Harbor Dam to pass upstream of the Project through the combination of the NLF Facility and the East Channel Fishway (the "Upstream Shad Passage Target").The NLF Facility shall be designed and operated to be capable of achieving the Upstream Shad Passage Target, provided that adequate numbers of upstream migrating American shad reach the Project Area.The Licensee shall not be deemed in violation of this condition if the Upstream Shad Passage Target is not achieved for reasons beyond the reasonable control of the Project, provided that the Licensee complies with Sections 9.9.3(c)(ii)-(v) and (d)-(f) below.

(ii) The NLF Monitoring Plan will be designed to investigate several issues: (i) whether the upriver migrating American shad passing the Safe Harbor Dam are reaching the Project Area; (ii) whether upriver migrating American Shad entering the Project Area are attracted to the downstream entrance of the NLF Facility; and (iii) whether there are barriers to American shad entering into and passing through the NLF Facility (e.g., velocity barriers or other constraints).

(iii) The NLF Facility will be deemed to be effective if: (1) in two consecutive years after installation or subsequent modification of the NLF Facility, (A) the Upstream Shad Passage Target is achieved or (B) 85% of the tagged American shad that enter the Project Area exit the combination of the NLF Facility and the East Channel Fishway (the "Project Area Passage Success Criterion"); and (2) Licensee complies with Section 9.9.3(d) below.

(iv) If the telemetry studies show that the Project Area Passage Success Criterion is achieved in two successive American shad upstream passage seasons which reflect a range of flows typical of shad passage seasons on the Susquehanna River, the Project Area Passage Success Criterion will be deemed achieved and the Licensee may terminate the telemetry studies.

(v) If the telemetry studies show that the Project Area Passage Success Criterion is not achieved in two successive American shad upstream passage seasons, and such failure was not due to unusual or extenuating circumstances (such as unusual flow or temperature conditions), the Licensee will undertake the actions set forth in Section 9.9.3(e) and then perform a telemetry study for at least two additional American shad upstream passage seasons to confirm achievement of the Project Area Passage Success Criterion.

(d) Licensee shall, in consultation with the Resource Agencies, evaluate the fish movement data from the NLF Monitoring Plan to determine if there are barriers to timely passage of upstream migrating American shad within the Project Area. If such barriers to timely passage of upstream migrating American shad are identified within the Project Area, Licensee shall prepare and submit to the Resource Agencies a plan and schedule for those actions to address such conditions that are feasible, appropriate under the circumstances, reasonable and technically sound, provided that the Project shall not be required to undertake the curtailment of electric generating operations. Such plan shall be subject to review and approval by PADEP and the Service and review and comment by the other Resource Agencies. Following approval by PADEP and the Service, and as necessary FERC, Licensee shall implement the approved plan in accordance with the approved schedule.

(e) If the Project Area Passage Success Criterion is not achieved, Licensee shall take the following measures, as appropriate and necessary, after consultation with the Resource Agencies:

- Evaluate fishway hydraulics and access for velocity and shear stress barriers, recognizing that hydraulics of the NLF Facility will vary with river flow and flow through the NLF Facility.
- Adjust positions of rock weirs and attraction water discharge if necessary.
- Adjust timing of supplemental attraction flows.
- Install ultrasound to deter fish from an area (such as the Powerhouse or East Channel).
- Reduce flows in the East Channel to reduce attraction of American shad to the East Channel.
- Adjust amount of supplemental attraction flows in the NLF Facility up to the Potential Increased Attraction Flow Value.
- Evaluate whether potential barriers exist in the channel downstream of the Main Dam hindering fish movement to the entrance of the NLF Facility, and if reasonably necessary undertake feasible and cost-effective modifications to the channel to remove such barriers.

(f) The upstream end of NLF Facility shall be designed to accommodate installation of Passive Integrated Transponder ("PIT") tag monitoring devices at such time as such

PIT tag monitoring devices become available and feasible for reliably monitoring American shad exiting the NLF Facility. At such time as requested by PADEP or the Service, Licensee shall conduct a feasibility study to evaluate whether a PIT tag monitoring facility can be successfully installed and maintained near the upper end of the NLF Facility to reliably monitor American shad exiting the NLF Facility. Licensee shall install PIT tag readers, or such other monitoring technology as may be agreed upon, after consultation with the Resource Agencies, by the Licensee, the Service and PADEP, at the upstream end of the NLF Facility when such technology becomes available, feasible, and technically sound for measuring American shad passage in the conditions of the NLF Facility as mutually agreed to, after consultation with the Resource Agencies, by Licensee, the Service and PADEP. The Parties contemplate that such monitoring will use American shad tagged at Conowingo or Safe Harbor to monitor overall effectiveness of American shad upstream passage within the lower Susquehanna River.

9.9.4 Upstream Passage of Eels

Licensee shall provide for upstream passage of juvenile American eels through maintenance of the existing Project and installation of the NLF Facility. Based upon their present understanding of the behavior of juvenile American eels and the design of the NLF Facility, the Service expects that the existing design of the Project in conjunction with the installation of the NLF Facility will be adequate to provide for successful upstream passage of juvenile American eels past the Project, and no other PM&E measures are presently believed to be necessary for such upstream passage of juvenile American eels.

9.9.5 Downstream Post-Spawning Adult American Shad Passage

(a) Licensee shall provide for downstream passage of post-spawning adult American shad through maintenance of the existing Project, installation and operation of the NLF Facility, and implementation of the protocol set forth in Section 9.9.5(b).

(b) During the period of May 1 to June 30, if River Flow exceeds the sum of Project Hydraulic Capacity, required flows through the NLF Facility, required flows through the East Channel, and required flows (if any) over the Main Dam, the Licensee will open and spill water via the Forebay Sluice Gate (~370 cfs) to the extent practicable during one to two hours during the morning during weekdays, subject to Project personnel availability and access requirements for operations and maintenance purposes. Such spilling may be provided in connection with opening of the Forebay Sluice Gate for purposes of passing debris, it being understood by the Parties that during the passage of debris, it will not be feasible to utilize the chute structure referenced in Section 9.9.6(e).

9.9.6 Downstream Juvenile American Shad Passage

(a) After issuance of the New License and until completion of the NLF Facility, Licensee shall implement the following protocol to facilitate downstream passage of juvenile American shad during the Downstream Juvenile American Shad Passage Period:

(i) During the entire Downstream Juvenile American Shad Passage Period, the Licensee will operate the Project units in the following order of priority, depending upon available River flow: (1) Unit 1-6 (Propeller units) may be operated without restriction up to available river flow; (2) Unit 14 (larger single Francis unit) may be operated if river flow exceeds capacity of Units 1-6; (3) Units 7-13 and 15-30 (double Francis units) may be operated in ascending order if river flow exceeds capacity of Unit 1-6 and 14.

(ii) During the entire Downstream Juvenile American Shad Passage Period, the Licensee will open and spill water via the forebay sluice gate (~ 370 cfs) between the hours of 5 pm to 11 pm Eastern Standard Time ("EST").[2]10

(iii) If River flow exceeds the sum of Project Hydraulic Capacity, required flows through the East Channel, and required flows (if any) over the Main Dam, the Licensee will open and spill water via the forebay sluice gate (~370 cfs) to the extent practicable for one to two hours during the morning, subject to Project access requirements for operations and maintenance purposes, in order to provide for downstream juvenile American shad passage.

(b) After completion of the NLF Facility, Licensee shall implement the following protocol to facilitate downstream passage of juvenile American shad during the Downstream Juvenile American Shad Passage Period:

(i) During the entire Downstream Juvenile American Shad Passage Period, the Licensee will operate the Project units in the following order of priority, depending upon available River flow: (1) Unit 1-6 may be operated without restriction up to available river flow); (2) Unit 14 may be operated if river flow exceeds capacity of Units 1-6; (3) Units 7-13 and 15-30 may be operated in ascending order if river flow exceeds capacity of Unit 1-6 and 14.

(ii) During the entire Downstream Juvenile American Shad Passage Period, the Licensee will open and spill water via the forebay sluice gate (~ 370 cfs) between the hours of 5 pm to 11 pm EST.

(iii) The NLF Facility will be operated to maintain a flow through the fishway of approximately 200 cfs.

(iv) If river flow exceeds the sum of Project Hydraulic Capacity, required flows through the NLF Facility, required flows through the East Channel, and required flows (if any) over the Main Dam, the Licensee will open and spill water via the forebay sluice gate (~370 cfs) to the extent practicable for one to two hours during the morning, subject to Project access requirements for

[2] Note: During the Downstream Juvenile American Shad Passage Season, a portion of the period is in daylight savings time and a portion is in standard time. All timeframes stated in this Offer of Settlement are stated in Eastern Standard Time. During October, sunset in the central Pennsylvania area is in a range of 5:50-5:05 pm EST. During November, sunset in central Pennsylvania occurs in a range of 5:05 pm to 4:42 pm EST.

operations and maintenance purposes, in order to provide for downstream juvenile American shad passage.

(c) The overall goal for juvenile American shad downstream passage is to achieve survival of 95% of juvenile American shad from above the Project powerhouse and dam to below the Project powerhouse and dam (the "Downstream Juvenile American Shad Passage Goal"). Measurement of such passage effectiveness and survival is subject to a margin of error. The effectiveness of downstream passage operations for juvenile American shad will be determined based upon (1) a route of passage analysis as described in Section 9.9.6(d), and (2) confirmation that Forebay Sluice Gate provides for safe passage as described in Section 9.9.6(e).

(d) For purposes of the route of passage analysis, the Service will assume that (1) juvenile American shad will pass through the NLF Facility, through the East Channel past the East Channel Dam, over the Main Dam, and into the head race in direct proportion to the amount of flow via each such route; (2) any juvenile American shad passing through the NLF Facility, through the East Channel past the East Channel Dam, over the Main Dam, or through the forebay sluice gate will survive; (3) juvenile American shad that do not pass through the NLF Facility, through the East Channel past the East Channel Dam, over the Main Dam, or through the forebay sluice gate will pass through the turbines that are being operated in accordance with the priorities set forth in Section 9.9.6(b), and absent observations to the contrary, are allocated between the operating turbines in proportion to the flow through each turbine; and (4) the survival rate of juvenile American shad passing through individual turbines (based on previous balloon tag and blade strike analyses) are as stated in Appendix D. Based upon the foregoing assumptions and confirmation that Forebay Sluice Gate provides for safe passage as described in Section 9.9.6(f), the juvenile American shad passage goal of 95% would be met if at least 60% of the tagged juvenile American shad released into the headrace exit via the Forebay Sluice Gate (that is, pass downstream of the Project headrace without passing through the turbines) (the "Headrace Shad Turbine Avoidance Target"). Licensee shall test the downstream passage efficiency of the operating protocols described above by a PIT tag monitoring study. Licensee shall, in consultation with the Resource Agencies, prepare a plan and schedule for the Headrace Shad Turbine Avoidance Study for review and approval of the Resource Agencies, consistent with the design criteria set forth in Appendix D. The Project will be deemed to meet the Downstream Juvenile American Shad Passage Goal if (1) the Headrace Shad Turbine Avoidance Study shows that the Headrace Shad Turbine Avoidance Target is achieved and (2) the Licensee complies with the provisions of Section 9.9.6(f) to establish conditions under which the Forebay Sluice Gate provides for safe passage of juvenile American shad.

(e) Within four (4) years following License issuance and prior to performance of the downstream juvenile American shad studies referenced in Section 9.9.6(d), License shall prepare and submit to the Resource Agencies: (i) designs for a chute structure to convey flows beyond the roadway on the downstream side of the Cable Alley structure, meeting the design criteria set forth in Appendix E allowing juvenile and adult American shad to land unimpeded in the downstream pool;

and (ii) removal of obstructions in or deepening of the downstream pool into which flows from the Forebay Sluice Gate land to provide an adequate depth of 1 foot for each 4 feet of drop into which juvenile or adult American shad may land. Licensee shall submit any design plans for improvements as described in this Section 9.9.6(e) and a proposed implementation schedule to the Service and PADEP for review and approval and to the other Resource Agencies for review and comment, and shall implement the proposed improvements in accordance with the approved designs and schedule. Any such required improvements shall be completed coincident with completion of the NLF Facility, and in advance of commencement of the monitoring described in Section 9.9.6(d) .

(f) If the effectiveness monitoring conducted pursuant to Section 9.9.6(d) shows that the Headrace Shad Turbine Avoidance Target is not achieved, Licensee shall implement the following sequence of adaptive measures in the next passage season:

(i) Open the NLF supplemental flow gate (800 cfs) during the same schedule as the Forebay Sluice Gate is opened.

(ii) Suspend operation of certain Francis turbine units during the hours of 5-11 pm EST when river flows are between 15,000 cfs and 22,000 cfs during the Downstream Juvenile American Shad Passage Period, up to a total generation loss of 1,000 Megawatt hours ("MWh").

(iii) Such other measures as may be agreed to by the Licensee, the Service and PADEP, after consultation with the other Resource Agencies, and (to the extent required) approved by the Commission.

(g) Within two years of implementing the adaptive measures referenced in Section 9.9.6(f), Licensee shall conduct a follow-up Headrace Shad Turbine Avoidance Study following the protocols referenced in Section 9.9.6(d) . If the follow-up Headrace Shad Turbine Avoidance Study shows that Headrace Shad Turbine Avoidance Target is achieved, such adaptive measures shall continue to be implemented for the duration of the License.

(h) If by January 1, 2028, (a) the Headrace Shad Turbine Avoidance Studies have not shown that Headrace Shad Turbine Avoidance Target is being achieved by adaptive measures implemented at the Project, and (b) based on all available information and after consultation with Licensee and the other Resource Agencies, the Service renders a determination on the basis of the record reasonably finding that (i) Licensee has not demonstrated that the adaptive measures implemented at the Project are reasonably anticipated to meet the Downstream Juvenile American Shad Passage Goal, and (ii) additional measures that are reasonably required to achieve the Downstream Juvenile American Shad Passage Goal (the "Additional Measures Determination") (which Additional Measures Determination shall be subject to the dispute resolution / appeal procedures set forth in the Settlement):

(i) Within 12 months of the Additional Measures Determination, Licensee shall, in consultation with the Resource Agencies, prepare a design and schedule for implementation of additional structural and operational measures reasonably

anticipated to meet the Downstream Juvenile American Shad Passage Goal that are feasible, appropriate under the circumstances, reasonable and technically sound. Licensee shall evaluate, among other options, options for a Fish Guidance System ("FGS") as described in the report entitled *Evaluation of Fish Guidance Systems* (Draft April 2013), or other appropriate technology to achieve the Downstream juvenile American shad Passage Goal. As part of the evaluation report, Licensee shall provide sufficient information to demonstrate the reasonably likelihood of the proposed option and measures to meet the Downstream Juvenile American Shad Passage Goal.

(ii) Following approval of the design and schedule by the Service and PADEP, after consultation with the other Resource Agencies, Licensee shall prepare and submit the applications for all required governmental approvals, including FERC approvals, and procure, install and implement the approved structural and/or operational measures in accordance with the approved schedule. Such approved measures shall be implemented by December 31, 2030 or such other date as agreed to by Licensee and the Service, after consultation with the other Resource Agencies, or as approved by FERC.

(iii) If Licensee does not present a design and schedule for implementing additional structural and operational measures reasonably anticipated to meet the Downstream Juvenile American Shad Passage Goal that are feasible, appropriate under the circumstances, reasonable and technically sound, or based on all available information and after consultation with Licensee and the Resource Agencies, the Service does not approve the Licensee's design and schedule for additional measures submitted pursuant to Section 9.9.6(h)(i), the Service may elect to exercise its reserved authority to prescribe such measures as the Service determines are necessary for safe and effective passage of downstream migrating American shad; and Licensee retains all rights to challenge any such exercise of reserved authority.

(i) Within one year after the implementation of the structural and operational measures implemented under Section 9.9.6(h), Licensee shall perform a follow-up Headrace Shad Turbine Avoidance Study to evaluate the number of tagged juvenile American shad that exit the Forebay without exposure to the turbines.

9.9.7 Downstream Passage for Silver Eels

Licensee shall provide for the downstream passage of silver eels in accordance with this Section.

(a) The overall goal for silver American eel passage shall be to achieve effective passage and survival of 85% of silver eels from above the Project dams and powerhouse to below the Project dams and powerhouse (the "Downstream Eel Passage Goal"). Measurement of such passage effectiveness and survival is subject to a margin of error.

(b) Licensee shall cooperate with the Resource Agencies and other interested parties in the conduct of (1) a Lower Susquehanna River Downstream Eel Study to evaluate the timing, magnitude, duration, annual variation and environmental

conditions associated with active migration of silver eels from tributaries stocked with elvers, through the lower Susquehanna River to the Chesapeake Bay; and (2) a Site-Specific Route of Passage Study to evaluate the route of passage selected migrating silver eels in the vicinity of the Project. The design criteria for the Lower Susquehanna River Downstream Eel Study and the Site-Specific Route of Passage Study are described in Appendix G.

(c) At least 12 months prior to the anticipated date for completion of the NLF Facility, in consultation with the Resource Agencies, Licensee shall prepare a plan and schedule for conducting a discrete downstream passage effectiveness study ("Site-Specific Downstream Eel Study"), consisting of a Site Specific Route of Passage Study as described in Appendix G and an Eel Survival Study as described in Appendix H. Licensee shall submit the Site-Specific Downstream Eel Study plan and proposed schedule to the Resource Agencies, for review and approval by the Service and PADEP and for review and comment by the other Resource Agencies. Licensee, in cooperation with the Resource Agencies, shall conduct the Site-Specific Route of Passage Study following completion of the NLF Facility in accordance with the approved plan and schedule, and Licensee shall conduct the Eel Survival Study in accordance with the approved plan and schedule.

(d) If the results of the Site-Specific Downstream Eel Passage Study indicate that the then existing Project operating measures and protocols achieve the Downstream Eel Passage Goal, then the Licensee shall continue to implement those protocols and measures.

(e) If the results of the Site-Specific Downstream Eel Passage Study do not indicate that the Project's existing operating measures and protocols do not achieve the Downstream Eel Passage Goal, the Licensee will prepare and submit to the Resource Agencies a plan and schedule for evaluating the feasibility and costs of potential physical and/or operational modifications to the Project to facilitate downstream eel passage (the Downstream Eel Improvements Study). The Downstream Eel Improvements Study plan and schedule shall be subject to review and approval by PADEP and the Service and review and comment by the other Resource Agencies. Licensee shall conduct the Downstream Eel Improvements Study in accordance with the approved plan and schedule. The Downstream Eel Improvements Study will consider and evaluate whether any of the following adaptive measures to facilitate downstream eel passage, which may be implemented in a sequence or in combination, are feasible, appropriate under the circumstances, reasonable and technically sound and are reasonably expected to contribute toward achievement of the Downstream Eel Passage Goal:

(i) Adjustment to NLF Facility operations. (ii)
Installation of current inducers.
(iii)Modifications to the juvenile American shad protection measure.
(iv)Installation of a fish guidance system.
(v) Replacement of turbine runner systems with units designed to have a lower mortality impact upon silver eels.

(vi) Other measures mutually agreed to by the Licensee, the Service and PADEP, after consultation with the other Resource Agencies.

(f) If the Downstream Eel Improvements Study identifies physical or operational adaptive measures listed in Section 9.9.7(e) to facilitate downstream eel passage that are feasible, appropriate under the circumstances, reasonable and technically sound, Licensee shall prepare a plan and schedule for implementing such measures and an estimation as to the ability of such measures to achieve the Downstream Eel Passage Goal, and will submit the plan and schedule to the Resources Agencies for review and approval by the Service and PADEP and review and comment by the other Resource Agencies. Following approval of such plan and schedule, Licensee shall implement the measures described in the approved plan in accordance with the approval schedule. If Licensee does not present such a plan and schedule for implementing physical or operational adaptive measures listed in Section 9.9.7(e) that are feasible, appropriate under the circumstances, reasonable and technically sound, and reasonably anticipated to meet the Downstream Eel Passage Goal, or based on all available information and after consultation with Licensee and the Resource Agencies, the Service does not approve the Licensee's plan and schedule for such measures submitted pursuant to this Section, the Service may elect to exercise its reserved authority to prescribe such measures as the Service determines are necessary for safe and effective passage of downstream migrating American eel; and Licensee retains all rights to challenge any such exercise of reserved authority.

(g) Within 12 months following implementation of any such improvements, Licensee shall evaluate and provide a report to the Resource Agencies regarding the effectiveness of the measures in relation to achievement of the Downstream Eel Passage Goal.

(h) If the adaptive measures implemented pursuant to the Downstream Eel Improvements Study do not result in achievement of the Downstream Eel Passage Goal, the Licensee and the Resource Agencies shall on an annual basis consult as to potential additional studies or adaptive measures that are or may become feasible, appropriate under the circumstances, reasonable and technically sound, and reasonably expected to contribute toward achievement of the Downstream Eel Passage Goal.

10. Scientific Names

American eel (*Anguilla rostrata*)
American shad (*Alosa sapidissima*)
Alewife *(Alosa pseudoharengus)*
Blueback herring *(Alosa aestivalis)*
Hickory shad *(Alosa mediocris)*
Shortnose sturgeon *(Acipenser brevirostrum)*
Atlantic sturgeon (*Acipenser oxyrinchus)*
Striped bass (*Morone saxatilis*)

APPENDIX E

Preliminary Fishway Prescription – Muddy Run Pumped Storage Project

FISH PASSAGE

A. General Requirements

1. Fish Passage Operating Procedures ("FPOP")

a. By January 15, 2015, EXELON shall submit a FPOP to the DEP for review and approval. The FPOP will describe existing baseline operations during fish passage season, including schedules for routine maintenance, procedures for routine operation (including: seasonal and daily periods of operation, pump and turbine operations), sequencing of pump and turbine start-up and operation, procedures for monitoring and reporting flows, procedures for monitoring and reporting on the operation of the facility, procedures for start-up and shut-down, and procedures for use in case of emergencies and project outages significantly affecting the conditions of this certification.

b. EXELON shall implement the FPOP consistent with the approval of the DEP. EXELON shall provide written documentation to the Resource Agencies that operational personnel have reviewed and understand the FPOP signed by the operations manager of the Project.

c. Copies of the approved FPOP and all modifications will be provided to the Resource Agencies.

d. By December 31 of each year, EXELON shall provide an annual report to the Resource Agencies detailing: the implementation of the FPOP, including any deviations from the FPOP and a process to prevent those deviations in the future; any proposed modifications to the FPOP, or in the case of emergencies or project outages, the steps taken by EXELON to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future. EXELON shall offer to meet with the Resource Agencies by January 31 of each year unless a different date is mutually agreed upon by EXELON and the Resource Agencies. Any required modifications to the FPOP shall be submitted to the Resource Agencies within 45 days of receipt of a request for the modification unless a longer period is approved by the DEP. The modifications to the FPOP shall be implemented consistent with the approval of the DEP. In the event EXELON fails to submit the modifications as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish modifications and EXELON shall

implement the modifications consistent with the approval of the DEP.

B. American Shad Passage

1. Upstream Shad Passage

a. Cooperation with Holtwood. If the Holtwood Hydroelectric Facility fails to meet its Tier I upstream shad passage target described and included in the 401 Water Quality Certification for the Amended Holtwood Hydroelectric Facility, and DEP determines that EXELON's operation of the Muddy Run Project is a proximate cause of Holtwood failing to meet the Tier 1 target, EXELON shall meet with the Resource Agencies to establish and implement a plan and schedule for a radio telemetry study or equivalent (Tier II Study) of American shad passage and behavior within the Muddy Run project boundary. This meeting shall occur within one month of the DEP's determination that Holtwood failed to meet its Tier 1 upstream shad passage target or such longer time as established by the DEP in writing.

b. Evaluation of Muddy Run Shad Passage. If EXELON is a proximate cause of Holtwood's failure to meet its Tier I upstream shad passage target, EXELON shall develop a radio telemetry study plan and schedule or equivalent to determine: (1) the percentage of American shad that enter Muddy Run project at the northern tip of Sicily Island area and subsequently exit the Muddy Run project area at the southern tip of Deepwater Island; and (2) any delay or impedance of shad passage attributable to the redevelopment of the Holtwood Facility. EXELON shall coordinate development of this plan with the Holtwood Hydroelectric Facility and the Conowingo Hydroelectric Facility. The radio telemetry study shall be designed to insert the transmitter at the Conowingo facility or at such other location(s) approved by the DEP.

c. Within two months of the meeting described in Paragraph III.B.1.a. or such longer period approved by the DEP in writing, EXELON shall submit the fish passage study plan and schedule to the Resource Agencies for review and approval by DEP. EXELON shall implement the plan according to the schedule therein and consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall

implement that plan and schedule consistent with the approval of the DEP. EXELON shall continue implementation of fish passage study for a minimum of four years or such other time period as required by the DEP in consultation with the other Resource Agencies. EXELON shall provide an annual report of the monitoring results of fish passage study by December 31st of each year.

d. At the end of the four-year study period, or such longer time as established by the DEP, if the results indicate that, as a result of Muddy Run operations, less than 88% of the American shad that enter the Muddy Run project waters at the northern tip of Sicily Island exit the Muddy Run project waters at the southern tip of Deepwater Island, EXELON shall propose a plan and schedule for operational modifications to enhance fish passage at the project. EXELON shall not be responsible for mitigating any impacts attributable to PPL Holtwood. This plan and schedule shall be submitted to the DEP as an amendment to the FPOP for the following year. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

e. The average of the two highest years in the monitoring period will be used determine whether the 88% fish passage percentage is achieved. If EXELON implements operational modifications, only those years following the operational modifications shall be considered to determine whether the 88% passage percentage is achieved.

f. If at the end of the monitoring period, or such longer time as established by the DEP, the results indicate that the operational modifications have resulted in less than 88% of the American shad that enter the Muddy Run project waters pass through the Project, EXELON shall propose a plan and schedule for mitigation, as defined in 25 Pa. Code Section 105.1 for the failure to achieve the 88% fish passage target. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and

schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

2. Downstream Shad Passage

a. Consistent with the relicensing studies for Muddy Run, by January 15, 2015, EXELON shall submit a plan and schedule to provide for 95% survival of the juvenile American shad and 80% survival of the adult American shad that pass through the project area. The schedule shall provide for full implementation of the plan by 2015. EXELON shall implement the approved plan and schedule. If EXELON fails to submit the plan, the DEP shall develop a plan and schedule, in consultation with the other resource agencies, and EXELON shall implement that plan and schedule.

b. By February 15, 2026 or such later date approved by the DEP in writing, EXELON shall submit a plan to measure the passage of American shad moving downstream past the project to the DEP for approval ("Discrete Passage Study"). EXELON shall implement the plan to measure the passage of American shad moving downstream past the project according to the schedule and consistent with the approval of the DEP ("Discrete Passage Study"). In the event EXELON fails to submit the plan and schedule required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

c. EXELON shall, in accordance with the plan, conduct the Discrete Passage Study. EXELON shall provide a report of the Discrete Passage Study within 180 days of its completion or such later date approved by the DEP in writing to the Resource Agencies.

d. If the results of the Discrete Passage Study indicate that EXELON can operate the Muddy Run project so that EXELON achieves at least 95% passage of the juvenile American shad and 80 % passage of the adult American shad that pass through the project area based on the likelihood of a shad being exposed to typical pumping operations and becoming entrained, then EXELON shall incorporate into the annual FPOP any required operational measures or protocols to meet the established percentages. These procedures will be subject to review at the annual meeting for the FPOP.

e. If the results of the Discrete Passage Study do not indicate that the project can be operated to achieve at least 95% passage of juvenile American shad and 80% passage of adult American shad based on the likelihood of a shad being exposed to typical pumping operations and becoming entrained, EXELON shall propose a plan and schedule for mitigation, as defined in 25 Pa. Code Section 105.1, for the failure to achieve the fish passage target or targets. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period or such later date approved by the DEP in writing. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

C. Eel Passage

1. Upstream Eel Passage

The terms and conditions of the EXELON Generation American Eel Passage Plan for the Muddy Run Pumped Storage Hydroelectric Project (P-2355), attached hereto as Appendix 1 (*Appendix 3 of the Department's Fish Pasage Prescription*), are incorporated as if fully set forth herein.

2. Downstream Eel Passage

a. The trigger date for initiation of downstream eel passage studies shall be the date on which the DEP, in consultation with the other Resource Agencies, determines that available data indicates that eels are present upstream of the project or other upstream areas in numbers appropriate to require downstream eel passage. This trigger date shall not occur prior to October 1, 2026 in order for the trapping and transport program to have sufficient time to reestablish a significant eel population.

b. EXELON shall achieve at least 85% eel passage through the project area based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained.

c. Within six months of the trigger date in Paragraph (a), or such later date approved by the DEP in writing, EXELON shall submit a plan

to conduct a passage study to the Resource Agencies. The plan shall be designed to demonstrate continued compliance with the 85 % fish passage target. The plan shall include radio telemetry studies or such other studies approved by the DEP in consultation with the other Resource Agencies. EXELON shall implement the plan according to the schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

d. The study shall be initiated within 1 year of the trigger date unless a different time frame is approved by the DEP in writing. EXELON shall provide a report of the study results within 180 days of the date of completion of the study.

e. If the results of a discrete passage study indicate that EXELON can operate the project so that EXELON achieves at least 85% passage of the American eel that pass through the project area based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained, EXELON shall incorporate into the FPOP any operational measures needed to meet this percentage. These procedures will be subject to review at the annual FPOP meeting.

f. If the results of the studies do not indicate that the project can be operated to achieve at least 85% passage of American eel based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained, EXELON shall propose a plan and schedule for mitigation, as defined in 25 PA. Code Section 105.1, for the failure to achieve the 85% eel passage target. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period or such later date approved by the DEP in writing. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

Reservation of Authority to Prescribe Fishways

In order to allow for the timely implementation of fishways, including effectiveness measures, the Department proposes to reserve its authority by requesting that the Commission include the

following condition in any license it may issue for the Project:

> *Pursuant to section 18 of the Federal Power Act, the Secretary of the Interior herein exercises her authority under said Act by reserving that authority to prescribe fishways during the term of this license and by prescribing the fishways described in the Department of the Interior's Prescription for Fishways at the Muddy Run Project.*

Preliminary Prescription for Fishways

Pursuant to section 18 of the Federal Power Act, as amended, the Secretary of the Department of the Interior, as delegated to the Service, proposes to exercise her authority to prescribe the construction, operation and maintenance of such fish passage facilities and measures as deemed necessary, subject to the procedural provisions contained above.

The Department's Preliminary Prescription for Fishways reflects a number of issues and concerns related to fish restoration and passage that have been raised by the applicant, Commission staff, State resource agencies, and other parties involved in these proceedings.

Fish passage facilities and or measures shall be constructed, operated, and maintained to provide safe, timely and effective passage for American shad, alewife, blueback herring, American eels and other designated resident riverine fish species at the licensee's expense.

To ensure the immediate and timely contribution of the fish passage facilities and measures to the ongoing and planned anadromous and catadromous fish restoration and enhancement program in the Susquehanna River, the following are included and shall be incorporated by the Licensee to ensure the effectiveness of the fishways pursuant to section 1701(b) of the 1992 National Energy Policy Act (P.L. 102-486, Title XVII, 106 Stat. 3008).

Fish Passage Requirements

Design Populations

American Shad

The design population at the Project for American shad is derived from the *1993 Settlement Agreement for the Development of Fish Passage Facilities at the Holtwood, Safe Harbor, and York Haven Projects on the Susquehanna River*[36]. Pursuant to that agreement the existing fishway at the Holtwood Dam immediately upstream of the Muddy Run Project was designed to pass 2,700,000 American shad. That same number of shad is the design population for the

[36] Settlement Agreement. June 1, 1993. Pennsylvania Power & Light Company, Safe Harbor Water Power Corporation, and York Haven Power Company, AND U.S. Fish and Wildlife Service – U.S. Department of the Interior, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Environmental Resources, Maryland Department of Natural Resources, Susquehanna River Basin Commission, Upper Chesapeake Watershed Association, and Pennsylvania Federation of Sportsmen's Clubs.

Muddy Run Project, as there is no spawning habitat between the two dams, and all fish need to continue migration upstream past Muddy Run Project to account for any migration fallout while attempting to pass through upstream hydroelectric projects.

Delays to upstream migration of American shad at hydroelectric facilities can compromise their ability to successfully spawn[37] through increasing energetic costs and causing a mismatch between when shad arrive in suitable spawning habitat and optimal temperatures for spawning. The Service developed a model to evaluate how rates of upstream shad migration (proportion of shad passed in a given number of hours) in the Susquehanna River affect the timing of when shad arrive in suitable spawning habitat upstream of York Haven Dam relative to optimal temperatures for spawning. Shad that reached areas above York Haven Dam prior to a time when temperatures would exceed those that are optimal for spawning were considered to have successful migrations.

The model estimated 97% of shad had successful migrations if there were no impediments (delays) to migration. As the number of hours to pass shad increased at each hydroelectric facility, successful migration approached 0% when delay times at a given facility reached 168 hours (7 days). The rate of passage in terms of percentage passed per time is also an important factor when determining the impact of migratory delays (USFWS 2013c). To minimize the impact of migratory delays on spawning success for migrating adult American shad, the Service is requiring successful passage of 80% of adult American shad at each project within 36 hours of arrival to the Project in addition to the SRAFRC Management Plan (2010) requirement of 85% overall upstream passage effectiveness for adult American shad[38].

Therefore American shad passage at Muddy Run Project shall be adequate (target number passed with minimal delay) so as not to interfere with passage objectives and targets established for the Susquehanna River. If fish passage monitoring require in this prescription indicates that American shad are not meeting the target passage of 80% of adult American shad at each project within 36 hours at the Muddy Run Project the licensee will need to consult with the Service regarding development of a plan for implementation of project operational measures and/or construction of facilities that will meet the passage target.

River Herring (Alewife and Blueback Herring)

The design population at the Project for river herring is derived from the *1993 Settlement Agreement for the Development of Fish Passage Facilities at the Holtwood, Safe Harbor, and York Haven Projects on the Susquehanna River*, and the existing fishway at Holtwood was designed to pass 10,00,000 river herring.

As such river herring passage at Muddy Run Project shall be adequate so as not to interfere with passage objectives and targets at the Holtwood Hydroelectric Project immediately upstream of

[37] Federal Energy Regulatory Commission, Division of Hydropower Administration and Compliance, Office of Energy Projects, 2004. Evaluation of Mitigation Effectiveness at Hydroelectric Projects: Fish Passage. September 2004.
[38] *Id* at 32.

the Muddy Run Project, or the Conowingo Hydroelectric immediately downstream of the Muddy Run Project.

American Eel

American eel do not currently have access to Project waters due to a lack of upstream passage at the Conowingo Hydroelectric Project located downstream, but the Department anticipates that passage to the Muddy Run Project area for juvenile eels will shortly become available through passage past the Conowingo Hydroelectric Project for migrating eels. While the Department does not have a precise estimate of the numbers of eels that would be expected to pass through the Muddy Run Project area, measures to achieve safe, timely and effective passage past the Muddy Run Project would enhance the eel stocks and help achieve overall management goals of federal and state resource agencies.

As such American eel passage at Muddy Run Project shall be adequate so as not to interfere with passage objectives at the Holtwood Hydroelectric Project immediately upstream of the Muddy Run Project, or the Conowingo Hydroelectric immediately downstream of the Muddy Run Project. The *American Eel Restoration Plan for the Susquehanna River Basin* (SRAFRC 2013) states that all available eel seeking passage at a hydroelectric project be passed upstream (i.e. no impact), and that there be 85% downstream passage survival at each hydroelectric project.

Fish Passage Operating Periods

Regarding the timing of seasonal fish passage operations, fish passage facilities and measures shall be maintained and operated, at the licensee's expense, to maximize fish passage effectiveness throughout the upstream and downstream migration periods for American shad, alewife, blueback herring, American eel, and designated riverine fish.

Table ~~1~~3: Upstream and downstream migration periods for species covered in this Prescription for Fishways. *

Species	**Upstream Migration Period**	**Downstream Migration Period**
American shad	April 1 through June 15	July 1 through November 15 (juv.) April 15 through July 1 (adult)
Alewife & Blueback herring	March 1** through June 15	June 15 through October 14 (juv.) April 15 through July 1 (adult)
American eel	May 1 through September 15***	September 15–February 15, whenever river temperature is above 37 degrees F ****

* Any of these migration periods may be changed during the term of the license by the Department, based on new information, and in consultation with the other fishery agencies and the licensee.

** This operational period is based on preliminary data on Alewife migration timing from other tributaries to the Chesapeake Bay (Sutherland 2000, Eyler et al. 2002, Slacum 2003).

***This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay.

**** The Department is requiring the licensee to study the magnitude and timing of downstream eel migration through the project so that the effectiveness of the reduced period can be evaluated. This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay (Welsh et al. 2009).

Fish Passage Operating Procedures

The timely and proper implementation of the fish passage measures is necessary to ensure the effectiveness of such measures. Therefore, the Department's Prescription includes the express requirement that the licensee develop Fish Passage Operating Procedures (FPOP) for implementation of operational measures during the migratory fish passage season.

By January 15, 2015, the licensee shall submit a FPOP to the Department for review and approval. The FPOP will describe prescribed baseline operations during fish passage season, including schedules for routine maintenance, procedures for routine operation (including: seasonal and daily periods of operation, pump and turbine operations), sequencing of pump and turbine start-up and operation, procedures for monitoring and reporting flows, procedures for monitoring and reporting on the operation of the facility, procedures for start-up and shut-down, and procedures for use in case of emergencies and project outages significantly affecting the conditions of this prescription.

The licensee shall implement the FPOP consistent with the approval of the Department. The licensee shall provide written documentation to the Resource Agencies that operational personnel have reviewed and understand the FPOP signed by the operations manager of the Muddy Run Project.

Copies of the approved FPOP and all modifications will be provided to the Resource Agencies.

By December 31 of each year, the licensee shall provide an annual report to the Resource Agencies detailing: the implementation of the FPOP, including any deviations from the FPOP and a process to prevent those deviations in the future; any proposed modifications to the FPOP, or in the case of emergencies or project outages, the steps taken by the licensee to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future. The licensee shall offer to meet with the Resource Agencies by January 31 of each year unless a different date is mutually agreed upon by the licensee and the Resource Agencies. Any required modifications to the FPOP shall be submitted to the Resource Agencies within 45 days or receipt of a request for the modification unless a longer period is approved by the Department. The modifications to the FPOP shall be implemented consistent with the approval of the Department. In the event the licensee fails to submit the modifications as required by this paragraph, the Department, in consultation with the other Resource Agencies, may establish modifications and the licensee shall implement the modifications consistent with the approval of the Department.

The Licensee shall prepare the plan after consultation with the U.S. Fish and Wildlife Service, the Pennsylvania Fish and Boat Commission, the Pennsylvania Department of Environmental Protection, and the Pennsylvania Department of Conservation and Natural Resources.

The Licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies’ comments are accommodated by the plan. The Licensee shall allow a minimum of 30 days for the agencies and other interested organizations to

comment and to make recommendations.

Inspection

The licensee shall provide personnel of the Department, and other Department-designated representatives, access to the project site and to pertinent project records for the purpose of inspecting the fish passage measures to determine compliance with the fish passage Prescription.

Consultation

The licensee shall develop in consultation with and submit for approval by the Department, all fish passage plans, schedules, and any supporting information to the fish passage measures described herein.

American Shad Passage

Fish Passage Facilities and Structures

As indicated under "Alternatives Considered" section above the Department is not requiring the installation of any engineered facilities or structures (e.g., intake screens, instream flow diverters and baffles) to eliminate or substantially reduce project operational impacts to migratory fish attempting to pass the Muddy Run Project area at this time.

Fish Passage Measures

The Department concluded that that impacts migrating American shad are the direct result of the Muddy Run Project generation discharge and pumping withdrawal flows; and these impacts could be reduced or eliminated by regulating these operational activities during the annual periods of anadromous and catadromous fish migration.

The Department is requiring that the licensee develop Fish Passage Operating Procedures (FPOP) as described in detail above. The FPOP shall describe the licensee's proposed baseline operations during fish passage season, including schedules for routine maintenance, procedures for routine operation (including seasonal and daily periods of operation, pump and turbine operations), sequencing of pump and turbine start-up and operation, procedures for monitoring and reporting flows, procedures for monitoring and reporting on the operation of the facility, procedures for start-up and shut-down, and procedures for use in case of emergencies and project outages significantly affecting the conditions of this prescription.

American Shad Passage Monitoring

The FERC determined that the process of mitigating adverse environmental impacts should include an assessment of the effectiveness of the mitigation that is implemented, and that in most cases, successful mitigation is dependent upon the development of such effectiveness monitoring plans (FERC 2004). The licensee shall implement an American Shad Passage Monitoring Plan (ASPMP) approved by Department in order to monitor the effectiveness of upstream shad

passage at the Muddy Run Project. Fish passage monitoring is (or will be) a condition of FERC license for the other four hydroelectric projects on the lower Susquehanna River. Each of the hydroelectric projects has engineered facilities or structures, and the associated project operations and measures as the primary form of upstream fish passage. Each of the existing upstream passage facilities is equipped with a fish counting window where the number and species of fish passaging the project can be visually enumerated by an observer during the fish passage season. These counts are used to monitor the effectiveness of fish passage facilities at the FERC licensed hydroelectric project.

Since there are no engineered upstream fish passage facilities or structures at the Muddy Run Project provisions cannot be made for visual fish counts to monitor American shad passage at the Muddy Run Project. The only other method proven to be applicable to monitoring fish passage is tracking of a representative sample of migratory fish as was done during the licensee's 2008 and 2011 American shad radio telemetry study. FERC (2004) determined that a radio tagging study to estimate the proportion of fish that are passed upstream can be an appropriate method of assessing effectiveness, and that it is also an appropriate procedure for assessing the effectiveness of downstream passage.

Therefore the licensee monitoring plan shall include execution of the radio telemetry monitoring similar to that conducted in 2008 for adult American shad, and in 2011for juvenile American shad by the licensee's consultant, unless some other technique is approved in advance by the Service. The monitoring measures contained in the ASPMP shall be conducted during the 2018 fish passage season, and be repeated every ten years thereafter for the term of any new FERC license that may be issued for the project.

The licensee shall implement the ASPMP consistent with the approval of the Department. The licensee shall provide written documentation to the Resource Agencies that operational personnel have reviewed and understand the ASPMP signed by the operations manager of the Muddy Run Project.

Copies of the approved ASPMP and all modifications will be provided to the Resource Agencies.

By December 31 of each year in which studies are done, the licensee shall provide an annual report to the Resource Agencies detailing: the implementation of the ASPMP, including any deviations from the ASPMP and a process to prevent those deviations in the future; any proposed modifications to the ASPMP, or in the case of emergencies or project outages, the steps taken by the licensee to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future. The licensee shall offer to meet with the Resource Agencies by January 31 of each year unless a different date is mutually agreed upon by the licensee and the Resource Agencies. Any required modifications to the ASPMP shall be submitted to the Resource Agencies within 45 days or receipt of a request for the modification unless a longer period is approved by the Department. The modifications to the ASPMP shall be implemented consistent with the approval of the Department.

The Licensee shall prepare the ASPMP after consultation with the U.S. Fish and Wildlife

Service, the Pennsylvania Fish and Boat Commission, the Pennsylvania Department of Environmental Protection, and the Pennsylvania Department of Conservation and Natural Resources.

The Licensee shall include with the ASPMP documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the ASPMP. The Licensee shall allow a minimum of 30 days for the agencies and other interested organizations to comment and to make recommendations.

The licensee shall meet with the Resource Agencies to discuss the results of the above ASPMP. The results of this study will be used to determine the need for and form of any additional fish passage measures or facilities. If the ASPMP results indicate that the Muddy Run Project is not meeting the passage goals prescribed herein, the licensee must propose measures calculated to meet the goals, and shall implement such measures upon approval by the Service, Pennsylvania DEP, and FERC, as needed. The licensee shall provide daily updates of monitoring results to the Resource Agencies. The licensee shall provide an annual report of the monitoring results to the Resource Agencies by December 31st of each year.

Downstream American Shad Passage Monitoring

The ASPMP described above will be used to monitor the downstream passage of adult out-migrating post-spawn American shad and assess the effectiveness of downstream passage measures at the Muddy Run Project. If the ASPMP results indicate that the Muddy Run Project is not meeting the passage goals prescribed herein, the licensee must propose measures calculated to meet the goals, and shall implement such measures upon approval by the Service, Pennsylvania DEP, and FERC, as needed.

American Eel Passage

Eel Passage Measures

For the catadromous American eel the licensee proposes to work with other licensees on the Susquehanna River to implement both an upstream and downstream trap-and-transport program to provide American eel passage for upstream migrating juveniles and downstream migrating adults between the Conowingo and York Haven dams. No specific plans for the program were provided in the Muddy Run Project Draft License Application. However the PA DEP Proposed 401 Water Quality Certification requires the implementation of trap and transport for juvenile American eel migrating upstream. We generally consider trap-and-transport to be an interim fish passage measure during the initial phase of a river restoration, and is appropriate for these initial stages, therefore this Prescription provides specific plans for a trap and transport program. As restoration efforts for American eel on the Susquehanna River progress, the capacity of PA DEP proposed trap-and-transport operation to move sufficient numbers of eel upstream will likely be exceeded and additional facilities and measures may be needed to accommodate adequate, safe, timely and effective passage through the Muddy Run Project area.

The licensee will need to develop a plan to assess placement, design and installation of facilities and measures needed to capture eel and provide safe, timely and effective eel passage past the Muddy Run Project. The plan should also include a description of studies to test the effectiveness of eel trap-and-transport as an interim means of passage at the Muddy Run Project. The licensee should develop this plan in consultation and cooperation with the Department and state resource agencies and provide it to the Department and state resource agencies for review and approval before submitting it to the FERC for its review and approval. This American Eel Passage Plan ("Eel Plan") is a condition of, and incorporated into this fish passage prescription.

To inform implementation of the Eel Plan, the licensee will establish an Eel Passage Advisory Group (EPAG) within 6 months of license issuance. EPAG will be chaired by the licensee and composed of a representative from each of the following (collectively, the "Resource Agencies"): the United States Fish and Wildlife Service (Service), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), the Maryland Department of Natural Resources (MD DNR), and the Susquehanna River Basin Commission (SRBC). Each designated representative shall be knowledgeable of American eel, the Susquehanna River, ongoing fisheries and other related resource programs being implemented in the Lower Susquehanna River (e.g., American shad restoration).

Consistent with the implementation plan set forth below, the licensee will trap and hold immigrating juvenile American eels from a point downstream of the Muddy Run Project, and transport them to designated points in the Susquehanna River watershed consistent with the level of effort established and described in the plan.

Trapping

Subject to required regulatory approvals, the licensee will design, install and operate eel trapping facilities according to the following schedule, unless an alternative schedule is approved by the Department in writing. In the event that the Resource Agencies or FERC determine that additional information, revisions, modifications, or amendments are necessary to the plans, specifications or construction activities, then within 60 days of receipt of written notice, the licensee shall submit to the Department, the Resource Agencies and FERC such information, revisions or amendments unless a longer period of time is approved by the requesting agency or FERC in writing.

1. Submit complete design plans and specifications for a trapping facility at a location downstream of the Muddy Run Project to the Resource Agencies and FERC within one year of license issuance;
2. Hold preconstruction meeting with the Resource Agencies and Service within 150 days of approval of the design plans and designs by FERC, the Resource Agencies and Department;
3. Begin construction within 180 days of receipt of approval of the design plans and specifications by the Resource Agencies and the Department;
4. Begin operation on May 1 after construction is completed or immediately if construction is completed during the upstream passage period for American Eel.

Beginning immediately after license issuance and until the licensee's trapping facilities are completed, the licensee will work with the Service to trap eels using the Service trapping facility and will assist in the financial support of the Service trapping facility through a payment of $20,000 per year to an entity approved by the Department with the capability of providing financial support to the Service's Maryland Fisheries Resource Office for the eel trapping program. This payment will be made by April 1 of each year. Immediately upon license issuance the licensee will participate in this effort using the Service facilities, including the Service trapping facility, tanks and trucks. Beginning May 1 the first year after license issuance, the licensee will use its own holding and transport facilities and continue working with the Service to trap eels using the Service's trapping facility. The licensee will begin operating the program independently, subject to the Service supervision and input, using its own trapping facility when construction of that facility is completed.

Subject to required regulatory approvals, the licensee also will design, install and operate additional temporary eel trapping facilities downstream and upstream of the Muddy Run Project or at alternative locations approved by the Department in writing according to the following schedule, unless an alternative schedule is approved by the Department in writing. In the event that the Resource Agencies, FERC, or the Department determine that additional information, revisions, modifications, or amendments are necessary to the plans, specifications or construction activities, then within 60 days of receipt of written notice, the licensee shall submit to the Department, the Resource Agencies and FERC such information, revisions or amendments unless a longer period of time is approved by the requesting agency or FERC in writing.

1. Conduct field evaluation using visual observation, electrofishing and other methods approved by the Department and the Resource Agencies, in writing, to evaluate and rank trapping locations beginning on 1 May after construction is completed or immediately if construction is completed during the upstream passage period for American eel;
2. Submit complete design plans and specifications to the Resource Agencies by November 1withn the same year as field evaluations occurred;
3. Hold preconstruction meeting with Department and the Resource Agencies within 45 days of approval of the design plans and designs by FERC, and the Resource Agencies;
4. Begin construction within 90 days of receipt of approval of the design plans and specifications by Department and the Resource Agencies;
5. Begin operation by May 1 the year after field evaluations occur.

If, after three years of operation, the Department in consultation with EPAG determines the temporary eel trapping facility is successful, the licensee will design, install, and operate a permanent eel trapping facility at this location in accordance with a schedule established by Department in consultation with the other Resource Agencies.

If, after three years of operation, the Department in consultation with EPAG determines the temporary eel trapping facilities for juvenile eels are unsuccessful, site-determination studies for an additional permanent trap will be performed beginning the following May. Congregations of

juvenile eels will be documented visually via bi-weekly nighttime surveys during the migration period; the locations surveyed will focus on areas that will allow for the collection of eels before they are exposed to impacts associated with the Muddy Run Project (i.e., generation and/or pumping flows). Based on the results of the site-determination studies, the licensee will design, install, and operate temporary mobile traps to inform the potential location of one additional permanent eel trapping facility. Temporary exploratory traps will be installed and operated at up to five locations determined by the Resource Agencies and the Department for a period of one to two additional years, in order to assess the ability to collect sufficient numbers of juvenile eels for the eel passage program. Collection facilities for the temporary site determination study will be similar to those used in the 2011 and 2012 studies conducted by the licensee for the Conowingo Hydroelectric Project.

Based on the results of the site-determination studies, the licensee, in consultation with EPAG, will determine if and where an additional permanent eel trap is justified in support of the Eel Passage Program. If a decision is made after the second site determination study to install an eel trap at the selected location, unless a different date is established by the Resource Agencies and the Department, that trap will be designed and constructed within one year of that determination, and operated beginning May 1 of the following year subject to required regulatory approvals. If a second year of study is needed, the dates would advance by a year.

The collection device(s) for the two permanent eel trapping facilities will consist of a ramp-style trap leading to a collection tank at the top of the ramp. The collection device(s) shall have a capacity to pass 50,000 eels over a 24 hour period accommodating a minimum size of 3 inches. One or more pumping systems will provide attraction flow at the entrance of the ramp, flow in the troughs to allow eels to climb the ramp, and water to the collection and holding tanks. The lower section of the ramp will be designed to have removable covers or grating to allow eels to enter at differing water surface elevations. The ramp will contain two side-by-side troughs to provide redundancy and allow for the potential use of different climbing media in each trough. For the ramp on the western shore, the entrance to the ramp will be designed to accommodate the normal range of tailwater elevation (El. 12 – 25 ft). The additional permanent collection facilities will contain elements of the facility on the western shore with the design modified to accommodate local conditions.

The trapping facilities will be operated continuously during the eel migration period from May 1 to September 15. The licensee will monitor and record days fished, hours fished and the weather. Daily counts of eels will be recorded. The method of counting under various capture scenarios will be developed in consultation with the EPAG. Temperature data will be obtained from Monitoring Station 643 (located approximately 0.6 miles below Conowingo Dam near the western shoreline) to examine river temperature in relation to catch rates of juvenile eels. Biweekly subsamples of collected eels will be examined for various life history parameters (e.g., length, weight, and condition factor). A portion of the subsampled eels will be sacrificed and examined for the presence of *Anguillicoloides crassus*. Some of the sacrificed eels will have the otoliths removed and retained for age analysis. *Anguillicoloides crassus* infection rates (proportion of eels infected), the number of parasites per eel, along with associated age, length, and weight data will be reported. Additionally, the licensee will pay to have 60 elvers/year sent to the Service or such other entity that the Department may approve in writing, for wild fish

health screening. The screening shall occur once per year and can occur anytime during the eel upstream passage season.

Holding

Subject to required regulatory approvals, the licensee also will design, install and operate the holding facility for the traps according to the following schedule, unless an alternative schedule is approved by the Department in writing. In the event that the Resource Agencies, FERC, or the Department determine that additional information, revisions, modifications, or amendments are necessary to the plans, specifications or construction activities, then within 60 days of receipt of written notice, the licensee shall submit to the Resource Agencies and FERC such information, revisions or amendments unless a longer period of time is approved by the requesting agency or FERC in writing.

1. Submit complete design plans and specifications for holding facilities to the Resource Agencies within 1 year of license issuance;
2. Hold preconstruction meeting with Department and Service within 150 days of approval of the design plans and designs by FERC, Department and the Resource Agencies;
3. Begin construction within 180 days of receipt of approval of the design plans and specifications by Department and the Resource Agencies;
4. Begin operation by May 1, after construction is completed or immediately if construction is completed during the upstream passage period for American eel.

Periodically, consistent with standards established by the Department, and the Resource Agencies, eels will be transferred from the collection tank to the holding tank(s) where they will be held prior to being transported upstream. The holding tanks will have an automatically engaging back up pump and an alarm that sounds in a daily staffed location if the primary pump malfunctions. The holding tank will have continuous temperature, dissolved oxygen and gallon/minute water exchange monitoring devices with alarms that sound in a daily staffed location if levels of any parameter are outside of established limits. Upon observation, dead eels will be removed, enumerated, and reported. The holding tank shall be designed and operated to hold eels at densities not exceeding 10 elvers per liter unless modified by the Department in consultation with the other Resource Agencies. If necessary, aeration will be provided to the holding tanks

Transport

Subject to required regulatory approvals, the licensee will design, construct and operate vehicle(s) to transport eels from the trap facilities according to the following schedule, unless an alternative schedule is approved by the Department in writing. In the event that the FERC, the Resource Agencies, or the Department determine that additional information, revisions, modifications, or amendments are necessary to the plans, specifications or construction activities, then within 60 days of receipt of written notice, the licensee shall submit to the Resource Agencies and FERC such information, revisions or amendments unless a longer period of time is approved by the requesting agency or FERC in writing.

1. Submit complete design plans and specifications to the Resource Agencies and FERC within one year of license issuance;
2. Begin construction within 180 days of receipt of approval of the design plans and specifications by the Department and the Resource Agencies;
3. Begin operation by May 1, after construction is completed or immediately if construction is completed during the upstream passage period for American eel.

Transport of juvenile eels will occur as necessary based on the capacity of holding tanks at the eel trapping facilities. All eels shall be moved within 1 week of capture. Eels from the holding tank(s) will be transferred to a transport vehicle equipped with an insulated transport container(s) that will be covered and aerated. The transport vehicle(s) will have an automatically engaging back up pump and an alarm that sounds in the cab of the vehicle(s). The transport vehicle taken will have continuous temperature and dissolved oxygen monitoring devices with alarms that sound in the vehicle(s) if levels of any parameter are outside of established limits. The transport vehicle(s) shall be designed and operated to hold eels at densities not exceeding 10 elvers per liter unless modified by the Department in consultation with the other Resource Agencies. If necessary, aeration will be provided to the holding tanks on the transport vehicle(s). These eels will be trucked to appropriate release locations on the same day of removal from holding. Upon observation, dead eels will be removed, enumerated, and reported.

Release

The licensee will release eels at locations identified by the Department in amounts consistent with the release information provided to and approved by the Resource Agencies in writing. Where feasible, eels will be released at public access locations. Unless otherwise directed by the Resource Agencies in consultation with EPAG, eels will be released: (1) at least one hour after sunset to promote eel dispersal and minimize predation; and (2) into at least three feet of water at multiple locations within designated release areas in order to avoid concentrations of eels that could become potential targets for increased predation. If necessary due to time limitations established by the Resource Agencies in writing, the licensee shall release eels at alternative locations to avoid mortality. The estimated number of eels released at each location will be documented in writing and on a GPS device capable of being mapped in a database as approved by the Resource Agencies. After release, any dead eels remaining in the transport vehicle or observed at the stocking locations will be removed, enumerated, and reported.

Any modification of, or revisions to, the release locations shall occur after consultation with EPAG and consistent with the approval of the Resource Agencies.

Quality Assurance/Quality Control

The licensee will develop a detailed quality assurance/quality control ("QA/QC) program according to the following schedule, unless an alternative schedule is approved by the Department in writing. In the event that the Resource Agencies, or the Department determine that additional information, revisions, or amendments are necessary to the QA/QC program then within 60 days of receipt of written notice, the licensee shall submit to the Resource Agencies

and the Department such information, revisions or amendments unless a longer period of time is approved by the requesting agency in writing.

1. Submit a draft QA/QC program to the Resource Agencies for approval by April 15, of the year in which a new license is issued;
2. Implement the QA/QC program approved by the Department when trapping and transport begin.

Important parameters associated with trapping, collecting, holding, transport, release, and stocking will be recorded to assure and control the quality of various program elements. The collection of these data will assure that the program will be conducted according to design parameters, will adhere to sound scientific principles, and will allow for any necessary adjustments. The results of these quality assurance and quality control measures will be included in annual reports to the Resource Agencies and EPAG. Changes to the QA/QC procedures shall be submitted as requested by the Department, or the Resource Agencies in writing.

At a minimum, the QA/QC program shall provide:

- Detailed description of the eel trapping and holding process to achieve a minimum 95% survival rate.

- Detailed description of the eel transport process to achieve a minimum 95% survival rate.

- Collection facilities will be visually inspected daily to ensure proper operation.

- Design parameters for flows and key critical components (e.g. attraction flow, spray bar, collection tank) that will be measured weekly and qualitatively assessed daily to ensure that traps are operating within design parameters.

- Water temperature and dissolved oxygen and water exchange in the collection, holding, and transport tanks will be monitored continuously to ensure that water quality remains suitable for juvenile eels.

- Information on the periodic checks on the accuracy of the estimates of volumetric counts.

- Information on the cleaning and disinfection of the collecting, holding, and transportation tanks.

- Protocols for monitoring, removing, enumerating, and reporting eel mortality.

Reporting, Monitoring, and Periodic Evaluation

Reporting and EPAG Meetings

During the eel passage season, the licensee shall provide a daily email to designated members of EPAG describing the status of trapping and trucking at each facility, the numbers of eels trapped and transported, any deviations from normal facility operations, and the timing and substance of the resolution of any deviations.

On or before December 10 annually, the licensee will submit a report to EPAG summarizing data from the trapping, collection, holding, transport, and stocking components of the Eel Plan for the calendar year. This report will provide program data to EPAG at the earliest practicable date, and provide EPAG with an opportunity to inform development of the Annual Report. On or before January 15 of the following year, the licensee will file an Annual Report with EPAG that analyzes annual data, including results from QA/QC.

Upon request, the licensee will meet with EPAG on or before February 15 of each year in which the Annual Report is filed.

Periodic Evaluation

Every three years, unless a different period is established by the Department in writing beginning in in the year following issuance of a new license, the licensee will conduct stream segment evaluations through electrofishing or other method identified after consultation with EPAG. Representative stream segments will include tributaries and shorelines of the main-stem river. The licensee will propose locations and methods for this survey at least one year in advance to the Resource Agencies. The licensee shall implement the survey based on approval of the Department of the proposed locations and methods.

To implement the evaluations, eels will be captured by electrofishing, or other methods approved by the Department in consultation with the Resource Agencies. Sampling will be performed at block-netted transects along river shorelines and at block-netted segments of small tributaries using backpack electrofishing. The exact number, length, and location of transects sampled will be approved by the Department in consultation with EPAG. Associated water quality parameters such as temperature and dissolved oxygen, as well as habitat characteristics, including mussel numbers observed, will be collected at each sampling location.

During sampling, the number of eels captured will be documented and data will be collected from a representative subsample of eels. A subsample of captured eels larger than 200 mm will be tagged with Passive Integrated Transponder (PIT) tags and released. Sampled eels will be scanned for PIT tags and data from recaptured eels will be recorded and included in the annual report. Data will include a variety of life history characteristics (e.g., length, weight, and condition factor) that can be assessed to determine how well stocked eels are utilizing the river and tributaries. A portion of the subsample will be sacrificed and examined for age (otolith analysis), gender, and level of *Anguillicoloides crassus* infection. Eels that are not sacrificed for further analysis will be measured, weighed, and released.

Results of stream segment evaluations will be included in the Annual Report and will document dispersal of the stocked eels, estimate the approximate density of stocked eels, and evaluate the

growth, condition, age, gender and level of infestation with *Anguillicoloides crassus* of stocked eels.

Downstream Eel Passage Monitoring

Licensee shall conduct of a downstream eel passage study to evaluate the timing, magnitude, duration, annual variation and environmental conditions associated with active migration of silver eels from tributaries stocked with elvers, through the lower Susquehanna River and past the Muddy Run Project to the Chesapeake Bay. This study will be conducted for at least two years and will begin three years after license issuance. The licensee shall submit a draft study plan for Department review and approval within one year of license issuance. The plan shall include details of how licensee will collect and radio tag adult silver eels from the upper Susquehanna Basin for this study. The plan will also detail how the licensee will deploy radio telemetry monitoring equipment in the vicinity of Muddy Run Project so as to adequately track movement of radio tagged eels through the project area.

Concurrently with the downstream eel passage study or at a later date as approved by the Department, the licensee will also conduct a Site-Specific Route of Passage Study to evaluate the entrainment rate of silver eels migrating in the vicinity of the Project. If the results of the Site-Specific Downstream Eel Passage Study indicate that the Project's existing operating measures do not meet the downstream passage criteria (survival of 85% of silver eels passing the Project), the Licensee will prepare and submit a plan and schedule for evaluating the feasibility and costs of potential physical and/or operational modifications to the Project to facilitate downstream eel passage.

Correspondence Regarding the Preliminary Prescription for Fishways

Any written inquiries, comments or other correspondence related to this Preliminary Fish Passage Prescription for the Muddy Run Project should be sent to:

Field Supervisor, Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

Appendix 1. Scientific Names

American eel (*Anguilla rostrata*)
American shad (*Alosa sapidissima*)
alewife (*Alosa pseudoharengus*)
blueback herring (*Alosa aestivalis*)
hickory shad (*Alosa mediocris*)
Alabama shad (Alosa alabamae)
gizzard shad (*Dorosoma cepedianum*)
shortnose sturgeon (*Acipenser brevirostrum*)
Atlantic sturgeon (*Acipenser oxyrhynchus*)
striped bass (*Morone saxatilis*)
walleye (*Stizostedion vitreum*)
smallmouth bass (*Micropterus dolomieu*)
channel catfish (*Ictalurus punctatus*)

Appendix 2. Administrative Record

The Administrative Record is being filed electronically under a separate cover due to its size.

APPENDIX F

Preliminary Fishway Prescription – Conowingo Hydroelectric Project

7. Statutory Authority

Section 18 of the Federal Power Act, 16 USCS §811, states in pertinent part:

> *The Commission shall require the construction, maintenance and operation by the Licensee at its own expense of such fishways as may be prescribed by the Secretary of Commerce or the Secretary of the Interior.*

Section 1701(b) of the National Energy Policy Act of 1992, P.L. 102-486, Title XVII, §1701(b), 106 Stat. 3008, states:

> *The items which may constitute a 'fishway' under section 18 [16 USCS §811] for the safe and timely upstream and downstream passage of fish shall be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and project operations and measures related to such structures, facilities or devices necessary to ensure the effectiveness of such structures, facilities, or devices for such fish.*

8. Alternatives Considered

The Service's Fish Passage Engineers (R5 FPE) examined seven alternative designs for the Conowingo Hydroelectric Project (Project) and created a matrix for selection and comparison purposes (USFWS 2013g). The seven alternative design concepts described in section 8.2 are based on existing fish passage facilities found acceptable to pass significant numbers of American shad in large rivers (>1000 square mile drainage areas). The selection of the alternative concepts below was made on the basis of improving fish passage efficiency and capacity only. Service engineering efficiency reviews showed delay to be a critical issue. This concern is validated by the 2010 and 2012 radio-telemetry study which revealed that passage efficiency was 10% and 0% within the 36 hour timeframe for the 2010 and 2012 studies, respectively (USFWS 2013a). Regarding fishway capacity in general, fishway passage capacity is a measure of the quantity of fish (typically expressed in adult shad-equivalent) that the facility is designed to successfully convey, upstream or downstream, in a given period. It is distinct and separate from fishway hydraulic capacity.

Early field and design fish passage engineering reviews (USFWS 2012a and 2012b) determined that a critical issue with the existing EFL is insufficient lift capacity (even with expanded or larger hoppers) to meet the restoration goals for the American shad (approximately 5 million American shad past Conowingo to yield 2 million upstream of York Haven Dam given less than 100% passage at all other hydroelectric facilities). In order to address this issue, R5 FPE has identified seven design alternatives that would increase passage capacity, while also enhancing other aspects of fish passage. Sequencing of construction is considered a tool to track and meet the performance of the anticipated population growth curve and was not used in the alternatives analysis since the incremental improvements are of little consequence if the final product does not meet the restoration plan goals.

8.1 Common To All Alternatives

There are certain elements common to all alternatives considered, primarily the design populations, operational periods, effectiveness testing, and eel passage, addressed below.

8.1.2 Design Criteria

8.1.2.1 American Shad Weight

The Service standard for American shad weight in fish passage capacity designs is four pounds and has been used for over 30 years on Atlantic Coast. Fish passage design is not developed for the "average" size fish, but rather must be more conservative in approach to accommodate for larger individuals within the population. In addition, American shad stocks have been heavily impacted in recent years by a variety of sources which have decreased the age and size structure compared to a healthy population (ASMFC 2007, Volume I). When designing fish passage projects, we need to anticipate the population as a restored and healthy population and not the current depleted state.

Regional data from American shad in both the Susquehanna River Flats and the Delaware River support the 4-pound design criteria when accommodating larger fish that occur in the system. Using the Delaware River shad data as a comparison to the Susquehanna River shad is appropriate because the Delaware River is geographically close, so it is fair to assume that the population demographics would be similar in size of individuals and frequency of repeat spawners. The Delaware River is also an appropriate comparison because the shad population is not impacted by mainstem dams, as with the Susquehanna River population. Because the situation warrants designing fish passage for the larger than average fish, we used the 95th percentile of American shad weights in regional datasets to support our use of the 4-pound standard in considering design and capacity of Susquehanna River fish passage facilities (Table 1). Such large fish are disproportionately valuable to the population, being exclusively female and with a high proportion of repeat spawners that have high fecundity (ASMFC 2007, Volume I).

Table 1. American Shad Weight for Fish Passage Capacity Design

Location	Average (lbs.)	95th Percentile (lbs.)
Susquehanna Flats[1]	2.34	3.17
Upper Delaware River[2]	2.55	4.03
Lower Delaware River[3]	3.71	5.97

[1]Data from Maryland Department of Natural Resources, Susquehanna Flats surveys from 2009-2013
[2]Data from the USFWS Delaware River Coordinaor, unpublished data on the Upper Delaware River American shad collections from 2009-2013
[3]Data from the USFWS Delaware River Coordinator, Delaware River Lewis Haul Seine Fishery from 1997-2006

8.1.3 Design Populations

8.1.3.1 American Shad

Under all action alternatives, fish passage needs to be adequate to maintain self-sustaining annual populations of 2 million American shad migrating up to and reproducing in the free-flowing Susquehanna River upstream of York Haven Dam and in suitable tributaries. In order to attain 2 million American shad upstream of York Haven Dam, at least 5 million shad will need to pass Conowingo Dam given that fish passage at other hydroelectric projects is less than 100%.

8.1.3.2 River Herring (Alewife and Blueback Herring)

Under all action alternatives, fish passage needs to be adequate to maintain self-sustaining annual populations of 5 million river herring, migrating up to and reproducing in the free-flowing Susquehanna River above York Haven Dam and in suitable tributaries. In order to attain 5 million river herring upstream of York Haven Dam, at least 12 million herring will need to pass Conowingo Dam given that fish passage at other hydroelectric projects is less than 100%, and assuming that dams have the same passage efficiency for herring as they do for shad.

8.1.3.3 American Eel

Under all action alternatives, fish passage needs to be adequate to pass all available upstream migrating eels that arrive to Project into the mainstem of the Susquehanna River above the York Haven Dam. Downstream migration of adult eels must be safe, timely and effective, achieving an 85% survival rate past the Project.

8.1.4 Scheduling

Timely construction, operation, and maintenance of fishways is necessary to ensure their effectiveness and to achieve restoration goals. Therefore, all action alternatives would include the express requirement that the Licensee (1) notify, and (2) obtain approval from the Service for any extension to comply with conditions the Department may prescribe. Under all action alternatives, fishways would have to be maintained to maximize fish passage effectiveness throughout the upstream and downstream migration periods for American shad, alewife, blueback herring, American eel, and associated riverine fish.

Fishway for upstream passage of anadromous fish would be operated daily during the American shad and river herring upstream migration season. Daily operation of the WFL and the EFL would be from dawn to dusk until water temperature surpasses 21oC for three consecutive days. Fish lift operations will start March 1 or when river surface temperatures reaches 48oF (9oC), whichever occurs first, in order to accommodate the earliest migration of anadromous fish. Fish lift attraction flow will operate continuously during the fish passage season to provide upstream migration cues at the fishway entrance and minimize delays at the start of each passage day. Fish lifts would have to be repaired and maintained as necessary in advance so as to begin operations when required.

Fish passage facilities for upstream passage of catadromous fish would be operated 24 hours per day during periods as provided in Table 2, below.

Table 2: Upstream and downstream migration periods for species covered in this Preliminary Prescription for Fishways. *

Species	Upstream Migration Period	Downstream Migration Period
American shad	April 1 through June 15	July 1 through November 15 (juv.) April 15 through July 1 (adult)
Alewife & blueback herring	March 1** through June 15	June 15 through October 14 (juv.) April 15 through July 1 (adult)
American eel	May 1 through September 15 ***	September 15–February 15, whenever river temperature is above 37 degrees F ****

* Any of these migration periods may be changed during the term of the license by the Department, based on new information, and in consultation with the other fishery agencies and the Licensee.

** This operational period is based on alewife migration timing from other tributaries to the Chesapeake Bay (Sutherland 2000, Eyler et al. 2002, Slacum et al. 2003).

***This initial operational period is based on preliminary data on American eel migration at Conowingo Dam (SRAFRC 2013a).

**** The Department is calling for the Licensee to study the magnitude and timing of downstream eel migration through the project so that the effectiveness of a reduced period can be evaluated. This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay (Welsh et al. 2009).

8.1.5 Fishway Operating Procedures

Under all action alternatives, within 12 months of license issuance, the Licensee would have to develop a Fishway Operation and Maintenance Plan (FOMP) and submit it to the Resource Agencies for review and approval. The FOMP would address regular maintenance activities as well as emergency procedures for fish passage. The Licensee would meet on an annual basis with the Service and the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) to discuss the FOMP. This meeting would occur no later than January 15 each year. This meeting is a continuation of the traditional SRAFRC Fish Passage Technical Committee (FPTC) meetings with the dam owners on the river to review the FOMP, fish passage results from the previous year and expectations for fish lift/fishway operations for the upcoming season. Participants at these meetings include: staff from the states of Maryland and Pennsylvania, Susquehanna River Basin Commission, National Marine Fisheries Service and the Service.

The FOMP will include, for each fishway, schedules for routine maintenance, procedures for routine operations (including: seasonal and daily periods of operation, dam and powerhouse

operational measures) detailing with how the plant shall be operated during the fish passage season, including: sequence of turbine start-up and operation; debris management; plant operations to provide near- and far-field attraction flows required for optimum fish passage; standard operating procedures for monitoring and reporting on operations that affect fish passage; and standard operating procedures in case of emergencies and project outages to first, avoid, and second, minimize, negatively affecting fishway operations and the effectiveness of upstream and downstream passage of target species life stages.

The Licensee would have to provide written documentation to the Resource Agencies that all fishway operational personnel have reviewed and understand the FOMP signed by the operations manager of the Project.

Copies of the approved FOMP and all modifications would have to be provided to the Resource Agencies.

By December 15 of each year following issuance of a new license, the Licensee would provide an annual report to the Federal and state resource agencies memorializing implementation of the FOMP. If there were deviations from the FOMP, they and measures to avoid those deviations in the future would be described. The report would contain any proposed modifications to the FOMP. If there are emergencies or project outages, the report would include steps taken to avoid adverse effects on fishway passage, and how the effectiveness of those steps could be enhanced. The Licensee would meet with the state and Federal resource agencies by January 31 of each year unless a different date is mutually agreed upon by the Licensee and the state and Federal resource agencies. Modifications to the FOMP requested by the Service would be submitted to the state and Federal Resource Agencies for their review within 30 days of receipt of it being requested unless a longer period is approved by the Service. The modifications to the FOMP would be implemented consistent with the approval of the Service.

For fish passage measures that do not begin operation upon license issuance, 60 days prior to operation of the enhancements and/or facilities, Conowingo Project would have to submit FOMP provisions for any such new fish passage enhancements, facilities and measures to the Resource Agencies for review and approval and shall implement the FOMP as approved by the Service.

8.1.6 Eel Passage

Under all action alternatives, a trap and truck (T&T) facility for American eels would be constructed on the west side of the river no later than one year after the completion any WFL construction, or within a year of license issuance under any action alternatives not involving reconstruction of the WFL. Volitional eel passage would be implemented by 2030. The specific location for collecting eels to T&T, the location of a permanent volitional eel passage, and other design criteria would be approved by the Service following consultation with the Licensee and Maryland Department of Natural Resources. Eel T&T activities would continue through 2029, switching to volitional passage in 2030. The eel passage facility would be operated continuously (24 hrs/day), during the American eel upstream migration season. Eels would be stocked at locations in the Susquehanna River Basin with the prior approval of the Service and respective state resource agency and consistent with the SRAFRC American Eel Restoration Plan.

This requirement would be included because the Susquehanna River Anadromous Fish Restoration Cooperative American Eel Restoration Plan (SRAFRC 2013b) calls for providing an upstream T&T program from Conowingo to various locations in the Susquehanna River Basin above Conowingo Dam for juvenile (elver) American eel. The goal of the plan is to ensure that every American eel that approaches Conowingo Dam is passed upstream into the Susquehanna River Basin in order to restore American eels to the watershed, to provide a net increase of out-migrating American eel, and restore the ecosystem functions provided by healthy American eel populations, including their role as predator and prey as well as acting as hosts for the glochidia of Elliptio complanata.

All action alternatives would further require the Licensee to evaluate potential trapping locations for American eel on the east side of Conowingo Dam or Octoraro Creek starting in May the first calendar year after license issuance or immediately if license issuance occurs during the American eel upstream migration period. By May 1 of the second calendar year after license issuance, the Licensee would be required to install and operate temporary T&T facilities for American eel at the eastern location. A permanent T&T facility for American eels on an eastern location would be required within 5 years of license issuance, with the location of a permanent eelway and other design criteria to be approved by the Service following consultation with the Licensee and the respective state resource agency. T&T activities at the eastern location would continue through 2029, with stocking locations throughout the Susquehanna River Basin as indicated above. In 2030, T&T operations would continue with stocking exclusively into Conowingo Pool. The eel passage facility would be operated continuously (24 hrs/day), during the American eel upstream migration season.

This requirement would be included because American eels approach the dam along both sides of the river and are not likely to cross the dam face (no crossing of eels was documented by Park and Minkkinen 2010 or Exelon 2011b. This second collection location is necessary to collect elvers that may be traveling up the east side of the Susquehanna River.

8.1.7 Effectiveness Monitoring

All action alternatives would require the Licensee to develop a Fishway Effectiveness Monitoring Plan (FEMP) in consultation with the USFWS and submit it to the FERC for approval within 6 months of license issuance. The FEMP would consist of:

8.1.7.1 Plan for Post-Construction Efficiency Testing of Project Fishways

Post-construction efficiency testing of the Project facilities for adult upstream-migrating American shad and juvenile American eel would be conducted after any significant changes in project structures or operations are made during the term of the license. This would include both radio-telemetry studies of passage effectiveness and a post-licensing computational fluid dynamics (CFD) model study of the tailrace to investigate permutations in the operation of the eleven turbines to identify which combinations improve fish passage conditions in the tailwater at the rebuilt fish lifts. The existing tailrace condition has been documented to cause delay of migratory fish attempting to locate the entrances to the fish trap and fish lift (Exelon 2011a and 2012c). American shad, in particular, are easily disoriented by the turbine boils and tailwater conditions. Similar delay conditions have been addressed at Safe Harbor, through adjustments in turbine operations and continuous monitoring of fish passage conditions. A CFD model study

will also provide important information to be used during the license term to refine fish passage measures.

8.1.7.2 Plan for Effectiveness Testing for Juvenile American Shad and Adult American Eel

Additional turbine survival studies should be conducted to ensure that any changes in structure or operation as a result of relicensing continue to meet the Plan goal for juvenile American shad survival of 95%. Juvenile shad studies will incorporate route of passage and passage efficiency through the Project impoundment as well as through the Project itself.

American eel studies will determine the timing of downstream migration, route of passage at the Project, and turbine specific injury and mortality rates for the Project. Survival past the Project must meet the Plan goals of 85% survival for adult American eels. We would also require that turbine mortality studies be done to determine both immediate and latent mortality and injury to migrating adult eels that has not yet been evaluated at this project. American eels collected from the Susquehanna River should be used in all future studies to ensure that the timing of migration is not altered by transferring eels from another basin and that eels used in studies are of representative size of what is migrating out of the river.

In the event Exelon is unable to achieve the downstream passage and survival goals for juvenile American shad and adult American eels, the next step will be to evaluate changes in operation and fish guidance systems to provide safe, timely and effective downstream fish passage. Fish guidance systems have been reviewed and the Service developed a presentation on this topic (USFWS 2013d).

By December 15 of each year, the Licensee would have to provide an annual report detailing; the implementation of the FEMP, including any deviations from the FEMP. The Licensee would have to meet with the Resource Agencies by January 15 of each year unless a different date is mutually agreed upon by Conowingo Project and the Resource Agencies. Any required modifications to the FEMP would have to be submitted to the Resource Agencies within 30 days of receipt of a request for the modification unless a longer period is approved by the Service. The modifications to the FEMP would have to be implemented consistent with the approval of the Service.

8.2 Engineering Alternatives

8.2.1 Engineering Alternative A: East Fish Lift (EFL), 1/2 Gallery & Kaplan Mods

Engineering Alternative A is defined by the following upgrades to the EFL in order to increase the number of fish capable of being passed (hereafter termed “passage capacity”). Upgrades include reductions in the lift cycle time, construction of a second and larger hoppers designed to operate simultaneously with the existing one, additional entrance locations provided by the half gallery, and modifications to the Kaplan’s discharge flow (allowing for a more attractive entrance signal).

Service calculations demonstrate that two 6,500 gallon hoppers do not offer sufficient capacity to effectively transfer 5 million American shad (the number of fish required within a single season to achieve sustainable restoration in the Susquehanna River) upstream of the Conowingo Dam (USFWS 2013e). The Service also predicts that the aforementioned alternative will not achieve 80% passage efficiency (of the available American shad located in the tailrace) within a timeframe of 36 hours or less mainly due to the expected recurrence of observed delays from previous studies.

Existing data also suggest that fish might be approaching the Project closer to the west bank of the tailrace, away from the Kaplan's discharge and the proposed half gallery (MDNR 2013, Exelon 2011a, 2011c and 2012c). Modifications to the Kaplan's discharge could only be considered as an experimental approach, because the modifications have not been tested at other projects in the Northeast. This alternative lacks the significant improvements the Service considers to be needed at the West Fish Trap & Transport Facility in order to provide effective trapping of 50,000 American shad annually. Restoration goals rely heavily on a successful trap & transport program at the Conowingo project (Pugh 2013) and therefore improvements are warranted.

8.2.2 Engineering Alternative B: EFL, Full Gallery & No Kaplan Mods

Engineering Alternative B proposes upgrades to the EFL that would increase passage capacity. This would be accomplished via reductions in the lift cycle time as well as a second hopper designed to operate simultaneously with the existing one. This alternative recognizes discharge from the Kaplan turbines as a longitudinal barrier and resolves it by providing a full collection gallery to minimize delay. Additional entrance locations provided by the full gallery are considered in this alternative for the purpose of enhancing attractive entrance signal and improving passage efficiency. The additional entrance locations minimize the turbine turbulence issue to attract and pass more fish.

This alternative shares the deficiencies of Engineering Alternative A, and also lacks the significant improvements at the West Fish Trap & Transport Facility and the possible increase in effectiveness or efficiency from the lengthened gallery is still limited by the insufficient lift capacity as the main cause for rejection.

8.2.3 Engineering Alternative C: East Fish Lock & 1/2 Gallery

Engineering Alternative C would address the issue of insufficient capacity under the current super structure by construction of a fish lock to provide additional capacity and avoid the need for sorting gizzard shad at the Project. Fish locks work similar to fish lifts in attracting fish through a collection gallery and crowding them at a holding pool before moving them over the dam. The main difference between these two technologies is the mechanism the lock uses to move the fish up into the exit channel. Instead of using a hopper (or bucket), a lock produces a column of water that starts at the tailwater elevation and rises to the head pond elevation. This method of elevating the fish upstream of the dam represents less stress on the migrating fish by handling them in a more benign way. The half collection gallery would serve as a channel into the holding pool of the lock.

The capacity of a lock is driven by the capacity of the holding pool, which means that renovations for the existing entrance channel would still be warranted. The Service also predicts that the aforementioned alternative will not achieve 80% passage efficiency (of the available American shadlocated in the tailrace) within a timeframe of 36 hours or less for the same reasons cited in Engineering Alternative A.

8.2.4 Engineering Alternative D: EFL, 1/2 Gallery, Kaplan Mods & Sorting

Engineering Alternative D proposes upgrades to the EFL to increase fish passage capacity. This would be accomplished via reductions in the lift cycle time as well as a second hopper designed to operate simultaneously with the existing one. Additional entrance locations provided by the half gallery and modifications to the Kaplan's discharge flow (allowing for a more attractive entrance signal) are considered in this alternative for the purpose of enhancing passage efficiency. The fish sorting would try to differentiate between the American shad and the gizzard shad. Preventing gizzard shad from entering the EFL hoppers would reduce the clogging in the EFL, increase the overall capacity for American shad, and improve passage efficiency.

The one difference with this alternative relative to A, B, and C is the element of sorting which the Service does not consider to be adequate to increase the capacity enough to meet the restoration goals. Both the modifications to the Kaplan's discharge and the fish-sorting could only be considered as experimental approaches. The difficulty with effectively discerning a gizzard shad from an American shad lies in the strong similarities between these. The two species share almost identical migration periods, the average size of their migrants are not noticeably apart, and their swimming speed capabilities are comparable. Sorting out gizzard shad could also result in sorting out target species, like river herring.

8.2.5 Engineering Alternative E: Kaplan Draft Tubes Extension, EFL, 1/2 Gallery & Complete WFL

Engineering Alternative E also proposes upgrades to the EFL to increase fish passage capacity. This would be accomplished via reductions in the lift cycle time as well as a second hopper designed to operate simultaneously with the existing one. Additional entrance locations provided by the half gallery are recommended for the purpose of enhancing passage efficiency. The Kaplan draft tubes extension would move the turbulent boil downstream and away from the EFL entrances. The Service expects the extensions to enhance passage efficiency. The complete WFL would provide volitional access to shad sounding in the western side of the power house. The Service is confident that this alternative would improve fish passage efficiency to 80% within a timeframe of 36 hours or less. The newly renovated WFL would also include a trap and transport facility. Sustainable restoration goals rely heavily on a successful trap & transport program at the Conowingo project and therefore improvements are warranted (MDNR 2013).

The main cause for rejection is the expected high cost and experimental nature of the extension of the Kaplan draft tubes.

8.2.6 Engineering Alternative F: EFL Entrances Relocation, 1/2 Gallery & Complete WFL

Engineering Alternative F upgrades to the EFL would also increase fish passage capacity. This would be accomplished via reductions in the lift cycle time as well as a second hopper designed to operate simultaneously with the existing one. Existing entrances A and B will be relocated in such a way to avoid the boil in front of the Kaplan units (USFWS 2013d). Access to entrance A will be available along the catwalk, through the area behind the piers, similar to the configuration at the Safe Harbor project. The relocation of entrance A will make it functional again (it currently gets drowned by the discharge of the Kaplan's). Additional entrance locations provided by the half gallery are considered in this alternative for the purpose of enhancing passage efficiency. A new and complete WFL would provide volitional access to migratory shad sounding in the western side of the power house. The newly renovated WFL would also include a trap and transport facility. Sustainable restoration goals rely heavily on a successful trap & transport program at the Conowingo project and therefore improvements are warranted.

8.2.7 Engineering Alternative G: Phased WFL and EFL improvements

8.2.7.1 Phase I

Item #1 - West Fish Lift - Construct a new fish lift in the west corner of the powerhouse tailrace by 2017. The West Fish Lift (WFL) would operate as a tailwater to headpond fish-lift, and as a trap-and-truck (T&T) fish passage facility. The new WFL would include two 6,500 gallons hoppers to move fish simultaneously. The modern T&T facility will be capable of safely and effectively accommodating at least 50,000 American Shad per year and available river herring. Captured fish would be trucked and released into the Susquehanna River at Exelon's Three Mile Island Nuclear Power Plant (TMI), or another river access point upstream of TMI. Trap-and-truck activities would continue through the life of the license or until the Service determines the activity has met management needs. Initial fish passage efficiency testing American shad and river herring at 80% efficiency within 36 hours and/or at an average seasonal efficiency of 85% will begin following construction of the WFL.

Construction of the WFL is considered essential to achieve the timely restoration of fish passage targets presented in the Susquehanna River's Migratory Fish Management and Restoration Plan (Plan) for the Susquehanna River Basin in 2010 (SRAFRC 2010). Significant fish passage improvements are considered necessary at the Conowingo Hydroelectric Project (Project) to achieve restoration passage goal of 80% effectiveness for upstream passage in 36 hours or less (85% total) of American shad and river herring. In the 2010 radio-telemetry study for American shad upstream passage, only 10% of the available American shad passed within 36 hours or less from the time at which each fish crossed the downstream boundary of the Project's tailrace (USFWS 2013a). The conceptual design calculation gives the sizing calculation that explains why the WFL should be built with two 6,500 gallons hoppers operating simultaneously (USFWS 2013c and 2013e).

Simulations of the American shad population via modeling (Exelon 2012b), showed notable fish population benefits from a T&T program, especially during the first 10 to 15 years of restoration (Pugh 2013). Without a T&T facility transporting American shad upstream the York Haven Power Company dam, the shad model indicates restoration will take longer. If 50,000 American

shad are captured and transported upstream of the York Haven project in a single season, the more likely it will be to achieve sustainable restoration during the license term. Having the WFL serving as both a T&T facility and a full-lift will help avoid the gizzard shad recycling issue that is currently an obstruction to passage and keeping American shad from ever entering and using the facility.

Item #2 - Auxiliary Water System (AWS) - The WFL would provide at least 3% of hydraulic capacity of the Project (2,600 cfs) for attraction flow. WFL attraction flow would be provided continuously (24/7) during the anadromous fish migration season. Continuous daily flow can be reduced to specific hours based on the results of effectiveness testing.

Construction of an AWS is necessary to meet the attraction water criteria and build in the increased efficiency needed to complete the restoration and meet the Project's fish passage goals. The prescribed attraction flow is in conformance with Service design standards, which require a minimum of 3% of the powerhouse turbine capacity emanating from the entrances of the fishway and hydraulically connected crowder/hopper system (USFWS 2013b).

Item #3 - Provide a zone of passage to the lift facilities – The Licensee would modify the 5,000-foot section of the east and west banks immediately below the powerhouse to provide a contiguous zone of passage to the lift facilities. The zone of passage will meet the biological needs and performance capabilities of American shad and river herring.

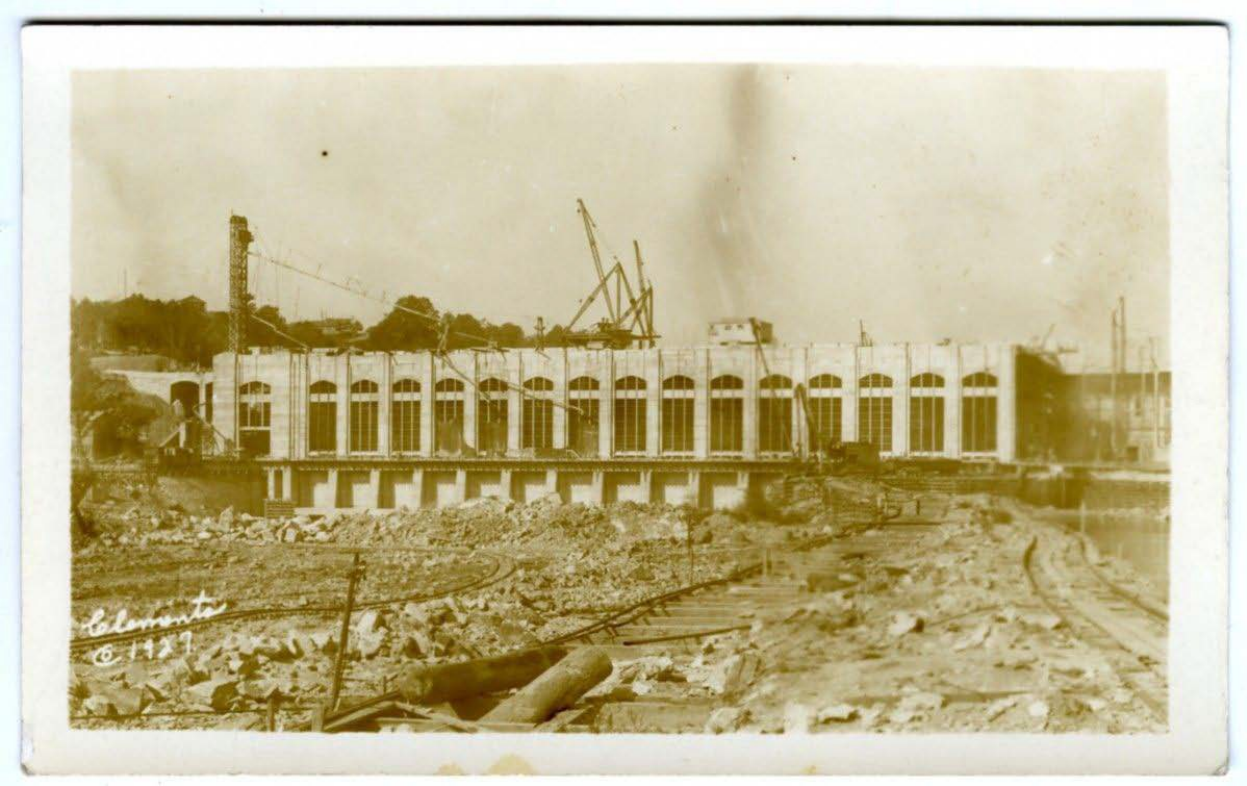

Figure 3. Conowingo Dam Construction in 1927 (Footnote 2).

The zone of passage is an integral element in the overall effectiveness of the fish lifts and is

considered a part of the fishway(s). This definition is in keeping with 16 U.S.C. § 811.[1] This area immediately below the dam appears to have been modified during channel modification in 1927[2](Figure 3). An effective zone of passage must maintain flow velocities high enough to trigger a rheotactic response in upstream migrating fish yet lower that the sustained swimming speeds of the weakest target species (i.e., river herring). Based on published values and methodologies for estimating sustained speed and associated fatigue times (USFWS 1986, Bell, 1991, Bain, 1999, Maine DOT 2004), the zone of passage must generally maintain instantaneous velocities between 1 and 3 feet per second over the range of fish passage design flows separated only by brief regions of higher velocity that river herring may traverse in seconds at burst speeds up to 6 feet per second (e.g., flow over weir crests). Hydraulic modeling of the Project indicates that depth averaged velocities in the tailrace exceed the capabilities of these fish over a significant range of design flows. Initial investigations by the Service indicate this 5,000-foot zone of passage on the eastern bank can be created through construction of multiple placed-rock stream barbs or bendway weirs (USACOE 2007) that will reduce the impassable velocities documented by hydraulic modeling. Design of this zone of passage or equally effective alternatives must be developed in consultation with, and approved by, the U.S. Fish and Wildlife Service and the Maryland Department of Natural Resources.

Item #4 - Control turbine ramping rates during the migration period - A maximum down-ramping rate of 20,000 cfs per hour will be maintained during the upstream fish passage season.

Rapid down-ramping of turbines has shown to create fish stranding (FLA, Exhibit E, -156). Stranded fish are delayed or killed, and will not be able to pass the project in a safe and timely manner. In order to reduce fish stranding below the east side of the dam spillway the maximum rate of 20,000 cfs per hour is needed. This will also provide a longer window of desired far-field and short-field fish attraction and movement toward the powerhouse tailrace and into the areas around the fishway entrances.

Item #5 - Construct and evaluate channel modifications – The Licensee would perform in-river modifications of the channel below the dam to hydraulically link disconnected pools so that an effective egress route is provided for stranded fish.

Fish stranding in the bypass channel is a concern. As stated by Exelon, “In addition, under Exelon’s proposed alternative the current peaking operations of the Project would continue to have impacts relative to fish stranding in the Conowingo Dam spillway (Exelon 2012a, FLA E-156)”. Low flow channels and isolated pools need to be linked and a clear egress route provided to the Susquehanna River downstream in order to address the current fish stranding.

8.2.7.2 Phase II

Phase II modifications to the EFL would start in the year the WFL begins operation.
Item #1 - Construct stilling basin modifications - Increase the size and height of the sill at the stilling basin located behind the EFL hoppers. Rebuild the EFL stilling basin sill high enough so

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1 http://uscode.house.gov/view.xhtml?req=fishway&f=treesort&fq=true&num=0&hl=true&edition=prelim&granuleId =USC-prelim-title16-section811.

2 http://www.conowingolake.com/gpage4.html

that the energy from a 900 cfs flow can be appropriately dissipated, by Service standards, before being diverted and utilized as attraction flow for the EFL.

The original design for the EFL requires 900 cfs of attraction flow to achieve preferred hydraulic conditions (e.g., water velocities) inside the fish lift, and to meet Service fishway design criteria. Currently the EFL operates with only 300 cfs because of its inability to dissipate enough energy from the flow before diverting it into the fish lift.

Item #2 - Relocate existing entrance A to the EFL – Extend the entrance channel at entrance A with two 90-degree bends, to discharge into the area behind the catwalk piers and upstream from the Kaplan turbine discharge/boil. The attraction flow should be effective all along the catwalk, and through the space between the piers (USFWS 2013d).

Given the bathymetry behind the piers, and the relatively quiescent flow pattern there, the attraction flow discharging from the relocated entrance gate A would provide an expected entrance jet and create a distinct flow path that should guide migratory fish into the EFL facility. This concept is similar to what exists along the powerhouse at Safe Harbor (the most successful fish passage facility in the Susquehanna River). The new location would also keep entrance A from being drowned by the turbulent boil that is caused by the discharge from the Kaplans' draft tubes. Currently entrance A is inoperable when adjacent Kaplan units are generating.

Item #3 - Construct an Entrance D and entrance gallery for the EFL. Construct a gallery the full length of the Kaplan turbine section of the powerhouse to provide access to the new and second hopper from the Francis turbine section of the powerhouse. The new channel will be located against and along the powerhouse wall (USFWS 2013f).

The existing fish lift entrances are considered ineffective at guiding and capturing migratory fish that are being attracted and held by the false attraction flow in the center of the tailrace produced by the discharge from the turbines. The Service expects modified operations of the turbine near the gallery, in combination with the relocated entrance A, would increase the total number of migratory fish using the EFL, reduce the average time for complete passage of all available fish, and add to the overall fish passage season capacity of the Project.

Item #4 - Reconstruct Entrance B – The existing entrance B would be modified such that the centerline of the discharge plume will be at a 45 degree angle to the river flow.

Successful fishways must create hydraulic signals strong enough to attract fish to one or multiple entrances in the presence of the competing powerhouse flows (i.e., false attraction). The angled discharge is considered to have a better chance of attracting fish into the fish lift by providing an attraction jet not only downstream from the fishway, but also into zones within the Kaplan discharge. The Service expects this modification to reduce the average time for complete passage of all available fish.

8.2.7.3 Phase III

In the event that after Phase II, American shad and river herring are not passing at 80% efficiency within 36 hours and/or at a total seasonal efficiency of 85% (defined by the ratio of passage count to population estimate or determined through telemetry tagging studies) one or more of the following adaptive measures would be required by the Service after consultation with the

Licensee:

a. Daily adjustments to the instantaneous minimum flows that create low-flow periods for fish passage while maintaining overall daily average flow
b. Modified turbine operations that enhance fish passage
c. Construction of an EFL Auxiliary Water Supply (AWS) - Construct a new AWS stilling basin and system so that up to 4,325 cfs can be dissipated and incorporated into the attraction flow emanating from the multiple entrances
d. Upgrade existing fish lift equipment at the EFL so that the cycle time of every hopper is reduced to 15 minutes and the overall project capacity increased
e. Any combination of the measures listed above or other options agreed to by the Service and the Licensee

Each of these measures offers a different approach to improving fish passage. Adaptive management measures are considered necessary to meet and address any unforeseen scenarios that would result in reduced performance or an effectiveness and efficiency resulting in less than restoration goals. Future information on fish passage performance and hydraulic conditions will need to be collected, evaluated, and used in selecting adaptive measures that fit into and meet the goals of the Plan. Monitoring and effectiveness studies have shown that a majority of the American shad and river herring entering the fishways do so during periods of lower flow (FLA (2012 FLA, Exhibit E, Section 3.3 Fish Passage for Migratory Species). Operational enhancements, such as modification of turbine operations or adjustments to minimum flows, may therefore be the most cost effective way to address poor fish passage performance. Including an AWS in the EFL construction would increase the attraction flow and improve the Project's fish passage efficiency if attraction to the EFL continues to be an issue. If EFL efficiency is an issue, design and operation reviews have shown that the existing cycle time of the EFL is no faster than one lift every 20 minutes. Changing out motors, pulleys, and other parts that limit the cycle time appears to be a low cost alternative to double capacity should the lift cycle time be able to be reduced to 15 minutes or less. Finally, if ability to get to the fish passage entrances proves to be an issue, channel modifications may amend this issue

9. Preliminary Reservation of Authority to Prescribe Fishways

In order to allow for the timely implementation of fishways, including effectiveness measures, the Department proposes that it request that the Commission include the following condition in any license(s) it may issue for the Project:

Pursuant to section 18 of the Federal Power Act, the Secretary of the Interior herein exercises his authority under said Act by reserving that authority to prescribe fishways during the term of these licenses.

APPENDIX G

Water Quality Certification – Muddy Run Pumped Storage Project

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

WATER QUALITY CERTIFICATION FOR MUDDY RUN PUMPED STORAGE PROJECT AND RELATED MITIGATION FERC PROJECT NO. P-2355-018

EA 36-033 : EXELON GENERATION COMPANY, LLC ,

Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19346

Drumore, Martic and Peach Bottom Townships
York and Lancaster Countys
United States Army Corps Of Engineers, Baltimore District

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Run project not in conformity with the plans approved by the FERC shall be made to any project works constructed under the Federal Power Act without the prior approval or authorization of the FERC.

D. Resource Agencies – "Resource Agencies" shall mean the DEP, Pennsylvania Fish and Boat Commission ("PFBC"), Pennsylvania Department of Conservation and Natural Resources ("DCNR"), Susquehanna River Basin Commission ("SRBC"), Maryland Department of Natural Resources ("MDNR"), and United States Fish and Wildlife Service ("USFWS").

E. General Requirements

1. The Muddy Run project shall at all times be subject to inspection by representatives of DEP. DEP reserves the right to require such operational and structural changes as may be considered necessary to assure compliance with the Federal Water Pollution Control Act ("Clean Water Act"), the Pennsylvania Clean Streams Law, the Dam Safety and Encroachments Act, and other appropriate requirements of state law. Subject to applicable law, DEP further reserves the right to alter this certification for failure to comply with the Clean Water Act and/or appropriate requirements of the state law, an administrative order of DEP, or a term or condition of this certification.

2. Any additional information or modifications to any plans or schedules required under this certification requested by the DEP shall be submitted within the time frame established by the DEP in writing.

F. Reasonable Assurance of Compliance – DEP supports issuance of a 46 year license for the project. Because certain conditions of this certification expire in 2030, because of changes in the characteristics of the Susquehanna River that will occur

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by 2030, and because the FERC licenses for the Holtwood Hydroelectric Facility and the Safe Harbor Hydroelectric Facility expire in 2030, this certification will be revised in 2030, as necessary to address demonstrated project impacts and subject to the provisions of this certification, to establish requirements consistent with Section 401 of the Clean Water Act, 33 U.S.C Section 1341.

III. FISH PASSAGE

A. General Requirements

1. Fish Passage Operating Procedures ("FPOP")

a. By January 15, 2015, EXELON shall submit a FPOP to the DEP for review and approval. The FPOP will describe existing baseline operations during fish passage season, including schedules for routine maintenance, procedures for routine operation (including: seasonal and daily periods of operation, pump and turbine operations), sequencing of pump and turbine start-up and operation, procedures for monitoring and reporting flows, procedures for monitoring and reporting on the operation of the facility, procedures for start-up and shut-down, and procedures for use in case of emergencies and project outages significantly affecting the conditions of this certification.

b. EXELON shall implement the FPOP consistent with the approval of the DEP. EXELON shall provide written documentation to the Resource Agencies that operational

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personnel have reviewed and understand the FPOP signed by the operations manager of the Project.

c. Copies of the approved FPOP and all modifications will be provided to the Resource Agencies.

d. By December 31 of each year, EXELON shall provide an annual report to the Resource Agencies detailing: the implementation of the FPOP, including any deviations from the FPOP and a process to prevent those deviations in the future; any proposed modifications to the FPOP, or in the case of emergencies or project outages, the steps taken by EXELON to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future. EXELON shall offer to meet with the Resource Agencies by January 31 of each year unless a different date is mutually agreed upon by EXELON and the Resource Agencies. Any required modifications to the FPOP shall be submitted to the Resource Agencies within 45 days of receipt of a request for the modification unless a longer period is approved by the DEP. The modifications to the FPOP shall be implemented consistent with the approval of the DEP. In the event EXELON fails to submit the modifications as required by this paragraph, the DEP, in consultation with

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the other Resource Agencies, may establish modifications and EXELON shall implement the modifications consistent with the approval of the DEP.

B. American Shad Passage

1. Upstream Shad Passage

a. Cooperation with Holtwood. If the Holtwood Hydroelectric Facility fails to meet its Tier I upstream shad passage target described and included in the 401 Water Quality Certification for the Amended Holtwood Hydroelectric Facility, and DEP determines that EXELON's operation of the Muddy Run Project is a proximate cause of Holtwood failing to meet the Tier 1 target, EXELON shall meet with the Resource Agencies to establish and implement a plan and schedule for a radio telemetry study or equivalent (Tier II Study) of American shad passage and behavior within the Muddy Run project boundary. This meeting shall occur within one month of the DEP's determination that Holtwood failed to meet its Tier 1 upstream shad passage target or such longer time as established by the DEP in writing.

b. Evaluation of Muddy Run Shad Passage. If EXELON is a proximate cause of Holtwood's failure to meet its Tier I upstream shad passage target, EXELON shall develop a

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radio telemetry study plan and schedule or equivalent to determine: (1) the percentage of American shad that enter Muddy Run project at the northern tip of Sicily Island area and subsequently exit the Muddy Run project area at the southern tip of Deepwater Island; and (2) any delay or impedance of shad passage attributable to the redevelopment of the Holtwood Facility. EXELON shall coordinate development of this plan with the Holtwood Hydroelectric Facility and the Conowingo Hydroelectric Facility. The radio telemetry study shall be designed to insert the transmitter at the Conowingo facility or at such other location(s) approved by the DEP.

c. Within two months of the meeting described in Paragraph III.B.1.a. or such longer period approved by the DEP in writing, EXELON shall submit the fish passage study plan and schedule to the Resource Agencies for review and approval by DEP. EXELON shall implement the plan according to the schedule therein and consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the

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approval of the DEP. EXELON shall continue implementation of a fish passage study for a minimum of four years or such other time period as required by the DEP in consultation with the other Resource Agencies. EXELON shall provide an annual report of the monitoring results of the fish passage study by December 31st of each year.

d. At the end of the four-year study period, or such longer time as established by the DEP, if the results indicate that, as a result of Muddy Run operations, less than 88% of the American shad that enter the Muddy Run project waters at the northern tip of Sicily Island exit the Muddy Run project waters at the southern tip of Deepwater Island, EXELON shall propose a plan and schedule for operational modifications to enhance fish passage at the project. EXELON shall not be responsible for mitigating any impacts attributable to PPL Holtwood. This plan and schedule shall be submitted to the DEP as an amendment to the FPOP for the following year. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies,

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may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

e. The average of the two highest years in the monitoring period will be used determine whether the 88% fish passage percentage is achieved. If EXELON implements operational modifications, only those years following the operational modifications shall be considered to determine whether the 88% passage percentage is achieved.

f. If at the end of the monitoring period, or such longer time as established by the DEP, the results indicate that the operational modifications have resulted in less than 88% of the American shad that enter the Muddy Run project waters pass through the Project, EXELON shall propose a plan and schedule for mitigation, as defined in 25 Pa. Code Section 105.1 for the failure to achieve the 88% fish passage target. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the

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event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

2. Downstream Shad Passage

a. Consistent with the relicensing studies for Muddy Run, by January 15, 2015, EXELON shall submit a plan and schedule to provide for 95% survival of the juvenile American shad and 80% survival of the adult American shad that pass through the project area. The schedule shall provide for full implementation of the plan by 2015. EXELON shall implement the approved plan and schedule. If EXELON fails to submit the plan, the DEP shall develop a plan and schedule, in consultation with the other resource agencies, and EXELON shall implement that plan and schedule.

b. By February 15, 2026 or such later date approved by the DEP in writing, EXELON shall submit a plan to measure the passage of American shad moving downstream past the project to the DEP for approval ("Discrete Passage Study"). EXELON shall implement the plan to measure the passage of American shad moving downstream past the project

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according to the schedule and consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

c. EXELON shall, in accordance with the plan, conduct the Discrete Passage Study. EXELON shall provide a report of the Discrete Passage Study within 180 days of its completion or such later date approved by the DEP in writing to the Resource Agencies.

d. If the results of the Discrete Passage Study indicate that EXELON can operate the Muddy Run project so that EXELON achieves at least 95% passage of the juvenile American shad and 80 % passage of the adult American shad that pass through the project area based on the likelihood of a shad being exposed to typical pumping operations and becoming entrained, then EXELON shall incorporate into the annual FPOP any required operational measures or protocols to meet the established percentages. These procedures will be subject to review at the annual meeting for the FPOP.

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e. If the results of the Discrete Passage Study do not indicate that the project can be operated to achieve at least 95% passage of juvenile American shad and 80% passage of adult American shad based on the likelihood of a shad being exposed to typical pumping operations and becoming entrained, EXELON shall propose a plan and schedule for mitigation, as defined in 25 Pa. Code Section 105.1, for the failure to achieve the fish passage target or targets. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period or such later date approved by the DEP in writing. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

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C. Eel Passage

1. Upstream Eel Passage

The terms and conditions of the EXELON American Eel Passage Plan for the Muddy Run Pumped Storage Hydroelectric Project (P-2355-018), attached hereto as Appendix 1, are incorporated as if fully set forth herein.

2. Downstream Eel Passage

a. The trigger date for initiation of downstream eel passage studies shall be the date on which the DEP, in consultation with the other Resource Agencies, determines that available data indicates that eels are present upstream of the project or other upstream areas in numbers appropriate to require downstream eel passage. This trigger date shall not occur prior to October 1, 2026 in order for the trapping and transport program to have sufficient time to reestablish a significant eel population.

b. EXELON shall achieve at least 85% eel passage through the project area based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained.

c. Within six months of the trigger date in Paragraph (a), or such later date approved by the DEP in writing, EXELON shall submit a plan to conduct a passage study to the Resource Agencies. The plan shall be designed to demonstrate continued compliance with the 85% fish passage target. The plan shall

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include radio telemetry studies or such other studies approved by the DEP in consultation with the other Resource Agencies. EXELON shall implement the plan according to the schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

d. The study shall be initiated within 1 year of the trigger date unless a different time frame is approved by the DEP in writing. EXELON shall provide a report of the study results within 180 days of the date of completion of the study.

e. If the results of a discrete passage study indicate that EXELON can operate the project so that EXELON achieves at least 85% passage of the American eel that pass through the project area based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained, EXELON shall incorporate into the FPOP any operational measures needed to meet this percentage. These procedures will be subject to review at the annual FPOP meeting.

f. If the results of the studies do not indicate that the project can be operated to achieve at least 85% passage of American eel

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based on the likelihood of an American eel being exposed to typical pumping operations and becoming entrained, EXELON shall propose a plan and schedule for mitigation, as defined in 25 Pa. Code Section 105.1, for the failure to achieve the 85% eel passage target. This mitigation shall be: (1) in addition to the compensatory mitigation described in this certification; and (2) reasonably related and proportional to the identified impact. This plan and schedule shall be submitted to the Resource Agencies within 6 months from the end of the monitoring period or such later date approved by the DEP in writing. EXELON shall implement the plan and schedule consistent with the approval of the DEP. In the event EXELON fails to submit the plan and schedule as required by this paragraph, the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

D. Resident Fish Passage

1. Resident fish species include all fish species that occur in the Susquehanna River excluding anadromous and catadromous fish.

2. From 2015 through 2030, EXELON shall implement the mitigation measures described in Section VI to compensate for the entrainment of resident fish species.

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IV. DISSOLVED OXYGEN ("DO")

A. Dissolved Oxygen Limitation.

1. EXELON shall operate the project in such manner that it does not cause a violation of the dissolved oxygen criteria in the DEP water quality standards (currently a minimum daily average dissolved oxygen concentration of 5 mg./l. and a minimum of 4 mg./l.) at a location downstream of Muddy Run.

2. To assess compliance with Section IV. A. 1. above, EXELON shall, at DEP's request but no earlier than November 1, 2027 submit a DO monitoring plan to the DEP. The plan shall propose a plan and schedule for monitoring dissolved oxygen in the Conowingo Reservoir below the project during the months of April through September for a period sufficient to characterize the impact of the project operations on DO levels. Appropriate flow and temperature criteria suitable to trigger the two year period will be developed in consultation with DEP. Such studies will be developed after consultation with the owner of the upstream Holtwood Project such that any water quality impacts of the Muddy Run facility can be isolated. The plan shall include data collection, analysis and reporting.

3. EXELON shall implement the plan and schedule as approved by the DEP.

4. If the monitoring conducted under the plan identifies violations, defined as meeting less than 99% of the daily average or instantaneous standards (or the alternative regulatory standard in place at the time of the study), resulting from operation of the project, EXELON shall, within 30 days, consult with the DEP and within 90 days submit a plan to resolve any DO violations resulting from operation of the project.

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5. In the event EXELON fails to submit the DO monitoring plan as required bySection IV. A. 2., the DEP, in consultation with the other Resource Agencies, may establish a plan and EXELON shall implement the plan consistent with the approval of DEP.

V. ENDANGERED SPECIES AND SPECIES OF SPECIAL CONCERN

A. Once every 10 years throughout the term of the license or such longer period approved by the DEP in writing, EXELON shall conduct an evaluation of all state and federal endangered or threatened species that may be present within the project boundary.

B. Where that evaluation identifies the presence, critical habitat, or critical dependence of endangered species, EXELON shall propose a plan and schedule to the Resource Agencies to ensure protection of the endangered or threatened species within 180 days from completing the evaluation. EXELON shall implement the plan and schedule as approved by the DEP.

C. In the event EXELON fails to submit the plan and schedule as required by Section V. B., the DEP, in consultation with the other Resource Agencies, may establish a plan and schedule and EXELON shall implement that plan and schedule consistent with the approval of the DEP.

VI. COMPENSATORY MITIGATION

A. Habitat Improvement Projects

1. By October 1 of each year from 2014 through 2030, EXELON shall provide a total of FIVE HUNDRED THOUSAND DOLLARS ($500,000.00) annually in compensatory mitigation to the Lancaster County Conservation District

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("LCCD"), the York County Conservation District ("YCCD") and the PFBC, or to such other conservation district, resource agency or 501(c)(3) organization as directed by the DEP, for the implementation of agricultural pasture and barnyard best management practices to address sediment introduction and other habitat improvement projects including small dam removals ("HIPs").

2. This annual compensatory mitigation shall be by corporate checks, or the like, one made payable to the LCCD in the amount of TWO HUNDRED TWENTY FIVE THOUSAND DOLLARS ($225,000.00), one made payable to the YCCD in the amount of TWO HUNDRED TWENTY FIVE THOUSAND DOLLARS ($225,000.00) and one made payable to the PFBC in the amount of FIFTY THOUSAND DOLLARS ($50,000.00) for HIP funding in Lancaster or York Counties or in such other combination or to such other entities as the PADEP shall direct. In addition, by March 1, 2014, EXELON shall provide a total FIFTY THOUSAND DOLLARS ($50,000) to the PFBC to be used for HIPs in Lancaster and York Counties. EXELON and DEP shall receive from LCCD, YCCD and PFBC an annual accounting of fund expenditures. The funds shall be deposited by the LCCD, the YCCD and the PFBC into a special non-lapsing interest bearing account established and to be used only for the HIPs required by this Water Quality Certification ("Exelon HIP Funds"). Funds provided to the PFBC shall be used solely for dam removal projects.

DEP shall ensure that each project proposed by the LCCD, the YCCD and the PFBC shall be submitted to the DEP South-central Regional Office Waterways and Wetlands Program Manager, or the successor position, for approval. No single project shall receive more than $75,000.00 in compensatory mitigation funding from the Exelon

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HIP Fund. Funding priority shall be given for projects that include stream forested buffers of at least 50 feet in width and wetland creation projects. Project funding shall not include any indirect administrative costs and, except where specifically authorized by the DEP, shall not include direct administrative costs. In no case shall direct administrative costs be greater than 5% of the project funding. At EXELON's option, and subject to land owner approval, for each project signage shall be displayed acknowledging EXELON's funding of the habitat improvement.

B. **Flow Modeling**

EXELON shall provide the version of the Lower Susquehanna River OASIS Model to the Susquehanna River Basin Commission as provided in the "Letter Agreement Addressing Exelon's Provision of an OASIS Model to SRBC" dated November 19, 2013 and attached to this certification as Appendix 2.

6-3-14

Scott Williamson Date
Program Manager
Waterways and Wetlands Program